ANNEX C

ANTHROPOLOGICAL SPECIAL STUDY FOR RELATION BETWEEN PASTORALIST COMMUNITIES AND THE PROJECT

FINAL REPORT

THE PROJECT FOR ENHANCING COMMUNITY RESILIENCE AGAINST DROUGHT IN NORTHERN KENYA

ANNEX C ANTHROPOLOGICAL SPECIAL STUDY FOR EXAMINING RELATION BETWEEN PASTORALIST COMMUNITIES AND THE PROJECT

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CHAPTER C1. STUDY IN MARSABIT

C1.1 General

C1.1.1 Objectives of the Research

An anthropological research was conducted at pilot project sites in Marsabit County by an anthropologist from Japan dispatched by the Project Team for 1 month in June –July 2014. The major objectives of the research were:

- To have a better understanding on social organization and decision-making process of the Project targeted communities.
- To investigate the organization, function, and responsibility of committees established by the Project, and its relation to local community.
- To examine the difficulties and challenges faced by pilot projects.

In this chapter, we first explain the social organizations and decision-makings of two communities, the Borana and the Rendille, and then examine the difficulties and challenges faced by the Project from both theoretical and practical perspectives.

C1.1.2 Methodology and Research Sites

The basic method used in this research was formal and informal interview with local leaders, committee officials, and people from local communities. Due to the limitation of time, not all pilot projects were investigated. Nonetheless, as the anthropologist had previously been carrying out ecological and anthropological research in Marsabit County for more than 15 years, the knowledge and experience would help to understand the reality of local livelihood and impacts on the Project.

C1.2 Observations

C1.2.1 Distribution and Relation of Ethnic Groups in Marsabit County

Except Mountain Marsabit National Park and Bio-diversity Reserve on the top of Mountain Kulal, over 90% of Marsabit County is covered by bushland, semi-desert grassland, and desert. By raising camels, cattle and shoats (goats and sheep), nomadic pastoralists have maintained self-sufficient subsistence in this arid and semi-arid environment for centuries. There are three major pastoral groups; the Borana live in between northeast and southeast of Mt. Marsabit who raise cattle, shoats, and cultivate on the eastern slopes of the mountain; the Gabra occupy the northern part of the county with their camels and shoats, the Rendille settle around local towns such as Korr and Kargi in the west and south of the county, and herd camels and shoats in the southern part of Marsabit County and northern part of Isiolo County. Other pastoralists such as Samburu and Turkana live in the Mt. Kulal and Lake Turkana area, but their population in Marsabit County is relatively small. People from other ethnic groups of Kenya can also be found in major towns. Pastoralists normally live with their own ethnic group and build traditional villages based on clanship or kinship in the rural area. Each ethnic group has their center areas to stay during the rainy season. But in dry season, they may encounter with each other and share the same rangeland and water resources.

Although peace-building activities have been done at different levels for more than two decades, relations among these ethnic groups are uncertain. Factors such as livestock raiding, competition for natural resources, and political conflicts cause tension among these groups. For example, raiding by the alliance between Borana and Gabra forced a large number of Rendille moving from the southwest slope of Mt. Marsabit to Korr area in 1992. In 2005, armed Borana raiders killed about sixty Gabra in Turbi town, which extremely destroyed the relationship between the two ethnic groups. In recent years, political events such as national election and decentralization also raised tension among these groups. Such ethnic uncertainty directly or indirectly affects the access to natural resources and mobility of human and livestock, both are considered as key responses to drought in arid environment.

The Project has eleven pilot project sites in the county, which cover all three major ethnic groups. Therefore, understanding the social organization and decision-making process of these ethnic groups are essential for the implementation of the Project.

C1.2.2 Social Organization and Decision-making of the Borana

(1) Social Organization

The Borana are originally cattle herders inhabited southern Ethiopia. They migrated into the lowland of northern Kenya in 16th century. In current Marsabit County, the majority of Borana live in the Gadamoji Division, which is close to Marsabit town. It is said that the Borana started to settle down and open farmland on the highland of Mt. Marsabit in 1970s. Then nowadays, most of them are agro-pastoralists, who grow maize and beans both on highlands and on the eastern slopes of Mt. Marsabit, and herd cattle, shoats for their livelihood and donkey for transportation in the lowland. Gadamoji Division consists of four locations, Qilta, Sagante, Dirib Gombo, and Jaldesa from north to south. Qilta and Sagante Location are relatively high, most farmlands located above 1,100 m, which is considered to be suitable for agriculture. Most of land in Dirib Gombo and Jaldesa Location are below 1,000 m, where people depend more on livestock herding.

Most farmlands in Marsabit County rely on rainfall, which has become more uncertain in recent years. According to a farmer who owns four-acre land in Gar Qarsa sub-location, the maximum yield was 2,900 kg of maize and 1,800 kg of beans in 2006, whereas only 36 kg of beans and nothing from maize field were harvested in 2014. Such rainfed agriculture on the highland of Marsabit County is considered to be a vulnerable production system to current natural disaster and climate change.

Two local adaptations to the unstable agriculture production were found. One is to raise livestock in the failed farmland; another is to grow cash crops such as *miraa* (*Khat: an indigenous narcotic plant*). As the farmer in Gar Qarsa informed, he has shifted half of his maize farm to *miraa*, and the other half to raise cattle, from which he can gain milk for daily consumption. For staple food (maize, wheat flour, rice), he would like to buy from the market in Marsabit town instead of growing by himself. On the other hand, people began to raise camels as an adaptation to recurrent drought in Dirib Gombo and Jaldesa Location, where cattle herding is regarded as a major subsistence. Raising camels was introduced to the Borana of the highland by the World Bank supported project named Arid Lands Resource Management Project (ALRMP) from 2004. According to a former staff of this project, they brought a total of 136 camels to local herders of Gar Qarsa and Jaldesa.

Today, the Borana are living either in their farms or with their relatives. Their social organization strongly reflects such residential pattern. The following are basic units of the Borana society.

Homestead (*Moga*): consists of three to twelve households who build their houses next to each other. The relations among households are referred to kinship, clanship, or people who share a farmland. The head of the homestead is an elder called *Jars Moga*.

Village (*Olah*): consists of several homesteads adjacent to each other. These households may not have direct relationship. The head of the village is an elder called *Abba Olah*. The decision of a village is generally made by elders meeting, which both *Abba Olah* and *Jars Moga* of all homesteads participate.

Zone (*Rerr*) and Location or sub-location (*Ardha*): if an area is wide, adjacent villages may form a zone. If the area is narrow, villages may form a sub-location or a location directly. Both zone and location are recognized as administrative unit.

Division or District (*Deth*): consists of several locations. It is not a common unit, normally used when Member of Parliament, County government, or *Abba Gadaa* (ritual leader) call for a large meeting of the whole Borana community.

Table AC1.2.1 gives an example of the social organization of Gar Qarsa sub-location of Qilta Location. There are three villages (*Olah*) in this sub-location. Each village consists of 5-6

homesteads (*Moga*). Not all homesteads have a head (*Jars Moga*). The elders meeting of the sub-location is generally held by all heads of the homesteads with other villagers.

Table AC1.2.1 Social Organization of Gar Qarsa Sub-Location

Sub-Location	**Gal Qarsa**		
Name of village（*Olah*）	Wago	Halkuno Gura	Jarso Boru
Number of homestead（*Moga*）	5	5	5~6
Number of head of homestead (*Jars moga*)	3	4	4
Participants of elders meeting	Above 11 elders plus villagers		

Source: JICA Project Team

(2) Decision-making Process

As described above, the current Borana social organization refers not only to kinship but also to residential pattern and government administration system. Generally, elders practice a central role in decision-making of the community. The *Abba Olah* and *Jars Moga,* who represent their villages and homesteads, have responsibilities to organize an elders meeting if there are any issues. The decision made in a certain meeting should be followed by all community members. However, as most of elders are illiteracy, it would be difficult for them to discuss current development issues or government policies. Thus new organizations or groups, such as youth group, women group, community-based organizations (CBO), and committees established by development projects are invited to join the discussion with elders. Once a decision is made, these organizations are expected to be the main players to implement.

On the other hand, it seems that influence from government administration on the Borana society is stronger in comparison with other communities living in the arid lowland. This is probably because most of the Borana are living close to Marsabit town.

Basically, the local chief is appointed by the national government as an administrative leader. His responsibility is to maintain security and social order in a local area. Meanwhile, in some location or sub-locations of Gadamoji Division, local chiefs performed actively in development issues, education program, and other social events. People agree that good relationship between local chief and community elders is important to maintain security and public order. But friction may occur when the judgment made by local chief and community elders is different.

Another important political leader is the new ward representative, who is elected by local community to represent the ward at County Assembly. It is said that the responsibility of a ward representative is to present the real situation of the ward and needs of their local community to the county government, as well as lead development activities in the ward. However, since this new political system just started recently under the new constitution and decentralization, the public awareness and influence of the new leader is not clear.

Although most Borana have settled in their farms, livestock herding remains as a major subsistence. They do not only keep cattle and shoats, but also raise camels as an adaptation to recurrent drought. Livestock herding is mainly practiced at the foot of Mt. Marsabit. But in the dry season, people and livestock may move frequently to a far distance. During a severe drought, livestock may move far north up to Ethiopia, or south to the Ewaso Nyiro River in Isiolo County, both are more than 200 km from Mt. Marsabit. Interviews with herders proved that they have abundant knowledge on the distribution and use of natural resources. According to them, the basic role of rangeland use is where a place has a permanent water resource (water pan, borehole, or natural spring), the surrounding rangeland should be recognized as a dry season grazing area. Herding activities are prohibited in such rangeland during the rainy season, because seasonal rivers may flow down Mt. Marsabit and create temporary water pans at the foot of the mountain.

When temporary water resources dry up in the dry season, herders start to move livestock towards permanent water resources. If the dry season extends, and pasture surrounding such permanent water resources becomes scarce, they move farther and farther. The decision of such movement is not made

by the herder. As mentioned above, most Borana live in their farms on the top or slopes of Mt. Marsabit. If they do not have enough labor to work both in the farm and with livestock, they usually hire a herder to look after their livestock. Meanwhile, families who have only a small number of livestock may join to each other, and hire one herder for all families. In both cases, when herders find the natural condition is hard for livestock, they first report it to livestock owners. The livestock owners then report the situation to the local chief and ward representative. If the chief and ward representative receive many reports from livestock owners, they will call for an elders' meeting to confirm the situation and look for solutions. After the meeting, some elders are sent to different rangelands to check the condition of pasture and water resources. When they come back, they hold a meeting again to share information with other elders and make a decision on the destination to move. Then local administrators and elders will visit the place, negotiate with local chief and community elders there, and ask for permit to move in. Finally, the decision is sent to herders so that they can start moving. Herders explained that by following this procedure, many livestock moved to Moyale area and avoided the damage of the severe drought between 2010 and 2012.

C1.2.3 Social Organization and Decision-making of the Rendille

(1) Social Organization

The Rendille inhabit the semi-desert of southern part of Marsabit County. They use the rangeland between Mt. Marsabit and Lake Turkana from east to west, and between the Charbi desert and Ewaso Njuro River from north to south.

Previous studies done in 1970s reported that the Rendille's livelihood was relied on herding camels and shoats, and mobility of settlement and livestock herding camps was very high. However, under the influences of government sedentarization policy and various development projects, most of the Rendille have settled down in areas close towns, such as Laisamis and Logologo on the main road, and Korr, Kargi, Ilaut, Ngurnit in the semi-desert area. Korr is the biggest population center of the Rendille, where about 21,000 people lived in 2009. Meanwhile, livestock herding remains the only self-sufficient subsistence in the semi-desert area. Today, the Rendille raise camels, cattle, goats and sheep in herding camps and remain high mobile.

Although the Rendille have experienced drastic socio-economic change in the past three to four decades, the descent system and age system, which is known as the principle of their social organisation remained. The Rendille descent system composed of four categories: the moiety, the clan, the sub-clan, and the lineage group. The society is divided into two moieties; the Eastern moiety consists of four clans (Saale, Urwen, Gaaldeylen, and Tupcha) and the Western moiety consists of five clans (Dubsahay, Nahagaan, Matarbah, Rengumo, and Uyam). Each clan has two to seven sub-clans, and each sub-clan has five to thirty lineage groups.

This descent system is particularly relevant to the Rendille's subsistence. Settlements are established by people from the same clan, sub-clan, or lineage groups. For instance, the Tupcha clan has two sub-clans, each of which established their own settlement with more than 100 households gathered in the Balah sub-location. Livestock herding camps are also made up of members of the same clan, sub-clan, or lineages. The Rendille set high socio-cultural and economic value on camel. Therefore, all camels from the same clan or sub-clan are gathered and large-scale herding camp is usually made.

The Rendille age system includes an age-grade, age-set, and generation-set for men, and an age-grade for women. Men's age-grades are boyhood, warriorhood, and elderhood, and women's age-grades are girlhood and womanhood. A collective circumcision ceremony is held in every 14 years. Boys are initiated into a new age-set and become warrior after the ceremony. The previous warriors get married and become elders at the same time. Girls are initiated into womanhood through marriage. Generally, small boys and girls stay in the settlement with their parents, and begin herding shoats near the settlements at the age of seven. Boys older than 10 are sent to camel or cattle herding camps and girls are sent to shoats herding camps. Young men at the warriorhood are in charge of camel or cattle herding camps. Most of married men and women live in settlements, where married men (elders) are in charge of local politics and rituals, and women are engaged primarily in housework.

(2) Decision-making Process

Korr town is surrounded by 39 settlements. Most of which are based on clanship. People who set their permanent houses in the town are government officials, teachers, missionaries, shopkeepers, staffs of development projects, and migrant workers in Nairobi. People who lost livestock and seek relief or occasional jobs may also come to the town and build small huts there. The Location is divided into two sub-locations, the Korr and the Balah. There is a senior chief for the location and two assistant chiefs for each sub-location. Korr and Ngurnit are recognized as one ward, and one ward representative is elected. However, in comparison with the Borana society on the highland of Marsabit government, administration and political influences are relatively low.

As mentioned above, both the descent system and age system establish social relations and structure daily life and livestock management in the Rendille society. Elders' meeting is the general way to solve problems both within and among settlements. Each settlement has a ritual place constructed at the center called "*nabo*." Elders gather at the *nabo* and pray for people and livestock every evening. Before and after praying, they discuss all kinds of issues, rain and drought, politics, relief food, security, etc. Normally people who come from privileged families and belong to high grade of elderhood are respected. Their opinions are highly regarded during the decision-making process. But there is no absolute authority over all elders. When meetings are held to discuss issues related to all settlements or location in Korr town, two or three elders are selected as representatives from each settlement. These elders cannot make a decision by themselves. Their mission is to collect all information and explain the issue in detail at the *nabo* to other elders when they come back from the meeting. The final decision should always through a discussion among elders at the *nabo*.

Different from the Borana society whose community elders and local administrators are involved in decision-making on livestock management, especially the migration of herding camps, the Rendille leave most of responsibility to herders. Camel and cattle camps are usually big which all animals from a same settlement or clan are gathered. Young men of warriorhood are in charge of such camps. Each camp has a common place called "*kulal*," where all warriors share food in the morning and evening, and pray together in the evening. Every night, warriors gather at the *kulal*, discuss the issues of pasture and water, condition of animals, security problems, and the timing for moving to next rangeland or waterpoint. Herding camps of shoats are made by families based on kinship or clanship. Each family can make a decision by itself. There is no distinct rangeland for dry season and rainy season as rainfall in the semi-desert area is extremely unpredictable. The balance between access to pasture and water point is the main factor that influences mobility of herding camps. Other factors are security, access to livestock market, and ritual event.

C1.2.4 Difficulty and Challenge in Application of CMDRR Approach

The CMDRR (Community Managed Disaster Risk Reduction) approach was introduced to East Africa by ECHO in the past ten years. It seems to be a progress of several previous development methodologies. The term of "community managed" can be traced to the paradigm shift in development policy in 1970s and 80s, which "top-down" approach was strongly criticized and community empowerment and participation, commonly known as the "bottom-up" approach was recommended. "Disaster risk reduction" can also be found in previous projects, such as the Early Warning System in disaster prediction and prevention, and risk management. The advantage in CMDRR approach is that the "community" is expected to identify disaster risks both to their livelihood and future generations by themselves, and to take the initiative in managing the Project sustainable at the local level.

However, the CMDRR approach is more comprehensive or complicated at a practical level than its simple definition. In the context of pastoral societies of northern Kenya where both traditional social organization and government administration exist, "community" is translated into different local terms to illustrate different social units. For example, when community is used by an elder from a local village, it may illustrate that village. When the representative of a clan or a zone use the term of community, he/she is giving the opinion of the clan or the zone. When a location chief uses it, it may represent the location. Therefore, if a project wants to apply community-based management, it should

have a clear understanding on different social units which people belonged to in a local society, and the decision-making process between traditional authorities and government administration system.

Several DRR committees were launched in different locations by this project based on the CMDRR approach. These committees were expected to take leadership not only in disaster response but also in community resilience improvement. DRR committee should practice as an "umbrella" of all other specific committees of development projects. However, by investigating the organization, responsibility, and function of some DRR committees, it seemed that none of committees were functional as expected. Several reasons can be indicated.

Firstly, most DRR committees were set up by local NGOs. These organizations are considered to have deep understandings and connection with local communities. Unfortunately, most of their work was a mere formality. The household survey and socio-economic baseline survey they carried out did not reveal the actual circumstances of target communities. The training workshop held by them to identify vulnerability and disaster risks of a local community was limited to general issues. This led to the result that the five-year action plan made by DRR committee and the NGO was not closely relevant to reducing local disaster risks and enhancing resilience. Furthermore after the DRR committee was established, the NGO left without any follow-up or future support.

Secondly, DRR committee officials are usually educated people who live in the town. Although some of them have working experiences for other projects, most of them are not recognized as representatives by the local community. Some community elders are involved in the committee, but they are not actually aware of the responsibility and activities as a committee member. On the other hand, the relation between the DRR committee and government administration at the local level is not clear. Thus whether a DRR committee has the authority to take a leadership or not is unknown.

Thirdly, the DRR committee is expected to be independent and take the initiative to manage the Project sustainable. However, no committee has a sustainable management fund. The committee is recognized as the "eye" of the local community, and their task is to seek funds and supports from outside. When a five-year DRR action plan is made, the DRR committee is asked to take the responsibility to look for donors or NGOs to implement the plan. However, if there is no human and financial support from either government or development agencies, the committee cannot function. On the other hand, to keep the motivation of active members is also difficult as they all work on a voluntary basis.

C1.2.5 Difficulty and Challenge in Enhancing Drought Resilience

In order to enhance drought resilience, the Project has set up three basic programs: natural resource management, livestock value chain, and livelihood diversification. Each program is practiced at several pilot project sites.

The scarcity of permanent water resources and difficulties in access to water are recognized as major vulnerabilities in pastoral societies of the arid and semi-arid area. To improve this situation, pilot projects such as building new water pans and rock catchment, and installing solar pump system at strategic boreholes have been implemented. Except the rock catchment which has some technical problems, most of these projects are highly evaluated by local communities. However, responses to the management schemes introduced by the Project differ from each other.

In Shurr, where one of the old diesel water pump has been replaced by the solar pump system, water management committee worked together with local community. The money they collected from water users was used to build a classroom of a primary school. Meanwhile, when the same solar pump system installed in a borehole in Korr, friction occurred between water management committee and local community.

One of the main reasons for the friction was the new concept of "communal money." The borehole in Korr used to run by a diesel pump. Money collected from water users was mainly spent on diesel. After the solar pump system was installed by the pilot project, a new management scheme was also introduced. Both registration fee and water fee were collected by borehole management committee and saved in the bank. The committee officials said that the money was for the community and would be

used for repairing the solar system and related facilities. But local people said that they were not aware of the money and were not involved in the decision-making process to use the money. Although the reality is that the committee officials make a decision by themselves, both the committee and local people are faced by the same question of who have the right to benefit from this money and who should be involved in the decision-making process to use the money. Similar cases were also found in other pilot projects. And hence, this kind of "communal money" is considered to be a latent challenge in local societies.

The main objective of livestock value chain program is to encourage pastoralists access livestock market. This was achieved by the construction of Dirib Livestock Market and Heifer Exchange Programs. According to interview survey results, both are highly evaluated by local community. It is said that the livestock market not only improved pastoralists' access to market, but also provided opportunities for local women to engage in small business, such as selling tea and food staffs at the market. The heifer exchange program also helped pastoralists to restock their animals as well as engage in livestock business.

However, whether such achievement would help to enhance drought resilience is still unknown. There is a misinterpretation on the culture of pastoralists which believes that instead of selling animals to the market, herders prefer to keep large number of livestock in order to demonstrate their social status. It is true that pastoralists set high cultural and social values on livestock. But as subsistence herders whose livelihood is relied on livestock, it is not easy to decide whether to sell an animal or to keep it for reproduction or yielding livestock products.

For example, since milk production is high in the rainy season, pastoralists prefer to consume and sell livestock products instead of sell the animals. At the beginning of the dry season, some rangelands and water points remain in good condition so that herders just move animals to those places. The necessity of selling animals to buy food is low. However, from the mid to the end of the dry season, when milk production is low and people suffer food shortages, they want to sell their animals. The health condition of animals is however not good and the market price is low. It is very difficult for herders to make a decision on whether they should sell animals at a low price or keep their hope alive for the coming rainy season. If they keep the animals but the rain fails and drought starts, they may face the risk of losing their animals in drought. Meanwhile, if they sold animals by the end of the dry season and the rain comes, the money is not enough for them to restock their herds because the prices go high in the rainy season. Both herders whose livestock were damaged by drought and those who sold animals by the end of the dry season have to seek alternative livelihood.

Another negative opinion on livestock market is that elders may waste money on luxury goods, such as beer and *miraa* after they sold animals at the market. Because saving money to prepare for the unpredictable drought is not common in pastoral societies.

The Heifer Exchange program is a core program of the livestock value chain program. The program is quite challenging because it provides a large amount of money for traders to bring heifer to the market. It has two aims: one is to activate the livestock market; another is to help people restock. The first one has been achieved. But it is said that only rich people, working class in Marsabit town, and skilled livestock traders benefit from the program, because the price to sell local animals is low, and the price to buy heifer is relatively high, so that only those who have amounts of money can buy. There is also a concern about the ability to manage the fund independently by DRR committee when the project leaves.

Livelihood diversification has been introduced by previous risk management projects in northern Kenya. It is believed that the more options people have, they are more resilience to disaster. Pilot projects such as Goat Merry-go –round program, Poultry program, and Salt production program have been implemented to diversify livelihood of local communities. Most of these programs target women groups. Interviews with chairladies and members of these groups show that they do understand the objective and method of the program, and would like to manage the program by themselves. They also run cash merry-go-round and VICOB by themselves.

One challenge in the Goat Merry-go-round program is the high rate of miscarriage and death of Galla goat at the Project site. Members of women group complained about the climate of the Project site as a major factor which causes the problem. But some other factors also should be taken into consideration. For example, in the Gar Qarsa sub-location where nine women groups run the Goat merry-go-round, not only the climate but also social factors are considered to affect the program. Growing *miraa* and crops is the basic subsistence in Gar Qarsa and it is mainly carried out by women. Livestock are generally owned by men and kept in the lowland by employed herders. Under such circumstance, women who received Galla goats cannot check the real condition of the goat and take care of it by themselves. Thereby it is difficult to clarify whether the miscarriage of goat was caused by cold or unskilled herding practices. In contrast, the Salt Program in Kalacha seems to be more successful, as women engage in both salt collecting and marketing. Therefore, choosing appropriate target groups is important to run such livelihood diversification program efficiently.

C1.3 Suggestion and Recommendation

Base on the understanding of social organization of targeted communities, and the difficulties and challenges faced by the pilot projects described above, suggestions are given in the following sections.

C1.3.1 Establishing Effective Committees

In comparison with the insubstantial DRR committees, specific committees established for water resource management or livestock market seem to function effectively. The Water Users Association (known as water committee) in Dirib Gombo Location was established to manage the Dololo Dokatu Water Pan built by this project. The committee works together with the traditional water manager *Aba herega*. Daily arrangement and general management of the water pan are left to *Aba herega*, whereas the committee concentrates in public relations and water pan maintenance, such as desilting. In early July 2014, after all livestock left the water pan for dry season grazing area, the committee organized an event and asked all members to participate in desilting the water pan. Elders of the committee said such activities would raise public awareness of the committee so that they can receive more support from the community in the future. Other specific committees, such as water management committee in Shurr and livestock market management committee of the new established Dirib Livestock Market also function well. Money collected from water users in Shurr was used to build a classroom in a primary school. And committee officials work at the market to collect tax from traders, clean the market, and help women of local villages to sell tea and food items in every market day.

The differences between specific committees and the DRR committee is that these committees work on a pilot project based which has a clear objective and the output strongly meet the needs of local community. Interviews with local people showed that they are glad to be involved in and provide their support to such pilot project. According to the CMDRR approach, it is important for the community itself to become involved in the Project. And community support is obviously important for committee members to keep high motivation and continue their activities. In contrast, DRR committee is recognized as “the eye of community,” which works on looking for funds and supports from outside. Since “community” is a general term which does not represent any specific social units, the objectives and achievements of DRR committee strongly depend on the donors. Therefore, specific committees with clear objectives seem to be more effective in connecting with local people than the comprehensive DRR committee.

However, not all specific committees work well in this project. In Korr, the borehole management committee raised friction with local community. Elders from local community criticized the borehole committee for distributing water unfairly and managing the money collected from water users unclearly, whereas officials of the borehole management committee argued that the local community did not support their works and share responsibilities on water management. When such friction occurred, both water and the money collected from water users could not be used efficiently. Examining the friction in the context of Rendille culture and social organization reveals that both the lack of social recognition and trust of the committee and unclear management of the “communal money” are major reasons of friction.

A challenge in establishing an effective DRR committee was found in Dirib Gombo Location. The DRR workshop held in June 2014 gathered all stakeholders from the location. The chief and assistant chief of the location and sub-location, representatives of each zones, DRR committee members, representative of Youth Group and Women Group, members of Market Management Committee, representative of Environment Management Committee, member of Community Development Committee, representative of Water User's Association, livestock traders, and NGO staffs all attended the workshop. The main objective of this workshop was to declare the responsibility of the DRR committee and find out sustainable way in managing it. It is said that a new DRR committee will be set up through an election by all stakeholders. If they succeed, it would be a new model of DRR committee which truly represents the whole location. More study should be focused on this movement.

C1.3.2 Understanding Drought and Improving Drought Preparedness, Response, and Recovery

Although drought is a natural event in arid and semi-arid areas of East Africa, under the influence of global warming and climate change, the increasing frequency of drought is causing more damages to local communities. To have a comprehensive understanding on drought, local response, and activities implemented by this project, and find out alternative ways to improve the Project, we use the classic method of disaster risk reduction, which is known as disaster preparedness, response and recovery, to review pastoralists' response to drought as well as the implementations of this projects in the specific context of northern Kenya.

In northern Kenya, a year is generally divided into four seasons; long rainy season from March to May, followed by long dry season from June to November, then short rainy season between mid of November and early January, and short dry season from January to March. In a normal year, the long dry season which last for about six months is regarded as the most difficult period, especially for farmers who depend on rainfed agriculture. But pastoralists do not recognize a normal dry season as a drought.

