

ter Steege, Bernie

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Infrastructure and water distribution in the Asqalan and Sufi-Qarayateem canal irrigation systems in the Kunduz River Basin

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Zentrum für Entwicklungsforschung
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University of Bonn



Working Paper Series 69

Bernie ter Steege

Infrastructure and Water
Distribution in the Asqalan
and Sufi-Qarayateem Canal
Irrigation Systems in the
Kunduz River Basin

(Amu Darya Project Working Paper No. 5)



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Authors address

Dr. Bernie ter Steege
E-mail: berniertersteeg@hotmail.com

Infrastructure and Water Distribution in the Asqalan and Sufi-Qarayateem Canal Irrigation Systems in the Kunduz River Basin

Field Report, March -June 2006

Bernie ter Steege

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Prologue

This field report will hopefully be of benefit for anyone to get a quick overview on the social and infrastructural organisation shaped around the irrigation systems of Asqalan canal and Sufi-Qarayateem canals and will be a preface on the follow-up in shape of a Master thesis. Field surveys were conducted from 23rd of March until a last visit on the 6th of June 2006. The research was done as part of a graduating thesis conducted at the Wageningen University, International Land and Water Management, specialization in Irrigation and Water Engineering. The opportunity to visit Kunduz was provided through the Center for Development Research (ZEF) at the University of Bonn. In cooperation with the German Agro Action (GAA) the opportunity for several students is created to conduct a field study within the framework of the Kunduz River Basin Programme, a development project funded by the European Union. I would like to thank ZEF for giving me the opportunity to spend quality time in such an inspiring country as Afghanistan and the whole GAA staff for their contribution in providing a pleasant and, not to forget, safe stay and meeting such a great deal of interesting personalities. Also the information shared by the KRBP staff was as valuable to grasp an understanding on the subject. The guys who helped with the translation in the field cannot be forgotten; who by their own enthusiasm taught me a great deal of their country and became good friends. In the last place, but certainly not in the least, I would greatly like to thank Usman Shah and Katja Mielke, for the time we spend together as one heck of a team had such enjoyable explorations in the remarkable Afghan society.

Wageningen, 6th of August, Bernie ter Steege

(For the final thesis report, contact berniertersteege@hotmail.com)

Glossary – Akronyms, Afghan Terms and Definitions

AKDN Aga Khan Development Network AREU Afghanistan Research and Evaluation Unit BMZ Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung IMT Irrigation Management Transfer KB Kok bashi KRBP Kunduz River Basin Programme KRA Kunduz Rehabilitation Agency MB Mirab bashi NSP National Solidarity Programme NGO Non Governmental Organisation PIM Participatory Irrigation Management QY Qarayateem Canals SQY Sufi- and Qarayateem Canals SMWA Social Management of Water in Afghanistan RAP Rapid Appraisal Process URD Urgence Réhabilitation Développement WUA Water Users' Associations GAA/DWHH German Agro Action / Deutsche Welthungerhilfe ZEF Zentrum für Entwicklungsforschung (der Universität Bonn)

-kh- is pronounced like the Dutch -g--q- like a 'clicking' -k-

Ab, au	water
Arbab	village head
Baluch	Baluchi are the name for from origin Pashtun nomadic tribes
Band/bande	check
Brinch	rice without caf
Dasht	desert
Jerib	one Jerib = 0.2 ha
Jungal	referred to as uncultivated forest/bushes/wasteland
Mantiqua	referring to a common used resource or facility (mosque, irrigation system, market etc.)
Ser band	canal's river intake
Kok bashi/Mirab	"water lord" of part of the irrigation system
Mirab bashi	"water lord" from head to tail of irrigation system
Mun or sir	7 kg (can differ per region)
Nahr	canal
Kotarma	'lifted up' canal
Qala	compound
Qishloq	= Qaria village
Qulba	land size versus water supply in hours, related to the water available, type of soil and sometimes crops grown
Quloq	off-take
Sir or mun	7 kg (can differ per region)
Shali	rice with caf
Shokh	tributary
Shura	a representative body of village elders
Wulus wal	district governor

1 Introduction

The choice to survey the canal systems of Asqalan and Sufi-Qarayateem was made because both systems are in the vicinity of Kunduz city. Due to security concerns surveys were only conducted during day light. As the main irrigation season only started at the end of this three month survey, a general idea of water distribution could be obtained by interviewing the actors who are dependent on and do the water distribution. Walking along the canals and its multiple branches gave an opportunity to interview farmer in the field and ask on the spot at the exact location of field application from the water source, what the expectations of water delivery are, their cropping patterns and understanding of the water distribution compared with their fellow irrigators in the system. Including the type of agreements made in concerning their land versus water distribution but also their contribution to the bigger picture in operation and maintenance. The relation of land unit versus water availability is one, water allocation versus labor input a second dimension. Also an understanding of who their water managers are or how to become one and what tasks are involved.

Two maps are drawn based on satellite images and field surveys. The idea was to develop a map with the important branches along the main canal and map the physical events of division and fusion of different canals and the physical structure which make this possible. Along surveying the liquidity of the physical canal system and getting a grip on spatial water distribution, mainly oral data on the quantity of water distribution was gathered in the field. With that an understanding of the social decisions on water distribution can be placed as an overlay on the physical infrastructure. Chapters 2 and 3 provide an overview of the two irrigation systems and describe some main issues at hand. Chapter 4 answers some questions based on the field observations. Finally, the report provides more detailed field data in several appendices.

The guiding **research objective** of the Master thesis to which this fieldwork contributes is to “Analyse and describe the original design and changes overtime of the irrigation system and point out the social relations (in and between communities) that run the system in the Kunduz river basin and developing possible scenarios for intervention strategies.”

The **research question** which is covering this report is as follows:

“What are the correlations between system layout, water distribution and water rights, in two irrigation systems in Kunduz, Afghanistan?”

Field surveys were conducted between 15th of March and the 15th of June. In Asqalan canal system 15 field days were spent. In the Sufi Qari Yatim system 21 field days were conducted. Several days were spent on orientation on other canals in the Kunduz basin. Experts in Kunduz and Kabul were visited. In-between reporting and data analysis was part of the stay.

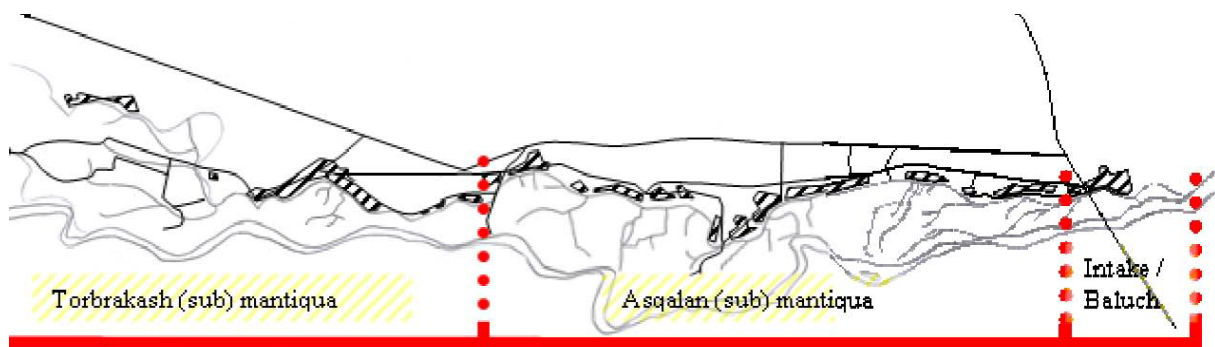
For all these interviews, translators with knowledge of several languages were essential (Pashto, Dari and Uzbek). The translation of interviews was done to English. Dari is the language most spoken in Kunduz, but a lot of communities in the systems also have Pashto or Uzbek as mother tongue

2 Asqalan - Physical and social setting of the irrigation system

2.1 System layout

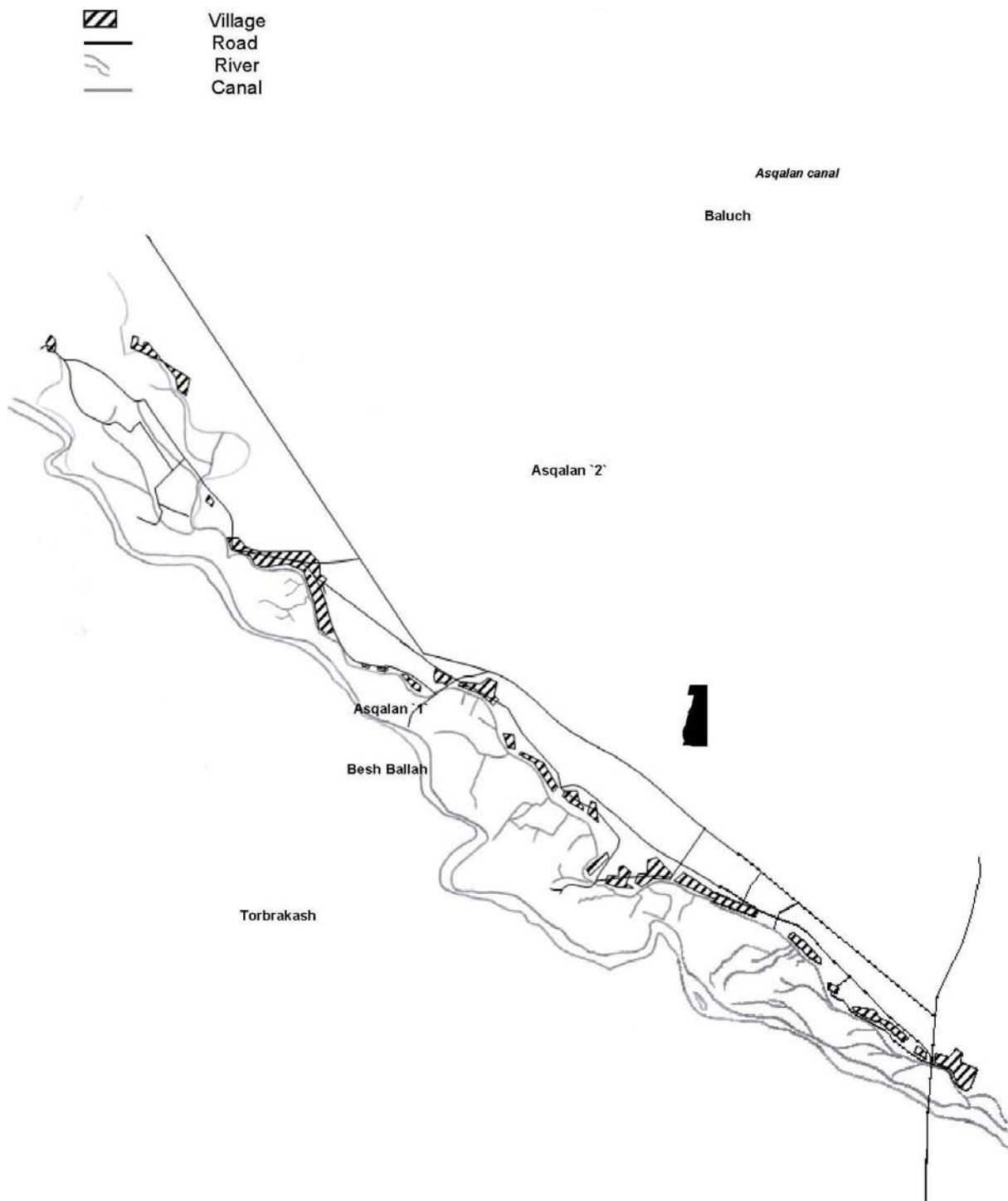
Asqalan main canal, a map of which is provided in figure 2, measures from the intake till the tail around 18 km. The whole canal forms one mantiqua; defined as a group of people/villages sharing the same resource or facility like a mosque, market, or irrigation system. Within the mantiqua of Asqalan the area is divided in two mantiquas, as the people have a mirab-bashi in Asqalan mantiqua up till Jaraldi, and a mirab-(deputy) in Torbrakash mantiqua, who are responsible for their own area but also help each other out in time or rotation and arrange schedules and maintenance together. At the head end a village called Baluch, also own land backed up by Asqalan canal, see figures 1 and 2. This group of people is not able to use canal water in free flow for their irrigation needs. A village is often referred to as qishloq. For this report the term mantiqua depended on the definition provided by people in the field. In Asqalan, over two third of the main canal is one long stretch following the edge of the desert. The canal is accessible by car by means of paths behind the villages, which are placed on the edge of the desert. With a bit more effort the canal can at some stretches even be followed directly along its path, but one may find him/herself blocked by ridges or houses and is forced to travel over the desert again. The first off-take is at 3 km from the river intake, the most far-off off-take surveyed by the KRBP is 22.9 km further downstream.

Figure 1: Subdivision of Asqalan's mantiqua (solid) into sub-mantiquas Asqalan and Torbrakash (dotted)



Between Torbrakash and Asqalan a rotation exists which in theory shares the water 50/50. To get an overview of the whole system, all persons dealing with water distribution gave a more or less similar anecdotes for the whole canal on for example important check locations or their names. Where a former mirab of Asqalan seemed to be able to tell quite precise the off-takes along the first part of Asqalan, information he provided on Torbrakash area was not as consistent and vice versa. Figure 3 provides sites where in rotation for the first half of the canal of Asqalan check structures are built to serve a number of off-takes. Based on a list of off-takes and locations of bande provided by a former mirab the area upstream can be calculated. This is not the command area. For example; bande Arzi's upstream land is not all irrigated: the first 400 jerib lands just behind the intake are too high for gravity irrigation and is only sparsely irrigated by pumps. Then there is a small parallel canal named Char Tepa which is said to irrigate 1,000 jerib, a number that can be questioned as well, but if this number is also included in estimations of command area, it is easy to make wrong assumptions. In the process of the KRBP, a survey of all off-takes along the main canal and main tributaries of Torbrakash was conducted which serves as basis for implementing infrastructure. Their choice is to intervene as little as possible in the current water distribution and as the strategy is now to open an off-take as wide as is pleased, off-takes are designed to provide 2 l/s/ha.

