# Water sharing and conflicts in the Wadi Laba spate irrigation system, Eritrea[1]

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## Abstract

The traditional Wadi Laba spate irrigation scheme is about a century old. The farmers use brushwood and stone structures to divert water. Spates frequently damage the structures. Their repair demands a collective labour and material input. In response to this, the farmers organized themselves into sub-groups, groups and committee. The group leaders together form the committee. Before each flood, the committee arrange the main diversion structure, the *jelwet,* in accordance with the location and size of the area to be irrigated, using their "experienced eyes". From the main canals, the water is distributed on a field to field basis in line with the rules – proportional/rotational between groups and sub-groups, upstream/downstream fields first, a knee height irrigation depth; a second irrigation turn only after all fields are irrigated once; in a new year, dry fields first; construction of new diversion structure only by the consent of all group leaders. Floods usually come at night making monitoring difficult. The friendship among the farmers has however made the rules function, but there were some violations, which at times created serious conflicts. Nevertheless, the farmers have in place traditional conflict resolution mechanism, which clearly defines who is responsible for what kind of conflicts resolution, and the process to be followed. In 2001, however, the system was modernized and a weir replaced the *jelwet,* transferring water distribution responsibility at the main system level, from the committee to gate operators. The breaching bund of the weir was destroyed during the first flood season in 2002. It was not repaired timely and seven spates were lost. Although it is illegal, the Sheeb-kethin group leader unilaterally constructed new structure to divert a portion of the water that was being lost, but this caused conflict. Furthermore, convinced that weir could not supply sufficient water, in the year 2003, the Sheeb-kethin farmers used the scour sluice as an irrigation canal, and the Ede-abay farmers diverted a portion of the overflow water into their fields. These activities caused damage to the downstream distribution structures and were a source of some friction among the farming community.

**Keywords:** Eritrea, *Sheeb,* spate, *jerif*, experienced-eye, weir, water distribution

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## 1. Country background

Eritrea is a small country in the Horn of Africa with a population of about 4.3 million and a total land surface area of 121,320 km$^2$ (Central Intelligence Agency, 2001). The Sudan in the Northwest, Ethiopia in the South, Djibouti in the Southeast and the Red Sea in the East, border the country (fig. 1).

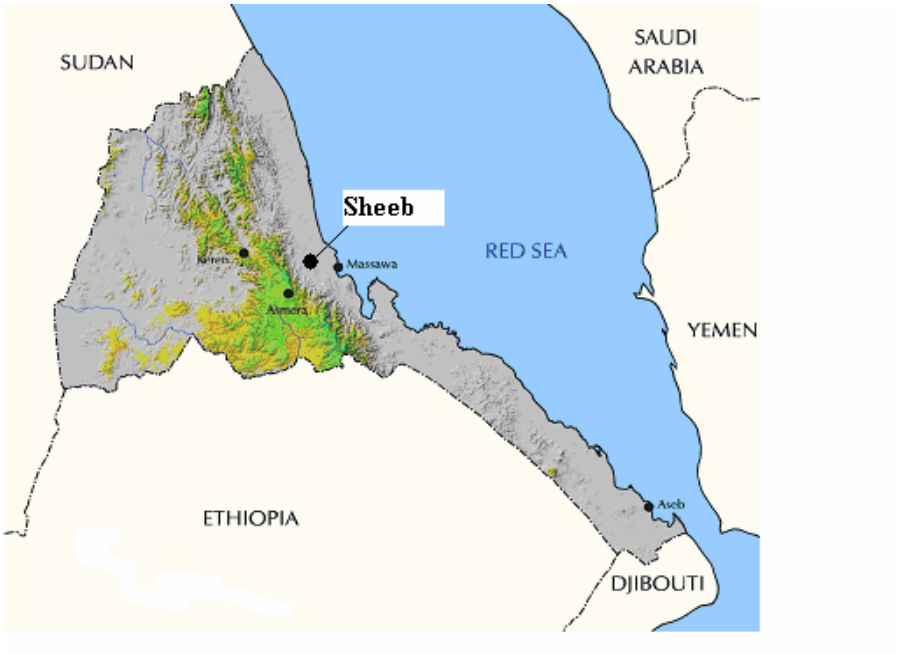


**Figure1: Location map of Eritrea (Photo by: Brigita Stillhardt, CDE, University of Bern, Switzerland)**

70% of the country is classified as hot to very hot with a mean annual temperature of more than 27 $^{o}$C, 25% as warm to mild with average annual temperature of about 22 $^{o}$C and the remaining 5% as cool with a mean annual temperature of less than 19 $^{o}$C (Ogbazghi, 2001). Nearly 50% of the country receives less than 200 mm, 40% between 300 and 600 mm and 10% more than 600 mm per annum (Ogbazghi, 2001).

