Tracing evolutions of water control in Wadi Siham, Yemen

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Tracing evolutions of water control in Wadi Siham, Tihama, Yemen

Master Thesis Irrigation and Water Engineering submitted in partial fulfilment of the degree of Master of Science in International Land and Water Management at Wageningen University, the Netherlands

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Preface

First of all we would like to express our joy for having been able to visit and to do our research in such a beautiful and rich country both from the human and natural point of view!
The fact that working and travelling in Yemen, today, is not as straightforward as in other countries, made this experience even more precious to us.

Therefore, we would like to thank very much the persons that gave us this idea and made its concretisation possible.

Thank you Leni you triggered out interest in Yemen! Thank you very much Frank as you introduced us to spate irrigation and put us in contact with TGH!

Merci beaucoup Lionel, Nicolas, Regis, Quentin, Zinedine and all the staff of TGH for your warm welcoming in Hodeidah! Although our methodology is not the very reflection of the "diagnostique agraire", we did our best to catch up some very useful comments you gave us during our continuous exchanges. We keep in memory with a smile the time and the weekends spent together! A special merci beaucoup to Pierre and Eve for the leisure in Ta'zz and the cultural trainings!

Shokran gazilan gazilan to our translators, Maria and Abdallah, who tried hard to reproduce in Arabic our struggles to understand the context. Thank you Abdulbaset for the patience and the Arabic lessons' attempt! Shokran to the drivers and Mohammad, we will never forget the songs and the keys locked in the car in the middle of the wadi! Thank you girls, Hannan, Shaima, Raja, Sara, Negla and Aline for the henna, the shopping, the dinners, for the many things you transmitted us, we will keep in touch!

We also would like to thank very much TDA staff that has been very helpful with materials, their time, and tours in the wadi!

Thank you very much to all our informants both in the wadi and outside. They have played the central role in informing us about Wadi Siham and have proved the greatest patience always responding to our hammering questions.

Thank you very much to our supervisors in Wageningen, Linden and Bert that with a "couple of hints" materialised infinite and immense paths in front of us. Always very useful!

Last but not least, this thesis is the outcome of almost two years of friendship and shoulder-to-shoulder collaboration. We really hope that this will create the basis of a more solid professional and good-humoured relationship…and one day, who knows, C&L may become the logo of our consultancy company!

Acronyms

BIS	Barquqa Irrigation System
CAC	Cooperative of Agricultural Credits
DIS	Debashya Irrigation System
EC	European Commission
KFAED	Kuwait Fund for Arab Economic Development
KIS	Khalifa Irrigation System
IIP	Irrigation Improvement Project
LC	Local Council
MAI	Ministry of Agriculture and Irrigation
MoU	Memorandum of Understanding
NWRA	National Water Resource Authority
TDA	Tihama Development Authority
TGH	Triangle Generation Humanitaire
WB	World Bank
WIS	Waqir Irrigation System
WSIP	Wadi Siham Irrigation Project
WUA	Water User Association
YR	Yemeni Ryal (200 YR= 1 US$)

Executive Summary

This thesis is the outcome of a field research conducted in Wadi Siham, Yemen, in collaboration with the NGO TriangleGH. Given the wadi's relatively recent and rapid history of both rural development and spate interventions, it was one of the least studied wadis in the Tihama plain. This research also contributes to both the unravelling the various components of the wadi's water management and the enriching of the scant body of knowledge on current organisational and operational practices in spate irrigation context after the introduction of controlled irrigation systems.

Hence, this thesis sets out to trace changes in water control and access with a particular focus on the role that the recent irrigation interventions (1995-still in progress) played in this processes of change. Furthermore, it intends to highlight constraints and opportunities and to draft recommendations for a sustainable and more equitable water management.

After a brief overview of the institutional, hydrological, and infrastructural stage of Wadi Siham in Chapter 2, this thesis is structured around three case studies, each analysing one specific locale of the wadi. Chapter 3 describes the conditions that once ensured an efficient irrigation, the cases for its demise. As a response to increasing water scarcity, some farmers that have lost access to spates after the introduction of the new canals adopt new discourses of organisational models (WUA), not so much to fulfil the WUA's general mandate, but rather as a means to appeal to the government and the international agencies for funding and support.

Chapter 4 describes a different situation. In the upstream parts of the wadi, Barquqa, traditionally the area was characterised by individual organisations that only cooperated for the division of a water source that has now disappeared, the spring flow. There, leaders were chosen by the TDA to represent other farmers in a new WUA. What happened in practice is that they influenced the implementation of the project, through which their infrastructure was improved and long-term support for maintenance. However, theirs is a skeleton organisation. Water management practices have turned back to an individual type shortly after the completion of the project.

Finally, chapter 5 describes the present construction of the last irrigation system in Khalifa. The area, currently a live theatre of interaction between the old and the new, presents itself for assessments of both the intervention process and the reactions and conflicts that arise in its within. A legitimate and overarching authority seems to be required to coordinate all the powerful interest of many landlords.

The present thesis concludes that the Wadi Siham Irrigation Project exacerbated, not initiated, a preferential water allocation in Barquqa, to the detriment of the rest of the wadi. In addition, nowadays Wadi Siham appears more of a technically and hydrologically interconnected unit than in the past, but there remains a serious operational and organisational discontinuity. Finally, in Wadi Siham, developments and evolutions of water control entail a strong political component that dictated the rate of and the means for success of the various actors.

1 Introduction

Spate irrigation is a type of water management that is unique to semi-arid environments. It is found in the Middle East, North Africa, West Asia, East Africa, and parts of Latin America. Floodwater from mountain catchments is diverted from riverbeds (*wadi*) and spread over large areas. Given the unpredictable nature of the floods and the frequent changes of the riverbeds from which the water is diverted, spate systems are very risk-prone. Spate irrigation, being an ancient type of water management, over the years substantial local wisdom has developed in organising spate systems and managing the floodwater, the heavy sediment loads that come with it, and generally also the conjunctive use of water – surface and groundwater (Steenbergen, 1997). Often the poorest segments of the rural population depend on spate flows for their livelihoods. Nevertheless, in order to cope with the variable and uncertain nature of spate flows, in a spate system people usually develop specific livelihood strategies that include the differentiation of income sources.

This thesis investigates spate water access and management in Wadi Siham, Tihama plain, Yemen (see Figure 1.1). It sets out to explore both threats and opportunities that arose from irrigation interventions, which were expected to improve flood-dependent irrigated agriculture, and farmers responses to them. It hopes to provide learning for the future through detailed case studies of the various areas where the four irrigation interventions have been implemented in Wadi Siham. It is the outcome of a collaboration with the French NGO Triangle Generation Humanitaire (TGH), which has been operating in Yemen for ten years and entered the wadi in 2008, as part of the EC "Integrated food security project in Wadi Siham"[1].

The Tihama plain has a very old tradition of spate irrigation. In 1970s, the Ministry of Agriculture and Irrigation began to realise that the poor use of available water resources was a major constraint for the agricultural development of the Tihama region. On the one hand, traditional spate irrigation systems came to be regarded as highly inefficient. On the other, the groundwater table began dropping at a fast pace after the introduction of motor pumps and has become a particular concern since the end of the 1970s. In other words, new agricultural polices needed to be implemented. Therefore, aided by foreign funding, the State became involved in extensive civil engineering interventions for "improving" existing spate irrigation systems, particularly in the Tihama plain. These became supervised by the Tihama Development Authority (TDA), the regional representative of the Ministry of Agriculture and Irrigation (MAI). From the end of 1970s, the "Irrigation Improvement Project" (IIP), a systematic single-wadi development that would eventually intervene in all wadis of the Tihama plain, began the restoration of several large spate irrigation systems (Wadi Rima, Wadi Zabib, and Wadi Mawr) and continued throughout 1990s and 2000s in Wadi Siham. The main purpose of these interventions was to increase agricultural productivity to boost the national economy. Within the Wadi Siham Project (WSIP), three new irrigation systems –

[1] Their project (2008-2012) has the overall objective to improve the food security status of vulnerable groups in the target area by contributing to improved food consumption and health status of targeted communities through integrated services. In this consortium, TGH is in charge of the improvement of both production and economic activities of the local population whilst AMI is responsible of the health education and creating new or improving old health posts.

In order to achieve these objectives, TGH's activities cover:

- Supporting existing coping mechanisms: Improving of the knowledge and practices (Agriculture, irrigation and livestock)
- Capacity building: Creating and/or strengthening collective organisation of farmers (Agriculture, irrigation and livestock)
- Involving farmers in the exchange and share of their knowledge with farmers from others villages.

Waqir Irrigation System (WIS), Barquqa Irrigation System (BIS), and Debashya Irrigation System (DIS)- have been already completed, while the fourth, Khalifa Irrigation System (KIS) is still under construction.

Nowadays, the main trend promoted by the Irrigation Improvement Project of the MAI for improving irrigation performance and cost alleviation is to return the system, or part of it, to users, along with the creation of WUAs (Spate Irrigation Network 2008). Also in Wadi Siham, a WUA has been recently introduced for maintenance and water distribution of lower system's levels of the upstream areas (Barquqa and Khalifa).

1. Initial concerns

Spate irrigation has been a focus of state intervention since the 1970s. Yet, most times, these interventions do not appear very successful: even so, little studies clarify *why* they fail *en mass*. When browsing the literature, a general idea that we gained through initial researches was that irrigation interventions entailed a process that violently disrupted the "indigenous", "egalitarian", and "functioning" pre-intervention agrarian equilibriums. This dichotomous perspective, so clearly biased against irrigation interventions, seems to us to discard the possibility that within this "traditional" world there may already have existed paradigms of agricultural development alternative to the subsistence one. Also these may have not always been compatible with each other and at times even conflicting, and some of those may consciously have been co-opting the state intention to promote commercial agriculture. In other words, over-emphasis of the role and impact of state interventions in shaping the daily livelihood struggles for the state subjects is limited, in so far as it excludes not only the receivers' agency, knowledge, and capability to react from its discourse, but also their independent pre-intervention evolutions (Bolding 2004).

When we first searched literature on the irrigation interventions in Wadi Siham, this vision seemed to be confirmed once again. TGH's terms of references for our research and their 2008 reports on the wadi constituted our main source of information about the actual agronomic and water management situation in Wadi Siham, after the implementation of the four "improved" irrigation systems. According to TGH, the irrigation interventions provoked a redistribution of water upstream, where big landlords growing mangoes have access to the water, whilst forcing several downstream areas to turn to rainfed agriculture. Additionally, these reports state that acquiescence of governmental agency responsible for the new structures was partly to blame for this redistribution of the water. What we felt it was missing was a focus on the situation before these interventions that would better substantiate the above statements of change.

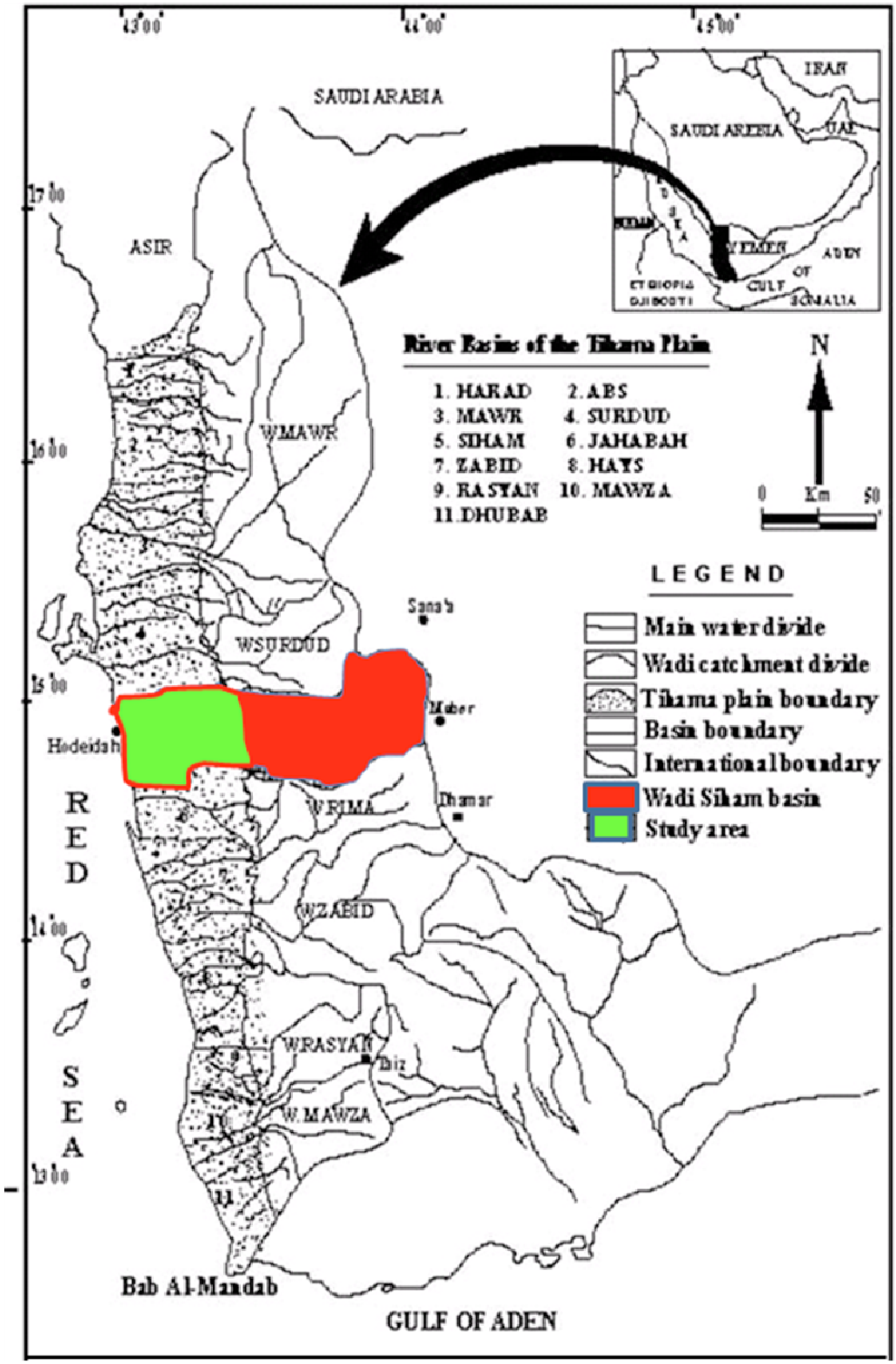

Figure 1.1 Tihama Plain and Wadi Siham

1.1 Problem statement

Despite its ancient origins, spate irrigation remains largely unexplored[2] in academic circles. The scant past literature and studies, primarily by anthropologists, were mainly concerned about traditional structures and institutions of spate water management. However, there is still little data on larger "improved" spate irrigation systems with permanent structures. The few existing studies are generally of a technical nature, where current spate irrigation practices and organisational arrangements are largely overlooked. Particularly, little is known about how the new infrastructure and its management interacted with existing spate irrigation networks. Wadi Siham too, with its relatively recent and rapid history of both rural development and spate interventions, was only marginally studied. TGH's reports, which constituted our initial framework for both approaching the wadi and understanding the impacts of the spate irrigation interventions, provided us with a quite dramatic picture with well/defined boundaries. This triggered our interest to investigate the underlying causes of the wadi's present water management reality.

1.2 Research objective

Rather than considering the impacts of the irrigation intervention as impinging on a passively receiving, "traditional" context, we deemed it indispensable to pull to the fore what water management practices were present in the wadi before the interventions and how they interacted with and affected by, and how the project was appropriated. Whilst past reports on the wadi had directed our full attention to the new irrigation structures, in our preliminary assessment, we realised that the wadi was scattered with several traditional barriers and canals, which differed in size, location, period of construction, and creating the present situation of water management in Wadi Siham through a sound understanding of why these structures and out of what context. Additionally, since in the near future TGH also plan a project to strengthen current water management, they specifically asked us to clarify the impacts of the four new irrigation systems within the WSIP on local water access and to highlight opportunities for collective water management. This became the second objective of our research.

Hence, this study aims at understanding the problems water users were confronted with by this transformation of irrigation infrastructure, how they responded, and in what ways they tried to appropriate the new system. This research will devote special attention to the analysis of the relationships between the irrigation infrastructures *versus* local water management *versus* the various support organisations.

[2] Which according to some experts "may be a blessing, as it allows us to learn from actual experience in actual places" (Van Steenbergen 2007)

1.6 Conceptual Framework

As mentioned in the introduction, our research needed to move away from a static perception of the wadi as a homogeneous receiving context of state intervention and instead argue its dynamism, in both past developments and present circumstances. Specifically, we want to move away from the over-rating of the role and impact of state interventions in "shaping the daily livelihood struggles of the state subjects" (Bolding, 2004:4) and instead characterise their impact through a study of the interactions and compromises at local level, between local level(s) and the implementers, and within/between the state and donor agencies.

1.6.1 Political ecology

Political ecology is a "powerful framework for integrating natural and social dynamics" (Crifasi, 2002). It provides insights into these human motivations behind actions that take shape on the ground and that alter the environment. Its focus on system dynamics, scale, and cross-scale interactions suits well our purpose to assess the ever-changing wadi context. Political ecologists argue that societies constantly reshape their environment in a way that reflects not only the technology available but also their conception of nature, the labour or the capital they can mobilise, and the distribution of power and agency which defines who can take decisions on how to control, use, and share water (Molle, 2007:358). Conversely, environmental change brought about by water-related human activities and shaped by particular ecological and physical conditions will impact back onto societies, often in a negative way, affecting particular areas or social groups (Greenberg and Park, 1994). As such, political ecology provides a sound framework to gain an understanding on water resources management (Crifasi, 2002).

1.6.2 Irrigation intervention as improvement of existing irrigation practices

In 1989, Coward and Levine write that intervention improvement anticipates significant changes in the ability to control and distribute water and potentially changes in rule for allocation. Occasionally but not universally, there will be increase in the basic supply and as a result, extension in irrigated areas and number of irrigators. In addition, there is a typical increase use in steel and concrete, revisions expected for irrigation schedules to allow greater response to production opportunities and developments of water users association (Coward & Levine, 1989:10). Moreover, in certain cases, intervention will also lead to land consolidation.

In the modernisation[3] of irrigation systems, especially where external donors and lenders are involved, the equity "rule" that underlies system modernisation is equality in meeting crop water needs, often according to a cropping pattern specified (idem:5). In these contexts, equity from the perspective of the farmers is rarely explicitly recognised or considered in the planning, implementation, and maintenance of the systems.

Since in our eyes this definition best suited the process of "modernisation" in our research area, we decided to interpret the WSIP as a broader attempt to promote (even further) the commoditisation of agriculture. It represents a strategy in which, through *improvement* of existing irrigation schemes, "traditional systems are further mobilised to contribute to national goals" (Eggink and J.Ubels, 1984:184).

[3] In this thesis, whenever we utilise the term "modernisation", we attach to it a more general connotation than recent discussions on it (see PLUSQUELLEC, H., BURTH, C. & WOLTER, H. W. (1994) Modern water control in irrigation: Concepts, issues, and applications. *World Bank Technical Papers 246,116.*, World Bank.). For us, it refers to a general package of "improved" elements that is less drastically connected to specific CWR and exact maximisation of the water supplied.

Spate irrigation systems may vary greatly in their hydrology and water management. Yet, they also often share forms of adaptation in "infrastructure, water rights, and governance mechanisms", hence we group them under the following two specimens: uncontrolled and controlled spate irrigation systems. Most traditional systems are "uncontrolled, without permanent structure at the headworks or within the system to control water and sediment flow" and managed by farmers. Controlled systems have permanent structures that give greater diversion and control capabilities, are usually much larger than uncontrolled ones, and are managed by a public agency, which directs their operations and management at primary level. (Lackner and Vincent, 1998:1).

In line with the socio-technical network of relations between actors, technology, and nature (water-networks) that we made our lenses for this research, we have utilised Bolding's definition of (state) *intervention* as "a measure to evoke a change in the ordering practices of social actors, artefacts, and natural elements by pursuing a model of how these three categories of actors might interrelate in a new way" (Bolding, 2004:16). Underlying this definition there are particular notions of human agency, which make the outcome of an intervention "contingent and only partly attributable to the original intervention" (Bolding, 2004:17). Thus, once again this adds to our effort to penetrate the wadi as a dynamic context with its own rationales that determine the final outcome of the WSIP's intervention.

These two archetypical systems, controlled and uncontrolled, are characterised by different organisational requirements and water distribution practices, more flexible and (theoretically) less reliable in the uncontrolled systems due to the nature of their headwork. Gates are often the most striking innovation of controlled systems and that around which more negotiations and compromise occur. This is particularly the case when the two infrastructures cross each other, as generally the controlled system tries to impose its social requirements of use on the previous existing ones. Thus, the physical link creates an intersection of interests, which generally leads to fast reactions and responses on part of water users against the implementing agency, usually the State. Interactions can also concern the organisational nature of one or more water-networks. Reaction and interventions are therefore processes that develop within a specific context, and as such we will interpret them in this thesis.

1.6.3 Irrigation as a social force

Eggink and Ubels (1984) perceive irrigation as a social force. Irrigation is looked at as an important means of production around which communities revolve and evolve. This allows for an exploration of how processes logical to internal dynamics of older systems may transform or disappear, as they are incorporated into a larger scheme. In order to become operational, irrigation must be reproduced through social organisation for operation, maintenance, and rules for water distribution. Eggink and Ubels' approach proposes an analytical framework for understanding the transformation of peasant society under the influence of the expansion of the commercial economy and government intervention (idem:118).

Hence, this concept will direct our analysis of agrarian changes in the wadi from a broader perspective of social variation. First, what typology of farmers managed to appropriate first the new paradigm of cash crops, new irrigation technology, and credits for agricultural developments. Second how this shapes and is constructed by social change at the national level, which in turn is bound to impact water users' choices and possibilities to access these new opportunities. The extent to which some can access changing opportunities better than others highlights certain power issues within the wadi context.

1.6.4 Water-networks and water control

As our unit of analysis we will utilise Zaag & Bolding's concept of water-networks: "a network of human and non human actors [that] emerges around water use" (Zaag et al., 2001:257). Networks are recursive and emergent forms: they cover different spaces and time, exist under constant making and re-making relations need to be performed repetitively or networks will fall apart), and produce different outcomes in terms of agricultural productivity, environmental sustainability, and social equity. In other words, water-networks are "the outcome of strategic action where actors use whatever is deployable in their bid to secure water" (Zaag et al., 2001:272).

The various typologies of irrigation technology are the first element that one encounters when arriving in Wadi Siham. By reconstructing the history of each irrigation artefact, one is able to extrapolate its function, both for controlling land use and people through the diversion of water (*social construction of technology*), its *modus operandi*, or the human and physical resources needed to achieve it (*social requirement for use*), and the effects that it has on the people and the environment around it (*social effects*) (Mollinga 1998). These are indivisible elements, whose coordination ensures the functioning of a certain technology. For instance, an irrigation artefact exists because of the need to irrigate a certain area and functions because farmers there are willing to collaborate for its maintenance, as they know that as a result, they will irrigate and eventually harvest a better yield. Once one or several of these links in the chain ceases to be applicable, an irrigation structure may decay. This may suggest either that it no longer serves the use it was constructed for (e.g. changing land use, changing hydrology, migration) or actors can no longer maintain it, for reasons that may be detached from irrigation management activities. Water-networks are comprised of relations that are not intrinsically coherent and may indeed contain conflict: by adopting the concept of "water control" as a further tool to our research, we will understand why each network takes the shape that it does.

The concept of water control suits this purpose. According to Bolding's definition, water control has three dimensions: physical control over water flows by means of canals, pipes, dams, and other means; organisational control over the people operating the infrastructural devices and finally, socio-political control over the effects and modes of organisation that emerge around water use (Bolding, 2004:117; see (Mollinga, 1998 for more details). In short, water control implies the human utilisation of a certain technology for water appropriation to suit a specific type of land use. Each of these three elements describes one feature of the practice of irrigation: only by considering them together, one can extrapolate the whole picture. Conversely, one of these factors cannot change without impacting the other two.

A water-network approach is interested in exploring how these networks materialise, hold themselves together and fall apart: what particular conditions are in place through time which enables their dynamic evolution. Water-networks thrive within changing political, agrarian, and agro-economic environments that often lie beyond their control. It is necessary for an understanding of the wadi's changing internal dynamics to approach them also as part of an evolving context that, in a way or another, impacts on the choices of its actors, the state of natural resources, and technological options. Practices of actors are therefore largely shaped by physical and other (social and institutional) resources available to them.

Around a given water source, various *water-networks* can coexist and their interaction and evolutions can be minimum, reinforce one another, or negatively impact each other. The interaction can be physical (one crosses the other or one's water diversion reduces another's water availability), and organisational (one overarching institution dictates the rules and, at least officially, supervises their implementation). To note here, these interactions not only occur at network level, but also

within each network, and this also affects the wadi's water management developments. We will discuss this further in the section on water control.

By stressing the interactions between and within them, we want to highlight what the evolution of each water-network can explain of the nature and outcomes of their actors' reactions, which arise when it has to interact with other networks. In other words, why, despite similar inputs, different outcomes may characterise different areas. The identification and explanation of these dynamics is a crucial factor for our final classification of management possibilities and potentialities to ensure the sustainability of new infrastructural realities in the wadi.

More specifically, within and between water-networks, we will investigate certain irrigation practices, namely appropriation (the physical ability to divert water through an infrastructure), resource mobilisation (those human, physical, political resources and strategies necessary for organisational activities), maintenance (why some artefacts are better maintained than others and what this tell us about agrarian relations and social change in the wadi), and distribution (water delivery on the fields, to highlight who finally receives water and who is excluded).

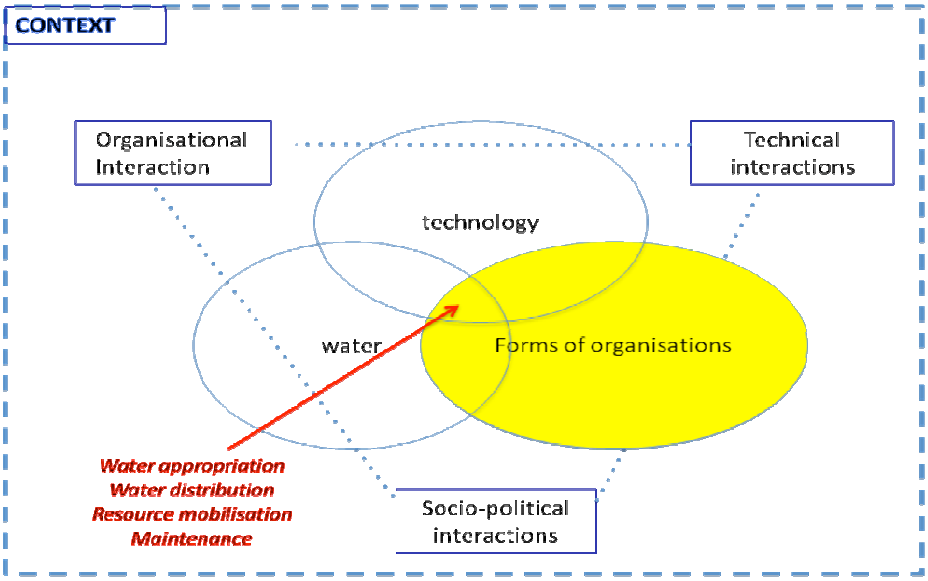

Figure 1.2 Water control in Wadi Siham

These practices, given both the different water network's context and not least, the characteristics of its infrastructure, can be either more collectively or individually organised. The extent to which collective action is embedded dictates also the type of water rights. Boelens defines *collective rights* as "the demands on water use by the organisation of users in an irrigation system, vis-à-vis other persons (individuals or collectives), whose interest may collide with their own. These rights also determine the collective forms and conditions for access to the water source. Conversely, *individual water rights* are..." inside each system, establishing relations for access to water among the different users and their respective rights and obligations" (Beccar et al., 2002:3). Individual and collective rights assume different connotations and evolutions according to the scale one considers them from.

Irrigation interventions, through the development of new infrastructure, modify water distribution patterns and irrigation practices – in other words, water rights. Whenever they take full charge of the construction works, their challenge is to recognise that the local normative framework (water rights) derives from the very collective construction of the artefacts. Since this also links "the irrigators with the driver of collective action in irrigation management" (Beccar et al., 2002:11), an

external intervention, both technical and organisational (WUA), should set clear obligations and benefits for the water users of the new systems, that should be in harmony with pre-existing practices. Otherwise, if an organisation is created with the sole purpose to discipline and control, users may soon lose interest in cooperating – even when they are traditionally used to collective organisational forms.

In other words, if implementers neglect the importance of the process of formation of the WUA, its actual structure, and the relationship between the Executive Board and the other water users, it may occur that power concentrates only in the hands of the former that monopolises access to – and control over- resources. A bureaucratic transition is coming in with certain models of organisation and materialization of rights – which often only cover what (Ostrom, 1992) defines as *constitutional-choice rules* and *collective-choice rules,* but they do not really embed necessary power for day-to-day irrigation activities, such as operations and conflict resolution (*operational rules*)

1.6.5 Mimicry and the struggle for water

Often, irrigation intervention projects come with ideas of standard organisational structures. Recently, these have been focused on formalised Water Users Associations (WUAs) usually to be in charge of operation and maintenance of the secondary and lower levels of the new systems. These tactics of water governance generally rest not just "on formal laws and official administration but on precise ways in which water users and water users' collectives become subjected and engaged in government politics" (Boelens, 2008: 40). The way in which water users themselves respond to this organisational imposition, to resist what often is its unresponsiveness to local needs of water control, and appropriate these discourses to their own advantage – e.g. to regain lost water rights or water access - will play an important part in the thesis to follow.

We will utilise the developmental mimicry[4] concept in the analysis of why water users' groups at times support new organisational models and regulations that do not necessarily correspond to their irrigation practices, neither are these new norms their prime objective *per se* (idem: 41).

1.6.6 Human agency and power

Although technology, nature, and actors are closely intertwined, the last feature deserves a special mention, as their agency creates specific patterns of actions and interactions that determine the evolution of a given water network. When, whatever the motives, someone takes the individual initiative to leave one of these networks in search for space and water somewhere else, s/he distorts not only the "equilibrium" that is left but also the new one where s/he migrates to!

In short, actors possess agency, which becomes evident in their actions and interactions with other actors and the environment:

> *"[…] people are knowledgeable and capable actors. They are active players in creating new social and material environments, even when they have to operate within a context*

[4] A direct application of the biological concept of mimicry, that occurs when a group of organisms, the *mimics*, have evolved to share common perceived characteristics with another group, the *models*, through the selective action of a *signal-receiver* or *dupe*. Collectively this is known as a *mimicry complex*. The model is usually another species except in cases of automimicry. The signal-receiver is typically another intermediate organism like the common predator of two species [...]

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that is only partially of their own making, and with motivations that are only partly conscious."

(Giddens 1976 in Mollinga 1998:29)

One of the first assumptions of the concept of irrigation as social force is that, in irrigated agriculture, not only power over land, but also power over water-distribution is a determinant of local social relations of production. Hence, power remains the concept that unifies the three dimensions of water control and as such, it plays a key role in the explanation of change. According to Giddens,

Power, in the narrower relational sense is a property of interactions and may be defined as the capability to secure outcomes where the realisation of these outcomes depends on the agency of others. It is in this sense that men have power over others. This is power as domination.

(Giddens, 1966 in Mollinga, 1998:29)

Overall, those with power may reach to further domains of interactions[5] than those without, and thus access supplementary sources for the achievement of their objective. For instance, they may access arenas of development where artefacts are being conceived. Yet there are different levels of power that determine the rate of success of the "powerful" ones, which are shaped by interactions with other groups within or without one's own domain of interaction. For instance, some gain a more localised type of power, which must be legitimated by local water-users and depends on them for its persistence, others may be very powerful in the national political context and utilise their extensive financial means to buy land and their social network to attract project to the area, or to appeal to the right authority in times of crisis.

As it appears, these domains of interactions may be found also outside the wadi and even detached from irrigation *per se.* Often the local elite appears in new institutional endeavours. They exploit the (generally) fragmented nature of institutions involved and/or created by state intervention, drawing on those that suit them the most and ignore the rest. Thus, these new organisational forms become a resource in itself. Our thesis will discuss who is able to appropriate them and on what basis: Ubels suggests how irrigation leadership will become more interesting for higher classes in local societies, when they are able to deploy agricultural surpluses for their own gains. Also transforming local political context often raises individuals' interest in new organisational forms to access resources. In turn, political actors may become interested in new water organisations as a key forum for local political parties (Khanal, 2003).

Being very closely linked to human agency, power is a dynamic concept, and it is very much determined by the way one appropriates various discourses in order to protect, increase, and establish ones status –which in turn will allow one to obtain her/his wanted outcome. In situations of water scarcity, power relationship emerge more visibly, as it becomes more obvious who can still receive spate water and who has the means to switch to another source of water (e.g. groundwater). Nevertheless, although power often enables its carriers' achievement of their objectives, sometimes it is helpless before sudden externalities, such as for instance the occurrence of a severe drought.

[5] Arenas and domains of interaction are the locales where the various interests are shaped, coincide –and collide (Mollinga, 1998). There, colonisation of a new space and the appropriation of water may be negotiated and fought over. New discourses –which reflect broader contextual changes (institutional socio-economic, agrarian) - gain ground, new initiatives are conceived, gain support, or collapse, and alliances forged or broken. For instance, a positive exchange of words-of-mouths may lead to the adaptation of new crops in a short period. Their scope may vary from local, national, international levels. Not only between the various levels, but even within the same boundaries, various arenas may coexist, interact, and seek opportunities.

1.6.7 Water scarcity

Water scarcity suggests a "state of immediate or impending crisis resulting from an inadequate water supply to meet the varied demands of humans and their environments" (Johnston, 2003:74).

In a spate irrigation system, the ephemeral nature of the floods plays a crucial role for many reasons. First, the variable probability of receiving spates (Steenbergen, 1997) is also an important factor because it introduces the theme of inequality of water distribution. This is often echoed by a differentiation in types of landowners and their locations: generally, those who have enough means settle in upstream areas, where uncertainty of irrigation is sharply reduced. Expectations of failure of a flood shape institutions for water management, as they affect water users' willingness to collaborate and contribute in the construction and willingness of the irrigation infrastructures.

Water scarcity not only reflects the relative aspects of supply and demand, but also the relative aspects of "how water is valued [culturally and economically], relative levels of access and patterns of use, and the relative degrees of control over water resource management and distribution" (Johnston, 2003:74). Uphoff et al. (1990) underline the relation between water-availability and the organisation of decision-making in irrigation management. They notice that farmers' interest in irrigation management is intrinsically correlated to water availability. Hence, they differentiate between relative and absolute water scarcity, and water abundance.

Briefly, when water is either abundant or too scarce, there is no incentive for farmers to engage in collective irrigation management: in the former, it can occur that management practices are restricted to some maintenance as there is no need for constant accountability of each; in the latter, especially where the power differential between farmers sets different access conditions, payoffs for farmers' engagement in collective action would be too low, and this creates a more individualistic situation. In this case only a very strong man –with violence – may succeed to control water management. On the one hand, in times of relative water scarcity, it is more worthwhile for farmers to become involved in allocation and management as this provides them with the much required information inputs and negotiation power to secure more appropriate distributional responses to localised and changing conditions within a given time period (Uphoff et al., 1990:16). In a situation of relative water scarcity, whenever water users may not supply the means necessary for their re-appropriation of the water resource, they may approach carriers of more powerful discourses located in higher domains that may help reach their objective. Once again, water scarcity's perceptions and scope for reaction is bounded to power.

Although this concept will help explain the various developments of forms of water management organisations in the wadi, (Mehta, 2007) discusses relative water scarcity not only in terms of individual or collective organisation. Also and more specifically she debates how water scarcity can be shaped and "manufactured", by choices around technologies, institutions, and politics that influence inclusion/exclusion processes and drive specific reactions (for instance, the mimicry phenomenon that we discussed above). Without belittling serious ecological crisis around water, food, and land, in some instances, she believes that absolute water scarcity exists more rarely than it is commonly believed: often it is rather a socio-political construct to suit the interests of powerful players, which obscures the fact that generally there is a highly differentiated control over land and water (Mehta, 207:661). The author investigates social mediation of water scarcity and its connection to socio-political and institutional processes. Finally, in line with political ecology, she also locates water rights within a wider historical, cultural, and socio-political processes. Altogether, this opens a debate on who is de facto able to appropriate water through which institutional paradigms, and on what basis. Hence, she warns against intervention processes that assume an unitary model of the receiving context. A "unitary model" treats a social institution comprising multiple individuals as though it behaves as a single entity, by assuming that all

members have common objectives, and that they pool their resources (Alderman et al., 1995 February).

1.6.8 Space and Time

The "space and time" dimensions are two major criteria that set the level(s) and nature(s) of various interaction patterns of water networks, and their developments. Borrowing Carlstein's words:

> *Any region when studied in continuous time can be looked upon as an open but delimited time-space region, which contains society and habitat, population and resources. Over the years, such a time-space region is affected by innovations which contribute to structural change of the socio*-[techno]-*environmental sub-systems.*
>
> (Carlstein et al., 1978:146)

Building on Carlstein's idea of innovations, we want to argue that each *water-network* emerges in certain time-space locations. On the one hand, the spatial distribution of the various water-networks can help reveal connections between irrigation, social change, and natural resources. On the other, the tracking of their spatial evolution through time is essential to explain why a certain infrastructure emerged in a specific period and how it evolved from there. Indeed, there must occur a synchronisation of factors that allow the materialisation of a structure, namely the right balance between what its initiators (actors) want, the availability of both resources to utilise and technology to mediate the link between the two.

Hence, addressing the specificity of each water-network is a necessary criterion to the understanding of the interdependence between such diverse networks, of how they promote or bar each other, and of how they interact among themselves and with the environment in which they are integrated.

Concluding, knowing the past helps us understand the present and can contribute to the forecasting of the future and, as such, to the drafting of appropriate solutions. In other words, time and space dimensions are key supporters of our argument that a dichotomy cannot be drawn between "traditional" and "pre-modernised" *versus* "modern" organisations and irrigation artefacts.

1.7 Research Questions

In line with what stated above, we formulated our research question and sub-questions as follows:

How and why have patterns of water control evolved over time and space within the various water-networks in the area of the WSIP*?*

Sub-questions

1) What technologies of spate irrigation have developed over time, how, and why?

2) What changes in the agrarian structure have taken place, why, and with what implications on local water management practices? What role have migration patterns played?

3) How have local forms of irrigation organisation materialised and been transformed? Have new actors entered the wadi, why, and with what implications on local reactions and forms of water management?

4) How have the irrigation improvement's interventions interacted with the receiving context and what effects have they had on water distribution and access?

1.8 Methodology

Below, we describe how we approached the wadi in order to answer the research questions above.

1.8.1 Scale of research

Initially, we believed that we should focus on few smaller areas rather than the wadi as a whole, in order to be able to investigate them in detail and then draw some generalised conclusions about the wadi based on these case studies. Yet, we soon realised that the wadi's richness in terms of irrigation infrastructures, crops, typology of farmers, history, and so forth, did not lend itself to this type of zoning. Therefore, we opted for a wadi-level scale of research. If on the one hand, by doing so, perhaps we missed some in-depth nuances into the exact livelihood patterns and perceptions, on the other, we gained the necessary information for highlighting the various water-networks and assessing the present situation of water control in terms of the past developments that characterise the region. Moreover, we were able to understand the various reactions that we witnessed within their broader context.

Our study area stretches from the command area of the new irrigation system furthest upstream, Barquqa, to Marawah (see Figure 1.3) covering the whole area of WSIP. Our study includes both new and controlled irrigation infrastructure and already existing, uncontrolled, and more temporary sandy barriers and canals.

1.8.2 Data collection methods

During our fieldwork, for sake of accountability to our data, we attempted to gather our information through several different sources: Primary data came from wadi visits, wadi's dwellers as informants, governmental agencies, NGOs, EC employees, and foreign consultants. We also drew on secondary information of past and present agencies' reports, maps, and research studies.

More specifically, for the sake of understanding specific developments and interactions between various water-networks, we began by dividing the wadi into three areas, in terms of what control structure was in place (see Figure 1.3). In turn, this allowed us on the one hand, to draft specific recommendations for each locale, and on the other, to compare and contrast our findings for each area and draw conclusions for the wadi as a whole.