Figure 2: Map of Asqalan Canal (See Annex for details)



Three check locations are named as the important ones of the canal system; bande Arzi, bande Qorban Nazar and bande Shajhurdi. If these dams serve the biggest areas or are dividing the command areas neatly, or maybe the most powerful landowners have land served by these check-sites is not known. But it was said these location are traditionally used. Numbers of jerib are provided by the former mirab who worked this out by heart with a former mirab of Torbrakash. It was tried to cross-check this with names and figures provided by the KRBP of their surveys, but different names or maybe a hassle in locations did not provide a more structured layout.

Figure 3: Major checks in first half of Asqalan and their upstream area versus probable command area (see annex for total map with approximate locations of checks)

Important checks in the first half of Asqalan canal	Jerib upstream (as from mirab)	ha
<i>Bande Arzi</i>	2,400	480
Bande Haji Rai Han	1,400	280
<i>Bande Qorban Nazar</i>	810	162
<i>Bande Shajhurdi</i>	850	170
Bande Jan Morad location unknown		
Bande Nazar Agha	1,000	200
Bande Saifi	3,000	600
Total	9,460	1,892

Jaraldi

The escape way Jaraldi marks the border between Torbrakash and Asqalan. To reach a sight on the spillway, one can drive over the dasht, along a big graveyard and a road leading to a ridge with an overview on the river. The spillway is this year made out of masonry by a World Banks supported project. Labourers are hired from the nearby villages. At the end of the spillway, near the river, lands are low and cotton is cultivated. Probably from this point onwards the canal was extended by the Pashtuns around 70 years ago under lead of the grandfather of present days arbab of Torbrakash.

Torbrakash

The Torbrakash area has several main branches. The first big one is named Kotarma, what means something in the line of 'lifted up canal.' This tributary starts as a deep ditch from the main canal; it eventually flows to flatter lands in the river plain where a levee is lifting the canals bed from the surrounding land. Along this canal off-takes to smaller canals and on farm turnouts are frequently installed with pipes. Despite the infrastructure the lands do not look like a lot of water is expected. Where in the upper regions of Asqalan people all are busy planting melons or other second season crops, in Kotarma people had no hope enough water would arrive to irrigate more water prone crops. In the plain of Kotarma a big waste way which looks like leftover drain from water from the dasht, crosses part of the plain up to some wastelands. A very important location in water diversion for Torbrakash is at the split between the Wulus and Sederague tributary. From this section on each tributary is supplying about half of the plain. Wulus will split in Kabrestan and Wulus. Sederague is diverted later on in Zarib Jan and Haji Baqi.

Parallel canals

At the river side, parallel to the location of bande Arzi, a parallel canal called Jer Tepa is irrigating around 1,000 jerib as farmers at this area and the mirab deputy told. The intake from the river is open without any reinforcements as diversion walls or weirs. Farmers can grow rice at this location, but this year after the wheat, no paddy is grown. The risk of loosing another crop like last year when very high water table occurred is still on the mind of the farmers. There is even one person, a mirab, responsible for arranging works around this. The canal is named after the prominent hill/old settlement on a sand bank in the Asqalan command area. According to a farmer the river gives and takes land over the years and the canal exists as long as the land arose from the river, i.e. before the Russians invaded Afghanistan. A second parallel canal flows over the plain near Nazar Agha-village close to the river where it calves at a ridge. The people here have small villages in the command area of Asqalan and around 30 years ago had to move their homes several times when the river eroded part of the ridge. After last year high flash floods and washing away of crops, people are doubting to plant rice here, afraid of a repetition of last-years events.

2.2 Some main issues

Baluch – at the edge of the water users map

The first area after the ser band (intake) is called Jou Sin Khil and covered about 600 jerib in the old days before the river washed away part of it. Close-by is the main village of Baluch at the east side of the road from Kunduz to the Tajik border. At the other side is a smaller settlement of Baluchi, a name which designates the people who are living here as 'from origin Pashtun nomadic tribes'. The Baluchi came from Kandahar province near the Pakistani border. The 4th generation lives now in Baluch. An elder told that about 350 families live at present in Baluch, but if everybody would return the number would probably double. Elders of the village could tell that long ago they were able to use the water from the Asqalan canal to irrigate their fields. Only a couple of jerib are irrigable now by means of pumping water out of the Asqalan canal. When we walked through their fields, we saw water being pumped with diesel pump in some canals. The old intake from the canal is right down from their village, but since the revolution in disuse as many of the villagers fled. The people of Baluch do not contribute in labour or kind to the canal; their lands are simply too high for gravity irrigation. As they do not receive water the mirab does not dare to ask them for a contribution, the more so as he sees the poor state the land is in, as the village elder explained.

The conflicts on entitlement of the *mirab-bashi*

Informants from the tail, Torbrakash, argued that before the revolution (around 1979), the mirab bashi was selected from the downstream part of the canal. This situation ensured water delivery until the tail of the canal, which would then result in equal water distribution. The mirab bashi had one deputy from the upper part of the canal to assist him. As a former mirab (Ghayoor) put it in a similar argument that according to irrigation law or a protocol in the time of Zahir Shah, the mirab had to be elected from downstream and the deputy from upstream, where exceptions could be made relating to experience. And that was exactly the case when he got elected. There was no experienced person in Torbrakash after the beginning of the revolution, as he was the only person with enough knowledge to fulfil this task. During the revolution, the people got disunited as a result of the rise of nationalism. Since two years Ghayoor is not the mirab anymore but since his long state of duty he still functions as a link between the irrigation department and the communities of Asqalan. Several informants told that since the government of Karzai (2001) the elders of the whole area are not united in choosing one single mirab bashi with a deputy. At present the mirab bashi is from the upper part of the canal, who is assisted by a deputy from Torbrakash. People from both head and tail complain that the other community has more influential people or connections with police and government. In other parts of Kunduz the NSP is establishing new community decision bodies, replacing the traditional shura. Budgets for small development projects are provided also by the NSP. No such thing happens in Asqalan, as not desired was told by one village elder.

(S)election procedure of the *mirab*

I use the term election and selection here combined, as election would suggest a democratic process with an equal vote of every user. The process is bound to certain social rules, which would encourage certain fairness in appointments. Surveys suggest that of course influences of certain people will count higher than in the utopian situation.

A representative body of village elders is called a shura, dealing with subjects of concern for the community as a whole. Gathered from the surveys was that this year the mirab bashi is (s)electd by the shura of the whole Asqalan mantiqua whereas the mirab's deputy is elected solely by the shura of Torbrakash mantiqua. The shura of whole Asqalan was met once at the intake when 20 members were participating and together with the mirab bashi and kok bashis discussing the contribution of the people to the works conducted at that same moment at the intake. In the month of Aqrab (23 October – 21 November) after the mirab (Sufi Abdelhakim) and his deputy (Torjan, literally: black friend) were elected they have to go to the irrigation department to get an ID-card. Kok bashis are not registered, as they are only responsible as assistants of the mirabs, being a supervisor during the maintenance work or keep track on water division schedules. The procedure before a mirab election as was described is that two

persons go around on a motorbike to gather the people. In a group discussion the mirab is selected. This year's mirab bashi has selected four kok bashis to assist him, and the deputy mirab has two. If these were also considered by the mirab bashi as his kok bashi is not clear. A kok bashi we spoke with from the Asqalan area was serving already under several mirabs. Besides kok bashi the mirab can also request other people to assist them. What characteristics make a candidate for a mirab is for sure the experience one has. Several reasons were heard why the former mirab was not elected anymore. Whereas he considered himself to be very busy with other activities and getting old, some farmers regarded him to work for his own benefit, others mentioned that someone else deserves a chance too. During surveys we met the mirab bashi only once and got the impression he was not really interested in any dialogue. On the other hand the mirab deputy, Torjan, was much easier to find and was met several times.

Water distribution

For Asqalan can be said that it is mostly a hierarchical system, although not 'designed' as such, traditional practice made it what it is today. Water is except from winter time distributed in rotation. Farm off-takes and bifurcations are often a cut in the canal bank, letting as much water through depending on the ambition of the beneficiaries of the particular off-take. The mirabs will discuss a water distribution schedule for the whole canal. Together they will discuss their proposal with the shura. The shura will, like the mirabs, predict the probable availability of water from the precipitation that has fallen in the winter and is stored as snow in the mountains. This will determine the shifts between the turns between Torbrakash and Asqalan. A rotation of around ten days each is practiced. Water is distributed in time versus a certain area using a unit called the qulba. One qulba for the Asqalan canal counts 40 jerib. It was mentioned that one qulba receives 8 hours of water. Decision making is said to be flexible,

i.e. if a deficit or excess of water in the canal occurs, the turn can be shortened or lengthened. Mirab bashi and deputy mirab make a plan and go to the elders, who will make a final decision on water distribution. In practice it was said that Asqalan always get the first turn.

A sequence of 10 days per half of the canal is used, where after the water returns to the first check-location of Asqalan. Depending on the water need, turns can be extended to 20 days in coordination with the shura and mirab bashi. For Torbrakash was said that every big tributary gets 2 or 3 turns per 10 days. This spreading of the water over a couple of days at least ensures that as many farms as possible get at least a bit of water. This method clearly reveals a protective irrigation strategy but this did not make people confident to grow more water prone summer crops. When distributing the water the deputy mirab will together with his two kok bashis keep track of time and see if the distribution goes as planned. But not only kok bashis assist the mirab. On one occasion we met a cousin of Torjan, who was patrolling along an offtake in Asqalan upper area on voluntary basis. At one field trip an old man sat posted for 10 days at one spot to oversee the earthen checks, protected from the bare sun by a piece of cloth. The mirab made sure he was provided with food and drinks.

Torjan told on one occasion that he did not go home for ten days, as he had to oversee water distribution. Tasks involved are for example arranging a tractor when needed to make dig out an off-take or announce in the village for labourers. Torjan can rely on about hundred persons to assist him if he wants, as they are obliged to help because their lands benefit from irrigation. In times he is not needed he can sleep over at any house he walks in. His work does not concentrate only on Torbrakash but in discussion with the mirab bashi he also coordinates construction of checks or oversees distribution in Asqalan. When meeting the deputy mirab at another day at the head of Asqalan at bande Arzi a check is just been build during the night. Torjan tells us that about 30 people of the four villages benefiting of this dam worked that night. 50 jerib (10 ha) can be irrigated this day and next night they would higher the dam up again to get more water in the canal. The dam will last only 4 nights and 3 days, not enough to irrigate 500 jerib under its command as villagers explained to us. But that is the agreement; the water has to move on to the next section, where another check dam will be build.

People in Torbrakash referred to a law said to be implemented under Zahir Shah, the settlements downstream should receive water first. But this system has not been working anymore since the advent of the revolution. For Torbrakash meaning they get the water after Asqalan had its share. This in a

rotation of around 10 days each. To ensure equal water distribution the mirab makes a suggestion to the elders to irrigate all field about two times per 10 days, in case no water is left at the last day of the turn, everyone receives some water. Besides the power struggle between Asqalan and Torbrakash, people do consider the biggest flaw in water distribution the water shortage obstructing equal distribution. People can discuss among themselves to change turns if one is in great need, but this is only possible on the section that is served. Sequences for temporarily checks seem to be fixed. Probably this only concerns the off-take that already is opened for irrigation that allows this flexibility, and not between offtakes. Most information on water distribution in Asqalan is acquired from the deputy mirab from Torbrakash, as he was more open for conversation.

Water scarcity in Torbrakash

In time of plenty, water will flow even till the very tail of Torbrakash. Observing the mirab at work, collecting money, assisting in distribution and watching all the people at work in the intake, people might be critical about the general output, but it is clear this institution is still believed in. From what is seen in surveys the main concern on water distribution is along the main canal. The next step to understand water distribution in Asqalan would be whether water distribution over tributaries is as clearly managed by the mirabs and their assistants. The strategy of protective irrigation as explained by the deputy mirab looks in practice more like a philosophical approach. Even with a deputy mirab which seemed to be on the job intensively, he does not expect to receive any water on his own lands in Torbrakash in a time he will need it most. Using a pump for irrigation seems quite possible in the tail, as groundwater seems to be not too far from the surface. The aquifer would be filled up annually in end of spring/summer during the floods and during the rains in the winter. But as diesel is too expensive for most people this is not practiced very often. For the head-end, only in the very head some pump irrigation was practiced.

Little cash crop were grown in Torbrakash like melons or grapes, only possible with pumps, mainly in head and middle of the canal. Rice is only said to be grown in the head in times of real plenty of water. Along lower plains, directly using water from the river rice is produced more frequently, but floods make people hesitant to invest in these lands. Almost all people will grow wheat in winter time. In the Asqalan part near the point where Torbrakash starts, last year people tried to grow melons but failed due to lack of water in the canal. If the lack of water was due to a shortage among the whole canal, or if unequal distribution was the primary cause has not been cleared during interviews. The output of other winter crops like (flower) cabbage, is unknown. Poppy is not grown since one year: Mullahs forbid it. People will only grow poppy in case of hopeless situation. During the stay in Kunduz, one small poppy field was found by police in Asqalan. It was said to only be partly eradicated, as even the police was in the opinion that people had no other resources and government was not providing any substitute in case poppy was left a side.