In Eritrea, agriculture engages 70 to 80% of the population and is the main stay of the Economy. It mainly consists of subsistence rainfed crop production, irrigation and pastoralism. 12% of the total land area of the country (around 1.5 million ha) is arable (Central Intelligence Agency, 2001). Nevertheless, about 50% of this receives an average annual rainfall of below 200 mm, which makes crop production under rainfed agriculture almost impossible. Even in the areas with an annual rainfall of 400 mm and above, crop yield is adversely affected by, among others, erratic nature of the rain.

The currently irrigated area in Eritrea is about 28,000 ha (Food and Agricultural Organization, 1997), with spate irrigation covering 50%. The total potential irrigable area is estimated at nearly 271,000 ha (Water and Power Consultancy Service, 1993).

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## 2. Spate irrigation systems

Spate irrigation is the oldest form of irrigation, which has been practiced mainly in the semi arid and arid regions for millenniums. Some of the well known and historically prominent spate irrigation systems are found in the Arabian Peninsula, notably in Yemen, where it dates back to 2000 years (UNDP/FAO, 1987); and the Negev Desert region, which were built during the Israeli, Nabataean and Roman-Byzantian periods going back to 1,300 to 2,900 years (Evenari et al., 1971).

Spate irrigation is locally known as *jerif,* in Eritrea. There are no any archaeological findings or artefacts that could, with certainty, enable to answer the question: When did spate irrigation start in Eritrea? Based on interviews conducted with elderly farmers in Wadi Laba irrigation scheme however, it can be suggested that the system has been introduced by Besisian tribes of Yemen around hundred years ago. At present, spate irrigation in Eritrea covers about 14,000 ha and has a potential, which is variously reported at 90,945 ha (International Fund for Agricultural Development, 1995) and 60,135 ha (Natural Resources Consulting Engineering, 1996).

In the context of Eritrea, spate irrigation could be defined as a method of irrigation that directs large quantities of surface runoff induced by rainfall in the upland areas which is emitted through normally dry streams to irrigate fields in the lowlands. The runoff water is diverted and conveyed to the fields by means of simple earthen, brushwood, gabion or concrete structures. The fields are flooded at least twice to three times to a depth of a minimum of 50 cm during the flood season in order to enable the soil retain enough moisture that can take the plants through the usually dry cropping season, and avoid the risk of poor yields due to the long, dry periods. Medium (50 to 100 $m^3/s$) and large (>100 $m^3/s$) floods frequently damage the structures making repair and maintenance the core element determining the sustainability of the system

Spate irrigation is identified by the Ministry of Agriculture as one of the main assets that could greatly contribute to the attainment of food self sufficiency in Eritrea. In the year 1997, the Ministry drafted a short-term (2001 to 2005) plan to modernize 4,000 ha of spate-irrigated land and establish 4,607 ha in the Sheeb. In the long-term (2005 to 2010), the plan is to modernize about 10,000 ha and establish approximately 50,000 ha (Ministry of Agriculture, 2000).

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## 3. The study area

The study area, the Wadi Laba irrigation scheme is located in the Sheeb, which in turn is situated about 82 km North-east of the Port City, Massawa (fig. 1), at an altitude of about 300 m+MSL The climate is hot and arid. The mean monthly temperature ranges from 25$^{o}$C in January to 45$^{o}$C in August. The average annual rainfall and potential evapotranspiration are 200 and 2000 mm respectively (Halcrow, 1997). Most of the soils are loams to silt loams. These soils have been accumulated as a result of build up of sediments over the last 100 years, and now often exceed a depth of 3 m (International Fund for Agricultural Development, 1995). The soils are assumed to be fertile with a good water holding capacity. Salinity is perceived to be not a problem (Halcrow, 1997).

The total currently irrigated area in Wadi Laba is about 2, 800 ha. There is an additional of nearly 1,400 ha which is distributed to farmers but has not yet been irrigated due to lack of infrastructure. In the Sheeb, there is a potential. The fields receive water mainly from the ephemeral streams, Wadi Laba, which drain between the beginning of July and the end of September. This is the time when there is heavy rainfall in the highlands. The mean annual flood discharges of Laba is estimated at 150m$^3$/s (Halcrow, 1997). There is no ground water abstraction other than from few scattered wells used for drinking purposes.

The major crops grown in the Sheeb area are sorghum, maize and pearl millet. Sorghum is the most widely grown and preferred crop. Farmers have through their years of experience identified several varieties of sorghum. *Hijeri* is the variety commonly grown as it is well adapted to the local climate and has a well-branched root system, efficient at extracting residual moisture from the soil. Minor crops include sesame, groundnut and some vegetables (Tesfay, 2001). The crops are usually sown from mid September, after the flooding of the fields has receded. They are entirely dependent on the residual soil moisture in the soil profile for their growth. The spacing between rows in sorghum is nearly 0.30 m; where as within the row, the seeding rate is very dense and irregularly spaced. The farmers apply neither chemical fertilizer nor incorporate crop residues into the field. They believe that the nutrient requirement of their crop is sufficiently satisfied by the fertile sediments brought by the floods from the upper catchments. This is not however supported by any scientific study as no analysis of the nutrient content of the floods has been done.