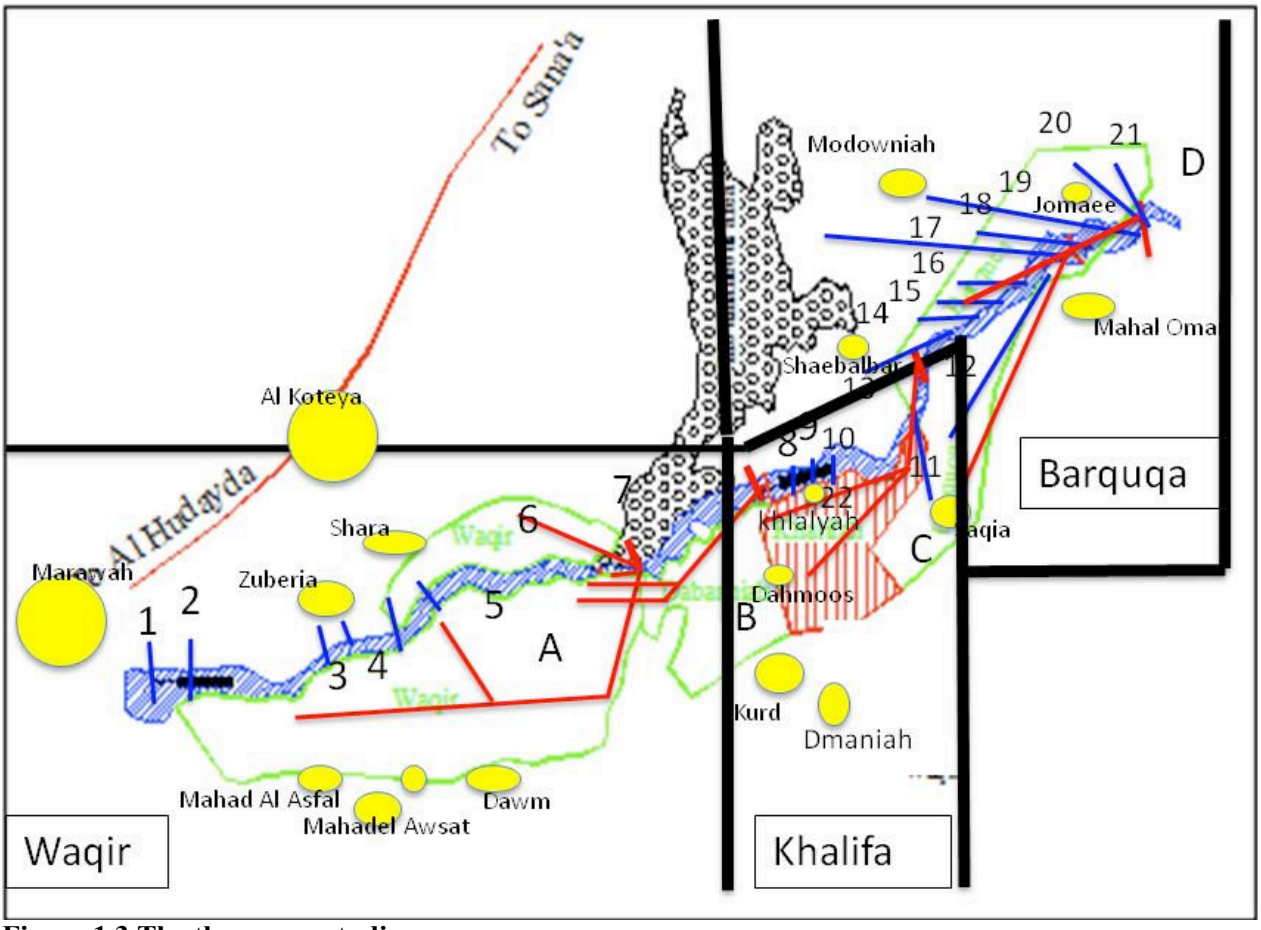


Figure 1.3 The three case studies

For each area, first we mapped villages, irrigation infrastructure, and crops. During this phase, we also informally chatted with those farmers, livestock-tenders, and water-carriers that we met on our way. Once we had a clearer idea of the physical situation, we began with a broader set of interviews, with which we aimed at reconstructing the history of the wadi about important events, dates, cropping and livelihood patterns, institutional figures, evolution of infrastructure and water availability, and water sources used by the various informants (rain, groundwater, and spate). This phase lasted one month, after which, based on our initial findings, in the next 6 weeks we narrowed our research down to water management practices and organisational forms, socio-political relationships between water users and between irrigators and both external and local institutions, and water access.

In the last weeks, we focused more specifically on the different reactions to the present irrigation patterns. We also focused on those appropriation mechanisms that emerged to create opportunities now that new irrigation infrastructure and a organisational model have been introduced. Additionally, we were assessing the potential viability of those new initiatives for water management presently developing in the wadi – which also include total abandonment -, centring on how and why they emerged and both the main constraints and opportunities they may face. To appreciate the variety of these initiatives we both needed to return to some key informants several times and wanted once again to highlight the diversity in water management upstream and

downstream. Thus, in this last phase we selected for study one originally private and one collective mandubi[6] upstream, in the area of Barquqa, namely Qaserah and Syali, and in the Waqir area, the villages of Zuberia and Mahad Al Asfal.

Moreover, we also assessed possibilities for water management reforms, by presenting our findings in three workshops with farmers and discussing options with them. Altogether, this allowed us to discover what irrigation technologies were in place, water management practices, what developments occurred and why, what new actors entered the wadi and why, and their implications on local forms of water management.

1.8.3 Typology of wadi-informants

We interviewed 150 wadi dwellers. Most of these were male and individual interviews were often unfeasible. We did interview some women, especially initially. Yet, despite their keenness to answer our questions, they often referred us back to men when we began to ask about spate water management, rules, and habits. Thus, they were precious informants in our first phase, where we tried to balance the number of men and women interviewed. Yet, afterwards, when our focus shifted more specifically on spate flows, canals, maintenance and operation, our informants came mainly from the male side of the world. Nevertheless, it was almost unavoidable to witness old women storm in and begin screaming and making broad gestures: often these women explained in a couple of sentences those details that men were struggling with. Hence, perhaps they knew more than they admitted!

As for the male interviewers, we attempted to include as broad a range as possible: we questioned about 30 external and local landlords, 5-10 newcomers and, amongst those who had been there for a longer time, about 70 medium and small local owners, 40 sharecroppers and labourers, and a few livestock-tenders. We also strived to cover these typologies in all the water-networks under study and in the various locations within them (up-, middle-, and downstream). We discovered that in some areas, one group predominated, whereas in others it was nearly completely absent: this added an important insight to our identification of what reactions were emerging.

Our selection criterion of informants was dictated by considerations of each group's different access to and control over resources

Figure 1.4 shows the villages where interviews were focused and those areas where we narrowed down our focus in the last couple of weeks.

[6] In Waqir, this term commonly refers to a bund structure, whereas in upper area of the wadi, for instance in Barquqa, it is associated with a small earthen canal.

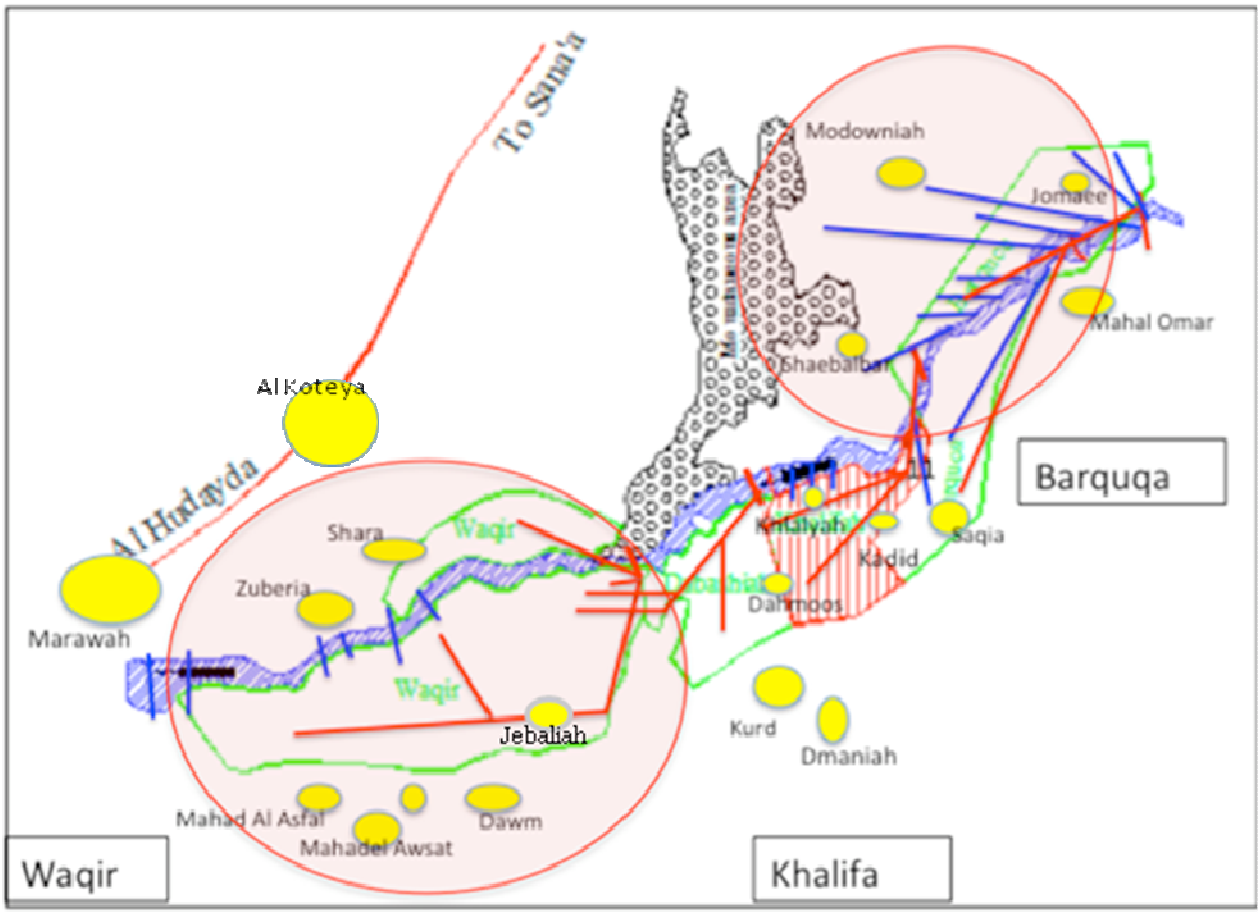


Figure 1.4 Main villages interviewed and areas where we narrowed down our focus in the last phase[7]

Although we were spending nearly all mornings and afternoons in the wadi, we also interviewed non-water-users. We often visited the TDA headquarters: amongst others, its General Manager, the departments of Extension and Hydrology, the WSIP offices, the head of the WSIP and the manager of O&M. We also interviewed various consultants for the WSIP, both those currently working in Hodeidah and those who had been involved with the Tihama plain in the past. In addition, we visited Rural Water Projects, in charge of urban and rural drinking water supply in the area, under whose supervision many deep wells are currently being dug in the downstream areas of the wadi, between Al Koteya and Hodeidah, and the Tihama Census for quantitative information on agricultural production, land use, and population growth. Furthermore, we paid a couple of visits upstream of our research area, around Boura mountains, to verify whether new agricultural developments there may be responsible for the reduced wadi flow, especially for the disappearance of the spring flow.

Finally, we also collected all the past feasibility reports, project descriptions, maps, training programmes, Terms of References and reports, that we could literally "get our hands on"!

1.8.4 Strengths and weaknesses of our fieldwork

As all research, ours too presented strengths and weaknesses. On the one hand, the first factor that we want to highlight here is the Yemeni people's accessibility and their willingness to answer our

[7] The wadi is also scattered with small groups of huts, where we often found sharecroppers or workers. Owners generally live in bigger villages or in isolated larger houses.

questions in any circumstance: under a 40°C sun, during a qat session, after prayer, during meals, and many more occasions that one would not pick as ideal for a hammering questionnaire! This allowed us to interview many of them and gain a very rich and precious insight of what we were studying. Many diverging opinions, at times also contradictory, many exciting new revelations that kept our motivation alive and curious throughout the fieldwork, were only possible because of their collaboration!

Moreover, once we learnt a few words of conversational and irrigation Arabic, even more doors opened. This also allowed us to involve our translators further in our research: since both of them live in Hodeidah, they often were as unaware as we were of the wadi's dialect. By sharing new findings on a regular basis, the research developments, new words and key figure that we discovered, we can assert that the four of us became a team, not two researchers and two translators. And this constant feedback surely contributed to the minimisation of translation losses and consequentially it rendered our results sounder.

On the other hand, sometimes it was complicated to access existing information or certain governmental offices. Moreover, past reports were often contradictory and therefore it was a struggle to try to gather coherent hydrological, agricultural, and statistical information. Furthermore, in the wadi, although qat often helped, we had to time our interviews precisely: as our colleagues explained to us, when people chew qat, they have a talkative high (which we needed) that is followed by an introvert phase. Sometimes qat made our informants follow their own train of thoughts rather than answer our questions more directly! Although this was certainly an interesting anthropological study, sometimes it slowed the proceedings of our research!

During our fieldwork, we were subjected to the same working hours as the rest of the staff. Hence, the time available for wadi visits ranged between 8am-12pm and 2pm-6pm. The location of the research area about one hour away from the wadi limited the time available for each visit. Conversely however, cars were available every day for us to carry out our fieldwork. In addition, had we had more time in Yemen and less logistic limitations[8], it would certainly be enriching for the research to visit other neighbouring wadis too. This comparison would have perhaps put our research more into perspective of broader changes and impacts of ideas on spate irrigation.

Concluding, during our stay in Hodeidah, the flood came twice. Yet, they were small floods, which only irrigated the Barquqa area and which we never saw flowing in the wadi or in the canals. Therefore, it was hard to imagine the magnitude of a spate and the hectic and sometimes conflictual operations for its distribution.

1.8.5 A two authors' thesis writing

This thesis is the outcome of an intensive collaboration between us. Since we found it both an exciting and a challenging process, below we would like to spend a few words on what such a work entitled.

After we discussed the structure and the content of each chapter together, we began to write them separately: each of us wrote the first draft of a couple of chapters. When this was ready, we exchanged them and reviewed the other's part. This cycle was repeated several times. This was necessary not only for the editing, but also so that each of us assumed ownership of all of the content. Hence, although our different backgrounds (agronomist and social anthropology) dictated

[8] For instance, our translators only worked half-day each and for such a visit we would need a full day.

that some technical details were refined by Cecilia and other more conceptual considerations by Laura, we can clearly state that each paragraph is the outcome of the inputs of both.

Although we believe that the final output has been greatly enhanced through our collaboration, it should be noticed that this working method is more time-consuming and requires compromise.

1.8.6 A final remark

Furthermore, 2007 and 2008 were allegedly two years of water scarcity. In August 2009, major rains came and big floods followed, "the biggest in 20 years" (said a farmer in Waqir). Water was running everywhere, personal communications with Hodeidah suggested. By no means does a big flood every two years signify that water has returned to Wadi Siham as before, but certainly, our perception of water scarcity, and that of our informants in the Wadi, may have been influenced by this.

1.9 Structure of our thesis

The structure of the thesis unfolds as follows:

Chapter 2 presents an overview of the hydrological peculiarity of spate irrigation system in general and Wadi Siham in particular, the spatial distribution of its various irrigation infrastructures, the institutions that dwell in it and around it, and the background of the last irrigation intervention project. By clarifying some background trends that frame, influence, and are shaped by the various evolutions of interactions - and reactions - that we will delve with more in depth in the next chapters, it sets the stage for the reader's understanding of what will follow.

Chapter 3, 4 and 5 deal with three case studies: more specifically, Chapter 3 analyses the developments of Waqir area, Chapter 4 of Barquqa, and Chapter 5 of Khalifa. The order of the chapters follows the chronological development of controlled structures. Each of these analyses the evolution of the various pre-intervention irrigation infrastructures, their forms of organization, the enabling possibilities for their establishment, and what type of water control they suggested. It then matches these water-networks against the new irrigation artefacts constructed as part of the WSIP. The focus remains on technical and organisational interactions. In other words, who retains better control of the water, why, where, how, and what for. The chapters conclude with the outcome of these interventions and specific suggestions on strengths and weaknesses of water management in the area treated.

Chapter 6, the Conclusions, summarises our findings in terms of water management reality in the wadi. It debates whether in the past, the differentiation of water sources connected less the various water networks with each other, and as such there was less need for an overarching institution. However, today the opposite is occurring: there is a need for a management of a convergence of water-networks, but there is much less organisational unity than previously. Moreover, it weights the impact on water management of irrigation interventions versus already existing agrarian evolutions. Finally, it analyses the emergence and adoption of new forms of organisation for water management.

2 Overview of Wadi Siham: an institutional, hydrological, and infrastructural tour

This chapter takes the reader through the overall institutional, hydrological, and technical peculiarities that characterise Wadi Siham. We hope that the setting a general frame will ease the reader through the more location- specific case studies that will follow. Moreover, we emphasize the relevance of the context for understanding the peculiarities that characterise each area, in line with our definition of water network as "a network of human and non-human actors that emerges around water use" (Zaag et al., 2001:272). Below, we will begin with a description of the human actors that traditionally have been involved in water management.

2.1 Changing water management institutions

This section explains better both traditional institutional figures of authority and more recent ones that have gained influence in water control activities in Wadi Siham in the last decades. Additionally, we also highlight how these institutions interact with each other and the socio-political ties that connect them. By doing so, we will begin to set the frame for our analysis of water control and its evolutions.

2.1.1 Internal forms of organisation: Sheikhs and Aqils

In Yemeni tribal society, traditional village heads are called *aqil.* Although the position has no direct role in water management, village aqil*s* are the first persons farmers would appeal to in case of conflicts of whatever kind, including water. Traditionally, the title of aqil is inherited from the father if he had shown remarkable qualities; otherwise water users may elect a new one. However, most cases that we came across showed that sons often succeeded their fathers, to the extent that some aqils' family had established their line for generations. When explicitly asked by farmers, some aqil*s* could/can supervise more than one village. The village aqil*s* are coordinated by water *sheikhs*, people from large families that the Imam chose to administer the area. Each water sheikh supervised one area of the wadi and organised water distribution and maintenance of the spate infrastructure (Pelat, 2004). Not everyone may become a sheikh or an aqil: above all, he should be an experienced farmer; gain the other farmers' trust; he should be acquainted with the flood season, the construction techniques of the infrastructure, and above all, the local system of water distribution.

In Wadi Siham, the influence of sheikhs is rooted especially in the lower parts of the valley, where agriculture developed first. There are historical reasons behind this. During the time of the Imams, the prestige of sheikhs reached its climax for they were bestowed of powers and legitimacy by the Imam. If we encountered contradictions on domains of power of some more recent sheikhs, the standing of Sheikh Suleyman Saleh remains uncontested. He controlled the whole plain of Wadi Siham under the Great Imam Yahya in the 1930s and ruled until shortly after the Imamate's demise. He had his stronghold in Mahal al Sheikh, today known as Mahal Al Asfal (see Figure 1.4), from where he supervised tax collection and maintained law and order. When sensitive quarrels occurred, for instance if some rich farmers attempted to build new dams along the wadi or to upset for their own gain the traditional system of water division, the matter was brought before the judges in Marawah, who were usually sheikhs but not necessarily water sheikhs.

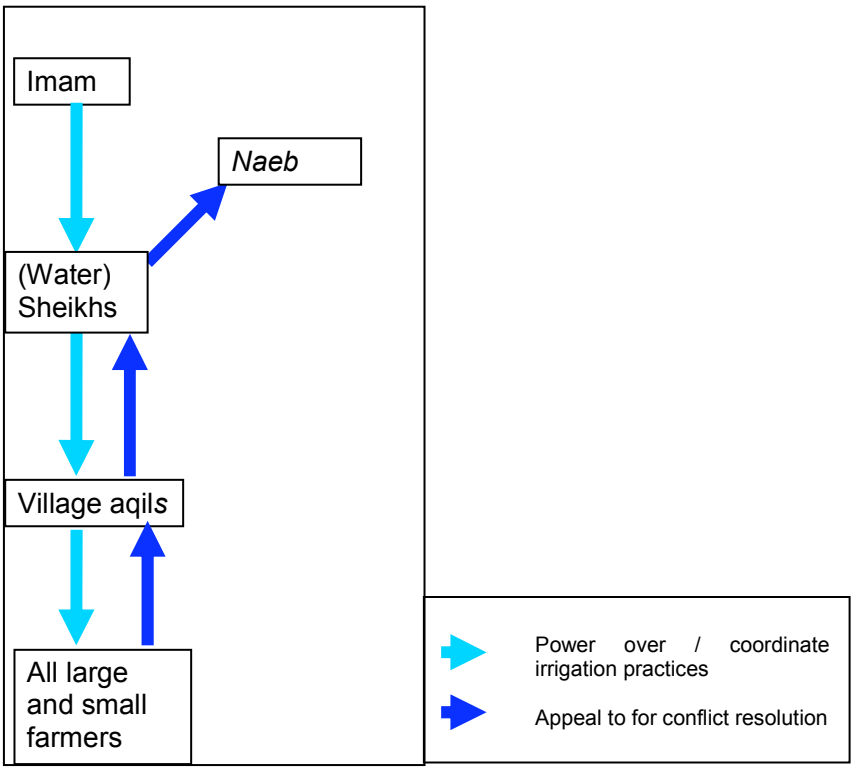


Figure 2.1 Past relationships of water management in Wadi Siham

Another very important sheikh family is the Qaserah clan: although they live in Marawah and Koteya, they possess extensive farmland in Waqir, which they irrigate almost entirely from Husseini mandab and Shroefia haghus (see **Errore. L'origine riferimento non è stata trovata.**). In addition, forty years ago, one branch of the family both several hundred maads[9] in the Barquqa area. Their role in irrigation management surfaced primarily after the death of Suleyman Saleh. To date, they remain the most powerful and respected local family in the wadi.

Concluding, it is worth to mention that, although the flood system requires supervisory roles in the allocation process to coordinate the distribution of water in the time of flood, the sheikhdom/aqilat in Wadi Siham was never as strong as in other wadis or Yemeni regions. Varisco attributes this to the ephemeral nature of the flood: according to him a stronger tribal structure emerges in areas where a permanent spring flow supports irrigation practices (Varisco, 1983). Surely, this had an influence on the fact that with the shift from the Imamate to the Republic, the title of sheikh was more loosely used and applied also to governmental persons as long as they satisfied the above mentioned requirements and could count on certain authority. Moreover, as we describe later, sheikhs also assumed important positions in the local government.

Whenever the local sheikh could not solve a dispute, he turned to the *naeb*, a governmental organism situated in Marawah, where important religious judges pronounced the verdict.

2.1.2 New actors and institutions

With the establishment of the Yemen Arabic Republic in 1962 in the North of Yemen, new institutions for water management emerged. Among the new institutions that play a role in the management of surface and underground water resources, below we highlight the ones that more often emerged in local discourses: the Tihama Development Authority (Hodeidah), which is

[9] A common unity of land measurement in the Tihama plain, it equates to 0,44 ha.

primarily concerned with irrigation infrastructure and extension services, and the Local Council (Marawah) that mainly solves local disputes. Figure 2.2 below summarises the present water management structure in the area.

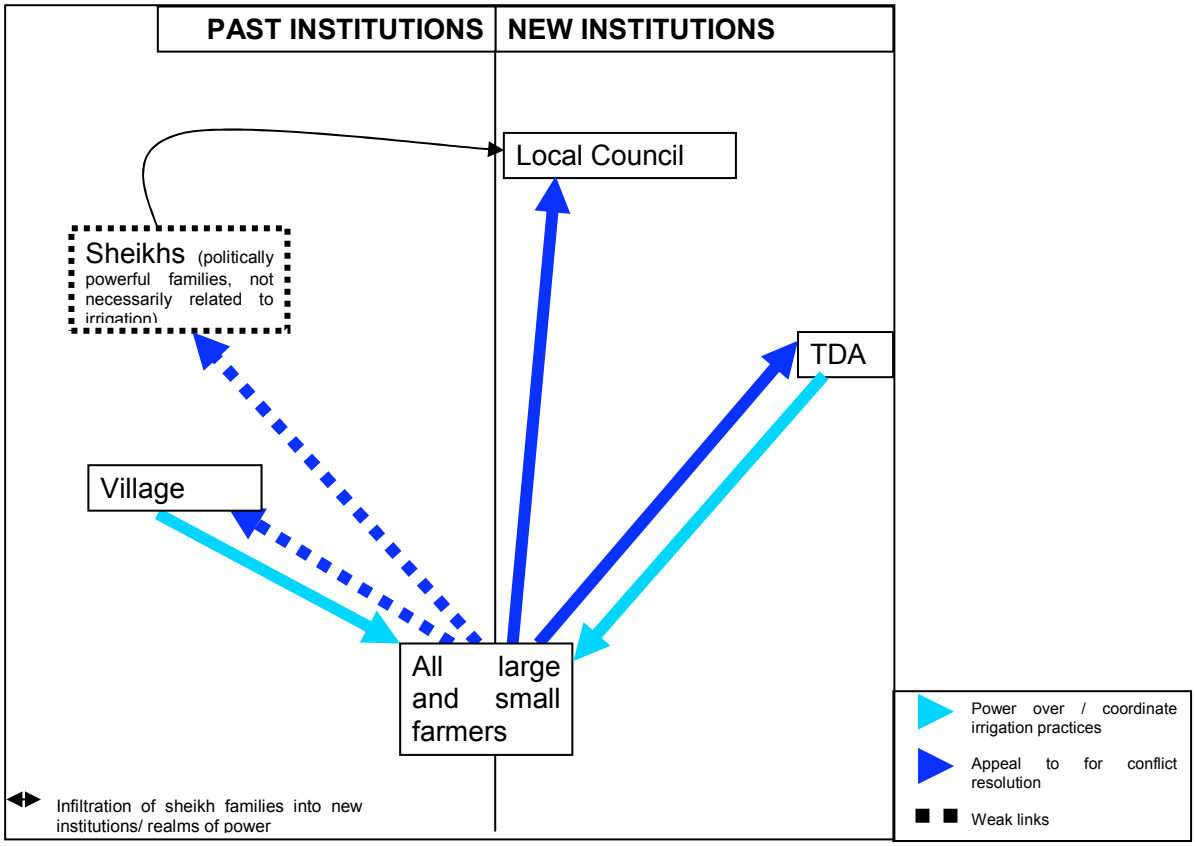


Figure 2.2 Present water management structure

Tihama Development Agency (TDA)

Founded in 1973 as a semi-autonomous governmental agency, the TDA is a branch of the Ministry of Agriculture and Irrigation. The primary long-term objectives of its water policies in the Tihama were to assure increased production and income for farmers whilst conserving the water source in sufficient quantity and quality for agricultural and other users then and in the future (DHV, 1988).

In the 1970s, in order to increase agricultural production, the government began to invest extensively in hydraulic works for irrigation and in the "improvement" of existing and "inefficient" spate systems, whose supervision and maintenance were entrusted to the TDA (TDA staff, group interview, p.c. March 2009). In addition, it began to train farmers on improved agricultural and irrigation practices at field level, as it was believed that inefficient water use in the field was another cause for low production. Moreover, from the 1980s onwards, farmers received credit facilities: this was one of the components of the "Integrated agricultural development" that the TDA was implementing in the Tihama, which also included physical works, research, extension services, and marketing.

The TDA became involved in Wadi Siham's rural development in 1985, as the wadi was included in the Tihama Irrigation Improvement Project, a systematic set of individual wadi developments undertaken over the Tihama region. The WSIP had three major components: irrigation, flood protection, and extension services. In theory, TDA was to take charge of the operation and maintenance of all the new irrigation structures, namely the diversion weirs and main level canals and gates of the four planned irrigation systems. From 2004, the TDA has also been involved in the

creation of Water Users' Associations for the operation and maintenance of secondary and lower levels of the various systems.

As it will emerge in the following chapters, the TDA's presence nowadays is a contested one: farmers blame it for both its creation of irrigation problems (with the introduction of the new infrastructure and WUAs) and its inefficacy in solving them. Nevertheless, for better or worse, its role in irrigation management remains a central one. Even in Wadi Siham, all types of farmers (large and small owners, sharecroppers, and workers) all over the wadi were often referring to this authority.

Local Council (LC)

This institution implements the various ministries' policies at local level. In Marawah District, to which the irrigated area of Wadi Siham under study belongs, it became operative in 2001, after it underwent major revolutions concerning its internal structure. Their activities range from infrastructure, particularly drinking water projects (the council's priority) and roads, management of groundwater developments for irrigation purposes, education, health, and political security. Several farmers and village aqil*s* of Wadi Siham are representatives in the Local Council where nominally they represent farmers' interest *vis-à-vis* the Head of the District Local Council who often happens to be a politically powerful tribal leader. Currently, the General Secretary of the Local Council of Marawah is the descendant of a local powerful sheikh family, who also happens to be the head of the Wadi Siham WUA and have several links with the TDA. The Local Council is also the authority that then presents people's interests and claims, including those of farmers, to the government that then decides upon their realisation, and implement new projects through the TDA.

Although it has no direct involvement in Wadi Siham's spate water management, the Local Council's role in solving disputes between farmers and claim making, including those concerning irrigation, seems to be gaining ground. Whilst the power of aqil*s* is declining and confined at village level, several farmers admit that they would rather appeal to the Local Council as nowadays, they generally believe it a more efficient institution for finding solutions than local village heads.

Nevertheless, despite the new authority that nowadays the modern Yemeni State has established in the Hodeidah governorate, the customary structure seems to have remained, yet much weakened. Many farmers from the downstream areas often appeal to Sheikh Qaserah, who still exercises a parallel political power to that of the LC.

2.2 Hydrological context of Wadi Siham

In this section, we present the hydrological situation of Wadi Siham and the overall perceptions of its inhabitants of water availability. While this section provides a general picture of water availabilities and scarcities in the wadi, Chapters 3, 4, and 5 characterise more specifically the different patterns of water distribution and look better into the underlying reasons.

We deem it necessary to describe the hydrological context for three main reasons. First, particularly in a spate system, the type of flow is crucial for explaining the choice of irrigation infrastructure, for determining water rights, and shaping organisational forms and irrigation practices (Varisco, 1983). Second, by highlighting the water availability in the various parts of the wadi, its evolution, and the perceptions that different farmers have of it, we want to introduce the theme of water scarcity and shed the first lights over how, whether, and where, we can talk about it. Thirdly, water availability strongly influences irrigation practices and shapes reactions to its change.

Wadi Siham is the middle of a series of six major wadis located in the Tihama plain (see Figure 2.3). It originates in the Highlands of Sana'a and drains in the Red Sea. On its course it runs through the Jebel Boura Mountains and enters the Tihama plain through the Bahra gorge, which is located at an elevation of 280 m above sea level. The total catchment area from Sana'a to Mahal Shuma, just upstream of the first irrigation system of WSIP, Barquqa, is 3500 km2 (CES, 2006). After entering the plain the gradient of Wadi Siham becomes progressively gentler. The slope up to Mahal Shuma is 7.2%, which becomes 6.6% up to Mahal Omar and comes down to 3.0% in the area of the lower irrigation system, Waqir (SOGREAH, 1985).

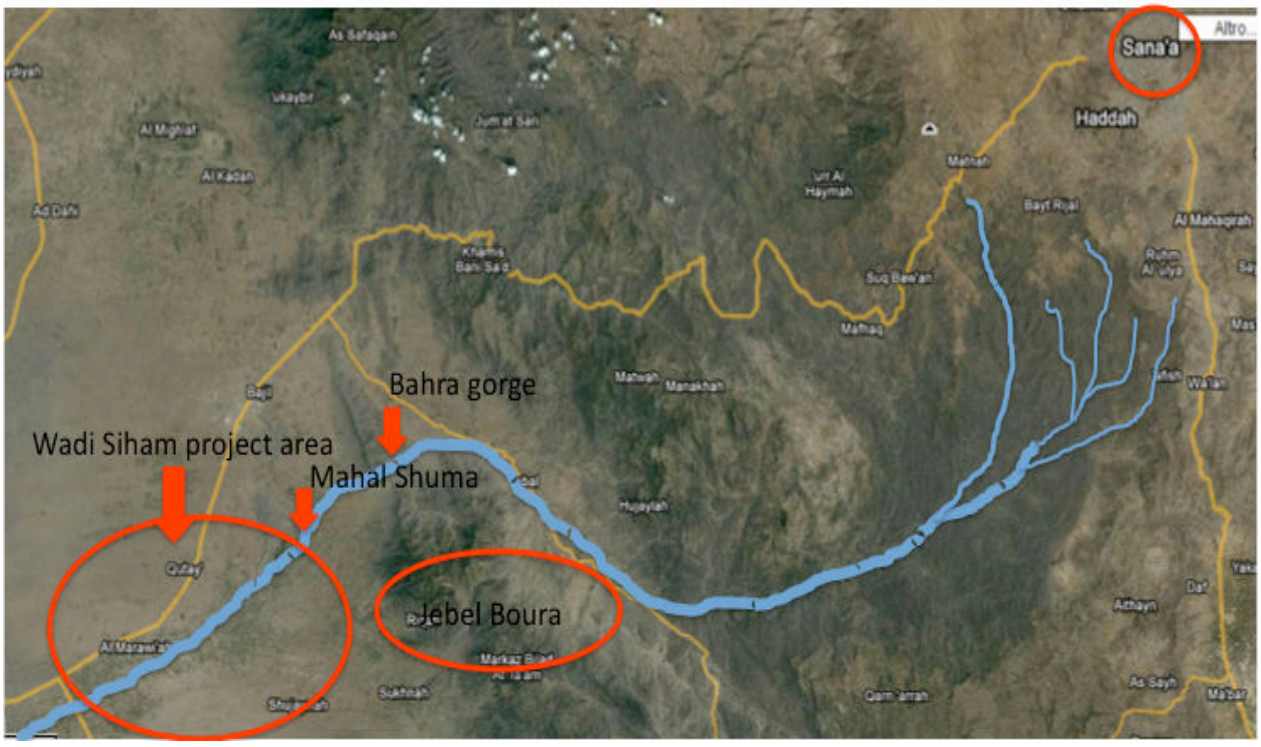


Figure 2.3 Wadi Siham catchment

Agriculture in Wadi Siham depends on three sources of water: rain, groundwater, and runoff (spring flow and flood flows).

2.2.1 Rainfall

Annual rainfall is very low and range from 150 mm/year downstream of the wadi to 300 mm/ year in Jebel Boura (see Figure 2.3), upstream of the wadi (Dumas, 2008). Rainfall is concentrated mainly in two periods: from March to May, and from July to September. The graph below indicates that rainfall has decreased in the last years. However, the time span of the data available does not permit a statistical verification of this pattern. Yet, overall, both farmers and TDA experts tend to confirm this.

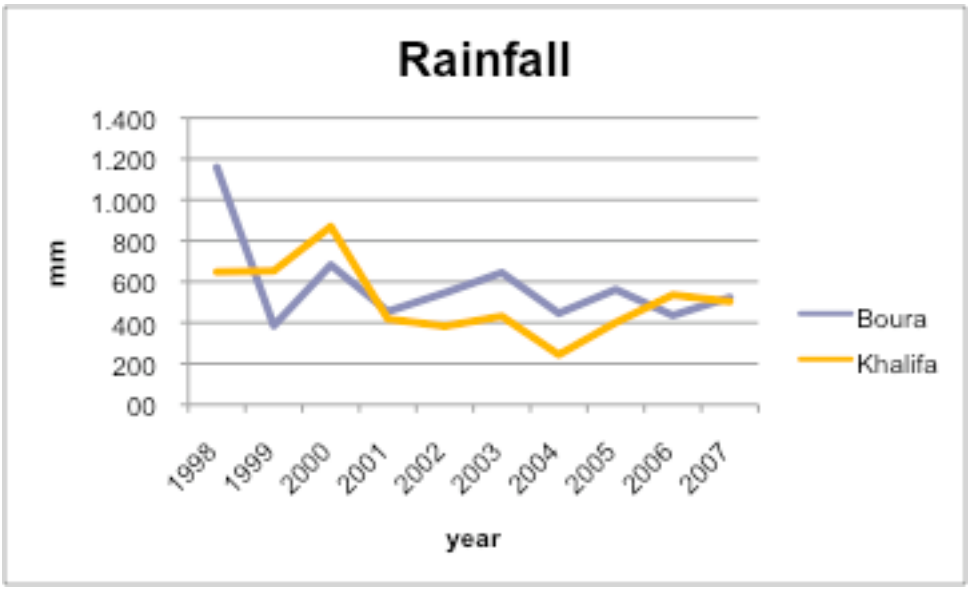


Figure 2.4 Rainfall 1998-2007 (source: TDA)

2.2.2 Groundwater

The Tihama Plain is underlain by an extensive alluvial aquifer, which ranges in depth from 0-50 m in the East, adjacent to the foothills, to 250-300m nearer to the coast. The aquifer, that comprises an alternation of cobbles, gravel, sand, silt, and clays, displays an extreme lithological variation both laterally and vertically (DHV, 1988).

Groundwater has played a central role in the development of tobacco in the downstream wadi and the initial mango cultivation in the upper parts. This resource, whose main recharge depends on runoff, is heavily overexploited, particularly downstream, and constitutes a major concern today for both farmers and authorities. Data on recharge and abstractions differ significantly. What emerges as a common outcome is a clear negative net balance, with estimates of 4-10m/year drop in the aquifer. Nevertheless, this varies across the wadi: for instance, until very recently, Barquqa was very rich in groundwater (see Box 1).

Box 2.1: Once there was a water bubble...

There is the belief among farmers that spring flow has disappeared because of the construction of the new dam in Barquqa:
"During the excavations for placing the foundations of Barquqa dam, workers found a huge water bubble just under the soil surface. This was the source of the stream they were irrigating from. Farmers were happy about such abundance until engineers covered again the bubble with stones and cement and from then on, the stream ceased to flow"
We believe that this phenomenon could be rather explained by the upstream water developments, both for agricultural and domestic purposes, proceeding at an incredibly rapid pace.

2.2.3 Runoff

Two types of runoff can be distinguished in Wadi Siham: *sayl*, the intermittent and ephemeral surface flood flows, and *ghayl*, a spring flow.

The unpredictable and variable nature of flows has a critical influence on the development of spate irrigation. Flows vary in magnitude, duration, timing, and frequency, and these characteristics are closely linked to location. While in upstream wadi areas close to the foothills of Jebel Boura floods are flashier in nature and more frequent, those t reach the lower areas of the valley are generally floods of greater magnitude and duration, and less frequency of occurrence. Additionally, the upper areas of Barquqa and part of Khalifa had traditionally the right to irrigate with the spring flow and arranged rotational turns among canals. The lower parts, Waqir and below, could count only on flood flows. Big floods covered indistinctly both areas.

The above has implications on the choice of irrigation infrastructure. For instance, in the upper parts of Wadi Siham, smaller spurs may be found to divert water into canals or directly to fields, while in the lower parts, they opt for larger sandy bunds across the wadi. These are more suited to divert primarily the larger flows. Different infrastructural characteristics put specific demands on the type of organisational structure required for their construction and maintenance.

Another characteristic of spate systems is that due to the erratic nature of spate flows, not only the irrigable area (developed area) is larger than the area irrigated during an average year but this may vary greatly in between years (Lackner and Vincent, 1998). Thus, different fields may show very distinct reliabilities for water, which depend largely on the location in the valley, the distance from the diversion point or from a canal, and the position along a canal. Steenbergen (1996) calls this internal differentiation of water access. On this basis, in Wadi Siham, they differentiate between regularly irrigated areas, watered by the spring flow, irregularly irrigated area and exceptionally irrigated area, both watered by flood flows. This creates the ground for the division of water rights and the ensuing differentiation of participation in organisational activities.

Once again, data on runoff proved to be quite poor and unreliable: there were remarkable contradictions between (and at times within too!) the records of earlier foreign consultants and measurements carried out by the TDA on a regular basis. Generally, average values of the total annual flow measured at Mahal Shuma, vary from 60 to 80 Mm^3/year. The consultancy CES presented the more pessimistic value of 48 Mm^3/year (CES, 2006).