Drought is identified by the fail of rainfall in a rainy season. For example, the long dry season last for six months, if rain fails in the following short rainy season, and falls in the following long rainy season, the dry period may extend to eleven months. This is recognized as a single-year drought. If rain continues to fail in the long rainy season and falls in the next short rainy season, the period of dry season extends to 18 months. If the short rainy season fails again, then the dry period will be 21 months. Dry period lasting for more than two rainy seasons is recognized as a multi-years drought, and the situation becomes severe. Since rainfall is unpredictable, pastoralists cannot forecast whether a drought may last for a single year or multi-years. Both the lack of rainfall forecasting information and uncertainty of drought make disaster preparedness difficult in northern Kenya. Therefore, the possibility of distributing accurate rainfall forecast information should be taken into consideration.

In recent years, drought early warning system (EWS) has been highlighted as an effective tool for drought preparedness. EWS has taken advantages from the development of GIS and remote-sensing technologies and information technology in the past two decades. It has been applied both in policy-making and in management in response of severe droughts in the United States and Australia. During the 2010-12 East Africa Drought, the Famine Early Warning Systems Network was the first organization to anticipate the crisis.

In northern Kenya, NDMA is regarded as the leading organization in charge of EWS. The Field monitoring conducted by their staffs cover the whole Marsabit County. Information and data analysis are published on a monthly-based NDMA Drought Monitoring Bulletin. However, since their major responsibility is to provide information of current situation to county government and development agencies, rainfall and drought forecasting information is rare.

Discussions with local herders show that they desire to receive rainfall and drought forecasting information if it comes from a reliable source. For example, rainfall forecast for the next one-month, three months, and six months may help them make an appropriate decision on migration as well as access to livestock market. If information is accurate and provided continuously, it will help people think of alternative ways to improve drought preparedness. With the widespread of cell phones in the

rural area of northern Kenya, information on rainfall and drought forecast can easily be distributed and spread among herders.

One of the major objectives of the livestock value chain program implemented by the Project is to encourage herders to sell animals and save money before drought, and buy animals later after drought. This is considered to be effective in improving drought preparedness and recovery. However, whether people would like to sell or buy animals is not only affected by drought but also by the dynamics of market price. For example, after suffering the whole dry season, livestock become weak and the market price is low. It is controversial decision whether herders should sell animals at a low price to avoid potential damage from drought, or they should wait for the unpredictable rain in the coming rainy season. Furthermore, when rain comes at the beginning of the rainy season, people who lost livestock in the dry season want to buy animals for recovery. But few people want to sell animals in the rainy season. When more people want to buy but few want to sell, the price of livestock rise no matter the health condition is good or not. To achieve success in this program, long-term and detailed investigation on the factors which influence livestock price and pastoralists' decision-making at the market, should be conducted.

Maintaining high mobility of both human and livestock is considered as a fundamental response to drought practiced by pastoralists. In most rangeland of northern Kenya, pasture can remain for about one month after the rainy season. Then herders start to move their livestock to where they can find better pasture and water. Normally they do not move very far from the settlement during the first dry season, because they expect to be fortunate to receive some rain in the following rainy season. If the rain fails, they start to move again. The longer a drought lasts, the frequency of migration and the distance between settlement and herding camps increase.

Different livestock species have different physiological characteristics and rely on different condition of natural resources. Camels can adapt to a dry environment without water for two weeks, whereas cattle must be given water for every two to three days. Shoats need water for every three to four days. Therefore, camels can be herded far from a water point, whereas cattle and shoats are usually kept less than 20 km from a water point.

When a skilled herder makes a decision to move, the timing, condition of new rangeland and water point, health condition and physiological characteristics of different livestock species, and the security issues are all taken into consideration. Herders believe that whether their livestock can survive from a drought both depend on how long the drought extend, and determined by the timing and destination of migration.

Such drought response has been improved by this project, especially by the natural resource management program. The new water pans constructed at Dololo Dokatu and Yaa Gala made it possible for pastoralists to extend their stay in the rainy season grazing area for about two months. This proved that developing water resources at appropriate places would both increase herder's migration destinations and improve efficient use of pasture. The solar pump system also provides new possibilities for efficient rangeland use. According to government officials, in order to spatially disperse livestock and reduce pressure on pasture, new strategic boreholes have been drilled by Marsabit County Government in some remote rangeland. Most of them use diesel pumps which depend on the access and supply of fuel. Since the county has a great potential of solar energy, if more solar pump system can be installed in such strategic boreholes, it would both save energy and sustain use of natural resources.

Implementations related to improvement of drought recovery are found in two challenging programs: the Heifer Exchange program and Goat Merry-go-round program. Heifer program has achieved some success in activating livestock market. And a new installment payment system is expected to operate so that more people can buy heifer for restocking. Women groups who run the goat merry-go-round suggest that it would be more success if the Galla goat introduced by the Project can be replaced with local goat. Another recommendable option is to introduce a dairy cow and implement milk merry-go-round within the group. Because a cow can be easily raised at the failed farmland by women, and milk always has a high demand at the market in Marsabit town.

Finally, since this project focuses not only on technology improvement but also on social development on local communities of northern Kenya, it should not be limited within five years. It takes time for local people to understand, apply, and adopt new technology and management schemes provided by the project. At the same time, the project also should have time to review and modify their designs and plans in order to meet local circumstances and needs. Furthermore, continuous discussion and cooperation among project implementers, researchers, and local people should be conducted to make the project sustainable.

CHAPTER C2. STUDY IN TURKANA

C2.1 General

C2.1.1 Objectives of the Research

An anthropological research has been conducted at pilot project sites in Turkana County by an anthropologist from Japan dispatched by the Project Team. The major objectives of the research are:

- To have a better understanding on social organization, administration, and decision-making process of the Project targeted communities,
- To investigate the organization, responsibility, and implementation of Development Committees (DC) and other related committees established by the Project, and the difficulties and challenges faced by them, and
- To examine use, management, and effect of new water resources (hand pump boreholes and water pans) constructed by the Project.

In this chapter, we first describe the social organization, political institution, and decision-making of the Turkana in general, and then examine the activities of DCs and effects of hand pump boreholes in detail. Recommendations are given in the final section.

C2.1.2 Methodology and Research Sites

The basic method used in this research was formal and informal interviews with local leaders, DC officials and members, and local community members of the pilot project sites. Ten DCs (out of 11), 16 boreholes (out of 20), and 2 water pans have been investigated during the research period.

C2.2 Observations

C2.2.1 Social Organization, Administration, and Decision-Making of the Turkana

The basic social unit of the Turkana is a homestead (awi), which consists of one to five households. A household is formed by a married man (elder), his wife (or wives), and children, and has a daytime hut, a sleeping hut, and a cooking place. Relations among households within a same homestead are normally brothers and in-laws. But such composition is not fixed, as other households may come and join the homestead, or households may leave when the homestead move. Each household has its own livestock herds and separate enclosures within the homestead. The distances among homesteads are different from place to place, and change seasonally. Normally near the local towns, homesteads are close to each other. In places near the border between Kenya and Uganda, between Kenya and South Sudan, and between the Turkana and their neighboring ethnic group in the south, homesteads gather in local towns, and high fences are built surrounding them. In contrast, homesteads are scattered throughout the rangeland, especially along seasonal rivers. On the other hand, homesteads may congregate into a certain area during the rainy season and break up in the dry season.

The Turkana keep livestock in different ways due to different species, access to pasture and water, seasonal changes and security. Cattle are mainly herded in the southern and the western mountain areas, where Acacia woodland and thickets cover the area. Camels, shoats, and donkeys are found throughout the County, from the western mountains to the central semi-desert, and to the west shore of Lake Turkana. Homesteads are scattered over pastureland so that livestock can be herded around. If pasture is not enough for a day herding, either the homestead will move to another place, or some members will leave the homestead and make temporary satellite camps (abor). Such decision is made by elders of the homestead. Livestock raiding is considered as the biggest threat in the northern, western, and southern parts of the Turkana County. In such places, big kraals are formed for living and livestock herding. Such kraal is called arumrum in the south, and arigan in the west and north. It may consist of 50 households and thousands of livestock, which is about ten times larger than a normal homestead. Each arumrum or arigan is named by an elder who is in charge of it. It is said that such

elder performs as an army commander, who can direct the whole kraal to move or stay, and mobilize young men to protect both human and livestock of the kraal. Since it is not safe for a homestead to move alone in such area, people living in local towns or permanent villages near the towns also have their livestock be kept at arumrum or arigan by their relatives.

In Turkana County, there are many local towns along the main road. Permanent houses are built close to each other in and near such towns. People living there run small business, such as selling food staffs and charcoals, work for government of development agencies, and rely on relief food distribution. Both the Central and County government administrative systems are based in these towns and spread to rural areas. It seems to have functioned effectively at the Location and Sub-location levels. Each location has a senior chief, and several assistant chiefs in charge of each Sub-Location. A sub-location consists of a town center and several villages. "Village" is used as an administrative term in Turkana County, which is referred to a geographic area. All homesteads located within the area are recognized to belong to that village, but there is no restriction on the movement of homesteads. Each village has a counselor elder and representatives of men, women, and youth groups, who are elected by local community members, and officially appointed by the location chief. A village normally has a public place (ekuko) where elders come to meet in daytime. According to a location chief, if a chief wants to hold a public meeting, he/she first sends the message to village representatives, and then village representatives will pass the information to all village members. Holding a public meeting near the town center is easy, but it is difficult to mobilize people from the whole location or sub-location, as homesteads are scattered throughout the pastureland and far from each other. Instead, a chief or assistant chief may visit a village and hold a meeting at the public place there. Since most villagers are pastoralists and do not follow formal administration hierarchy, government officials provide information and guide them to make a decision. Meanwhile, a decision is made by the counselor elder in association with other elders at a village level, and finally determined by the elder at a homestead level.

C2.2.2 Investigation of Activities of Development Committees

In order to enhance drought resilience and promote development activities among local communities in Turkana County, 11 Development Committees (DC) have been established by the ECoRAD Project. During the research, 10 DCs have been visited. Investigations into (1) forming process of the committee and social relations among its members, (2) effects of training provided by the Project, (3) current activities and problems of the committee, have been conducted through interviews with chiefs and assistant chiefs of targeted locations, officials and members of DCs, and community members. Following is the summary of the findings.

(1) Forming process of the committee and social relations among its members

Basically, all Development Committees (DC) were formed through the same procedure. The task of establishing a DC at the Project-targeted location was given to a local NGO. At the beginning, the local NGO made contact with the location chief and asked for administrative support. Then the chief called for a public meeting. At the public meeting, NGO and Project staffs explained the aims and plans of the Project, and asked community members to choose their representatives for CMDRR training. After the training, representatives from both town centers and villages were chosen to form the DC of that location or sub-location. From this process, it is obvious that first support by the location or sub-location chief is important. Both the Project staffs and local NGOs cannot make direct contact with local community without informing the chief. Furthermore, since public awareness and advocates of the Project are strongly relied on the participants of the first public meeting, it is important to have the chief mobilize community members from the whole location.

The organization of a DC is similar to other existing committees founded by other projects or donors. It has a chairperson and a vice chairperson, a secretary, a treasurer, and between six and ten committee members. Chief is regarded as an observer of the committee. It seems that most of DC officials have been chosen from the renowned or active individuals in the location, such as the candidate of Members of County Assembly (MCAs), pastors, former counselors of the location, teachers of primary schools, former officials of other committees, and shop owners in town. Most of them living

in town centers and know each other very well. Such member composition has both positive and negative influences. The positive aspects are the local people's trust in them and their understanding on development activities. And the negative aspect may come from their working experiences with other development agencies or donors that have had different policies and approaches. Except these officials, each committee has six to ten village representatives. This is to ensure the equity of the Project, and to demonstrate that development activities are to benefit the whole community. Such DC members from villages are expected to report the needs of local people and extend project activities to rural areas. Some of them are shopkeepers or livestock traders, others are pastoralists. Interviews with them show that they have strong interests in the Project, but they also face difficulties with financial support and lack of local understanding. This will be discussed later.

(2) Effects of training provided by the Project

After the first public meeting held at targeted locations, participants were chosen to attend a training workshop provided by the Project. Chiefs and DC members who had attended the training listed following contents: (1) drought early warning system and alarm signs taught by the NDMA; (2) rangeland management skills, such as to preserve pasture near water resources, and keep a certain area in rainy season for dry season use; (3) drought preparedness, such as selling animals early when its physical condition is good, using vaccines and drugs to protect livestock from diseases, and planting and storing grasses near their settlements; and (4) status and function of the development committee established by this Project.

According to location chiefs and DC members, they started looking for opportunities to teach local people what they had learnt as soon as they came back from the training. Some DC members asked the chief to arrange meetings with local people, and others took the advantage of relief food distribution to talk with people. One DC said that they had made a timetable for committee members to visit all villages of the location. Therefore such training and teaching activities have been recognized as major practices of the DC at the beginning of the Project.

When asking whether the contents provided at the training workshop are useful or not in term of drought preparedness, most DCs gave affirmative replies. They mentioned that it is necessary to remind pastoralists about the risk of drought and think about preparation even in good season. Members highlighted such ideas as preserving dry season pastureland in rainy season and promoting livestock early off-take. They said that old generation of the Turkana used to preserve pastureland for next dry season, but young people did not practice that when their homesteads moved toward town centers. Meanwhile, old people preferred to keep livestock instead of selling them. After DC members spread such knowledge to the community, local people started to think about how to use the rangeland efficiently and how to prepare for a drought. Meetings have been held by elders to discuss where they should preserve for the next dry season. People who did not sell animals unless they need money are now thinking about selling animals early and keeping the money in the bank.

The idea of planting grasses near the settlements had also been practiced by some DCs with local community members, although it only succeeded in areas where had enough rain. Both DC members and local people paid attention to the drought early warning system taught by the NDMA. Unfortunately, such knowledge had not been applied because people were still waiting for the NDMA to provide updated information as well as the flags using for drought alarm signs.

Through the training, most of committee members understood the principle that DC should serve as an umbrella committee for all other existing committees. They also highlighted that cooperation with location chiefs and administrative system is important for them to take a leadership. DC of Lorengikpi gave a good example on this. Recently, after the Project constructed a water pan in this location, the DC has helped the location chief to mobilize local people to build a fence surrounding the pan. On the other hand, some DCs recommended follow-up trainings and exchange programs with other committees and development projects. Such activities may help them to share information and learn new ideas and methods from each other.

(3) Current activities and challenges of the development committee

In comparison with the positive attitudes to the training, DC members' responses to current activities turned to be passive. Although some DCs mentioned that they would like to teach people and monitor activities of other existing committees, most of them answered that they had no particular activity recently. Only one DC continues to work on drought preparedness with local community. Reasons given by location chiefs, DC members and local people illustrate the problems faced by the DC and the Project.

Lack of funds or incentives from the Project has been raised as a challenge both by committees and by local communities. Most DCs said that they had made plans to hold monthly meeting and teach all villages of the location after the training. However, without financial support, members had to pay all costs by themselves. No one offers transportation, food and drinks to them when they teach at the village. Some DC officials complained that their members might lose motivation to work if such situation continued. Furthermore, if nothing were given to local people, they would lose interests in the Project and no longer come to the meeting.

It should be indicated here that such circumstance came from the influences of long-term and large-scale humanitarian aid and development works implemented in Turkana County. Both distributing food staffs and giving incentives have been used to attract attention from local community in the past three to four decades. However, through deep discussion with both DC officials and local people, we found that people did not seriously care about such incentives. Most of them appreciated the Project's efforts of constructing water resources and spreading knowledge for drought preparedness. Although they used to ask for incentives, they were more interested in practical activities. During the discussion, DC members showed strongly concern about whether the activities in the action plan would be implemented. Some also recommended that DC should have their own business to become self-reliant. They pointed out that lack of support on practical activities should be considered as the real challenge faced by DCs.

The DC of Kerio Sub-location has provided a good example. It is the only DC answered that they were continuing to provide drought information to local people and encourage them to sell livestock before drought happens. There is a big livestock market in Kerio town, which is supported by the Project. Most of DC officials also serve as officials of the Livestock Market Association (LMA). They said that such facility as livestock market had helped them to demonstrate the achievement of the Project, and provided more opportunities to meet local people. Moreover, they had taken this advantage to advise pastoralists to sell their livestock when the price is high, provide drugs for disease control, and encourage women to run small business at the market. In comparison with such achievements, DCs in other locations were still struggling to take action.

C2.2.3 Investigation of Management and Effects of New Water Resources

Water is essential in the arid and semi-arid environment of Africa. Successful use and management of water resources not only improve living conditions of local community, but also reduce risks from both natural hazards and human conflicts. The Project has constructed 20 hand pump boreholes and 6 water pans in Turkana County. Among them, 16 boreholes and 2 water pans have been investigated during the research period.

In order to use borehole sustainability, the Project has introduced a maintenance insurance scheme operated by an NGO in Turkana County. The scheme is very simple. Local community who use the borehole is asked to pay Ksh.7,000 for a two-year registration at the NGO. Then the NGO's technical staff will look after the borehole. Both the expenses of spare parts and technical services will be covered by the NGO during the registration period. Then after two years, community will be asked to register again. Among 16 boreholes which have been visited, 12 have registered, one was in the process of collecting money, one did not have a hand pump structure to be maintained due to an artesian well, and two were temporarily locked for security reason. Investigation into money collecting process for registration and management activities has shown important factors of local resource management. Following are some case studies.

(1) Case study 1: Ngasoge borehole

Ngasoge borehole is located in about 15 km southeast to Oropoi town. The place is covered by dense acacia woodland and thickets, which is highly evaluated for livestock herding. However, since this place is close to the border of Kenya and Uganda, raiding among pastoralists in both countries has caused conflicts and insecurity. All homesteads are gathered in Oropoi town and double enclosures are built to defend themselves, and all livestock are kept in five big kraals (arigan) in pastureland. Each kraal has a commander and some armed warriors to defend themselves.

In this area lack of water resource was the biggest problem for both human use and livestock. The only permanent water resource was a generator-pumped borehole built in Oropoi town. During the dry season, livestock had to wait for the whole night to be watered. When a severe drought occurred in 2004, Turkana herders had to cross the border and looked for water in Uganda. However, pastoralists in Uganda were also facing water shortage so that they refused to give water to the Turkana. This caused an outbreak of fight between pastoralists. Many herders were shot and cattle scattered in the rangeland like wild animals. Most people of Oropoi remember this tragedy, then they declared that nobody should make a joke on water in the town because water issue was really sensitive and serious. If someone did, he might be beaten.

Due to such circumstance, people of Oropoi greatly appreciated the Ngasoge borehole build by the Project. They said that herders were no longer taking risks to cross the border for water in dry season. When the borehole was completed, they immediately contributed the money for registration. The water users' committee that manages the generator-pumped borehole in town is now giving the authority to manage the new borehole. People living in town said that it was their responsibility to manage the new borehole because their livestock was watering there. After registration, the borehole was used free of charge to avoid conflicts. When the two-year period of the registration passes, people will start another contribution for the registration. The committee said that it was their routine to do registration because both people and livestock would suffer from water shortage if the borehole was broken.

This case shows that a strategic borehole not only supplies water to human and livestock, but also functions in peace building in the area where water shortage may cause conflict. On the other hand, people who have experienced serious problems with water seem to know how to manage water resources successfully.

(2) Case study 2: Nakoros borehole

Nakoros borehole is located 10 km southwest to Kakuma town. About 40 homesteads scatter along a dry rive near the borehole. Most of people moved from rangeland in southwest to rely on relief food after a severe drought damaged their livestock in 2000. Currently, their livelihood depends on selling firewood and charcoals to the Refugee Camps next to Kakuma town. Some families receive small fund from the Hunger Safety-Net. People use rainwater or water from the river in rainy season. After the rainy season, they dig shallow wells on the riverbed. When water in this river completely disappeared, women fetch water in Kakuma town after selling firewood or charcoals there. There is no close relationship among homesteads. Administration system is under the assistant chief, who appointed a counselor elder and three village representatives to help him.

The borehole was completed in September 2014, but it was locked until the end of December 2014 due to the delay of registration at the NGO's maintenance scheme. After the borehole was built, a water management committee was established and three officials were chosen to attend the training held by the Project. After the training, these officials came back with the assistant chief and held a public meeting. They informed the community about the maintenance insurance scheme and started to collect money for registration. About Ksh.1,500 was collected after the meeting, which is far from the Ksh.7,000 registration fee. Another meeting was held by committee officials, Project staffs, and the chief of the location by the end of December. At this meeting, community members explained that people of refugee camp who used to buy firewood and charcoals from them changed to exchange firewood with food staffs, and they have no alternatives to gain cash. Other solutions have also been discussed at the meeting. One committee official suggested opening the borehole so that they could

collect money when people came for water. Others refused such suggestion and argued it might cause conflicts within the community. One elder said that the only solution was to lock the borehole until people got money to contribute. He gave another example of money contributed to build a classroom of the local primary school last year. The amount was collected within 3 days because people had income at that time. The meeting could not reach a solution, but the problem was finally solved by a different way when a politician decided to do them a favor.

This case illustrated two factors of the borehole management; one is the economic situation or income generation of local people that related to money contribution, another is the social organization of the community that related to the function and decision making of the management committee.

From the above case studies, three important factors that affect water resource management can be highlighted here.

i) Water scarcity or people's demand for water

ii) Social organization of water users

iii) Economic situation or income generation

Since such factors are also found in the management of other boreholes, all 13 investigated boreholes (12 registered, 1 in the process) are categorized as follows.

(1) Boreholes constructed at a place where local people's demand for water is high, the social organization of the community is strong, and economic situation is relatively good (either have livestock or cash income) include Ngasoge (Oropoi community), Nakalimon (Loreng), Kokorio (Loritit) and Losagam (Kerio). Both officials of water management committee and local community emphasized that they greatly appreciated the borehole because water used to be the biggest problem for them. Hence they would like to take the initiative to contribute money for the registration. Since money was collected from the majority of community members, each paid a small amount. Regular water fee, such as monthly fee, was not charged because people supposed it may cause conflicts among the community members.

(2) Boreholes constructed at a place where people's demand for water is high and the social organization of the community is strong, but economic situation is weak include Lotilo (Urum) and Lokwakel (Milimatatu). Both are marked as the first borehole in the area. People used to walk very far to fetch water before the boreholes were built. Each borehole was used by 3-4 villages with 20 to 40 homesteads. Most of them were pastoralists who did not have cash income. They asked for financial support from outside to pay registration. One was supported by a construction company, and another was funded by a politician. Currently, management committees of both boreholes are charging water users Ksh 50 per month to prepare money for the next registration two years later.

(3) Boreholes constructed at a place where people's demand for water is high and economic situation is relatively good, but the social organization of the community is weak include Lochor Edome (Lokichar), Kakali (Lokichar), and Nakejuamosing (Lochwaagikamatak). Registration fee was contributed by a few of rich members of the community, who became the core members of the management committees. Water fee is collected monthly, and the committee decides how to use the money.

(4) Boreholes constructed at a place where the social organization of the community is strong, economic situation is relatively good, and people also have alternative water resources include Kaidir (Namourupus) and Lolupe (Lochwaagikamatak). Both were not far from town centers. People are used to pay for water when they fetch water in town. After the borehole was built, they borrowed the management system of the water resources from the town.

(5) Boreholes constructed at a place where local people's demand for water is relatively low, social organization of the community is not strong, and economic situation is weak include Nakoros (Kakukma) and Kakuromosing (Lokiriama). Both faced difficulties to collect money for registration. The community is not organized because homesteads scatter in a vast area. People are using different water resources, such as rainwater and shallow wells. Lack of income generation has made them

difficult to contribute money for registration. Moreover, there is no effective money collecting system function in the place.

C2.3 Recommendation

Based on above investigation, the following 4 points are recommendations.

(1) Improving communication and mutual understanding among the Project administration, the Development Committees, and local communities is essential. As mentioned above, Turkana County had experienced many aid and development projects in the past three to four decades. Although the purposes and approaches of these projects were varied, most of them had established their committees and provided subsidies and incentives to local people. In comparison with such projects, the ECoRAD Project was new and the approach was so different from the others. This Project basically did not provide financial support, e.g. per diem or refreshments, to committee and local community when they had meetings in villages. Instead, the Project mainly concentrated to provide the civil facilities, water pans and boreholes, and execute trainings and technical supports to establish a comprehensive and self-reliant development committee. The DC was expected to take the leadership in all development activities in the targeted area. Since this approach was new to most of people, the Project should spend more time and made more efforts to explain their principles, methods, and practices to both committee and community. Furthermore, the Project should listen to the feedback and find out the appropriate approach in each pilot project sites. However, interviews with local people showed that many of them did not have a correct understanding on the Project. Some village members suspected that the DC had received benefits from the Project but refused to share it with local people. Such misunderstandings may lead local people to lose faith in committee. On the other hand, many DC members did expect to receive incentives because other projects used to give it. It is important to make DC members understood that they may not receive small incentives from the Project in a short term, but their activities shall benefit themselves and the whole community in a long run.

(2) Follow-up training and feasible activities that planned and supported by the Project are important to keep the DCs active. The training workshops held at the beginning of the Project have had positive effects on establishing development committees. However, some location chiefs and committee officials complained that lack of feasible and practical activities have declined influences of the DC. Although the action plan has been made during the training, they expected start-up supports from the Project. On the other hand, some committee members recommended that a DC should have independent economic activities to sustain themselves. As most DC members do not have a permanent job to support their families, it is difficult to ask them to continue it on a voluntary basis.

(3) Three factors that have affected borehole management, water scarcity or people's demand for water, social organization of water users, and their economic situation or income generation can be used as indicators to examine the priority of a borehole site and evaluate efficiency of resource management. Furthermore, appropriate suggestion on resource management can be given through investigating interactions among these factors.

(4) It should be declared here that Turkana County is a vast region. The natural environment, livelihoods of residents, social organizations and decision-making process are varied from one location to another. It is important to understand the reality of the Project site as well as the difficulties and challenges faced both by the Development committee and by local community in a particular area.

ANNEX D

SUB PROJECT
- NATURAL RESOURCE MANAGEMENT

FINAL REPORT

THE PROJECT FOR ENHANCING COMMUNITY RESILIENCE AGAINST DROUGHT IN NORTHERN KENYA

ANNEX D SUB PROJECTS – NATURAL RESOURCE MANAGEMENT

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CHAPTER D1. CONDITIONS AND CONSTRAINTS OF NATURAL RESOURCES MANAGEMENT

D1.1 General Conditions of Water Resources

D1.1.1 General Conditions of Water Resources in Marsabit

(1) General

In ASAL areas, water facilities to be used for livestock and domestic water supply in pastoralist communities are classified as shown in Table AD1.1.1, with reference to Rainwater Harvesting Handbook (African Development Bank, 2006).