The most common types of livestock reared are camels and goats, while oxen are kept to construct and maintain the irrigation canal and field structures and to till the land. Due to mainly insufficient floodwater and frequent damage of the structures, farmers usually do not usually manage to harvest enough food and fodder during an average flood seasons. As a supplementary livelihood strategy therefore, they migrate to the highlands during the months of June to October. In these months, the surrounding area in the Sheeb is a semi-desert, with no grazing area for livestock. During October to end of May, the livestock is kept tethered and is fed with grass cut in the fields. This system locally known as *zeriba* is meant to avoid the livestock from trampling and/or grazing on young growing plants and to economize the scarce animal feed.

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## 5. Water sharing systems

### 5.1 Introduction

The risks of spate (flood) irrigated agriculture are high, but the probability of being irrigated or not is not equally distributed through out the command area of the flood irrigation systems (Steen Bergen**,** 1997). Within the area served by one flood river and within the command area of one off-take, there may be land with high, medium and low probability of irrigation. This probability depends to a larger extent on the location and level of the command area along the flood river, but also on the water sharing rules in place. Small and medium floods usually benefit the upstream fields, as they do not have the required velocity and strength to reach the far lying downstream fields. Large floods on the other hand, which usually are uncontrollable by the traditional structures, create a situation of "Free water distribution", where the flood finds its own way. The downstream fields are the highly probable beneficiaries from this situation.

## 5.2 Water sharing and conflict resolution under the traditional diversion structures

### 5.2.1 Organizational structure of the farmers

Maintenance and rehabilitation of the canal and field structures is vital in the Sheeb spate irrigation: without it there is simply no irrigation in the subsequent year. To cope with these challenges, the farmers established their own traditional organizational structure that has significantly contributed to a sound and successful collective water management. This has enabled the farmers to sustain their system for the last hundred years, although it has not relieved them from their subsistence life.

The farmers in Wadi Laba are organized into committees, groups and sub-groups locally known as *Mahber, Barty* and *Teshakil* respectively. A sub-group normally consists of 20 to 40 farmers and has one leader, who is an important intermediary between the individual farmers in his sub-group and the group leader, *ternafi.* The major tasks of a sub-group leader are: mobilizing and supervising a team of farmers to work on main structures; implementing water distribution rules; reporting water related and other social conflicts; and messages and requests from individual farmers to the group leader.

Most groups have more than one leader, but only one is considered as the head or chairman of the whole group. He is responsible for: assessing the amount of labour needed to carry out a specific work; conveying information and directives from the committee/administration/Ministry of Agriculture to sub-group leaders; investigating reasons when a farmer has not contributed labour and decide on the type of punishment; transfer messages and requests from individual farmers to the committee or directly to the local administration/Ministry of Agriculture. All group leaders together form a committee, which decides on, among other things: when and how a construction of a structure should be done; the planting season; the allocation and distribution of water.

The farmer's organizational structure responsible for the "management" of the Wadi Laba irrigation scheme is presented in figure 2. The term "management" here refers to the conflict resolution of water allocation, delivery and

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distribution and the broad organizational duties of operating and maintaining the system infrastructure. There are 10 village elders in the Wadi Laba, who form a board of advisory council (fig 2). They are considered to be the most knowledgeable people about the overall water management requirements and are highly respected by the majority of the farmers. Their major task is to provide advice to the irrigation committee members, in issues related to water distribution and conflict resolution. The local administration and the ministry of Agriculture offices play a supportive role in conflict resolution and technical assistance respectively. They only interfere in such matters however when only there is a request from the irrigation committee or a group of farmers, usually in written form.