Wadi Siham is characterised by an average of 15 floods per year that reach the upper boundaries of project area. Some occur during *seif* season, from March to July, but the majority during the *kharif* season from July-November (Dumas, 2008). Their spatial distribution differs enormously within a single flood event and between different flood events, even more so given the great variability that flood flows show within the year and among the years. Thus, a precise picture of the inundation frequencies in the various parts is not available. On a general basis, we can state that downstream areas, Waqir and below, receive on average 1-2 floods yearly, whilst 5-15 floods are received in the upper area of Khalifa and Barquqa.

Data collected from the TDA from 1998 to 2007 from the same Mahal Shuma gauging station, upstream of Barquqa, does not suggest any evident decrease in total annual flow volumes (see Figure 2.5).

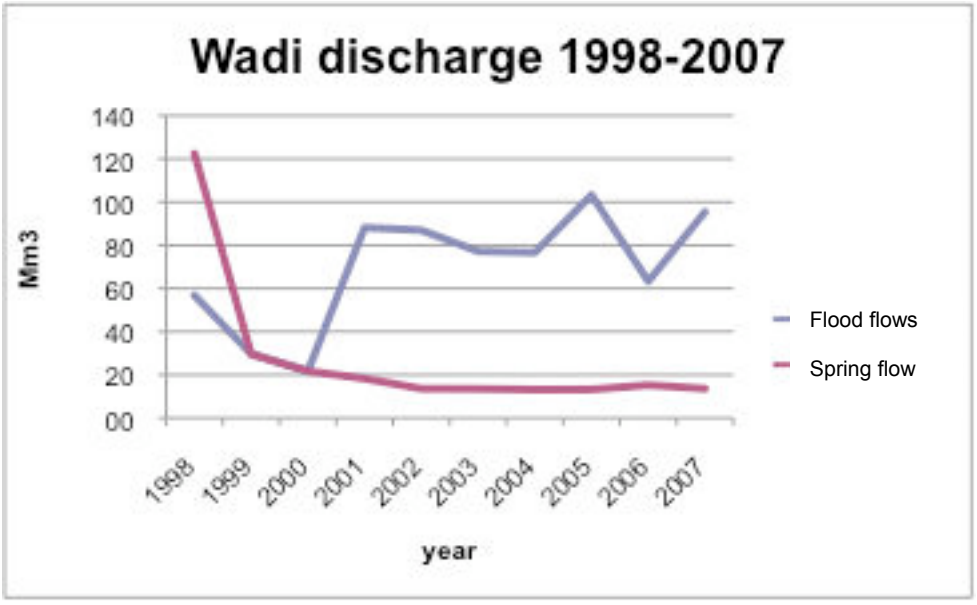


Figure 2.5 Annual flood flows and spring flows 1998-2007 (source: TDA)

Although the annual flood flows have not varied drastically, the overall feeling among farmers in the downstream parts of the wadi is that they have been tapering off, particularly in the last 10-15 years. 2007 and 2008 have been dramatically scarce in floods, particularly big ones, and this may have exacerbated the feeling of water penury among downstream users. To everyone's agreement, in 2008, the lowest total flow was recorded. According to water users, whereas in the past, at least once a year floods that reached the lower wadi would cover with water the whole area, which would then remain on the fields for weeks, nowadays, floods are rarely of such scale (Roux, 2008). Additionally, whilst big floods that reach the end of the valley occur on average every four years (1998, 2002, and 2006), every time they arrive less downstream: in 1998, the flood reached the sea, in 2002 to Hodeidah airport, some 30 km downstream of the last irrigation structure, and in 2006 to Marawah only.

Volumes of water recorded upstream indicate little about actual water availability downstream. The potentiality of floods to reach the tail-end areas depends firstly, on characteristics of single flood events; secondly, on the water requirements and diversion upstream (both capacity and frequency of irrigation), which appear to have soared in the last years. Thirdly, whether upstream and downstream areas depend on the same type of flows. Whereas before higher areas in the wadi irrigated primarily with spring flows, *ghayl*, in the Wadi Siham project area spring flow began to decrease in 1998 and eventually disappeared in 2002 (see Figure 2.5). The consequence is that whereas before, there was a clearer boundary between the water source used upstream (mostly spring flow) and downstream (flood flows) nowadays, they are both dependent on flood flows.

The strong feeling of water scarcity among farmers derives from the concomitant decreasing availability of their three water sources, rain, groundwater, and spate flows, both spring flow and flood flows. On a general basis, the intensity of this feeling varies along the valley: it increases heading downstream and further away from the water source (e.g. canals, wadi). However, we also found out that within the lower area of Waqir, different feelings about single flood events emerged that did not correspond to average tail-end reasoning. We believe that these contradictions emerge from the state of their infrastructure, which are on average less maintained than in the past, on the new diversion capacities, and on organisational skills and interests.

Summing up, water resources; rain; groundwater; and spates; both spring flow and flood flows, seem to be becoming scarce. However, evidence shows that not all the water sources are scarce to the same extent and that their scarcity is not evenly distributed. In 2002, spring flow disappeared and this affected the upstream areas of the wadi that depended on it. Groundwater is also irreversibly scarce throughout the wadi, but in a more pronounced and dramatic way in the wadi's lower areas, where they cannot rely on as regular spate flows as in the upper locales. However, the effects of a preferential access to this resource by some farmers on the potential use of others are localised and not immediately felt.

On the contrary, it seems that the availability of flood flows at the entrance of the study area is rather a cyclical one. Although subtractions of spate water upstream of the WSIP area are increasing, total volumes of flows available at the entrance of the research area do not show a neat trend towards a decrease. This "stability" is counterbalanced by opinions about changing spate water availability.

The hydrological situation depicted above and the different perceptions suggest the following: water control has changed within the wadi -some control the water better than others- and spate water has been redistributed. Additionally, while certain scarcity may be an ecological reality, scarcity is also produced by socio-political forces and games, and as such, it spreads differently throughout the valley (Mehta, 2007).

Changing availability of a certain water source may be triggering factors for reactions and attempts to appropriate the resource in a different way: by changing infrastructure or management practices for instance, or appropriating another water source. Therefore, a change in the control of flood flows may have been also urged by the disappearance of spring flow and the declining availability of groundwater.

2.3 Irrigation infrastructures in Wadi Siham

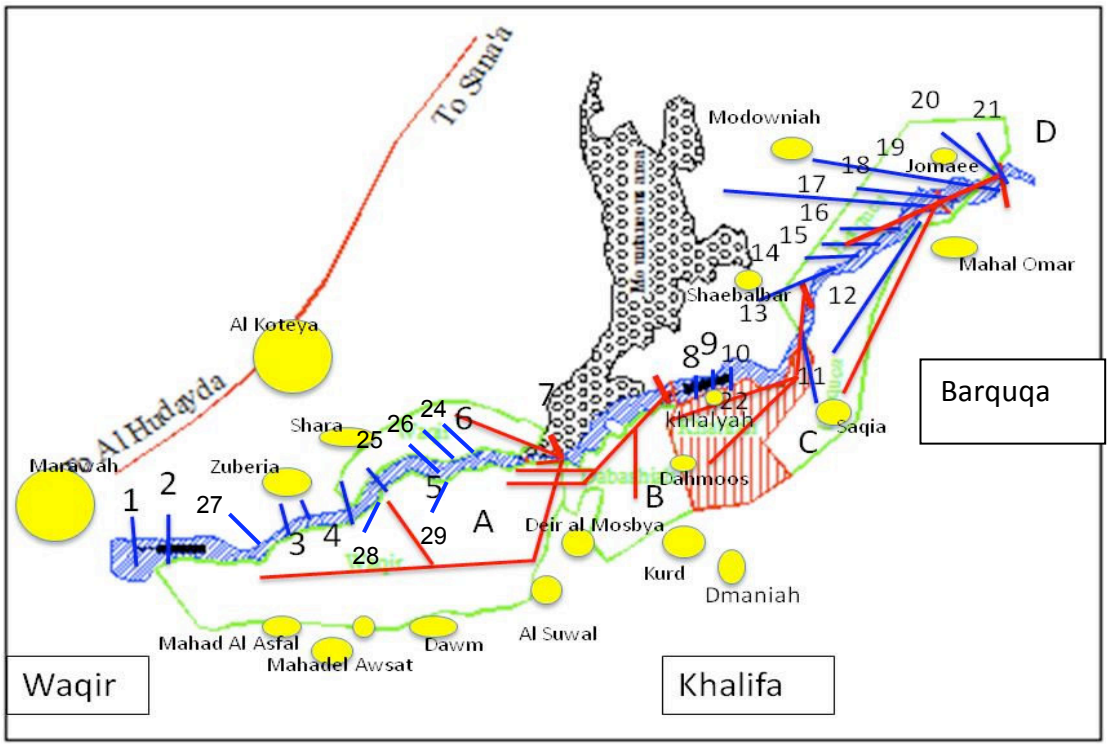
Above we mentioned that hydrology has implications on the choice of irrigation infrastructure and water management. The next section describes the diverse irrigation infrastructure we encountered in Wadi Siham and highlights the link between water and technology.

Wadi Siham offers a large variety of irrigation structures (see Figure 2.6). Not only can we distinguish between controlled and uncontrolled artefacts, but the latter category also conceals various types. Earthen canals, small spurs, and large sandy bunds accompany permanent dams and are intersected by lined canals and gates as shown in the following picture.

Different types of artefacts were conceived in a spatial and chronological continuum and were crucial for the upstream agricultural development of the wadi. Retracing the wadi from Marawah upstream, sandy bunds are the first sign of irrigation we encounter. In the wadi, "sandy barrier" is the general translation for any *haghis*, large or small. More specifically, other terms used are *akm,* indicating a general large barrier, or *uthun,* a big sandy barrier, which collects "all the water", "*hamila"*, which means big wall that holds water, and "*mokraee"*, signifying a barrier collecting all the water. In Wadi Siham, Akm and Uthun were also two nicknames that came to refer exclusively to the two largest irrigation infrastructures there (see Figure 2.6). Moreover, mandab traditionally indicates either a small private sandy barrier or a small earthen canal. For sake of simplification, in this thesis we will utilise the term haghis (pl. haghus) to refer to general large sandy barriers.

These are: Mahadeli, Bahlooli, Shroefia, Husseini, Uthun, and Qamusia. Upstream of Qamusia and defining the upper boundary of what was traditionally called Wadi Siham there used to lay Akm.

The new diversion weir of the WIS, which was completed in 1996 (system A in Figure 2.6) nowadays stand where Akm used to lie. We mentioned before that irrigation infrastructure matches the nature of the different types of wadi flows, which are location specific. This type of large barriers across the wadi developed to divert most of the residual flows[10] and to master the big and less frequent floods arriving in this tail areas of the wadi.



KEY			
Sandy Barriers/Lateral dykes	*Mandubi*		*WSIP*
Mahadeli	8. Humaiqani	18. Marzouki	A. Waqir
Bahlooli	9. Beshari	19. Qaserah	B. Debashya
Shroefia	10. Khlalyah	20. Wajeh	C. Khalifa
Husseini	11. Saqia	21. Shamiri	D. Barquqa
Uthun	12. Dehna	22. Hajar/ Hakoume	
Qamusia	13. Syali	23. Beshari NEW	
Akm/ Waqir	14. Matani		
24. Mohammed Yahya	15. Khanani		
25. Omar Qadi	16. Magaribi		
26. Mohammed Abdallah	17. Barquqa		
27. Humaiqani			
28. Mohammed Ali Sanaa			
29. Hassan Karar			

Figure 2.6 Wadi Siham's irrigation infrastructure

Between Waqir headwork and Shroefia, a succession of numerous smaller and lateral dykes, generally referred to as mandubi, alternate the bigger ones, the haghis. Mandab Mohammed Yahya, Omar Qadi, Mohammed Abdallah, occasionally irrigate areas in the north bank of the wadi, around Wasset, Afaja, and Hazamya. Additionally, some recent barriers were built in the last 10 years. Amongst others, these are Mandab Mohammed Ali Sanaa, Humaiqani mandab, and Hassan Karar. They are mainly located on the left bank of the wadi. The state of preservation of haghus and mandubi differs greatly. While some appear to be abandoned, others are well-maintained and others again show signs of "external" intervention of the Tihama Development Authority and are

[10] In a hydrograph, a residual flow is the tail of the flow after the peak.

reinforced by gabions. The canals of WIS (A) mark the boundaries of the originally irrigated area, the so-called former "Wadi Siham".

Immediately upstream of Waqir, there appears the Debashya Irrigation System, the smallest of the four new systems, completed in 2005. As Figure 2.6 illustrates, one of its branches ends inside the command area of the WIS. It was built to supply WIS' technical deficiencies, as a result of which a whole area entitled to water rights could not irrigate.

Proceeding upstream, the landscape of the wadi banks is scattered with a series of smaller spurs on both sides of the wadi, diverting the water into small earthen canals, mandubi**.** These document a more recent and progressive colonisation of new spaces and their transformation from pasture and rainfed areas into regularly and irregularly wadi irrigated lands.

In the middle stream, around Khalifa Mountain, there are several mandubi (earthen canals) that have been constructed by small groups of farmers. Apart from the first two mandubi*,* the outcome of individual effort of two influential persons from Sana'a named Humaiqani and Beshari, most are village mandubi*:* Khlalyah*,* Hakoume (Government), Dehna, and Syali. Hakoume is currently being renovated: a new system is being constructed by TDA/EC over the older canal, which will be named Khalifa, after the mountain that overshadows the main canal. Its main system will comprise of a North Canal and a South canal, the former Hakoume and Khalifa branch of Hajar respectively.

Continuing upstream, other mandubi make their appearance: Matani, Khanani, Magaribi, Barquqa, Marzouki, Qaserah, Wajeh (now called Rweishan), and al Jomaee (now Shamiri). These canals generally carry the names of their founders, yet sometimes they changed name along with large transfers of land from one owner to another. Recently, another private mandab has been completed by Beshari in the Shaebalbar area.

Finally, we arrive at diversion weir of BIS, finalised in 2006. The dam diverts the water into a main canal (BMC) that runs along the right bank of the wadi until it parts into two branches: a secondary canal (BSC) follows on the right bank, while the main canal crosses the wadi through a siphon and continues until the village of Saqia. The new canal system crosses the upper seven mandubi on the right bank of the wadi.

The picture we presented above is the outcome of history, a process of negotiations and collisions between people, their needs and interests, and their interactions with the physical environment and technology. Each movement in the direction of the infrastructural scenery that we witness today entailed certain swings in water control. The actual situation is by no means a static one. On the contrary, there seems to be still room for further evolutions: Beshari's recent investment in yet another mandab exemplifies this continuous thrust.

2.4 The al aela fil aela rule

Al aela fil aela, "first the upper then the (next) upper", is the regulating rule for water distribution that is widely accepted by water users throughout the Yemen, and the Middle East. It originates from one of the basic Islamic principles of irrigation that dictates that the farmers closest to the water source should irrigate before the ones further distant from it. This regulation has very practical reasons. Due to the erratic nature of flood flows, the easiest and most efficient irrigation method would be to follow the natural sequence dictated by gravity (Varisco, 1983). Additionally, farmers generally prefer few fields irrigated until the fulfilment of their requirements rather than many fields irrigated inadequately. Traditionally the al aela fil aela rule entails respect for historical

rights and sets limitations to more recent upstream water use: in Wadi Siham we found that this rule has implications for both the construction of new irrigation infrastructure and irrigation turns.

The al aela fil aela rule implies particular water distribution patterns: when a flood arrived, the first barrier would divert it to the lands around, which were then irrigated field to field. When a field was irrigated, the person in charge would breach the field bunds and release water to the next farmer. Landowners would talk and find arrangements on the order of water distribution in case of disagreements they would solve between themselves or with the help of the aqil. In case of excessive water, after irrigating the whole command area of a certain barrier, irrigation would start again from the first field. Were the flood not sufficient for the whole area, the second flood would be led directly to those fields that had not irrigated before: those farmers who had irrigated were forbidden to reconstruct the bunds around their fields.

In Wadi Siham, field bunds are a measure for irrigation duration. Farmers can irrigate until water has reached the bund, which for sorghum is generally knee-high, for tobacco half-calf. This detail has implications for how water control developed in upstream areas and with mangoes. The allocation rule between two or more barriers remained unvaried: each barrier is meant to irrigate a particular area and when fully irrigated, farmers would make an opening in the barrier in a specific point close to the wadi bank letting water flow downstream to the next barrier. *Ams*, for instance, is the name of the small canal cut on the right side of Uthun. Over-irrigation of fields would be reported to the aqil*s* or sheikhs and punished accordingly. Before seif and kharif, farmers would refill the canal and repair possible damages in order to catch the next floods.

If it is true that according to the al aela fil aela, it is possible to irrigate new areas upstream and construct new irrigation infrastructure, there are also certain boundaries within which this is accepted: no structure upstream of Akm can cross the whole wadi. According to this principle new farmers have room for appropriating the water resource upstream by constructing their own canals as long as this does not affect flows to traditionally cultivated areas downstream. Moreover, the construction of a new barrier and further diversion of water cannot constitute a threat for nearby villages. There was a case of a large landowner, who wished to build his own sandy barrier for irrigating his fields, but was prevented to do so as his barrier would have menaced Marawah town by increasing its risk of flooding.

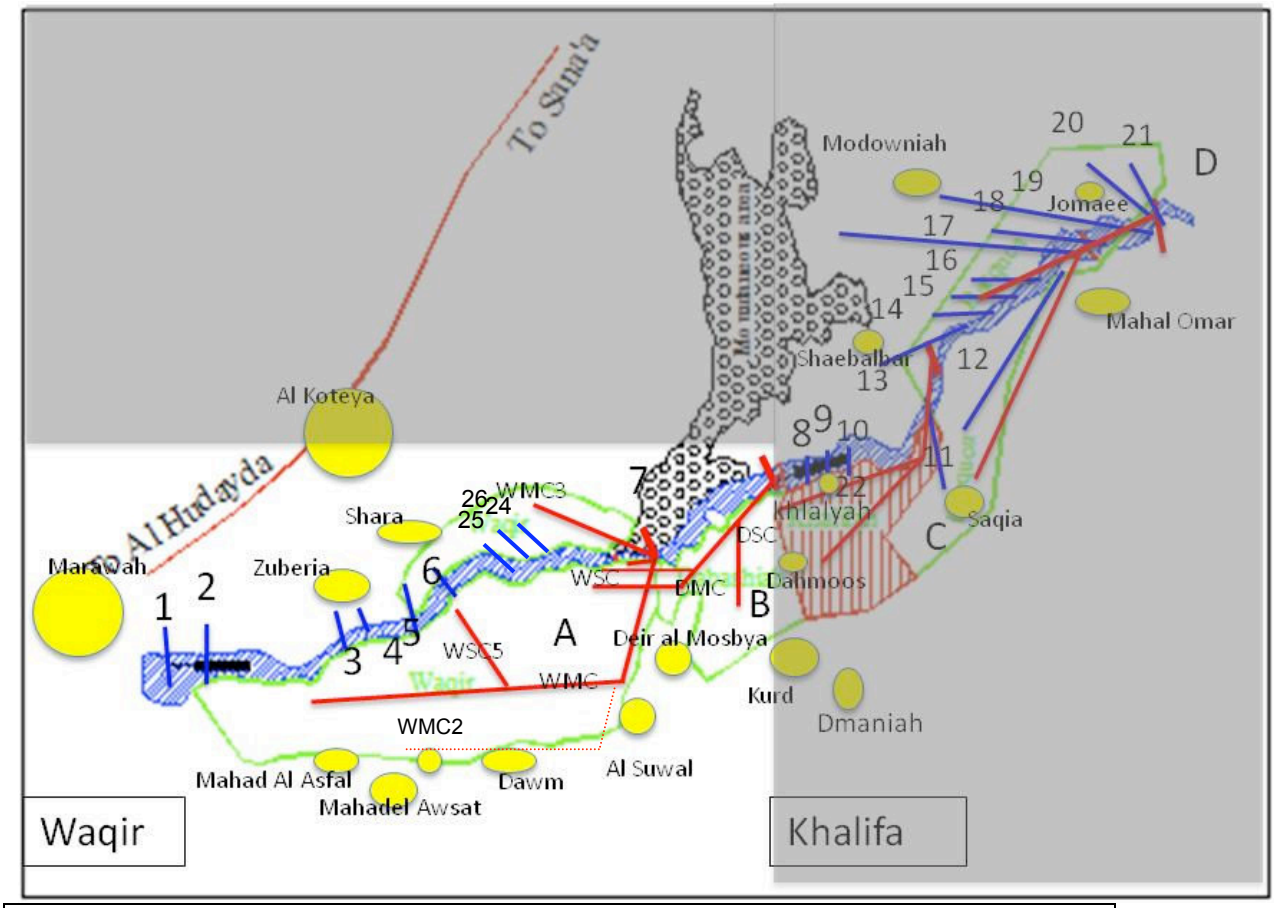
The above shows how the al aela fil aela rule traditionally protects downstream water requirements. However, as we unravel in the next chapters, in the past decades in Wadi Siham this rule has been increasingly loosely applied and this allowed an upstream appropriation of the water source, which does not appear in line with considerations for downstreamers suggested by the Islamic law itself. One brief anecdote, as several interviewees suggest, nowadays, bunds of new mango fields in Barquqa are built higher than one metre and farmers fill them up until the bund.

2.5 Conclusion

Overall, the first picture of Wadi Siham that we portrayed above shows a lively scenery: water resources, or at least some of them, are getting scarce in a different way and for different people, different irrigation structures cross and interact, traditional irrigation rules are getting lax, and institutions for water management are merging.
In the next chapters we will analyse in depth the interconnectedness between water, technology, and society, and how their interplay, that is, water control in its three dimensions, technical, organisational, and socio-political, changed over time and space according to certain contextual transformations.

3 Case study I: Waqir and below, where Wadi Siham's commercial exploitation began

The first area, whose water management's dynamics we will explore, lies between the headwork of WIS and the town of Marawah (see Figure 3.1below). Until the WSIP began in 1993, this locale was usually referred to as "Wadi Siham", which differentiated it from areas further upstream where irrigation was introduced later.



KEY			
Sandy Barriers/Lateral dykes	*Mandubi*		*WSIP*
1. Mahadeli	8. Humaiqani	18. Marzouki	**A. Waqir (WIS)**
2. Bahlooli	9. Beshari	19. Qaserah	**B. Debashya (DIS)**
3. Shroefia	10. Khlalyah	20. Wajeh	C. Khalifa (KIS)
4. Husseini	11. Saqia	21. Shamiri	D. Barquqa (BIS)
5. Uthun	12. Dehna	22. Hakoume	
6. Qamusia	13. Syali		
7. Akm/ Waqir	14. Matani		
23. Mohammed Yahya	15. Khanani		
24. Omar Qadi	16. Magaribi		
25. Mohammed Abdallah	17. Barquqa		

Figure 3.1 Waqir, or former "Wadi Siham"'s irrigation infrastructure

Nowadays, in this area, three types of structures direct water to the fields: transversal bunds that cross the wadi, lateral dykes, and the new canals of the WIS. The latter's concrete diversion structure and its flaming red field outlets caught our eyes first (see 7 in Figure 3.1). When proceeding downstream along the wadi, some sandy barriers seem abandoned, others are in a better state, some smaller others bigger; on the way, we also met excavators of a digging company removing copious volumes of sand from the wadi bed. Nearby, we saw large structures reinforcing the wadi banks. In March, on most fields that we crossed on our way, tobacco leaves had recently been cut and left on the fields to dry. Towards the end of our tour, we encountered a construction site, where many bulldozers and workers were busy around the barrier of Shroefia (see 3 in Figure 3.1), building gabions and reinforcing its structure. Continuing along this dry desert, we finally arrived at Bahlooli and Mahadeli (see 2 in Figure 3.1), where one cannot help but wonder whether water has ever reached it. Yet, during our research, we heard several comments similar to what the Aqil of Mahad al Asfal recounted:

"In the past, we used to irrigate our lands from huge sandy barriers that could give water to the whole area!"

"In the past, there was a lot of water, everything was green and production was excellent!"

What happened then in between the past and the present? Was this desolation that we were witnessing merely connected to the time of the year, the end of the dry season, or did it exemplify a serious problem of water scarcity? Moreover, how could we explain this diverse panorama of sandy barriers? What irrigation organisation had evolved around the different traditional haghus? How was the recent irrigation intervention interacting with the various sandy barriers and pre-existing irrigation activities? What farmers' responses to water management evolutions, in particular what organisational arrangements, could we highlight, around what irrigation structure did these develop, and why? Was there a pattern of change that characterised them, or had they all developed autonomously?

By answering these questions, we want to pull to the fore the evolutions in who has the control of water, how, where, and what for. We believe that a good grasp of past processes is a necessary step to understand the present situation of water control, particularly in a post-intervention context where some actors seem more successful than many others in appropriating the new irrigation reality to their own advantage. Therefore, in the sections below, we will begin our analysis of this part of the wadi by tracing the different phases of pre-intervention irrigation progress. We will focus on those enabling and/or hindering factors peculiar to those irrigation technologies, their organisational forms and their specific forms of water control, and their evolution, apogee and eventual decline. Then, we will analyse current patterns of water access and distribution, which partly follow from these evolutions and partly result from new inputs into the wadi's reality, namely irrigation improvement projects, national socio-economic and political changes, and institutional reforms, which we will examine in the due section. We will explain current water access and distribution through a description of the various interactions between recent interventions and older water networks and the reactions that emerged, for instance the creation of new WUAs.

3.1 Enabling factors for the flourishing of sandy barriers

The first large sandy barriers appeared about 70-80 years ago, sponsored by the second Imam, Ahmed Bin Yahya, who was interested in the agricultural growth of the area, particularly of tobacco and cereals. When he took over his father's reign, smaller sandy barriers already existed. By relying on the local power of certain sheikhs, whom he nominated his local representatives for the direction

of the toilsome construction works of new and much larger barriers, he managed to gather a numerous labour force amongst the local farmers.

The type of hydraulic structures needed to marshal Wadi Siham's flood flows in the lower part of the wadi were both of considerable size and labour intensive in terms of materials, and human and animal resources. For instance, although the works varied according to the damage, we were told that 60 oxen and one month of intensive effort by 3-400 farmers conjunctively was a quite normal scenario when Akm, the biggest sandy barrier, was damaged. Hence, force alone would not have sufficed.

According to the data that we collected on the field, we identified that three conditions for use (Mollinga, 1998) should be satisfied for an efficient technical water control through the barriers' proper maintenance and operation.

1. Strong cooperation reinforced through a common objective –agriculture;
2. A sufficiently-satisfying hydrological context that fostered expectations of a potential irrigation enough so that farmers would willingly contribute to the infrastructure's maintenance;
3. An authoritarian but respected figure that coordinated construction and maintenance works, and supervised the barriers' operation.

3.1.1 A common objective: farming and irrigation

In Yemen, "Wadi Siham" is famous for its tradition and expertise in tobacco growing. Farmers have been cultivating it since the beginning of the 20th century, if not earlier, although intensively since Imam Yahya. Until today, the cropping pattern in this lower area of the wadi is based on tobacco during the dry season and sorghum (and few other cereals) in the rainy period. These two crops are central to farmers' local livelihoods: sorghum for human and animal consumption and tobacco for cash generation, crucial in an environment so full of uncertainties as a spate irrigated area.

Wadi Siham was one of the main national sources for grain production since the time of the Imam. Grains were even exported to Saudi Arabia. Every year, during harvest times, hundreds of families from all around the area, especially from Lahj, came as seasonal workers. Tobacco was already as the established local cash crop when the Imamate began in 1918. Yet, our informants in the wadi mentioned that Saif Al Eslam Mohammed and Saif Al Eslam Abdullah, the two brothers of Imam Ahmed Bin Yahya, the son of the great Imam that defeated the Turks in 1918, gave a further thrust to tobacco. They started a trade for the tobacco of Wadi Siham and appointed Sheikh Suleyman to be the buyer.

In the wadi, spate water has been/is crucial to the satisfaction of both crops' water requirements, although in different ways. Sorghum is directly irrigated with floodwater, diverted by the barriers onto the fields: two spate irrigations ensure very high yields of about 20 tons/ha of fodder and 2 tons/ha per year of grains (Dumas, 2008). Tobacco, on the contrary, is very sensitive to the high pressures of wadi flows and needs frequent irrigations with smaller amounts of water. Hence, it is cultivated during the dry season when it is irrigated through wells, which in the past used to be shallow and provide bountiful water. However, tobacco too benefits from the soil fertility left by the highly sediment loaded floodwater. Additionally, tobacco growers have long been aware of the importance of wadi flows for the recharge of their wells. Therefore, farmers need to ensure that sandy barriers be built properly every season and since the only way to do so is to cooperate with other farmers, they were willingly joining the type of collective organisation that we found in the wadi.

Box 3.1: Tobacco

Wadi Surdud and Wadi Siham are the wadis with a tradition in tobacco cultivation. Wadi Siham, being a quite recently agriculturally exploited wadi, this crop appeared about hundred years ago. Whereas Wadi Surdud's variety is smaller and is of higher quality, Wadi Siham's one has bigger leaves and is more rustic. To give an idea, one bundle of Wadi Siham's tobacco corresponds to three bundles of Wadi Surdud's in size and whilst the former are sold 900 Ryals (4,50US$) a bundle, for Wadi Surdud's buyers pay 1000-1200 Ryals (5-6 US$).

As far as we were informed by TDA, tobacco nowadays does not enjoy specific support in terms of providing seeds and support in agricultural practices as "farmers have already got the expertise and little research is done on tobacco".

3.1.2 Authoritarian figures lead irrigation practices: Sheikh Suleyman

As we mentioned above, the imam had elected some local sheikhs as his area representatives for water management. From the 1940s until the 1970s, Sheikh Suleyman Saleh ruled the whole "Wadi Siham" area. During this period, the wadi flourished. As Suleyman himself possessed lands that were irrigated from Uthun (see Figure 3.1), during his government, this became the greatest barrier of Wadi Siham as special effort was placed in its maintenance. Nevertheless, the Sheikh was able to enforce his power also on other locales and henceforth, he could maintain properly also other barriers that equally flourished and whose people cooperated under his jurisdiction. For instance, under his supervision, Zeid and Bukhet were the local sheikhs in charge of the Akm barrier, which together with Uthun, were – and remain – the two biggest structures and those most vital for the area's irrigation. Akm barrier functioned as flood regulator as well as diversion structure: its high wall slowed down the flood, and this limited the destructive impact of the flood on the successive, smaller barriers.

Most of those whom we interviewed agree that their authority and charisma were essential prerequisites for maintaining coordination amongst farmers:

> *"Strong leaders are necessary for holding farmers together"* (a sharecropper in Dawm)
>
> *"One man could call all farmers"* (Aqil of Zuberia)

These are only some of many similar accounts that we collected in the wadi and that express the importance of charismatic figures for this collective type of irrigation and water control, as, in order to ensure the continuous prosperity of the area, they had to convince water users to set aside any internal conflict and rivalry in name of the common good.

These figures ruled the wadi with an iron fist, according to our informants:

> *"Why did we contributed to maintenance of sandy barriers? We had to! There was no other way!* [...and after we inquired a bit further…] *but we were happy! In the past, despite the high taxes collected by the imam, there was a lot of water, everything was green and production was excellent!"*

Although perhaps idealised, references to a greener past in association to the figure of Suleyman Saleh (and Zeid, although to a minor extent) constantly emerged in farmers' conversations. As we said, he favoured both agricultural development and the mastering of the water, and its prestige, in turn, affirmed itself through these means.

Hence, in those past bountiful years, before seif and kharif, the area sheikhs gathered the large landlords of each barrier in turns to discuss about the coming flood season and to elect two or three

barrier-representatives, who would be in charge of coordinating the works concerning the sandy barrier. Generally, these agents were always the same: aqil*s* of the villages and other influential farmers. After the elections, they reunited all owners, including small ones, organised maintenance turns and the collection of those financial resources, oxen and materials, necessary to its completion. Once this was arranged, sheikhs supervised the works.

Participation in maintenance activities was differentiated and decided according to type of land tenure, land size, wealth of households, and frequency of irrigation. Those areas that could be inundated on a more irregular basis and whose irrigation was subordinated to others were not expected to contribute as much as other areas that received more frequent spates. Moreover, until the 1970s, only large owners were asked to provide enough means and materials for the maintenance, whilst smaller owners and sharecroppers contributed with their labour. Since then, in some barriers, the latter group began to supply money also, as maintenance grew more expensive with the introduction of tractors and financial inputs became more necessary than before.

Cloudy sky and fresh air were the signals for which farmers were waiting for: a flood was about to come and people had to prepare for irrigation! When water came, in line with the al aela fil aela rule, barriers were working in sequence. Although surely conflicts arouse back then too, generally, if the flood was not abundant enough to overflow/ break the barriers, water users from the next one used to break it to allow the water flow to their haghis. The traditional Wadi Siham area was divided in two irrigation locales: Rakaba and Rabassa. These depended on different sandy barriers. The higher Rakaba area, upstream, relied on Akm barrier, whilst the lower areas of Rabassa was irrigated from Qamusia, Uthun, Husseini, Shroefia, Bahlooli, and Mahadeli (see Figure 3.1). Rakaba area had priority rights in the summer (March-June) while Rabassa in autumn (July-September). This rule appears to be partly a hydrological one as generally only during autumn, floods are of enough magnitude and frequency to reach tail areas. These tail areas used to receive spate flows once or twice a year on a regular basis, both in summer and autumn. Floods then generally inundated the whole area of both Rakaba and Rabassa or, at least, major extensions of it. Hence, although administratively separated areas, it occurred that Rakaba and Rabassa's hydrological boundaries merged at two levels. At "main system" level, the wadi flow created operational interdependency between the barriers, while at field level, during big floods, water diverted from Akm flowed from field-to-field and reached naturally also the lands of the upper Rabassa villages.

Lateral dykes (see Figure 3.1), as they did not block the water flow. Instead, they only diverted a small part of it, were not supervised by the Sheikhs, but instead, they were autonomously managed by their owners. Mohammed Yahya, Omar Qadi, and Mohammed Abdallah dykes, for instance appeared about 60 years ago for irrigating lands that could not be reached by the existing barriers. They irrigated areas in the north of the wadi, around Wasset, Afaja, and Hazamya that received water from Akm only during floods of exceptional magnitude.

3.1.3 A satisfying hydrological context

Another enabling factor that we identified is *water*: farmers contributed to the laborious maintenance primarily because they knew that they could expect a satisfying return in irrigation terms and hence in production. Yet, given the nature of spate, the availability of water varied significantly from one year to the next: therefore, legitimacy of organisational forms was constructed across several hydrologically-satisfying years. Similarly, they would collapse after a period of water scarcity, not solely one year or two. Since the sheikhs' power and legitimacy in the eyes of the local farmers was largely dependent on their good harvests, the presence of water was a crucial element for the persistence of their rule:

"*Sheikh Suleyman could bring water until the sea!"* (Aqil of Mahal Asfal)

The association of the sheikh to the materialisation of good floods reflects a more practical explanation. Several years with scarce rain and higher unreliability of spates than normal will gradually impoverish people and eventually, it may discourage them from this endeavour. Over the years, the fruitful combination of hydrology, farmers' common objectives, and a strong and legitimate figure of authority ensured the overall wealth of the Wadi Siham area, although with some fluctuations from one year to the next. Farmers held the various sheikhs too in high consideration, as under their authority, barriers could divert sufficient volumes of water.

3.2 The beginning of a demise

The optimal – if slightly idealised! – situation depicted above was set to alter drastically with changes in the triad of water-farmers-leaders, particularly after Independence and the creation of the Republic of North Yemen. Water scarcity, impoverishment, migration out of the wadi, less labour and animal power, coupled with the financial requirements of tractor rentals, were disenabling conditions for a proper maintenance of the barriers. Although this is a general trend for the former Wadi Siham, these factors impacted differently on the various barriers as each one represents a specific water network.

3.2.1 Water scarcity

In the last decades, dry-spells affected the area in 1982-3, 1987-8, once in the 1990s, and 2007-8. Overall, farmers tend to agree that water availability diminished. They reported that whilst in the past, some spring flow reached their part of the wadi for more than once month per year, in the last decade this water source disappeared and even the frequency of floods decreased to less than twice a year. Moreover, floods do no longer cover the whole area (until Bahlooli), if not exceptionally. This seems to be a major cause for the decline of the role of sheikhs, which in turn may have led to the present decayed state of several barriers.

"Nowadays there is no water, so there is no role for sheikhs"

(A small farmer in Shara)

Yet, hydrological changes alone cannot justify these changes in water control. However, farmers resources were certainly drained as a result of the numerous droughts, which, coupled with the unstoppable deepening of the groundwater table, constrained them to seek jobs somewhere else or to sell their oxen, which were indispensable for a proper maintenance of barriers. One of the principal causes for the abandonment of many barriers was the pressure placed on groundwater resources since the late 1960s by state subsidies for groundwater exploitation. As a consequence, the water table began to drop by a few metres every year, which in turn impeded the proper cultivation of tobacco that as mentioned above constituted the main source of cash income for the majority of the local farmers.

3.2.2 Migration

Broader socio-economic changes have occurred in Yemen since the 1970s. After the Imams' defeat in 1962, Yemen experienced some decades of rapid and incredible economic growth, particularly thanks to its large oil and gas resources, along with money flows from Yemeni workers in Saudi Arabia. Migration to Saudi Arabia and to the cities, which followed a dry spell in 1970s, appears to have begun to switch some of the attention of Wadi Siham's farmers away from agriculture towards the seeking of new sources of income. This was also dictated by an increasing population pressure, whereby the new generations had to deal with a serious land shortage.

However, it seems that the second migration wave at the beginning of the 1990s, after the Gulf War, had a greater impact on the maintenance of sandy barriers and particularly on the maintenance of Uthun barrier in specific. Farmers, whom we interviewed in Shara, where the main labour force for Uthun maintenance resided, reported that many of them moved to Saudi Arabia to find other sources of income to sustain their families in the wadi. Indeed, following another dry spell at the end of 1980s, agricultural production fell significantly.

As a result, farmers grew poorer: many smallholders of Shara with 1-5 ha sold their lands and left, whilst those who stayed behind were often forced to sell their animals in order to deepen their wells, provide for marriages and household needs, and because of lack of fodder.

It is interesting to notice that although Uthun and Qamusia's functioning was severely affected by these migration waves, Shroefia and Husseini continued to irrigate satisfactorily. This is largely explained by the different social fabric of the water users in each barrier: small and medium owners in the former two, whilst the large Qaserah family dominated the lands irrigating from the latter two barriers. As such, the latter were better prepared to face similar bottlenecks to production. Theirs is an example that illustrates that the location of the barriers does not necessarily determine a certain pattern of water access.

Nevertheless, foreign and urban remittances balanced this seeming agricultural crisis. This new type of welfare led to an explosion of births which increased the population in Waqir manifold. When this generation grew up, land available grew scarcer for both large and small owners and sharecroppers' sons and this propelled another migration wave upstream, towards the Barquqa area, which we will examine more in depth in Chapter 4.

3.2.3 The arrival of the tractor

As we mentioned above, maintenance of sandy barriers was an expensive undertaking that required much labour and oxen, both of which were lacking in the early 1990s. Since the 1970s, a new machine, the tractor, was increasingly substituting the use of oxen in the fields, and in the maintenance activities of the sandy barriers. Oxen had in the past been crucial for constructing the barriers, but tractors required less labour, were more comfortable and time saving. This apparently balanced the unwanted effects of weaker barriers that broke more frequently thereby hindering an adequate irrigation. Yet, a recurrent analogy among farmers was:
Imam=oxen = strong barriers vs. *Republic = tractor = weak barriers*
Indeed, fewer water users could contribute to the more expensive maintenance with tractors.
Furthermore, this led to a loss of ownership for the barriers: external personnel should be hired to drive the tractors and the farmers who had sold their livestock were now required to submit cash contributions to pay for the rent of the machines.

3.2.4 A generation of sons

According to the near totality of our wadi interviewees, another factor that, conjunctively with the previous ones, appears to have led to the collapse of earlier social arrangements for maintenance, is the alleged absence of a charismatic leader.

After Suleyman Saleh, no sheikh has succeeded to reach his level of legitimate authority, whereby the whole area respected him and followed his orders, which in turn ensured a proper irrigation, and finally, abundant yields. After Sheikh Suleyman's death, his son, Ibn Abdullah Suleyman Saghir, inherited his position. Yet, farmers believed him inappropriate to take over the role of sheikh for his "unusual" interest in medicine. Similarly, in the Rakaba area, the son of Sheikh Mohammed Ahmed Zeid, responsible for Akm barrier, was not believed as worthy as his father because of his less

charismatic attitude. Hence, this new generation was struggling to replace the one of their fathers. It suffices to say that local farmers still refer to them as the "generation of sons": in their perception, they were a collection of "lazy" people, "too educated to be interested in agriculture", "detached from farmers' realities", and so forth.