3 Sufi- and Qarayateem Canals – Physical and social setting of the irrigation system

3.1 System lay-out from a historical perspective

In the Sufi-Qarayateem irrigation scheme (figure 4) two main mantiqua are using the same intake from the river to supply their canals, Nahr-i-Sufi and Nahr-i-Qarayateem. Nahr-i-Sufi is divided from up to downstream in four areas which are based on core-villages and ethnicity; Kharkar/Sufi, Sujani, Quzaq Tepa and Mang Tepa. Qarayateem mantiqua has two main villages, Qarayateem (1) and Qarayateem (2) / Madrassa as well as several smaller villages. (As the definition of a village is unclear, in this case a village is designated by the presence of a mosque, with main villages harbouring Friday mosques.) Both Sufi- and Qarayateem have a mirab bashi with several kok-bashis or mirabs responsible for parts along the main canal or larger sub-canals. The most likely information on when the canals were dug was acquired from an old village-elder in Qarayateem, claiming to be 85. His people of the (Pashtun) Oemarchil tribe first came to Kunduz but then headed for Bukhara/Tajikistan and returned to Kunduz during the Bashmachi revolt (1916 –1924). In some cases time might be over-estimated, however, looking at the informants claimed age and considering he was born in Kunduz after the return from Bukhara, his story sounds plausible. On several occasions was told that a man named Sufi decided to dig the Sufi canal. He hired machines, shovels, etc. to do the job. While he started it, the villages coming after the first section of the canal continued digging.

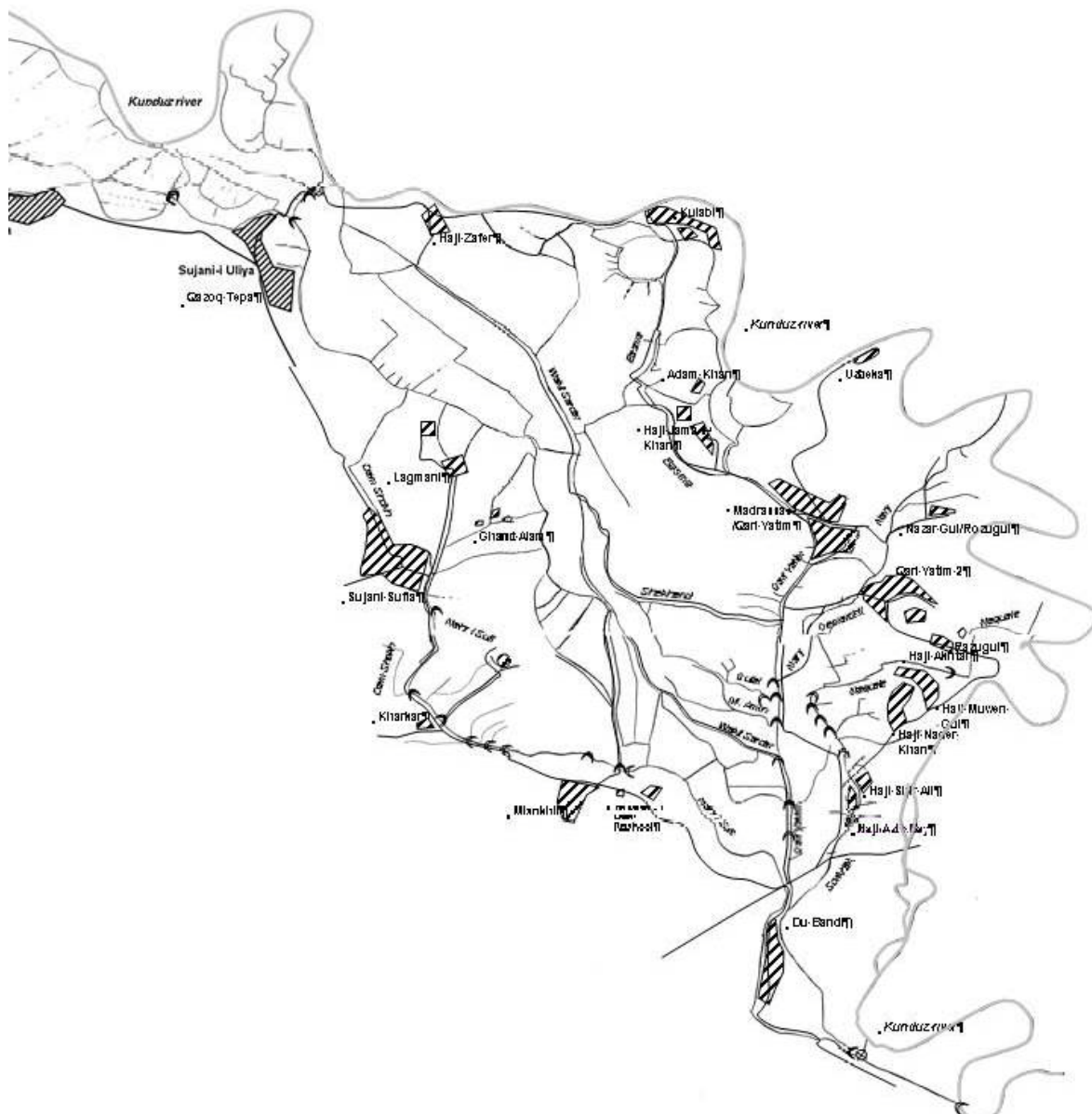
When people of Qarayateem came back from Tajikistan, they joined in the effort to cultivate Kunduz by digging their own canals. People in the field claimed that under Zahir Shah (1933-1973) the canal Qarayateem was dug out, but only after the construction of Sufi canal. Both Sufi and Qarayateem canals had first separated intakes at the river. Even one of the main branches of Qarayateem, the Sorkhak canal had its own intake. As the river moved its path Sorkhak joined later with Qarayateem. The river meanders a lot during peak flows. On satellite images, e.g. is visible that the river meandered first more to the west. Due to these riverpath movements the users of the canals decided to use one system intake. However, the water demand on one intake rose because of the, from now on, bigger command area. Probably, these two factors were decisive to move the intake upstream. At the west side of the area, Sufi canal borders a big irrigation system, supplied by the canal Chardara which originates in the district of Aliabad, Kunduz province.

The intake serves the canals of Sufi, depending on who you ask, somewhere between 80 or 120 qulba (one qulba represents for the Sufi canal 40 jerib) resulting in 640 to 960 ha. The KRBP has designed its infrastructure to be implemented this autumn for 795 ha. To get more confusion, people in the field gave different numbers in qulba or jerib on the size of land to be irrigated. One example is from the village Mang Tepa in the tail of the canal where in interviews came out that the area claiming for water is representing only 20 qulba, there is actually more land. This saves them labor for the intake, as labor input is counted per water right: qulba. For Mang Tepa their 'trick', as was named by the informant, also results in too little water in the extremes. Sufi canal will continue at the left side and water spills of the lands in the Qarayateem canal. Another 10 qulba / 400 jerib of land is supplied by two off-takes. A structure named Haq Dot is used to regulate the inflow where too much water can be spilled just couple of hundred meters north. Where two gates are letting water through to Mang Tepa, one of the gates is fixed at an open position as the mechanism is destroyed. One of the offtakes supplying Sujani-i-Uliya is just before a concrete escape-way, also build by GAA/BMZ with two gates in the crest of the weir, so energy concentrates on the middle of the structure, instead of harming the walls. Mang Tepa is the last area in the Sufi system and according to this years kok bashi has right over 20 qulba of water. The village also owns 20 qulba of land in Chardara. These lands have 80 jerib / qulba. Just before Mang Tepa's lands, a sand hill raises from the river bed, between the higher plain of Chardara canal and the river. In front of it the canal splits in two by a double gated structure build by BMZ-GAA in 2004, one running at the left side, between hill and higher plain, diverting 10 qulba. The second going around the hill supplying around 10 qulba. Along this canal a spillway is build again by BMZ-GAA in 2004. Villagers of Mang Tepa

also own 20 qulba of land in Chardara canal area. For this canal is counted 80 jerib per qulba. Mang Tapa has about 400 families, making 4,000 people and two NSPs. No budget to spend yet. Together with Sujani i-Ulya and Qazaq Tapa they form one mantiqua, referring to the water they use of Sufi canal and have a rotation scheme separated from the Kharkar area.

Qarayateem is situated between the Sufi canal and the left bank of the Kunduz River. The Qarayateem canal serves 10,000 jerib (2,000 ha) representing 140 qulba, according to the mirab bashi of Qarayateem and the mirab/kok bashi of Sorkhak canal. This number corresponds with the number used by the KRBP for their designs. After the village of Du Bandi both Sufi and Qarayateem canals are closing in to each other, divided by a road. At this point Qarayateem has a first off-take named Sorkhak which irrigates on its own 2,100 jerib. Qarayateem continues and is by the people in the field referred to as Madrassa or Qarayateem canal. According to people in the area, Sorkhak canal had in the past a separate system intake from the Qarayateem. But the river moved its path and Sorkhak had to join the canal of Qarayateem. This happened long ago, at least before the Russian revolution. My personal impression is that names of villages were started as one family, extending overtime and now named after the present day village heads. When succession takes place, people refer to the new village head for the village location. From field survey, the mirab bashi told that there are 17 settlements and mosques in Qarayateem.

Figure 4: Map of Sufi-Qarayateem Canals (See Annex for details)



3.2 The main issues at hand and their background

Kharu Ti's aqueduct

Just next to the intake is the village of Kharu Ti. People do have land along the Sufi-Qarayateem canal but use water for irrigation from the Chardara canal. Approximately 16 years ago in Najibullahs time, in 1368 (1989), people of Sufi and Qarayateem (also called Oemarchil after their Pashtun tribe) bought 12 jerib of land from the Kharu Ti people to be able to extend the intake. This deal was made when a lot of people of Kharu Ti were in Pakistan, who are now slowly returning. On an old map shown by a village elder of Qarayateem is visible that these lands first could be supplied by the bigger canal Chardara, flowing aback of the Sufi-Qarayateem canals, were suddenly cut-off. As these lands are too high for irrigation by Sufi-Qarayateem, the people of Sufi-Qarayateem and Kharu Ti made a deal that obliged people from Sufi-Qarayateem to build an aqueduct bringing water from Chardara canal over the Sufi-Qarayateem canal. It has been rebuild twice now after it eroded away, and is destroyed a third time during last years flood. Since last years flood the riverbed has moved and the intake is extended again. 15 jerib of land arose from the river, causing a dispute on who owns these lands which is still continuing on the moment of writing.

Du Bandi's diversion structure

A structure build in 1999 named Du Bandi (literally: two intakes) under the Taliban regime, divides both Sufi and Qarayateem canals, ensuring proportional inflow (2 for Sufi over 3 for Qarayateem). This structure made an end to years of conflict between the people of the two branches. Before this structure was build, Sufi canal was said to have most problems to get enough water in the canal. To higher the water table a temporarily check was build. This obstructed the intake of Qarayateem, who then took measures to overcome this, leading to tense situations. When comparing with the data of the KRBP and using the diversion of 2 over 3 regarding the diversion structure Du Bandi, following table shows the assumptions in command area, which as I will show later, do differ a lot from the data provided in the field.

Total command area of Sufi-Qarayateem Canals = 3,400ha

Sub-command areas (all ratios 3:2, diversion at Du Bandi)	Qarayateem	Sufi
hectare:	2,04	1,36
jerib:	10,2	6,8
qulba, if one qulba is 40 jerib:	255	170
qulba according to mirabs relating to contribution at the intake:	120	80

Figure 5: Command area of Sufi canal and its main bifurcations

	According to	mirab Rashool	kok bashi Mang Tapa	ex kok bashi Sujani	Haji Sadique, last years mirab
Village	command area (jerib)	qulba	qulba	qulba	qulba
Sechai	200	5			
Miankhil	400	10			
Basokil	400	10			
Quitepa	100	2,5			
Kharkar	800	20			
Lagmani	800	20	60	40	60
Qazaq Tapa	400	10	15	10	20
Sujani	400	10	15	10	11
Mang Tapa	800	10	30	20	20
Total jerib	5,800 145	120	80	111	
Total ha	1,160 1,160	960	640	888	

The border of Nahr-i-Sufi with Chardara canal is shaped by two off-takes, both named Dam Shokh and supplying 7 qulba each. One big off-take made out of concrete but damaged is going of the main canal to the left under the road. Later on it will drain in the extension of the water that drained all the way from an off-take called Haji Manan, running of to Mang Tapa. In Sujani Sufla a lot of people own or cultivate land in Chardara-command area.

Silt in the canal

At the first part of this big drain both sides of the canal face problems with water logging, until the last spill will mark the border with the section of Sujani. Annually people try to heighten their lands by flooding plots with the water that is loaded with sediment. One farmer claimed his land was about half a meter lower when he was a kid 30 years ago. The aim was to heighten his land as much that it would be able to produce melons. He considered that only poor people grow rice. In his case it meant he had no alternative. More farmers along this big drain/tributary gave a similar story. Other people claimed that as 30 years ago everyone was able to grow rice, the sediment in the water heighened the land a lot.