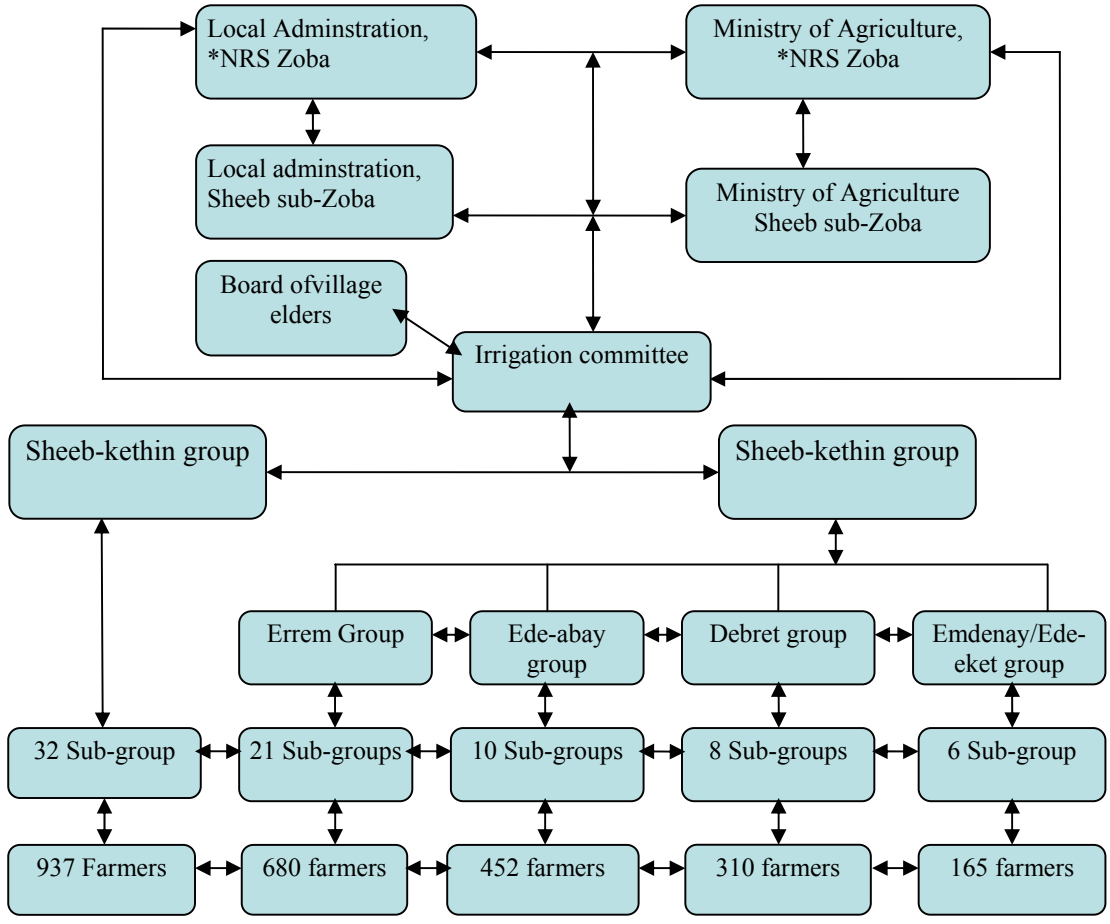


**Figure 2: Wadi Laba Farmers' organizational structure and its links to government institutions (source: own survey, 2002/2003)**

* ***"NRS" refers to "Northern Red Sea Zoba", the Zoba to which the Sheeb sub-Zoba belongs. "Zoba" is equivalent to province.***

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## 5.2.2 Water allocation and distribution

The basis for the water allocation and distribution rules and practices is ensuring equity among the farming community. The Wadi Laba farmers strongly believe in social equity and each person has a societal obligation to work to that goal.

At the main system, water has to be divided proportionally between the two main canals: Sheeb-kethin and Sheeb-abay. This is done by adjusting the two wings of the traditional diversion structure, the [5]*jelwet* (fig 3), in accordance with the needed proportionality. The committee members, through their years of experience, they can predict with greater certainty the onset of flood. Several hours or a day before the expected flood, all the committee members (group leaders) gather at the *jelwet* and make on site decisions as to how the structure should be arranged to deliver the proportionality of water distribution agreed upon. This usually involves several hours of discussions and although it is mostly concluded with amicable understanding and collective decision, occasionally, disagreements and conflicts occur.


**Figure 3: Traditional diversion structure, the *jelwet* (Photo by Author[1])**

[5] *The jelwet is a historical picture as it does not exist anymore. The place where it was built was an area where the most famous traditional practitioners cured some severe skin and other diseases. The farmers told that they chose that place because as it was a place where people were relieved of diseases, they want to be a place where people are relieved of hunger.*

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From the main canals, the flood water is distributed to the secondary and tertiary canals through broad U-shaped earthen structures in Ede-abay and in some sections of Sheeb-kethin; and in the rest of the schemes with the help of single brushwood and/or earthen bunds constructed at the bed of the canals. As in the case of the main system level, these structures are continuously relocated and rearranged during almost each flood. This is in order to ensure that all the different irrigation zones get their proportional share, which is usually determined based on the irrigable command area of the canals. To do all these arrangements, the only tool the farmers possess is their "experienced eyes". These arrangements of the structures are more frequently and more carefully done during July; as the July floods are believed to be rich in nutrient and high in sediment concentrations, prompting each farmer leader and individual farmers to guard carefully their share of water and even some to try to acquire more than they deserve. This is a month when most of the serious water distribution related conflicts occur.