Table AD1.1.1 Type of Water Points for Pastoralists

Type of water points	Water source	Water source facility
Water pan	Surface water and rainwater	Reservoir pond for harvesting rain water and surface water from relatively small catchment generally excavated below ground level.
Rock catchment	Rain water	Rainwater harvesting facility with water tank, constructed on lower reaches of bare rock without fractures or cracks, where runoff losses to the soil, vegetation and structures is minimized.
Sand dam	Surface water	Storage dam build on and into the seasonal riverbed, effectively increasing volume of groundwater available for abstraction. Water is captured through a scope hole, hand-dug well or tube well.
Sub-surface dam	Riverbed water	Storage dam consists of a vertical, impermeable barrier through a cross section of a sand-filled seasonal river bed.
Shallow well	Groundwater and riverbed water	Wells drilled along seasonal rivers by machine or manpower. Water is abstracted by pump and manpower.
Borehole	Groundwater	Wells drilled by machine, from which water is abstracted with pump and flowed into trough for livestock though pipe.
Spring	Spring	Small inlet structure provided with concrete wall Water is generally abstracted through pipeline, or directly flowed into trough for livestock

Source; JICA Project Team

Natural resource potential in Marsabit was analysed by reviewing previous reports.

The existing water potential reports “Marsabit & Moyale Districts Water Resource Assessment Study Report (June, 1997)” and “Marsabit District Water Source Assessment and Mapping (January, 2003)” were reviewed to seize water potential condition in Marsabit. In addition, supplemental data have been collected from the related agencies for confirmation, interview to communities and through field survey.

(2) Marsabit and Moyale Districts Water Resources Assessment Study Report 1997

Water Resources Assessment (WRA) was executed by GoK and the Government of Netherlands from 1993 to 1996. The study aimed at preparation of some information concerning the areas which are suitable or unsuitable for the development of a particular type of water supply facility. The study included making inventory of available data and information, and water related organizations. The results were presented on 18 thematic maps.

WRA Study Report suggested potential rock catchment in areas having exposed rock surfaces, which included Forole, Turbi, Golole and Ngurnit-Illaut-Korr triangle, while water pan development was limited; hence, it concluded that surface water development area was limited. Shallow groundwater was

expected in the northwestern and southern parts of the Marsabit County and near Moyale Town. The report revealed that about 40% of the study areas have no potential for deep groundwater potential.

The report said that there were poor road network and large un-accessible areas. All the water points were not visited and, this therefore suggests that there is need for further surveys, which would include bacteriological analysis and water quality tests. Because water quality tests were considered to be very important in order to confirm the present conditions of water and its projected future trends.

(3) Marsabit District Water Source Assessment and Mapping, Final Report 2003

In order to support planning activities within the water sector, Oxfam Quebec commissioned Rural Focus Ltd. to undertake water source assessment and mapping (WSAM) assignment in Marsabit County. The main objective of the assignment was to establish a Geological Information System (GIS) based on database of water sources and related socio-economic data for the County.

The WSAM report stressed on necessity of continuous management and updates of prepared GIS, improvement of seasonal population demand data (livestock and human) and other additional data. According to the report, the number of shoats and total livestock units increased more than 10 times in the early dry season as compared to wet season. This does not seem to be realistic but it was said that there were a lot of livestock movement outside of the district actually according to local information.

A pasture condition map was produced by Marsabit resource persons, in which the pasture condition was divided into 3 categories, namely good, medium and poor. In the map, the good pasture condition area was from eastern to northeastern parts of the district. The medium condition area covered southern end and northwestern part or most of the North Horr area. The poor condition area extended from the central western part of the district. Hurri Hills and southern part of Marsabit North (Chalbi) District (the east side from Mt. Marsabit) were classified as good range.

The report assessed the proposed development options taking into consideration the pasture condition and accessibility to water sources. It mentioned that the distribution of permanent water sources for livestock within the county was sufficient, and overgrazing is evident around the permanent water sources.

D1.1.2 General Conditions of Natural Resources in Turkana

(1) General

Turkana County lies in the ASAL area having an annual rainfall less than 500 mm. Most of the rivers called "*Laggas*" have seasonal water flow only during the rainy season, except the Turkwel River with perennial flow regulated by the Turkwel Dam located in the upstream of river basin. Water resources for the pastoralist communities are therefore limited only to i) groundwater utilized from shallow wells and boreholes, ii) riverbed water in the seasonal rivers, and iii) small scale harvesting of surface water and rainwater, such as water pan, sand dam and rock catchment.

In these years, pastoralists in the county were seriously affected by chronic droughts especially from 2008 to 2011. During the drought period, water for the pastoralists could not be sufficiently reserved nor recharged and dried up, hence no longer in use during the drought for long time. Even at the deep wells, water level and discharge were observed to decrease and some of the wells dried up, which forced the pastoralists to access far distance to the water points and caused deterioration of the grazing area due to concentration of their livestock into the limited available water points during drought.

(2) Existing Water Points

In 2009-2010, MWI and Oxfarm (NGO) conducted mapping survey of the water points in Turkana County, in which 997 water points were surveyed in total, including 501 deep wells, 226 shallow wells, 148 reservoir dams and water pans, and 7 rock catchments. During the survey period of ECoRAD Project, data was obtained from DWO offices and updated the numbers of existing water points. The types of water facilities developed in Turkana County are shown in table below. Locations of these points referred to Turkana Water Sources Final Mapping Data, MWI-Oxfam are shown in Annex E.

Table AD1.1.2 Summary of Existing Water Points

District	Water pans	Rock catchment	Boreholes	Shallow wells	Springs
Turkana Central	6	2	42	45	4
Loima	4	-	36	32	3
Turkana North	18	-	82	15	5
Turkana West	35	3	13	87	3
Turkana South	3	-	36	24	3
Turkana East	10	-	25	18	2
Turkana County	76	5	234	221	20

Source; District Water Offices, June 2012

D1.2 Potential Water Source Development

D1.2.1 Basic Concept

It is commonly known that development of permanent water source should be carefully studied, since it may cause overgrazing and environmental degradation in the Project area. Seasonal water sources and strategic / contingency water sources are recommendable, taking into consideration the grazing pattern and available extent of the grazing area. In the latter case, a strong water management system is needed to be established in consultation with community and the training of committee members.

According to the previous study reports, both successful drilling rate of borehole and operational borehole rate are not high. Control of new borehole by new water management system seems to take substantial time. Therefore, the preferred main interventions considered are, new construction of water pan / dam, rock catchment and other seasonal sources, as well as the rehabilitation of all kinds of water sources.

D1.2.2 Type of Water Sources and Development Potential

Development potential of rainwater harvest, surface water, subsurface water, shallow groundwater and deep groundwater are considered.

(1) Rainwater Harvest

Water pan / dam and rock catchment can be developed in certain areas in the Project Area, even though there is not ideal potential site due to limited rainfall and high evaporation. This will be discussed in D1.2.3.

The WRA report prepared a rock catchment development potential map in Marsabit, where the potential area is identified only northern and southern border highlands. However, there are certain numbers of bare rock outcrops place to place probably usable for rock catchment from technical viewpoint, except for the deserts.

(2) Surface Water in Marsabit

According to the information obtained during the field survey, there was one on-going project at the time, the construction of new Badasa storage dam with water supply pipeline system toward Marsabit City. This dam project was expected to be complete by 2013, on which the condition of domestic water supply would be improved including livestock use in and around Marsabit City, such as Jirime and Dakabaricha Locations. Other than the Badasa dam, there was no identified plan for the relatively large scale surface water resource development.

(3) Surface Water in Turkana

As for surface water, there is no permanent river except the Turkwel River in the county. Water source in seasonal rivers were considered in the project by means of development of small storage dam and water pan. Lake Turkana water is alkaline and lies at the lower level, and not considered as potential

source at then. The east Turkana basin is located too far and needs higher cost (water treatment device and/or pump) for the sub- projects. Other lakes and swamps including craters have water, which is mostly seasonal and some are for wildlife. Further study is desirable for future projects.

(4) Subsurface Water and Groundwater in Marsabit

Boreholes seem to be clustered along the National Road No.A2 (Nairobi - Moyale) and at major settlement areas in the county. Shallow wells occur in clusters along the edges of the Chalbi desert, on the eastern and southern slopes of Mt. Marsabit and along the seasonal rivers in the northwest of the county. Springs occur mainly along the Chalbi belt and on the slopes of Mt. Marsabit, Mt. Kulal and the Ndoto range.

Subsurface water can be developed mainly through sand dam along seasonal river bed. Groundwater level is shallow at the edge of hill or plateau, or the edge of deposit plain. Shallow wells or water holes have been developed in and near dry river beds providing permanent water in a number of places, such as Balesa Kulal, Dukana, El Dere, etc. Shallow wells are being developed by the communities themselves and/or with less external assistance, and hence the shallow wells are not target water source in the sub- project.

There are a number of boreholes in the county and three distribution patterns were distinguished, namely linear, nucleated and scattered. Operation of some existing boreholes is strictly controlled not to operate during the rainy seasons in order to preserve the dry season grazing area, which is called strategic borehole.

Drilling of boreholes is continued by the Government authorities such as National Water Conservation and Pipeline Corporation. Kenya National Highways Authority has also drilled many boreholes (13 nos. according to Water Resource Management Authority (WRMA)) along the National Road No.A2 (Nairobi - Moyale) for the road construction. These boreholes were agreed to be handed over to the communities for domestic and livestock use upon completion of the road construction in near future.

Since success rate of drilling for deep groundwater is not high enough and functional borehole rate is very low, development of the deep groundwater was not included as water source for the sub- project.

Due to the abovementioned situation, exploitation both for shallow well and borehole was not considered in Marsabit as the target of the project, because of the low potential of the groundwater as mentioned above. In addition, the operation and maintenance (O&M) activities for the pump and the diesel generator at the existing borehole were not properly achieved in many cases. Under the then water charge collection, only day-to-day operation cost could be covered, while periodical and occasional maintenance and repair were hardly covered , requiring external financial support for the maintenance, The rehabilitation of the existing non-functional boreholes could be considered in case that such borehole would contribute the effective use of the grazing area under the strategy of the Project with the condition that improved operation and maintenance system would be introduced.

(5) Subsurface Water and Groundwater in Turkana

1) Subsurface dam

Subsurface dam consists of a vertical, impermeable barrier through a cross section of a sand-filled, *laggas* bed. Rocky banks and gorges are the best features. The optimum zone for constructing subsurface dam is generally found on gentle slopes in the transition zone between hills and plains. Finding suitable places to build the dam is harder when the river is wider. In view of an efficient reservoir it is important that it is based upon impermeable beds or bedrocks are underlying the reservoir. General conditions of proposed sites for subsurface dam are as follows (AfDB, 2008; VSF-Belgium, 2006):

- Limited to areas with seasonal riverbeds with floods event during the wet season
- Rivers with less coarse sand will not have sufficient water storage capacity.
- Suitable river slope lies between 1% and 5%.

- River bed should be solid rock without fractures.
- Construction material should be local available.

In Turkana County, suitable site for sand dam/subsurface dam is restricted by geographical and geological condition. Since site investigation is very important to evaluate the potential of subsurface dam construction and decide the exact location, it is necessary to narrow down target watershed before detail site survey.

Rift Valley Water Services Board (RVWSB) has been planning the projects including construction of 10 subsurface dams along mainstream of Tarach River. The projects were expected to benefit about 100,000 people together with their livestock with potable water and minimize the movement the communities make while searching for water.

JICA Project team selected Tarach River watershed as the construction target on the basis of the previous analysis. Finally, the exact location is evaluated by site investigation on geographical and geological condition, river condition, accessibility research and others.

2) Proposed Sites for Subsurface Dam

The 6 sites were proposed in Tarach River watershed. These sites for subsurface dam are plotted on surface water condition map (Figure BD1.2.1) and the site information is summarized in Table AD1.2.1

Table AD1.2.1 Proposed Sites for Subsurface Dam in Tarach River Watershed

No	Sublocation	Coordinate						Width (m)	Area (km^2)	Geology	Accessibility
		Northing			Easting						
D-1	Nadapal	3°	42’	33.9”	34°	51’	01.5”	15	77	Consolidated Sand	Very Good
D-2	Kalobeyei	3°	45’	07.8”	34°	43’	47.8”	20	50	Consolidated Sand	Very Good
D-3	Loreng – Loritit	3°	32’	43.7”	34°	48’	15.2”	40	633	Consolidated Sand	Fair 20km from Kakuma
D-4	Letea – Lokipoto	3°	17’	29.8”	34°	40’	27.4”	100	454	Consolidated Sand	Not Good 50km from Kakuma
D-5	Letea – Puch	3°	15’	19.1”	34°	42’	42.0”	20	1,559	Bedrock, Consolidated Sand	Not Good 57km from Kakuma 7km from D-4 on the *lagga*
D-6	Loreng	3°	31’	44.0”	34°	38’	01.9”	70	347	Bedrock, Consolidated Sand	Fair 42km from Kakuma

Source: JICA Project Team

(6) Groundwater in Turkana

Investigation and potential study were conducted in ECoRAD in collaboration with UNESCO, and results evaluation on groundwater potential is shared in Annex E.

D1.2.3 Water Pan Development Potential in Marsabit

(1) Factors for Evaluating Water Pan Development Potential in Marsabit

In the WRA Study Report, water pan development potential was assessed using 7 factors to 7 subareas consisting of the study area. These 7 factors are land slope, soil type, soil depth, runoff, evaporation, erosion hazard and catchment land use. Because the “rest” area is quite large including various areas, it is divided into four areas, namely eastern slope of Mt.Kulal, northern foothill of southern border highlands, eastern plain of Mt. Marsabit area and reduced new rest area. Based on such new area categories, potential analysis for water pan in Marsabit County was examined. Summary is shown in the below table. Detail evaluation is shown in Table BD1.2.1

Table AD1.2.2 Summary of Evaluation of Potential for Water Pan

Area		Evaluation by potential
(1)	Forole-Diribsoi-Godoma triangle	Middle
(2)	West Middle & lower slopes of Marsabit	High
(3)	Western slopes of the Hurri Hills	High
(4)	Eastern slopes of the Hurri Hills	High
(5)	East Turkana Basin lowlands	Low
(6)	Hedad plain, Karole and Kaisut Deserts	Low
(7)	Eastern slopes of Mt. Kulal highlands	High
(8)	Foothills of southern border	Middle
(9)	Eastern side of Mt.Marsabit area	Middle
(10)	Rest of the Study area	Low

Source: JICA Project Team

Those results are based on the potential of water pan mainly based on consideration of physical conditions, such as water availability and hazards of soil erosion, etc. Thus final priority areas should be selected with other factors of the strategy for draught resilience, such as rangeland utilization, livestock migratory routes, accessibility by project staff, and so on in combination with the above results of water potentials.

(2) Holding Capacity and Size of a Water Pan

1) Holding Capacity within an Area around a Water Pan

Based on the above mentioned grazing circle area, holding capacity of a grazing circle area around a water pan is calculated with the stocking density of rangeland.

Stocking density data is available in "Rangeland Management Handbook of Kenya (Volume II,1): Marsabit District. 1991" as shown in the following table for Hurri Hills (sample of good rangeland) and Hedad (sample of poor rangeland), which approximately represents major rangelands in Marsabit area.

Table AD1.2.3 Maximum Stocking Density (Unit: ha/TLU[1)]/grazing days)

	1st rains	2nd rains
Range Unit 13 (Hurri Hills)[sample of good rangeland]		
Cattle	**0.8 (85)** [2)]	1.1 (50)
Goat	1.3 (105)	1.9 (70)
Sheep	4.1 (135)	6.9 (90)
Camel	4.3 (150)	7.3 (100)
Range Unit 13 (Hurri Hills) [sample of good rangeland]		
Cattle	**1.1 (50)**	-
Goat	2.0 (70)	-
Sheep	7.6 (100)	-
Camel	8.4 (115)	-

Note 1): TLU: Tropical Livestock, Unit: 1TLU = 1 cattle = 0.7 camel = 10 sheep = 11 goats
Note 2): 0.8 (85) = 0.8 ha/TLU/85days, 0.8 = stocking density, 85 = optimal number of grazing days at maintenance level only

Source: Rangeland Management Handbook of Kenya (Volume II,1) : Marsabit District. 1991

As shown in Table BD1.2.2 in detail, based on an available amount of pasture around a pan, an area around a water pan in Hurri Hills (good pasture condition) and Hedad (poor pasture condition) areas can hold around 55,600 heads and 35,700 heads respectively, in maximum, for cattle for 2 months in

1st rainy season. The numbers in the following table shows samples of total livestock numbers in major pastoralists' districts of Marsabit County based on the District Livestock Production officer (DLPO) Annual Report 2011. In comparison with those numbers and the above, it is realized the above numbers are incredibly high, actually not realistic number, because one water pan can hold 35,700 - 55,600 heads which is equivalent to more than a total cattle numbers in Laisamis district (27,200 heads).

Table AD1.2.4 Number of Total Livestock in Major Pastoralists' Districts

District Name	Cattle	Sheep	Goat	Camel
North-Horr	18,690	239,903	224,651	27,624
Maikona	12,000	219,075	124,895	16,848
Laisamis	27,200	95,950	91,781	17,848

Source: DLPO Annual Report, 2011

Based on this sample calculation, it is recognized that holding capacity of an area around a pan has big capacity much more than our expectations, and it can support quite large number of livestock theoretically.

2) Size of a Water Pan Based on a Theoretical Calculating Basis and an Empirical Basis

a) Storage capacity based on daily consumption

Using the above mentioned values of the holding capacity of an area around a water pan, and daily consumption of water of cattle (16.4L/head/day), the required capacity of water volume of a water pan can be calculated. According to the calculation, capacity of a water pan for cattle herd for 2 months in Hurri Hills and Hedad areas are 69,300m^3 and 49,200m^3 respectively, including percolation and evaporation (see detail in Table BD1.2.2).

By the way, in Northern Kenya region, it is noted and broadly accepted by many donors and NGOs personnel that a capacity of a water pan "should not be too big", in view of sustainable rangeland management and prevention of degradation around a water pan. Based on the several interviews and observations by the Project Team, it seems that the capacity of most of water pans constructed by such agencies were set around 10,000 - 30,000m^3 as "a not too big pan" empirically. It means they set up to utilize only 15 - 40% (from 10,000/69,300 to 20,000/49,200) of available pastures around a pan in order to preserve rangeland degradation. Even with such utilization rate of 15 - 40%, a pan can hold around 5,000 - 20,000 heads of cattle. This is still big number because actually it is very hard to imagine that 10,000 - 20,000 heads of livestock gather daily at only 1 water pan. Thus it can be said that, in terms of volume of pasture, a water pan has enough capacity in comparison with the number of livestock which gather to a water pan.

It seems that matter of rangeland degradation around a water pan should be discussed with certain other factors, apart from the relation between number of livestock, available pastures and water Potential.

The other aspect of consideration on this matter is the effects of hoofs on soil and vegetation. Degradation of rangeland by hoofs is pointed out by several researchers and observers. However it is difficult to verify, with scientific data, the relation between livestock density and degree of degradation of rangeland by hoofs. At this moment, without specific data it is hard to judge that this empirical volume of pans of 10,000 - 30,000m^3 is adequate or not.

b) Storage capacity based on available river runoff

Proposed capacity of water pans should be designed fully depending on water balance considerations. However, there are no meteorological, hydrological and other technical data available in individual proposed sites, such as rainfall, evaporation, river discharge, catchment area, and so on. Therefore the available water source flowing into the proposed pans is preliminary estimated based on available information, field survey and applying various assumptions as explained below.

c) Installation of water flow marking plate

In addition to information from pastoralists who know the site conditions about pastures and water availability in the area, water flow condition was surveyed by installing water flow marking plates (wooden timber with white water-based paint and plastic cover) for selection of proposed sites of water pans

	
Installation of water flow marking plate at proposed intake points of seasonal river :	Water flow marking plate installed :
	
Water mark investigation after installation : Five days after installation, water mark was confirmed	Water mark investigation after installation : From the mark, water depth in this runoff is 28 cm and discharge was estimated at 1.5m^3/sec at maximum in that day with assumptions of .river width and gradient

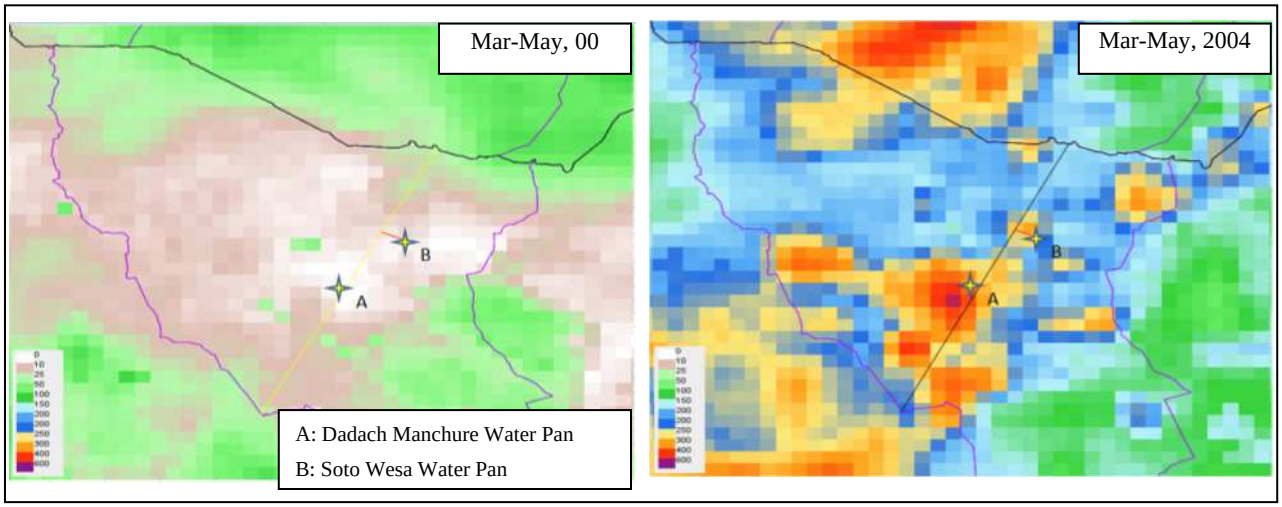
Source: JICA Project Team

Figure AD1.2.1 Photos of Installation of water flow marking plate

The observation results evidenced that water with the discharge of about 1.5 m^3/sec flowed in the river, which can fill up the pan of 10,000 m^3, if the flow continues for 2 hours or more.

d) Estimate from meteorological data

Runoff of the seasonal rivers at intake points of water pans in the rainy season is also estimated based on the information and assumptions, such as i) rainfall pattern obtained from website, ii) catchment area estimated based on Google Earth and topographic data base obtained from website, iii) runoff coefficient assumed to be 0.05 - 0.1, and iv) dependability of 80%. Sample estimate of runoff at proposed water pans in Gar Qarsa (Dadach Man Churre Water Pan) and Turbi (Soto Wesa Water Pan) are shown below.



Source: JICA Project Team

Figure AD1.2.2 Sample estimate of runoff at proposed water pans

(i) Three month-accumulated rainfall (mm) in 12 years from 2000 through 2011 were analyzed based on rainfall data obtained from satellite as shown in above figures.

(ii) With reference to satellite images and topographic map, catchment areas (km^2) of each proposed site of water pan was estimated.

(iii) Applying the catchment area estimated in (ii), rainfall estimated in (i) and assumed runoff coefficient of 0.05, total runoff volume flowing into the pan was estimated.

(iv) Comparing runoff volume and storage capacity of proposed pan, dependability was calculated.

As a result, the dependability in 2 cases of storage capacities, 10,000 m^3 and 15,000 m^3 are estimated as shown in the following table. The optimal capacities estimated in terms of the runoff are 15,000 m^3 for the pan in Gar Qarsa and Turbi with a dependability of 80%.

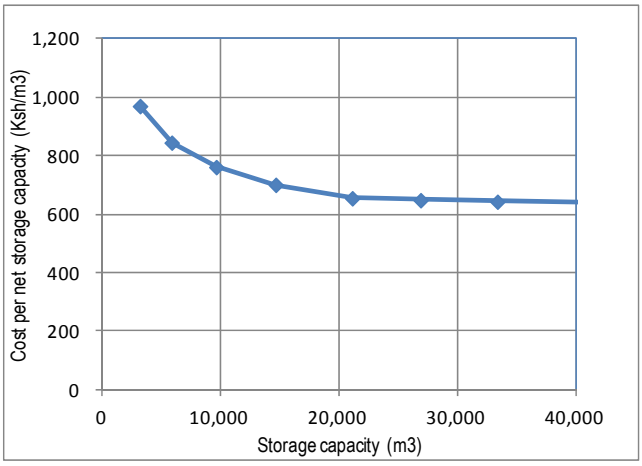
Table AD1.2.5 Estimated dependability indifferent storage capacities

	Case 1 (capacity; 10,000m^3)	Case 2 (capacity; 15,000m^3)
Gar-Qarsa Water Pan	92% (22/24)	79% (19/24)
Turbi Water Pan	92% (22/24)	79% (19/24)

Source: JICA Project Team

e) Storage capacity based on construction cost

Cost performance is also one of the important factors to decide the storage capacity of a water pan, because of limited available funds. Construction cost increases with increasing excavation volume, while construction cost per storage capacity decreases in general. As a sample calculation, construction cost per storage capacity significantly decreases up to the capacity of 20,000 m^3, while there is not so clear a decrease over 20,000 m^3, as shown in figure on the right. In this regard, the most suitable capacity in terms of decreasing cost per capacity is more than 15,000 – 20,000 m^3.



Source: JICA Project Team

Figure AD1.2.5 Construction cost per Storage Capacity

D1.2.4 Potential Sub-project Sites for Natural Resources Management in Turkana

Based on the water resource potential survey in Turkana County and resource condition of the rangeland through field survey including interview to the communities and concerned government offices, potential areas for implementing sub- projects of water point development were preliminary examined. The basic concept of development of water points and its criteria for selection of sub-projects were almost same as those of the sub-projects in Marsabit County.

(1) Development Potential in Turkana North District

1) Development of watering point in rainy season grazing areas

Livestock concentrate around the wells and water pans located close to the center, which serves as the watering point during the dry season. As there is no suitable site for potential water development in the dry season grazing area, the establishment of a water supply facility within the rainy season grazing area farther from the center will allow for the extended use of the rainy season grazing area during the dry season, while making use of remaining forage. By expanding the usable rainy season grazing area through the construction of a water supply facility, the grazing pressure placed on the dry season grazing area can be alleviated. As various family camps exist in the vicinity of the potential water development site, it may also serve as potable water for the pastoralist community.

2) Development of watering place between the dry season grazing area and center

Livestock concentrate around the wells and water pans close to the center during the dry season as it is the only watering place. By establishing a water supply facility midway between the dry season grazing area and the center, the range for movement of livestock will be expanded and the dry season grazing area can be more effectively utilized. Furthermore, by reducing the number of livestock gathering in the center, competition for water between humans and livestock will be alleviated. As the establishment of a watering point within the dry season grazing area will further heighten grazing pressure, the intent is to establish the watering point some distance away.

(2) Development Potential in Turkana West District

1) Halfway point between rainy/dry season grazing areas

As there are few watering places in the dry season grazing area, the range of use is limited. The extent of usage of the dry season grazing area can be expanded by establishing water supply facility along the route from rainy season grazing area to dry season grazing area.

2) Establishment of watering place in the dry season grazing area

There are a few watering points in the dry season grazing area of the Mogila range, and there are only 3 springs in the eastern foot of the Mogila range. The grazing area can be expanded by establishing watering point around the dry season grazing area.