> *"*Sheikh *Zeid's son was not as charismatic as his father. He was a weak man. He sold his fertile lands and chewed qat!"*
>
> *"[Suleyman's son] quit for studying medicine. He was worth nothing!"*

Their already wavering reputation was also accompanied by three years of drought, which, in light of what we mentioned above on the meaning of water for a sheikh' legitimacy in water users' eyes, certainly did not reinforce their status. In practice, the weak personality and authority of the various "sons" materialised in the physical characteristics of the barrier at that time: their barriers broke frequently.

In the midst of this context, profiting from both the new sheikhs' unpopularity and accusing Suleyman Saghir of participating in the Hamati revolution of 1977[11], Mohammed Abdullah Qaserah and Beshari appointed themselves as area sheikh. Qaserah became the head of Rabassa, whilst Beshari collaborated with Zeid's son in Rakaba. The former was the first member of his already politically- powerful family to become a water sheikh, as the barriers under their control were significantly smaller than Uthun and Akm. The latter was a governmental person sent from Sana'a to supervise the newly introduced cotton production in the area, who had earlier befriended Zeid's son.

Box 3.2 Cotton

In the beginning of the 1970s the two governments of Yemen heavily pushed for cotton cultivation in the Tihama and in the Gulf of Aden. In the Tihama, the National Cotton Company was founded to encourage farmers to grow cotton.

In Wadi Siham, intensive cotton plantations were introduced first in the area of Khalifa, Kadid, and Saqia villages by Awadh Abdullah and Beshari, one agronomist from Aden and one governmental bureaucrat from Sana'a respectively, and a decade later, also in the lower valley, in the area of Malakydya village. Whereas in the downstream locale cotton was primarily irrigated with groundwater, in the area of Khalifa, spring flow and floods were the main sources of irrigation. Between Malakydya and Khalifa, cotton could not expand as there tobacco had already established itself as the main cash crop.

Cotton cultivation and trade significantly pushed the economic development of the mid-Wadi Siham. However, in the last decade, due to a decrease in cotton prices and degradation of soil and water resources, especially groundwater, this crop lost its competitiveness and agreements between farmers. All these factors induced the complete abandonment of this crop cultivation.

Nevertheless, despite their power, neither succeeded to gain as strong a legitimacy among local farmers as their predecessors. For instance, landowners in the upper part of (the traditional) Wadi Siham, Rakaba, rarely mentioned the sheikhs of the Qaserah family and contemporaneously, Beshari and Zeid are largely unknown by those farmers in Rabassa. Yet, there were two consequences of this power shift from Sheikh Suleyman to Qaserah and Beshari. As power moves resources, on the one hand the attention was deflected from Uthun barrier towards Husseini

[11] In 1974, the coronel Ibrahim al Hamati gained power over the whole Arab Republic of Yemen. In 1977, he is murdered in the so called "al Hamati Revolution". The following year, Ali Abdallah al-Saleh becomes the new President. He remains the President to date. (http://enciclopedia.studenti.it/yemen.html)

mandab, from where Qaserah irrigated. On the other hand, Beshari, with the help and "permission" of junior Zeid became responsible for *Akm* barrier and its upgrading.

The present states of the barriers illustrates the relevance of charismatic leaders – although less powerful than Saleh -for the endurance of sandy barriers. Those barriers administered by Qaserah are still functioning today, whereas those others where nobody very powerful was in charge, such as Qamusia and Uthun, have not been able to irrigate to their full potential for at least the last decades. Not least, Beshari's barrier was chosen by the World Bank as the site of the diversion weir for the new WSIP, despite the fact that the most logical place was upstream, where the DIS now lies. As a reaction to the collapse of several large barriers, some large farmers who had the means to do so constructed their own smaller, lateral barriers, mandubi. These are for instance Mohammed Ali Sanaa and Beshari (see Figure 3.1).

3.3 State entrance in the wadi

While these traditional structures were decaying, Akm barrier continued to flourish. When in the 1970s, the Government sent him to the area for enhancing cotton cultivation, Beshari took possession of lands that were previously owned by a former supporter of the Imam, escaped to Saudi Arabia. These lands, however, were higher and further upstream in the wadi, and could not be inundated from Akm. Hence, at the beginning of 1980s, Beshari organised government funding for the raising and widening of the Akm barrier (which became 80 m high!), so that it could irrigate more lands upstream, amongst others, his own fields. Thanks to his governmental position, Beshari could attract the attention of Abdallah Bin Hussein Al Ahmar, the head of the Yemeni Parliament at the time, which was already drafting plans for agricultural development, towards Wadi Siham. Promptly, support from Sana'a arrived in form of bulldozers and tractors. As it appears, Akm's course of development began to follow a new path, more independent of local resources of water users and local leaders, but which relied intensively on external and state intervention.

The improvement of Akm was not only intended for irrigating Beshari's fields but it would also benefit the farmers of Rakaba, whose maintenance burden was reduced. Finally, it also extended water rights to the area that is presently irrigated by the DIS. For instance, the village of Deir el Beheri became the first indirect beneficiary without previous rights to wadi irrigation. Deir el Mosbya, part of Jebalya, and Al Suwal (see Figure 3.1) seem to have also received water rights whereas before they used to be rainfed. Hence, Beshari was called by these beneficiaries as the new sheikh, because he "*brought the water*".

Concretely, in the lower Wadi, Siham Beshari-led state intervention represented the beginning of a shift from sheikh's community-based power for water control and the pursuance of external, governmental support for irrigation and agricultural practices by those who could access it. This could perhaps not have occurred in such a drastic fashion were the hydrological context still satisfying, the leadership legitimate, and migration not such a strong phenomenon. Moreover, we argue that the type of social network around the various barriers and the presence of an influential elite have an influence on how interactions with state interventions develop and on the opportunities for improving water control.

This endeavour exemplifies very well the broader institutional change Yemen was undergoing from the Imamate to the Republic. In addition, the fact that Beshari was a governmental representative in the wadi may have played a significant role in the World Bank choice of the site for the WSIP. Yet, the change is less drastic that it may seem: from the Imam to the new government, agriculture in the Tihama plain remains a priority – particularly commercial agriculture. Moreover, let us remember

that around the same time, Awadh Abdullah, another governmental representative in charge of cotton production in Khalifa, had already extended the old mandab and introduced large-scale cotton cultivation.

Overall however, we can claim that the basis for the WSIP (commercial production through irrigation improvement endeavours) had been set for at least a decade before the actual inception of the works.

3.4 The Wadi Siham Project (WSIP)

As a result of the changes mentioned above, when the WSIP began in 1993, despite few exceptions, a general trend of badly maintained irrigation infrastructure with resulting irrigation deficiencies could be witnessed in the lower wadi, particularly around Uthun, Qamusia, Mahadeli, and Bahlooli.

In Wadi Siham, the first irrigation interventions comprised of the construction of "Waqir" permanent diversion weir and canal system at the Akm site, funded by International Development Agency of World Bank (WBIDA), the Government of the Netherlands, and the Kuwait Fund for Arabic Economic Development (KFAED). From the beginning of the project, this downstream region that was previously addressed as "Wadi Siham" began to be referred to as the Waqir area. After more than a decade of attempted designs, the final version was proposed by National Engineering Services Pakistan (NESPAK) in 1991. Since Wadi Siham was the last of single-wadi development projects, and aware of the troubles that larger irrigation schemes were undergoing, here TDA/WB attempted to create a series of smaller systems rather than one large.

In 2005, the irrigation systems of Barquqa and Debashya were also completed while the last system, Khalifa is still under construction (see Figure 3.1: A,B,C,D). On paper, TDA should take charge of the operation and maintenance of all the new structures, namely diversion weirs and main level canals and gates of the four irrigation systems. Lower system levels should be under farmers' responsibilities. According to designers and implementers, in 10 years the envisaged increase of the production by at least 2/3 should have been achieved with the help of a constant monitoring of operation activities, water distribution, and water use.

In Waqir, a diversion weir of concrete was to substitute the traditional Akm barrier and a canal system of a total capacity of 22.5 m^3/s, for a potentially irrigated area of 3448 ha[12] was supposedly to cover also the command areas of Qamusia and Uthun. Three canals were to have their inlets after the main intake, which also feeds flushing gates: WMC, WMC3 – which crosses the wadi through a siphon and flows on the left bank- and WSC that very surprisingly ends on the very first fields after its intake (see Figure 3.1). The canals have a design discharge of 16.5 m^3/s, 4 m^3/s, and 1 m^3/s, respectively. Within the frame of the Waqir project and with the purpose of flood protection, the TDA also reinforced some traditional structures along the wadi. For instance, Bahlooli dyke was supposed to be provided with gabions and concrete in order to protect Hodeidah and Marawah from destructive spates – this project never materialised.

Looking through official reports, monthly diversion volumes both at diversion weirs and at field outlets are calculated according to a recommended cropping pattern and for both schemes of Waqir and Barquqa considering their joint functioning. Numbers seem to match perfectly the needs of the crops, the water availability in the wadi, the coordination required between Barquqa and Waqir

[12] Yet other sources state 4429 ha (Nespak 1996)!

water needs and operation. Everything would hint at a smooth and precise operation of the system allowing the supply of the exact amount of water needed by the crops in a certain period.

However, in practice, ideas embodied by interventions are rarely met to the desired extent, whilst their outcomes are more heavily shaped by externalities and by the interaction with the local arena (Long, 1989). This is surely the case of Waqir. We often heard complaints from both farmers and TDA staff that serious impediments were hindering the smooth operation of the systems and water distribution to fields. It emerged that technical deficiencies and the way the system was operated and maintained in practice were underlying causes for this. The effects of the intervention process reached beyond the new irrigation system's command area and farmers. They were felt also within the irrigation reality of the traditional sandy barriers. Below Figure 3.2 shows the patterns of change in water access and water distribution in Waqir. We will then explain how this situation was produced by investigating the interactions between the intervention and the receiving context.

3.5 Different patterns of water access and water distribution

On a general note, farmers also pointed out that the situation got remarkably worse in terms of both less floods and worse state of the barriers only in the last 10 years, elements, which are directly connected. It is difficult to say whether the construction of the weir in Waqir and the type of diversion (now proportional when the flood arrives *versus* rotational of the previous Akm barrier) has had an impact or not on water availability for the barriers further downstream. What is sure is that both the increased diversions upstream that were heavily favoured by the later interventions in Barquqa in the last 5 years, and the scarcity of floods of the last 2 years, have seriously diminished the presence of floods in the lower wadi.

In order to draw a map on the present situation of water access in the wadi, during our fieldwork, we interrogated people from different areas; tail and head-enders of wadi irrigated areas; systems; and canals, about the frequency of spate irrigation and the last time they could irrigate from mandubi, barriers, or new canals. Figure 3.2 below summarises our findings. The area marked in light blue is the one that used to be flooded in the past. The ones in dark blue are those who can at times irrigate nowadays. Additionally, according to the seriousness of the farmers' water loss, compared to previous water rights, and to their importance for agricultural production and livelihoods, we identified three zones (those in red) that in Waqir have been most seriously affected by scarce water access, each for its own specific reasons.

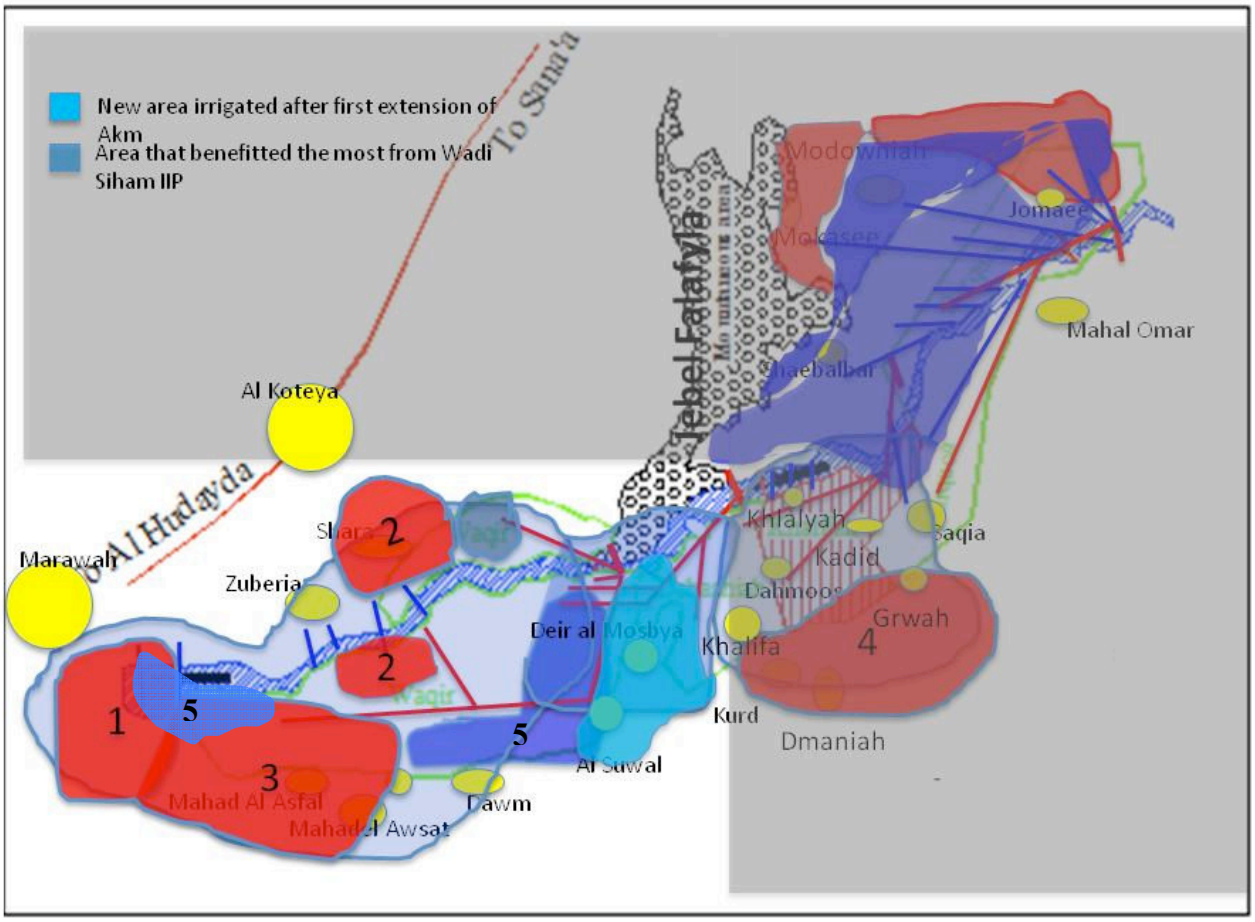


Figure 3.2 Most affected (and benefitting) areas in Case Study I.

MOST AFFECTED AREAS

Area 1: **downstream of Al Bahlooli barrier: this area used to irrigate with exceptional floods but regularly twice a year. Nowadays, floods do no longer reach this area on a yearly basis, but once in four year on average. Farmers cultivate rainfed fields with millet and sorghum, which they also irrigate with pumps.**

Area 2: **From Waqir to Shroefia: this area was previously inundated twice a year, yet during the last 10 years, only once per year. Farmers rely on rains, erratic spates, and wells.**

*Area 3***: along WMC1 also exceptional floods but regularly twice year at least. Now some still get spate water once a year from canal, some lost completely the spates and rely on rain and pumps.**

Much of these areas, and particularly several villagers of Zuberia, Mahad al Awsat, and Shara have shifted in a more or less permanent way to rainfed agriculture of sorghum and are beginning to abandon tobacco. Additionally, these villagers reported that many fields were abandoned altogether and even in those still cultivated, they witnessed a generalized drop in production. Moreover, whereas in the past there were several farmers that could grow vegetables, nowadays, this initiative has been dropped by almost all those farmers pursuing it before. Hence, the general feeling shared by many large and small owners, and sharecroppers, is that agriculture here in Waqir is going down and the scarce rains of the last years aggravated the situation even more.

Area 5: **Around Husseini and Shroefia, and along WMC and WSC5, there stand the farmers who can still access or have a better access now of flood water. Interestingly, it is almost all large owners.**

One must not forget that Waqir has traditionally been an area for the cultivation of tobacco, where farmers always practiced a conjunctive water use of surface and groundwater. Spates recharged the groundwater. Today, a significant decrease in the latter source can be noticed in those areas which lost access to the spate. As for tobacco growers, it has become harder for them to afford the very high costs of diesel. The number of wells that increased at a higher pace after the construction of the Waqir weir, and massive groundwater extraction in the area of Waqir caused the drying out of many dug wells. Indeed, the drawdown of the groundwater table is without doubt a major concern, especially in this lower part of the wadi. Ensuing salinisation of the soils, to which young plants of tobacco are very sensitive, is another impending problem. There is a further issue that has been raised by farmers irrigating from the canal. That is, now that the area is no longer flooded by the sediment rich water and due to the reduced distribution of water on fields that concentrates only near the canal, it appears that the structure and fertility of the soils have been negatively affected.

In order to shed light on the reality of water distribution presented above and keeping in mind the hydrological context described in the previous chapter, the following sections explore the implications of the project's implementation on water control and access. In particular, we are interested in current organisational undertakings for water management. We will attempt to unravel what lies behind the present water control situation, which is crucial for our objective of drafting suggestions for future water management initiatives in the wadi.

3.6 Technical interactions and implications on water distribution of old and new irrigation schemes

Here, we highlight the main causes that led to both the loss of water access in areas 1, 2, and 3 and a favourable water access of area 5. For clarity's sake, we defined two typologies of interaction and emerging implications: technical and organisational. This does not intend to box them: rather, we want to stress that the nature of interaction may trigger diverse reactions. By doing so, we will highlight who lost and who gained from the various technical alterations that either preceded or followed the irrigation intervention project.

Within technical interactions and implications we outline the process of exclusion and inclusion in the command area of the new system that emerged from the following: implementation, modifications of technical details; operation and maintenance of the various infrastructures downstream; and improvements of existing irrigation structures. In other words, how pre-existing and new water-networks interact with each other and what outcomes take shape as a result.

3.6.1 Implementation process of the WIS and "participation" of farmers

During Waqir Irrigation System's construction (1993-1996), externalities like the civil war in Yemen (1994), the consequent devaluation of the Yemeni currency, and internal issues between the Contractor and the Implementing agency over the resulting increased costs caused delays in the accomplishment of works. These were further delayed by interruptions by farmers whose production was severely hindered by the lack of a diversion system/sandy barrier.

This tense climate enabled farmers to try to push for those modifications of the design that they felt necessary. WMC3 should have been longer and irrigate all the way until Shara. However, its length has been drastically reduced. TDA engineers informed us that there is a financial issue underlying

these modifications of the original design, which were caused by the withdrawal of KFAED from the funding. Although it may be a case, this main canal ends exactly on the fields of a large landowner with governmental connections. Out of the four secondary canals, only one, WSC5 was completed for the same reason of lacking funds – as a result, at the end of this canal, members of the family of the aqil of Shara can nowadays periodically irrigate their fields.

Another canal, WSC, was also shortened – some farmers stopped its construction as the canal was lower than the fields and because they could not irrigate well from it. They feared that its lengthening would have favoured downstream farmers. Meanwhile, there were canals that were not constructed (WMC2) or shifted to a different location (WMC1). WMC1 originally was designed to run parallel to the existing one but more distant from the wadi, behind the villages of Dawm and the three Mahads, all the way until Suleymanya.

WMC2, that was supposed to run next to Deir el Mosbya until Suwal (see Figure 3.1), and its three secondary canals (2, 4, and 6) were deleted from pleas of some powerful farmers of Dawm. These very farmers, all large owners, are the same who asked for the shift of location of WMC1. According to our sources, farmers that would have received irrigation from WMC2 were not included in traditional water rights, as their lands were higher and as such unreachable by the flood. However, this alteration resulted in the fact that nowadays, only those fields along the canal, belonging to the same farmers that pushed for the change in layout of this canal seem to be able to irrigate!

As it appears, powerful farmers managed to direct the implementation of Waqir to their own advantage. Less powerful farmers were unable to influence the process. Some rich owners turned to the construction of their own private mandubi or rehabilitation of older ones. This process, coupled with a relative/absolute water scarcity, heightened social differentiation between upstreamers (near the new canals) and downstream water users: those with direct access to spates via new works reduced the share of water belonging to downstream.

3.6.2 Technical havoc

Farmers in Waqir often lamented:

> "*The canal is too low, water is not entering into our fields!"*
> *"The canal is too small! That is why water is not arriving to us!"*
> *"We do not have a gate! They do? Why?"*
> *"Water stays near the canal*!"

In theory, the manager Amin opens all the three intake gates of WMC, WMC3, and WSC simultaneously and then his workers open those along the canals "al aela fil aela", first those most upstream then the next ones. From there, water will flow field-to-field until reaching the end of the command area. Yet, while water arrives at headwork level at least once per year and often more, many fields still cannot irrigate.

It emerged that most of these bottlenecks spurred from technical problems of the new irrigation system. Although they are seldom the result of a deliberate by the engineer, technical faults can severely impede the system from functioning properly and as such, can hamper significantly the achievement of a project's objective. In our case, an increased agricultural production through a more efficient water distribution. Additionally, by creating a situation of water scarcity, they open up further spaces for power games and unequal water distribution.

Several issues were raised by both farmers and TDA engineers: under-dimensioning of Waqir's weir, and its wrong location; WMC-1 is lower than the fields and of low capacity; there is an absence of secondary canals, few gates, and low capacity of WMC3. These are the major factors that according to them obstruct the correct operation of the system.

During the various design processes, the dimensions of Waqir's dam have been reduced from taking into account a 20 year-return-period flood (peak of 1200 m^3/s) to one of a return-period of 10 years (peak of 824 m^3/s). This proved an unwise strategic choice as the dam suffered heavy damages during the first very big flood of 1998. In one of those floods, TDA realised that the flushing gates too were under-calibrated: damages occurred, and engineers were urged to intervene to redesign them. In 2006, the dam was again harmed. This time, the flood came at night and the gates were not open in time: trees and sediments blocked the flow, which continued downstream leaving the Waqir area dry. This particular episode had devastating effects downstream, as flood flowed at full force downstream. Farmers in both Qamusia and Uthun mention that after the 2006 flood, their barriers were damaged beyond repair. However, in the midst of disaster, Shroefia, at the far end of the wadi, could irrigate from the same flood most of its command area, like in the old times!

Furthermore, during the construction of the diversion weir, its foundations were lowered from 118 m to 115 m above sea level (it appeared that there were some problems with the altimeter!). As a consequence, nowadays WMC-1 and WSC are lower than most fields. On WMC-1, where this inconvenience is more severely felt, this impedes water flowing from field to field even when the gate is open. Hence, unless larger floods occur, always the same fields are irrigated along a thin strip of land on both sides of the canal. According to Abdulmohni, the General Manager of WSIP, this issue could have been avoided had the headwork been placed further upstream.

Continuing the list of technical faults, there are many fewer gates than the 52 claimed. This exacerbated the already existing impediments in the water distribution. The fact that farmers at the tail end of the sole secondary canal seem satisfied with the water they receive, whilst those where the other three secondary canals should have been built express openly their discontent, exemplifies the impact that their elimination from the implementation process has had on water supply. Yet, according to the manager of Wadi Siham's Operation and Maintenance, if farmers really needed them, they could build secondary canals themselves. For him, the problem is rather of an organisational nature and due to the "laziness" of farmers.

Moreover, it should be noted that NESPAK 1989's proposed offtakes were to be open-flume type proportional modules, whose discharge was to be proportional to the water level in the main canal, so as to ensure a better distribution of spate water. However, after a few years[13], farmers near Waqir's main canal (WMC-1) demanded gates, as early floods endangered their tobacco cultivations: as a result, all the field intakes are now gated and under the (theoretical) supervision of the TDA. We also discovered that in Waqir, some farmers who ask for a new gate/opening are granted permission by TDA, whilst others are not. According to the manager of Waqir and farmers we interviewed in Dawm, an engineer evaluates the feasibility of the new gate and farmers then pay for its construction. Since its inception, 6 additional gated field inlets have been built along the WIS.

Conversely, numerous farmers (both large and small owners) along WMC-1 canal whose fields lay distant from the canals insisted that they could not irrigate because those nearest to the gate had complete control over it. If the flood came during the tobacco season, these upstream farmers would close the gate and let the water flow downstream regardless of the next fields' water needs; whereas

[13] Unfortunately, it is unclear when, between 10 and 4 years ago.

if they needed water for sorghum (in summer), they would use it all for themselves. On the one hand, it was difficult to weigh the real impact of these claims, as at present nearly all farmers seem to cultivate tobacco in winter and sorghum in the summer. On the other, however, as a result of the lack of floods and lowering groundwater table, an increasing number of water users is beginning to abandon tobacco for other winter crops because those closest to the gate take all the scarce floods that come into the canal (see Area 2 and 3 in Figure 3.2). As we will discuss later, several initiatives are being undertaken and proposed by these groups of farmers, such as for instance new water users associations, or the revival of the old irrigation structure.

Most of the lands that now have access to irrigation belong to those large tobacco farmers - from the villages of Dawm, Jebalya, and Deir el Mosbya- who pushed for the change of location of WMC-1. These farmers are usually local landowners who sometimes live in the cities nearby. They have been cultivating tobacco for generations; possess large livestock, wells, and have an average cultivated surface of 3-500 maads (132-210 ha). Not only these farmers have control over the closure of gates, often they also manage to negotiate extra irrigation turns with the TDA manager.

In order to try to overcome the technical bottlenecks and meet the expected irrigated area, in 2006, the TDA supervised the implementation of the DIS both to restore water rights to an area previously irrigated by Akm (after it was heightened by Beshari – section 3.3) and to redress this system's inability to irrigate a whole area near the wadi: two of Debashya's canals protrude inside the command area of Waqir scheme (see Figure 3.1). In theory, in total, DIS irrigates 1,000 ha. Yet, to date the new canal irrigates a much smaller area than it was intended: farmers in that locale blocked its construction because of water rights issues, which many supposed beneficiaries of the new canal did not hold. Moreover, and again to compensate farmers for water losses, the TDA has also built two siphons along WMC-1, one for Uthun (10 years ago) and one for Qamusia (5 years ago). After the (eventual) improvement of the two barriers, which is currently being advocated by remaining landlords, these will lead the wadi's water from one side to the other of the canal. These structures are raising many expectations among farmers of the three Mahad villages (see Figure 3.1).

3.6.3 Technical implications of the WSIP for traditional barriers

Undeniably, the weakening of traditional sand barriers had already started some time before the irrigation intervention of Waqir dam 16 years ago. Yet, amid a generalised situation of less water availability downstream – whether from a dry spell or from increased water diversion capacity upstream, some barriers could control water better than others. It is worth remembering that the structures are not homogeneous: Uthun and Qamusia were in a noticeably worst state than Husseini and Shroefia.

A point calling for better reflection was the discrepancies with respect to the last time farmers irrigated from the different barriers. Villagers of Zuberia and Mahal al Asfal that both used to irrigate from Uthun, agreed that the last time this barrier was reconstructed properly and could irrigate its entire command area was about 15 years ago. More recently, some farmers could still irrigate from Uthun, but a smaller area was flooded as the barrier was weak and kept being destroyed by floods. Qamusia barrier underwent a similar destiny. The last time farmers could irrigate some lands from it was in 2006 after the destruction of Waqir, when the barrier was abandoned because of the enormous investment that it needed. This meant that both barriers could not divert any flood since then. Shroefia, on the contrary, despite the fact that it is further downstream, could irrigate some lands until 2 years ago. Other interviewees of Zuberia relying on Husseini mandab, mentioned that they have been reconstructing the barrier in the last years and could irrigate both in 2006 and even some lands last year! However, they too lament the weakening of their barrier which always breaks before water reaches the end of the area. Thus, not only there were big floods of 1998, 2002, 2004, and 2006, as farmers reported, but also during a dry water

year such as 2008. Therefore it happened that barriers further downstream could irrigate whereas those who should have irrigated first, were unable to.

Husseini Mandab deserves a special mention here. It was less affected by those factors causing degradation of other barriers because of an increased participation of farmers and a strong leadership by the Qaserah family. Husseini Mandab has changed strategy: 10 years ago the Qaserah clan began to demand all farmers irrigating from their mandab to pay for the maintenance as they could (or did not want) no longer afford its costs. Their authority and legitimacy in the eyes of local farmers was enough to guarantee the latter's collaboration. Even those farmers who nowadays rely primarily on groundwater for irrigation would contribute, as on the one hand they need spate water for improving soil fertility and recharge of their wells, whilst on the other they are usually worried about the seemingly irreversible drop of the water table, which increases incredibly the costs of well irrigation.

In addition, some other barriers benefitted directly from the WSIP. We already mentioned that the intervention in Waqir also contained a flood protection component. Some time after the reinforcement works on the dyke of Al Bahlooli began in 1990s, due to impending demands by powerful downstream families, the project shifted to Shroefia, the barrier immediately upstream of Bahlooli, where the family has many lands. For many months they visited the TDA office in Hodeidah and placed pressures on the various officers in charge, with the argument that if they upgraded Shroefia, the whole area would be protected by the floods anyway but the new barrier would also ensure irrigation for the downstreamers! The barrier, which had been insufficiently maintained for many years, began to function again as a water diversion structure for irrigation. As a precondition for the upgrading of this barrier, the TDA put demands on farmers to establish a WUA that had to contribute 10 % of the works. Nowadays, TDA is finalising a road protection project, adding stone masonry and more resistant walls and gabions. Thanks to the flood protection project, Shroefia's potential to receive water has significantly increased and its maintenance costs have diminished.

Yet, not all barriers benefitted from intervention as much as Shroefia, if at all! As Qamusia and Uthun were initially to be included in the command area of the WIS, expectations to receive irrigation from the new canals were high. They managed to convert popular understanding against maintenance of their more expensive and less functional barriers, which were gradually neglected until being definitely abandoned in 2006. The fact that they presented their project after a drought certainly played to the implementers' favour. Nevertheless, the new canals do not bring water to their fields.

During its 1989 feasibility assessment, the consultancy NESPAK announced that irrigation works were necessary to release farmers from the heavy burden of periodic maintenance of the barriers, so that they would have more means to invest in improved agricultural techniques. Although farmers were not consulted during the design, they were all informed when its construction was about to begin and that is perhaps when expectations began to rise. The idea of the consultancy that farmers struggled to maintain their infrastructure is strictly related to the time of their research, in 1988-89, after a few years of drought, where production in Waqir's spate irrigated areas was at its lowest, hence the farmers' financial means were seriously constrained.

The WIS had yet another negative effect on the maintenance of Uthun and Qamusia. Farmers claim that the deepening of the wadi bed due to massive extractions of gravel and sand raised maintenance costs to such an extent that they became unsustainable for farmers. While the excavation activities started in the 1970s, it is only in the last 10 years that they increased greatly for building roads included in the project's design.

Nevertheless, in 2006, as a compensation for exclusion of Uthun's lands irrigation through the new canals, TDA also intervened in reconstructing Uthun, first without farmers' contribution, then asking money for the rental of machines. According to farmers, the TDA carried out the job summarily and the fact that Uthun was completely wiped away during the project is partially their fault too! Uthun's water users were complaining about this partial intervention by the TDA: we had the impression that recently, expectations on TDA involvement have risen beyond simple maintenance or sub-renting of machines. Emulating the Shroefia episode, the Uthun irrigation community is now asking for and expecting major interventions.

3.7 Organisational interactions and reactions

We mentioned above that many barriers degraded because of the collapse of a previously well-suited and legitimate organisational structure around the construction, operation, and maintenance of the barriers. Yet some were still managed by powerful leaders and succeeded to mobilise sufficient (local or external) resources for a successful continuation of irrigation. When the WIS was completed, the TDA took charge of the system's main level whilst the farmers remained in charge of field level water allocation and distribution. In theory, this could have successfully worked. Yet, since some farmers utilised their power to turn the operation (and implementation) of their system to their advantage, his division of tasks was not very successful and this resulted in serious maintenance deficiencies.

For instance, in the last couple of years, the government has not given TDA any funds for maintenance. This year, they were waiting for a new transfer that was never coming! Therefore, along the wadi, we observed that maintenance of the new structures was often deficient. Amongst others, in Waqir, our observations confirmed that WMC-3 is seriously degraded: not only the canal banks are insufficiently high and eroded and its slope irregular, but high and resistant vegetation present a serious constraint to water delivery. "*This canal is more efficiently used by shepherds to pasture their livestock rather than for irrigation purposes!*" we were told by the tail-end farmer. (However, we heard that in August 2009 he irrigated too!).

Here we would like firstly to dwell on relevant organisational reactions and their socio-political nature that underlies the technical evolutions and implications for water control described above. We argue here that technical undertakings are not casual and there are organisational and socio-political explanations behind the capability of certain groups to control better the water resource. In other words, we will now turn to the reactions, again of an organisational nature, that emerged as an attempt to re-appropriate a certain water control. Four main reactions of organisational nature emerged in this area of the wadi, two forms of collective initiative and two types of individual enterprise. On the one hand, a Committee along WMC-1 and two Water Users Associations, one for Uthun and the other for Shroefia, whilst on the other, an individual initiative along WMC-3 and the recent individual construction of some mandubi and the rehabilitation of formerly abandoned ones.

3.7.1 Collective initiatives: WUA, the spread of an idea

In 2003, a Water Users' Association (WUA) was created in Barquqa (upstream) to maintain the lower levels of the irrigation system. In the beginning, its leaders received conspicuous funding from EC for the maintenance of the traditional mandubi that had become the secondary canals of the new irrigation scheme. In Chapter 4 we will investigate more in depth the evolution that this new organisational form took in Barquqa. Here, we would like to focus on what reactions the WUA's creation propelled downstream, in the Waqir area.

In this lower part of the wadi, farmers' perceptions of Barquqa WUA differ significantly from those of its supposed beneficiaries. Here, the story has been transformed. According to local narratives, thanks to the creation of the association, Barquqa's problems of maintenance were solved by TDA and EC conjunctively and this turned the area into a flourishing network of well-maintained canals, which irrigate verdant mango and banana farms. On the wave of this romanticised belief, two associations of water users emerged amid the realisation that only in this way, they could "get things done", namely to receive governmental funds for the irrigation development. Below we discuss firstly, the ideas behind these associations and the circumstances under which they were created. Additionally, we highlight what groups have access to this form of organisational reaction and their relations with local governmental authorities.

Firstly, in April 2009, a new WUA was created by the farmers of the barrier of Shroefia. According to the President, Sheikh Abdul Qarim Qaserah, the TDA encouraged them into this when the last phase of Shroefia's construction began. Indeed, according to the new rules set by the MAI/WB, farmers should contribute 15% of the total cost of placing gabions and stone masonry. In return, all the contributors would benefit from the water diverted by the new structure. According to its leaders, the WUA already counts 150 members, who pay an average of 500 YR/trimester (2.50 US$). This amount would never permit them to finish the rehabilitation of their sandy barriers, yet the status of WUA legitimates external sponsors to contribute to up to 90% of the costs. Moreover, according to its members and officialised in the Statute, another major task of this WUA is to control groundwater exploitation, monitor the illegal digging of wells, and explain farmers new techniques for more water efficient irrigation. Major maintenance will remain a duty of the TDA.

The form of WUA in Shroefia was pushed by the TDA during works, but built on a former organisational structure that existed around the barrier, headed by members of the Qaserah family. Farmers here had both a collective interest and a charismatic leader, the old sheikh Qaserah who also prides himself on many connection in the Government –amongst others, his nephew is the LC General Manager. They had already exercised a collective pressure on the TDA for having their barrier reconstructed instead of Al Bahlooli, and now they joined into a WUA in order to reduce the future costs of maintenance. They knew that the Government was interested in flood protection, which entitled the strengthening of the barrier that in turn suited their irrigation interests: the coordination of objectives assured them success to their pleas.

Secondly, another WUA, the "*Water Users from the canals of Wadi Siham*"[14] was created three years ago for a similar reason, by large owners irrigating from the Uthun barrier. It emerged as a means to gain easier access to TDA for training in new irrigation techniques and funding for the improvement of the haghis, whilst at the same time have an organisation that would represent and defend its members. The main objective of the association was the reconstruction of Uthun that after the 2006 flood and due to the increasingly deep wadi bed is now unaffordable even for the rich farmers. Ahmud Taher, its President, who is himself a large landlord, admits that he copied the idea of the WUA in Barquqa. He hoped that by creating an association, it would be easier for their project to receive attention and funding. Once again, here like in Shroefia, this WUA too was created on existing organisational arrangements for Uthun's water management.

This WUA initially counted of 120 members, all owners from the area traditionally irrigated by Uthun, who paid a quarterly fee of YR 500 – "a derisory amount", they admit, "but at least we will ensure the continuation of our association, not like in Barquqa, where now it has fallen apart!". Once the WUA was established and fees had begun to be collected, Taher commissioned a feasibility study for the rehabilitation of Uthun from an engineer. The final project estimated an

[14] It is remarkable that, although this initiative began because of their lost water access from the new canals and for promoting the reconstruction of Uthun, they chose to call their association with such a label!!

expenditure of 92 million YR (460,000US$), which, compared to the 400 million YR (2,000,000US$) that the government invested in Shroefia, seemed to them a reasonable amount to ask funding for. Since then, with a project ready, they have been trying to attract funds from various donors, but until present, to no avail. Beside their main objective, namely the rehabilitation of Uthun, the members now receive TDA support for agriculture. The authority subsidises members 50 % of the price of a drip irrigation kit and provides them with trainings and demonstrations for better field water management. Leaving aside debates over the veracity of these rumours, it appears that whenever farmers adopted a form of organisation in line with that promoted by TDA and donors, e.g. WUA or Memorandum of Understanding (see Chapter 4), they create a space for new opportunities for their water control, not only of spate water – although this remain the most needed –but also of groundwater and rainfall. Thus, nowadays the idea of an official status seems to surpass the water-networks of the individual barrier: external forces are called into the game to face the reduced water availability and luck of funding. However, despite the willingness to keep the barrier alive, from 120 initial members, already half of them abandoned the venture, as they did not conceive the importance of being in an association without some guarantees. Indeed, what distinguishes the participation in the WUA of Shroefia from the one of Uthun is that the former rotates around an already improved structure, whilst the latter still struggles to find the required financial aid.

By appealing to the TDA in terms of its own rationale, flood protection, farmers on the outskirts of the wadi area managed to promote their own objective –irrigation. Yet, not all that glitters is gold: coordination and communication with the TDA, whose interests in the restoration of the barriers would potentially merge with the ones of this WUA, does not seem optimal. The very same TDA engineers sponsoring the intervention on Uthun barrier are not aware of the association! Furthermore, we could not clarify whether the Uthun's project proposed by the farmers' organisation is the same as the TDA's one or they differ.

Thirdly, we came across an initiative for groundwater regulation pursued by a group of villagers of Zuberia and that appeared to be promoted by the National Water Resource Authority. In the village of Zuberia, farmers themselves, coordinated by the aqil, have commenced to monitor groundwater exploitation and limit each other's pumping within legal guidelines. This initiative has emerged from the realisation that the water table continued to decrease at an alarming pace. Therefore, now villagers are fighting against the digging of more wells: they supervise the whole area and it has already occurred that they stopped farmers. Not having the authority themselves, they bring their claims to the LC, or NWRA. Perhaps, a suggestion may be to train them in improved rainfed agricultural techniques.

Overall however, collective participation still proves to be an effective means to get water on the fields, even if it embodies a disengagement from grassroots initiatives and instead a greater dependence on external institutions, which however is not a new phenomenon in the wadi. Moreover, it seems that wherever these new organisations emerge on top of an already existing tradition of collective action, they are more easily established. Nevertheless, the various initiatives under way do not seem to have yet managed to reverse an impoverishment process that appears to affect many in the Waqir region.