Land conflicts

During the drought people from Sujani sold land along this branch to people of Lagmani to accumulate some money. They build a new village on these lands, Lagmani Navabad, around ten years ago. That is one story. The other is that these lands were already cultivated for a long time by these people, but that a commander of Sujani occupied some lands. The end result is at least that people of Lagmani do cultivate the lands now. People in the upper part of Sufi canal tend to be Pashtun, village names or names of off-takes are already indicators from which region they were originating (Lagmani from Lagman district, Mianchil, similar tribes' name). Also at the tail of Sorkhak canal (Qarayateem) lands are claimed to be taken over by certain commanders, which to some extent have returned ownership.

Ethnic diversity and scattered plots in Qarayateem

The biggest group of people in Qarayateem is from Maydon Shahr, south of Kabul into the direction of Kandahar from the Oemarchil tribe. The Oemarchil live mainly in the head and middle of the canal: main canal of Sorkhak (named after one tribe of Oemarchil: Sorkhabi) and the Qarayateem canal until Madrassa village. When they arrived, the lands were already partly cultivated. People went of to Tajikistan (Bukhara for example) as they got offered good lands. During the Basmachi revolt in the

Emirate of Bukhara they fled back to Kunduz. Two Uzbek villages near the river never acquired land, as they hoped to return to Bukhara, as one of the people told. This did not happen, as after the Soviet-Union established its reign new borders were drawn and closed in 1924. This example comes from the villages Uzbeku Nos. 1 and 2, where almost everybody is working as a laborer, and besides plots right next to the house only very few had a bit of land or are sharecropping. Many other people who did get or bought land are now facing problems with small and scattered plots. Land became divided among sons and scattered till only a couple of jerib are left per family. This also counts for the Sufi and Asqalan canals. As an indication how women are placed in village life, to some extent daughters can claim land too. One example was, that if a son gets 4 jerib, a sister gets 2 jerib of land. How often this happens and on the same rules is unknown. When dealing with water rights for example she will send a representative.

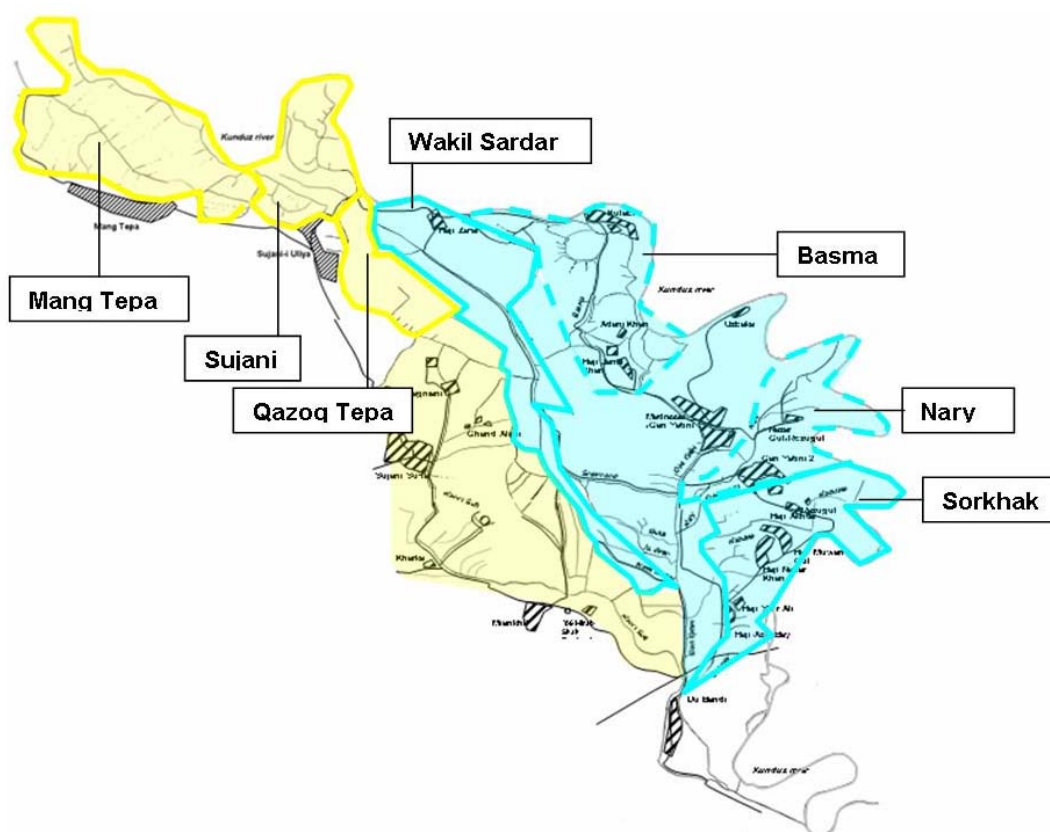
Figure 6: Overview of Qarayateem's main branches provided by the mirab bashi

Branch	command area in <i>jerib</i>	command area in ha	jerib per single <i>qulba</i>
- Sorkhak canal			
along Sorkhak	500	100	20
Sorkhak, Naqale branch	800	160	5 to 20
Sorkhak, Oemarchil branch	700	140	20
- Wakil Sardar	2	400	20, close to the main canal 40
- Nary	800	160	
- Madrassa, along main canal and village	2	400	20, close to the main canal 40
- Basma / Haji Juma Khan	600	120	20
- Kulabi	600	120	20 or less
Total	8	1,6	

***Mirabs* in Sufi Qarayateem**

Sufi and Qarayateem canal operation is almost as being two separated systems. Both Sufi and Qarayateem have a mirab bashi, assisted each by several kok bashis. It seems that this years mirab bashis hierarchically are on equal terms with each other, e.g. in a joint meeting with Asqalan's mirab bashi at KRBP, the Sufi- as well as the Qarayateem-mirab bashi took part.

Figure 7: Mirabs and kok bashis in Sufi (yellow) and Qarayateem (blue).



Areas with thick border lines reflect the areas of kok bashis. In Qarayateem two of these areas could not be clearly indicated.

Where in Asqalan kok bashis are assisting the mirab bashi in the whole system, along Sufi canal three kok bashis are only responsible for the three successive areas to the tail. These respective areas are called Qazoq Tapa, Sujani and Mang Tapa referring to the villages where the landowners live. The mirab bashi is organizing the water diversion in the upper half of Nahri-Sufi. He is the representative to the outside world when irrigation is concerned. This years mirab bashi has some helpers around such as a son or cousin. He has appointed his brother, last years mirab bashi, as kok bashi mainly responsible for water distribution in the branch named Dam Shokh. These persons can also figure as a stand-in in busy times. The mirab bashi of Sufi canal told that his father was in the job for years, and as his brother has been mirab bashi last year it looks like knowledge is here transferred through the generations. Just as in Sufi, the mirab bashi of Qarayateem is also the representative of the community when it comes to water management. At least four kok bashis are responsible for water distribution along certain sections. Kok bashis are serving along the following branches: Sorkhak, Wakil Sardar, Nary and Basma (see figure 7). These kok bashis are sometimes also named mirab without the suffix 'bashi', which is reserved solely for the mirab in charge of the whole canal.

(S)election of the *mirab bashi*

Every year mirab elections are held. In general, the mirab has to be a person who is knowledgeable on the management of water, he has to own land in the area and be available around the clock. Once it was mentioned that in Qarayateem the mirab is elected one year from the tail, the next from the middle and thereafter from the head end, as this satisfies the people along the canal who are of different ethnicities (providing a means of equality). On other occasions people told the mirab has to be from the tail, but this can be overruled if someone from upper parts of the canal is more qualified. As the mirab of Sufi canal put it: a mirab with people skills or someone who is respected is more likely to be able to divert the water just, as he can use the influence that he already has in the community. Elections of this year's mirabs happened different from other years. The director of the Kunduz Irrigation Department organised

elections for the Chardara district earlier in the year and elections of the different canals in the district were planned around the same time. The outcome of the elections was announced on television. Normally, elections are held in Hut or Hamal, when the main canal is cleaned. This years elections were already held in the slack period of November. LEE (2006) reported that "... the irrigation director introduced secret ballots for mirab election, in order to prevent the influence of commanders and other factions". When in the field we were not aware of these facts yet, but all stories seem to confirm the earlier elections and that these "secret ballots" were held, provided some interesting anecdotes.

For example, in the village of Lagmani Navabad, along the Sufi canal, elders told that this year for the mirab election the elders of Lagmani and many other villages were not notified about the election. They considered that only three persons selected the present mirab; the wulus wal (district governor, or yet they might also refer to the Irrigation Department's director), arbab (village head) Iman Ghul from Mang Tapa and Abdel Boi from Sujani. When the mirab came to their village to notify them on his selection they complained first but as he was now officially 'elected by the people' they accepted him. The present mirab of Nahr-i-Sufi calls himself the arbab of his community, but he is also the head of the NSP and the traditional shura. For Qarayateem an even more frank story was heard: As a village head of Haji Nazar Khan (which is the name of his father, still alive) arbab and also the NSP head of several villages he told that every village wants to have a representative from their area. The man that is chosen must be trustworthy and has the power to make sure the water will reach the tail. The same arbab/NSP head mentioned that today's mirab of Qarayateem is in his present position because he ordered the elders to elect him. It was noted in the field that this arbab had quite a reputation of being powerful and also mentioned as a 'just' commander.

(S)election of the *kok bashi*

The kok bashi must be a reliable and experienced person with land in the canal system. The job of the kok bashi is not very appealing the people in Mang Tapa mentioned, as a kok bashi will face a lot of confrontations. The kok bashi of Mang Tapa told indeed that he did not choose voluntary for the job, but that the villagers pressed him to be their kok bashi as they figured he was the only one to be just. Besides he was also a farmer of a large family and a mullah. In Qarayateem the kok bashi of Sorkhak canal is responsible of a water flow which is distributed proportional from the main canal. But as the intake is not reinforced, people along the main canal sometimes questioned the fair distribution over the canals. For this kok bashi and the other three it seems people who are using water from the particular canal have a say in the election process. The kok bashi were not selected earlier this year but appointed in hut, also around the time the intake has to be reconstructed. Sorkhak's kok bashi told he did not volunteer for the job but that the elders choose him, even over two persons who did volunteer. For Wakil Sardar one man told that he has been kok bashi for several years, but that this year he did not volunteer for the job as he would have no one left to help in the meantime on his fields. This illustrates again that the job of a kok bashi is less desirable than that of the mirab bashi. Being the mediator of one branch between his community and the mirab bashi with expectations to ensure enough water to be diverted from the main canal will obviously desire great negotiation skills and respect of the irrigation community as a whole.

Water distribution

In the Qarayateem system one canal has a special status. Water is divided proportional between Sorkhak and the main canal of Qarayateem (but no reinforcement of flows). For the other big branches check structures are installed in the main canal and in off-takes, making it possible to close of one or the other. An explanation for Sorkhaks independency could be that in the past it probably was an independent canal. The kok bashi of this canal is more independent as farmers along this canal do not pay any rice to the mirab bashi of Qarayateem. The rotation schedule for the summer is decided in Jawza (21 May – 21 June). Considered is the amount of water at that moment in the river, having in the back of their mind the precipitation that fell in winter (snow storage in the mountains). People will have planted their rice already, and if there is not enough water to irrigate the full plot they may decide to grow cumbersome rice and use this as fodder. For Qarayateem rotation starts around Saratan/Asad and continues in Sambala and Mizan. In general 1 qulba is entitled to 3 hours of water, according to the kok

bashi of Sorkhak. In Kulabi a farmer gave the example of rotation when water is scarce, if rotation takes more than ten days it will harm his yield output. When the rotation cycle reaches his village only 10 farmers can irrigate at a time from one check. With little water in the canal, to supply the whole village can take 3 days and nights. When more water is available up to 20 farmers can irrigate and the whole village is supplied in 1 day and night. Mirabs will consult elders in their section and make a schedule for their own branch. Water delivery is not scheduled according to the crops grown, however, ad hoc adjustments are occurring. If a farmer grows mung beans, for example, instead of needing the scheduled one hour the farmer closes his off-take in half an hour. Whereas someone growing rice might decide to dig out a bigger off-take to be able to irrigate his land.

In Sufi off-takes are served according to need and water availability. In times of need for rotation, for example, 200 jerib get one day and one night, 400 jerib (10 qulba) 2 days and nights. If there is less water service can be extended. When a real rotation scheme is implemented, the mirab will make sure someone takes guard at the big open off-takes and his kok bashi will go around the system to check on water stealing. The canals served first in the upper part of Sufi canal are the ones which have higher lands, by constructing checks in the canal. Lower lands often only have to cut a gap in the canal bank to get their water. Further information on water distribution is provided out of snapshots in single canal branches. For example, water distribution near the village of Kharkar, what was told at the Miyaan Khil off-take, that a rotation scheme is implemented by the mirab. This can be a rotation of 10, 15 or 20 days, depending on the amount of water available. Per qulba (40 jerib) 4 hours are given. In times of scarcity the application time can be higher, up to 8 hours per qulba. The rotation makes the people work together and avoid fighting over the water. The rotation schedule as such is existing since the canal exists. People close to the river can use a pump. Other people can hire these. But as an example near Kulabi in Qarayateem, a lot of people cannot afford to hire or buy a pump because the gasoline is too expensive.