At field level, the water is shared in accordance with the rule that states: during small and medium floods that do not have the strength to reach the far downstream fields, the upstream farmers have absolute right to the water; where as in large controllable floods, the downstream fields have the first priority. The fact that the fields have no individual inlets and that water has to be conveyed from head to tail end on a field to field basis, makes it easy for the upstream farmers to violate this rule (which some do) and creates conflicts.

Their years of water management experience have taught the farmers that, no matter how hard they tried to ensure equity among them through their flexible, proportional and in some cases rotational water distribution practices; and how efficient they try to be in timely maintaining the structures; in any year, there will always be a group of farmers who will not be able to get even a single irrigation turn. This led the farmers to come up with a water distribution rule, about 10 years ago, that states: "New year, dry fields first". This rule was observed being put in practice in 2003, where the *Tsawra* tertiary unit in Ede-abay group, which did not get irrigation the previous year due to the combined effect of the damage of its distribution structure and the failure of the breaching bund of the modern diversion weir, was totally irrigated by fully diverting the first small (20 $m^3/s$) flood, before any of the rest of irrigation scheme received a single irrigation turn.

The unwritten, but widely known and practiced water distribution rules in Wadi Laba could be summarized as follows.

1. Each field is entitled to a depth of irrigation of a knee height at each turn;
2. Second turn only after all fields get one turn;
3. At main, secondary and tertiary levels, proportional and/or rotational water distribution depending on the flood discharge;
4. At field level, small and medium floods, upstream field first; large floods, downstream first;
5. In any new flood season, dry fields are first fully irrigated before any other field gets a single turn;
6. New diversion structure can only be constructed by the consent of all group leaders and upon approval in a meeting by majority of farmers.

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Rule no. 4 is perceived among the Wadi Laba farmers to be very important, as it creates an atmosphere of cooperation between the upstream and downstream farmers, which is a necessity for the sustainability of their irrigation scheme. This is mainly because the *jelwet* (fig. 3), which is built of stones and brush-woods, is usually washed away by high to moderate floods. Its reconstruction is beyond the labour and material cost of the upstream farmers, making the contribution of the downstream farmers invaluable. The interviewed downstream farmers and farmer leaders explained that had it not been for this rule, they would have not contributed for the reconstruction of the diversion structure. They understand that large floods could cause damages to their field structures, but they also know that they are better served by the water distribution system induced by these floods - "The free distribution". The downstream farmers underlined that they do not need the assistance of the upstream farmers to maintain or reconstruct their field structures.

The upstream farmers have through the years learned that, as long as the *jelwet* is timely and properly maintained, they will always be able to irrigate their fields with small floods. Hence, they have largely being abiding by the rule no.4. As stated earlier, however, as during the large floods, the water has to pass through their fields on its way to the downstream fields, they have a possibility to easily manipulate and violate the rule. Downstream farmers recall serious violations, particularly during the 1985 and 1989 flood seasons, which were induced by the acute shortage of spates. The upstream farmers used almost all the spate that occurred, leaving about 80% of the downstream fields un irrigated. The tail-enders filed a complaint with the committee, but the case was peacefully settled, with the help of village elders without being communicated to the Local Administration. Based on the advice of the village elders, the committee decided that the following year, the upstream fields will only get water after the downstream fields have received two irrigation turns. This decision was fully implemented, paving the way for confidence building among the farmers.

The spate floods usually come at night and early mornings making it difficult for the group and sub-group leaders to monitor the implementation of the rules. The interviewed framers nevertheless stated that it is not the monitoring system; but the existence of a real accountability between the leaders and farmers and the good relationship among the farmers in general and the neighbouring farmers in particular that have helped make the rules function.

Unlike in the spate irrigation systems in Yemen (Steenbergen, 1997) and Pakistan (Hamilton and Kahlown, 1995), in Wadi Laba, contributing labour for the construction of diversion structures is not a prerequisite for getting access to water. If a certain farmer however repeatedly fails to participate in organized collective works (after being fined for at least three times), the committee reserves the right to confiscate his land and distribute it to a landless farmer. This harsh measure is however rarely implemented. The interviewed elderly farmers could only recall three such cases in the last 70 years.

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### 5.2.3 Conflict resolution method

The majority of Wadi Laba farmers are by and large well disciplined and always strive to ensure that water is distributed in accordance with the rules that are drafted and implemented with their consent. They have strong desire and they perceive it as their social and religious obligation that water is shared equally among the different economic and social classes of the farming community. Despite all these however, they understood that it would be difficult to completely avoid water conflicts and they decided to put in place conflict resolution mechanism (fig.4).