3.7.2 Individual initiatives

Some farmers however still prefer to pursue individual solutions to the present conundrum. In order to face the maintenance deficiencies along WMC-3, where he is the tail end water user, around a decade ago one large farmer substituted TDA in the maintenance of his branch of the main canal, in a fashion that recalls owners strategies further upstream (see Chapter 5). However, due to water scarcity, he too abandoned the endeavour a couple of years ago. In 2008, he attempted to promote

with the TDA the rehabilitation of one of the old mandubi in Waqir, but the Roux feasibility assessment (2008) deemed it too costly to reopen. Additionally, some recent barriers were built in the last 10 years as a response to the collapse of collective barriers by those who could afford it. These are Humaiqani mandab, Saleh mandab, Koteima, Hassan Karar, and others. Many private mandubi were abandoned too. Yet, some of them are still alive and divert water when there, and in this way proved to be successful strategies for water control. Whenever this is not enough, some farmers also resort to tamper the new systems by opening illegal pipes or placing sandbags in correspondence with their outlets.

3.7.3 TDA's initiatives

After developments in the upper parts of the wadi, the TDA is now driving the attention towards lower areas and traditional sandy barriers in particular for several reasons. Groundwater recharge, compensation for areas that failed to be included in WIS, and flood protection, despite hints to a wadi's retreat, appear today's major concerns for the TDA. After their shaky intervention (according to the farmers' perspectives) on Uthun, at stake now is a plan to restore Qamusia barrier. This would compensate all those areas that are not currently irrigating from Waqir. For instance, it may irrigate Mahal Ala, Awsat and Asfal, three villages that almost completely lost access to spates after the construction of the new canals. The rationale of such a barrier is that, once reconstructed, also farmers that traditionally irrigated from Uthun could access spate water from Qamusia. What strikes one here, is that this proposal will include a canal system, despite that most farmers whom we interviewed manifested their attachment to field-to-field irrigation practices and their rejection of canals, as they prevent a proper enrichment of their soils with fertile sediments.

In addition, two years ago, TDA Eng. Fawaz designed a groundwater recharge project in Shara: 1 maad, three metres deep, destined exclusively to the recharge of groundwater from flood flows arriving there. In total, he has implemented 3 of those in Wadi Siham (Shara, Mokasee, and Afajah) and 2 near Bajel. Although farmers are not directly involved in the project, in some areas, farmers have already begun to enjoy its benefits.

Finally, following further protests of farmers at the tail of WMC-1 about unequal water distribution favouring upstreamers, TDA suggested to create yet another "committee for water distribution", a locus for discussion in which farmers could find agreements between themselves under TDA's supervision. Quite expectedly, as water along WMC-1 can be considered scarce and those large landowners who at present hold water control want to maintain it, this attempt failed. According to one of our TDA informants, the real problem of Waqir is indeed of organisational nature – too many power interests involved - and that explains why farmers have not taken yet any initiatives towards the improvement of their irrigation conundrum.

3.8 Suggestions for future interventions

Zone 1, downstream of Shroefia, is probably the one that has been affected the most by changing hydrology and upstream developments of water**.** For these reasons, increasing spate water availability in this area is rather unconceivable. Instead, improving rainfed practices (e.g. soil moisture managements, see Mehari Haile, 2007), water use at field level, choice of crops and agricultural practices seem to be a better option. As for its organisational structure, this area is near Marawah where there stands a TDA extension office. A suggestion would be to improve the relationship between the two by for instance informing the farmers about what the TDA is there for.

As for the Shroefia area, the farmers' interests seem protected by the Qaserah family, who owns the large majority of the land and has already succeeded to stop a powerful landowner from building

another barrier that would endanger the town of Marawah in case of large floods, and also that would reduce water availability in the Shroefia-irrigated farms. Unfortunately, in this area we did not interview any small owners, as they often live in town and occupy themselves with other activities besides agriculture. Nevertheless, an in depth study of the impact of the WUA of Shroefia – who is excluded from membership and why, their activities, their finances, the extension services that they gain and who these benefits– would certainly highlight specific power dynamics that may need to be addressed.

In the locale potentially included inside Waqir's command area, chances for a renewed equity in water distribution that may ensure a better respect of al aela fil aela looks grim because of too strong a power of certain landlords who have connection with various governmental institutions. Nevertheless, despite partial disengagement, the large majority of farmers seem particularly interested in re-appropriating their degraded sandy barrier, in what perhaps exemplifies a desperate attempt to be able to irrigate their fields. One of our standard questions was what they would rather invest in: groundwater, traditional structures, or the new canals, if they could afford it. With few exceptions in Down and Jebalia, where those close to the new canal expressed their willingness to contribute to its maintenance, most farmers, both in the Mahads area (along WMC-1) and along WMC3, communicated a vivid desire to rehabilitate traditional bunds and abandon the new canals, which are causing even more conflicts for water distribution than they had before.

An additional point for betting on traditional barriers is the realisation by farmers of the prohibitive costs of groundwater extraction. Until a few years ago, farmers could still gather the 1 million YR needed for seasonal maintenance and many agree that finding the financial means for collaborating is not a problem if there is hope for water. Economic availability is as ephemeral as the flow and fluctuates with the harvest.

Since we have highlighted a few emerging local initiatives in this area, we suggest to collaborate with them *vis-à-vis* the authority (TDA and LC) in order to maximise these internal efforts to regain water control. However, a careful assessment of power relations within these initiatives, with a focus on the excluded, is also suggested. We remind the reader that traditionally, larger landowners have been in charge of maintenance and operation, whereas small owners and sharecroppers contributed with their labour. This is an endemic practice which perhaps demonstrates why only larger farmers are taking initiatives nowadays – not necessarily because they want to exclude smaller farmers even further.

3.9 Conclusions

As we discussed, the irrigation intervention process developed in the area of Waqir did indeed change local patterns of water access and water control and ideas of equity. Its layout, its implementation and operation, and its involvement in improving some traditional irrigation structures surely has influenced processes of inclusion and exclusion in water access and created and/or exacerbated a situation of problematic water management and distribution. The clear impression that we gained was that the way the irrigation intervention was implemented created more imbalances than its actual design, although this too was not in line with traditional al aela fil aela practice. Additionally, the appearance of new institutional figures and forms of governance- TDA, LC, and WUAs to mention some- shaped local possibilities for water control. Mehta's argument that technical "solutions" to scarcity such as large infrastructure are not neutral (2007:661) largely emerges in our analysis of the implementation of the WSIP in Waqir.

Yet, in Waqir, the state irrigation interventions are not solely responsible for evolutions and constraints in water control. Indeed, it entered a context in which water management was already changing. Already before the implementation of the WSIP, water access for some groups of farmers was restricted due to the collapse of several traditional irrigation realities. Thus, other factors, such as socio-economic changes, institutional reforms, the opening up of society, changes in the needs and priorities of local people, and impoverishment, have also determined changes in water control and access. Overall however, most conflicts and reactions that arose were dictated by a differentiated access to water.

It is crucial not to discard the strong political component permeating the possibility to benefit from technical and organisational reforms. Elites have influenced the construction and operation of the irrigation system, enabled advantage from state interests in technical reforms concerning their traditional barriers (some tobacco farmers even embraced the idea of having canals and gates), adoption of proposed organisational reforms (WUA) whether under suggestion of the TDA or on their own initiative. On the one hand, local elites and commercial farmers, thanks to their preferential relations with the new formal structure of water governance, had a greater control over decision-making process and could influence, for instance, which traditional barrier to improve first and through what process (WUAs).

On the other hand, new form of governance represented by a WUA structure have been appropriated and utilised by groups of farmers as the only means believed suitable to achieve the necessary legal status to obtain some government's/foreign financial support to restore their irrigation infrastructure. By doing thus, they aim at regaining those water rights that the project, both because of technical faults and power games of the upstream users, had deprived them of. Far from being a new phenomenon, Taher's WUA exemplifies the concept of mimicry, whereby one assumes certain behavioural characteristic that imitate what their prey would seek.

In this case, for instance, the process through which farmers of Uthun barrier (the mimics) organised themselves in a Water Users Association (the models) to gain the attention of donors and government (signal-receivers), could be seen as mimicry. In another words, people adopt donors' objectives to their own advantage, which may drastically differ from initial aims of an initiative! What downstreamers perceived as the success of farmers in Barquqa in receiving funds for the rehabilitation of their infrastructure was determinant for the establishment for both Kurd and Taher's WUA. In other words, the newly established WUAs represent their members' awareness of the added opportunity that a "modernised" organisational structure may bring as compared to traditional ones. Despite the fact that this mimicry generally builds on existing collective forms of organisation (e.g. keeps the same membership, with few exception, the possibility to show an official certificate and a legalised status opens many doors previously considered as irreversibly closed. This initiative is highly representative of the appropriation of an external intervention discourse by local actors to suit their own local dynamics.

The creation of one (or more) WUA(s) thus may lead to the reversal of a previously linear process whereby water control seemed fixed upstream. It remains to be seen whether the hydrological context will indeed enable this turnaround, or will in fact continue to retreat further and further upstream!

Within this human context, one element emerged significantly: the crucial importance of a charismatic person, who can seize the best opportunity for (himself and) those under his authority. When the traditional sheikh figure waned, conflicts arose between farmers, barriers lost strength, less water was diverted, and farmers grew poorer. Similarly, those barriers where a strong control remained are still standing nowadays. In one way or another, although to different extents, farmers

who dwell around the barriers always relied on this type of authoritarian leadership for irrigation, be it the TDA, Sheikhs, aqil*s*, and so forth. Now, strategic leaders also press for WUA – whereas on the one hand they may siphon the potential funds, their very availability may also reinforce the elite's link with other farmers, who together may begin to exploit the barriers once again under a legitimate form of authority.

While these conditions were developing in Waqir, other dynamics were taking their own course upstream. In the next chapter, after a brief introduction of the area, we will turn more specifically to the evolution of the Barquqa and Khalifa locales.

INTERMEZZO Wadi Siham spate irrigation moving upstream

Following the wadi upstream of Waqir, a series of smaller spurs are found along both its banks that divert the water into small earthen canals, or mandubi, as water users in this area generally address them. These document the progressive colonisation of these spaces and their transformation from pasture and rainfed areas to regularly and irregularly wadi irrigated lands.

To label all these mandubi under the same tag is misleading. On the one hand, both their physical characteristics and their rationale were the same, namely to irrigate areas previously rainfed – whether for subsistence or commercial purposes - and to control the destructive effect of the larger floods. However, some were built by collective action, others through individual initiatives, and others again by the government. Some are still the same as they were originally; others have been extended or disappeared altogether. Some were built specifically for commercial purposes, others for subsistence. Finally, these mandubi were built over a thirty-year time-span. Overall, this endemic colonisation of the wadi's upstream lands resulted in the sharp increase of the irrigated area that was initially only developed in the old "Wadi Siham" locale.

According to the information we gathered, the earliest testimonies of irrigation practices upstream of Waqir brought us to the mandab Hajar, built collectively by local farmers in the first half of the previous century, to irrigate the area around Kurd, Khalifa, Dahmoos, and Kadid, with its two branches (see Figure Int.1). Although it is unclear when precisely it was built, it already existed in 1934, when farmers told us that the Imam expropriated 300 maads of pastureland from Kadid and Kurd and began to irrigate them from the Hajar mandab[15]. According to our sources, although the mandab was shallow, the semi-permanent wadi spring flow, ghayl, allowed an abundant mandab offtake flow that in turn permitted good yields to the cultivation of cereals (sorghum, millet, and sometimes corn). In total, the two branches of the Hajar mandab irrigated an area of about 2,000 maads (880 ha).

[15] Under Shari'a law, this practice is referred to as *waqf*, or religious trust, whereby land is willed in perpetuity for the promotion or maintenance of religious institutions or affairs. We attempted to investigate why the Imam chose that land specifically. Some possible explanations of the locals range from the fertility of the uncultivated soil, the fact that Kurd and Kadid were not peacefully submitting to the Imam's domination and, finally, that in the area there were no large and powerful landowners. Even local leaders owned less than 100 maads. On the contrary, in Waqir, where the Imam was primarily exercising his power through the development of tobacco cultivation, land was divided between few and very large families, and as such, much more powerful than Kurd and Kadid's small farmers. We believe that a mix of these factors may explain the deed of the Imam.

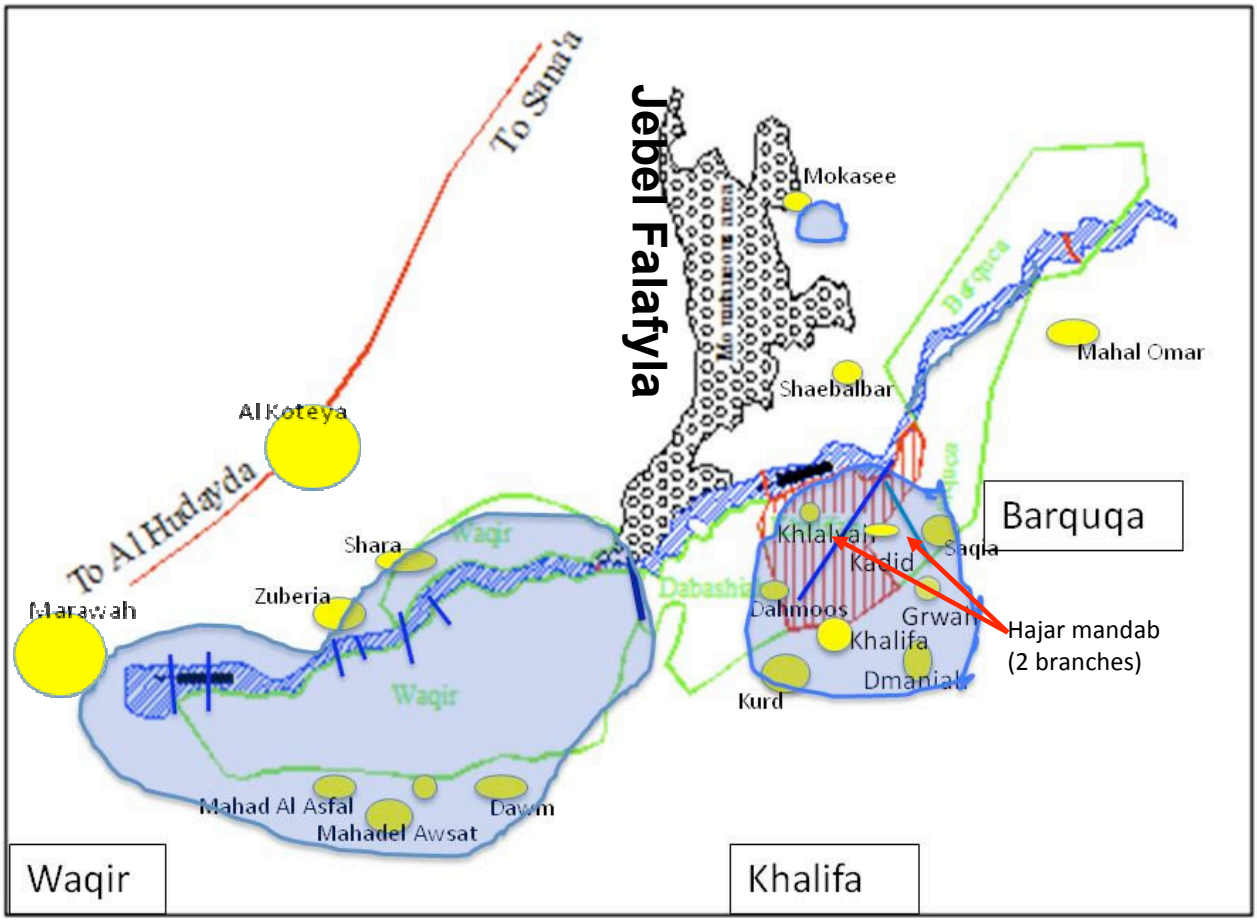


Figure Int.1 Original irrigated area until 1960s

With independence and the establishment of the new Yemeni State, agricultural developments began to be promoted at a national level, by introducing national policies that facilitated credit for groundwater exploitation and agricultural machines, and favourable market prices. As a consequence, in Wadi Siham farmers began to colonise new spaces for agricultural purposes, which were reinforced by the several irrigation infrastructures built in a few decades.

Around half a century ago, a farmer from Waqir, Mohammed Ali Barquqa, inaugurated the first colonisation wave of the right bank of the wadi, by purchasing about 1,000 maads (440 ha) from Al Ghreiban, the ruling landlord of that prevalently pastoral area. Barquqa lengthened and enlarged an existing small mandab, which irrigated a few maads near Jebel Mokasee (see Barquqa canal in Figure Int.2), in order to ensure better water conveyance of the spring flow to his newly acquired fields. Due to the abundant water source, in a short time he enlarged the tiny irrigated area and transformed the previously (primarily) pasture land into fertile cereal cultivation, both for livestock and human consumption.

On the wave of his success, a few years later, in the Shaebalbar area, the Benna and Deber families built another mandab to irrigate a total of 350 maads (154 ha), that they named Syyali (see Figure Int.2). This mandab irrigated few other lands besides the fields of those who had constructed it. For acquiring the right to use water, these farmers needed to participate to the maintenance of the infrastructure. Moreover, in 1985, a collective of water users extended the mandab further south to irrigate an extra 100 maads (44 ha).

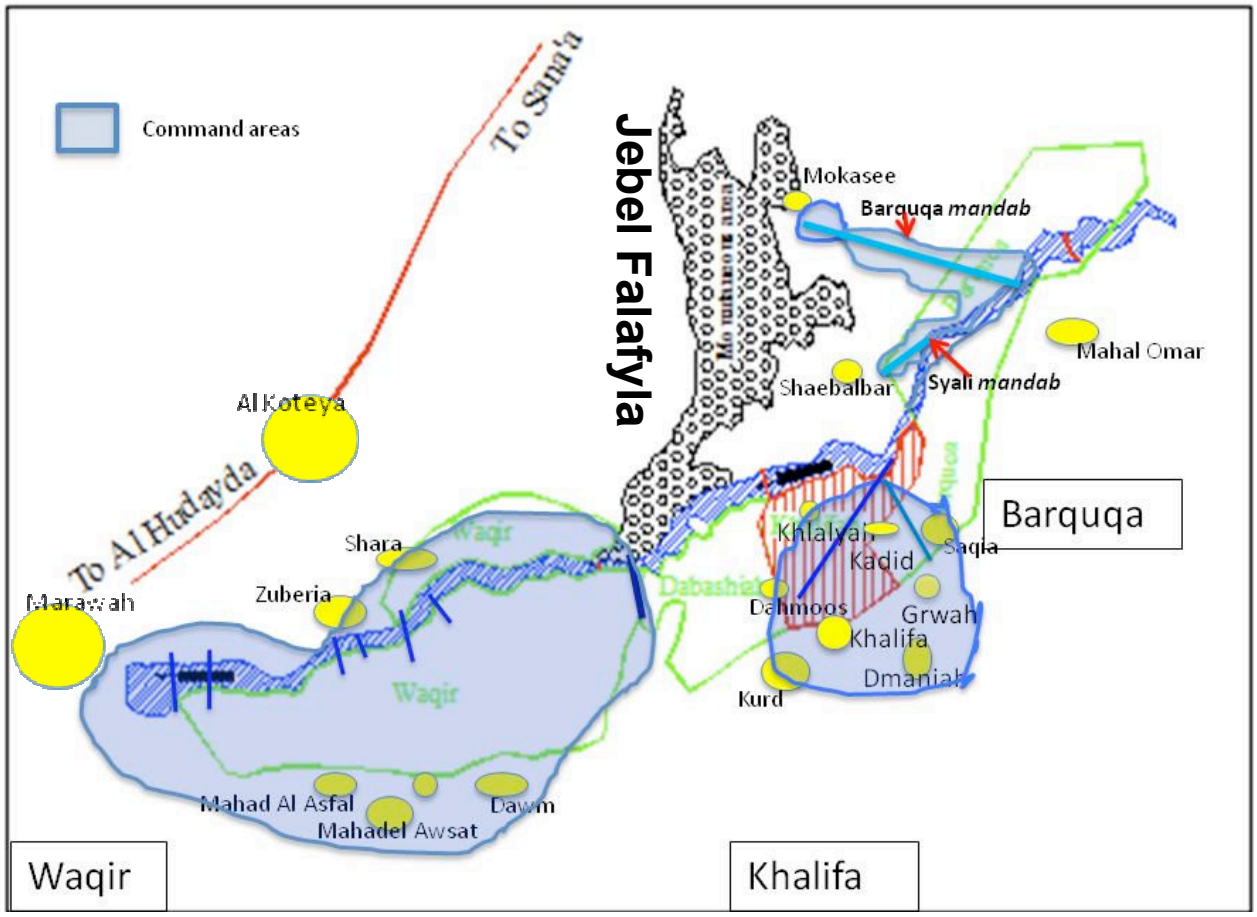


Figure Int.2 First colonisation of right bank

After the fall of the Imam in 1962, the Government (Hakoume) took possession of the Imam's land near Jebel Khalifa and in the late 1960s enlarged and lengthened the Hajar canal, which was then nicknamed Hakoume, "government's" canal. Shortly after, two external investors, Humaiqani and Beshari (the governmental man from Sana'a mentioned in Chapter 2), bought land at the tail end of the renewed Hakoume canal and in addition, each of them built his own new intake directly from the wadi.

At the same time, Hodeidah's new governor's uncle, Saleh Jebeli, bought the land immediately North of Jebel Khalifa and built his own canal near Mahal Omar. Although it is unclear where exactly this canal stood, some evidence places it where nowadays there lies the Dehna mandab (see Figure Int.4). As the story goes, 15 years ago three large landowners from Al Koteya, namely Dahmoos, Sahel Mohammed, and the aqil of Mahal Rubahi sponsored the rehabilitation of the then very old and semi-abandoned Saleh Jebeli mandab, whose land they had purchased after his death, and renamed it Dehna mandab.

In the 1970s, ten local farmers from the village of Khlalyah in the lowlands next to the left bank of the wadi (see Figure Int.3), dug their own mandab, again collectively managed, which brought a further 4-500 maads (170-220 ha) under regular irrigation.

Similarly, Mohammed Abdullah Qaserah, a member of a very influential family from Marawah, which owned about 2000 maads (880 ha) in Waqir, sold his inheritance share of his father's land and bought 400 maads immediately upstream of Mohammed Ali Barquqa, from Suleyman al Mahadeli. Arrived there, he began to dig a new canal to irrigate his lands and in a short time, similarly to Barquqa's story, his thought-of stony farm turned into a bountiful area.

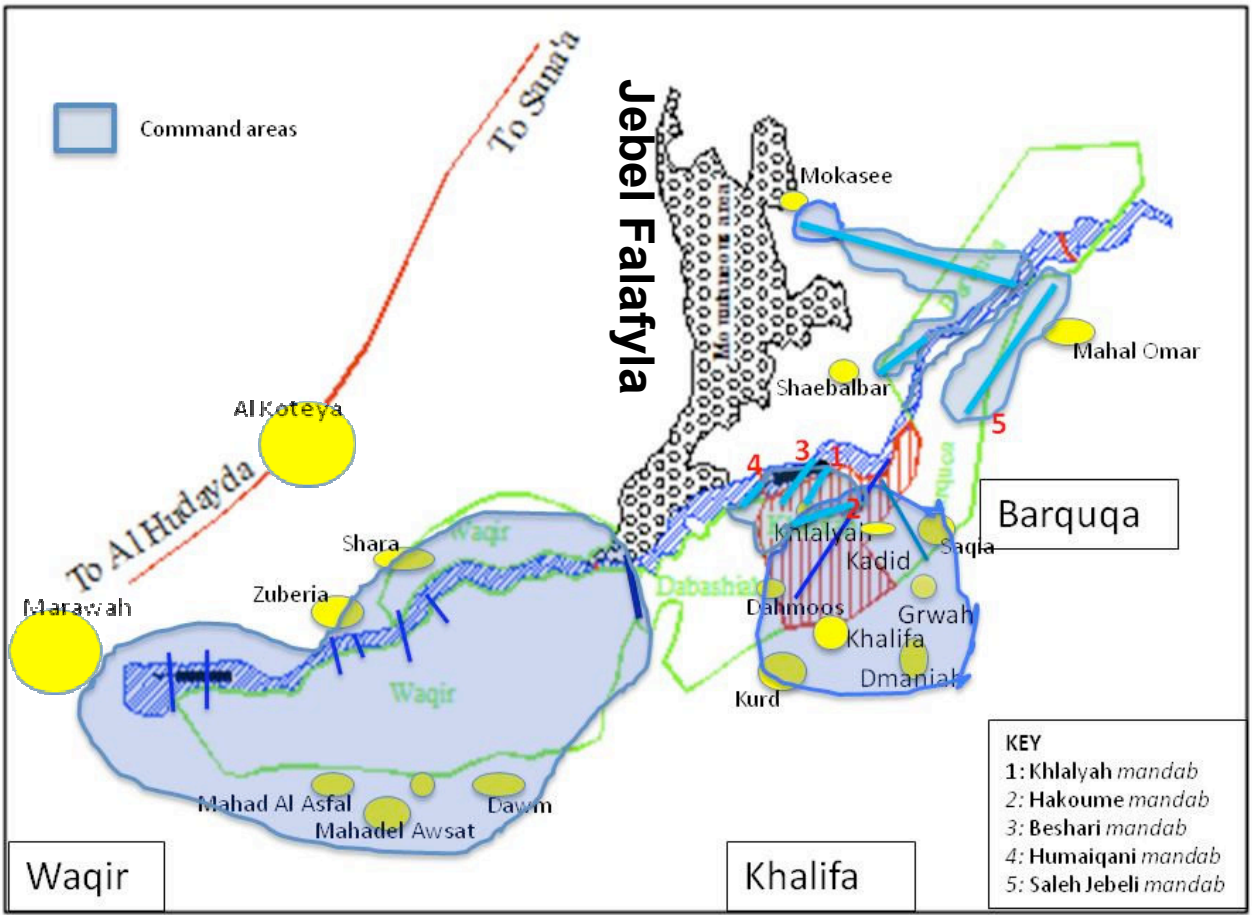


Figure Int.3 Post- independence irrigation infrastructure developments

Attracted by their success and by public agricultural credit, others then followed their example. Over about two decades, between the 1970s-1980s, seven other new mandubi were built by individual farmers on the right bank: Al Jumaee (now called Shamiri), Wajeh (now Rweishan), Marzouki, Magaribi, Mattari, Khanani, and Matani (see Figure Int.4 below).

Together with those mentioned earlier, these new mandubi conveyed the *ghayl* to about 5,000 extra maads (2,200 ha), which increased significantly the wadi's total irrigated area that before was mainly conscribed in the lower locale of Waqir. This development has not yet halted: less than a decade ago, the Beshari family, who already owned a mandab on the left bank, sponsored the construction of yet a new one on the right bank, south of the Syali mandab.

With the construction of canals, agriculture – specifically commercial agriculture – moved further upstream. In less than three decades, thanks to the new mandubi, an area that had traditionally been considered a cumulus of stones and abode of shepherds by the more agricultural people of Waqir, became the new focal locale for (subsistence) farming. In other words, Wadi Siham began to move upstream!

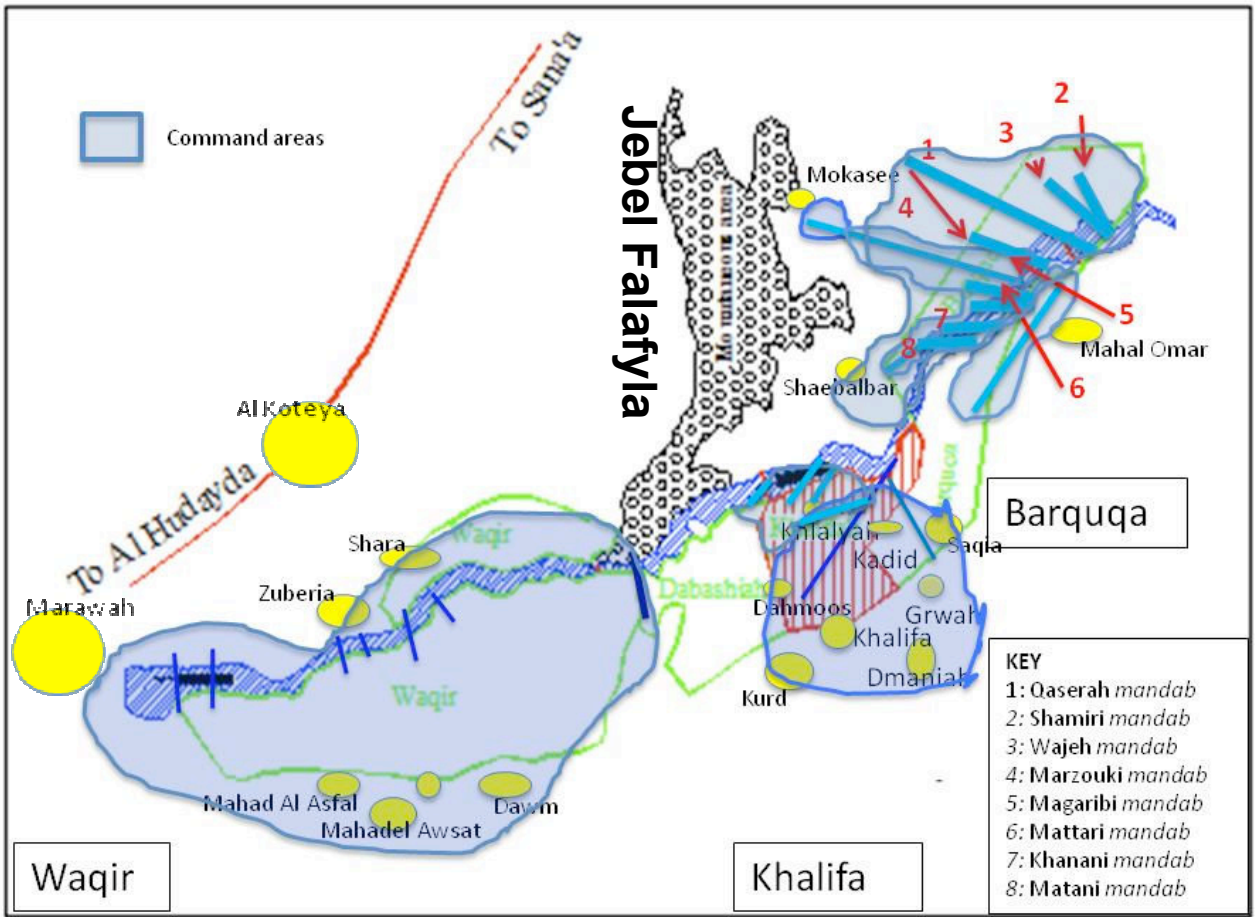


Figure Int.4 Last wave of local migrants

How was this intensive development possible? The abundant ghayl is certainly a primary driving factor. Both in Barquqa and in Khalifa, the spring flow was running for many months every year[16], which drastically reduced the uncertainty of larger and less frequent spate floods, on which Waqir farmers depended almost entirely for irrigation. When we asked a couple of farmers why they thought that many sold their land there and moved upstream, they smiled and asserted: "They followed the water, and they were right". This favourable hydrological condition also may explain why some canals in this upper area had already developed and ensured good production –despite their rudimentary shape before the arrival of state experts concerned with improving agriculture in the area. However, it was a particular combination of favourable factors, such as for instance, capital and thrust for investment, changes in the Yemeni state, society, and economy that led to a shift from a predominantly small agriculture and livestock livelihoods to the current exploitation of the area through cash crops. In the next chapters, we will investigate what happened and how local and external investors played their game of commercialisation of agriculture in the zone.

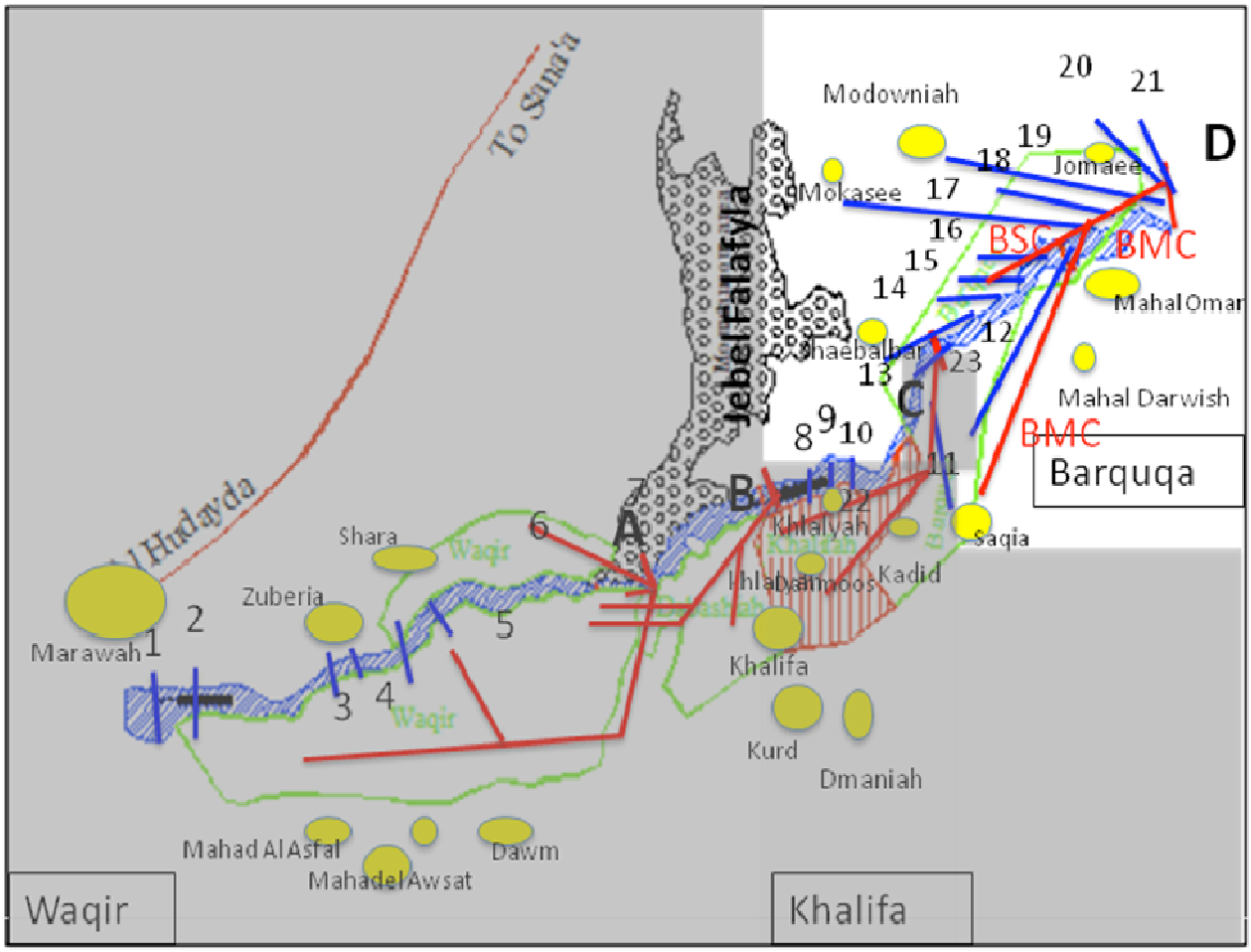
With this Intermezzo, we intended once more to remark that the three zones that we chose for our case studies should not be considered as black-boxes, but rather that their developments occur in parallel fashion with neighbouring ones and are often driven by similar, if not the same, factors. We will now analyse of the areas Khalifa and Barquqa separately, as they interact with two different irrigation interventions, which were/are being introduced under the WSIP.

[16] An average of 305 days per year in 1970s (SOGREAH 1979).

4 Case Study II: Barquqa's successful shift from pastureland to intensive commercial agriculture

Until about 40 years ago, most of the area North of Jebel Khalifa (now Right and Left Bank of the Barquqa Irrigation System) was pastureland for the numerous livestock that people used to own. In the restricted zones where agriculture was practiced, farmers generally cultivated rainfed sorghum and few other cereals. People from lower areas used to refer to this region as the "land of stones". Yet now, strikingly enough, Barquqa is the most verdant locale of the wadi, where mango and banana production flourishes. The channel intakes on the right bank are reinforced with gabions and concrete, and controlled by gates. They convey water to several earthen canals that wind their way through the mountain Falafyla, crossing mango fields almost incessantly. In the centre of the area, many maads were being harvested of sorghum. Most canals are well-, or sufficiently maintained. Some, however, are in a very bad state and one has been abandoned. A large headwork structure, named "Barquqa", overlooks these fields and infrastructures from upstream where the new canal of the "Barquqa Irrigation System" originates, follows the wadi for a while and then crosses it and continues on the left bank. Whenever an old mandab crosses the new canal, a siphon is in place. At the same time, the new canals are also feeding, along with some fields, the old mandubi through cross-regulators and gated outlets. Interestingly, along the new main canal, gates are of two types: some are red, others grey. Moreover, the new canal does not reach until Syali, but rather it intersects only the first seven mandubi (see Figure 4.1).

Early into our fieldwork, we discovered that the evolution from pastureland to extensive agriculture had been initially propelled by waves of newcomers from either downstream or even further away, Sana'a and Ta'zz. We began to wonder what forces propelled this agrarian change – why did people begin to move upstream and colonise what downstreamers described as "just some stones" (Sheikh Qaserah p.c.)? What evolution of water-network were we witnessing? What strategies did people adopt and to what end? How did they manage to settle there so permanently that nowadays mango and banana cultivation flourish, and sorghum and other cereals produce high yields? What did this "colonisation" of new lands change at wadi level? What did the new infrastructure highlight? After a summary of the mandubi' evolution and the expanded spate irrigated area, this chapter will proceed to portray the conditions that enabled the village canals' establishment, explain their diversification, and illustrate their interaction with the new structures and the ensuing impacts on water distribution at canal, area, and wadi level. Once again, this unravelling process will pave further grounds to then turn to constraints and possibilities for a potential water management in the next chapter.



KEY			
Sandy Barriers/Lateral dykes	*Mandubi*		*WSIP*
1. Mahadeli 2. Bahlooli 3. Shroefia 4. Husseini 5. Uthun 6. Qamusia 7. Akm/ Waqir 24. Mohammed Yahya 25. Omar Qadi 26. Mohammed Abdallah	8. Humaiqani 9. Beshari 10. Khlalyah 11. Saqia 12. **Dehna** 13. **Syali** **14. Matani** **15. Khanani** **16. Magaribi** **17. Barquqa**	**18. Marzouki** **19. Qaserah** **20. Wajeh** **21. Shamiri** 22. Hajar/ Hakoume **23. Beshari NEW**	A. Waqir (WIS) B. Debashya (DIS) C. Khalifa (KIS) **D. Barquqa (BIS)**

Figure 4.1 Barquqa's irrigation infrastructure

4.1 Enabling possibilities for upstream colonisation and evolution of water-networks

We have described in previous chapters how upper wadi water users managed to control the water through the construction and restoration of the mandubi, in other words, through the physical shaping of the landscape. In order to verify any alterations in water control that may have *de facto* occurred in the wadi, it is necessary to proceed beyond the analysis of the visible marks of its shift upstream, the presence of the mandubi. Rather, we need to understand the whole set of factors and their interconnections that first enabled their construction and second, emerge from their development. Therefore, we will assess the correlations between the constructions of new canals, a changing agrarian structure through the arrival and regional deployment of new agricultural

producers, an ensuing transformed power landscape (both socio-political and economic), and the state-of-affairs in the wadi up until the commencement of the Irrigation Improvement Project.

4.1.1 Migration, appropriation of space, and agrarian change

The settlement of migrant farmers is an important feature in the process of agrarian change in these upstream areas of Wadi Siham, as they were the actors behind the manifold extension of the irrigated area upstream. Albeit to different extents, all these groups brought the investment capital and agricultural/entrepreneurial skills that triggered the process of agricultural growth to the current situation, which we witness nowadays in the wadi: a few large owners who control practically all the local production.

In order to avoid generalisation and bracket all migrants under the same umbrella, it is important to highlight what characterises each wave of migrants and the reasons that attracted them to buy land in the wadi. According to their principal motives, we highlighted three key migration waves which took place between 1960s and the end of 1990s, namely local upstream migration, outmigration of an important share of the "original" upstream inhabitants of the wadi, and finally, the arrival of external investors.

Local migrants searching for water and space (1960s-70s)

As we mentioned above, in the 1960s, some local farmers began to move further upstream from the traditional "Wadi Siham", in search of both space for agricultural expansion and more secure water sources. Despite the profitable tobacco plantations, the agricultural area downstream was becoming saturated because of increased fragmentation of land[17], coupled with a fast population growth that reduced possibilities of substantial earnings for the new generations.