(3) Development Potential in Turkana Central District

1) Establishment of watering point in the year-round grazing area

During the dry season, the pastoralist communities utilize the water kiosk in the center, and livestock use water from Lake Turkana and the Turkwel River for drinking. The establishment of water point will help lessen the area of activity of livestock.

2) Domestic water development

The ground water of the lakeside region has a high saline concentration and is therefore not adequate for human consumption. Furthermore, fluorine content is also high, and in many cases surpasses the safety standards for use by livestock. Development prioritizing the improvement of water quality for human consumption is necessary in this region.

(4) Development Potential in Loima District

As there is a lack of watering points in the grazing areas, the center with watering point currently acts as a nucleus for movement. The dispersal of watering points will enable more effective utilization of the dry season grazing area.

(5) Development Potential in Turkana South District

1) Improvement balance between supply and demand of water at existing watering places

As the current demand for water surpasses supply, the establishment of new watering places is necessary. Albeit being voiced by only a part of the pastoral people, there is a request for the construction if possible of watering places farther away from the dry season grazing area, as there is a risk of increased grazing pressure if they are situated within the dry season grazing area.

2) Establishment of watering place on route between rainy and dry season grazing areas or in the vicinity of the dry season grazing area

As there is only a small number of watering points in the dry season grazing area, this poses a limit to the total usable grazing area. In this scenario, the distance from the livestock farming community to their domestic water source will be reduced.

(6) Development Potential in Turkana East District

As the area around Lopii is inadequate for groundwater development, those residing in the center currently utilize water that is transported from Lokichar in tanker lorry. Livestock utilize the spring and hand dug well in northern Lopii as well as the spring in Lokwamosing located south-eastern to Lopii.

D1.3 Issues observed and Other Considerations for Sustainability

D1.3.1 Sedimentation Problem and Silt/Sand Trap Structure

According to the site observations, there are so many water pans which have currently sedimentation problems resulting in reduction of effective storage of water. For sustainable use of water pan, the maintenance work, especially sediment removal work, is inevitable.

And, for such sediment removal work, a concept of “beneficiary participation/sharing” should be introduced. It is preferable that sediment removal work should be executed by all the users of a water pan at the same time when they water livestock. However the present condition of pan does not allow it.

For example, it was sometimes observed, in good organization, that several users worked to remove sediment at water pan during usage. However it looks so hard for them to accomplish the works because there is standing water inside pan.

On the other hand, after the pan has dried-up at the end of dry season, the users can execute the removal work much easier. However at that time, there are not so many available workers because most of migratory users are not around the pan which does not have water. Thus normally it is likely that only the users of the host community of the water pan are obliged to execute such removal works, then unfortunately they fail to maintain it due to limitation of workers and the huge burden.

In addition, from a structural point of view, most water pans do not have “silt/sand trap structure”. The silt/sand trap structure is a common structure in several river facilities, such as river water intake, ponds, etc., for catching small suspending particles of sands and silts in river water at the place before river water getting into main facility.

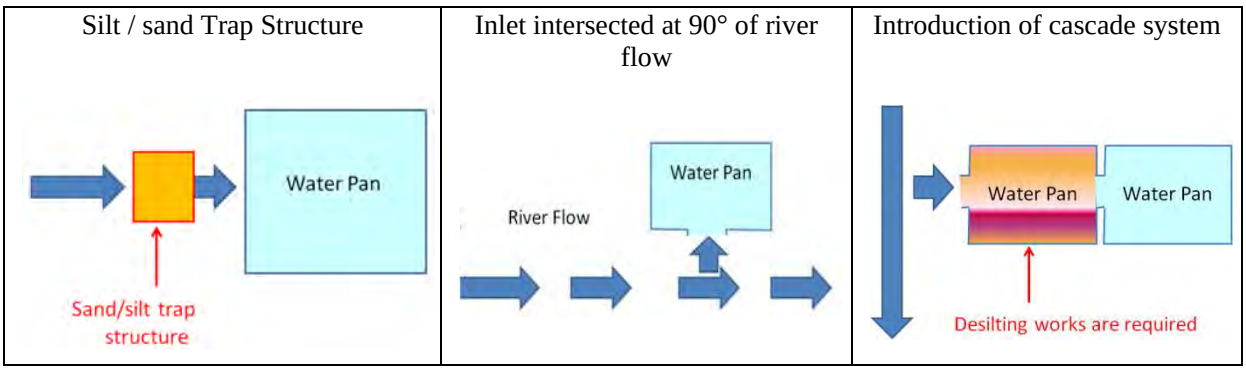
If a good silt/sand trap structure is provided, the users can execute removal work even if a pan has water. And if removal work can be executed at the same time of watering livestock, full beneficiary participation/sharing can be realized. The following problems were found on site in terms of sediment issues.

(1) Problems

- Location of inlet of a water pan: Location and direction of inlet of a water pan is one of crucial points for reducing volume of suspended sand particles in to a water pan. There are so many water pans which are located in a wrong location and direction.
- No sediment removal function: The most important point for designing the silt/sand trap structure is how to provide a physical function for reducing burden of periodical sediment removal works. However there is not so much consideration for such point in the existing facilities.
- Organization and system for maintenance: In flat places, sediment removal work of the silt/sand trap structure should rely on manpower. Thus strong organization and maintenance system is required for sustainable use of pans. Since work for sediment removal at silt/sand trap structure is hard work, it requires not only strengthening of the organization but also physical and structural improvement, which facilitates removal work by reduction of work load.

(2) Possible approach to overcome the observed constraints

1) Inlet of water pan should intersect at 90° of river flow direction not so as to allow suspended particles to enter into the inlet directly.
2) Inlet of water pan should have certain height of a hump not so as to allow bed load (particles rolling at river bed) to enter into the inlet directly.
3) Silt/sand trap structure made by concrete or stone masonry with certain volume of capacity should be provided at inlet of water pan.
4) Such silt/sand trap structure should have functions for facilitating sediment removal works, such as access way for entering to middle of the structure, functions in consideration of using 1-wheel-hand trolley.
5) It is required of establishment of regulation for daily maintenance works of sediment removal with beneficiary participation, i.e. sharing burden by each beneficiaries.
6) If increase of storage capacity or the rehabilitation of existing water pan is proposed without new silt/trap structure, introduction of a cascade system is also recommended. By placing several pans in series, the total volume of sediment flowing into the pans can be reduced compared with pans placed in parallel. In addition, upstream pan functions can be expected as a silt/sand trap for the downstream pan.



Source: JICA Project Team

Figure AD1.3.1 Structural Improvement of Silt / Sand Trap

(3) Desilting of water pan and rehabilitation

Community participation in desilting sometimes is a problem because the communities have been relying on external support with free donation, cash for work or food for asset. According to the site observations, there are so many water pans which have currently sedimentation problems resulting in reduction of effective storage of water. The maintenance work, especially sediment removal work, is inevitable for sustainable use of water pan. For such sediment removal work, a concept of "beneficiary participation/sharing" should be introduced. It is preferable that sediment removal work should be executed by all the users of a water pan at the same time when they water livestock. However the present condition of pan does not allow it.

From a structural point of view, most of water pans do not have "silt/sand trap structure". The silt/sand trap structure is a common structure in several river facilities, such as river water intake, ponds, etc., for catching small suspending particles of sands and silts in river water at the place before river water getting into main facility. If a good silt/sand trap structure is provided, the users can execute removal work even if a pan has water. And if removal work can be executed at the same time of watering livestock, full beneficiary participation/sharing can be realized.

D1.3.2 Problems in Structures and Functions of Water pans

(1) Insufficient compaction of embankment

Observed embankments of water pan and dam are mostly insufficiently compacted. These embankments are usually not so strong against erosion by rainfall. To protect embankments from failure or breach sufficient compaction and turf or grass seeding on slope is desirable.

(2) Spillway

It has been observed that some dams/pans have no spillway. To protect embankment of dam/pan from flooded water, setting up of proper scale of spillway is preferable. In case the design flood water level is not higher than the embankment crest and extreme overbank flow does not cause serious damage, spillway may not be necessary. Comparison between spillway construction cost and rehabilitation and damage cost without spillway may suggest direction in the selection. Anyway checking of the conditions is required in case by case.

(3) Contamination in water pan

At some existing water pans, it was observed that the livestock drink water, directly from the water area, which results in water contamination in the pans. However in other cases, the water area is protected with temporary fencing made from bush trees, which does not allow the animals to enter into the water. It was also observed that small ditches were temporary constructed as trough for the animals by water user pastoralists themselves in order to avoid water contamination. These facts evidence that some of the pastoralists will understand the ill effects of the water contamination in the water pan. For the construction and rehabilitation of water pan under the project, structural measures to avoid water contamination caused by livestock were carefully considered.

D1.3.3 Shortage of Drinking Water Supply due to Increasing Water Demand

It was widely observed that the villagers are facing serious shortage of their drinking water in many parts of the County due to lack of water facilities or deterioration including boreholes and other water harvesting facilities caused by lack of maintenance funds, while water demand is increasing. ECoRAD considers improvement of water supply systems including small scale water harvesting facilities, such as rock catchment and pipeline system from water source at spring.

(1) Rock catchment

Rock catchment facilities scattered in the County are mainly used for drinking water, which have the following constraints as reported during CMDRR workshop.

- Due to insufficient storage capacity against water demand in the villages, they dry up within 3-4 months in the middle or end of the dry season. The villagers are obliged to carry water from other far remote water sources causing a heavy burden on their lives.
- Storage tanks of these rock catchments are filled up quickly with rainfall once or twice, even rainy days continue in the remaining rainy season. Therefore, water source of rainfall is not effectively utilized, wasting a certain volume of water because of inadequate capacity of their storage tanks.

(2) Water supply pipeline

Water supply pipeline, for instance in case of Arapal Community in Marsabit County, had the following constraints, i.e., i) insufficient discharge against increasing water demand, ii) insufficient capacity of the existing tanks due to their deterioration, and iii) leakage of the pipes due to lack of maintenance fund. Out of these constraints, item i) is the most serious one because it's improvement was beyond the capacity of the community, while the other problems could be solved with relatively low cost within their routine maintenance activities. The insufficient discharge was caused mainly due to 2 main reasons, which are i) insufficient water source and ii) insufficient capacity of pipeline because of a limited pipe size.

D1.3.4 Existing Pumping Water Systems and Their Improvement

There are a lot of boreholes and wells in Marsabit presently for human and livestock use. For such facilities, two type of operational system are introduced: one is manual operation, i.e. hand pump, and another is the system with motor pump. Normally diesel generator supplies power to operate such motor pump.

Hand pump system has many advantages such as simple mechanical system to be repaired, simple spare parts which can be obtained in local town, and economical system without fuel. However due to limitation of available pumping up depth, normally up to 50 m, it is not so applicable in Marsabit area. In Marsabit efficient aquifer is located at 200-300m in depth, especially in the areas where water shortage is chronic. Thus the majority of residents who live in Marsabit rely on diesel pump system for their drinking water.

(1) Problems of Motor Pump Operated by Diesel Generator

There are many bore holes with motor pump operated by diesel generator in Marsabit County. It is regrettably noted that the O&M activities for such diesel pump system at existing boreholes are not properly achieved in many cases, requiring external financial support for the maintenance.

The existing diesel pump systems are observed to have the following problems/constraints:

- Due to technical characteristics of a diesel generator, it requires several maintenance procedures for sustainable usage, such as changing of oil & lubricant, changing oil filter, and spare parts which are planned to be replaced periodically, in its lifetime. And also several mechanical troubles occur due to a complicated mechanical driving system. Thus diesel generator requires a certain amount of maintenance cost for normal operation. On the other hand, submergible motor pump do not have trouble and have less regular replacement of spare parts. It can be noted that mostly problems are derived from a diesel generator portion in diesel system.
- Operation cost is also one of key issues. Because fuel cost including transportation cost become so expensive for remote area.
- Due to the reason above mentioned, most of existing water user associations do not have sufficient saving fund for unforeseen expenses, such as unexpected mechanical trouble to be repaired, or damage of its parts to be replaced. Therefore, if once an unforeseen trouble happens, the water pump system is obliged to stop until external support become available.

As mentioned above, it is conclude that, without external aids/supports, present diesel pump system in Marsabit is so fragile in terms of sustainable and continuous usage.

(2) Alternative Natural Power Source for Pumping Water

As mentioned above, the biggest constraints of diesel pump system is high operation and maintenance cost. To solve the problem, there are two alternative natural power sources for pumping water, which costs less than diesel pump system. One is wind power and another is solar power.

a) Wind Power

In Kenya, the *"Kijito pump"* is well-known and nation-widely utilized as pump with wind power. However the Kijito pump cannot be used at borehole with its depth more than 100m. Thus it is not applicable much in Marsabit area where deep aquifers exist.

b) Solar Power

Solar power pump system (generating power with solar panels) is seldom observed in Marsabit.

The followings are the reason why solar power pump system was not introduced in the past in this area:

- Direct current motor pump (D/C pump) is the most suitable type of pump for solar power system. However, due to its technical reasons, D/C pump has very small power for pumping water and not suitable for deep wells.
- Alternating current pump (A/C pump) with an DC/AC inverter can provide higher power than D/C pump, but even A/C pump, its pumping yield was too small in comparison with diesel pump system to provide sufficient water in deep wells. For example, the diesel pump system can yield up to 5-10 m^3 per hour even in the borehole of 200-300m in depth easily. However such high yield did not realize, but only maximum of approx 1m^3 per hour by solar pump system.

However, new high capacity solar power system with A/C pump was recently developed. Now the solar power system can reach yields of up to 5-10 m^3 per hour in 200-300 m deep wells.

Once the yield problem has been solved, there are so many advantages for solar power system in Marsabit area as mentioned below:

- In comparison with diesel generator, there is less mechanical trouble,
- Regular replacement of spare parts is much less than diesel system, and
- No consumption of fuel, no required fuel charge as long as sun light is available.

(3) Installation of Solar Pump System

As mentioned previous section, it is technically possible for us to install the solar pump system in Marsabit and it is highly recommended to install such system for sustainable usage of pumping system.

Solar pump system is comprised of (1) Alternating Current Pump (A/C pump), (2) solar panels, (3) DC/AC inverter, and (4) other accessories. A/C pump is normally used in diesel pump system, solar panel and an inverter portion requires special care and consideration for actual installation at site.

For installation of solar pump system, the following points should be examined and considered.

a) Vandalism

Solar panel is essential element of solar pump system, and such panels should be placed outside to be exposed to sunlight always. Thus special care should be taken against vandalism and robbery in unattended period, such as night time and rainy season in which nobody use the pump. Total panel size is too large to handle, so it is not realistic to store them in night time in somewhere.

In consideration of such conditions, such solar pump system should not be installed at remote area where security cannot be established. Basically it should be installed at the boreholes which are located in residential areas or highly secured places with security guards.

b) Alternative Power Source

The solar pump system can be operated during daytime. However operation hours might be extended up to night in drought spell. Thus alternative power supply system is essential for reliable usage.

It was highly recommendable to install new solar pump system at existing diesel pump system in order to use existing diesel generator as stand-by purpose in a spell of drought.

c) Operation and Maintenance

After installation of solar pump system, it is expected that operational expenses is dramatically decreased and financial status of water management committee is improved so much. Thus it is strongly required to establish strict income and expenditure control system by water management committee to utilize revenue of water effectively.

Thus training of water management committee should be an essential component in addition to physical improvement with solar pump system.

d) Improvement of Pastoralists' Resilience

Following the main purpose of the natural resource management in the Project, it was recommended to install the solar pump system at the boreholes which contributed not only human use but livestock. In this context, the strategic boreholes were the highest priority for the selection. There were at least 3 strategic in Marsabit County, i.e. Shurr, Jaldesa, and Kubi Qallo.

(4) O&M of Pump Equipments

The O&M activities for the pump and the diesel generator at the existing borehole was not properly achieved in many cases under the present water charge collection system, requiring external financial support for the maintenance. In this project, drilling of new borehole was not targeted because of its low potential, while the rehabilitation of the existing non-functional boreholes could be considered in cases where such boreholes would contribute to the effective use of the grazing area under the project strategy with the condition that improved operation and maintenance system would be introduced. Introduction of solar power system was therefore proposed as a sub-project to minimize their O&M cost.

D1.3.5 Issues on Quality of Constructed Facilities and Management by the Community

(1) Poor Quality Due to Inadequate Management

Though many water facilities, such as water pans, boreholes and shallow wells have been constructed and they have helped to increase volumes of water for humans and livestock, misuse of funds and corruption are reported, because some contractors do unsatisfactory work. Many unfinished works may be left, because the money allocated for work was not enough or maybe there was mismanagement of funds. Community involvement and ownership of initiated projects was limited, because the communities were not sufficiently involved in the initial stages of the activity. It was also observed that some facilities were constructed poorly due to poor workmanship for topo-surveys, designs and lack or minimal consultations by some stakeholders before construction of the facility. Insecurity has also made some of the best water facilities with lots of pasture not to be used. Community participation in de-silting of water pans is a challenge because most communities are used free hand-outs before participating in an activity.

(2) Poor construction workmanship and insufficient reinforcement for concrete water tank

This was generally seen in the project area that reinforced concrete wall was used for water tank of 2 m or higher wall on the ground. Since stored water pressure causes tensile stress in the water tank wall on

the ground, the wall must be strong enough against the stress. Almost all concrete water tanks observed were not sufficiently reinforced or poorly constructed. Only thin iron wires were used in many cases and concrete hollow block or quarry stone block masonry is seen in some cases. Cracks are found on the wall in general. Some of the tanks are not usable after a few years according to local information. This point should be clearly understood and improved.

D1.4 Rangeland and Grazing Activities

D1.4.1 Analysis of Present Grazing Pattern

(1) Movement Characteristics of Herds

1) Acceptable Interval for Watering Livestock

Based on interviews with local pastoralists, the watering cycles are as shown in the table below.

Table AD1.4.1 Acceptable Interval Days of Watering Livestock in Northern Kenya

	Wet Season	Dry Season
Cattle	3-4 days	2-3 days
Camel	No drink[1)]	12-14 days[2)]
Sheep & Goat	No drink[1)]	3-4 days

Note 1): It is believed that camel and shoats should not drink water during wet season for their healing

Note 2): This is for Rendille Camel. In case of Somalia Camel, it is only 5-6days under the Northern Kenya climate.

Source: JICA Project Team

In addition, normal grazing distances in a day during dry season for each livestock are summarized in the following table.

Table AD1.4.2 Grazing Distance between Water Points for Each Herd in Northern Kenya in Dry Season

	Distance*
Cattle	10 km/day
Camel	20 km/day
Sheep & Goat	7 km/day

Note: Under normal conditions (with grazing) of stress level in dry season.

Source: JICA Project Team

It is said that moving speed of goats is around 10km/day and much faster than that of sheep, 7km/day. Since pastoralist normally combine sheep and goat in the same herd for grazing, speed of goats is set at the same of sheep in this report. This data is based on the results of interviews with a numbers of pastoralists. Thus this data should be examine and compared with scientific based and authorized data.

2) Grazing Distance of Herds in Dry Season

(i) Transfer from a water point to another: In dry season, herds move from one water point to another when pastoralists judge that pasture is exhausted around a water point. At that time, herds have to move to another without drinking water. Thus the maximum grazing distance in dry season between water points is calculated and shown in the following table, based on the above data of (a) acceptable interval of watering, and (b) stress distance.

Table AD1.4.3 Maximum Grazing Distance between Water Points for Each Herd in Northern Kenya in Dry Season

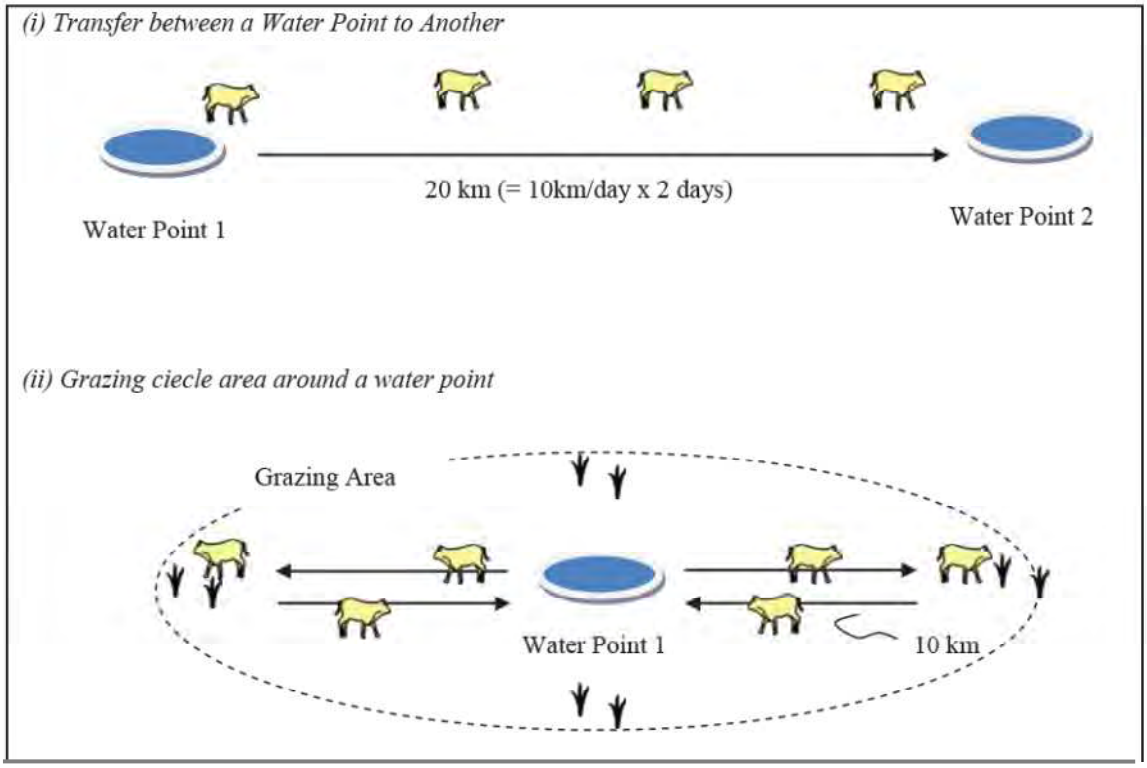
	Maximum Grazing Distance between Water Points		
Cattle	20 km	=	2 days x 10 km/day
Camel	40 km	=	2 days x 20 km/day
Sheep & Goat	21 km	=	3 days x 7 km/day

Note: Camel can stay in a grazing area without water for 10 days, and move to a water point on 11 - 12th day.

Source: JICA Project Team

With this data, it is proved that camel have high tolerance against drought due to its high mobility. Thus, in this Report, natural resource management, the relation between water and rangeland, shall be considered mainly based on the characteristics of cattle and shoats, approximately.

(ii) Grazing area around a water point: As shown in the next figure, in case that cattle herd can move 20km for 2days without watering, the herd can go for grazing for 1 day away from the water point, then come back for 1 day to the same water point. Thus a half of 20km, i.e. 10km, will be the maximum reachable grazing distance from 1 water point for cattle. It means that a circle with a radius of 10km will be the cattle herd's grazing area around 1 water point.



Source: JICA Project Team

Figure AD1.4.1 Transfer Distance and Grazing Area

In general, livestock can be divided into browsers such as goat and camel, and grazers such as cattle, each of which are grazed in separate campsites during the dry season. An exception is the sheep which are grazers but often brows in the same campsite as the goats and camels. For instance, in the case in which goats and sheep utilize dwarf shrubs, both can directly feed on the leaves. However, in the case of shrubs, goats are able to stand up on the hind legs and feed on the higher leaves while sheep feed on the dry fallen leaves underneath the plant. Thus, although goat and sheep have different feeding habits, they can stay together to graze in areas where there is vegetation that both can utilize. Moreover, herds are divided into young animals and adult animals when they graze.

The form of mobility varies depending on the family structure, number of people and heads of livestock that make up the pastoral household, but it also varies depending on whether the family camp a.k.a. “main camp” is situated in the rainy season or dry season grazing area, as well as the location of the watering point, its distance from camp and its security. Judging from the results of oral surveys conducted, the form of mobility is varied but can be classified into the following four types.

1) The family camp is close to being a permanent residence and livestock are taken out to pasture for the day or a few days, during both the rainy and dry seasons.

2) The family camp is situated in the dry season grazing area, and during the rainy season they move to a satellite camp erected in the rainy season grazing area, leaving only part of the milking livestock. In the dry season, livestock are generally put out to graze from the family camp where the watering point is located, although cattle are moved to areas with more grassland.

3) The family camp is situated in the rainy season grazing area, and during the dry season the livestock move to the dry season grazing area via temporary satellite camps, save for part of the milking livestock. Where there is no watering point in the dry season grazing area, livestock are grazed shuttle between grazing area and the family camp.

4) There are main camps in both the rainy and dry season grazing areas, and they move between the two campsites depending on the seasonal forage resources available.

(2) Grazing Patterns and Routes

1) Grazing Patterns of Wet Season in Normal Year

In wet season livestock can graze in rangelands covered with sufficient pasture but with less water sources, because the livestock can survive under condition of not requiring special drinking water during the wet season if good pasture is readily available. Generally, there are several wet season grazing areas which have enough pastures even if the grazing period is extended. However these areas cannot be utilized for grazing during the dry season due to scarcity of water.

Generally speaking, if pasture condition allows, pastoralists tends to locate their herd camps at the area close to their home villages so that herd keepers can meet their families and can exchange produced milk at camps and procured food at town constantly. In wet season, they can do it easily.