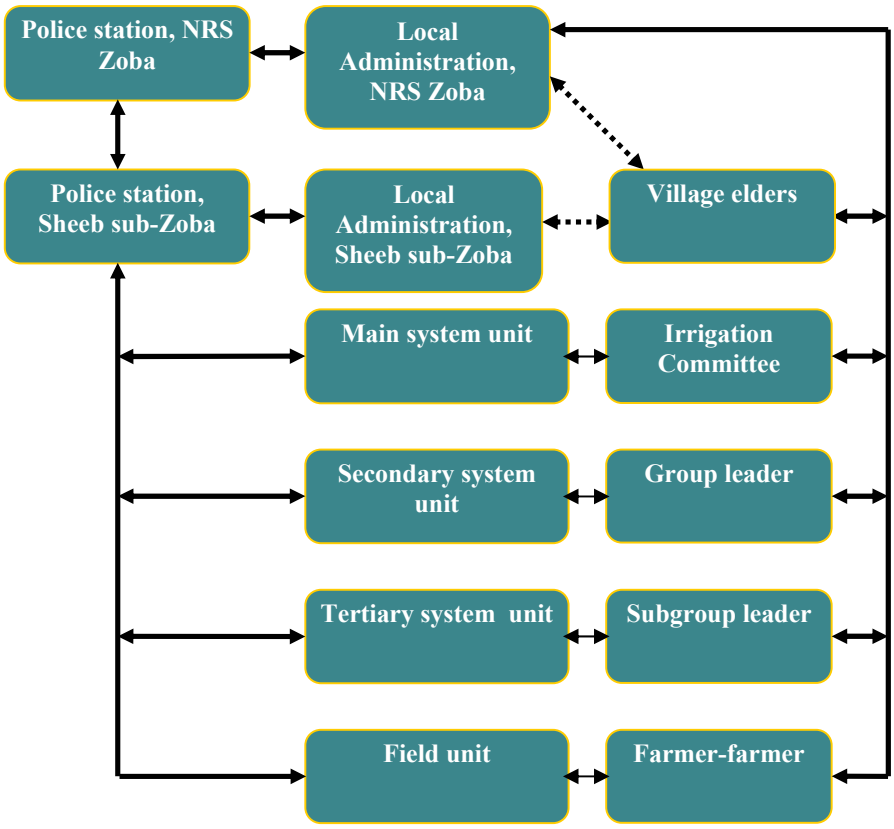


**Figure 4: Organizational structure for conflict resolution (source: own survey, 2002/2003)**

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Most of the causes for the conflicts that arise at field level are: in the upstream tertiary units (during small to medium floods), the breaching of the field bunds by the downstream farmer before his immediate upstream farmer gets knee height irrigation depth. Within the downstream tertiary units (during large floods), the blockage of flood by the upstream farmer. This can result in a very serious conflict as it is the violation of rule no.4, the rule perceived to be the corner stone for ensuring the cooperation between upstream and downstream farmers. Conflicts resolutions at field level are preferred to be solved by mutual understanding between the worrying persons. If they fail to solve the problem, on the request of one or both, the sub-group leader could interfere. If he fails to handle the situation, he can ask the assistance of the group leaders and on request basis it can reach the village elders or even the local administration (fig .4). Such cases however do not go beyond the scope of the sub-group leader. In 2002, 4 such conflicts were witnessed. In three of the cases, the neighbouring farmers solved it through bilateral negotiations, in which the affected persons were allowed to take the next two irrigation turn of the other persons. In one of the cases, one of the farmers resorted to force and physically hurt the other. In such cases, there are very clear rules, which state that: a person who uses force to solve any sort of problem, even if he was the victim, he should be directly reported to the police station and the other person will not be penalized even if he breached the
water sharing rules. This rule was applied and the concerned person was put in jail for two nights.

Solving conflicts at tertiary, secondary and main system levels are the responsibility of the sub-group and group leaders, and committee members respectively. Interference can only be done made on request, and when it comes to the local administration, a written request is usually required. Most of the conflicts at these levels result due to disagreements in the location and design of the diversion and distribution structures. As stated earlier, the structures have to be rearranged frequently, sometimes after every flood event, making it inevitable for such disagreements to occur. In solving such conflicts, the worrying groups and the mediators all go to the site of the conflict. They observe how the concerned structure is built, its location in relation to the areas to be irrigated, and decisions are made on site. They follow a real democratic system, where both quarrelling sides are given enough time to make their case. The decisions given, which could result in reshaping or relocating of the structure(s) concerned should either be perceived as final and implemented or the case is transferred to the highest authority, the local administration, whose decision is final and binding.

Some times, conflicts could arise between a group of farmers, sub-group leaders, group leaders and/or irrigation committee; and Ministry of Agriculture sub-Zoba staff/irrigation project team. Such conflicts are very rare and mainly came to existence with the modernization of the scheme. In 2002, the failure of the project team to maintain the breaching bund timely created serious conflict between the committee and the project staff. This was the first ever case where the committee filed written complaint with the Local administration of the Northern Red Sea Zoba.