Diverse qulba

In the area of Qarayateem some lands are higher than others; one qulba can be 10 jerib instead of 40. Meaning irrigation for one qulba is still scheduled for the agreed 3 hour, creating time for the water to rise before irrigating the plots. A person who has such arrangement is also obliged to send one person per qulba to work at the intake. The smallest qulba are found along Sorkhak canal where lands are higher, but also in the tail at Kulabi smaller plots make one qulba. Plots along the main canal have obviously less problems with water supply and one qulba represent 40 jerib. Plots a bit further away from the parent canal will often have 20 jerib per qulba. Qarayateem was the only case where it was mentioned that the people will use the unit of qulba in such flexible matters. When you want to earn the right for more water and access is not as easy that you can tap directly from the main canal, you have to work for it. But in case of some farmers at the tail of Kulabi, this wasn't even an issue: They did not expect that for their situation working harder at collective maintenance would really ensure more water distributed that far to the tail. These were also the only places where for a long time no rice was grown (see table in annex). So if a farmer will contribute a lot for work at the intake he is entitled to more water in the hot months. The mirabs keeps track of these agreements by enlisting the people who are present the collective works.

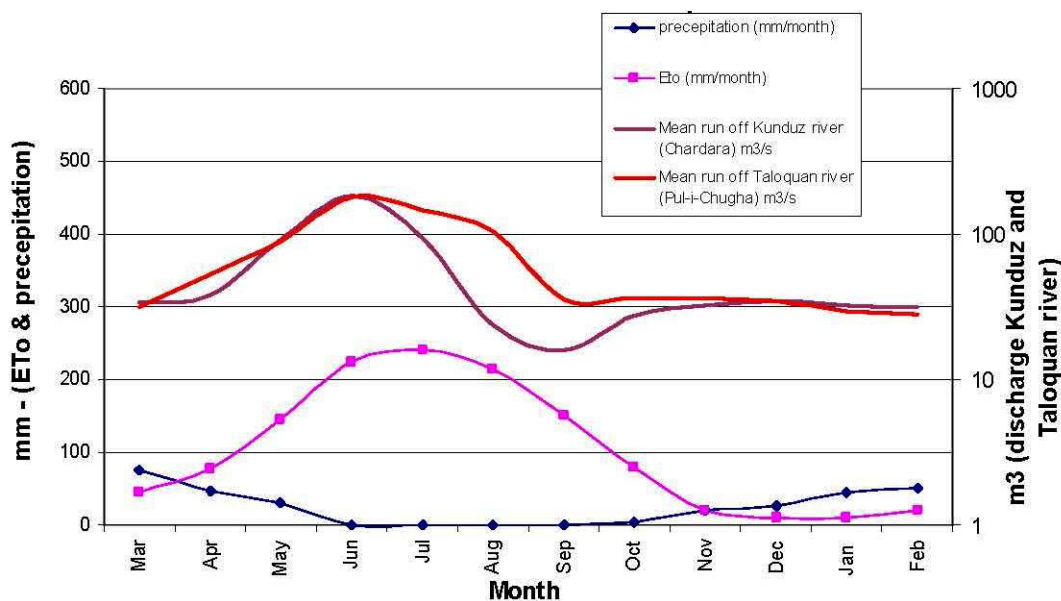
4 Concluding the field work: some questions answered

4.1 What is the water availability for the two systems ?

The province of Kunduz, located on the northern border between Afghanistan and Tajikistan, is part of the Amu Darya river basin, which supplies water for irrigation to the provinces of Kunduz and Takhar in the northeast as well as Balkh and Jowzjan in the north of the country. Most of the rivers are perennial, but with high variation in seasonal flow. Water levels gradually rise in the spring, reaching a peak in June and July, before receding to a minimum in December. “The Kunduz and Khanabad rivers take their sources from among the highest mountains in Afghanistan. These mountains are generally not covered with glaciers (except few in Warsaj district) but thanks to the high elevation, snow is melting until late in the summer, keeping a water-flow that allows farmers to plant a second crop after wheat harvesting in June”

(FAVRE and KAMAL, 2004). In previous times Afghanistan had developed various complex systems of irrigation schemes, adapted to their local conditions. In the Kunduz River Basin large areas of gravity irrigation systems characterise the region. Within the framework of the KRBP, this field study tries to understand the technographic setting in two systems: Asqalan canal, supplied by the Taloqan/Khanabad river, and Sufi-Qarayateem canals, supplied by the Kunduz/Chardara river. Both rivers have a distinct peak in June, according to data from two stations located as close as possible upstream of the canal intakes. However, the data is rather dated as recording came to a halt when the insurgency against the Russian occupation started.

Figure 8: Mean discharge from '64-'78, stations closest to Asqalan (Taloqan/Khanabad river) and Sufi Qarayateem (Kunduz river) irrigation systems.



Based on FAVRE and KAMAL (2004).

Water extremes

Drought. The most recent drought covered seven years, mainly during the Taliban reign. It is difficult to provide a clear picture of what were the most significant consequences of this event. As in this period a lot of people left the region and since a couple of years are returning again, the combination of factors led probably to more difficulties in agricultural production. Farmers in Sufi-Qarayateem told that people were still able to produce rice or at least melons in some of the dry years. In Asqalan the people could still use the water from the river. During the drought, the water level in the normal flooding period was

not too high and, hence, did not destroy the intake as often as in other years. Instead all river water was guided through the canal. This situation lasted for three years. Therefore, mainly people in the head of the system could acquire water for their crop production.

Last years flood. Due to high peak flows the intakes of both studied systems were damaged heavily in a period with high water demands. Many people reported to have lost yield because plants withered away, as not enough water could be let through the system. In Sufi-Qarayateem land close to the river was in the worst case washed away and crops were destroyed. In counteraction a levee of several kilometers, in combination with several groins in the river, were build in an emergency project. Consequence this year was that the intake had to be reconstructed over a long stretch to get connected with the river. In Asqalan a similar sequence of events occurred.

4.2 What is the general agricultural practice in the two systems ?

Landowner versus sharecropper versus labourer

Sharecropping arrangements can be found plenty in both systems. Examples are 50/50 arrangements, where the landowner provides 50 % of the input and receives 50 % of the output. These arrangements can differ, mostly in disadvantage of the sharecropper. In all cases the neshpakar (sharecropper) is obliged to fulfil the labour not only on the land but as well the maintenance duty for the irrigation system. Not many people were actually renting land. One man told he had to buy extra rice from the market to pay his landlord as he was only able to grow mung-beans and oil seed. This made him shift to a 50/50 arrangement as well. A lot of landless people were working in, e.g. wheat harvest or rice transplanting or at the intake. In certain weeks the competition on labourers is reportedly that strong, that it causes a rise in labour prices, what makes in turn some farmers decide to keep the crop even longer on the field until the labour prices drop again. Besides from their own area a lot of labourers from other districts worked during harvesting or transplanting times in Sufi-Qarayateem.

Agricultural produce

Around Saur (21 April – 21 May) most people will determine what to grow for the summer months, which is the same period the mirabs will start to think of irrigation scheduling for the summer period. This year it seems, that people figured not a lot of water to come. Whether a farmer decides to grow rice or other crop is up to him. As last year crops were mostly destroyed, they had to work as labourers elsewhere on the land in the area to earn a living. A wide variety of crops is produced. Soil type is not only an indicator for the types of crops it can sustain, but also for the type of field application which can be used. Together with water availability, water tables and type of crop the width of the furrow is determining. The plant is the indicator for irrigation needs, fresh green means enough water, but as soon as the colour will change this indicates that irrigation is needed. The soil is not used as an indicator. (See annex for pictures of field application).

Sufi-Qarayateem has a loam soil and the water table is about 4 m below surface, whereas Asqalan has mainly sandy soils and loam soils (according to Arif Zahir, GAA agronomist). Along a lot of canals timber-trees are grown in Sufi-Qarayateem. In Asqalan this is mainly visible in the head and middle of the canal or close to the parent canal. Major crops are wheat and rice in Sufi-Qarayateem system. Only in the tail end of all the branches the people complained more about the availability of water, and not all were able to grow rice. Cotton is not much grown since the Spinzar factory in Kunduz doesn't work any longer. In Asqalan most people grow at least wheat or barley in winter. Everyone in the head seems to grow a second crop, in summer melons or grapes are now most appreciated for yield prices. In the tail this is only possible to grow with the help of water pumps. Not everyone is investing in summer crops, even in less water prone crops like oilseeds.

Wheat is irrigated around three times, where critical are the first 15 days of growth. After that it can mainly depend on rain water. One mirab explained that at a sandy hill, where wheat is planted, lalmi (rain fed) land results in 1/5 of the yield compared aubi (irrigated) land.

Potato is cultivated more than in other years in Sufi-Qarayateem, mainly due to a project of an NGO named ICARDA.

Poppy had been planted before the take-over of the Taliban, cultivation ceased with their rule. Also two to three years after the fall of the Taliban the people grew opium poppy until the mullah made the point that it is not in line with Islamic values and beliefs. Figure 9 provides an overview in which period some crops are grown in Kunduz. Only those crops are noted which were actually growing on the field during the period of the three months field stay.

Figure 9: Western versus Afghan-Persian solar months and agricultural practice

Western solar months	Afghan-Persian solar months	Crops grown
21 March – 20 April	Hamal	sesame, (water) melon, potato, tomato, cucumber, unions, etc.
21 April – 21 May	Saur	Cotton
22 May – 21 June	Jawza	harvest of wheat, beans, potato, mung-beans (mosh), beans, (water)melon, corn, rice (directly after wheat harvest)
22 June – 22 July	Saratan	transplanting rice
23 July – 22 August	Asad	no work, too hot
23 August – 22 September	Sunbulah	harvest corn and beans, mosh, etc.
23 September – 22 October	Mizan	rice harvest, wheat planting
23 October – 21 November	Aqrab	Wheat planting
22 November – 21 December	Qaus	
22 December – 20 January	Jadi	
21 January – 19 February	Dalwa	
20 February – 20 March	Hut	Cutting of tree branches, planting sesame seed when no wheat is grown.

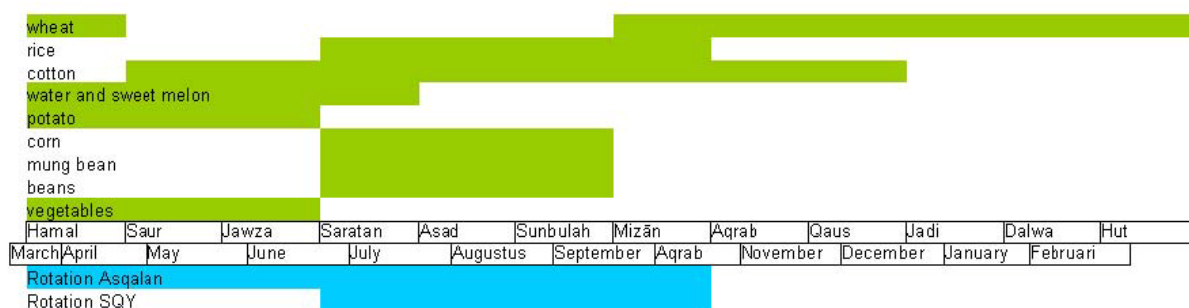
Rice cultivation methods in particular regions depend largely on factors such as situation of land, type of soils, irrigation facilities, and availability of labourer's intensity and distribution of rainfalls. Around Kunduz rice is grown according to the wet nursery method, i.e. (a) transplanting in puddled fields, and (b) broadcasting sprouted seeds in puddled fields. Along Nahri-Sufi in Mang Tepa one farmer reported he harvested 160 sir (112 kg) of rice of one jerib (5,600 kg/ha) (see figure 4 for location of villages). Along Qarayateem a farmer in Kulabi gave the same figure and a third farmer in the tail of Sorkhak had 112 sir of 1 jerib. He used 25 sir/jerib for next year's seed (making 88 g/m², a rather high number). Another farmer told that 4 sir of rice is enough for one jerib (0.2 ha) (making 14 g/m²). One farmer explained 1 jerib of nursery is sufficient for 10 jerib rice. In the first 6 days of growth the rice needs constantly water, which is given during the night. After that the plants resistance is a bit bigger and a bigger range in water delivery is practiced. After 40 days the saplings are transplanted to the fields. The plants are put in a small bed of straw or a special desert plant (named asfand) which is a source of nitrogen. Also fertilizers are used ('black' and 'white') or a cheaper solution is ash, which is spread over the land before transplanting. The 14 g/m² figure and the 10 % of nursery area could be very plausible when taking into account the long nursery stage, so plants do need more space to grow. Rice is grown on the heavier soils, which get waterlogged more easily, but even those lands do not consist of real clay but are mere loess soils (see annex for pictures of field application). For Asqalan rice production was only noted for the areas close to and near river level and along the bigger off-take named Quy Guzar at the head end of the

canal. In Sufi Qarayateem only some higher and sandier areas were considered not suitable for rice cultivation.

Greenhouses: Only one greenhouse was seen for both canal systems in operation since this year. It was located in Qarayateem and covered 0.25 jerib (0.05 ha). Investment was divided over the landowner and several organisations. Water is pumped directly from the canal in to a barrel mounted on a small tower, which supplies the pressure for the drip. 600 liters per 24 hours was stated to be used by the hired labourer of the greenhouse. The water is cleaned from silt by a filter driven by a diesel pump. When no water is available in the canal in Hut and Hamal the water was pumped out of the river in barrels and transported by car to the greenhouse. This landowner also owned an orchard and in total his 5 jerib was entitled for one kulba, as said by the labourer.