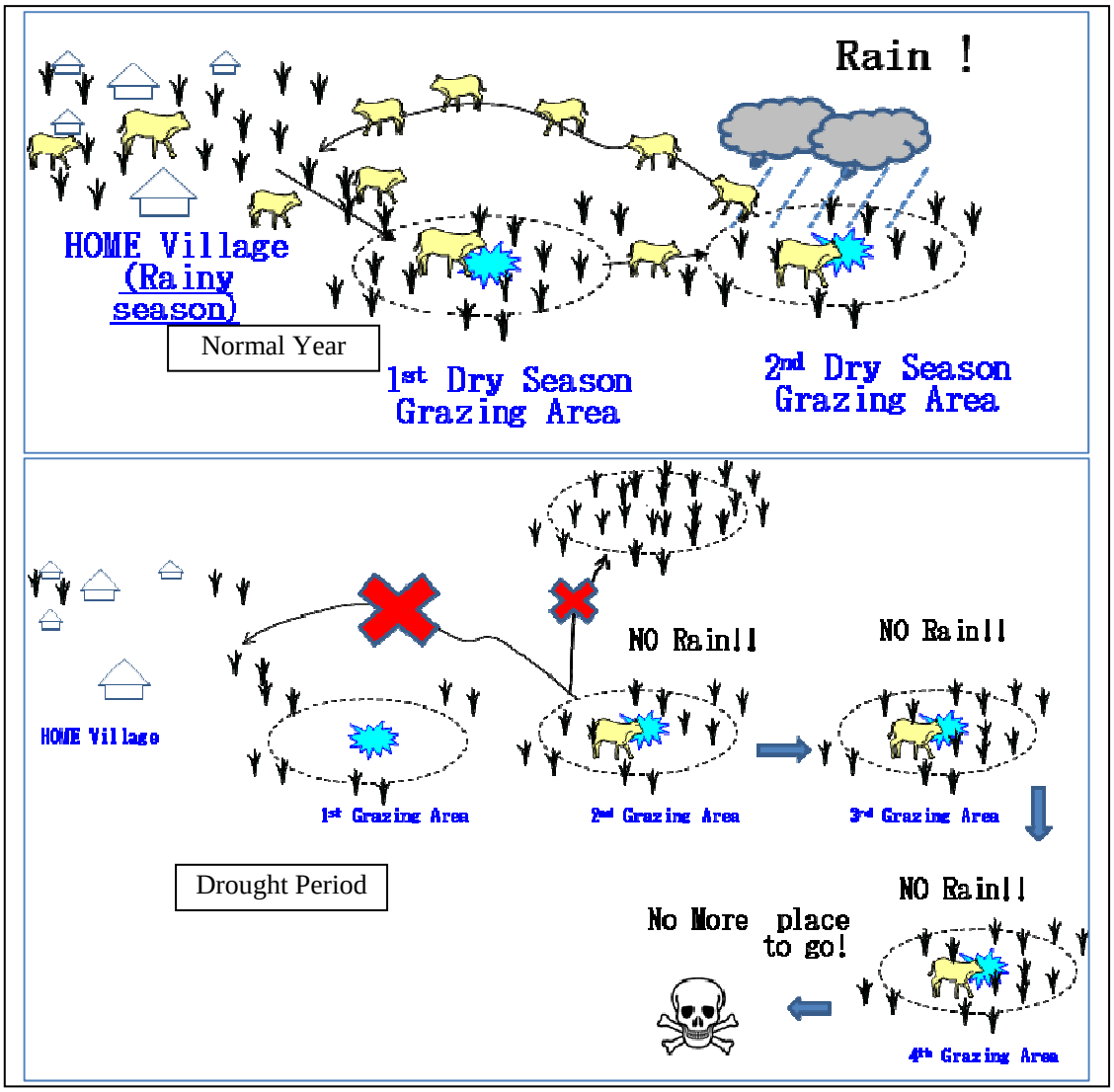
2) Grazing Patterns of Dry Season in Normal Year

In the dry season, pastoralists with their livestock move to rangelands covered with certain amount of pasture and with permanent and/or seasonal water sources, such as borehole, water pan and rock catchment, etc. They stay there for a while to enjoy pastures and water. Then, after consuming available pasture around a water point, the herds move to the other grazing area searching for new pasture and water. In this manner, the pastoralists move their herd from one place to another until a rainfall comes in the next wet season.

3) Grazing Patterns in Drought Period

If dry lands do not have rainfall unfortunately in the next wet season, they are obliged to continue to move toward further grazing areas in search of water and pasture. Currently there are several permanent water sources, such as boreholes and springs, in major towns and villages.

It seems that herd keepers mainly decide to move their herds to other grazing areas due to scarcity of pasture, not water. When herds leave a grazing area to another, it means that pasture of previous grazing area is exhausted, and herds cannot return to such exhausted area before another rain comes. Generally speaking, this is one way journey for searching pastures during drought. Then, if a drought prolongs even after the herds reach the end of their migratory route, they have no place to go but die.



Source: JICA Project Team

Figure AD1.4.2 Grazing Pattern in Normal Year and Drought Period

In Marsabit County, there are major 3 pastoral tribes, i.e. the Rendille, Gabra, and Boran, and basically they have their own territories and dry season grazing areas which are generally and mutually accepted based on their tribal histories. Such concrete grazing areas and pastoralists' migratory routes of livestock are described in Livestock session.

D1.4.2 Available Rangeland and Migratory Routes in Marsabit County

(1) Migratory Route

As mentioned in the previous sub-section (3), there is common tendency for grazing patterns and migrant route for the pastoralists. However, in each area, each tribe has their own territory and own grazing areas which they respect and accept mutually based on their tribal histories. For seizing such actual concrete grazing areas and migratory routes of livestock, information of migratory routes were collected from the key informants in manner of interview. Information on migratory routes was also collected from the authorities concerned. The pastoralist migrations are captured during the Biannual Food Security Assessments conducted annually by Kenya Food Security Steering Group as shown in Figure BD1.4.1. Based on such data and the interview, the following findings are obtained and schematic image of their migratory routes are summarized below and described in Figure BD1.4.2

1) Rendille Migratory Routes

There are following 3 major routes for Rendille peoples depending on home village they belong to.

a) Korr:
[Normal year] Moving to southern part of Marsabit (from Korr to Merille direction).
[Drought] They continue to move to the south, upto near Isioro area.

b) Kargi:
[Normal year] Moving to Mt. Kulal area through Hedad area (from Kargi to Arapal).
[Drought] They continue to move to west, upto Lake Turkana.

c) :
[Normal year] Moving to southeast area of Mt. Marsabit (from Logulogo to Qudas/Soliadi)
[Drought] They move to south, taking the same route of Korr people case, as mentioned in the above.

2) Gabra Migratory Routes

There are following 3 major routes for Gabra peoples depending on the type of livestock and home village.

a) Cattle & sheep holders of Hurri Hill area:
[Normal year] Grazing around Hurri Hills, Tull Galla, and Tull Dimuto areas (rich pasture areas) by using water of Kalacha, Maikona, El Gade, and Balese.
[Drought] They move to the north, upto near the national border or beyond the border of Ethiopia.

b) Camel & goat holders of Hurri Hill area:
[Normal year] same as the above.
[Drought] They move to the south, upto north food of Mt.Kulal (to Malobot and Ashe).

c) People around Galgalu plain:
[Normal year] Grazing around Galgalu areas (rich pasture areas) by using water of Alo Thita, Burgabo, Turbi, Kalacha, and Maikona.
[Drought] They move to Ethiopia area or to the west taking the same route of Hurri Hills people case, as mentioned in the above.

3) Boran Migratory Routes

There are following 2 major routes for Boran peoples depending on the type of livestock.

a) People around Galgalu plain:
[Normal year] Grazing around Galgalu areas (rich pasture areas) by using water of Alo Thita, Burgabo, Turbi, Kalacha, and Maikona.
[Drought] They move to Ethiopia area or to the west taking the same route of Hurri Hills people case, as mentioned in the above.

b) Dirib Gombo, Jaldesa people:
[Normal year] Moving to east area (Dirib Gombo to Jaldesa/Shurr).
[Drought] They move to the south, to Yamicha area or even area of Ewaso Ngiro River.

(2) Rangeland

In ASAL area, the condition of pasture in rangeland is strongly affected by rainfall. And generally speaking, such rainfall pattern varies so drastically year by year. Figure BD1.4.3 shows 3-month accumulated rainfalls in rainy seasons, such as long rainy season from March to June and short rainy season from November to January, estimated based on satellite images by NOAA's Climate Prediction

Centre and shared in Early Warning Explorer. As shown in the figure, rainfall was not constantly observed at the same place every year basically. Thus spatial rainfall condition should be deeply considered if you want to identify reliable wet season grazing areas. In the project, the key informant interviews were made in order to find reliable wet season grazing area. According to the key informant interviews, the following 5 areas were identified as the not fully utilized rangelands during dry season on/adjacent to the major pastoralist's migratory routes. Location and relation to the pastoralist migratory routes are shown in Figure BD1.4.3.

In order to confirm actual rangeland conditions in the recommended 5 areas, NDVI was utilized in the Project. Figure BD1.4.4 shows vegetation conditions (eMODIS NDVI decadal data, at 250m spatial resolution, provided by FEWS-NEW) in the 5areas in the middle of rainy seasons, i.e. May and December, in normal years (2002-2004). This figure could clarify that all the 5 selected rangelands has quite enough vegetation at that moment in normal years.

For further analysis of vegetation condition, NDVI-G Dataset (Version 4, NOAA-16 calibration) was utilized. This NDVI data is derived from data collected by NOAA satellites, and processed by the GIMMS at NASA. This NDVI data is provided in 10-day period for 1995-2008 in FEWS-NET. Those data could be analyzed with special software of "WinDisp51". In the Project, annual accumulated NDVI data was produced to sum-up all the decadal data from January to December to seize the overall annual vegetation condition in each year (1995-2008). Then average of such 14years annual accumulated NDVI data was calculated. The result of the calculation is shown in Figure BD1.4.5. According to this data, those 5selected areas have considerably high vegetation in comparison with the other adjacent areas and considered to be the reliable wet season grazing areas. Thus those areas could be the additional grazing areas in the early stage of dry season if water pans were constructed in those areas.

D1.4.3 Available Rangeland and Migratory Routes in Turkana County

(1) Status of quality grazing area

Turkana land is formed by a pinnate network of seasonal river (Lagga) flowing toward the region's main drainage systems (Lotikipi Plain in the north and Kalakol, Turkwel, and the Kerio River basin lowlands in the central and south regions flowing into Lake Turkana). In the lowlands and gentle hilly region of central Turkana, riverine forests (Acacia Tortilis, Ziziphus Mauritiana, Salvadora Persica, etc.) have developed along many seasonal streams and have become an essential forage resource. The vegetation density of the riverine forests along the seasonal streams fulfils one condition of quality grazing area.

According to Range Management Handbook of Kenya, 1994, 82% of the plant species that exist in Turkana are highly palatable to livestock, and although 10% are considered of low palatability, approximately 92% are utilized for livestock. Only 8% of plant species are not utilized by livestock. Of the woody species which are an important forage resource in Turkana, 59% can only be utilized by camel and goat; while a mere 8% can be utilized by all livestock. Furthermore, not only the young shoots but also the dead leaves and fruit are eaten in 49% of all woody species, thus making them useful throughout both the rainy and dry seasons. Examples of highly palatable and valuable woody species include Grewia Tenax, G. Tembensis, G. Villosa, Indigofera Cliffordiana, Acacia Tortilis and Cordia Sinensis. As for herbaceous species, 98% are eaten and are highly palatable. Of these, 56% are eaten by all livestock species.

As mentioned above, most vegetation can be utilized by livestock, though the palatability differs depending on the species of livestock. Therefore high vegetation density, a developed hierarchical structure of vegetation, and a good balance between the woody species and herbaceous species listed in Table AD1.4.4 are conditions for quality grazing area. The grazing areas both for rainy and dry seasons in Turkana County are illustrated in Figure BD1.4.6.

Table AD1.4.4 Classification of Vegetation Type in Turkana County

Grazing season	Vegetation type	Type No.	Main forage		Livestock species	Landscape	Location
			Woody plant	Grasses			
	Deciduous shrub		*Acacia reficiens* (S)	*Aristida spp.*	All stock	Flat and gently rolling plain	Central and northern part of south district
	annual grassland	**W-1**	*Acacia tortilis* (T)	*Tetrapogon cenchriformis*			
			Indigofera spinosa (DS)				
Wet		**W-2a**	*Indigofera spinosa* (DS)	*Aristida spp.*	Goat, Sheep	Flat and gently rolling plain	Central district
	Deciduous dwarf shrub		*Balanites aegyptica* (S)	*Tetrapogon cenchriformis*	Camel		
	annual grassland	**W-2b**	*Duosperma eremophilum* (DS)	*Aristida spp.*	Goat, Sheep	Flat and gently rolling plain	Southeastern Lotikipi Plain
				Tetrapogon cenchriformis	Camel		
				Sporobolus sp.	All stock	Flooded plain	Lotikipi plain
	Grassland	**W-3**		*Stipagrostis uniplumis*			
				Tetrapogon cenchriformis			
			Acacia reficiens (S)	*Cymbopogon sp.*	All stock	Mountain foot slope, Hilly terrain	Loima range
	Deciduous bushland	**D-1**	*Acacia mellifera* (S)	*Heteropogon controtus*			Foot slope of Ugsnda escarpment
			Acacia senegal (S)	*Chloris roxburghiana*			
Dry				*Leptothrium senegalense*			
			Acacia mellifera (S)	*Oropetium capense*	All stock	Mountain foot slope	Songot mountain
	Deciduous shrubland	**D-2**	*Acacia reficiens* (S)	*Sporobolus spp.*			Mogila range
			Acacia senegal (S)	*Enteropogon macrostachys*			
	Evergreen and		*Acacia tortilis* (T)	*Sporobolus spicatus*	Goat, Sheep	Riverbank flat	Turkwell, Kerio, Tarach riverine
	semi-deciduous woodland	**WD-1**	*Hyphaene coriacea* (T)	*Aristida mutabilis*	Camel		
Wet/dry			*Salvadra persica* (S)				
All year round	Deciduous woodland		*Acacia tortilis* (T)	*Aristida spp.*	Goat, Sheep	Riverside flat	Side of Turkwell river
	annual grassland	**WD-2**	*Salvadra persica* (S)	*Tetrapogon cenchriformis*	Camel		Side of large seasonal river
			Indigofera spinosa (DS)				
			Acacia tortilis (T)		Goat, Sheep	Rivrbank,	Seasonal river
	Riverine forest	**WD-3**	*Ziziphas mauritiana* (S)		Camel	Dry wash	
			Salvadra persica (S)				
			(T): Tree, (S): Shrub, (DS): Dwarf shrub				
Source: Refer to Range Management Handbook of Kenya, Vol. Ⅱ.9, Turkana district, 1994, MALDM, Republic of Kenya							

(2) Grazing patterns and migratory routes in Turkana County

The grazing areas in the Turkana County can be broadly classified into rainy season grazing area, dry season grazing area and rainy/dry season grazing area. The plains stretching from the relatively low altitude interior toward Lake Turkana are utilized as rainy season grazing area, while the northern mountainous region (Kadingetom range, Lorienetom range, Lokwanamoru range, Lapurr range, Mogila range, Songot Hills), western mountainous region (Moru-Angithiger Loima Hills, Puch Prasir Plateau, Uganda escarpment), southern mountainous region (Loriu Plateau) and the Turkana lakeside region make up the dry season grazing area.

Mainly cattle graze in these high altitude dry season grazing areas. In years of drought, they cross over the Uganda escarpment into Uganda. The areas along the banks of the Turkwel, Kerio, and Tarach Rivers and their river basins are utilized as rainy/dry season grazing area. Experience dictates when and where to move, a decision based on the conditions of the year's precipitation, vegetation and security situation. The migratory routes in the County are shown in Figure BD1.4.6, and that in each district are described hereinafter.

(3) Grazing pattern and migratory routes in each district

1) Turkana North District (refer to Figure BD1.4.7)

In Turkana North District, livestock consist of goats, sheep, camels, and a few cattle. The main forage in this rainy season grazing area is the Duosperma Eremophilum Community stretched out on the plain and the riverine forest.

The grazing system currently used in the district is seasonal livestock movement. Rainy season grazing areas are east of Yapakuno, Kaeris Locations and Lotikipi plains. Nakalale and Gotome Rivers flow into the Lotikipi plain, and riverine forests have formed along the river banks. During the dry season livestock especially cattle migrate to Lorionotom ranges, Lokwanamor range and,

Moru-Eris ranges within this district, Pelekech and Songot ranges in Turkana West District and Loima ranges in Loima District. In years of severe drought, the crossing is made over to the Uganda escarpment into Uganda.

2) Turkana West District (refer to Figure BD1.4.8)

In Turkana West District, livestock raised include goat, sheep, cattle and few camel. Vegetation type is rainy/dry season grazing area (D-1), more cover of the dwarf shrub indigofera spinosa than graminaceous species in the rainy season grazing area.

Constituting the hilly area of the upper Tarach River, this district serves as the northern gateway to the prominent Loima range dry season grazing area of Turkana. The riverine forest growing around the Tarach river basin is of high ground cover density. During the dry season, a large number of livestock gather from the eastern and northern lowlands (rainy season grazing areas) to the Loima range and foot slope of the Uganda escarpment.

The rainy season grazing area of northwestern Turkana is the expansive Lotikipi plain rich in grass resources. However, from the end of the rainy season to the beginning of the dry season, as the pools of water accumulated is dried up and the water pans diminish, livestock begin to migrate to the Mogila range and the Songot Mountain. In years of drought, livestock migrate to the escarpment in Uganda.

3) Turkana Central District (refer to Figure BD1.4.9)

In Turkana Central District, livestock raised include goat, sheep and camel. Vegetation type is rainy/dry season grazing area, more cover of the dwarf shrub Indigofera Spinosa than graminaceous species in the rainy season grazing area (W-2a, WD-1).

This region is relatively rich in water resources as it is situated on the banks of Lake Turkana, with Turkwel River running along its southern border. Facing the lake, the district receives the least amount of precipitation and is therefore sparse in vegetation. The gently rolling plains form a swamp forest on its lowlands, and serves as the watering point during the rainy season and grazing area during the dry season. During the rainy season grazing takes place on the interior plains, while there is a migration from the Kerio and Kalapata riverside which is relatively rich in vegetation to the Turkana lakeside during the dry season.

Grazing here takes place in the same area year-round, but as forage runs low at the end of the dry season, the leaves and prematurely-dropped fruit as well as fruit peels of Hyphaenecoriacea distributed on the lakeside and in the riverine forest of the Turkwel River serve as forage.

As livestock ease the propagation of seeds, the unpopular invasive plant Prosopis juliflora (hereinafter referred to as Prosopis) is widely distributed on the lakefront, but the ripe fruits of the Prosopis serve as an important forage source during the dry season.

4) Loima District (refer to Figure BD1.4.10)

In Loima District, goats, sheep, cattle, and camels are raised. Vegetation type is rainy season grazing area (W-1, WD-3), and dry season grazing area (D-1).

Grazing during the rainy season takes place in the eastern lowland plains, and during the dry season the vegetation rich area from the hilly region around the center to mid-way up the Uganda escarpment (close to the national border) serves for grazing area. Cattle graze on the Loima range where graminaceous species are widely distributed. In years of drought, migration occurs over the Ugandan border towards Mt. Moroto despite security issues and also migration towards Pokot North District in Kenya which is south of Loima district.

5) Turkana South District (refer to Figure BD1.4.11)

In Turkana South District, goats, sheep and camels are raised. Vegetation type is rainy season grazing area (W-1), dry season grazing area (D-3), rainy season grazing area (WD-2) and dry season grazing area (D-1,WD-3).

The Lochwaangikamatak Range (Moru-Anok, Moru-Aligoi, Kobiribiri) lied north and south to the west of the highway moving down through this sub-location, and various Lagga traverse the sub-location from the range to the Lokichar River flowing from south to north in the region's east. The eastern plains are the main grazing area during the rainy season, while the Range and surrounding areas to the west as well as part of the riverine forest to the east is used for grazing during the dry season.

Plains constitute the western region with numerous Lagga traversing the area toward the Lokichar River, while lava plateaus lied to the east. The pastoralists utilize the western plains for pasturing in the rainy season, and migrate to grazing areas in the hills area of the southeast (Turkana East District) during the dry season.

In drought spell, migration occurs in the direction of the southern Turkana mountainous region and toward Kalemnyang and Kotaruk along the Turkwell River.

6) Turkana East District (refer to Figure BD1.4.11)

In Turkana East District, livestock raised include goat, sheep, cattle and camel. Vegetation type is rainy season grazing area (W-1, WD-2), and dry season grazing area(D-1,WD-3). As both the Lopii and Lokichar livestock pastoral communities belong to the same territorial section, grazing takes place in the western plains of Lokichar during the rainy season, while livestock are moved south to the hilly region around Lopii in the dry season. During drought, migration occurs to the mountainous area further south.

D1.4.4 Approaches of Natural Resource Management Based on Grazing Patterns

(1) General

In order for pastoral subsistence livelihood as a living to support resilience against and recovery from drought in an average year, livestock must be maintained in good health and the number of bred livestock increased through high reproductive performance. For this, there is a need for adequate supply of feed and water as well as disease control. In the current pastoral system heavily reliant on the natural environment, not much grazing area exists with a well-balance supply of feed and water. In order to solve the problem of unequal distribution of water and forage resources, the improvement of lack of feed, or in other words the recovery of vegetation becomes necessary, and there is a need to plan the improvement of vegetation from a mid to long-term standpoint. The development of water resources on the other hand may take time for site selection, but as soon as the site is decided, development is possible in a relatively short period of time. Within the scope of this project which has a strong emergency aid aspect, the establishment of water supply facilities will be of top priority.

(2) Approach for the effective utilization of potential dry season grazing areas by developing water supply points

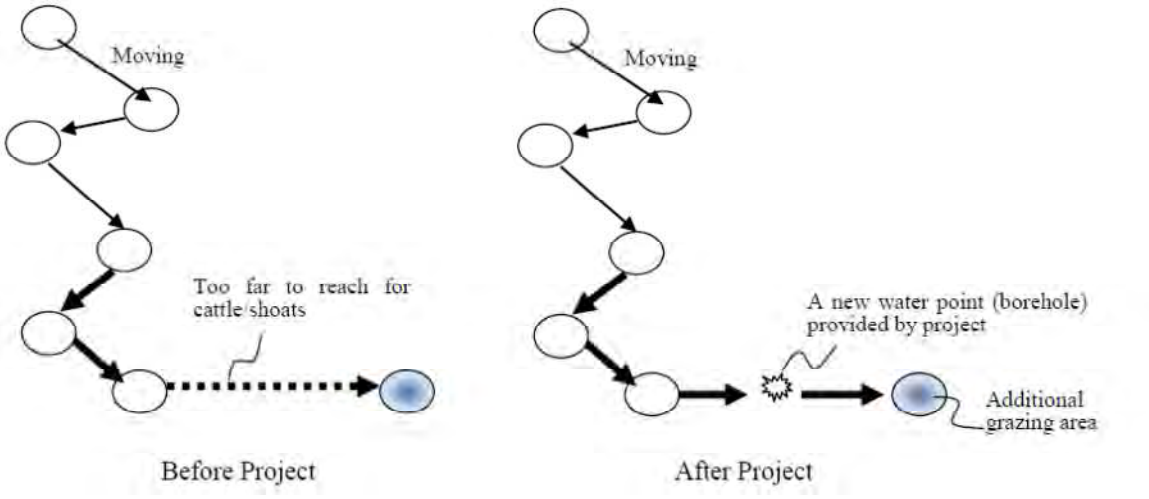
The unequal distribution of water and feed resources in rainy and dry season grazing areas shall be improved by establishing water supply facilities in regions where the supply of water to livestock is a factor limiting the effective utilization of these grazing areas. Qualitative and quantitative improvement of water of existing facilities will be included in the development of water resources.

In grazing areas where water shortages at the beginning of the dry season force people to move on even though forage resources still remain, the establishment of new water supply facilities or repair of existing facilities will allow for extended use of rainy season grazing area, and grazing pressure on dry season grazing areas will be alleviated.

Based on the above mentioned understandings of characteristics of pastoralist movements in dry season and drought period, the following 3 approaches are considered in order to tackle to improve pastoralists' drought resilience in terms of natural resource management.

1) Extension of Pastoralists' Migratory Route at the End to New Grazing Area

This is an intervention that, at the end of pastoralists' migratory route, several water points are provided to connect from the end of migratory route to another new grazing area. In many cases, those water points should be boreholes, and water pan is not effective. Because when herd reach such an end of its migratory route, it is almost the end of a dry season or middle of drought period. So water pan may have dried up at that time.



Source: JICA Project Team

Figure AD1.4.3 Extension of Pastoralists' Migratory Route at the End to New Grazing Area

In this case, a water point should be a permanent water source, such as borehole, because pastoralists need such an additional new grazing area during drought period in which a water pan cannot hold water. Thus location of a water point will be governed by its hydro-geological condition, in addition to other factors. In Marsabit area, interventions with this approach will be limited due to scarcity of groundwater potential.

2) Slow-down of moving speed to another grazing area, and extension of grazing time on the same migratory route

In this intervention, herds shall consume available pastures as much as possible, but within sustainable and acceptable grazing intensity for environmental aspect, before moving to another grazing area. In this approach, not only interventions of providing borehole but also water pan and rock catchment are effective, if its location is properly selected. It is recommended that such water pan/rock catchment should be constructed at the beginning of migratory route, i.e. wet grazing area with unutilized pastures. This approach is based on following basic conditions;

- Wet season grazing

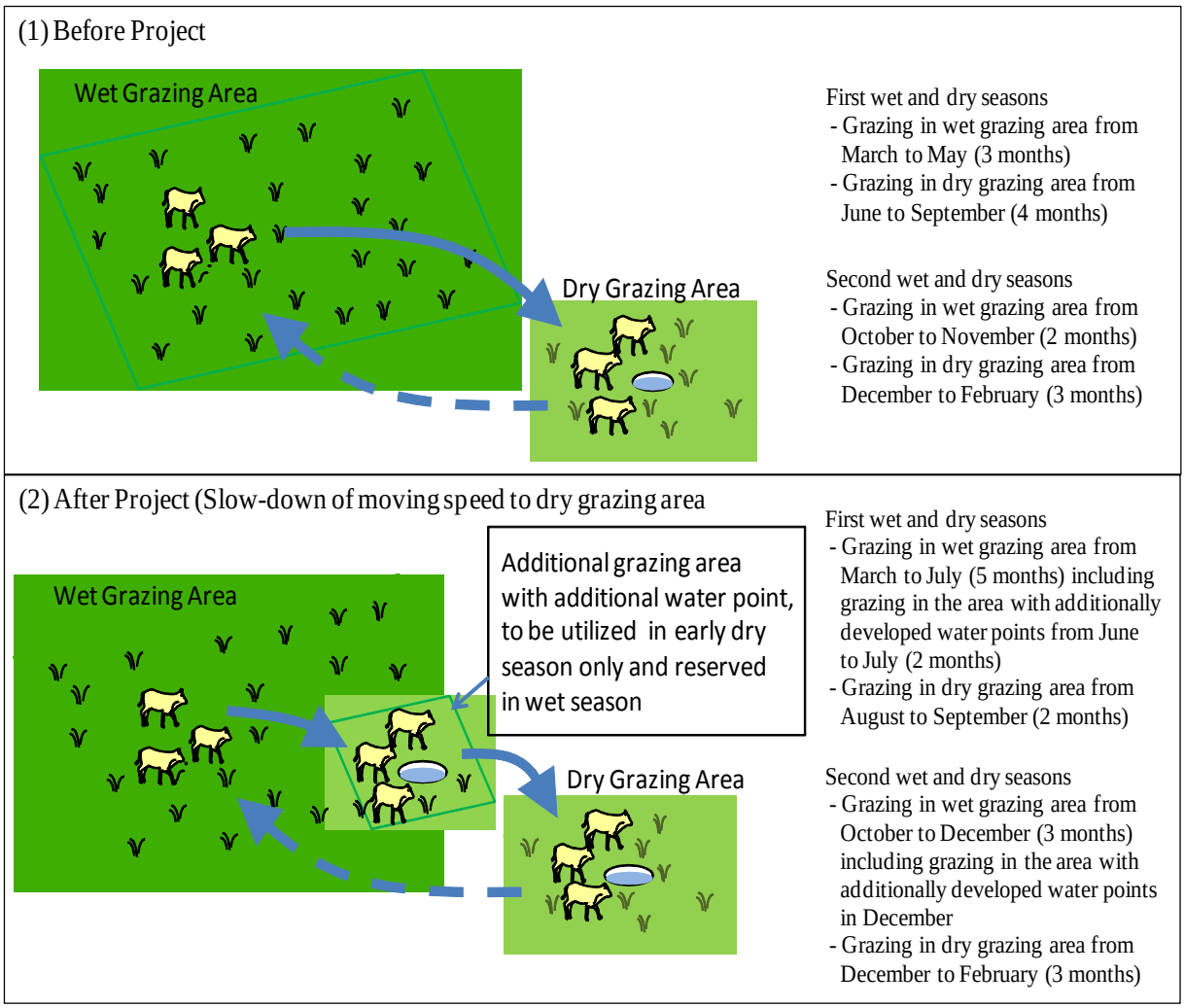
Livestock graze in rangelands covered with sufficient pasture and with less water sources, because the livestock survive not requiring special drinking water during the wet season if good pasture is available enough. Generally, the wet season grazing areas have enough pasture even if the grazing period is extended, however these areas cannot be utilized for grazing during the dry season due to the shortage of water.