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### 5.3 Water Sharing under the modern diversion weir

As part of the efforts to modernise spate irrigation systems, the Ministry of Agriculture, with technical assistance from Halcrow Engineers and financial support from the International Fund for Agricultural Development (IFAD), established an Eastern Lowland Wadi Development Project (ELWDP). The project constructed a permanent concrete underflow diversion weir (fig.5) at two major Wadis, namely at Laba and Mai-Ule, completely replacing the *jelwet* (Halcrow, 1997). These new structures were intended to better control the spate floods and divert more water to the irrigated fields there by improving the crop yield. One of the main justifications for the replacement of the construction of the weir is that traditional structures are frequently washed away in the middle of the flooding season and before they can be (re)constructed and/or maintained many spates are lost. This results in a huge loss of production. The worst scenario that could occur is that the *jelwet* could be washed away by the first flood in a certain season. Given the unpredictable nature of the floods, there may not be any flood after the *jelwet* was reconstructed, virtually resulting in no crop production. As far as the allocation and distribution of water from the Wadi to the main canals is concerned, the introduction of the weirs has resulted in an immediate shift of responsibility (at the main system level) from the group leaders to the gate operators. The "experienced eye" was replaced with the supposedly "accurate measurement" of the undershot gates.

**Figure 5: Undershot Wadi Laba diversion weir (Photo by Author[1])**

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The Wadi Laba weir became fully functional in the year 2002, which was a relatively dry year with a total of only nine spates. The farmers in Sheeb classify the flood season into excellent, good, average and dry, when the number of spates are above 25; 20 to 25; 15 to 20; and below 15 respectively. The farmers informed that the third flood that came early morning at around 2:00 AM, which had a depth of about 2.5 meters at the immediate upstream of the weir completely swept away the breaching bund. As the gate operators were given an instruction by the project team to keep the scour sluice gate closed, and only open it during large floods; the gate was closed and the gate operators in fear of their lives (as the flood was very large ), they did not open it. Some of canal head regulator gates were also blocked with large tree-branches and boulders. These have significantly contributed to the total sweeping away of the reaching bund, which was built with a return period of five years. The breaching bund was constructed in such a away that once destroyed, the water is disposed into a non irrigable area, mainly to protect the fields from erosion and field structures from damage. This however has negative impact, especially in dry seasons, because it did not give farmers flexibility to benefit from "Free water distribution'', by converting part of the lost water. Although the downstream farmers were willing to combine efforts with the head-end farmers, the reconstruction of the breaching band was beyond their labour and material capacity, and even their technical ability as it involves many engineering aspects such the upstream and downstream slopes, which the farmers have not been informed about. The project team probably did not expect the incident and were unprepared and as claimed by some engineers, they had no dozers and loaders in place. The breaching bund was not reconstructed timely and all the seven spate floods that followed were lost.

The Sheeb-kethin group leaders concluded that there is no chance that the breaching band will be maintained and unilaterally constructed an earthen *agim*, and diverted part of the water that was being disposed by the breaching bund. They managed to irrigate about 50 hectares, but as their action was a violation of the sixth rule stated in the above, their action created friction with the other group leaders, who filed a written complaint with the local administration, Sheeb sub-Zoba. The administration argued that as what was diverted was water that could have been lost, it should be considered as a good temporary solution and not a violation of any rule.

The failures of the structures in the 2002 has however helped farmers to better prepare themselves in searching ways of supplying water supplementary to the one delivered by the head work. The Ede-abay and Sheeb-kethin farmers agreed on ways of sharing the overflow water. Eda-abay farmers accordingly identified a location in their main canal that allows them to divert additional water, with out interfering with the functioning of the modern structures. The Sheeb-kethin group leader convinced the other group leaders to allow him to retain the *agim* he constructed unilaterally arguing that the culvert that was designed to supply water to his zone was observed experiencing difficulty in delivering the required quantity of water. The other group leaders agreed with the views of the Sheeb-abay and Sheeb-kethin group leaders, as they understood that such actions will furnish additional water and would allow their respective irrigation zones to utilize most of the water that comes through the main canal head regulator gates.