If one is lucky enough to have enough water to grow rice and land not too low for the melon and the soil quality fits both too, people will often crop wheat, rice and melon in rotation. When one grows wheat in the winter it is possible to grow rice or, if you don't have enough water, mung-bean (mosh) or sesame seed (conjit). It is even possible to start to grow wheat earlier in the year to be able to grow melon in spring. People do intercrop a lot, examples seen in the field have been: sesame seed and mungbean, corn with mungbean or corn with melon. Figure 10 shows the periods between first planting and last possible harvest per particular crop, yet the exact production time per crop is not noted in this figure.

Figure 10: Agricultural pattern for Kunduz from field observations and interviews



4.3 What type of infrastructure exists?

Scheme intakes (*ser band*)

Both Sufi-Qarayateem and Asqalan have open canal intakes. Every year the main canal has to be de-silted, whereafter the intake can be dug out. The whole mantiqua of farmers/labourers will end up at the intake for the digging. The mirab will decide when construction of the intake starts under his and the kok bashis' supervision. Sand bags and bundles of straw are placed in the river. These are glued together with clay, dug out on a location nearby. This bund will either function as a diversion wall and direct part of the river stream into the canal or it can cross the whole river, functioning as a weir and creating a stable water flow in the canal. Both the Taloqan/Khanabad river and the Kunduz/Chardara river meander considerable during peak flows. When snow melts in spring and beginning of the summer the intake is often destroyed or simply out of range after a period of floods. Besides the risk of shifting of the river, the force of the water would probably undermine any type of permanent intake at these points in the rivers. This year the Sufi-Qarayateem intake was crossing the whole canal width, where even too much water was flowing in the canal and the excess was spilled out a couple of hundred meter downstream in an escape way. As the Taloqan/Khanabad river is wider, under good expectances for water only a minor part of the river is diverted in the canal. But in case of a drought as e.g. in 1997, for several years the whole river was diverted into the canal, securing water for at least some melon production in the head of the system. The Taloqan/Khanabad river has a longer higher discharge, not only providing a longer period of more water but also an extended period of a moving river bed and undermining of the intake. During peak flows, which can be shorter and higher than the mean shown in the figure, for both cases the canal

intakes often collapse, instead of flooding the area this will cause a deficit of water. For example, when the intake of Asqalan was nearly finished on 9 April, a rain shower caused the river to swell and destroying the intake. Because of this, less water was carried in the canal, and a lot of people had to be mobilized to fix the intake. The delivery scheme for one part of the canal was extended by two days to give the people their fill.

Water level and velocity control structures (*bande*)

Virtually every other observed division point along the main or tributary canals in Asqalan seems to be served from a check or control structure, rebuild for every rotation turn. In Qarayateem a proportional flow is going to Sorkhak canal, this point does not have any reinforcements. People along the main canal are complaining that too much water is flowing in Sorkhak canal where several of the interviewed considered that a simple flow dividing structure could put an end to this argument. Such places also offer excellent conditions for adaptation to water measurement because of their capacity to generate shooting flow or free overfall (see KRAATZ AND MAHAJAN, 1975). The constant flow of water and the parent canal being not too big in size, makes the threshold to invest in more permanent structures probably lower in Qarayateem. Along Sorkhak canal in Qarayateem, between the villages of Haji Sher Ali and along Naquale canal till Haji Akhtar, three concrete checks can be spotted. These checks are said to be paid by one wealthy man who is living in Haji Muwen Gul. Along the same height but on the main canal of Sufi-Qarayateem, between the road leading to Aliabad and the village of Madrassa, four other masonry structures were build. Here cooperation between several farmers probably financed these projects. For example, bande Amin was made by 12 farmers who have their lands between this bande and Wakil Sardar. If more farmers along this stretch of canal also benefit of these investment and, if so, contribute to it is not known (see COWARD 1986 on the creation of hydraulic property relationships). What is known is that the farmers consulted their elders before taking any action. The elders will speak with the mirab and they together will inform people downstream about the plans, also making sure that water distribution was not disturbed by the construction of the check. With iron bars where still sticks, plastic and weeds are used to close off the check and rounded bulging canal sides out of masonry, these structures resemble very much indigenous checks. In smaller canals the concrete structures resemble the smaller indigenous ones as well. The concrete/masonry sides and bottom are also fixing the canal bed, preventing the stream to curve itself deeper in the landscape.

Escape ways (*parchawun*)

With escape ways I group spillways and waste ways under one heading. The spillway is a protective structure, placed upstream of diversion structures which ensures that the carrying capacity of the following canal stretch is not exceeded. A waste way is used to empty a whole canal stretch if needed, to wash silt or debris out for example. These last structures are mostly equipped with hand operated gates. To save costs, waste ways are often combined with spill structures. In both canal systems these functions can also be found separated in different escapes. Where the escape way of Sufi-Qarayateem discussed above is merely a cut in the bank, fortified by sand bags, the drop it makes is causing considerable erosion problems. In Asqalan a similar escape way is in times of higher water tables more functioning as an intake, causing the actual intake to silt up, where silt has to be dug out again in periods with less water. The spillway of Baluch, at the west side of the road, has the function of a silt flusher. Since beginning of 2006 a concrete body is built. Two big gates can be opened to empty the first canal stretch. If closed, the water can spill over the crest, shaped as the top of the gates. The people of Asqalan considered the bottom of the structure too high for its main purpose of washing out the silt in the canal. When on several occasions informants told that even after discussion with the implementing party, through the irrigation department, the design was not modified according to the users' wishes. Instead the structure is adapted afterwards under instruction of the shura of Asqalan. The bottom of the escape is lowered by cutting out part of the concrete. The gates were later reinstalled as well. Another escape way from the main canal in Asqalan shapes the border between Asqalan and Torbrakash. This location is called Jaraldi and during the survey this spring the turnout was put in masonry. Other excess of water in the canals is released by leading it through a tributary to the river side.

Examples of escapes in Nahr-i-Qarayateem are at the end of several tributaries/drains which mostly end up in wastelands too high and/or too sandy to irrigate. Only since last year some of these bifurcations

have spills fixed in concrete. This was part of a road construction project. One of these constructions is already destroyed after last year's river peak. Before these drains were crossed by bridges made out of poles of wood or steel. In Nahr-i-Sufi only Sujani-i-Ulya and Mang Tapa have actual escape ways out of concrete in the main canal; all built in 2004 by GAA and BMZ. One of these escape ways has a fixed weir instead of gates to maintain fixed water level. The drop structure is designed not to cause erosion on the canal where the two openings in the crest channel the water to two areas, avoiding turbulence at the walls. It is not visible but probably it will have a pit to get rid off the energy. Silt can not be removed through this escape.

Water mills

About 40 years ago there was a flower mill at the Miankhal off-take for threshing wheat. In Sujani and near the sub-governor's office are also mills left. In Chokani there are 2 mills. They use the water during the irrigation season only at night as there is too little water in the day. In the winter the mills can use water all day and night. URD/AKF (2006) have found in canals systems in Takhar that water mills are prominent factors in water distribution. Both Asqalan and Qarayateem do use machines to do the job, or as was found in Asqalan for one case, that only in the wintertime sufficient water was available for such water mill.

4.4 How the is water distributed ?

For both Asqalan and Sufi-Qarayateem it counts that the systems are upstream controlled; a method used in an irrigation system where water resources are limited at least during part of the year. The "follow on systems" used in India next to the "fixed turn" system describes the Afghan situation in both Asqalan and Sufi-Qarayateem very well, where the turn time for each cultivator is calculated on the basis of so many hours use of discharge per 100 acres, or per qulba as in the Afghan case (KRAATZ AND MAHAJAN, 1975). When one cultivator finished his turn he hands over the supply to the next in the roster, where in our case it is the mirab and his helpers and the next in turn who sees to this.

Like in Asqalan, mirab bashis are present in meetings with the Irrigation Department in Kunduz. On one occasion was revealed, that they were ordered to answer any questions from foreigners, as it was instructed this might contribute for implementing development projects that are in the pipeline for them. In Sufi-Qarayateem the mirab bashis have a similar role as in Asqalan, but here the kok bashis seem to be more present as the representative and defender of rights for the main tributaries. The job seems to be regarded tougher than that of the mirab bashi, the reward for their work is diverse as it seems from the snap shot interviews. Why for example the kok bashi of Sujani in Nahr-i-Sufi and the kok bashi of Basma in Nahr-i-Qarayateem get less paid has not been revealed. Possible more cross-checking is necessary to get the whole picture to know if these numbers are on individual basis or there is another reason. For Asqalan water division over branches is in ratio based on open-close type of structure. This is almost year round, only in the winter water is excessive as water is only used to clean soil of silt as rain is often sufficient for winter crops. Sufi-Qarayateem almost operates as two independent irrigation systems as in the start water is diverted proportional. Along Nahr-i-Sufi big intakes of bifurcations ensure a lot of water to be sent through a section when rotating. The upper half of the system's excess water will flow to the second part of the system, which has a separated rotation system purely depending on drain and spill water from the upper part. In spring time water is still abundant in Sufi-Qarayateem. Over most of the canal branches water is divided on a more ad hoc basis and inflow is adjusted with adding or removing mud or sandbags or (partly) closing of the indigenous checks with brushes. Farm intake is often ad hoc adjustment of an open cut in the canal bank, sometimes with the help of a pipe.

4.5 How are water rights established within and between communities ?

Depending on water availability from the river and the part of the system, soil quality and elevation will determine the water rights over a plot of land: the qulba. In the area of Qarayateem some areas with

more elevation one qulba can be 10 jerib instead of 40 jerib, which are used along the whole Sufi canal and along the main canal of Qarayateem. Meaning that to irrigate one qulba still the timing determined by the mirab and the shura will be used, as the water needs time to rise before it can irrigate the lands. A person who owns such plots of land should also send one person per qulba to work at the intake. For Sufi and Asqalan such arrangements were not distinguished and one qulba counts 40 Jerib. On the other hand it seems that ventilation of the true amount of qulba an area is representing to outsiders is another story, when comparing the command area used by the KRBP with the information given by various actors in the field. Especially in Sufi-Qarayateem it is evident that indeed some areas were larger than agreed water rights, to lessen labor input on maintenance works.

4.6 What operation and maintenance activities are conducted ?

Sufi and Qarayateem are two independent systems thanks to an intervention in proportional distribution at Dubandi, with support of both communities. Coordination seems to happen mainly on the higher level between the two mirab bashis. For example, along Sufi a lot of people seemed not to know about flexible arrangements regarding the qulba in Qarayateem. On the other hand in Qarayateem people were amused by the fact that people could pay the kok bashi in wheat instead of rice due to water scarcity. The following table (figure 11) shows a short comparison of the main activities.

Figure 11: Comparison of operation and maintenance activities in Asqalan and Sufi-Qarayateem Canals

	Asqalan		Sufi-Qarayateem	
Intake construction	up to 12 x	from Navruz till Mizan	up to 4 x	from Navruz till Mizan
Canal cleaning				
- main	1 x	before Navruz	1 x	before Navruz
- minor	1 x	when irrigation is expected	1 x or 2 x	before irrigation starts or after rice harvest
Rotation / building and operating of main checks	sequences of around 10 days per half of canal every 20 days once or twice	only not in winter	every 1 or 2 months	Saratan till Mizan but for the second part of Sufi starting from Navruz.

Asqalan maintenance

About 200 people are mobilized by the mirabs and their kok bashis with share of 50/50 from Torbrakash and Asqalan. For digging the ser band (intake) not only money is collected for construction material. In addition, per 40 jerib one labor day has to be contributed per day of collective maintenance, like cleaning the main canal or working at the intake. The main canal is cleaned once a year for big maintenance, which mainly consists of silt removal as is also visible in the high bunds of soil next to the canal. This is done before the intake is dug-out. During the irrigation period it might be necessary to fix small erosion problems once or twice a month along the canal. Along the bifurcations, people will organise themselves to do cleaning work once a year. But digging a supply canal does not mean that the only right on the land along the canal is considered to be solely for these persons. Per 40 jerib (1 qulba) 10 sir of wheat is paid for the labour of mirab and kok bashi in the Torbrakash area of Asqalan canal. In total, last year 1,200 sir were collected for Torbrakash only, as Asqalan mirab has the responsibility for the revenues in his area himself. 600 sir went to Torjan, the mirab bashi, and 2 x 300 sir were for his kok bashi. Other revenues are collected as well, ten Afghani per jerib is gathered, making a sum of one lakh or 100,000 Afghani. 50,000 thereof are for the expenses of the mirab bashi, and 2 x 25,000 for the expenses of his two kok bashis (the sum does not correspond exactly with the 12,072 jerib Torjan claimed to be irrigating

in Torbrakash). The money is spend on material for repairing the intake, motorbike and fuel needed for patrolling. When we met Torjan once on his round to collect the money for the maintenance work at the intake he collected 2 or 3 Afghani per jerib.