- Dry season grazing

In the dry season, pastoralists with their livestock move to rangelands covered with certain amount of pasture and with permanent and/or seasonal water sources, such as borehole, water pan and rock

catchment, etc. These areas however have limited grazing area and pasture within the daily stress distance of the herds against the available water. Because, the herds need to return to the water point everyday during the dry season. After consuming available pasture, the herds move to the other grazing area searching for pasture and water. Especially in the drought period, limited rangeland with water and pasture available for the long dry season is most critical issues as discussed in the previous section.

Based on the above conditions, plan on natural resources management is set up to minimize the grazing duration in the dry grazing area by means of slow-down of moving speed to another grazing area utilizing unused wet grazing area through additional development of water pans/rock catchment in the wet grazing area. Figure below shows comparison of grazing patterns between before and after the project.



Source: JICA Project Team

Figure AD1.4.4 Comparison of Grazing Cycle between before and after Project

- Grazing cycle before Project

Herds of livestock graze in wet grazing areas without water source during the first wet season till the end of May. They move to dry grazing areas at the beginning of June and stay in one or more dry grazing area(s) depending on the available pasture. When the second wet season starts in October in normal years, they move to the wet grazing areas and finally return to their base points. After the beginning of the second wet season in November, they move again and stay in the dry grazing area from December through February, repeating this cycle every normal year. In drought years, the

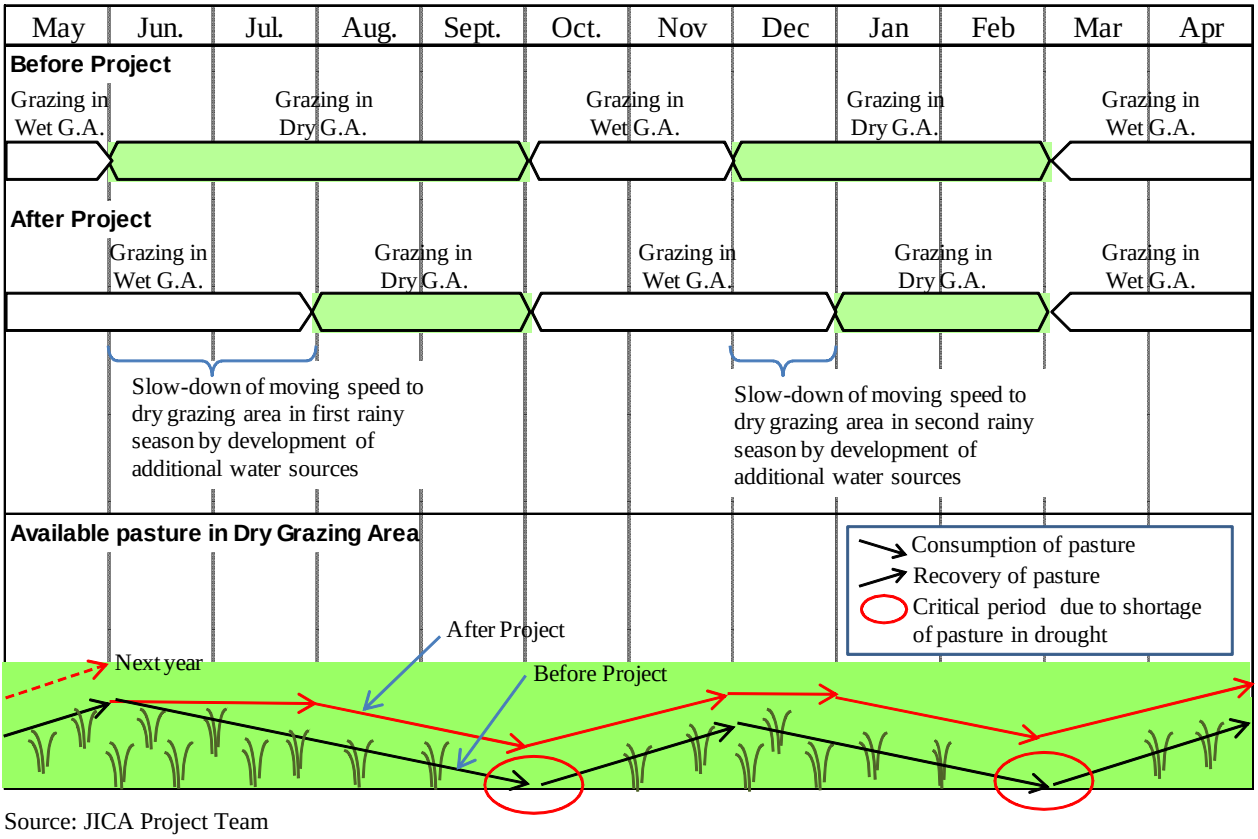
serious damages to the livestock occur at the end of dry seasons, due to the limitation of the available pasture in the dry grazing areas.

- Grazing cycle after Project

The herds graze in wet grazing areas without water till the end of May in the first wet season as same as before the project, after when (beginning of the dry season) they move to and stay in the additional grazing area with new water sources developed under the project. When water is consumed in this area within approximately two months in most cases, they move to the existing dry grazing area from August to September. In the second wet season, they move to the wet grazing area in October and stay till November. As same as the first wet season, they move to and stay in the additional grazing area with new water sources for probably one month only due to less rainfall during the second wet season in the normal years. When water is consumed, they move to the existing dry grazing area in January and February. In the drought year, they can stay more in the dry grazing area with enough pasture.

As compared in the above, new development of water pans/rock catchments in the wet grazing areas creates possibility of utilization of unutilized grazing area or expansion of the existing wet grazing area, which will result in reduction of grazing period in the dry grazing areas and mitigation of grazing pressure to the limited pastures in those areas. In this intervention, the important issue is that this area should be utilized only in the early dry season for slow-down of moving to the dry grazing area and reserved in the wet season by strictly protecting from uncontrolled grazing in the wet season.

The variation (consumption and recovery) of the available pasture in the dry grazing area are shown in the figure below.



Source: JICA Project Team

Figure AD1.4.5 Variation of Available Pasture in Dry Grazing Area before and after Project

3) Providing additional water source at halfway points among grazing areas

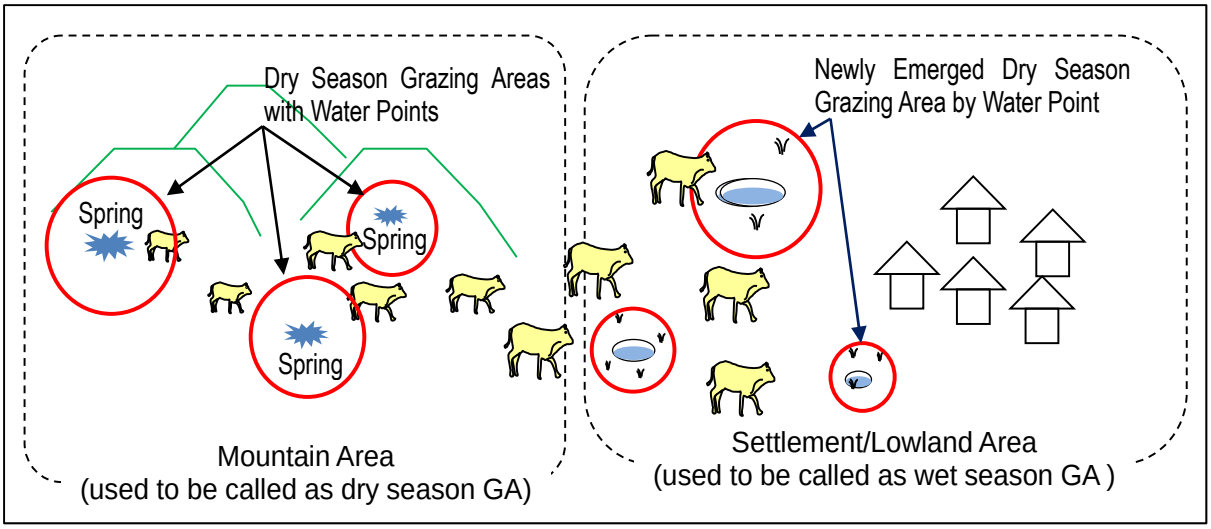
By securing a water supply at halfway points among grazing areas relatively rich in forage resources along the migratory route from rainy season grazing area to dry season grazing area, the grazing pressure on dry season grazing areas can be alleviated, and available dry season grazing area will be expanded up to the rich rangeland located far remote in far remote area.

4) New emerged dry season grazing area with water pan

For example, if a water pan is constructed near the settlement area, an area around the water pan, which is approximately 10 km in radius, will be converted from a wet season grazing area to a dry season grazing area. It means that the new emerged dry season grazing area is established due to the construction of a new water pan near the settlement areas.

In the mountain area, there are a lot of water points for watering animals. However, not all the areas in the mountain area have water sources. Even within the mountain areas, there are several rangelands where livestock cannot graze in dry season due to the scarcity of water. The kind of rangelands should be called as wet season grazing areas in a mountain area.

And in settlement areas, most of the rangelands are used as wet season grazing areas. But, nowadays, several of the new dry season grazing areas are established with water pan. With this, it cannot be called as a uniform wet season grazing area.



Source: JICA Project Team

Figure AD1.4.6 Newly Emerged Dry Season Grazing Area with Water Pan

(3) Forage Resources Development

The Kenya Forestry Research Institute (KEFRI) is striving toward the rehabilitation of vegetation, with the use of enclosures (fences to keep out livestock) and the reforestation of indigenous tree species. Upon inspection of a demonstration pilot field in its 7th year, a significant difference could be observed in vegetation density inside and outside the fence, and the ground surface was covered in Duosperma Eremophilum, very rarely seen outside of the fence. The planted Acacia Mellifera, Balanites Aegyiptica, and Cordia Sinensis had grown to a height of around 2 m. Furthermore, pasture had been remarkably well established in the grassland where surface water had been harvested in a semicircular micro catchment and pasture grass (Cenchrus Ciliaris) had been sown. Residents had harvested the seeds from this pasture to establish new field next to pilot field. Although the past three years had seen relatively high rainfall (391.8 mm in 2011, 385.6 mm in 2012, 263.9 mm in January to August, 2013 at Lodwar Meteorological Station), the potential for rehabilitation of vegetation had been demonstrated. Wire mesh had been used to construct the fence in this case, but if this were substituted by planting cactus (Opuntia Spp.), it could also serve as famine feed during drought.

With a business model for livestock fattening for instance, incorporating both long-term rehabilitation of vegetation and short-term pasture development, sustainable development seems possible.

1.4.5 Other Observations and Recommendations Regarding Grazing Management

(1) Protection of Dry Season Grazing Areas in Wet Season

For effective rangeland utilization, pastures around water points should be consumed only in dry season. Then, in wet season, other areas without water should be utilized because those wet season grazing areas cannot be utilized in dry season. Such concept for "conservation of dry season grazing area in wet season" should be introduced widely into pastoralists' migratory operation.

They say that several tribes have traditional customs and rules for conserving dry season grazing areas in wet season. However, due to following reasons, such good function are seems to be jeopardized nowadays.

- As generally happened in any places of traditional societies in the world, traditional functions in village are weakened by influence of capitalism, modernized thinking, and individualism etc.
- There are so many water points scattered in wet season grazing areas, and new water points will be constructed in near future too. Once a water point is constructed in wet season grazing area newly, the area around this water pan should be recognized as dry season grazing area. And pastures in this area should be conserved until dry season, without consumption in wet season. It seems such rules are not clear to pastoralist communities, especially newly constructed water pans.

It is important that, in Project, that introduction of concept for "conservation of dry season grazing area in wet season" should be introduced with strong intentions when the Project constructs a water pan. Since new water pans will be constructed in a remote area from the residential area of the host community because of its strategic location, it is difficult to put control at the site. Therefore, supporting facilities should be planned such as pile-mark to indicate a range of rangeland management, security fence, control hut, and so on.

(2) Training pastoralists on land use management

Traditional grazing committee thereafter different committees are preparing their grazing plans and peace agreements among the conflicting communities. Communities/pastoralist are reminded of their traditional systems of managing grazing fields (rainy and dry season grazing areas). Many communities/pastoralists have come up with several grazing plans. The grazing plan has much useful information like seasonal migratory patterns location of rainy and dry season grazing areas and water sources during the rainy and dry seasons. During committees meetings or peace agreement meetings the information in the grazing plans are shared for peaceful sharing of resources like pasture and water.

As negative results, it is observed that formed committees did not last long but disappear because of poor local management, fear of insecurity for those communities in insecure areas and may be improper selection of committee members e.g. an official of the committee originating from settled village cannot work closely with the mobile pastoralists. In some communities insecurity has discouraged people from following their grazing plans.

(3) Land rehabilitation by removing Prosopis and replacing with sorghum, maize and vegetables

This activity created space for planting and also helped to slow the spread of Prosopis. In some communities harvested sorghum and maize boosts their food security. This is mostly in along the Turkwel and Kerio Rivers. However, formed committees did not last long implementation because most communities cleared Prosopis when there were hand outs i.e. food for asset and cash for work. In addition, water for sustaining the planted crops was a problem because some farmers depend on rain water farming.

(4) Pasture re-seeding

In areas where it is successful, the fenced/guarded plots with pasture are used during the dry season and reduce distance of livestock searching for pasture. Pasture seeds are sold to those communities who are interested in practicing the idea. However, some communities that engage in pastures re-seeding have no market for selling their dried pasture/hay.

D1.5 Institutional and Human Capacity Development for Natural Resource Management

The management of natural resources including water and pasture in Northern Kenya has been challenging. This is attributed to the gradual erosion of the traditional system of both water and pasture management; diminishing grazing lands and knowledge gap among beneficiaries in professionally managing their water management system. Most communities living in Northern Kenya have some kind of traditional resource management system, especially water and pasture. This traditional system/practice seemed to have been weakened by the emerging and preferred modern system of resource management that is advocated for by the Government agencies and other development actors. Most of the pastoralists' communities inhabiting this part of Kenya from time immemorial have a system where elders are charged with the responsibility of managing both water and pasture on behalf of their respective communities. Their powers and authority is derived from an informal by-laws established by the communities that are enforced to govern the effective use/utilization of both water and pasture.

To strengthen and as a way of reinforcing the existing traditional resources management system within the pastoral setting, i.e. in Arid and Semi-Arid areas, government of Kenya and other development partners have introduced several policies. A major government strategy executed by the government of Kenya is water sector reforms through the Water Act 2002, which delegate responsibility of water supply and management of water to the community encouraging communities to form organized groups such Water Users Associations, Water Management committees, and Environment Management Committee (EMC) that are responsible for effective management of resources, particularly water and pasture within their respective localities. These structures are common practices in this part of Kenya.

D1.5.1 Legislation of Water Resource Management

The Water Act 2002 is an Act of Parliament that provides for the management, conservation, use and control of water resources and for the acquisition and regulation of rights to use water, management of water supply and sewerage services, and certain provisions of the Local Government Act. Water Act 2002 created several institutions/bodies under the Ministry of Water and Irrigation each mandated with specific functions. One such institution is the Water Services Regulatory Board (WASREB) that carries out (i) performance benchmarking; (ii) approving Water Service Providers; and (iii) water tariff adjustments. Other institutions created by Water Act 2002 include Water Resource Management Authority (WRMA) that is responsible to manage, regulate and conserve all water resources by involving the stakeholders guaranteeing sustained access to water and equitable allocation of water while ensuring environmental sustainability, and the water services trust fund (WTF) that provides financial support for improved access to water and sanitation[1].

Government policy in water resource management and the Water Act 2002 recognize the need for stakeholder participation, and ownership of the community by delegating management function of every water source to the community for effective water resource management. WRMA accounts for establishing partnerships to improve the management of water resources.

D1.5.2 Water Users Association

At the community level, community members have been encouraged and enabled to form Water Users Associations (WUAs) which registered themselves as either Self Help Groups (SHGs) or Community

[1] Water Service Trust Fund and Water Resources Management Authority (2009) 'Water Resource Users Association Development Cycle (WDC)'

Based Organizations (CBOs) under the Ministry of Gender, Children and Social Development. With the water sector reform, registration of Water Resources Users Association (WRUA) under WRMA was introduced to promote controlled and legal water use activities as well as to promote good management practice for efficient and sustainable use of the water sources [2]. These community-based groups/associations are mandated to manage and run water and related resources such as pasture within their location.

The groups or association registered as SHGs or CBOs are officially recognized to conduct meeting, to open bank account, to raise funds and to undertake its activities, despite it does not provide legal recognition[3]. This means SHGs and CBOs cannot enter into any contracts or own assets. As the registration process and conditions for SHG and CBO are not complicate, those are realistic and feasible status for newly established groups.

WRUA is a category of community groups which focus on water resources management and conservation of a particular area, river or aquifer. WRUAs are registered with the Registrar of societies as an association at the Attorney General's Chambers. Registration provides the group with legal status to operate, open bank accounts, hold assets and enter into legal contracts.

In Northern Kenya including Marsabit County, there exist so many WUAs mostly registered as SHGs with very few registered as CBOs. Registered groups that have currently transformed themselves into WRUAs in Marsabit County were only three[4] at the beginning of the project.

D1.5.3 Traditional Water Management System

Different communities living in Marsabit have their own traditional water management system. The most practiced system is the 'Aba Herega System' especially in Borana community where an individual is appointed by the whole community living in a given location (locally called 'dedha'). The Aba Herega is thus charged with the responsibility of water distribution and enforcement of related-by-laws at a given pan/dam. This position is normally held or given to a male gender and is often a powerful and respected position in any setting where pastoralism is practiced, especially in Northern Kenya. Aba Heregas supervise use of water source and pasture around the water source in daily basis with help of two to three village elders to support supervision at the site in turn. They are serving the community in voluntary basis. Currently as most communities have started gradually embracing modernity, other management structures have found their ways into these communities and are utilized along with their traditional structures of water and related resources management system.

D1.5.4 General Situation of Water Facilities and their O&M before the project

Most water sources, including Pans/Dams, Boreholes, Rock Catchments, are depended on by both human and livestock except for the few man-made shallow wells. Scarcity of the water sources compared to the population that depends on them results in overuse, which often leads to breakdowns of water supply facilities. Break down or minor problems frustrates the beneficiaries, especially in situations where they do not have immediate resources to correct faults such as skilful manpower, funds and/or where water sources are distant from town centres and assistance could not be easily sought. In case of any problem, communities often rush to Non-governmental organizations (NGOs), Constituency Development Fund which is under the management of their area Member of Parliament or any other assistance. The following explains the commonly observed status of O&M in each water source in the project area.

[2] Water Service Trust Fund and Water Resources Management Authority (2009) 'Water Resource Users Association Development Cycle (WDC)'

[3] Ministry of Water and Irrigation, Kenya (2012) 'Trainer's Manual for Community Managed Water Supplies in Kenya', FAO and UNICEF-Kenya

[4] Source of the information from WRMA Marsabit office through verbal conversation (Feb 2013)

(1) Water Pan

For both sustainable use of water and maintenance work, sediment removal work is inevitable. Although pan desilting is a common practice among the pastoralists of Northern Kenya, most of the existing pans still have sedimentation problems resulting in reduction of effective water storage. Essentially, users of the water pans work to remove sediment during their stay for watering, by forming temporary wall to hold back water and remove sediment as the water level decline. Since this measure does not work perfectly for sustainable use, silting problem raise periodically in most of the pans despite their effort of desilting. The main challenge with regard to major desilting after a certain amount of sediment accumulated is labour because the pastoralist communities often migrate from one water source to another. This means the bulk of the desilting work is left to the host settled community who often do not have enough labour to execute the desilting work. In many cases, as the burden of desilting work left to the owner community exceed their capacity, they depends on external assistance for machinery work to remove silt from the pan.

(2) Borehole

Most of the existing boreholes have water fee collection systems in place mainly to cover fuel cost for generators. However, many of them do not have proper and effective water charge collection system thus often constrained by inadequacy of funds for effective operation and maintenance activities. The poor water charge collection is attributed to their lack of knowledge in water tariff calculation and setting. O&M activities for the pump and the diesel-run generators at the existing boreholes are not achieved under the current water charge system, which often require external financial support for maintenance. In addition, delay of the payment of water charge has been one of the causes of difficulty for the committee to manage their operation. This is mainly due to absence of money economy in the pastoralist community. Pastoralists in the area do not normally keep cash in their hand and they sell livestock to obtain cash whenever they need monetary payment. However it is difficult to find opportunities to sell livestock promptly when they need due to scarcity of livestock market in place. Although complete default of the payment is not very common owing to the mutual reliance among the pastoralists, delay of the payment cause crucial problem to the operation that should be run by diverting money from their income directly to the expenses.

(3) Pipeline

Piped water supply is very minimal in the whole of Northern Kenya. Where it exists, the supply system is confined to the town centres to serve settled communities and the system is often managed by the Ministry of water except in major urban areas where municipalities, city councils, private entrepreneurs/companies also manage piped water supply system. This means pipelines in rural area managed mainly by the community do not have any established system of O&M unless the institution that installed the pipeline introduced a particular management system.

(4) Rock catchment

Potential rock catchment areas, having exposed rock surfaces, are fewer due to limited rainfall and high evaporation in the location and there is no common management system for rock catchment observed probably because rock catchment itself does not require much maintenance work. However, many rock catchments have supplemental structures such as water tank, tap and pipes attached to the rock catchment, thus maintenance work for these structure shall be required. Besides, management of quality of water is another issue of rock catchment water source. Although rock catchment is mainly established for domestic use, hygiene and quality of water are not well maintained.

D1.5.5 Pasture Management

Pastoralists thrive in disequilibrium that is characterized by uncertainty and variability of resource base. Critical resources like rains and ensuing growth of pasture cannot be clearly determined on fixed timeline and proportional output. It is spread overtime and space between seasons and this therefore calls for management system that is constantly adapted to changing environment and circumstances that is fluid and flexible. Mobility is thus a key strategy tool used by pastoralist to opportunistically exploit

these spatial and temporally spread resources. Movement between wet and dry season grazing areas is key features that keep the vibrancy of the pastoral system in place. To ensure not only resource use prudence but also orderly availability during periods of scarcity, pastoralists have developed elaborate management systems over pasture use in consideration of relation with other communities and tribal groups. Grazing areas is guided by intricate and sophisticated negotiations between groups, observance of principles of reciprocal rights and property regime right as defined by past customs.

Traditionally, pasture management had been the work of elders of every pastoralist community of Northern Kenya. The elders by the powers conferred upon them by their respective community members, decide where livestock should graze during wet and dry seasons as well as setting appropriate rules of governance regarding rangeland management. Rules of grazing area and pasture use are defined by the community of the area that are applied to all the pastoralists within and outside the area. Therefore whoever comes to graze in the area should follow the rules set in the community of the area. Conflicts occur predominantly in cases when outside pastoralists violate the rules of the owner communities. When infringements occur, community elders warn the person who breach the rules, and if further defence raises, the issue is referred to the elders of the original community of the person who breach to reconcile the issue between elders of the concerned communities.

A new grass-root a structure called Environmental Management Committee (EMC) has been introduced by the Government through National Environmental Management Authority (NEMA) in partnership with Non-governmental Organizations. The EMCs are community-based structures comprised of selected community members mandated to protect and conserve the environment within their respective location through such regulation as restriction of logging and over grazing. EMCs are entitled with a certain governing power to regulate their rules and are charged to enforce sanction for cases of violation. However, in cases of conflict around the pasture use of logging, reconciliation is often made by community elders with necessary intervention of the administrators if necessary. It means the EMC works closely with the grass root government administration and community elders to ensure their environment is well protected and conserved from misuse by the people that are expected to sustainably benefit from it. EMC's presence is found in almost every sub-location / location across the country.

D1.6 Proposed Scope of the Sub- Projects under ECoRAD

D1.6.1 Facility Improvement for Natural Resource Management

Natural resource management under the project is defined as the effective use and conservation of water and pasture for the pastoralists. These two issues of water and pasture shall not be discussed independently of each other in order to comprehensively manage both water and pasture, but comprehensively considered based on the grazing pattern and migratory routes of the pastoralist. Under such understanding and based on the examination of the issues discussed in the previous sections, natural resource management including water points to be newly constructed and/or rehabilitated in the target communities shall have the following strategic concepts for drought resilience.

1) Strategic distribution of water points
   - Extension of pastoralist' migratory routes at the end to new grazing area
   - Slow-down of moving speed to another grazing area and extension of grazing time on the same migratory route
   - Providing additional water facility at halfway point among grazing areas
2) Structural improvement of water pans
   - Easy for silt removal, and protection for water contamination
3) Improvement of maintenance activities
   - Burden sharing system for sediment removal
4) Improvement of operation activities
   - Conservation of dry grazing area in wet season

5) Introduction of Solar Pump System
   - Maintenance free to reduce O&M cost
6) Introduction of Underground Water Reservoir of Rock Catchment
   - Increase storage capacity to meet increasing demand
7) Improvement of Water Supply Pipeline
   - Increase water supply to meet increasing demand

These strategies do not mean the covering area of a sole target community, but shall contribute all the concerned pastoralists from other communities, based on which the development of water facilities and their management plan for sustainable water and pasture should be selected in the target communities.

D1.6.2 Collaboration between Water and Pasture Management

As mentioned above, there are existing systems of water management as well as pasture management both in traditional ways and with systems introduced by the government and other assistance. However, each respective management body such as Water Users Association and Environment Management Committee often has separate rules and authority working in the same area on the interrelated issues. The project is proposing and encouraging collaboration between water management and pasture management as those are deeply interrelated as pasture consumption is highly depending on the availability of water source. The collaboration between water management and pasture management will be particularly important for the water source such as strategic water pans that are established to provide water during early dry season to make pasture accessible in the area where animals could not have grazed during dry season without the water source, which prolongs the time for livestock to reach and start gazing in the area around the permanent water source. For those water pans constructed through the project, water management committees in collaboration with EMC are encouraged and facilitated to set their rules and management system on water source and grazing patterns in consideration of sustainable and efficient pasture use to preserve available pasture that will enhance resilience against drought.