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The year 2003, was categorized as an excellent year both by the farmers and some site engineers, and in did it was. Till August, 28, Wadi Laba brought 28 spates, but the irrigated area, about 1,500 ha was far below the design target value, 2,650 ha, planed to be irrigated not during an excellent, but in an average flood season. This is despite the fact that the Ede-abay farmers were continuously diverting additional water and the Sheeb-kethin farmers used the scour sluice as an additional irrigation water gate supplier. The scour sluice was designed to relieve the pressure on the breaching bund during large floods and to remove excess coarse sediments. According to the latest report obtained from the site irrigation engineer, floods continued to come till mid October and that 2,200 ha have been irrigated in Laba and 67% in Mai-ule. This has to be verified and elaborated as to : 1) how many of this additional 700 ha presented as being irrigated, indeed received the optimum crop requirement perceived by farmers - three irrigation turns of knee height irrigation at a turn, and 2) were they exclusively irrigated by the main canal head regulator gates. Even if the irrigated figures are taken as correct, the report of the engineer still justifies that even in an exceptionally excellent year; the modern structures could not irrigate their set targets. It is worth mentioning for sake of sound comparison that in 1997, the year that had as excellent flood season as 2003, the farmers explained that they fully irrigated their fields three times and they had to occasionally discard excess water. This was when the *jelwet* was still in place.

## 6. Concluding recommendations

With the limited scope for irrigation expansion in the future, the need to ensure that modernization efforts yield the expected performance improvements has become more important now than ever before (Uphoff 1991). To be productive, however, the modernization process should necessarily include matching of infrastructure with a suitable institutional framework that can properly handle the operation and maintenance of the system.

In the Sheeb, as a result of the above stated operation and maintenance problems, a consultancy study was initiated to try to find ways on how to strengthen the farmers' institutional set up. There is however no tangible actions taken to that end. It could be argued that such a study should have been started some recommendation done between 1994 and 1998 when data was being collected and technical design was being drafted. Furthermore, after the completion of the construction of the structures, till now (2003), it can be said that almost no serious effort has been done to provide the farmers with the necessary training in operation and maintenance of the modern scheme. It might have been considered as understood, but it is worth mentioning that the second major objective of the ELWDP does not even make a mention of "Farmers or farmers' organization leaders". It only states: "to strengthen the Ministry of Agricultural staff capability in spate development"

In July, 2003 operation and maintenance workshop led by a Halcrow site engineer was organized in the Sheeb, where most of the project team and Ministry of Agriculture Sheeb sub-Zoba staff participated. A number of issues concerning the sharing of responsibility of operation and maintenance between farmers and the project team and the Ministry staff were discussed. The medium of discussion was English, but translations of important points could have been arranged and some farmers' opinions accommodated. Capacity building of farmers should be given due

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attention and this is one of the main area where IFAD and other development agencies should actively be engaged in. The long term sustainability of the scheme depends on the farmers' capability to timely operate and maintain the systems infrastructure. Ultimately, the water management responsibility of the Wadi Laba scheme is planned to be handed over to farmers.

The Sheeb farmers have about a century old experience with spate system and have been actively engaged in designing and constructing diversion structure that have sustained the system for years. The active participation of the farmers through out the design process of the modern structures could definitely have helped make a better design and created a better atmosphere of cooperation during the difficult times in 2002. The interviewed farmers and farm leaders however expressed their regret for not been given an active role in the design process. Many farmers explained that even before the completion of the construction, they expressed their concern that the undershot openings are too small and that the planned operation of the scour sluice gate could create operational problems as floods usually come at night and are of high intensity and short duration nature. These claims may not necessarily be correct, but at least serious efforts should have been done to justify to the farmers why things were done built the way they are. The non-involvement of farmers in the design process is a fact acknowledged by a number of the interviewed sub-Zoba Ministry of Agriculture staff; even by some Halcrow engineers.

The incident of 2002 has made the project team to closely work and cooperate with farmers. Currently, a regular weekly meeting is being held between the farmers and the project team under the chairmanship of the project coordinator. This a good step forward to try to understand the views of farmers and the practical problems of the scheme. It has however to lead to enabling farmers to have a say in the actual decision making in issues such as site selection and nature of design of structures. The modernization in Wadi Laba is not yet complete. There is still a need to design and construct field distribution structures and probably off take structures to provide supplementary water. There is therefore an opportunity to allow the farmers to be actively, not passively participate; and make them feel a sense of ownerships of the schemes.

Halcrow (1997) clearly stated that "understanding the functioning of the traditional water distribution of spate irrigation systems in their totality is of high relevance for making an appropriate technical design. However, it needs detailed and prolonged studies, and if taken to their logical conclusion, would involve deferring such developments for many years whilst data are being collected. Such deferral, in the context of the development needs in Eritrea, is not desirable." If a sustainable development is to be achieved however, care must be taken so that a failure of a technical design does not cause conflicts among farmers. There are a number of modernized spate irrigation systems in Balochistan, Pakistan that were not utilized due to water sharing conflicts (Steenburgen, 1997). Examples include: Uthal Kantra (Las Bela District), Ahmadzai (Zhob District) and Safi Band (Loralai District). One diversion system in the Anambar Plain, Pakistan was blown up by the consent of two conflicting parties (Steenburgen, 1997).

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