Sufi-Qarayateem maintenance

Main canal digging in Sufi starts from the diversion structures in front of the small hill of Mang Tapa. At every new section of the canal new people join in the digging process, ending at the intake where they work together with the people of Qarayateem. The mirab bashi is responsible for announcing when work is needed for maintenance at the intake or canal cleaning. The kok bashi will after consultation with the mirab bashi mobilize the people from his section. The mirab bashis have lists with the amount of qulba a farmer has. The cleaning of the smaller canals is said to start around Hut although people reported that they already cleaned minor canals at the end Mizan, after the rice harvest or people simply answered that when ever the canal did not have water and they had time to work on it. This activity is done without any coordination by kok bashi or mirab bashi. The bigger branches with a kok bashi are cleaned before cleaning continues with the bigger canals. Together the people of Sufi-Qarayateem will dig out the intake. Normally this starts around Hut or Hamal but this year through the Irrigation Department an earlier effort in intake construction was started. A calculation of revenues for maintenance is said to be discussed with elders. The intake has to be prepared about 3 to 4 times a year due to the water peaks. Mirabs are responsible to hire a digging machine. For every 5 labourers, Sufi delivers 2 and Qarayateem 3, as the division structure of the canals is also diverting the water stream 4 m for Sufi and 6 m for Qarayateem. The mirab sends notice around that he wants to start at the intake. Like in Asqalan the contribution is one labourer per qulba per working day. In addition, about 500 or 600 Afghani per qulba is asked to contribute to spendings on materials. The amount can vary depending on the water availability and on the sum needed for material or equipment for the diversion weir. Mirabs and farmers told 200 people are working at the intake, 80 from Sufi, 120 from Qarayateem. This is said to represent the amount of qulba, but what is contradicted in surveys and KRB data which give higher numbers. The kok bashi of Mang Tapa gets from one qulba 10 sir of rice or wheat, half of this goes to the mirab. People with only couple of jerib give no or little yield as they are already poor, this is the reasoning of the kok bashi. For Qazoo Tapa was mentioned that farmers pay 20 sir of shali, 15 for the kok bashi and 5 for the mirab bashi. Reasoning is that the kok bashi also has a full time job but has to do with a smaller area than the mirab bashi. In Sujani was mentioned, that the kok bashi collects 30 sir of rice per qulba, of which 25 sir is for the kok bashi, leaving 5 sir for the mirab bashi. This year 3 x 3,600 Afghani was collected for material at the intake (90 Afghani / jerib x 3), but this amount can differ every year. Farmers were complaining this year over high investment costs.

4.7 What are the possibilities for intervention strategies ?

That the KRB is working on improving water management in Kunduz is to some extent known by people in the irrigation systems. In a half yearly mirab meeting at the Irrigation Department in Kunduz the main actors in water received a document of GAA which also explained that some work will start as counterpart of KRB on capacity building and small infrastructural improvements on several canals in Kunduz. Via the Irrigation Department's director is made sure that people nosing around are often shown to the areas, as was requested to contribute, what would make it more likely projects would start sooner. In the meetings people do have ideas to develop the irrigation infrastructure, e.g. to connect all canals along the Khanabad River and build a big intake/dam site to supply all at once. As was phrased: 'The canals are like fingers without a palm, the dam would make the hand complete'.

When these structures will be implemented creating property rights could be a foundation of user cooperation, when considering the collusion COWARD draw (1986): "Their [traditional community irrigation groups] action in creating hydraulic property [irrigation facilities] establish among them property relations. These form the basis for their collective action in utilizing and sustaining irrigation facilities. State assists local people in making their own investment and in creating their own irrigation property would support the formation of social groups based on their common relationship to irrigation

property.” On emergency projects people expect, and therefore do rely strongly on NGO investment, as the example from Qarayateem shows. A process GAA has to deal with is how to solve the problems on the local level, what will be the scope of these farmer groups? The idea is now to focus on an area where a particular group of farmers can improve their water delivery by their own means, meaning at the local level. From the SMWA project there are already constraints that Asqalan can prove to be too big for such approach regarding the project’s means for action. On what criteria the farmer groups than should be grouped speculation is still going.

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6 6. Annexes

6.1 Off-takes Asqalan

	Off-take No.	Off-take "Name"	jerib as from mirab	ha
	1	Jou Sim Khil, no off-take, Baluch area	400	80
	2	Baluch spillway	0	0
	3	Quat or Qatat	400	80
	4	Alow Shaw	400	80
	5	Mhohammed Shah	150	30
	6	Haji Namoz/ Qayem	50	10
	7	Abdul Aziz/ Kahn Jan	300	60
	8	Haji Doest Muhammed Ali	200	40
	9	Sahip Khan	100	20
	10	Arzi	400	80
Bande Arzi / Sahib Khan		<i>Sub-total</i>	2,400	480
	11	Mumin	100	20
	12	Jura Bai	100	20
	13	Haji Rai Khan	100	20
	14	Rozi Bai	100	20
	15	Qoi Guzar	400	80
	16	Qoi Guzar, spillway and off-take	600	120
Bande Haji Rai Han		<i>Sub-total</i>	1,400	280
	17	Er Gash	60	12
	18	Haji Khaliqal	100	20
	19	Haji Khaliqal	150	30
	20	Commander Amir Khan	50	10
	21	Haji Chary	300	60
	22	Qarbon Nazar	150	30
Bande Qorban Nazar		<i>Sub-total</i>	810	162
	23	Bai Marza	400	80
	24	Arbab Ekrom	250	50
	25	Jungal Amin	200	40
Bande Shajhurdi		<i>Sub-total</i>	850	170
Bande Jan Morad	26	Shokh Qasom Ali / Shah Lowla	700	140
location unknown but,	27	Big Nazar	100	20
near Malach village	28	Big Nazar Haji Rani	200	40
Bande Nazar Agha		<i>Sub-total</i>	1,000	200
	29	Rafiq Bai / Nazar Agha	200	40
	30	Haji Rahim Ullah	500	100
	31	Nur Said	200	40
	32	Archah Shokh	1,300	260
	33	Haji Ismael	200	40
	34	Haji Chariz	100	20
	35	Haji Badullah / Imam Ali Shah	100	20
	36	Haji Comran	100	20
	37	Jhani Bai	100	20
	38	Saijfi	200	40
Bande Saifi		<i>Sub-total</i>	3,000	600
	39	Haji Res Bai	200	40
	40	Jar-qoloq	200	40
	41	Jaraldi / waste way plus off-takes	200	40
Total			10,060	2,012

Off-takes in the Torbrakash section of Asqalan Canal

as given by Ghayoor, who assembled this with help of this year's deputy mirab.

The areas provided an interpretation of the situation, but could it has to be noted that dat is not exact and probably not up-to date. It does prove some insight on which data waterdistribution might be based.

Off-takes	<i>jerib</i>	ha
Jalot	300	60
Oren Pahlawan	200	40
Masoem Mirab	200	40
Nasir	100	20
Haji Khal	100	20
Shoro	100	20
Abdul Samad Mirab	300	60
Sadiqulah	200	40
Qubrestan	700	140
Rahim	100	20
Jalil	100	20
Aub	300	60
Wulus	4,000	800
Haji Rostam	200	40
Abdul Meleq	100	20
Moloy Asadellah	300	60
Qaria Balucha	200	40
Abdu Salam Munchi	200	40
Alajor Kharoti	1,000	200
Haji Baqi / Zarib Jan	1,800	360
Haji Alam Jan	500	100
Haji Alam Jan	150	30
Haji Alam Jan	150	30
Haji Abdul Baqi	100	20
Jangle Qoly	700	140
Haji Mohammed Shah	150	30
Haji Abdul Baqi / Asya	500	100
total	12,750	2,550

6.2 The qulba and surveying rights and deeds in Qarayateem

Data provided, resembles figures listed from the interviews in the field, and try to illustrate the diversity in water delivery and payments for the water manager between different irrigated sections within the Qarayateem irrigated area.

Location along canal	Informant from village	jerib per qulba	did grow rice		payment per qulba	kok bashi
			this year	last 10 years		
	QY-Mirabs				10 sir for MB + 5 sir for KB	
main canal, middle	Madrasa village	40	yes	yes		
Sorkhak, Naqala branch	Razugul	6 or 8	yes	yes		Abdul Azim
Sorkhak, head	Abdul Aziz boy		yes	yes	10 sir M / KB	Abdul Azim
Sorkhak, head	Haji Sher Ali	20	yes	yes		Abdul Azim
Sorkhak, middle	just behind Haji Sher Ali	20	no	yes	10 MB, 10 KB	Abdul Azim
Sorkhak, Oemarchil		+15	yes	yes		
Sorkhak, Naqala	Haji Hanan	10	yes	yes		Abdul Azim
Nary,	Haji Hanan	20	yes	yes		Boz Mohammed Gul
main canal, middle	Haji Jama Khan	20	?	?		
main canal, close to river	Qulabi	20	yes	yes		
Wakil Sardar, tail	Haji Zafer	40	?	?	10 sir MB + 10 sir KB	Akhtar Mohammed
main canal, close to Gulay branch		40	no	?	10 MB	Abdul Rahim
Gulay branch		10 or 20	yes	yes	10 sir MB	?
Sekhand		10, 15 or 20	yes	yes		?
between Jama Khan and Wakil Sardar		20	yes	yes		Nahim
between Basma and main canal		40	yes	yes	10 MB 5KB	Nahim
Basma	before Qulabi	20 (some times 40?)	yes	yes		Nahim
Basma	behind Qulabi	15 or 20	no	no	10 MB	Nahim
main canal, tail	behind Qulabi	40	no	no		

6.3 Field application in Asqalan and Sufi-Qarayateem



Figure 9 Furrow irrigation on vegetables (okra) (photo: Katja Mielke)



Figure 10 Small plots with flood irrigation on spring-unions (photo: Katja Mielke)



Figure 11 Qari Yatim canal, Kulabi branch the becoming paddy field application ridges(9 May 2006)



Figure 12 Paddy nursery, with the wheat still on the fields, Qari Yatim narrow cotton with



Figure 13 Rice field preparation, Qari Yatim



Figure 14 Grapes in Asqalan, furrows with grapes on high and wide ridges (at least 1m wide).

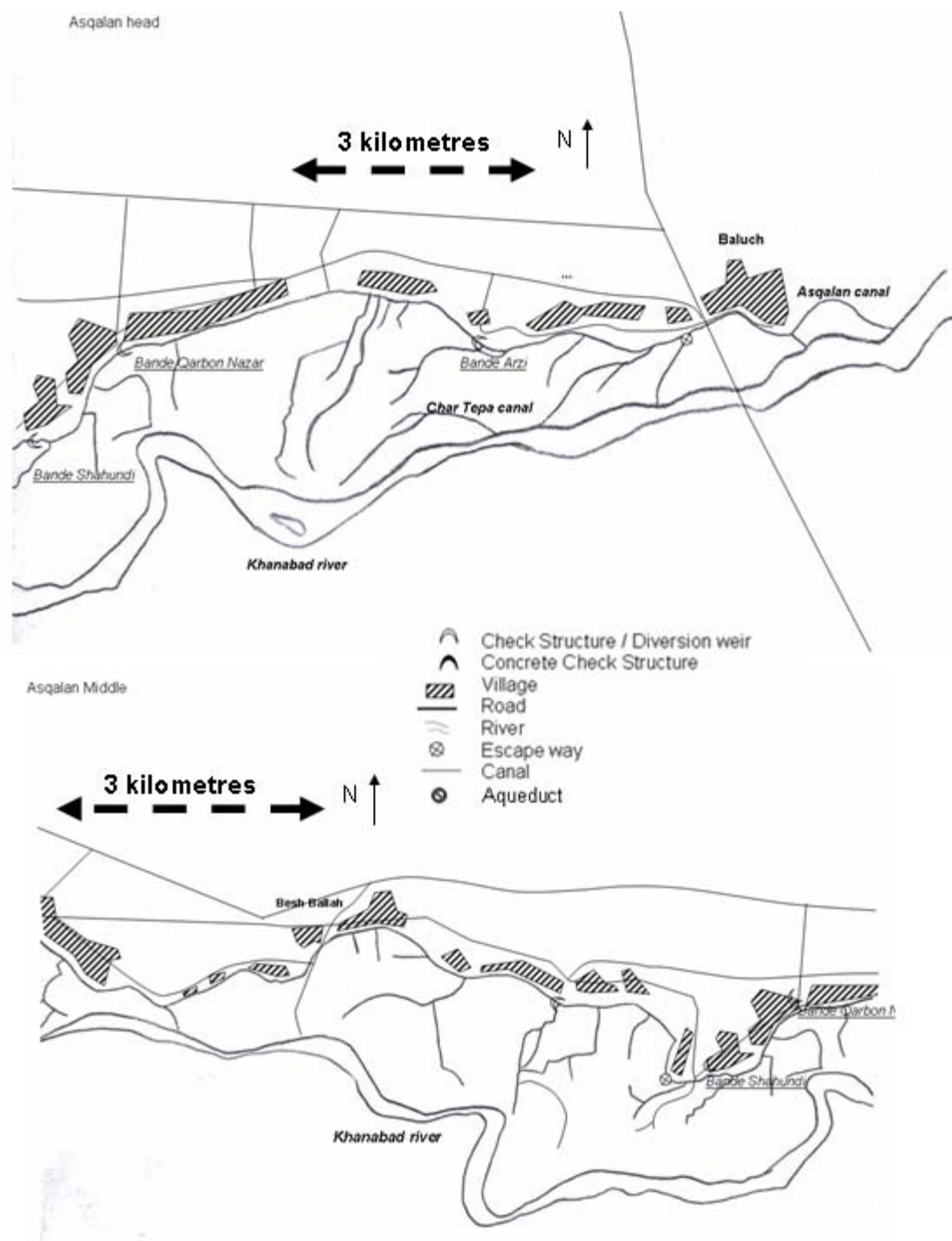


Figure 15 Melon beds with furrows, Wide ridges up to two meters. Asqalan-Torbrakash (photo: Katja Mielke).