Box 4.1: Yemen's water crisis in brief

In the last three decades, Yemen has fallen into a very serious water crisis whose causes are primarily the raising water demand as population and market-led agriculture develop rapidly; unregulated deep groundwater exploitation became possible because of new technologies and subsidised diesel prices; money flows from workers in nearby oil rich countries was often reinvested in land acquisition (Ward et al., 2001); and government policy promoting expansion rather than efficient use and sustainable management of water.

In Wadi Siham, as a result of the above, groundwater levels are dropping at an average of 4m/ year, which increasingly transforms well irrigation into an elitarian business! Nowadays, the drinking water situation is also alarming: with average households of 9 members (vs. the 5.6 national average) and wells drying out, often young girls and women walk many kilometres each day to catch water from another area.

On the contrary, upstream, space for expansion seemed to be attainable, primarily because of the cheap price of the land, a quarter of Waqir's, and secondly because of both large and small local owners' willingness to sell. Those may be grouped into two categories. Firstly, there were few large landowners upstream and even fewer who practiced agriculture. The biggest one, al Ghreiban, thought that "*he might be sealing the deal by selling all his uncultivated land to crazy farmers from Waqir to what seemed a good price"* (Mohammed Ali Barquqa's son, p.c.). Mahadeli followed soon after when he was almost completely bought out by Mohammed Abdallah Qaserah (belonging to an influential family of Marawah), to whom he sold 400 of the 500 maads that he owned. The newcomers' buying power ensured a win-win situation. Selling land seemed more remunerative than the low value agriculture that they were practicing and enough space remained for pasture land, so that their livestock would be provided for. On the other hand, medium and small

[17] According to the Yemeni inheritance law where all sons (and sometimes daughters) receive an equal share of their father's land.

landowners were deeply affected by the 1970s series of droughts: their mostly rainfed fodder fields dried and as a result, they had to sell first their livestock and later, they sold their lands. Most children of these original sellers that we interviewed mention the social pressure of parents to marry their sons as one main drive behind land sales. Others seem to have sold their land because they had decided to migrate and begin a different life in an urban context, whether in Hodeidah, Sana'a, or Saudi Arabia. However, most of these were expelled in the 1990s after the Gulf War and returned *en mass* to a changed wadi.

Together with these large transfers of land, these newly arrived big landlords were also responsible for the construction of most mandubi, with the exception of Syali, which, similarly to Hajar and Khlalyah in Khalifa, was built collectively by three local owners. Their lands were (and largely still are) generally located in the upper reach of the mandubi, which were supposed to convey an abundant spring flow only to their land. However, when larger floods occurred, they also covered areas further downstream, at times until Jebel Falafyla, were smaller owners, whether local or immigrants, were generally clustered. Given the temporary nature of their lateral dykes, large floods destroyed them and hence much water could flow downstream to Waqir several times per year.

It is important to highlight that not only rich local farmers migrated upstream, but also a collection of poorer ones, at times even landless, moved to Barquqa. The few who owned land were generally located in the vicinity of the new mandubi so as to irrigate with irregular floods. However, the majority worked as labourers or sharecroppers for the owner of the canal, most of who lived outside the area (Wajeh, Shamiri, Al Aqil, just to mention a few). This phenomenon is still clear today, as their villages still exist and are always located in the middle of large plots of land. The social structure along the Qaserah canal illustrates this diversity. There, we found a conglomeration of sharecroppers settlements within the landowner's property and a village of small and medium owners located immediately downstream of his lands. Almost unanimously, these people agreed that they had settled in the area "at the time of their fathers, together with Qaserah", about 40 years ago.

<u>Outmigration: out of the wadi and in again</u>

As it appears, from the beginning of the 1970s till now, there have also been two main waves of emigration to either Yemeni cities or Saudi Arabia, of both small-medium owners and landless. Initially, these people remained away for several years and at times they even brought their families with them. This emigration opened spaces for the affirmation of the new landlords' appropriation of the territory.

At the same time, however, several outmigrants saved conspicuous amounts of money, which they commonly invested in land once back, generally around the village of Shaebalbar, downstream of the new large landlords. It is frequent to hear stories like that of Mohammed Suleyman, a farmer from Saqia, who after 20 years in Saudi Arabia bought 50 maads and is now one of the largest owners in the village!

In 1990s, after the Gulf War, a second migration wave of the young generations began. Yet, since the War, Saudi Arabia's immigration laws have become tighter, thus although many young people still venture there, they have lower guarantees of a worthwhile remuneration and longer stays. We noticed that the majority returns to the wadi for the agricultural season, to work as daily labourers for the mango and banana plantations. Hence, a returnees' buying power has drastically diminished: life is more costly, families are bigger, boys marry younger, land prices grew hundred-fold, water sources are shrinking, and so forth.

By the end of 1970s, this shift in land tenure in Barquqa led to a scenario whereby less than 15 landowners and a few smaller owners managed to purchase all the upstream locale of the wadi. Indigenous villages can be distinguished from the more recently established ones as they are primarily located either near the Jebel, or on the road to Bajel, in areas generally outside the new mandubi command area. Since these people were not traditionally farmers, with these developments they lost a considerable share of pastureland. Even when they themselves did not possess land, much of the Ghreiban and other owners' land were open for them to pasture their animals, a trend that was reversed with the arrival of new investors and eventually almost disappeared in late 1990s with the intensification of mango plantations.

As a result, most of them out-migrated in search of new sources of income or began to work as labourer or sharecropper for the new proprietors. Those who continued to own land near the Jebel could potentially still irrigate with exceptional floods (1 every 4 years), yet they did not acquire any new rights to the spring flow that the new infrastructure managed to divert from the wadi. In other words, a new social setting was created upstream, whereby owners who live in the wadi and sharecroppers depend on the same source of income, whereas owners who live outside the area diversify their earnings through more "urban" revenues, such as for instance shop keeping. However, today very few inhabitants of the wadi depend solely on agricultural production or livestock tending.

4.1.2 Successive agrarian developments

Despite significant irrigation developments, in the 1960s and 1970s the cropping pattern in the Barquqa area remained homogeneous, with a production of sorghum, millet, and maize (possible now because of more frequent irrigation) largely dominating, however with much higher yields than previously. This is probably due to the marked domination of feudal-type farms, where 80% of the irrigable land on the right bank belonged to large landowners with numerous livestock themselves.

In 1980s, mango and, at smaller scale, banana farms began to appear in the upstream section of the wadi. According to our wadi informants and confirmed by some TDA employees, Thoum Benna's family, the aqil of Shaebalbar, was one of the first to convert part of his land, about 30 maads, which irrigated from Magaribi mandab, from cereals to mangoes. Contemporaneously, further upstream Al Fareah followed his example and shortly after, Qaserah and other landlords too began to cultivate some maads with mangoes. The entry point of the mangoes into the wadi can be fixed in 1985, when TDA, in collaboration with FAO, promoted mangoes through extension courses and farmers' training. Although these new farms produced bountiful yields, they were not expanded until later because of the state of the roads, which created difficulties for both these farmers to reach market areas and buyers to coming to collect the fruits. Furthermore, farmers did not yet fully trust the new crop and since the majority still possessed large livestock numbers and held sharecropping agreements (although in decline according to a report of SOGREAH of 1985), sorghum remained a central cultivation in the area of Barquqa. The real investment in mango farms began more or less at the time of the construction of the WIS, in 1990s, when a last wave of external newcomers bought land and began to cultivate cash-crops first with wells only and then conjunctively with spring flow and larger spates, through the extension of existing mandubi.

We were interested in understanding the reason why cotton and tobacco sponsorship had not been pursued in this upstream region of the wadi as in other locales, but instead the State promoted fruit trees, and specifically mango and banana.

Box 4.2: Work opportunities

The fact that even some larger sharecroppers employed daily labour when needed indicates that the area experienced a period of prosperity. Big portions of land were leased to the same farmer, as it simplified relationships with the many landlords who lived outside the wadi. Sharecroppers could manage up to 60 maads and hence their need to employ workers. This also suited those who preferred to migrate to urban areas for parts of the year: with the seasonal or daily nature of the worker's jobs, they were more flexible to move out and in the wadi.

This favourable condition of sharecroppers was also generated by better sharecropping agreements than in other wadis. In Wadi Siham, revenues generated from cash crops and vegetables produced under groundwater irrigation are divided into three portions of one third each: the sharecropper gets one third, the landowner gets one and the irrigation unit (which is owned by the landowner) is entitled to one third to cover running costs, maintenance and depreciations. Whilst most of the production costs are paid by the sharecropper, the landowner contributes only to the costs of the seeds and chemicals. For sorghum and millet produced under groundwater irrigation, the revenues division is different: the sharecropper gets only 25.0%, the irrigation unit gets 50.0%, and the landowner 25.0%. Revenues from crops produced under spate irrigation are divided 50:50: the sharecropper receives 50.0% and landowner 50.0%. Finally, when sorghum is planted to be sold as green fodder, the sharecropper receives only 25.0% and the landlord 75.0%.

(CITCS, 2008)

Agricultural statistics collection of those decades is extremely weak. However, two major trends are discernible for this period. The first is a reduction in the production of other export crops, especially cotton and coffee, because of fiercer international competition. During the 1970s, annual cotton production declined from about 20000 to 6000 tonnes (NRMED, 1997). The second major trend is the substantial growth in production of high-value, income-elastic crops (qat, fruits and vegetables) in response to a growing domestic demand and high export potential to neighbouring countries. As a further encouragement for fruits and vegetable production, in 1983 a ban was introduced by the Yemeni government on their imports. In addition, in order to facilitate their development, subsidies and credits for investing in "high-value, income-elastic" crops were made available through the creation a new Bank, the Cooperative of Agricultural Credit (CAC Bajel - General Manager April 2009 p.c.).

The above explains why cotton production was not expanded further upstream. Yet, tobacco continued to remain the traditional crop of lower Wadi Siham. A TDA staff, who used to be involved with the project, replied that, given Barquqa's good water quality, its inexperience with tobacco, the abundance of spring flow, and the frequent spates, which could have endangered tobacco production, mangoes seemed a reasonable crop to encourage. On the social side, tobacco needed intense labour throughout a very limited period (harvest time), whereas mango farmers need workers all year long (Extension Department, TDA, May 2009, p.c.). Finally, tobacco was generally leased to sharecroppers whereas mango would require labour: given that at the end of 1970s sharecropping was already diminishing (SOGREAH, 1985) in favour of temporary urban jobs, the promotion of mangoes seemed more logical and beneficial for local farmers. Moreover, according to TDA Extension Department, mangoes could be sold at a higher price than melon, muskmelon, and watermelon –the other option that they had in mind.

4.1.3 Newcomers, new areas, new canals…

In the 1990s, a second wave of external investors, primarily from the mountainous region near Sana'a and generally occupying high administrative or governmental positions, began to buy land in Barquqa's right bank and exploit it for commercial purposes. It should be remarked that by then, around Sana'a, groundwater prices had already become prohibitive: with the price of a well there, in Wadi Siham they could buy hundreds of maads! Others came from the Ta'zz region, often to invest

the money earned with qat cultivation, and a couple were informed by friends already in the wadi – one even decided to invest there although he was living in the USA!

How could they enter the wadi? At that time, some years of drought and the return of many workers from Saudi Arabia had left many families in much need for cash since their land was no longer sufficient to feed the whole family. This situation met the interests of the new investors to whom impoverished families were selling their land Moreover, as said earlier; many local inhabitants were also lured by income possibilities in urban areas and sold their lands. When large surfaces began to be converted from sorghum into mango plantations, sharecropping and livestock tending possibilities further diminished in favour of agricultural labourers[18].

This wave of newcomers, with high financial means, then began to buy hundreds of maads to turn into well-irrigated mango plantations. One of this new landlords commented: "when I arrived, everybody was very poor, all they had left was their land, which they sold with no qualms, as they needed money". Not only disadvantaged inhabitants sold their land, also former landlords' families sold portions of their holdings either because they needed liquidity for social events, for instance, or because their children sold their inherited shares. The decrease of the wadi prosperity also led to a parallel degradation of many of the 11 existing mandubi, after which some owners preferred to sell their land and leave the wadi.

In a short time, these newcomers managed to accumulate significant land holdings, ranging from 400 to 1000 maads each (176 and 440 ha respectively), that were often situated beyond the ghayl's reach, near the foothills of Jebel Falafyla. Although many of these farms depended primarily on groundwater sources for their commercial farms, the occasional spate remained a precious source of fertilisers and well recharge. We highlighted their need for securing spate water to their fields. Their ensuing hope that the WSIP would have facilitated that is one crucial factor that may justify the arrival of several investors right at the beginning of the construction of Barquqa, and few others in the more recent years. In order to be included in the spate irrigated area, most of these newcomers extended existing canals or built new branches at their tail ends with their own means. For instance, Badani, a "hobby farmer" coming from very far, from America, lengthened the Qaserah mandab so that it would reach his newly purchased land near Jebel Falafyla.

The division of migration waves into categories may mislead the reader into boxing the process of agrarian change in impermeable compartments, with local migrants at the head ends of the mandubi, and external investors often at their tail-ends, where they grow cash crops, sharecroppers scattered around, and landless at the edge of the irrigated area. Although we realise that "the geography of water distribution and social differentiation is more complex than this" (Mollinga, 1998:101), in the wadi we could certainly highlight certain patterns as described.

All these developments occurred primarily because of individual entrepreneurship and financial liquidity of the newcomers. Yet external factors are equally significant for the shift of water control, as they created its enabling context: irregular hydrology, migration waves, fractioning of land, development policies that initiated credit, ban on imports, and so forth. Without these, perhaps individual initiatives would not have found the fertile space for entering the wadi in such a consistent and unstoppable pace and so drastically change its agrarian structure, with all its implications. According to our informants in the wadi, all these developments largely changed water distribution patterns in the area of Barquqa. Below we present and discuss these changes.

[18] This information matches with the shift from subsistence to cash crops that began to characterise the upstream area of the wadi. Indeed, commercial farms tend to employ workers exclusively and not lease land to sharecroppers.

4.2 Water redistribution in Barquqa before the inception of the WSIP

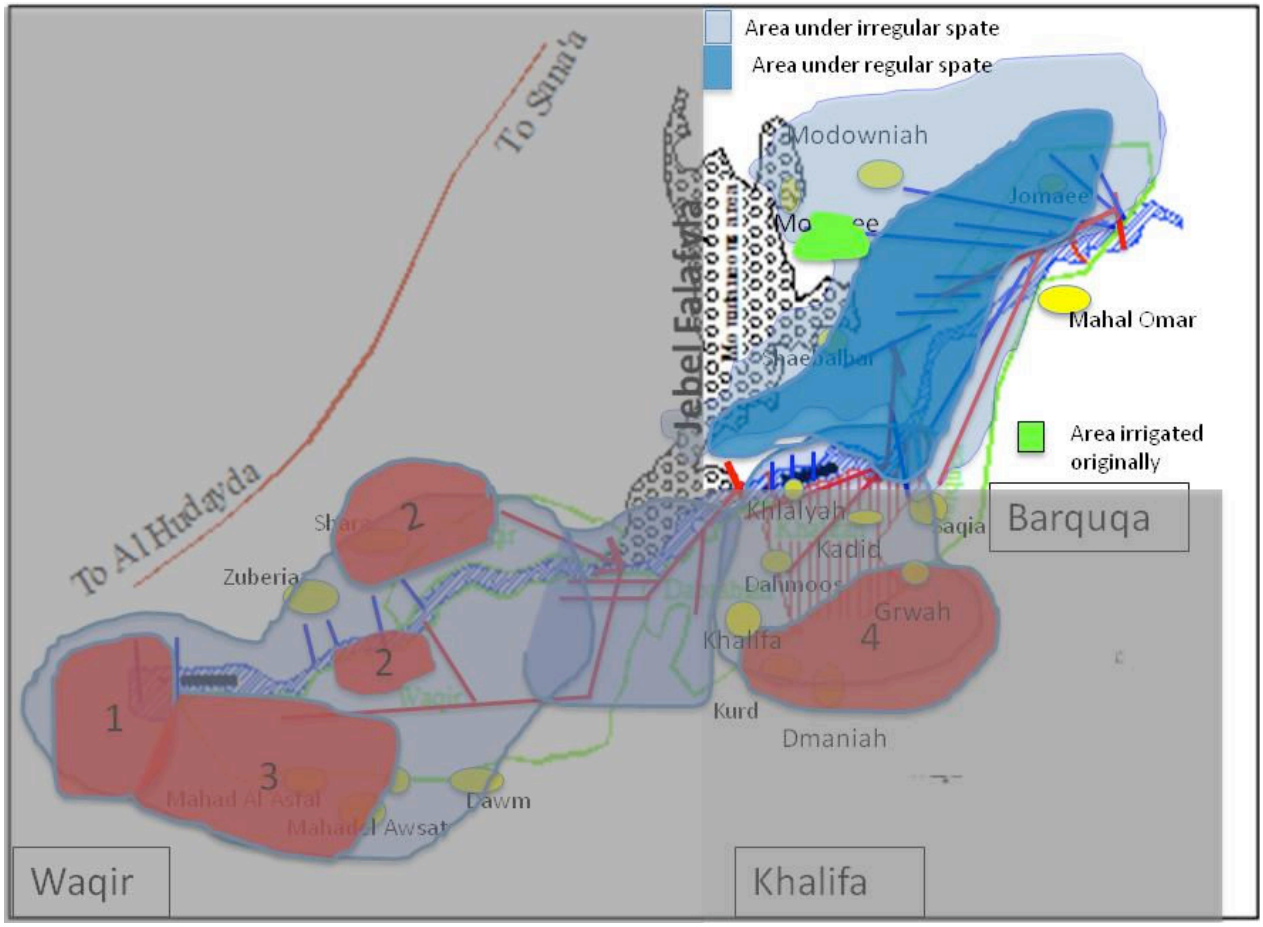


Figure 4.2 Water distribution after the first migration wave

Landlords were the ones who particularly benefitted from the improved water distribution that followed the extension of irrigation systems by newcomers. Nevertheless, also villages situated beyond the former canals' command area–Modowniah for instance–could enhance their water supplies. Whereas before, water arrived to their lands field to field, after the construction of the new branches, they gained the right to access this water since these canals crossed their lands. At the same time, however, farmers close to the foothills of Jebel Falafyla (e.g. Mokassee), downstream of the new canal-irrigated area, along with then improved water control upstream, started to gradually lose those irregular spates they had relied on until that moment.

Yet, although one could confirm a marked water redistribution upstream through the multiplication of the spate irrigated area in Barquqa, when the Irrigation Project began in 1999, the situation was far from idyllic. Not all mandubi functioned in the same way and their state of the maintenance in 1999, when Barquqa project began, varied greatly from one to the other. On the one side, an EC pre-irrigation intervention survey demonstrated that, not surprisingly, the best ranked canals were Barquqa, Magaribi, Khanani, and Qaserah, where newcomers had already invested in mango plantations. With respect to this last point, there is an additional remark to make. That is, water control seemed to have already shifted away from the figure of the traditional canal representative, belonging to the family that originally constructed the mandab, towards the ones that have more interest - and means - in ensuring an optimal water distribution by maintaining properly the mandubi: external investors, such as for instance Humaiqani on Syali mandab.

On the other hand, during the same survey, that preceded the state interventions, many of them showed irregular slope in some segments, damaged channel intakes, and Dehna, Wajeh, Marzouki, and Shamiri, were obstructed by trees and sediments. Thus, although having a potential capacity at the entrance varying from 2-6 m^3/s, some of the mandubi could no longer receive any water from the wadi and in others this was very limited (Pichel, 2002). Hence, these mandubi were increasingly less able to divert water, which therefore was almost completely appropriated by its "owners", whose fields were generally located in favourable upstream positions. As we mentioned above, the unfeasibility for the various owners to maintain their mandubi eased the purchases of new external investors in 1990s.

4.3 The arrival the WSIP in Barquqa

In Barquqa, the WSIP began in 1999. In line with the NESPAK 1991 proposal, which was largely maintained in the final implementation, the main canal was constructed with a discharge of 5 m^3/s, calculated on the basis that sorghum was the main crop, for two primary reasons. First, NESPAK accounted for the 90% of spring flow that the area was diverting at the time for many months per year, which seemed to satisfy the area's water requirements (27 Mm^3 of yearly spring flow *vs.* <20 Mm^3 that Barquqa needed). Second, a first survey indicated that the irrigated area there amounted to 2000 ha solely. This design, which entailed a diversion of 22.5 m^3/s in Waqir versus 5 m^3/s in Barquqa, was therefore reckoned more equitable and better suited to the type of floods that each of the two systems should benefit from.

In line with what occurred in Waqir, in Barquqa too the project's implementation did not proceed without hazards and modifications.

4.3.1 Rehabilitation of traditional mandubi and flood protection

During the implementation of Barquqa, the EC was complaining that such a costly structure may irrigate only 2000 ha. The construction was momentarily suspended and the consultancy company DHV completed another assessment of the area, where they realised not only that the command area had been underestimated and should instead include 3,700 ha, but also that the sharp increase of mango and banana production made obsolete the NESPAK 1991 calculation of the design discharge based on sorghum. Finally, spring flow was rapidly diminishing, a havoc that implied that the system should be adapted to divert larger floods too. Therefore, protection and consolidation works were designed by DHV/TDA with the main objective of improving traditional channels'[19] capacity, which had to consider an irrigation module of 10 l/s/ha, a standard Tihama calculation for fruit trees. Although the updated requirements would imply a design discharge of 37 m^3/s, we estimated that by rehabilitating all 11 mandubi the total capacity of the system would probably permit a much larger potential diversion. The works included the partial conversion of temporary sandy dykes at mandubi intakes into more permanent gabions. Moreover, protection works were felt necessary on the right bank of the wadi in order to avoid further damages to traditional mandubi and to bring the "mouths" of those which were destroyed by the big flood of 2002 back to their place. In order to supply to this need, a 1 km long gabion structure was constructed along the wadi bank, which also protected the first fields from the destructive effects of larger floods.

In 2003, along with the consolidation and protection plans, and in line with contemporary models of farmers' participation in irrigation interventions, the head-end farmers of the eleven upstream mandubi[20], or their canal representatives, were gathered to sign a "Memorandum of Understanding"

[19] Here, the terms traditional channel, village channel, and mandab, are used in an interchangeable way.
[20] Shamiri, Wajeh, Qaserah, Marzouki, Barquqa, Magaribi, Khanani, Matani, Syali, Dehna, and Saqia mandubi.

with the TDA, and the donors FSMU-EC. This agreement aimed at assuring farmers' support and inputs for the second phase of the irrigation project, namely the rehabilitation works, while enhancing communication and collaboration between farmers and the TDA (DHV 2003). In practice, this meant that farmers had to agree on both the suggested TDA re-alignment of channel intakes and the provision of gates at their mandubi' intakes. This would have made it easier to control the inflow into the traditional mandubi and in its turn, would have limited the negative implications that a constant diversion of 37 m^3/s may have had on downstream. Yet, although in theory, TDA would operate these gates on a rotational basis, we noticed that most of them seemed to remain open the whole time. In addition, the Memorandum also settled a cost-division between farmers and TDA for the intakes' improvement and future maintenance, according to farmers' possibilities. They were also allowed to request TDA technical help whenever needed, including the rental or borrowing of its machines for maintenance. Lastly, this agreement should also pave the way for the formation of a Water Users Association, the WUA of Wadi Siham, which was then hectically created in 2004. We will come back later to this union when focusing on the organisational aspects.

The protection and consolidation works, the rehabilitation of mandubi, and the partial reinforcement of sandy barriers with gabions, have increased six-fold the diversion and conveyance capacity of mandubi. Before, large-medium floods destroyed the sandy barrier and moved downstream, which also prevented an excessive diversion that would have damaged the sheikhs' fields. Nowadays, bigger flows can be diverted by the reinforced sandy barrier and better conveyed and controlled by both the improved mandab's capacity and the new branches made by new large landlords.

4.3.2 Operation by manual

After the BIS was completed, it was established that the new canals, BMC and BSC (see Figure 4.1), should have irrigation priority. Thus, when the flood arrives, Mohammed Ahmed, the TDA officer in charge of the new system's operation, gives the order to first open the field outlets that feed directly from the canal, and only once these have irrigated, will he deliver water to mandubi on a rotational basis, from the first upstream to the furthest downstream, Khanani. According to the availability of water, several channel offtakes on the new canal are open at once. The height at which gates are opened depends on the area that canals have to irrigate. If a second flood arrives within short time, those offtakes that have already irrigated will remain closed, and water is conveyed to those canals further downstream that are still to receive water.

Finally, theoretically, the manager Mohammed Ahmed should also be in frequent communication with the manager of the new Debashya and Waqir systems, in order to ensure a proper water distribution that may take into consideration also the downstreamers' needs. Although the above appears to be a smooth and efficient process, in practice things flow in a rather different way.

4.4 Technical interactions between old and new infra-structure and ensuing reactions

Here as in the previous chapters, we will investigate technical and organisational interactions between the old system and the new EC-funded irrigation scheme. In Barquqa, we noted that the most rampant farmers' interference with the new irrigation infrastructure rotated around field and secondary level outlets (mandab outlets along the new BMC and BSC), various types of gates, and their operation. Outlets and gates embody the material connection between farmers' domain of irrigation and the TDA's management of the main system. In order to shed light on their evolution, an analysis is necessary of the presence and interfaces of ideas, interests, and practices of water control. The principal interaction is that between farmers and the TDA. Yet, which farmers manage

to influence the decisions of the TDA reflects their different ideas, socio-political position, and inclusion in the design and implementation of the intervention. Moreover, the respective authorities of the different actors are weighed in these dynamics.

4.4.1 The issue of gates

Traditionally, irrigation turns were either regulated through social supervision, whereby when the water master reckoned that one field had sufficiently irrigated, he allowed the next farmers to break the bunds and let water flow to their fields (al aela fil aela). At wadi level, the temporary nature of the sandy barriers both upstream and downstream imposed a certain level of equitable water distribution: when big floods occurred, large volumes of water broke upstream bunds and irrigated lower areas.

In order to maintain this rotational type of water distribution, in Barquqa, gated field and mandab outlets along the new canal were installed from the beginning. Moreover, with the second phase of Barquqa projects, the village channels' mouths were also gated.

During the implementation process, as their different colours suggest, many additional field outlets appeared along the new canals, and others are currently being constructed. In Barquqa, farmers often justify their quest for an additional field turnout in terms of their absence at the time of the cadastral survey, whilst others admittedly reported a smaller surface to the surveying authorities as they feared they would be taxed more because of their land holdings. Consequently, some lands were not included in the initial design and several commercial landowners could not accept to have a canal passing through their properties without having access to its water. These large owners, who mainly belong to the last two waves of external investors mentioned above, having the required financial means and power, managed to negotiate the permit for building new openings on the new canals, whose expenses they allegedly fully provided for.

Meanwhile however, some others are refused this right to new gates, such as for instance the village of Mahal Darwish, situated on the right bank of the wadi along Barquqa main canal (see Figure 4.1). Although they originally possessed irrigation rights from the old Saleh Jebeli mandab *(*see Figure 4.1) that used to run near the new BMC, the irrigation project did not include some of their fields into the canal's command area. When they complained to the TDA about the lack of openings and asked for new gates, TDA refused to pay for them. Since they had no means to invest in the new gate, they abandoned their cause. Although the manager justified this by affirming that they should pay for it like everyone else, the fact that in the end only wealthier owners can open new gates is significant of the power games at play around the new irrigation infrastructure – evident in the present design, where tens of new grey gates stand alongside the original red ones.

Additionally, whereas all the other mandubi*'* intakes from the wadi are gated, the absence of a gate at the entrance of Qaserah mandab may be yet another sign of the preferential relationship that certain farmers have with the TDA. This family also negotiated that their gates on the main new canal be left constantly open. The canal representative of Qaserah mandab, who, far from being merely a large owner himself, belongs to the acclaimed Qaserah family, was not only elected the head of the WUA of Barquqa but he is also the General Secretary of the Local Council. Thus, he can enter many domains of power from where he may exercise power also to his own benefit, from a traditional and locally grounded one (local elite) to project (head of WUA) to governmental (Local Council) domains.

4.4.2 Operation in practice: Barquqa's power game around the gates

Overall, there was a profound dissatisfaction among farmers about the gates, both at the entrance of the wadi and at the mandubi' outlets along the new canal of Barquqa, and particularly about the type of control exercised through them. Before the project, when there was a small flood, the various mandubi were irrigating one after the other: only when the first was satisfied with the water received, according to the local customs, the next could irrigate. Now, with the new gates which ensure an easier control of the flow by the hands of the TDA, the new concept is to give a little water to everybody, which if on the one hand may ensure "equity", on the other it seems in clear contrast with existing al aela fil aela arrangements.

Moreover, the TDA, operating the gates collectively, reduces the scope of action of the individual canal representatives, who are often either passively or actively contested by these TDA operators. The reality of the system's operation largely illustrates the interaction and reactions between these forces.

In Barquqa, contrary to the heralded priority of water distribution that should be given to the new canal, both the TDA manager and farmers suggested that even with small floods, water flows simultaneously both in some mandubi and in the new canal. We were lucky enough to witness a flood in April 2009, which confirmed our secondary information. It was a relatively small flood and the first six mandubi on the right bank irrigated, whilst on the left bank, supplied by the new canal, not all fields received water – when theoretically first the main canal should irrigate all its outlets and then the gates on the channels' mouths should be opened by a TDA employee!

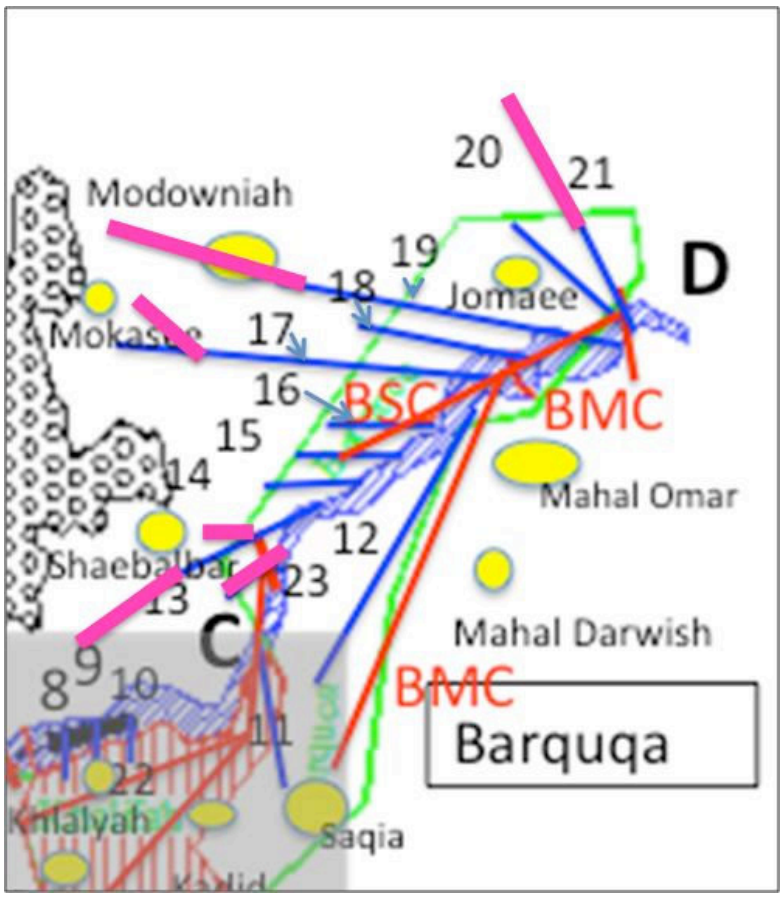
Whilst some farmers appear to have a larger say than others in the operation of the mandubi *(*e.g. Qaserah mandab*),* others are less able to directly influence operational decisions and instead opt for coercive measures such as manipulation of the irrigation structures. For instance, in Barquqa, last year, when the flood came, seeing no water in their mandab, a group of farmers, located at the tail end of Barquqa mandab*,* headed by the Aqil of Shaebalbar (the son of a former aqil, a much respected local authority) destroyed the gate that controls the mandab*'s* turnout along BMC. The opening was very small and not even the first fields could be sufficiently irrigated although the flood was big. Upon the order of the General Secretary of the Local Council, al Darasee Qaserah, they were all arrested and interrogated. The aqil was imprisoned for a month. We were informed about several other tampering attempts, which again involved members of those families (e.g. Shamiri, Barquqa) that moved to Barquqa area first and that in the past decades have lost part of their traditional status and goods mainly to external newcomers. This anecdote exemplifies that making generalisation that all large landowners are happy with their new system and in a coalition against poor farmers is inaccurate. Certainly some "gang up", but also within each category there are discernible contrasts that should not be left unaccounted for.

Numerous farmers, both small and large ones, pointed at the son of the Mohammed Abdullah Qaserah, central reference figure in Barquqa until his death a couple of years ago, as the person who informally decides upon water distribution turns in Barquqa together with a couple of other big commercial farmers. However, many large and small farmers mentioned his power with contempt: "He thinks he is the boss", "he is not like his father, that was a real leader", and so forth. Therefore, we highlight once again the lack of a legitimate coordinating figure of water distribution, like perhaps Awadh Abullah in his times, or Mohammed Abdullah Qaserah. Generally, it seems that the new generations, the "generations of the sons" are not only letting down farmers in Waqir, but the whole wadi. The TDA is never mentioned either when farmers speak about power in the wadi. The few times that they refer to it, it is usually associated to big foreign lending institutions, such as the World Bank, or the EC. On its own, the TDA is believed to hold little means and authority.

Nevertheless, some turn to it when in need because of this very lack of a legitimate authoritarian figure.

4.4.3 Large external owners' reactions and further extension of the traditional canal network

We said already that the traditional canal network was extended before the project. After the construction of BIS and the rehabilitation of the mandubi, this process did not halt, on the contrary, it went on at an intensified pace. For instance, since the inception of the project, Beidani lengthened and widened Barquqa mandab, Humaiqani did the same with Syali mandab, Badani lengthened both Shamiri and Qaserah mandubi, and the list goes on. The latest canal extension dates back to one year ago, when Esaee built a new branch of the Syali canal. Altogether, in less than 5 years, these new developments brought under regular spate irrigation an additional area of about 1,500 ha and led to an even more drastic change in the place's agronomy, where the few mango farms grew to now cover more than half of the Barquqa area.



Mandubi
12. Dehna
13. Syali
14. Matani
15. Khanani
16. Magaribi
17. Barquqa
18. Marzouki
19. Qaserah
20. Wajeh
21. Shamiri
23. Beshari NEW

Figure 4.3 Last extension of mandubi in Barquqa by external investors

Other landlords, who could already access regular irrigation, such as Qaserah and Barquqa, intensified their mango plantations. Additionally, after having tested the performance of protection dykes along the wadi banks, other mango and banana growers have recently converted to cash crops those surfaces near the wadi, which before were left for less valuable crops. On the left bank, we could witness the same pattern: many small mango trees have recently been planted by several medium landowners, who own between 20-60 maads (8-26 ha). Figure 4.4 shows the updated water redistribution in the Barquqa area after the conjunctive construction of Barquqa and lengthening of those canals mentioned above.

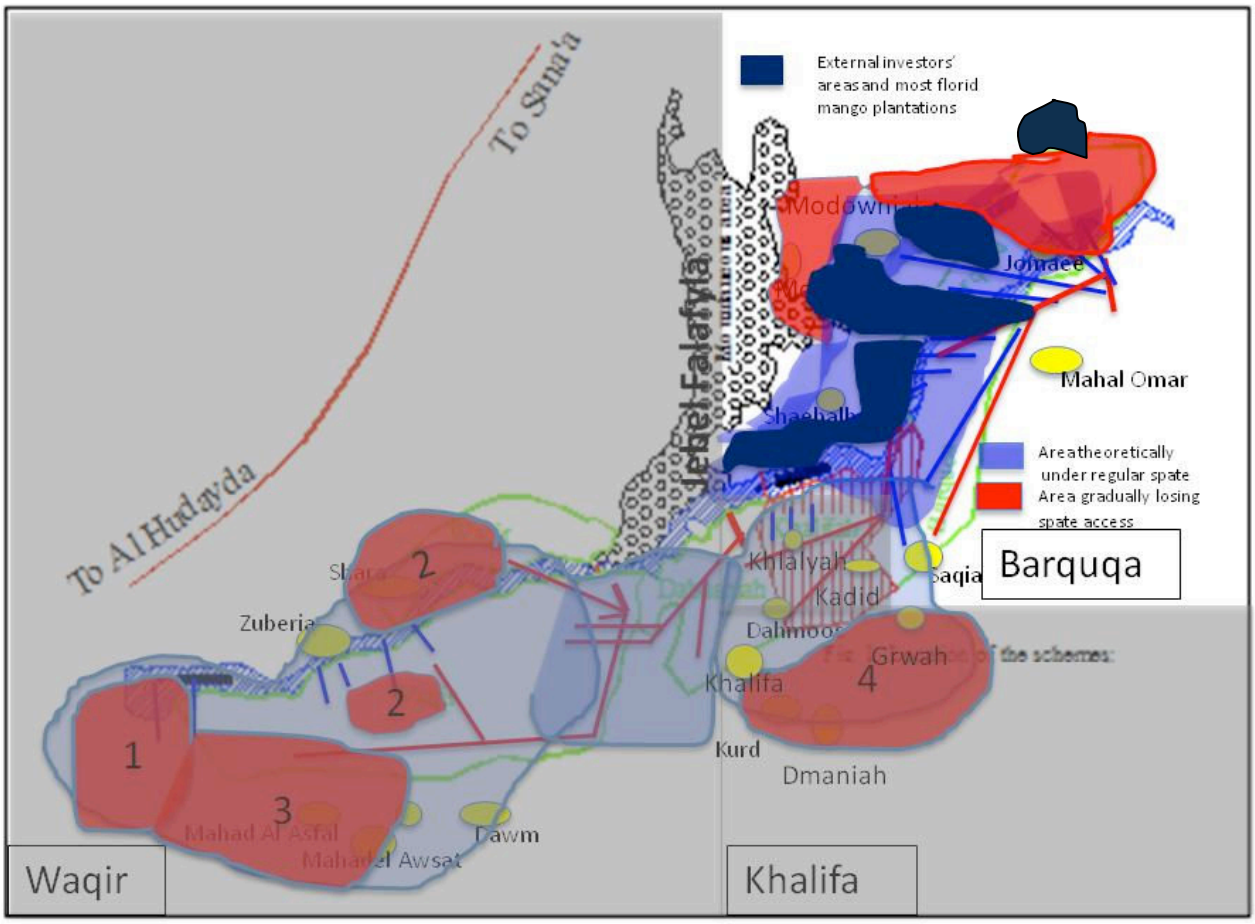


Figure 4.4 Present water redistribution after the extension of the mandubi network by newcomers and the construction of BIS

4.5 Implications on water distribution at system level

Although a water redistribution, had already emerged before its implementation, which favoured the newly irrigated areas on the wadi's right bank. Barquqa project, certainly exacerbated inequities between various locales up and downstream were. Indeed, wherever a new rich businessman bought land in these downstream areas, he generally invested in the lengthening of a canal. The thus immediately gained access to the spates (see the landlord Al Badani on Shamiri mandab), although his access remained restricted by the magnitude of the flood, according to the al aela fil aela rule. Next to him, an underprivileged village that used to rely on floods rather than spring flows for its irrigation, without any means for extending the existing canal, loses its water access (e.g. the village of Mokasee, next to Badani, whose inhabitants sold many fields to). Moreover, if a large mango grower is not at the tail end, he will divert more water to supply to its own requirements, and the tail-enders will remain dry (e.g. Beidani on Barquqa).

However, as we mentioned before, many medium and small owners in Barquqa still appear satisfied with their renewed possibilities of income. Many, even with a couple of maads, have recently begun to cultivate mango and, despite the recent drop in its market price, are enjoying some prosperity. Thanks to the improved maintenance of the mandubi by either the Irrigation Project directly, or large landowners who extended or renewed the maintenance of some mandubi (in Modowniah, Shaebalbar, and Khlalyah, just to mention some), those who grow sorghum gained two – at times three - bountiful harvests.

Nevertheless, not everyone in Barquqa benefitted from the improved canals. We have already mentioned the dissatisfaction of some groups of farmers who tampered with the system. In addition, the sharecropping group was doubtlessly the most affected by this water redistribution and specifically by large scale transition from sorghum towards mango plantation. From the beginning of the area's evolution to its current state, sharecroppers enjoyed some years of prosperity but from 1980s both their income and overall work possibilities have been constantly declining.