D1.6.3 Strengthening Organizations and Management Capacity

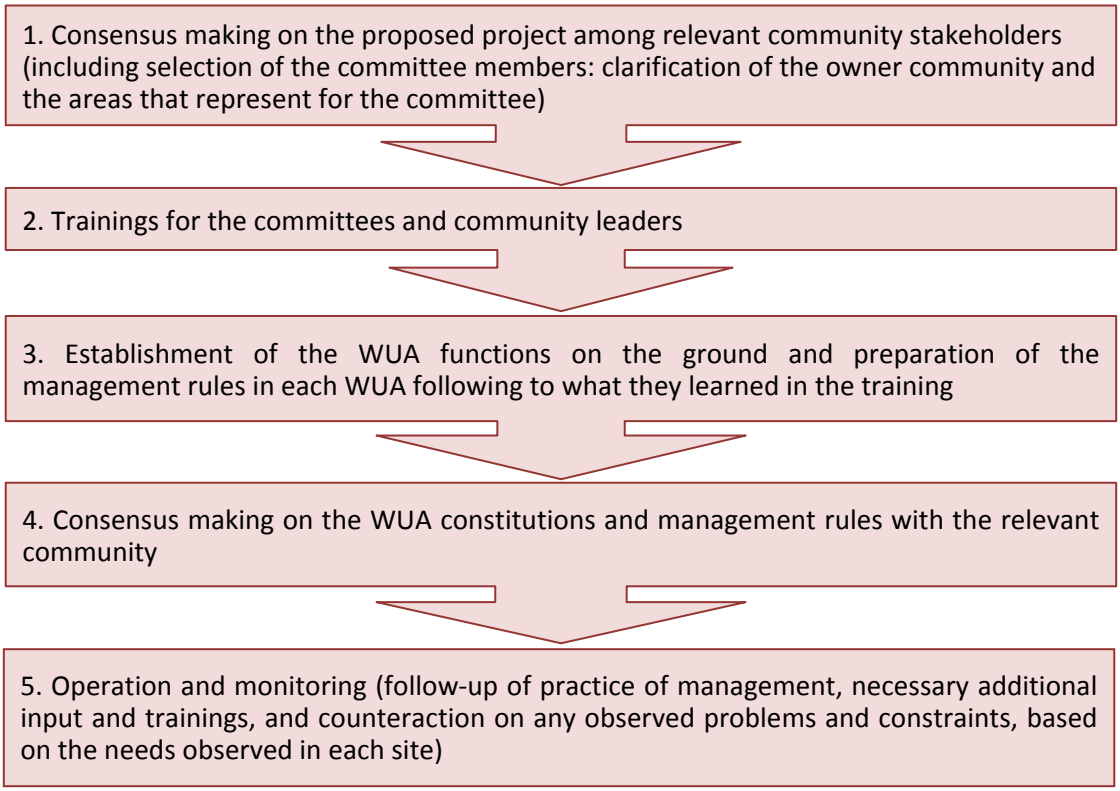
In consideration of the above mentioned current situation, the project shall support establishment of management system in each water resources, which focus on the corrective action by the community and which can contribute to the community resilience.

A part of the project support on establishment of water management body was subcontracted to the local NGOs that have some experience in the local community and the Project team was to supervise the work with necessary interventions with the views of outsiders that the local NGOs may lack or neglect. Recognizing the organizational capacity building takes time with close monitoring, the project engaged in the intense monitoring work with necessary additional intervention after the training programs conducted by the subcontracted NGOs.

Basic management function was to be established in a management body for each water source even though the detail management needs differ in different water source. Rules and regulation setting and their practice are fundamental function to be expected in the management. Since rules to be set may highly depend on the water source and situation of the community, sensible process was taken to build capacity of the management bodies on establishment of feasible rules and their operation.

(1) Basic steps for the establishment of water management bodies

Establishment of the water management system will be supported through the following steps.



Source: JICA Project Team

Figure AD1.6.1 Basic Steps for Establishment of Management Bodies

Consensus building and participation of the community at each stage is especially emphasized for enhancing their ownership of the Project considering the incidents of several external assistances having been implemented without enough involvement of the communities and relevant stakeholders in decision making process that was pointed out by the people. Community meeting shall be organized by supporting the people in charge to share the information about the occurrence in each step of the operation.

Capacity development trainings were conducted targeting the relevant stakeholders such as the water management committee members, EMC members, community elders, field level administrators, and community opinion leaders. The trainings consist of the following topics, though the contents shall be customized according to the necessity in different water sources. Contents of the training is show in the following table

Table AD1.6.1 Subjects and Contents of the Management Trainings

Subject	Topics	Issues for discussion
Formation of the organization	- Definition and registration of membership - Registration of the WUA/WRUA	- Needs assessment of WUA. - Whether it is necessary to form an association of users with membership not only the committee. - Judge whether to form WUA or manage with the traditional system. - Necessity of registered organisation, considering the eligibility and condition against their capacity and current situation. Through discussion of benefit, condition and procedures and let them decide whether they will establish with legal entity or not.
Constitution of the organization	- Rules and regulation of the WUA	- Importance of practical regulation to manage a group to be understood - Establishment of rules and regulation of the membership, roles and responsibilities, organizing regular meeting, and decision making process

Financial management	- Needs of financial management - Basic bookkeeping of the organization - Utilisation of the group fund - Transparency and accountability	- Discuss on the needs of introducing fee collection to the water source such as water pan that may not require cash expenses in operation (e.g. maintenance work can be done by labour contribution) - Option of small fund (not water charge but users fee) to manage small expenses such as payment for guards, minor repair, instead of introducing a complicate water charging system. - Transparency of the financial status and decision making to minimize mismanagement especially in the situation where majority of the members are illiterate. - Enhancing awareness and mind of collective responsibility. It is important for the people in the community to understand what is happening in the committee as it is their property and they are responsible on it, not rely totally on the committee members. - Proposing some options of accountable management that can be understandable to general people in the community (e.g. visual explanation in the general meeting) - Installation of water meter to assure collection of fees and to confirm the amount collected with the quantity of water used. Assess the needs in terms of the number of water point and meter reading skills. - Regulation in procedures for expenses and procurement such as meeting with community/members for decision of purpose of expenses, procedure to withdraw money from bank with signature of more than three committee executives and counter signature of administrative officer, disclosure of the expense
Natural Resource management	- Explanation of the structure of water source and works to be done in the project - Calculation of cost and setting of water charge - Rules and regulations, and responsibility of users in water use and pasture consumption (including non-members/outsider users) - Management of pasture use (cooperation with EMC)	- Operation and maintenance of water source (e.g. desilting for water pan, hygiene/cleaning of surrounding environment of the source, Security of the water source and structure (esp. Solar)) - Water fee setting based on the necessary costs (fuel (for borehole gen set), maintenance and repair, workers for operation, administration costs), based on usage of water by livestock, household, and other users, in consideration of wastage and leakages, and in consideration of disparity of income as per season - Rules and regulations, and responsibility of users in water use and pasture consumption (including non-members/outsider users, internal users (mainly for domestic use), livestock purpose by the internal community, seasonal user (outsider, pastures), commercial traders, water lorry, etc) - Use of seasonal water source (to prolong the duration of grazing at the seasonal water source by prohibiting the pasture consumption around the water source during rainy season) - Management of pasture around permanent water source (to preserve pasture around the permanent water source for dry season) and rules in pasture control (duration and timing of grazing around the water source) - Regular operation and monitoring system of management (who to be responsible, and how to operate) - Management of several water distribution points
Fund management	- Utilization of savings	- Possible suggestions of utilization of savings (including; savings for the drought disaster situation, interloaning for the members, capital for community development work, allocating for strengthening operation and maintenance (e.g. payment for person in charge for management, pasture management supervisor) - Management and accountability of the utilization of savings (e.g. decision making and accountability in utilization for community development work, rules in inter-loaning, etc)
Access to safe water	Water and Sanitation	- Hygiene at the water source where animals and human share water by restricting animals entering water with fence, temporary wall etc, by constructing latrine near the water sources)

Source: JICA Project Team

For the water sources that require fee collection, establishment of adequate and applicable financial management is crucial considering the situation where the majority is illiterate. When only a few persons have literacy and power over the financial control, mismanagement can be easily manipulated. Individual measures should be taken on the management of water charges and fees to avoid mismanagement, which include introduction of accountable record keeping with feasible monitoring system, disclosure of the financial status to the community in understandable manner for the illiterate, and strict procedures for collection and withdrawal of the funds.

CHAPTER D2. MARSABIT: SUB-PROJECT OF NEW CONSTRUCTION AND REHABILITATION OF WATER PAN

D2.1 General

D2.1.1 Outline of the Sub-project

General outline of the sub-project is summarized below.

Table AD2.1.1 General Outline of the Water Pan Construction and Improvement Sub-project

1. Objectives	This sub-project aimed to improve sustainable natural resources management both of water and pasture in the grazing area through new construction and improvement of an existing water pan in the rainy season grazing area. Further, to improve operation and maintenance activities, especially strengthening of water users' association was targeted.	
2. Number of Beneficiaries	Unspecified	
3. Implementation Organization	JICA ECoRAD Project, water users' association and environmental management committee	
4. Project Contents		
1) Project Outline	1) Construction of new water pan and related facilities, such as intake, inlet channel, silt trap, spillway, etc. 2) Improvement of existing water pan with new construction of additional pan (Cascade system) and other related facilities 3) Rehabilitation of existing water pan such as desilting and shaping, etc. 4) Strengthening of water users' organization 5) Improvement of operation and maintenance system and regulations through training program.	
2) Facility / Activity	*Facilities/Activities*	*Implementation*
	1) New construction and rehabilitation of water pan	1) Contractor
	2) Organization and strengthening of water users' association	2) NGO and project team
	3) Procurement of O&M tools	3) Contractor
	4) Monitoring	4) Project team
3) Organization for O&M	Water users' committee and environmental management committee	
4) Construction Period	- Yaa Gara and Sotowesa Water Pans Construction started in January, 2013 and completed in June, 2014. - Dadach Manchure, Dololo Dokatu and Haro Girisa Water Pans Construction started in December, 2012 and completed in June, 2014.	

Source: JICA Project Team

Sub-projects under natural resources management, aimed at improving sustainable natural resources management both for water and pasture in grazing areas. This is through new construction and improvement of existing water pans in rainy season grazing areas. They further aimed to improve operation and maintenance activities, especially for desilting works, structural improvement of silt trap facility and strengthening of water users' association.

D2.1.2 Concept of Water Pan Development

Poverty and food insecurity induced by drought in Northern Kenya shall be mitigated. To enhance pastoralist communities' resilience against drought, sustainable natural resources management shall be

realized in the target communities. Natural resource management under the project is defined as the effective use and conservation of water and pasture for the pastoralists. These two issues of water and pasture shall not be discussed independently from each other, but comprehensively considered based on the grazing pattern and migratory routes of the pastoralists.

Presently dry season grazing areas with permanent water points are deteriorated due to over grazing, while some rainy season grazing areas are unutilized due to the lack of water points during the dry season. Therefore new construction and improvement of existing water pans are the key issues of the enhancing resilience in order to improve sustainable natural resources management both of water and pasture in the grazing area. For effective rangeland utilization, pastures around water points should be consumed only in dry season. Then, in rainy season, other areas without water should be utilized because those rainy season grazing areas cannot be utilized in dry season. Such concept for "conservation of dry season grazing area in rainy season" should be introduced widely into pastoralists' migratory operation.

As for surface water, there is no permanent river in Marsabit County. The Lake Turkana water is alkaline and lies at the lower level, and hence not considered as potential source at present. Other lakes and swamps including craters have water, which is mostly seasonal and some are for wildlife. The locations of the sub-projects of new construction and rehabilitation of water pans were selected taking into conditions the pastoralists' migratory routes, available rangeland that are not fully utilised and distribution of existing water points. Further, to improve operation and maintenance activities, especially for desilting works, structural improvement of silt trap facility and strengthening of water users' association were targeted.

D2.1.3 Selection of Sub-Project of Water Pan Development

Target areas for water pan development were selected taking into consideration basic concepts of strategic distribution of water points for efficient preservation and management of grazing areas, which were (1) extension of pastoralists' migratory route at the end to new grazing area and (2) slow-down of moving speed to another grazing area and extension of grazing time on the same migratory route as well as potential rangeland conditions.

In selected target communities, community managed disaster risk reduction (CMDRR) was conducted, and community action plans (CAPs) have been formulated, according to the above strategic distribution of water points. CAPs proposed various interventions including new construction and improvement/upgrading of civil structures and facilities. Four sites were selected for construction and improvement of the water pan during CMDRR, and in addition to the originally selected as above, rehabilitation of an existing water pan was requested by the community during the course of the sub-contract works. Finally, 5 sub-projects sites were implemented for construction and improvement of water pan under the Project as listed below and their location map is shown in Figure BD2.1.1.

Table AD2.1.2 List of Water Pan Construction and Improvement Sub-project

Name of water Pan	Community	Type of Civil Works
Yaa Gara	Hurri Hills Location	Improvement (introduction of cascade system)
Sotowesa	Turbi Location	New construction
Dadach Manchure	Gar Qarsa Location	New construction
Haro Girisa	Gar Qarsa Location	Rehabilitation (desilting work) and improvement
Dololo Dokatu	Dirib Gombo Location	New construction

Source: JICA Project Team

Salient features of the construction works of the sub-projects are summarized below, and the final revised design of the water pans and related facilities are shown in Figures BD2.1.2 –BD2.1.5. EIA for those facilities were made (see Attachment D2)

Table AD2.1.3 Salient Features of the Water Pan Construction and Improvement Sub-project

	Yaa Gara	Sotowesa	Dadach Manchure	Haro Girisa	Dololo Dokatu
Length of temporary access road	-	7.0 km	-	-	21.7 km
Catchment area of water pan at intake point	5.8 km^2	8.8 km^2	4.0 km^2	-	237.1 km^2
Effective storage capacity of water pan	17,300 m^3 & 3,100 m^3	15,700 m^3	12,100 m^3	6,000 m^3	15,800 m^3
Dimensions of water pan (water surface) in m	121 x 81	77 x 77	110 x 60	irregular	85 x 85
Dimensions of water pan (bottom) in m	112 x 72	60 x 60	100 x 50		70 x 70
Effective depth of water pan	1.8 m	3.3 m	1.1 m		3.0 m
Dimensions of silt trap (bottom) in m	-	20 x 20 x 2.0	25 x 15 x 1.0	-	20 x 10 x 2.0

Source: JICA Project Team

D2.2 Outline of Construction and Improvement of Water Pan Facilities

D2.2.1 General Conditions of Natural Resources in Hurri Hills Area around Yaa Gala Water Pan

The proposed site lies in Hurri Hills Location of Marsabit North District as shown in the location map. Hurri Hills are located 70km to the north of Maikona Town and lies at 1,685m above sea level. The area is normally cold throughout the year with temperatures ranging from a low level of 15ºC to 27ºC at the highest. The area is characterized by mist and fog during the coldest months of the year. Rainfall ranges from 500 to 600 mm per annum though erratic and poorly distributed.

Hurri Hills, both the eastern and western slopes is wet season grazing area since it has no permanent water source and the availability of surface water attracts an influx of livestock from the surrounding neighborhoods of Turbi, Bubisa, Kalacha, Maikona, Balesa and Forole areas. Since the area has no permanent water source, people rely on rainwater harvested in pans, underground tanks and rock catchment. There are 3 existing water pans, namely i) Yaa Gala Water Pan, ii) Blalat Water Pan and iii) Holo Gandile Water Pan in and around Hurri Hills, of which operational duration are about 2 to 4 months.

Existing Yaa Gala Water Pan located 23km north from Badha Hurri Town has a storage capacity of about 3,000m^3, which is utilized both for drinking water and livestock use mainly during the rainy seasons. The pan dries up within one or two months after rainy season finishes due to insufficient storage capacity. Therefore, increase of storage capacity of existing water pan is required and a cascade system is proposed. By placing several pans in series, the total volume of sediment flowing into the pans can be reduced compared with pans placed in parallel.

D2.2.2 General Conditions of Natural Resources in Turbi Area around proposed Sotowesa Water Pan

The proposed site lies in Turbi Location of Marsabit North District bordering Moyale district to the south and Wajir to the west, as shown in the location map. Turbi has acute water problem with recurrent drought hazards affecting the pastoralists' livelihood resulting to vulnerability. The community in Turbi depends on seasonal rain fed pans for domestic and livestock water needs. In addition, some boreholes have been developed around the town under the national highway project recently. Rainfall is bimodal with mean annual ranging from 150 to 200mm. Temperatures may rise up to 40ºC.

The area has harsh climatic conditions, unreliable and unpredictable weather patterns and general remoteness with the inhabitants commonly exposed to frequent natural disasters more so droughts causing famine. Whether in normal times or drought times, the biggest factor that affects Turbi livelihoods is water. Though water is scarce, Turbi has one of the rich range lands in the region often unutilized due to water scarcity.

The proposed Sotowesa Water Pan site is located near the location boundary with Bubisa in the Galgalu Plain, in which there is rich pasture, while no permanent water source available. Existing water points in and around Sotowesa including water pans and boreholes are listed as below.

Table AD2.2.1 Existing Water Points in and around Turbi

Water Pan and Rock Catchment	Borehole
- Funan Itha Water Pan - Funan Kumbi Water Pan - Tita Water Pan - Village Water Pan - Turbi Water Pans No.1-No.6 - Rock Catchments	- Rawana Community Borehole - Dasawachu Borehole No.1 - Dasawachu Borehole No.2 - Dasawachu Borehole No.3

Source: JICA Project Team

Proposed Sotowesa Water Pan located 38 km east from national highway No.2 is designed in Gal Galu Plain, which has not been fully utilized during the dry season with rich rangelands. There is no river that has certain discharge even during the rainy season. However, it is reported by the pastoralists that runoff from the catchment is inundated according to the local topography and sufficient water source is available during the rainy season at the lowest area, and hence the new construction of water pan is proposed at this area.

D2.2.3 General Conditions of Natural Resources in Dirib Gombo Area around Proposed Dololo Dokatu Water Pan

Dirib Gombo Location is under Gadamoji Division of Marsabit Central District. Dirib Gombo Location comprises of two sub-locations namely; Qachacha and Dirib Sub-locations.

In the area, there are many water points including pans and boreholes, which have however deteriorated or malfunctioning due to the poor maintenance and lack of fund. Existing water points in and around Dirib Gombo are listed as below.

Table AD2.2.2 Existing Water Points in and around Dirib Gombo

Water Pan and Dam	Borehole and Shallow Well
- Gar Qarsa Water Pan - Qarsa Simiti Dam - Guyo Tendeke (Dub Goba) Dam - Qubi Kalo Water Pan - Boru Haro Dam - New Water Pan - Dambala Gombo Water Pan - Jaldesa Water Pan - Halo Girisa Water Pan	- Bubisa No. 1 Borehole - Qubi Kalo Borehole - St. Paul Secondary School Borehole - Qubi Bagasa Borehole - Shallow Well

Source: JICA Project Team

Proposed Dololo Dokatu Water Pan located 20km east from Dirib Gombo Town was selected from some alternative sites, in which rich rangeland has not been fully utilized during the dry season. There is one seasonal river run off from eastern slope of Marsabit highland that has certain discharge in rainy days during the rainy season, and hence the new construction of water pan is proposed at this area.

2.2.4 General Conditions of Natural Resources in Gar Qarsa Area around Proposed Dadach Manchure Water Pan

Qilta Korma location is located in Marsabit Central District, covering an area of 282.5km^2 and is administratively divided into two sub-locations namely, Qilta and Gar Qarsa. The area is classified as part of the agro-pastoral zone. In the area, there are many water points including pans and boreholes, which have however deteriorated or malfunctioned due to the poor maintenance and lack of funds. Existing water points in and around Gar Qarsa are listed as below.

Table AD2.2.3 Existing Water Points in and around Gar Qarsa

Water Pan and Dam	Borehole and Shallow Well
- Halo Girisa Water Pan - Gar Qarsa Water Pan - Gar Qarsa Dam - Qarsa Simiti Water Pan	- Bubisa No. 1 Borehole

Source: JICA Project Team

Proposed Dadach Manchure Water Pan located 7km north from Gar Qarsa Town was selected from some alternative sites, in which rich rangeland has not been fully utilized during the dry season. There is one seasonal river run off from northern slope of Marsabit highland that has certain discharge in rainy days during the rainy season, and hence the new construction of water pan is proposed at this area.

D2.3 Implementation of the Facility Improvement Works

D2.3.1 Implementation of construction works for water pans

Implementation of the sub-projects at Dadach Manchure and Dololo Dokatu was commenced in December 2012 by a selected sub-contractor, and Yaa Gala and Sotowesa in January 2013 by another selected sub-contractor. Details of events and observation during construction period are described in D2.4.

D2.3.2 Extension of Construction Period

Though these sub-projects were targeted to complete by middle of April 2013 before the long rainy season, the construction works were disturbed and much delayed due to the various reasons, which were mostly evaluated to be force majeure or events beyond the control of the project team and the sub-contractors and which, by the exercise of due diligence, neither party was able to overcome. Reasons of the delay in the construction works were mainly the following events.

1) The construction was suspended due to public disturbance during the election period in entire Kenya from the beginning to the end of March 2013, when the foreign consultant of the project team was obliged to go to and stay in Nairobi. During this period, the field works were completely stopped, and even after the election, the sub-contractors were not able to resume the works for long period due to the social instability up to May 2013.
2) In April, the rainy season started and seriously affected the sub-contractor's re-mobilization to the construction sites, especially due to inundation and muddy conditions of their access roads.
3) Due to security conditions getting worse in Marsabit County, all the field activities of the project team in the county stopped till end of May 2013. During this period, supervision by the project team including design modification according to the site conditions was not properly operated and hence the construction works were much affected.
4) In the long rainy season in 2013, unpredictable heavy rainfall was recorded, of which return period was evaluated to be less than 1/50 years probability.

After evaluation by the project team of the delay due to these events and affected period, the extension of the sub-contract periods for each sub-contract was accepted. Major events on contract amendment are shown in Annex J.

D2.4 Issues Observed during Construction Period

D2.4.1 Damage of Flood in March – April 2013 in Marsabit Central District

During the project's construction period of the water pans, a huge flood attacked several construction sites, especially in Marsabit Central District in March and April, 2013. Then some facilities were damaged by such flood.

Since there is no any discharge data in the rivers, the Project tried to evaluate this flood itself and damages of water pans in the following manners.

(1) Data used in the analysis

The Project obtained and used the following data for rainfall analysis:

Data-1) Daily rainfall data observed in the period from February 1st to June 30th, 2013

Data-2) Daily rainfall data observed in the period from January 1st, 1935 to December 31st, 1994.

Regarding Data-2 which could be obtained in the office quickly, the Project judged the data could suitable for the purpose of our quick analysis even this is slightly old data.

(2) Overall rainfall in Marsabit County in the long rainy season 2013 (March – May 2013)

A following table presents (i) monthly rainfall in the period from February to June 2013 and (ii) average monthly rainfall for 60 years which was derived from the data-2.

Table AD2.4.1 Monthly Rainfall in 2013 and Average Data

	Feb	Mar	Apr	May	Jun	Total
(i) in 2013	2.7	365.8	302.7	21.2	2	**694.4**
(ii) Average for 60 years*	25.0	64.9	232.6	95.4	8.4	426.4

*Calculated based on the data-2.

Source: JICA Project Team

In comparison with the average rainfall data for 60 years, such as 426.4 mm, rainfall in 2013's long rainy season (694.4 mm) was equivalent to about 1.6 times of average rainy season in volume. The probability of rainfall in half year (Feb-July, Aug-Jan) was also calculated using Gumbel-method, and shown in the following table. According to this result, total rainfall of 694.4 mm in a half year was found to be around 1/8 years probability.

Table AD2.4.2 Probability of Rainfall in Rainy Season

Probability period (1/year)	1/2	1/3	1/4	1/5	**1/8**	1/10	1/15	1/20	1/25
Rainfall (mm)	442	535	594	638	**726**	767	840	891	930

Source: JICA Project Team

Although the rainfall at 1/8 years probability is quite low possible during the project's construction period, furthermore, 2 times of heavy rainfall days were observed on March 10, 2013 (105.3 mm) and April 3, 2013 (102.7 mm) according to the rainfall record data (Data-1). It means the 2nd heavy rainfall came in just 3 days after the 1st heavy rainfall.

As shown in a following table, it was quite rare case to have such a phenomenon, in which 2 heavy rainy days more than 100 mm/day were recorded within 5 days. Such phenomenon was observed at only once in the past 60 years of rainfall data (1935 – 1994).

Table AD2.4.3 Frequencies of 2 Rainy Days within 5 Continuous Days in 1935 – 1994 Data

Excess rainfall (mm)	**100**	90	80	70	60	50
Frequency (times)	**1**	2	2	3	5	12
Return period	**1/60 yr**	2/60	2/60	3/60	5/60	12/60

Source: JICA Project Team

As mentioned above, it was concluded that the series of such magnitude of heavy rainfall was unpredictable.

Source: JICA Project Team

Figure AD2.4.1 Trace of Flood: Measuring Height of Flood Water

(3) Damages by the flood

During the last rainy season, 2 water pans at Dololo Dokatu and Dadach Manchure had serious damages by scouring embankment and sedimentation in the water pans. Taking of the huge magnitude with 1/50-60 probability into consideration, such damages made by the flood were classified as force majeure.

The damages of water pans were estimated and shown in the following table.

Table AD2.4.4 Flood Damage of Water Pan in 2013

Items	Damaged Portion
Dololo Dokatu	Sedimentation in water pan
	Sedimentation in silt/sand trap
	Damage by scouring at left side of embankment
Dadach Manchure	Sedimentation in water pan
	Sedimentation in silt/sand trap
	Damage by scouring at outlet portion/spillway of water pan

Source: JICA Project Team

The damages of pans occurred because 1) the flood was a huge magnitude with 1/50-60 probability, 2) it occurred during construction and some protecting facilities such as spillway, outlet channel, bank and so on were under construction.

Source: JICA Project Team

Figure AD2.4.2 Damages by Scouring Dololo Dokatu Water Pan

(4) Repair of Damage and Measures

The damages made by the flood were classified as force majeure in this case. And hence the additional works to repair and the original design was reviewed and modified to avoid future damage. The additional works included desilting of soil deposit in water pan and silt trap and an additional embankment and shaping. The design modification included

D2.4.2 Design Modification due to Unpredictable Rock Excavation and Underground Boulders

Due to limitation of available time and cost for site investigation, topographic survey and facility design before tendering, as well as insufficient technical data and information such as hydrological data and underground conditions, the project team were obliged to plan and design with various kind of

estimation during the design stage. In the course of actual construction, one of the major design modifications was resulted from insufficient information of the underground conditions. These were i) depth of common soil above hard rock level, and ii) unpredictable large boulders existed underground, which have much disturbed the construction progress and sometimes forced to design modifications, as explained below.

(1) Sifting location of pan and/or modification of dimension of pan

Because of unpredicted hard rock appeared in a part of pan bottom, dimension of the Yaa Gala Water Pan was modified, which were about 10 m extension laterally to the western direction, instead of excavation up to the original design depth, while the location and total storage volume of the pan remained unchanged. For Sotowesa Water Pan, location was about 30 m shifted to north direction, while deign depth remained unchanged.

This type of modification was also applied to the silt trap for Dadach Manchure Water Pan, for which length of silt trap was expanded instead of maintaining designed depth to keep designed capacity of the trap. For this trap, stone masonry works that was originally designed to protect trap slope was cancelled because of rock appeared on bottom surface

(2) Changing excavation depth and reservoir capacity

At the bottom of Dadach Manchure Water Pan, hard rock was observed. The sub-contractor tried to remove all the hard rock by his bulldozer equipped with a ripper, however finally dimension of the pan was modified. For this modification and subsequent changing effective storage capacity, dimensions of pan were carefully examined with an understanding that percolation loss would be reduced in case that most of the bottom surface is covered with such type of rock.