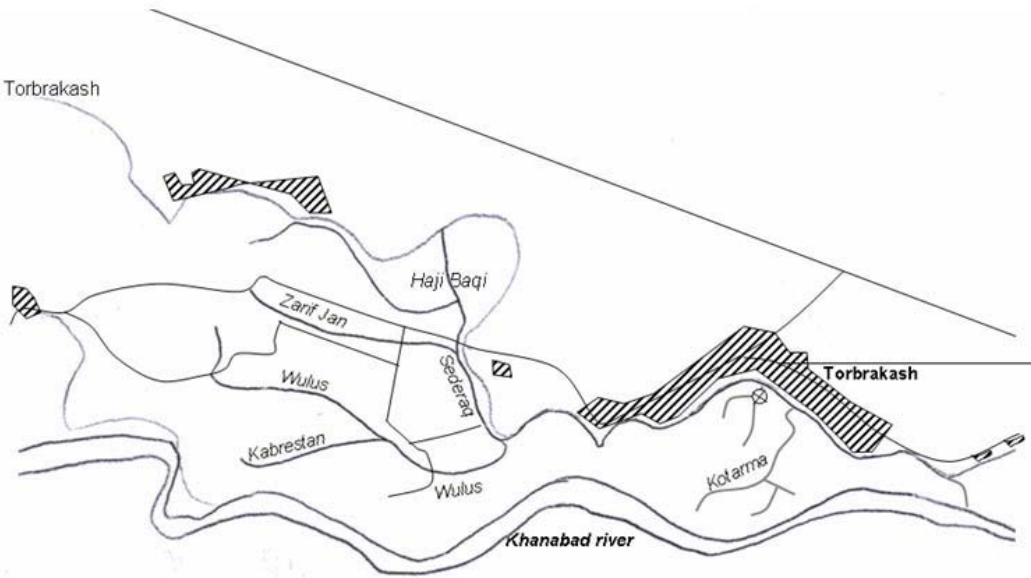


Figure 16 Left: cornfield with snake-like furrow. Right: furrows with small bunds on a cotton field

6.4 Detailed map of Asqalan Canal



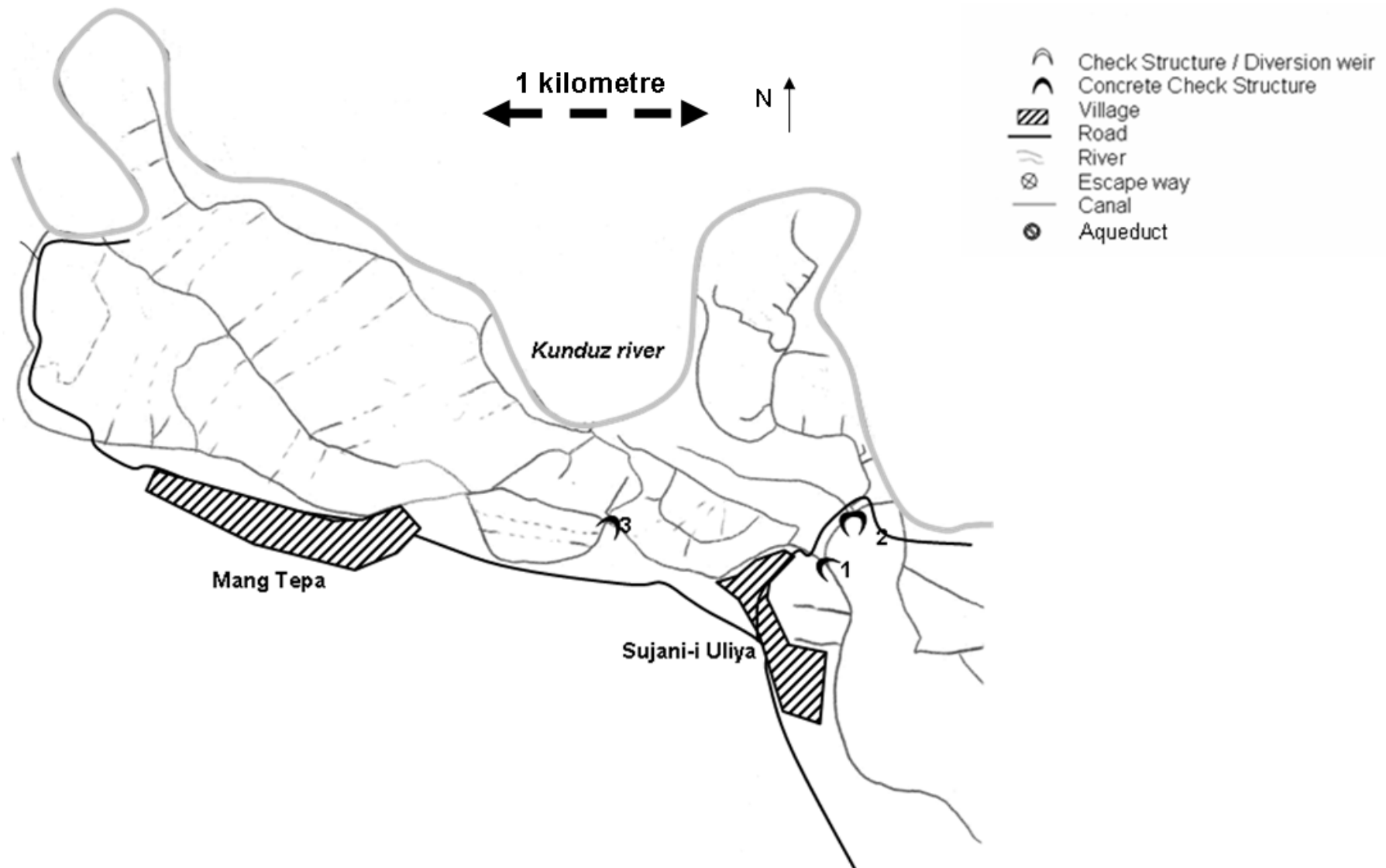
Asqalan - Torbrakash

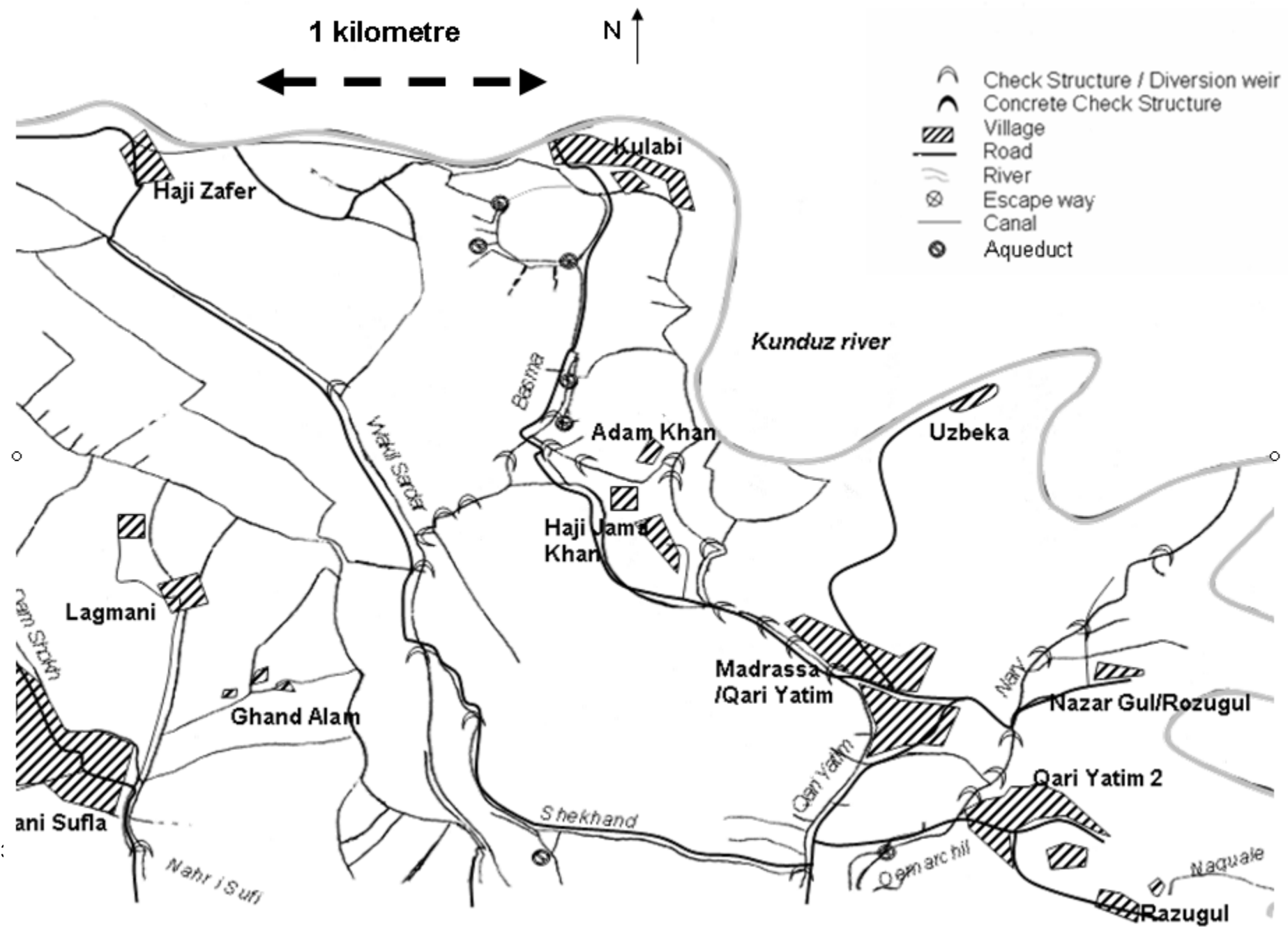


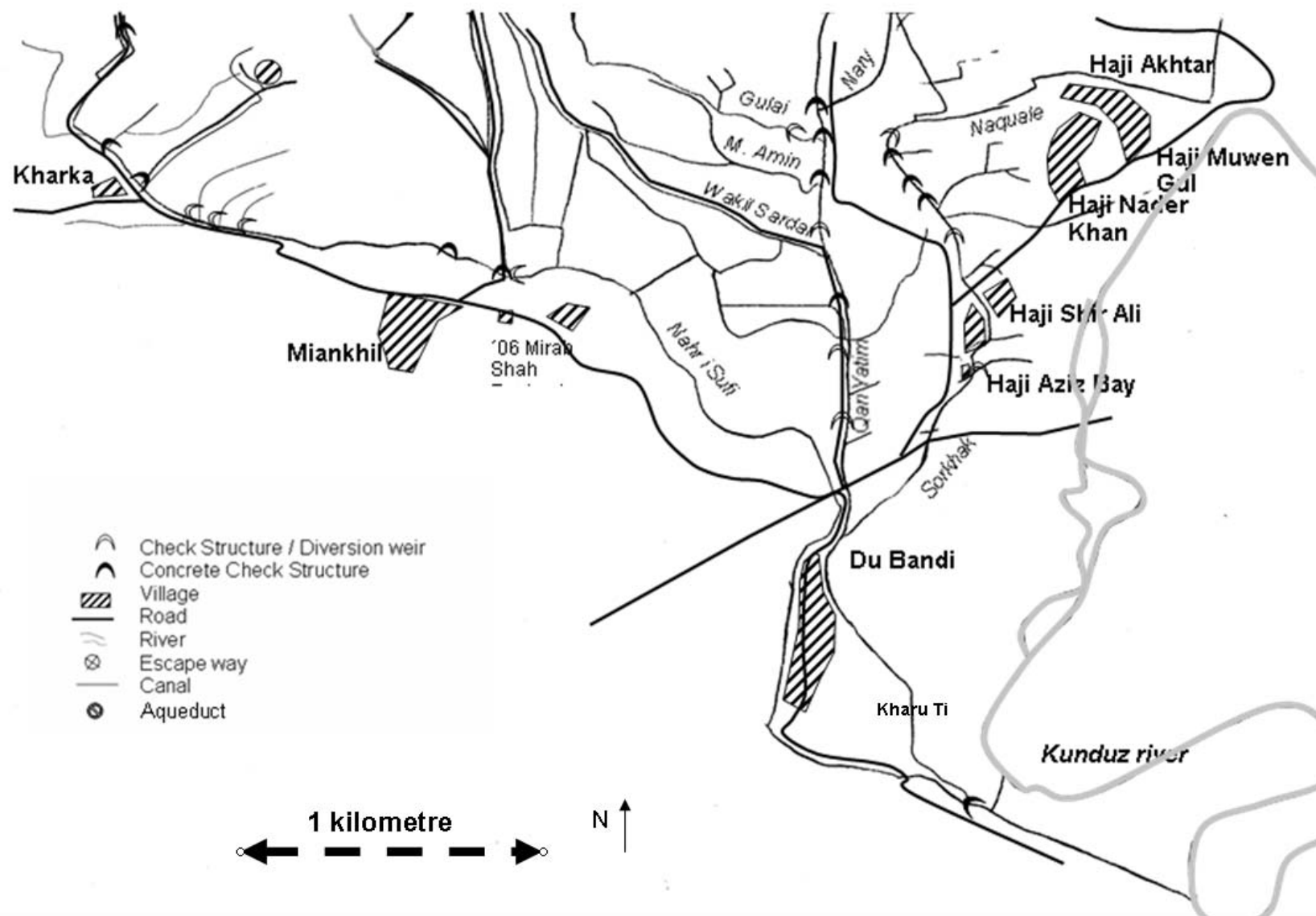
- Check Structure / Diversion weir
- Concrete Check Structure
- Village
- Road
- River
- Escape way
- Canal
- Aqueduct

3 kilometres N ↑

6.5 Detailed map of Sufi-Qarayateem Canals







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