As a result, and as their fathers did before them, many youngsters migrate. Nowadays, most of the wadi's villages are populated by women, children, and elders. Older boys and man are rarely to be found: sometimes, they are small owners, most times sharecroppers. The remaining landless group usually opts for seasonal migration: they work in the wadi during the agricultural season, after which they seek for work in Hodeidah, Sana'a, Shabwa, or Saudi Arabia. Many women explained to us that at least this ensures them a good-enough livelihood. Moreover, as a result of intensification of mango and banana plantations on what formerly used to be communal pastureland, many poorer families lost access to feeding grounds for their animals. Where protection gabions were placed to secure the wadi banks from the violent nature of the spate floods, that in the past used to destroy these upper land on a regular basis and therefore limited agricultural practices on them, now those upstream owners are intensively croppung commodities. Everywhere along this upper side of the wadi it is noticeable that new fields are being created for such production: "we take all the water!" a local landowner woman said laughing, standing in the middle of one of these new fields.

4.6 Organisational interactions and reactions: the power of money and individual initiatives

In this section, we will analyse firstly the interactions between the various figures, past and present, involved in water management organisation in the upper locale of the wadi and secondly, how organisational practices changed as a result of the last irrigation interventions in Barquqa. Investigating the organisational aspects enables one to shed further light over the technical interactions described above and the type of reactions that followed. Furthermore, it helps highlighting constraints and possibilities for future water management. The main actors that play a role in Barquqa are the canal representatives, the Wadi Siham WUA, and the TDA. Below, we present the links, evolutions, and relationship of these with each other, and the practices that impact current water distribution patterns significantly.

4.6.1 Newcomers vs. traditional canal representatives: mutual dependency for maintenance?

Traditionally, a canal representative should be an experienced farmer. He should be acquainted with the flood season, the construction techniques of the infrastructure, and above all, the local system of water distribution. Finally, he should gain the other farmers' trust. These figures embodied the water control authority and supervised both conflict resolution and maintenance. In collective mandubi, they were periodically elected by all owners, or by village representatives, or aqils, who were themselves chosen by all villagers. If water users felt that they were fair and efficient, they kept this position for all their life, to the extent that in some mandubi it became hereditary.

In private mandubi, the situation was more autocratic, since the owner of the mandab became automatically the figure of reference for the water users. There, when one of the original funders died, their sons either continued to become representatives (for instance, Qaserah canal, where Al Darasee substituted his father) or, in case they sold significant portion of their land, the next biggest

farmers took up this position (see Hattami along Barquqa canal). Increasingly, the election criterion, although surely not free from economic pressures either, was discarded in favour of a more visibly economic rationale. An example from Syali is figurative, where 2 years ago, since the death of the old aqil of Shaebalbar, water users ceased to elect a representative –the choice would have fallen over the aqil's son– and instead, Humaiqani, a rich landlord whom we already presented in the previous chapter, comes forward every year as a volunteer to be in charge of the mandab.

In previous sections, we have already hinted at the upcoming role of external investors in maintenance practices concerning both mandubi and sandy barriers. Indeed, since investors began to extend existing village channels, they were often asked by the canal representative to contribute - in return for their permission to do this- a larger share than other small farmers to the works for the maintenance of the sandy spurs in the wadi. Although this collaboration between rich investors and traditional canal representative had already started in 1990s, before the project, in the last 5-6 years this practice has intensified along with the increasing costs of maintenance for the newly introduced gabions at the various mandubi intakes and along the wadi bank. For instance, along Qaserah mandab, nowadays Al Badani, a rich external farmer, is the main person responsible for the sandy spur and either Al Wosabi or he, another large owner, contacts the TDA for hiring tractors and personnel.

In addition, sometimes, the rich newcomers, situated at the tail end of various mandubi, have begun to provide themselves for the maintenance of the mandab too. Some mentioned that they would rather do it and later collect the money from the farmers who want to irrigate, mainly out of their fear of losing the flood. Others, like Qasem along Khlalyah mandab in Khalifa area, began to do it as a clause of his permission to buy land in the area. Others again have lost trust in the current canal representative, who according to them is inept.

By asking for a larger contribution from the most important farmers, the canal representatives could/can on the one hand gather enough funds for a stronger sandy barrier than the one that he himself could not have built with his own means. On the other, he can keep smaller farmers' contribution at an affordable level and ensure their cooperation and his legitimacy in their eyes. Nobody, not even small farmers, complained about the price of maintenance. In Qaserah mandab, farmers are charged about 1000 YR/maad (5 US$), which seemed fair to all, including some very small owners, with 5 or 6 maads. Even in other mandubi, such as for instance the Dehna mandab, where a general maintenance fee adds up to 5000 YR/maad (25 US$), people contribute without complaining. If compared to Waqir's sandy barrier's maintenance fees, described in Chapter 3, one realises that it is not a demand beyond the scope of the majority of farmers. It should be remarked that generally, owners with less than 5 maads are exempted from maintenance.

Thus, the presence of wealthy owners remains fundamental for the good maintenance of a canal. However, at times this diminishes the authority of the traditional canal representative, and, at a smaller scale, participation and appropriation of the system by smaller farmers, whilst reinforcing that of newcomers. The role of smaller farmers is less affected: already at the time when those traditional families that colonised the area of Barquqa were managing the mandubi, small owners and sharecroppers were not always asked to participate monetary in maintenance, but with their labour.

Nevertheless, at times these large entrepreneurs are so powerful that even local aqils and sheikhs, either dependent on them for maintenance of the mandubi (Barquqa), or simply less powerful (Waqir), do not have any means force the rich transgressors into a court appearance, whether local or in Marawah. This seems to further deter smaller farmers from presenting their claims before a governmental authority.

4.6.2 The Wadi Siham WUA

In 2004, all Barquqa and Khalifa's farmers were gathered by EC/TDA to elect the Wadi Siham Water User Association board out of 15 candidates. Some of them were already canal representatives, some others large landowners, others village aqil. Both Al Darasee Qaserah and Dahmoos, the son of a very large local landowner in Khalifa, were elected to lead the WUA, yet in the end, the latter abdicated in favour of the former, exponent of the new generation of the well-known sheikhs of Marawah, who was more educated. Since Barquqa and Khalifa new irrigation systems were to be managed by the same TDA manager, Mohammed Ahmed, this WUA was supposed to coordinate maintenance and water distribution amongst all traditional mandubi there and at the secondary level of the new schemes.

We wondered what the link was between the possibility to influence the technical implementation process and the operation of the system, and both the Memorandum of Understanding and the WUA. What part does the Water Users Association play in the changing organisational arrangements for the maintenance mentioned above?

First, we will discuss more details concerning the WUA's statute, its creation process, and the way it developed. According to the association's statute, the activities of the Administrative Assembly (the Board), should concentrate on the maintenance and the irrigation management of the system's secondary level (the totality of mandubi). Associations of this kind should have facilitated access to its machines (by renting them), advice and support in agricultural practices, trainings, and facilitated access to on- farm technologies such as drip irrigation. Furthermore, according to its statute, the WUA should be a financially independent organisation based on membership fees, shared costs for its activities, and eventual private and public donations (e.g. governmental or foreign agencies' support).

After the election of the Board in 2004, 4 million Euros were made available by the EC to the WUA for a first rehabilitation (maintenance and reshaping) of the "village channels", from the wadi intake up to the crossing with the new canal. After this, further maintenance should have fallen under responsibility of the WUA with money collected from the farmers. Yet, to date it remains unclear where the EC money was spent and to whom it was given, if directly to the contractor for the works, or, what appeared more likely, directly to the WUA's higher positions. Several informants suggested that the head of the WUA spent a large amount of this money for improving his own mandab whilst the remaining share was dissipated in cars and other personal needs of other Board members.

Initially, farmers were keen to vote for the Board, expecting positive outcomes such as technical support and machinery that were being promised by the various candidates. However, now, after five years, the totality of our wadi informers that was still aware of the existence of this association claimed that the association's beneficial achievement was nil. A common complaint is that the head of the association did not extend his maintenance duties further than along his own mandab: as a group of farmers put it, "he promised to help us and we voted for him, yet he just cares for his own interests and that of his rich companions". Hence, the idea of a WUA vanished quickly and farmers forgot about it: even some board members that we interviewed hardly remembered being part of it.

Nowadays, as suggested in previous sections, contrary to the attempt of having common organisation for inter-mandab maintenance and water distribution, the arrangements in place rotate around single mandubi. In these arrangements, canal representatives and newcomers concretely engage in maintenance and, independently of each other and the WUA, they deal directly with the TDA for aid. Now as in the past, along single mandubi, (e.g. Qaserah mandab*)* rich farmers continue to communicate amongst themselves for maintenance works and for requesting and

negotiating their irrigation turns between themselves and with the TDA. As a large mango grower on Qaserah mandab and "member of the WUA", explains: "the organisation is very simple, big farmers along the same mandab communicate between themselves and send for tractors to do the works that have to be done".

What the TDA and EC failed to recognise is the limited incentives for having an association putting together what before was divided. Several factors lie behind this. Firstly, the TDA's control of water distribution to single mandubi (at least on paper), the relatively simple maintenance operations and the possibility for farmers to contact directly the TDA for tractors, and the individual character of pre-existing irrigation management (entailed in the nature of irrigation infrastructure). Additionally, the disappearance of spring flows, earlier legitimating the presence of arrangements for water distribution. Moreover, overall spate water supply for farmers in the area of Barquqa has been quite satisfying, even more so after the last irrigation interventions and the increased diversion possibilities! This, together with the relevant role that groundwater use plays in irrigation supplies to mangoes, further reduces the need for a joint management for water distribution.

Hence, the legacy of the Memorandum of Understanding and the WUA is primarily the improved contact and communication between TDA and (some) farmers- elite, commercial farmers- and the empowerment of these very farmers *vis-à-vis* the TDA and EC staff that because of the label attributed to them by this institutions. This phenomenon has reached such an extent that nowadays many of these farmers overlook the still existing traditional figures of authority and turn directly to the TDA for technical help, advice, complaints about the "improved" infrastructures, and even conflict resolution! There we could witness a general trend whereby many WUA and MoU members now feel legitimated to give voice to their quests and to gain, not without certain pressures, "concessions" for better water distribution on their farms.

So, one could affirm that the organisation process induced by the irrigation intervention– e.g. the WUA - did not manage to infiltrate in a system that was already in place. When the WUA was created, already the most influential farmers had already ensured their access to TDA assistance and equipment, which, coupled with their influence on the workings of the canal gates, generally secured a sufficient water delivery to their farms. It made no sense for them to co-opt it. Nowadays, only the WUA's President seems to believe in his authority over the other farmers!

4.7 Conclusions and recommendations

The near-doubling of the irrigated area over half a century and the extensive shift to water demanding cash crops in the area of Barquqa surely had an impact on water distribution both at wadi and at area level even without the project, although perhaps it would not have been so drastic without the presence of the TDA and the WSIP.

Nevertheless, we believe that, taken alone, the impact of irrigation intervention on water distribution would not have been so strongly felt had the spring flow not disappeared in 2002 – due to both hydrological context and developments in the upstream part of the Wadi Siham's catchment. In our opinion, this was the final straw that entrenched this pattern of water distribution in the wadi's dynamics. Nowadays, the four irrigation systems in the wadi rely on the same water source and as such, increased water demands –and diversion – of upstream areas are more immediately felt in lower zones. By affirming this, we do not deny the relevance of power and politics, which are indeed the driving force behind who can access the water, on what basis, and in what quantity, even in water abundant areas!

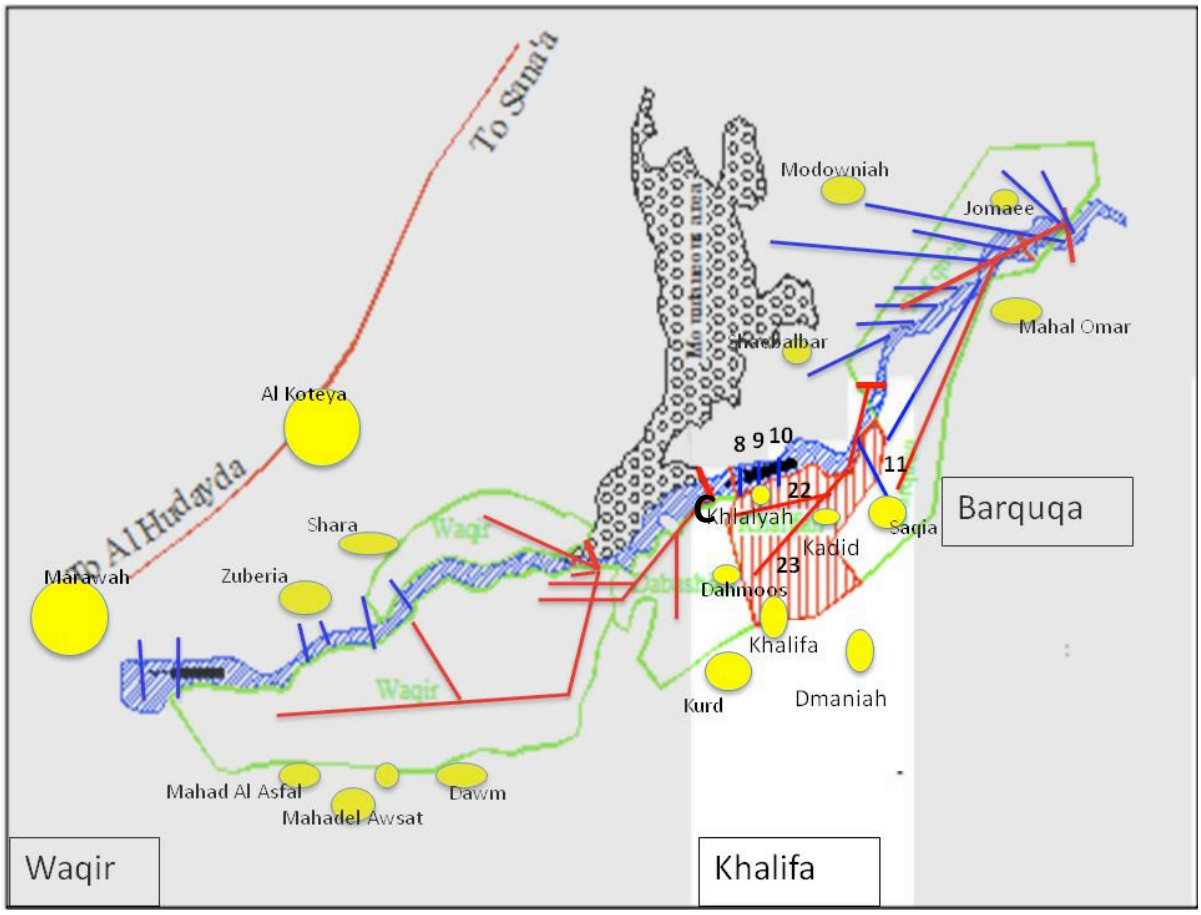
Together with this water redistribution in the upper locales of our study area, a social differentiation has also occurred: as far as it concerns irrigation issues (water appropriation, water distribution, resource mobilisation, and maintenance), the power of local landlords –the first to migrate to Barquqa– has gradually been substituted by that of the emerging class of external, commercial "farmers", who in their turn benefit from TDA machines and support. Amongst the former group, only those who managed to shift their authority towards new institutional establishments external to the wadi, whether the WUA, LC, or TDA, could retain a certain power. The anecdotes of Thoum Benna *vs.* Al Darasee are self-explicative of this shift.

Barquqa's case study clearly demonstrates how difficult it is to mitigate the strong irrigation interests of its influential users. The attempt to introduce a joint management for maintenance and water distribution through a WUA model failed not so much for being an external imposition. Rather it failed because of the strong individual vocation in water management practices and the missed recognition of the characteristics of the people that were gradually transforming the local society. There was enough evidence that if downstream requirements were to be respected, a strong authoritarian central authority would need to set the rules of the game. This authority could potentially be the TDA. The TDA, however, at the moment does not appear to have the means (financial, organisational, power) to counterbalance the political pressures coming from the project's beneficiaries. Nevertheless, one must recognise that within the TDA there is a widespread awareness that water is distributed unequally, at least in words, and this could be a starting point for something to change. All the same, a TDA staff who has been working for more than two decades in the wadi seems highly pessimistic in this regard: "*I have been fighting with powerful owners from the very beginning. To change their behaviour is beyond our capabilities, they are too* powerful".

In our opinion, the TDA could attempt to ensure a more equitable distribution amongst the new irrigation systems by improving communication and coordination between its systems' managers. Another suggestion is that affected groups from downstream gather together, whether in a WUA or in another type of organisation, and put pressure on the various owners to change water distribution practices. Nevertheless, we believe that at the moment, even those organisations that are emerging, are primarily concerned with their own branch or structure and fail to address the problem at a wadi-level scale.

5 Case Study III: Khalifa

In Khalifa the WSIP has not yet completed the upgrading of the existing Hakoume canal, which will mark the (official) phase of the project. However, we researched this area because it is a live theatre of exchanges between internal and external forces. There, we could witness "live" interactions during the current implementation of the new irrigation scheme, with the ensuing dialogues, reactions, clashes, changes, and trends that emerged. At present, older and newer actors and infrastructure are searching for a new equilibrium. Moreover, this area is also interesting from an organisational perspective, since a WUA is currently being proposed by the EC for managing the new canals, in a context where not only the first externally-created WUA has already failed in 2004 but also aqil*s* and sheikhs remain the reference point for most farmers. Additionally, water management is becoming increasingly individualised.



KEY			
Sandy Barriers/Lateral dykes	*Mandubi*		*WSIP*
8. Mahadeli 9. Bahlooli 10. Shroefia 11. Husseini 12. Uthun 13. Qamusia 14. Akm/ Waqir 23. Mohammed Yahya 24. Omar Qadi	**8. Humaiqani** **9. Beshari** **10. Khlalyah** **11. Saqia/old Hajar** 12. Dehna 13. Syali 14. Matani 15. Khanani	16. Magaribi 17. Barquqa 18. Marzouki 19. Qaserah 20. Wajeh 21. Shamiri **22.** Hakoume **23. Khalifa/old Hajar**	A. Waqir (WIS) B. Debashya (DIS) **C. Khalifa (KIS)** D. Barquqa (BIS)

Figure 5.1 Khalifa's area: irrigation infrastructure

Following a similar structure to the previous case studies, we first explain socio-political and agronomic evolution of the area until the WSIP. We then turn to the current implementation process, with the resulting reactions by the various stakeholders. We conclude with some recommendations for future intervention in the realm of water management.

5.1 Socio-political and agricultural evolution of the area

In 1960s, Awadh Abdullah, a governmental agronomist from Aden, was sent to Wadi Siham in order to improve the agricultural production in the Khalifa area through the promotion of cotton and tobacco cultivations. Amongst other initiatives, he organised the lengthening of the mandab Hakoume and the re-opening of the Kurd branch, which had been blocked by the Imam in 1940s as a form of retaliation against the village for their rebellions against his despotic rule. In addition, whereas for tobacco, a market connection had already been secured by Waqir's long-term production and trade, for cotton growers the State ensured a contract with the national cotton company. By this intervention, the state stabilised its presence in the wadi, which successively continued to increase both in Waqir, with the 1983 improvement of Akm, and Barquqa, with the introduction of mangoes, through to the beginning of the WSIP. The developments upstream that we described in the previous chapter did not affect Khalifa's water availability to a significant extent, mainly because the spring flow remained abundant to suit everybody's requirements and as such, Khalifa enjoyed a couple of decades of prosperity.

Meanwhile, rich external investors, who seldom lived in the wadi, attracted by these governmental initiatives purchased substantial plots of land from Ali Mohammed Ali Haluli, a former supporter of the imam who had to escape into exile. Whereas the Sana'adi Al Aqil opted to rely mainly on groundwater for his banana plantations, Beshari – the government representative for cotton collection - and Humaiqani – an MP, relied partially on the new Hakoume branch (see Figure 5.1); for the lower lands, each of them constructed another private canal with their own means. At the end of 1970s, another farmer from Al Koteya, Mohammed Dahmoos, began buying off many small farmers in the stretch between Kadid and Khalifa, along the Kurd branch of the Hakoume canal, for a total of 350 maads. To the North of the *Jebel*, Saleh Jebeli and Rubahi owned most of the region until Mahal Omar.

As it appears, a trend seemed set towards a complete control of the area by regional, large, and urban-based landlords. Yet, a few pockets of small owners remained. Villages like Saqia, Kurd and Kadid refused to sell their lands: although lured by richer newcomers' high offers and not able to recover their land expropriated by the Imam, the majority continued to practice agriculture, whether sorghum or cotton, and to benefit from the restored Hakoume mandab. As an additional source of income, many of this latter category found work as sharecroppers in the governmental lands managed by Awadh Abdullah and enjoyed his advice and the benefits that derived from it.

According to all our informers, in this period (1970s-80s), the Khalifa area's prosperity increased considerably. Once again, the wadi's wealth materialised through the promotion of commercial crops. This is another sign that the introduction of new irrigation structures by the TDA did not begin a pattern of commercialisation - although it surely exacerbated it by improving the conveyance capacities of some canals and barriers - but rather that this was already a recurrent phenomenon. The major difference between past and present state assistance to agriculture in Wadi Siham is that, in 1970s-1980s, a great effort was placed on extending groundwater exploitation as a more secure and reliable source of water. Nevertheless, both the Hajar mandab and the Akm extension demonstrate a parallel and persistent investment in spate water irrigation too.

Although the Intermezzo illustrates that Barquqa and Khalifa developments at times overlap, until the last one or two decades, their cropping patterns remained divergent: cotton on the left bank (Khalifa) and sorghum and other cereals on the right bank (Barquqa). Therefore, although technically speaking, regular irrigation had been introduced on both banks of the upstream wadi, the political and economic water control initially remained in Khalifa.

Only in the 1990s, after the cotton crash, Khalifa's hegemony began to be falter before Barquqa's new technological and agrarian. Recently, whilst some more "traditional" landlords like Dahmoos turned back to vegetables and sorghum, several others, following the undisputed success of Barquqa's farmers, prioritise mango and banana plantations along the wadi. These include Humaiqani, Beshari, some children of Dahmoos (near the village of Kadid), some renters of the governmental land near Jebel Khalifa, the Benna and Rubahi family North of the Jebel, and another few and scattered fields. As we noticed, most of the mango and banana extensions lay south of the Jebel in the lands of large AND external landlords.

Overall, this development upstream exemplifies a thrust for water and investment towards new spaces. What Khalifa's economic growth clearly demonstrates is the persistent presence of the State and State authority, with the sole exception of Khlalyah area, behind any shift towards a more commercial type of agriculture and a more efficient organisation of water control. As we demonstrate below, this intrusion in local organisational practices followed their principles and did not upset them.

5.2 Organisational water control before WSIP

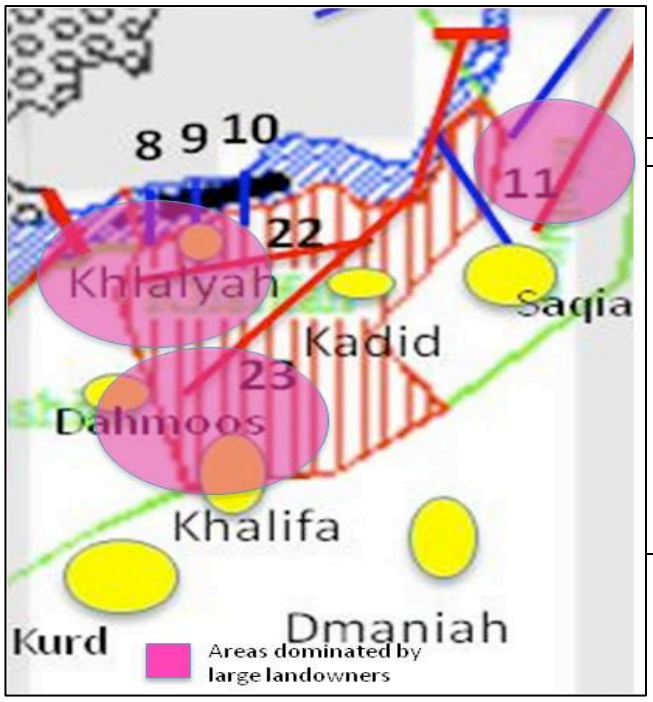
Since the introduction of canal irrigation about one century ago, the Khalifa area was irrigated primarily by the Hajar mandab, which had two main branches that were maintained seasonally by its users, namely the Saqia/Dmaniah and the Khalifa/Kurd groups. All villages irrigating from it, namely Khalifa, Kurd, Saqia, Kadid, Dmaniah, and Dahmoos (see Figure 5.1), these are the largest villages in the area) named one man responsible for the maintenance of each branch, generally from the leading family, who checked what works needed to be done, collected money, and gathered all farmers on certain days for adjusting both the barrier and the mandab. This normally occurred before each of the two main flood seasons or when some damage occurred to the infrastructure during a flood. For instance, years ago, Yahya – succeeding his father as the aqil of Saqia- and Dahmoos, aqil of the homonymous village, inhabited largely by his family and sharecroppers and workers, was elected by all landowners unanimously to manage the mandab*s'* maintenance. As for the Northern Branch, Awadh Abdullah, also became its representative. It should be remembered here that the majority of the land irrigated by this new branch belonged to the Government, which had "inherited" about 600 maads (264 ha) from the Imam.

During his time (1960s-beginning 1990s), Awadh Abdullah supervised the two aqil*s*, who first collected money from their water users and then handed it to Awadh Abdullah who in turn contracted tractors and drivers for the work to be executed. Those who could not pay offered their labour. In the beginning, before tractors were available, everyone had to contribute with oxen and/or labour. Punishment was the loss of access to water, but, as agriculture was their major livelihood strategy, all our informants agreed that, given the great need of that water, their totality complied with the requirements. The Hajar/Hakoume mandab also had several secondary canals, "more than 100!" according to an old farmer, whose water users maintained autonomously.

Thus, on the one hand, the good state of the canals was guaranteed. On the other, although farmers in Khalifa agree that their representatives met more often, they also state that at least twice a year,

before irrigation season, all water users were called forward to discuss any issue related to agriculture and irrigation. Generally they felt that they could bring their claims to a legitimate authority, Awadh's, which would help them to consider and solve any problem. Our interviewees were always very keen to assert that at the time of Awadh Abdullah, "*no conflict got out of hand. He was always dealing with everyone in a rightful way, whether they were big or small owners. He always kept large landlords in their place whenever they were trying to perpetuate an injustice*" (collection of quotes from our informants, Wadi Siham, March-June 2009).

When Awadh Abdullah died 15 years ago, this practice began to change. Having lost a common figure of reference and control, the organisation of maintenance, similar to pre-Awadh times, was reappropriated by Dahmoos and Yahya. Beshari junior (son of the government representative who sponsored the production of cotton) substituted Awadh Abdullah as the responsible person for the Hakoume branch. Although institutional figures remained unaltered, many farmers complain that the ones responsible for supervising irrigation practices, and other influential farmers too, suddenly acquired more power along with additional portions of land and the consequent concentration of water rights in their hands. Figure 5.2 highlights the land under control of few large investors. At times some of them began abusing their power by diverting more water to their field or charging higher fees to farmers for the right to irrigate.



Mandubi

8. Humaiqani
9. Beshari
10. Khlalyah
11.Saqia
22.New SOUTH branch/ former Khalifa branch of Hajar
23. new NORTH branch/ former Hakoume branch of Hajar

Figure 5.2 Areas dominated by large landowners

As a consequence, farmers stopped complying with their obligations as religiously as they did before. Moreover, the end of the North branch was gradually abandoned as some large landowners who used to irrigate from it started to focus primarily on their own private mandubi that diverted water directly from the wadi. Even Beshari himself, when his own canal was abandoned 15 years ago because of problems with its slope, preferred to invest in the maintenance of the Khlalyah mandab (see Figure 5.1) rather than relying on the Hakoume. Overall, after the death of Awadh Abdullah, too many separate interests, particularly between the North and South branch, began to collide. As we heard several times in the wadi,

> "*Since Awadh's death, the large landowners have not ceased to quarrel and consequently, irrigation became less efficient!*"

As a result, at the beginning of the WSIP, the old canals could no longer irrigate the whole area. For instance, in the last decade, Kurd, Dmaniah, and other tail-end villages with traditional water rights ceased to receive spate water not so much from ecological water scarcity but primarily due to the bad state of the canals – and the higher "water requirements" of powerful upstreamers (see area 4 in Figure 5.3).

Moreover, Awadh had been both the figure of reference for water conflict resolutions and the manager of a rotational distribution of the spring flow amongst all mandubi in the upper Wadi, including the Barquqa area. Turns, which could only be altered with the unanimous vote of all water users, ranged between 2 (Syali) and 6 (Hakoume) days according to their command areas. Since his death, which coincided with the arrival of the last wave of external investors in Barquqa, nobody has had the power to regulate this group's intervention in the previously agreed upon water allocation and distribution practices. A common pattern is that these newcomers often prolonged irrigation turns of their mandubi in order to fulfil the water requirements of their farms, which often lay outside the original command area of the aforementioned infrastructure. This extension of the irrigated area has been increasingly felt in the past decade, when spring flow began to diminish until it completely disappeared and hence the two areas, Barquqa and Khalifa, became fully dependent on the larger spate flows.

Similar to Waqir's story, in Khalifa too it seems that the presence of a strong and charismatic man was an unavoidable element for good and equitable irrigation practices:

> *"When Awadh was alive, he had the power to talk to all farmers, rich and poor, solve all the conflicts and ensured that everyone received water when it was his turn"*
>
> *"Awadh was a great man, nowadays we do not have someone like him"*
>
> *"Since he died, nothing has remained the same"*

However, although certainly significant, to attribute the gradual abandonment of the Hakoume mandab to the singular loss of a strong leader would be by insufficient. For instance, in the same years, at the beginning of the 1990s, a massive migration wave of young men is recorded, which amongst others, resulted in a drastic labour scarcity. Moreover, the introduction of mango plantations in some areas reduced the sharecropping opportunities, on which the majority of small farmers and landless used to rely for their livelihoods. This trend was paralleled by emerging interest for investments and the redistribution of irrigation and organisational roles to a few large farmers, which further exacerbated a power divide. Finally, during the construction of BIS, bulldozers excavated the wadi bed too deep, which further impeded the proper functioning of the Hakoume canal.

Already before the intervention of the TDA with the WSIP, less water seems to have been available to farmers in the Southern Khalifa area, and to a great part, this water appeared to have been controlled by newcomers and large landowners. The unsatisfactory state of the irrigation infrastructure at the beginning of the project parallels that of many mandubi in Barquqa and haghus in Waqir. Main causes are migration, population pressure, water scarcity (whether relative or absolute), and an uncontrolled use of groundwater. Below, in Figure 5.3 see the map of water distribution until the beginning of Khalifa Irrigation Project:

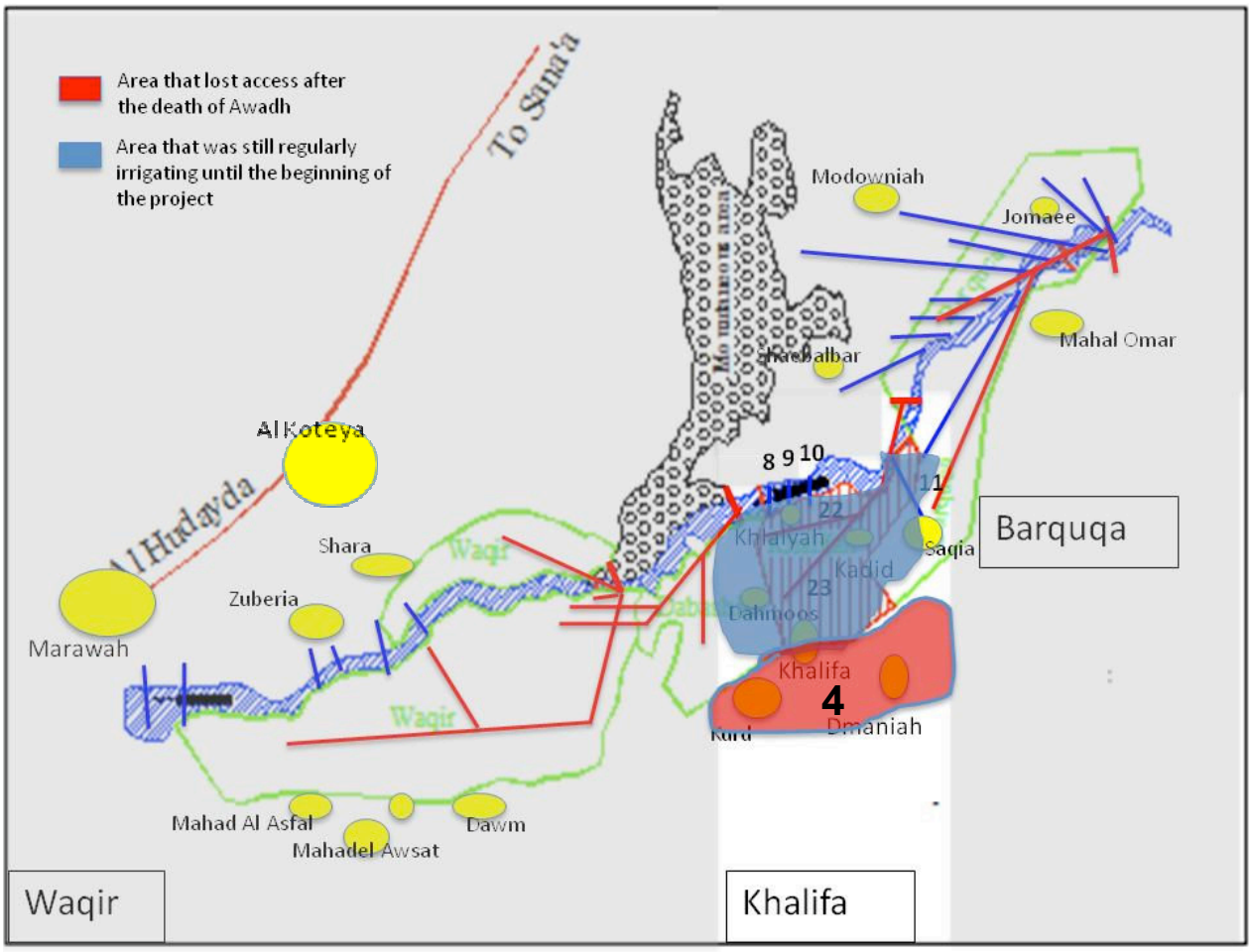


Figure 5.3 Overview of water distribution patterns in Khalifa area in summer 2008

Yet, not all locales suffered because of this scarce or unequal water distribution, which emerged for various reasons after the death of Awadh. Khlalyah mandab pursued a different path. Being collectively managed by its ten initial funders, its maintenance has been running satisfactorily until today and managed to resist the infiltration of (too many) external investors. Nowadays, only a few grow mangoes, whilst the others continue to cultivate sorghum and sesame. Last year, however, the mandab was enlarged and extended to new owners. The representative of the Qasem family, from Ta'zz, who arrived in the area one and a half years ago, was thrilled by the numerous floods that his farm managed to benefit from: *"in one and a half year, 10 floods, came there, 10 floods…and I was swimming for how much water there was, up until my armpits...!"* he claimed, indicating the water level marks on the field bunds.

We believe that the reason behind Khlalyah's success is in its micro-climatic status: it is favoured by an optimal hydrological location, by the small scale, which facilitates its management and water distribution, and by the limited migration of its water users. There is a general consensus amongst the mandab's water users that the main change, which followed Awadh's death, is that now they turn to Dahmoos for solving those conflicts that they do not manage to internally – and "*He ain't no Awadh!*" they generally conclude. Hopefully the hostile terms in which two of Khlalyah's farmers, presently in quarrel, referred to each other, will not lead to serious power conflicts that will affect the local irrigation!

5.3 The Khalifa Irrigation Project, 2008-2010

The last component of the WSIP, the Khalifa Irrigation Project, which began in summer 2008, is still under construction. Yet, some of its elements are already in place. Where before a sandy spur functioned as a diversion point, in Khalifa there stands a protruding dyke with an approach channel after which a permanent main intake of concrete will convey the flow into the canal system on the left bank of the wadi. The canal retraces the former Hakoume mandab and its three main branches, namely Saqia, North Canal, and South Canal. In June 2009, workers were still toiling around the construction of the division structures corresponding to the Saqia and the North/South division of the main canal (see Figure 5.1).

Due to the irregular and often unpredictable spate discharges, the strategy of a spate irrigation project is to deliver a maximum amount of water to the agricultural lands in a very short time. This necessitates rather large irrigation modules, which in the Tihama valley, the TDA normally sets at 10 l/s/ha[21]. However, even in a spate irrigation system, this module seems exaggerated. It overlooks both water availability and crops water requirements. The consultant in charge of the implementation of the KIS believes that it should not exceed 5 l/s/ha.

For the Khalifa project, with a total irrigable area of around 1,800 ha, this results in an intake structure able to let 18 m³/s enter the project area. The design also intends to maintain former water distribution arrangements: therefore, with a command area of 1000ha, North canal will remain the biggest ($10\,m^3/s$), then South canal which will irrigate 600 ha, and finally, Saqia canal will serve 200 ha. Yet, many squabbles are developing about this sensitive issue. The several secondary canals remain under their users' circumscription and are not touched by the project.

5.3.1 Implementation Process: bottlenecks and expectations

According to foreign consultants, TDA staff, and farmers whom we met during our fieldwork, the implementation works are proving to be rather intricate and, as such, they are undergoing severe delays. Major issues remain at stake, which range from the organisational, to the human, political, and to the technical realms. Below we list those that according to us are leading now to delays - and may lead to even further bottlenecks in the future:

1) **Monopolisation of water and conflicts** around water distribution between North canal and South canal due to interests of large landowners. Additionally, many farmers pointed at a couple of very influential newcomers from Sana'a that have recently bought large lands along the North canal and who have supposedly pushed for the irrigation intervention in Khalifa. Rumours suggest also that once completed, the North canal will be entirely to the benefit of these landowners.
2) **Dahmoos**, by requiring enormous compensations for works to pass through his land. He also refuses to include Kurd into the canal's command area, where according to the design, there should be a secondary canal until the road, crossing it through a box culvert and then irrigating field-to-field until Kurd's lands. Even if the project managed to force him into compliance, it is doubtful what the future holds for Kurd's irrigation.
3) **Design mistake**: the main canal was mistakenly designed too near to Mahal Rubahi's fields and houses, villagers protested, and works had to wait until after harvest to resume. Moreover, since according to the new design, the canal will run very near the wadi, its implementation requires a

[21] The reader may wonder why Waqir Irrigation Scheme was not designed according to the same principles: this occurred because at that time, the World Bank was fully in charge of design and hence TDA was seldom consulted. Additionally, commercial crops, for which the irrigation module of 10 l/s/ha was computed, were less widespread.

much larger investment in gabions in order to protect the canal from erosion of its banks. This in turn makes it more susceptible to the destructive momentum of larger floods.

4) **Gates and openings**: many complain about gates, especially along the Saqia branch (see Figure 5.1), where water users are afraid that the new scheme will irrigate a smaller area than in the past, due to the intake from the main canal, which is much smaller than it used to be. Under farmers' pressure, one man who claimed to be the rightful volunteer representative of Saqia mandab, chosen by the Wadi Siham WUA[22], went first to the head of the WUA and then to the TDA to bargain for a larger share of water. According to him, from 0.60 m^2, the gate will now measure 1 m^2. Yet the head of the WSIP was not aware of these changes.

From a hydrological perspective, TDA and consultants do not seem to worry that the increased diversion capacity of the headworks may negatively influence water availability downstream. The new diversion structure is not intrusive like the dams of both Waqir and Barquqa, instead, it can be seen as the improved intake of the existing Hakoume mandab. Yet, although taken by itself, Khalifa project may not impact that much the overall water availability for downstream users, its effects, must be added to those created by the disappearance of the spring flow and the increased diversions in Barquqa.

Additionally, there is a widespread tendency among TDA staff to trust in the functioning and effectiveness of gates in controlling Khalifa's diversions. When we asked for the O&M manager's opinion on this regard, he answered: "there is a gate, so we will control that only the right amount of water flows inside the system". Inshallah! We answered, as past experiences in Barquqa, portrayed in the previous chapter, drive one to the opposite conclusion. Gates are very susceptible to farmer's political and physical interference and rarely can the system be operated as provided for by the manual. At system level, farmers are afraid that the richer owners will receive the lion's share of the additional water available.

Concluding, although the new system is not operational, technical and human interactions are already real and drive the conflicts surrounding the implementation process. Now, we will turn to the organisational implications produced by both the presence of the TDA and the promotion of WUAs in this dynamic irrigation context.

5.4 Organisational interactions and reactions

In 2004, farmers in the command area of the KIS have been formally included in the establishment of Wadi Siham WUA, (see Chapter 4). Supposedly, the "Khalifa Water Users Association" should have played an important role in distributing floodwater according to the traditional water rights, providing agricultural services to the members, and solving any problems regarding water rights and water distribution. Moreover, by formalising existing organisational arrangements, the TDA hoped for some guarantees about the sustainability and viability of maintenance practices. After the main system of Khalifa scheme (previous Hakoume mandab*)* is completed, the numerous existing branches of Hakoume mandab would have constituted the secondary system level. Their ordinary maintenance would have been under farmers' responsibility, and the costs of their possible rehabilitation would be shared between the TDA and farmers.

Yet, what remains today of this organisational endeavour is a hazy reminiscence of few farmers (mostly heads of villages and larger farmers) of the elections days and the successive disappointment about the non-fulfilment of the many promises spread during the election campaign.

[22] Curiously, both farmers and the aqil of Saqia were unaware of his title of WUA representative!

It emerged that expectations of farmers were many and ranged from technical advice, machines and subsidies for agricultural practices, to new and functioning irrigation infrastructure. None of these promises could be met and this created dissatisfaction among those few farmers who were aware of the WUA. Several reasons lie behind the failure of the WUA. Firstly, the way in which the ground for the WUA was prepared and its first steps followed by the TDA and foreign consultants should evoke no surprise about today's ghostly presence and total inactivity of the WUA as such. During the two months that preceded the election of its Board, the level of awareness creation among farmers was very low. Thus, only a very restricted number and type of farmers (those more aware) could finally reach the appointment in the village of Mahal Omar for the vote.

Secondly, candidates' promises were at times impossible to accomplish as either they lay beyond the WUA's responsibilities (construction of irrigation infrastructure), or because of the ineffectiveness and the meagre budget of the TDA, which should have provided support to farmers in agricultural practices. Due to the scarce participation of farmers and the absence of a clear definition of responsibilities, rights, and benefits of individual users, the result was that not a single meeting or collective initiative of any kind under the name of WUA after its creation. Furthermore, once it became clear that the WUA would not provide new canals and tractors, as they had wished, nobody really felt the need to have such an organisation. Consequently, whilst the WUA should have also had a role in both water distribution and conflict resolution, unanimously, farmers still all turn to their traditional reference figures: the aqil*s* Dahmoos (senior) and Yahya, despite awareness of farmers about power abuse and inequities in water distribution.

This shows that where there is no particular incentive (such as for instance getting funds for improving irrigation infrastructure) for organising under the legal status of a WUA, not least for the elite, this label is quickly forgotten. In 2004, when the WUA was created, maintenance works were already organised by the canal representatives and this system was working fairly well. Nowadays, farmers are getting new irrigation infrastructure from the TDA without having to participate in sharing the costs or construction. Moreover, migration out of the wadi, the expansion of large owners' properties and their increased role in maintenance had already shifted Khalifa's water management to a more individualised one. Why should farmers of Khalifa have been interested in a WUA? Despite this, recently, foreign consultants have been called again by TDA to study the feasibility of a second WUA attempt in Khalifa.

Yet, there is another example of a WUA, opposed to the previous one, emerging precisely from areas that do have a purpose for seeking that appellative. This is the case of the village of Kurd, which lies at the tail end of the South Canal and does not record a good relationship with the representative of that canal[23]. The villagers of Kurd have not been irrigating from the canal for several years, because "*water is kept "somewhere else"*. It follows that they do not recognise the authority of the canal representative and instead they would rather turn for advice and support to the TDA, EC, and TGH. Hence, farmers in Kurd expressed their willingness to create a WUA of their own, with the objective of gaining a stronger voice against those powerful landowners further upstream that block their access to water. Indeed, impressed by the success of the Wadi Siham WUA in Barquqa, they believe that only by following their example they may appeal to higher institutions such as the EC or the Ministry of Agriculture and thus ensure their water access. They recounted that in 2004, when they were gathered by the EC and the TDA to vote for the new WUA, they voted for this very farmer that now is concertedly blocking their access to spates.

[23] Kurd has a long history of rebellions and the people are known in the wadi for their brave spirits, particularly when struggling against injustice. At the time of the Imam, they revolted against his oppressive rule and as punishment and they were deprived of their customary access to both Debashya and Hajar mandubi – the former had been constructed by the village aqil himself. After the Imam, Awadh assisted the villagers in the reconstruction of their branch on the Hakoume mandab and since then, for many years, they irrigated sufficiently.

"A WUA seemed a good idea, we have always organised ourselves in a collective manner, and until sometime ago, it worked well. [the big farmer] is a liar, we voted for him because he promised us water, but now…"

Nevertheless, *"the WUA only worked upstream, for those farmers up there"*.

This seems to be the general feeling of Kurd inhabitants. Hence, at the moment, they are drafting an organigram and searching for a name. According to them, the EC should support them in this process of creation of their authorisation, as much as they helped Barquqa's farmers in forming theirs and promoting their claims. Once again, mimicry appears as the only feasible solution for gaining a voice before the external authority, which is believed to be the one with enough power and resources to mobilise change.

5.4.1 The role of the TDA

In a context where collective action has lost some of its previous energy, on the other, nowadays, the WSIP further reinforces and affirms the state presence through the growing role of the TDA. Paradoxically, despite the promotion of a decentralised management entailed by the WUA model, providing alone for the construction of new irrigation infrastructure, the TDA has weakened the already vacillating collective spirit in irrigation practices. The feeling that we could widely note among farmers can be well summarised by the following statement:

"If they want to build it [the new canal], do so! But then the canal will be theirs and they will be responsible to maintain it, we will not pay…"

Even though farmers referred to the main system level, which should be managed by the TDA anyway, they were also hoping for a state intercession at secondary level (channels branching off from Hakoume mandab*)* where maintenance and operation should be responsibility of farmers. Moreover, several small farmers were also complaining that the new system was asked by and built for rich farmers, the primary beneficiaries of the Khalifa project. This further undermines social cohesion and collective action.

Whilst on the one hand we are witnessing a situation of individualisation of irrigation practices, on the other hand the present situation would urge for a collective type of water management and water distribution. Amid growing inequities at Khalifa's system level and the need for a water allocation at wadi level that takes into account both the requirements of the four new irrigation systems and those of the traditional structures, it would appear that there is a call for an authority (like Awadh Abdullah in the past) to harmonise the water needs of the various irrigation realities. This authority could act as a coordinating umbrella of the various types of organisational forms emerging in the wadi, and mitigate the strong individual interests, which undermine the rights of both systems and wadi's downstreamers.

The question remains whether the TDA has the potential for incorporating such a role. We introduced this question to several farmers, the majority of whom was severely hostile to the TDA. One farmer mentioned to us that the TDA representative at the moment has no chance, because there are too many conflict and at the time of Awadh, conflicts were almost forgotten. The majority that we interviewed in Khalifa reminisced about a better past and of the good companionship that they had built with Awadh.

We obtained one very critical account of the TDA from the canal representatives of the Khlalyah mandab. Last year, the water users agreed to build some gabions to reinforce the intake of their mandab

and asked the TDA, which according to them asked for an exorbitant price. Two years earlier, the same had occurred. When they had demanded the TDA to give some support to remodel, deepen, and clean the canal, they paid huge fees for food, transfers, paper signatures, tractors, qat for the workers, and so forth. They have now decided never to ask for TDA support again and instead sold some land to a rich owner from Ta'zz, who will contribute a larger share of the maintenance. Moreover, they extended their mandab's command area also to the fields of Beshari and Humaiqani. Although this may mean slightly less water for the head-enders, by doing so the ten original water users guaranteed that enough financial means may be available for future maintenance.

5.5 *Implications of shifts in water control in the last century for overall water availability downstream*

The technical and organisational evolutions of water management that we described in this thesis evidently led to a remarkable shift in water allocation and water distribution.

In a 2008 feasibility report, Lionel Roux, the former technical coordinator of TGH in Hodeidah, evaluated the possibility of additional irrigation projects in Wadi Siham. Based on a proposal for an Irrigation Management Plan commissioned by EC in 2004, he calculated that given a certain flow-duration curve of an annual average flood with 100 m^3/s peak discharge, and the diversions from Barquqa, Khalifa, Debashya, and Waqir, the remaining water in the wadi after the last diversion weir would be very limited (see Figure 5.5**).** Figure 5.4 and Figure 5.5 demonstrate this evolution in water allocation upstream, that resulted not only from the project, but also from agrarian developments and migration processes in the region.

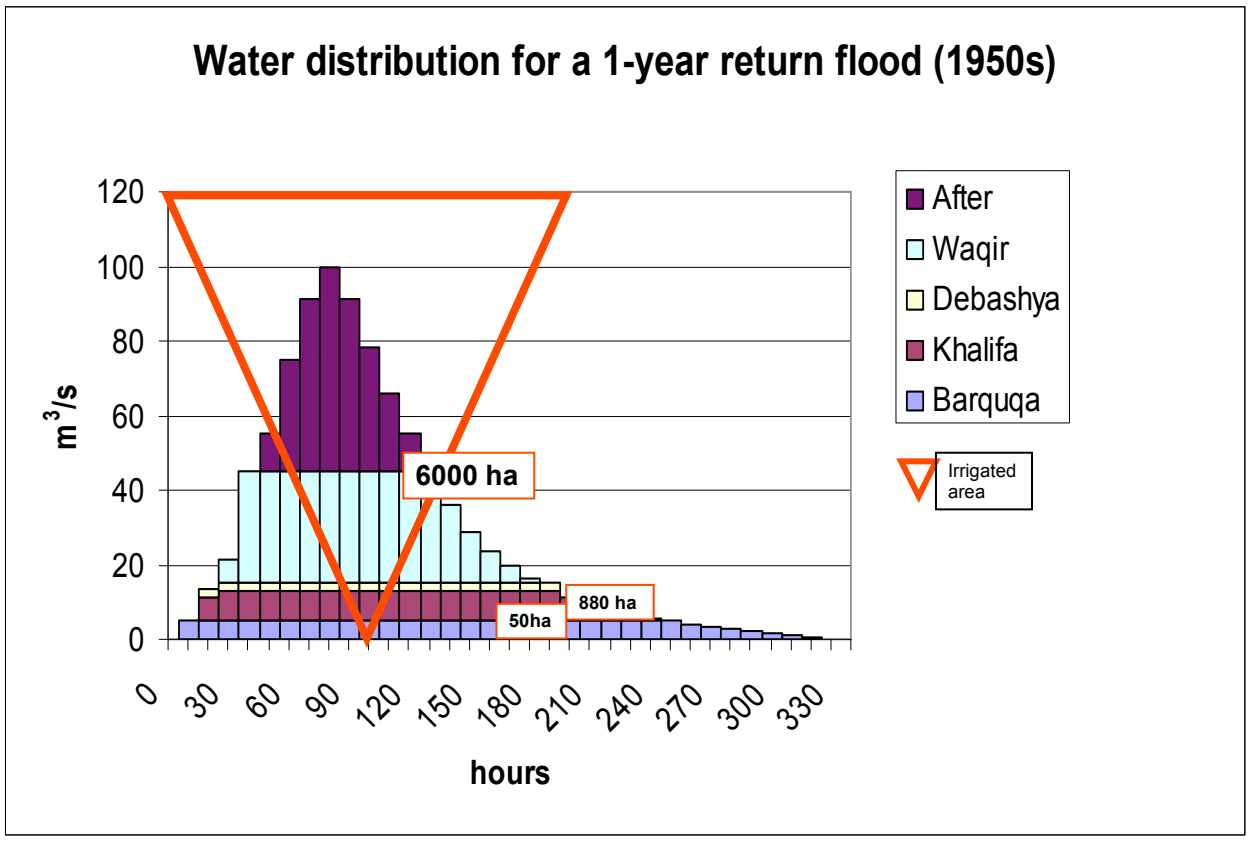


Figure 5.4 Water distribution for a 1-year return flood in 1950s.

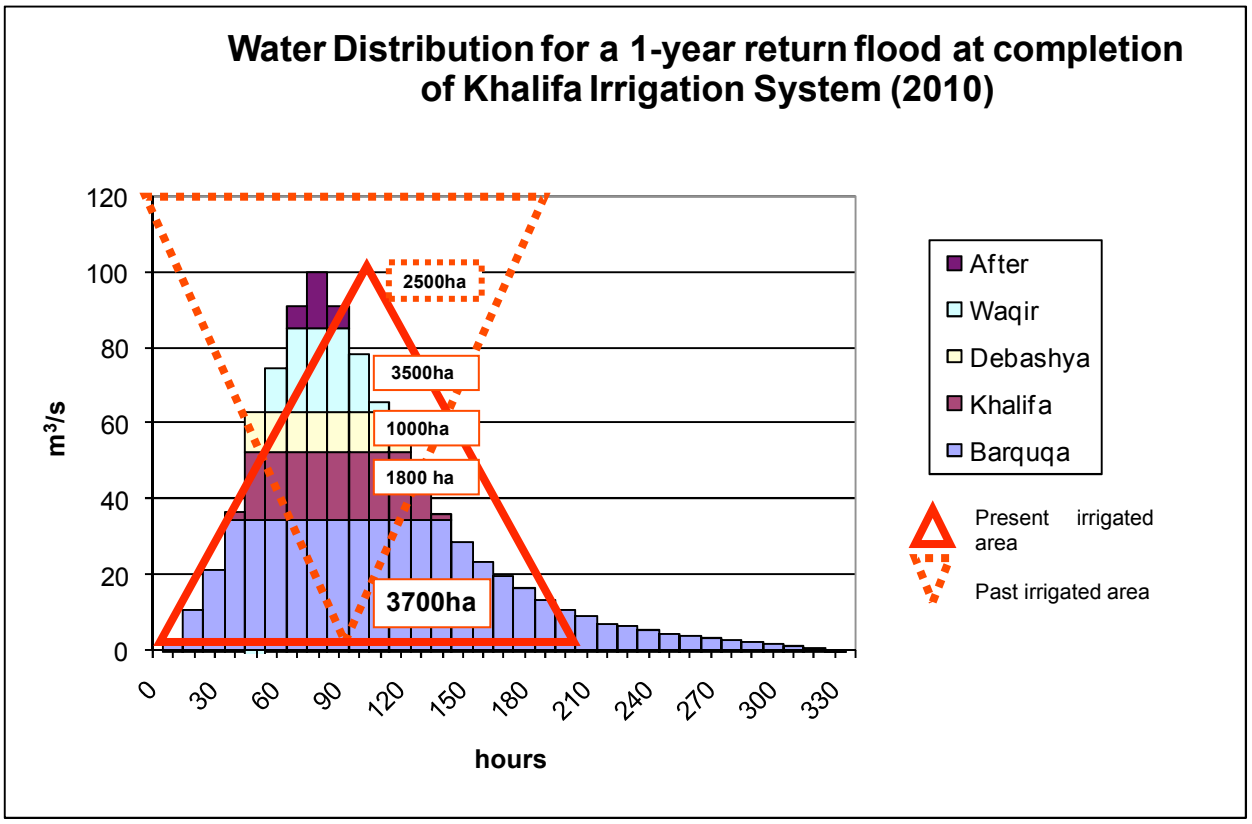


Figure 5.5 Expected water allocation according to the WSIP

As foreseen, the increased Barquqa's diversion potential and conveyance capacity impacted negatively on Waqir's hydrology whilst in the past, weaker sandy spurs would have been washed away by medium and larger floods and consequently, water reached the lower areas more frequently (see Figure 5.4).

Moreover, Figure 5.5 is designed according to a flood with a 100 m^3/s peak discharge which can potentially reach Waqir and below once a year. It is important to emphasize that all the smaller floods will be diverted upstream, particularly as a result of the *de facto* operation of the system. We described in the previous chapters all the contestation and negotiations around the physical control of the water. The fact that, despite the promoted concept of "Single Wadi Development", there is a total lack of coordination and communication between the manager of Barquqa and that of Waqir, definitely exacerbates the biased diversion upstream. A rotational type of water distribution method – that was accounted for in the design – is not (yet) materialising.

A final remark is that due to the technical havoc of the new Waqir infrastructure and the state of most traditional sandy barriers, the actual irrigated area (approximately 1,500 ha) in this lower locale of the wadi is much lower than the command area foreseen by the project (3,500 ha). Figure 5.6 below illustrates how water is distributed at present in the wadi after the implementation of the WSIP.

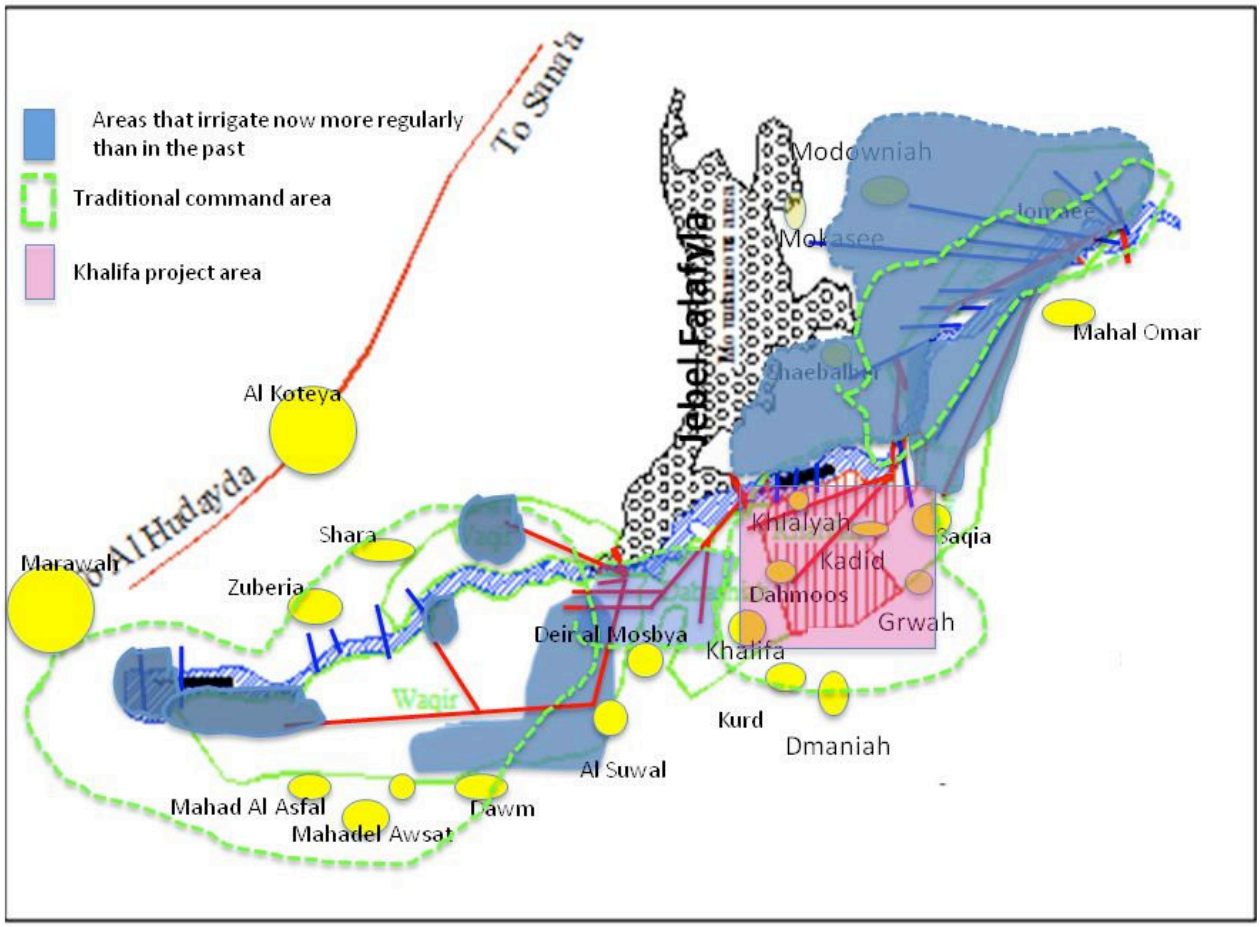


Figure 5.6 Water redistribution in Wadi Siham

Nowadays, what can be noticed is a continuous shift upstream: from Waqir under the Imamate, to the rise of Khalifa, to Barquqa area. This tradition of "following the water" may in the end mark the doom of Barquqa too. Intensive new exploitations and water projects in the valleys above the mango area have already appropriated the spring flow that once used to constitute the main water source for Barquqa. As we mentioned in Chapter 1, large floods too have visibly been retreating: they ended in the sea in 1998, in Hodeidah in 2002, and finally, in Marawah in 2006. Upstream water developments for supplying a population that is increasing at an accelerated pace are unstoppable. Any local initiative to regulate these developments is unrealistic in the near future as it lies beyond the scale of Wadi Siham's management and decision making. Gradually but at a constant pace, this may restrain the water available downstream. One day perhaps not too faraway, the bountiful farms of Barquqa, now the "lucky upstreamers", may turn into the downstream area and join the downstreamers' queue for water.

5.6 Conclusions and recommendations

In this chapter, we highlighted that inequities are increasing in the area of Khalifa in the last decades and strong interests of powerful landowners in both North Canal and South Canal may hinder a fair distribution of water between and along the canals of Khalifa system. In addition, although it is too early to assess whether Kurd will be able to irrigate after the completion of Khalifa project, certain power dynamics have emerged during its implementation that would suggest the contrary. Beside these internal issues underlined in the system of Khalifa, also at wadi level water is gradually becoming scarce as the development of new infrastructure, the expansion of irrigated areas and the higher needs of commercial crops upstream place pressures on the water

resource. This trend reaches beyond the wadi scale and instead characterises the whole of Wadi Siham's catchment and the overall situation in Yemen.

Whilst water allocation both at Khalifa system level and at wadi level has become a real challenge, the current projections of consultants about another attempt to introduce a WUA in Khalifa appear unrealistic for the following reason.

As water management in Khalifa is taking a more individualistic character (towards Barquqa style), this collective organisational form may encounter the same problems that led to its past failure in 2004. Where there are no concrete incentives for farmers to seek such a label, be it funds to improve of irrigation infrastructure, for agricultural support, or the reclamation of water rights, chances of success are small. Additionally, where tasks, obligations, and especially rights and gains of individual irrigators vis-à-vis the others are not clearly defined, farmers may lose interest in collaborating. Even more so, if one considers that the collective construction of irrigation infrastructure may be a necessary step to create links between water users and drives of collective action (Beccar et al., 2002) and this is precisely what is missing in the current improvement projects in Khalifa.

At the same time, it is debatable whether a WUA model with the current mandate, according to which its tasks are limited to water distribution and maintenance of the infrastructure may incentivise water users enough to join. Given the ephemeral nature of the flood, is there an actual need for such an official organisation that in fact would need to meet only a couple of times per year for organising the maintenance? What would be the benefits and obligations of the members?

For an organisation like TGH that wants to try to improve water management building on local, collective initiatives, we believe that what we outlined in this chapter –the strong presence of local figures for conflict resolution and the WUA ideas, both grassroots and promoted by the TDA– offers a challenging basis to work on.

The question remains whether organising themselves in a WUA, would be enough for solving the problem of the villagers of Kurd. We got the impression that there is a potential need for an overarching authority with enough power to decide upon water distribution. In this sense, TDA has a great responsibility but has still to gain trust among farmers. Although we acknowledge that there are very valid and experienced persons in its staff, too often it has proved to be acquiescent towards pressures of the more powerful, and its financial and organisational capacity too weak. The other side of the coin is that the creation of a WUA may also be interpreted as a palliative for the farmers, which allows the deciding institution to procrastinate on some political choices, for instance, on forcing Dahmoos to let the canal pass through his land and reach Kurd. Indeed, when Kurd complained to the TDA, apparently they replied: "*Make your own and we will talk about what you need*!".

The WUA tool, then, can be seen as a double-faced sword. On the one hand, the adoption of this specific label is an option that farmers have for reaching a purpose. On the other hand, however, it can be seen also as a blackmail of authorities that want to pursue their discourses. Whoever does not accept it, is left behind.

6 Conclusions

Our research question emerged from a need to move away from those approaches that promote a dichotomous black-box between irrigation interventions and what preceded it. Our first objective was to shed light over those dynamics that characterise the present situation of water management in Wadi Siham through a sound understanding of why they materialised and out of what context. We placed special efforts to identify both the interactions between the WSP and the receiving context, which entailed those varieties, contradictions, and initiatives, both in technical and organisational aspects that could explain current water distribution patterns. Additionally, we pulled to the fore the various evolutions on who has access to and control over the water resource, by paying a special attention to the political dimensions of relationships between the various actors.
Since in the near future, TGH also plan to run a project for the strengthening of current water management, they specifically asked us to clarify the impacts of the construction of the four new irrigation systems within the Wadi Siham Project on local water access and to highlight opportunities for collective water management. This became the second objective of our research.

Consequently, we phrased our main research question as follows:

How and why have patterns of water control evolved over time and space within the various water-networks in the area of the Wadi Siham Project?

Below, we illustrate our main conclusions.

1. The Wadi Siham Irrigation Project exacerbated, not initiated, a preferential water allocation in Barquqa, to the detriment of the rest of the wadi.

In Wadi Siham, the local agrarian structure transformed significantly throughout the past century. In the past, Wadi Siham's local society was characterised by pastoralists in the upstream areas and agriculturalists concentrated specifically in the downstream locales of the wadi, where few owners dominated large plots of cereals and tobacco. Nowadays, we turned to a growing society of external investors who live outside the area and focus on cash crop production in the upstream regions of the wadi. Due to the favourable hydrological context, the wadi's agricultural history had already began with the cultivation of commercial crops (tobacco in Waqir) long before the WSP, continued with the exploitation of cotton (in Khalifa) and developed into mango plantations (primarily in Barquqa). Temporary or permanent migration waves that characterised the wadi from 1960s both developed new irrigation infrastructure and influenced a redefinition of irrigation and organisation roles and tasks. Migration also caused shortage of labour for operation and maintenance, which, in turn, led a consequent redefinition of collective rights. This either resulted in the abandonment and deterioration of the irrigation infrastructure (Waqir area) or in the infiltration of new figures in charge that bought land of the impoverished farmers after the recurring droughts (Barquqa and Khalifa) and actively invested in commercial agriculture. The greater land availability for sale upstream, where the presence of a spring flow also ensured a more secure water availability, coupled with governmental support of the agricultural sector, created an initial bias towards advantageous water diversions upstream.

In summary, in Wadi Siham, already long before the WSP a line of commercial transformation of agriculture began, which wad paralleled by a water control gradually moving upstream and concentrating in the hands of investors with a certain social status. The WSP undeniably attracted new investors with the prospect of an increased water supply upstream and indeed permitted the mango and banana cultivation of a much larger area. However, such an agronomic revolution would

have perhaps taken place regardless – and indeed began earlier than the irrigation intervention, with previous state interferences and the first migration waves that created the fertile ground for them to arrive.

The WSIP, whose outcomes in terms of technical implementation and water management have been, and are, remarkably shaped by the project's interaction with the receiving context and its actors, influenced present water distribution patterns. In Chapter 4 this thesis debates to what extent in Barquqa, commercial landlords managed to influence the implementation process. Similarly, in Waqir, canals were redesigned after the pressure placed on the implementers by some water users. In addition, several technical and operational choices introduced by the WSIP are debatable. For instance, the irrigation module of 10 l/s/ha, the contested interaction between existing and new irrigation artefacts, and the type of control imposed by the TDA impacted negatively ideas of an equitable water distribution at wadi level. Particularly in Waqir, technical faults are widespread. Moreover, the weak control over large landlords by the TDA allowed a prioritarian water appropriation upstream. As a consequence, the assumed rotational type of water distribution has not yet materialised. This reduces even further the technical water control of downstream farmers and their water supply. It is remarkable that these "mistakes" occurred although by the 1990s, foreign consultants could already price themselves with experiences in other wadis, where generally the irrigation intervention was severely flowed, particularly with regard to water control.

Finally, by playing on water users' perceptions that with the new Waqir system, the burdensome maintenance costs of the traditional sandy barriers would have disappeared, the project sponsored even further – if indirectly – their gradual abandonment. In its turn, when it became obvious that the new canals would irrigate no more than a limited percentage of the expected command area, the bad state of many of the traditional sandy barriers hindered even further people's attempts to appropriate the water.

2. Nowadays Wadi Siham appears more of a technically and hydrologically interconnected unit than in the past, but there remains a serious operational and organisational discontinuity

The advent of the TDA as the one manager of the new Wadi Siham infrastructure has shifted several loosely-associated communal systems into more interrelated systems that require new levels of water distribution to come into being. The problem lies in the fact that this interrelatedness has not yet materialised. A bureaucratic transition is under way which promotes certain models of organisation and materialisation of rights, which however do not *de facto* embed the necessary power for operations and conflict resolution.

What the TDA and the implementers failed to recognise is the particular nature of each pre-existing organizational unit (water-networks), some of which were of a more individual character (Barquqa), whereas others held a more collective tradition (Waqir area and below). Moreover, even in these latter locales, implementers seemed to have overlooked that collective construction shapes collective action. Additionally, if the WUA they attempted to impose does not clarify rights, responsibilities, benefits, and obligations of each member, farmers quickly lose interest in collaborating even in a context where community-managed irrigation is common practice (Beccar et al., 2002). As many scholars highlight, in the last decade WUA's promoters have often been neglecting the importance of the process of creation of such an organisational model. As a consequence, these WUAs are often created with a management team at the top that takes all executive and decision-making dimensions. No power trickles down to lower levels. These weak organisations are then easily captured by political actors that siphon funds away. The Wadi Siham WUA is highly explicative of this unitary model's failure: the project manager gathers all the canal

representatives assuming that they would also transmit smaller owners' perspective and share an objective with them.

This organisational weakness results in the following paradoxical situation. With the disappearance of spring flows, nowadays, upstream and downstream areas of the wadi depend on the same type of flood (*hydrological unity),* which they divert through a more interconnected infrastructure that is theoretically controlled by one institution, the TDA (*technical unity*). However, at the organisational and operational levels, there occurs a greater discontinuity than in the past. The different irrigation realities and organisations appear scattered. Some farmers in the Khlalyah area reject any TDA involvement in their affairs, while others whose lands lay within the Uthun command area created a WUA in order to get funds for their own traditional barriers, and yet others, namely the soon-to-come WUA of Kurd, adopt the label temporarily in order to appropriate themselves of lost water rights. Even those WUAs that were promoted by the TDA itself, in Barquqa and in Shroefia, are barely aware of the other's existence – and this only because the two Presidents belong to the same Qaserah family. Also with respect to the operational aspect, the TDA's management of the new infrastructure appears uncoordinated and lacking a holistic view of the wadi's water requirements. This further subordinates dowstreamers' water availability to upstream uses, which the development and improvement of irrigation infrastructure by the WSP have already exacerbated. In other words, no real coordination and communication between water users and managers of the different infrastructure exists.

It follows that rather than focusing on single organisational arrangements, be it the WUA or local operational practices in general, there is a need for an organisational model that creates communication and co-operation between the various organisational systems in the wadi.

In this sense, TDA holds a great responsibility: it could act as a coordinating umbrella of the various types of organisational forms emerging in the wadi, and mitigate the strong individual interests, which undermine the rights of system's and wadi's downstreamers. However, it still needs to gain trust among farmers: although we acknowledge that there a very valid and experienced persons in its staff, too often it has proved to be acquiescent towards pressures of the more powerful, and its financial and organisational capacity too weak. In the future, TDA's legitimacy may grow as the elite, using WUAs as a political platform, may increasingly seek its authority for receiving additional economic and political power (Khanal, 2003). This may reinforce social differentiation due to a concentration of resources in the elite's hands, as it occurred in Barquqa. However, it may reinstate the link between the irrigation elite (both local and newcomers) and less powerful water users that at present seems to be missing.

In the past, the sheikh, although he was pursuing his own interest in terms of irrigation and agriculture, was bringing prosperity to the area and the other irrigators that in turn legitimated his authority in the eyes of the local society. Obligations and benefits were clear to all. At present, it seems that the elite is monopolising the gains that the adoption of the WUA-model made available. However, less powerful irrigators, rather than passively observing this process, may increasingly recognise these actors as a resource-funnel that may bring benefits to them too. Eventually, the latter's awareness of the power of the former to channel resources may incentivise them to join the new organisational type. Thus, the internal structure of these organisations may improve, which may facilitate a more federative model of organisation at wadi level. However, clear obligations and gains remain to be specified in any potential mandate.

3. In Wadi Siham, developments and evolutions of water control entail a strong political component that dictated the rate of and the means for success of the various actors.

In this thesis, through the decline of traditional figures such as sheikhs and aqil*s,* and the appearance of new actors and institutions, we highlighted a transition of power regimes and the control structures that certain groups utilise to counteract their loss of traditional authority. Specifically in a given context of restricted water availability, we demonstrated that certain groups have a facilitated access to and control over the water resource.

Mehta (2007) differentiates between ecological water scarcity and socio-political water scarcity. The latter can be shaped by choices around technology, institutions and politics that influence inclusion/exclusion processes and drive to specific reactions. In other words, issues of power, which are intrinsically related to a wider historical, cultural, and socio-political context and processes, are absolutely fundamental in the appropriation of discourses around a given water resource. In other words, those with power may count on further domains of interaction than those without (Giddens, 1990). In this thesis, we described how often local elites appear in new institutional endeavours, whether it is the Local Council, TDA, or WUA. As it appears, different reactions for the appropriation of water control emerge according to the extent of someone (individual or group)'s power to "manufacture" their needs.

For instance, in Barquqa a more individual type of water control exists, similar to the pre-intervention period's, and even those who are aware of the WUA admit that it is a ghost organisation. Nevertheless, the elite was willing to join it –if in a temporary format, because they saw it as a means to direct the last phase of the project to their own personal/group advantage. Their mandubi were restored with foreign funds, gabions were set in place to protect their lands near the wadi and even enabled them to extend their cultivable area, and tractors are available for a very cheap fee for the maintenance of their infrastructure. On their example, nowadays some other large farmers in Waqir are actively seeking this tag as the best means available to them at present for achieving their objective, which is not always in line with the WUA's official purpose, namely, the operation and maintenance of the irrigation infrastructure. Interestingly, in the Board of two out of the three WUAs currently officialised in the wadi, the same (sheikh) family rules, that also holds contacts with LC and the TDA.

Concluding, our thesis demonstrates that water management can be shaped, "manufactured" (Mehta, 2006:661), by choices around technologies, institutions, and politics that influence inclusion/exclusion processes and drive to specific appropriation of intervention processes.

This thesis characterised Wadi Siham's spate water management. Given the wadi's relatively recent and rapid history of both rural development and spate interventions, it was one of the least studied wadis in the Tihama plain. The few existing studies on spate irrigation systems are either of anthropological nature and focus on traditional structures and institutions; or they are of technical nature and focus on improved/controlled spate irrigation systems. Moreover, there is still little data on current organisational and operational practices in spate irrigation. In addition, the impacts of improved spate irrigation systems on these practices remain marginal both in academic circles and among irrigation intervention professionals. This research contributes to enriching the scant body of knowledge on these topics, beyond the Wadi Siham's boundaries.

6.1 Suggestions for future research

In the course of this thesis we question certain technical and organisational choices, which current spate irrigation intervention in the Tihama plain are currently promoting (10 l/s/ha, permanent diversion weirs, canals, and WUAs). As for the technical aspects, in our opinion, future research, aimed at informing policy-makers for such projects should test whether this technical modernisation, which emerges from criteria for permanent flows, is applicable in a spate system. They should pay attention on what can be modified to better suit the ephemeral and unreliable nature of spate flows and its high content of sediments. It should also take notice of the different uses of spate flows: irrigation and groundwater recharge. Often water distribution through canal systems may increase water use efficiency to the detriment of the latter. The challenge to implement the most optimal technology is particularly crucial in a context characterised by an incipient reduction of water availability.

With regard to the WUA-model proposed by the TDA and donors, we reckon that future research should investigate whether this current WUA model would *de facto* be a suitable one for the wadi's water users in the long term. Given the nature of the spates that requires a seasonal commitment, future research should assess what model would instead be suitable. Moreover, a spate system community generally tends to diversify its livelihood strategies. Therefore, future research should examine the feasibility of an organisational model that entails a diversified set of activities related to livestock, agricultural production, and handcrafts. We believe that this may be more suited to a spate irrigation context.

Annex 1: Suggestions for TGH

Many of the aspects TGH asked us to investigate are treated in the various chapters. Here, we will present some suggestions concerning water management in Wadi Siham that emerged in the course of our research.

In previous chapters, we highlighted downstream areas as the most endangered ones by reduced water access. Our hints, therefore, are directed to these people that are also the ones where TGH is already working with.

1. To continue helping farmers with **farming practices** that are more suitable to a scenario of decreasing surface and underground water availability.

2. **Water (and non-) users' perceptions of the actual water management** are a crucial component for any potential plan for its improvement. By highlighting the various discourses that characterise the wadi at present, our thesis may be aid a potential future project to devise a sound intervention based on an authentic ground scenery rather than following some blue prints.

3. Overall, dissatisfaction for the present situation is increasing among farmers, particularly in the Waqir area. The main complaints of the farmers are that 1) they lost access to water and 2) they feel that nobody will listen to their claims and intervene on their behalf (this is particularly the case of smaller owners). A significant number believed that either a charismatic actor or a group of farmers' venture might be able to improve the current situation of inequitable water distribution. The WUA in Barquqa has proved to be nothing more than a label; yet, the same institution may provide group of farmers the needed legal status for asking funds, projects, and trainings.

   Considering all these claims, the already conceived initiatives, their rationales, and the dynamics that emerged from previous chapters, we conclude that there is the **potential for strengthening collective ventures for water management**. One suggestion is to help those initiatives that are emerging (e.g. WUA of Kurd and "Water Users of Wadi Siham") through the procedures for their establishment, and to facilitate the various organisations' initial phases. We warmly recommend that the specificity of the context where a WUA is formed should be considered in the process, through the drafting of specific activities in addition to the more standard ones now included in the mandate. For instance, a WUA in Barquqa may need more inputs for maintenance of the infrastructure and water use efficiency at field level, whereas in Shroefia the priority may revolve around new agricultural techniques to face the reduced water availability and groundwater management. Moreover, in order to strengthen these organisations, it is important to be aware of the social and power relationships that shape their formation process. The different needs and priorities of the various potential members should be clarified by setting clear obligations and benefits for all. In order to achieve this, a particular attention should be devoted to the structure of the organisation, so to avoid the concentration of power in the executive board. Without capsizing local social relations and acknowledging the role of the elite, such an organisation may reinstate those ties between the elite and the rest of the water users.

4. Whilst nowadays, the wadi seems to be much more hydrologically interconnected than in the past, the different irrigation realities and organisations appear scattered and uncoordinated. The majority of farmers were neither informed nor concerned about other groups' organisations. Therefore, we advise to spread awareness of existing WUAs. It follows that rather than focusing

on single organisational arrangements, be it the WUA or local operational practices in general, there is a **need for an organisational model that creates communication and co-operation between the various organisational systems in the wadi**. A confrontation of different interests and needs may indeed create a favourable ground for negotiations around water division. The TDA should be better informed about local initiatives, WUAs and informal forms of organisations, and current irrigation practices. Additionally, if, as envisaged, the TDA could become the coordinating umbrella of Wadi Siham's water management, the link between this institution and the different irrigation realities should be reinforced.

5. During an informal chat with a member of the TDA, he expressed a general feeling of the institution of being bypassed by external consultants and organisations. Consultants, NGO, experts come and go and very few really build on TDA expertise. **TDA** has been in Wadi Siham since the 1980s and can therefore be considered an **expert on local realities**. Thus we believe that despite all its limitations in terms of financial and organisational means, politics, and preferential relationships with the elite, it would be a pity to overlook its potential! It is advisable to recognise that TDA is not a homogeneous block, instead, that it encloses various and at times diverging opinions that also open spaces for fruitful collaborations.

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