D2.4.3 Capability of the Local Contractors

The construction works for these sub-projects were sublet to local contractors selected through local competitive bidding. Contractors available in Marsabit were generally small, having less experience in works under the international projects in terms construction quality and management including financial, schedule, quality and safety control. Qualified contractors with sufficient equipment and capable engineers were quite limited. Generally, local contractors do not read and scrutinize the conditions of the contract, drawings, and general and technical specifications, only depending on their past experiences for local small construction works. Due to the low capability of the local contractors, the following were observed, for which such experience should be feedback and reflected to the future construction works to be scheduled in Turkana County as well as preparation of guidelines by the Project.

(1) Less understanding on contract conditions, drawings and technical specifications

Sub-contract documents for construction works under ECoRAD was prepared referring available contract documents prevailing in the previous similar projects of water facilities construction works administrated and supervised by MWI, DWOs, KERRA and/or NGOs. Generally, the contract conditions available were referred to or directly abstracted from FIDIC (International Federation of Consulting Engineers), 4th edition, and hence the sub-contracts under the Project were also prepared based on FIDIC.

In the conditions of contract, various rules were specified for communications between the project team and the sub-contractor, such as written notice, submission, approval or rejection and so on within the specified time. However, the sub-contractors were generally ignorant to these conditions and therefore started, modified and finished the works without any prior notice or seeking approval of the project team. This created many difficulties for proper supervision for quality control and keeping time schedule. Also, this resulted in re-work after demolishing of once constructed structures in some cases.

The design drawings and subsequent construction drawings indicated various engineering values, such as coordinates, elevation and dimensions. The sub-contractors did not well understand the designed requirement, and many times they were working without necessary drawings at hand in working sites, which also resulted in additional works and re-work causing delay of the works.

The technical specifications described the measurement and payment terms and conditions, which clearly specified whether the payment could be made separately or to be included in the other items. The sub-contractors did not understand these conditions, resulting unacceptable claims and their own financial problems.

(2) Lack of heavy equipment, capable engineer and technician

Working capacity of the local contractors was generally low, especially in terms of available heavy equipment, capable engineer and technician. His own equipment was quite limited or sometimes a required machine was not available by himself, depending on rental or borrowed one from the other local contractor(s). Therefore, timely mobilization and ordering additional works were affected because of difficulty of timely arrangement of equipment. It was observed sometimes that one sub-contractor long waited for the completion of the other works that were being done by the other sub-contractor under the other sub-contract

Lack of capable topographic surveyor was also one of the constraints in Marsabit. The sub-contractors under the Project did not have their own permanent surveyor, and temporarily employed a freelance surveyor by contract basis. Three sub-contractors employed the same person who was the only available in Marsabit during the construction period. The works were often delayed due to the delayed setting out and check survey.

(3) Quality of works

Construction works under these sub-projects were consisting of simple earthworks (mostly excavation) and limited stone works, which did not require any high construction technology, and specified equipment. Their workmanship was however not fully acceptable and required various instruction and additional order were given by the project team. Their workmanship observed during the construction is summarized below.

1) Excavation

There was no special problem observed on their workmanship for excavation both by machine and manpower. However, their accuracy of the excavation works was not fully acceptable on control of elevation, dimensions and depth for excavation, which were often beyond the permissible tolerances. These errors were easily happened because of lack of accurate setting out survey and also insufficient setting of finishing stake and fixed ruler showing designed elevation, dimensions and depth at working sites.

2) Stone masonry works

Quality of stone masonry works was low, which were not constructed in conformity to the technical specifications and drawings. The specifications noted that masonry stone shall be placed by hand that each stone is completely surrounded by mortar, however actually the mortal was plastered only on the top surface of stones and no mortar was filled underneath surrounding each stone. The thickness of masonry was also much less than the designed one in the drawings. The project team therefore ordered for these works to be demolished and reworked.

D2.4.4 Delay of the Works

Construction of the sub-projects at Dadach Manchure and Dololo Dokatu was commenced in December 2012, while construction of Yaa Gala and Sotowesa pans were commenced in January 2013. Though these sub-projects were targeted to complete by middle of April 2013 before the long rainy season, the construction works were disturbed and much delayed due to the various reasons, which were mostly evaluated to be force majeure or events beyond the control of the Project Team and the sub-contractors and which, by the exercise of due diligence, neither party was able to overcome. The reasons of the delay in the construction works were mainly the following events:

- The construction was suspended due to public disturbance during the election period in entire Kenya from the beginning to the end of March 2013, when the foreign consultant of the Project Team was obliged to go to stay in Nairobi. During this period, the field works were completely stopped, and even after the election, the sub-contractors were not able to resume the works for long period due to the social instability up to May 2013.
- In April 2013, the rainy season started and seriously affected the sub-contractor's re-mobilization to the construction sites, especially due to inundation and muddy conditions of their access roads.
- Due to security conditions getting worse in Marsabit County, all the field activities of the project team in the county stopped till end of May 2013. During this period, supervision by the Project Team including design modification according to the site conditions was not properly operated and hence the construction works were much affected.
- In the long rainy season in 2013, unpredictable heavy rainfall was recorded, of which return period was evaluated to be less than 1/50 years probability.

After evaluation by the project team of the delay due to these events and affected period, the extension of the sub-contract periods for each sub-contract was accepted.

D2.5 Completion of the Works and Handing Over

D2.5.1 Completion and Handing Over of the Facilities

All the contract works have been completed and the water pans have been handed over to the communities. The major events are summarized as below.

Table AD2.5.1 Completion of the Sub-project Works, Handing Over to the Communities and WRMA Registration

Major Events	Yaa Gara	Sotowesa	Dadach Manchure	Haro Girisa	Dololo Dokatu
Substantial completion of the works and issue of taking over certificate	24th Mar. 2014	24th Mar. 2014	21st Nov. 2013	21st Nov. 2013	21st Nov., 2013
Handing over of the facility to the community	6th Aug 2014	16th Dec 2014	3rd Jul 2014	-	16th Apr. 2014
Completion of outstanding works and issue of defects liability certificate	24th Jun, 2014	24th June, 2014	21st Feb, 2014	21st Feb, 2014	21st Feb, 2014

Remarks : As Haro Girisa Water Pan is exsiting and only desilting works were conducted, it was not officially handed over to the community

Source: JICA Project Team

Yaa Gara Water Pan

Sotowesa Water Pan

Haro Girisa Water Pan

Dadach Manchure Water Pan

Dololo Dokatu Water Pan

Source: JICA Project Team

Figure AD2.5.1 Water Pans under the Project

D2.5.2 Observations during Operation and Defects Rectification and Improvement

(1) Yaa Gara Water Pan

In the short rainy season in 2013, the Yaa Gara Water Pan did not hold water for livestock use, because large parts of Marsabit North Sub-county including Hurri Hills Location did not benefit from the short rains in November 2013. The newly constructed pan was however, half full in mid April, 2014 during the long rains. It was the only pan in Hurri Hills that collected good amounts of surface runoff. Further works was carried out at Yaa Gara pan in July 2014 to repair the inlet channel rip rap which had been destroyed by inflowing water

New Yaa Gara Pan in April 2014

Silt trap and existing pan in April 2014

Damage of connecting channel between existing and new pan April 2014

Source: JICA Project Team

Figure AD2.5.2 Yaa Gara Water Pan during the Monitoring Period

(2) Sotowesa Water Pan

Construction Works of Sotowesa Water Pan was completed in February 2014 after suspension of the works by the long rains in 2013. The defects of the construction works such as damages to the stone

masonry rip rap in the inlet channel during the long rains in 2014 were repaired by the contractor in July 2014. During the short rains in 2014, the pan collected only limited runoff water due to the little rainfall in this area.

Sotowesa Water Pan

Silt trap

Some damages on stone works

Source: JICA Project Team

Figure AD2.5.3 Sotowesa Water Pan during the Monitoring Period

(3) Dadach Manchure and Haro Girisa Water Pans

Dadach Manchure Water Pan has been satisfactory operated since the short rains in mid-November 2013. The pan received a little water during the rains in February and March 2014. During short rains in 2014, the community people reported that there was siltation on the connection channel from the silt trap and the main pan or any defects on correlation between the spillway level and bed elevation of connection channel, causing spilling out of the collected water.

Dadach Manchure Water Pan in November 2013

Haro Girisa Water Pan in November 2013

Source: JICA Project Team

Figure AD2.5.4 Dadach Manchure and Haro Girisa Water Pans during the Monitoring Period

(4) Haro Girisa Water Pans

Haro Girisa Water Pan was enlarged under the Project and operated since the short rains in mid-November 2013. After completion of the works, no technical problems were observed.

(5) Dololo Dokatu Water Pan

Operation of the Dololo Dokatu Water Pan started from the December 2013 short rains. It was surrounded by lush pastures after the rains and the WUA in charge saw it wise to conserve the pastures and water for use during the January dry season after all shallow wells and *laggas* (seasonal rivers) were dry. The pan was protected using twigs from nearby bushes and a rule was made to disallow any pastoralists from using the pan before it was officially opened. Although the pan was damaged by the

heavy flood during the construction works in 2013. After the repairing works, however no damage and technical problem have been reported.

		
Shoats and cattle drinking water from the main reservoir at Dololo.	Dololo Dokatu Water Pan in January 2014	Dololo Dokatu Water Pan in May 2014

Source: JICA Project Team

Figure AD2.5.5 Dololo Dokatu Water Pans during the Monitoring Period

D2.6 Lessons Learned Regarding Construction Works

D2.6.1 Strategic Distribution of Water Points

Water points should be developed for 1) extension of pastoralist' migratory routes at the end to new grazing area, and 2) slow-down of moving speed to another grazing area and extension of grazing time on the same migratory route. Their location and distribution should be carefully planned based on the analysis of the grazing pattern of the pastoralist, such as 1) acceptable interval days for watering livestock. 2) watering cycle, 3) grazing distances in a day during dry season for each livestock, and so on.

D2.6.2 Holding Capacity and Size of a Water Pan

Using values of the holding capacity of an area around a water pan, and daily consumption of water of livestock, the required capacity of water volume of a water pan can be calculated. According to the trial calculation, capacity of a water pan for cattle herd for two months in Hurri Hills and Hedad areas are 69,300m^3 (for 55,600 heads) and 49,200m^3 (35,680 heads) respectively, including percolation and evaporation.

In Northern Kenya region, it is noted and broadly accepted that a capacity of a water pan “should not be too big”, in view of sustainable rangeland management and prevention of degradation around a water pan. Based on the several interviews and observations by the project team, the capacity of most of water pans were set around 10,000-30,000 m^3 as “a not too big pan” empirically. It means they set up to utilize only 15-40% of available pastures around a pan in order to preserve rangeland degradation. Even with such utilization rate of 15-40%, a pan can hold around 5,000-20,000 heads of cattle. This is still big number because actually it is very hard to imagine that 10,000-20,000 heads of livestock gather daily at only one water pan.

D2.6.3 Structural Improvement of Water Pans

Water pan related facilities should be designed making easy silt removal and protection for water contamination into consideration maintenance activities, especially for sediment removal should be executed with burden sharing system.

D2.7 Improvement of O&M and Management Capacity

D2.7.1 Basic Concept and Approach of Water Pan Management

Judging from the common situation of the existing water pan, sediment removal work is inevitable for both sustainable use of water and maintenance work. Most of the existing pans have sedimentation problems resulting in reduction of effective water storage. In Boran speaking community, users of the water pans work to remove sediment during their stay for watering, by forming temporary wall to hold back water and remove sediment as the water level decline. Since this measure does not work perfectly for sustainable use, silting problem raise periodically in most of the pans despite their effort of desilting. The main challenge with regard to major desilting after a certain amount of sediment accumulated is labour because the pastoralist communities often migrate from one water source to another immediately after water in the pan finishes. This means the bulk of the desilting work is left after the herders move away from the pan. In many cases, as the burden of desilting work left to the owner community exceed their capacity, they depends on external assistance for machinery work to remove silt from the pan.

As mentioned above, although the existing water pans have been managed with their traditional ways of desilting, many of them face accumulation of sediment that requires major desilting once in a few years. In most cases the communities seek for assistance from donor agencies, NGOs or government funds for major desilting work. To improve this situation, silt trap and cascade system were introduced, which enable the users to desilt more effectively. Silt trap and cascade systems, making use of their function as mentioned in the earlier section, not only collect silt at the trap or the first pan of the cascade, but also enable users to remove the silt accumulated in the silt trap or the first pan of the cascade system while they are using the main water pan. This makes desilting work easier and may enable to introduce the new system of work division such as ‘desilting for water’, in which desilting work is imposed to all the herders in exchange for watering animals. It shall be encouraged to share responsibility of desilting work among all the users establishing clear rules on the allocation of the responsibility to each herder with practical methods of desilting.

Apart from the strategy of desilting and pasture management for water pans mentioned above, institutional and organisational issues for water pan management is somehow unique. In Boran-speaking community, people have a traditional way of managing water pan that is called *Aba Herega* system. The Project approach for strengthening the management system in these areas shall follow and incorporate with the traditional system while introducing new components such as desilting with silt trap, management in alliance with pasture management.

Moreover, management of the water pan to be constructed in the Project requires further attention in terms of the responsibility and work arrangement of the persons in charge of the management. The water pans to be constructed by the Project are strategic water pans, which are located between the wet season grazing area and permanent water sources to prolong the grazing period in the wet season grazing area thus to delay consumption of pastures around permanent water source. This means the newly constructed water pans are far away from the settled residential areas that are normally located nearby the permanent water sources. This can be taken as a critical challenge for management. Therefore, management of the pan needs to be designed according to accessibility and movement of the owner community and management members.

D2.7.2 Project Interventions and Output of Pilot Sites of Water Pans

(1) Yaa Gala Water Pan in Hurri Hills

1) Situation before project intervention

Even though most of water pans in the area have been managed in traditional ways, Hurri Hills has established registered water users association as a kind of umbrella organization that handles all the water sources within the Location. There are fourteen existing water pans in Hurri Hills Location, each of which has its *Aba Herega*. The association governs overall management of all the water pans with some other water source such as shallow wells, establishing rules that regulate all water sources within the location. The water pan to be upgraded by the project will be managed under this

association. This association has fee collection for water users both within the location and from pastoralists using the pans.

Table AD2.7.1 Summary of the Water Management Body in Hurri Hills

Items	Situation
Group name	BADHA - HURRI WATER RESOURCE USERS ASSOCIATION
Group status	Registered Water Users Association (before the project) Registered Water Resource Users Association (WRUA) (registration certified during the project)
Year of establishment	Established in 2007, registered as a Community Based Organization in 2011 and as a WRUA in February 2013
Members	25 committee members comprising of all Aba Herega. 130 group members (representatives of a kind of extended families)
Collection of fees /water charges	Registration fee for members (household) of Ksh.500 They collect annual subscription fee :Ksh.200/season per registered households Charge for livestock watering : Ksh.700/season regardless the number of livestock
Management of water source	Each water pan is managed by appointed local elders known as Aba Herega Aba Herega oversee water use by allocating watering days to pastoralists and supervise desilting The association set rules, e.g., they close the water pans when rain starts, charge penalties e.g. Ksh.5,000 for stray animals around pans and Ksh.15,000 for entry to the water pan without permission.
Other remarkable issues	This region has a remarkably developed water management system. This can be attributed to water scarcity in the region. They rely on water pans, underground tanks and early morning dew.

Source: Key Informant Interviews of JICA Project Team (January 2013)

2) Focal issues and approach

The association with strong leadership took initiative to organize and register as WRUA on their own. Since the existing Water Users Association is relatively firm and well established being approved for WRUA registration, focus will be on the financial management of the water charge and effective use of the fund, management of desilting and strengthening pasture management around the water pan. Although they have traditional ways of desilting, the silt trap attached to the existing water pan under the management of the same WUA has been totally filled up and dysfunctional. Judging from the discussion with the community, concept of silt traps had not been understood well. Establishment of the effective desilting system with the newly introduced cascade system of the pans will be crucial for this management body. Division of work for desilting can be proposed that include desilting work for water by setting desilting work as a condition for watering either according to the number of animals or at fixed rate. Although the original concept of the desilting with silt trap and cascade system is to enable all the herders to desilt while they water their animals, work allocation shall be set in consideration of fee charge as the WUA has been charging the water fee.

3) Output Summary

Table AD2.7.2 Summary of Water Pan Operation in Hurri Hills

Time	Situation of water pan	Management	O&M progress
Jan - August 2013	During construction	Upgrading WUA to WRUA Management training for the management committee	Discussion on rules of O&M
2013 short rain (Nov-Dec)	Only little water was held due to less rainfall	Management roles were applied to other water pans in Hurri Hills	Established bush fence around the pan.

2014 long rain (Mar-May)	The pan was filled up, held water till June with the number of herds.	Management of the pan by the Aba Herega	Minor desilting with utilisation of traditional 'meer' structure
2014 short rain (Nov-Dec)	The pan was not filled	N/A	N/A

Source: JICA Project Team

4) Output of Institutional Development

The management mechanism in Hurri hills is unique. The area is divided into six zones, namely Shankera, Bori, Mangudho, Baqaqa, Guba, and Balesa. Each zone has a committee composed of elders. Elders are responsible for management of pans near their settlement. During the dry season, committee members hold meetings to discuss grazing pattern, water allocation, desilting works on the pans, and other works such as new inlet channels for the pans. Since the committees overlap, the EMC also discusses on tree and bushes conservation. After the committees have met, they then bring the discussed information to the elders for adoption. Most of these meetings are held during the dry season.

The WUA was registered as WRUA under WRMA in February 2013, which entitles the association to undertake project with official funds. Management was further strengthened to equip the WRUA with enough capacity to implement community activities with accountable procedures. The WRUA is supposed to prepare a sub-catchment management plan that is required for all the WRUA as the WRUA is to manage wider water related resources in the area. Since the water management committee in Hurri Hills has been registered as WRUA, they received training on Sub Catchment Management Plan (SCMP) by WRMA officials, utilising the Water Services Trust Fund (WSTF) disbursed in June 2014. Although the SCMP was prepared, none of the plan has yet been materialised by February 2015.

5) Output of O&M and Natural Resource Management

The major function of the newly constructed Yaa Gara cascade water pan was established in 2013. During the short rain in 2013, from November to December, the Yaa Gara water pan did not hold enough water for livestock use due to less rainfall in the surrounding area. In the following long rain from March to May 2014, the pan was filled up with water. Only two water pans in Hurri Hills including Yaa Gara water pan collected good amounts of surface runoff. Since all livestock herds especially cattle moved to Yaa Gara pan, they decide to allow livestock to use the main pan, the newly constructed part, while the old part, the upper side of the cascade system, to be used only for domestic purposes. The community put up a bush fence around the pan to protect the water and herders have collected animal dung during use of the pan. The pan served from April to June after rain, for roughly 70 herds of cattle, 55 herds of shoats, and 42 herds of camel including those from other locations. The livestock and human population estimates are shown in Table AD2.7.3.

Table AD2.7.3 Estimated Veneficiary Livestock Population at Yaa Gara Water Pan

Livestock Species	Area of Origin	Number of Herds
Cattle	Dukana	25
	El- hadi	18
	Forole	27
Shoats	Kalacha	30
	Maikona	22
Camel	Kalacha	23
	Maikona	19

Remarks:There are 8 villages with an approximated 420 households

Source : JICA Project Team

Source: JICA Project Team

Figure AD2.7.1 Natural Fence Prepared by the Community at Yaa Gara Water Pan

The herders and users of Hurri Hills water pans have been following their established management system. Each pan has about three elders in charge of day to day watering when the pan is in use. The number is to ensure that there is at least one elder present during the three day watering cycle. The elders allocate watering days and also ensure that the pastoralists use 'meer', traditional trough/wall made of mud, when watering. After watering, the herders remove the 'meer' together with some silt around. A group of 20-50 herders erected 'meer' using mud and sticks to be used as temporary troughs and each group was tasked with erecting their own 'meer' in the morning and remove it in the evening after all livestock have watered. They also remove all livestock droppings accumulated during watering. The Project provided the Maintenance tool such as wheelbarrows, pickaxes and scoops. Desilting tools are kept at the community social hall. There is an inventory and people requiring using the tools are invited to borrow for use and return.

When the pan got almost dry, people of Hurri Hills decided to allow cattle to trample on the pan surface, instead of conducting major desilting. This was, according to the WUA, because trampling for new pans helps compact the base to prevent seepage in the next rainy season. Yaa Gara pan has not received any major desilting apart from defect correction detected after the first use. This is because desilting is especially minimal for new pans to allow for them to hold some silt which can seal some spaces on the pan floor hence enabling the pan to hold water longer. On the other hand, observing the situation of the pans after they dried up in other pans in Hurri hills, silt started accumulating heavily, and use of machines is favoured over manual desilting work. The community decided to desilt the two water pans in Hurri Hills through assistance from the Ministry of Water at the County.

6) Impact and Contribution to Drought Resilience

Pasture in Hurri Hills is sufficient for grazing for a long period of time. However, there has not been enough water for livestock to take during dry season when livestock require water while grazing. Migrant herds are mainly from El Hadi, Balesa and Forole. Migrants have visited Hurri Hills only during the rainy season for pasture due to lack of water sources. During dry season when the water sources in Hurri Hills dry up, herders have migrated to El Hadi, Balesa and Forole. According to the results of interviews to beneficiaries, the expansion of the water pan capacity contributed to prolong the use of surrounding pasture. However, the level of contribution of the water pan to drought resilience highly depending on the amount of rain received. Herders mention that rainfall pattern differ by season and availability of the water in different water pans depends on the rainfall. However, after the long rains in April of 2014, livestock grazed around Yaa Gara pan for one and a half months while using the water pan. When the main pan dried up, the water remaining in the silt trap was used for domestic purposes for another month. It can be said that upgrading of the water pan capacity of Yaa Gara improved the pasture availability by availing water that enable livestock to stay in the pasture rich area longer. Water held in the pan also supported settled people who have to rely on the water brought by water bowsers during dry season.

The upgrading of the Yaa Gara water pan with increased water volumes also attracted more settlements around the pan. While livestock will migrate during the dry season, the settlement remains at the pan. There are community plans for infrastructure development near the pan such as health and education facilities.

Having several water pans and shallow wells, and facing severe water scarcity, Hurri Hills has a stronger water management system. Since they do not have permanent water source, management of available water is crucial for them. People have established their own roles in water management with a certain contribution to prepare for severe dry season. The factors contributed to this stronger water management are mainly seriousness on the water availability. However, some other factors would have also contributed. In Hurri Hills, influence and leadership of the Location Chief is remarkably strong compared to other areas of target pilot sites in Marsabit. While actual management such as operation of the water pans are taken charge by the elders, Chief take initiatives in organising committees, leading them for development activities. Chief's initiative was quite strong in formation of WRUA, upgrading the WUA. It can be also judged from the external support brought to the area that include soil erosion control support and WASH training by PISP, C.A.P for the community for the coming five years, restocking and issue of food voucher by PACIDA, rehabilitation and desilting of water pans by the government, establishment of rock catchment by CDTF.

7) Challenges and Constraints in Sustainable Operation and Maintenance

Hurri Hills has a stronger system of managing water resources in their area. However, there are still people who are not aware of the management. As the management develop and become complicated, such as formation and acting as WRUA, only limited representatives are able to understand the system. Even as it is inevitable to introduce new systems as the situation change, it is important to respect the established workable system with majority of the community. It can be said that the system can be functioning to some extent even when a limited number of people are fully involved as long as the representatives who are involved manage adequately.

(2) Sotowesa Water Pan in Turbi

1) Situation before project intervention

Sotawesa is located at north boarder of Bubisa Location. Although the area has a vast grazing potential, it is suitable only during rainy season due to scarcity of water. It has no permanent water point and natural water points such as temporary ponds of rain water are very shallow that can hold water only for a short period after rain. Since Sotawesa is very harsh environment in dry period, there is no settlement around. It is located about 118km away from Marsabit town, 68km from Bubisa town, 73km from Turbi town, and 40km from Marsabit to Moyale highway.

Sotawesa being a rich grazing zone though only for rainy season, it attracts herds from Bubisa, Turbi walda, Rawana, Wajir, Shurr and even Marsabit central and Maikona. However rainfall in the area is normally insufficient for natural water sources to be formed to accommodate many herds from various areas. Following this meagre water sources in Sotawesa the herders drive back to other grazing areas for search of water to ensure their livestock to survive.

2) Focal issues and approach

The main concern in management of Sotowesa water pan is distance to the pan from residential areas. Since the water pan is far away from any residential village, arrangement for daily duties of management was exceptionally demanding. Due to the location of the water pan, main users and so called owner community of Sotowesa water pan are not permanently settled but only moving towards and staying nearby the water source during the period of use of the pan. Hence the management members are expected to move to the water source during the period when the water pan is in use so that they can manage the pan on a daily basis. In this case, the issue to be discussed might focus on how they can manage pasture during the wet season preventing grazing in the area around the water source to preserve pasture. Collaboration with the EMC members enables the committee to handle pasture management during wet season even during absence of the persons in charge of the water

management who may move with their livestock. Therefore, pasture management shall be discussed with EMC members seeking the possibility to collaborate in supervision and setting rules such as penalty for misuse of pasture.

3) Output Summary

Table AD2.7.4 Summary of Water Pan Operation in Sotowesa

Time	Situation of water pan	Management	O&M progress
Jan - August 2013	During construction	Formation of WUA Management training for the management committee	Discussion on rules of O&M
2013 short rain (Nov-Dec)	Only little water was held due to less rainfall	Started contribution for O&M	No maintenance work has been done
2014 long rain (Mar-May)	Silt trap was filled with water, main pan received only a little water	No herds used the pan	Challenge of desilting due to distance and absence of settlement was raised
2014 short rain (Nov-Dec)	The pan did not hold water due to less rainfall	No herds used the pan but some herds started settling close to the pan	No desilting has been carried out yet as the settlement came after rain

Source: JICA Project Team

4) Output of Institutional Development

A meeting with the community mainly with village elders was conducted before starting the construction work in January 2013. Issue of management of the water pan was discussed and it was agreed among the participants to form a new committee to manage the new water pan at Sotowesa as it is located far from any other water source. As the community involved for the management of the Sotowesa water pan consists of eleven villages, it was decided to elect one representative from each village for the management committee. Formation of the water management committee with necessary institutional structure and rule making was supported through training and on-site practice in parallel to the construction of the pan. Management training was conducted focusing on the formation and establishment of committee's management function. Following to the action plan formed in the training, the committee has prepared their constitution and rules on WUA with registration of membership, and completed formal registration of the WUA as a CBO. It was agreed to collect membership fee from the registered members for operation and maintenance purpose.

Even though the WUA was formed and started developing its institutional function, it has not been actively performing mainly because the water pan has not been filled with water so far and the water pan is quite far for them to manage during the time when the pan is not in use.

5) Output of O&M and Natural Resource Management

Construction of major functions of Sotowesa water pan completed in 2013. However, Bubisa and Turbi areas where the pan was situated did not benefit from the short rains in November 2013, the pan therefore could not been used.

Sotowesa water pan received little water in the long rains of April 2014. The silt trap was full while the main pan had quite limited amount of water that quickly dried up. As a consequence, only three herds of camel were around Sotowesa water pan in the month of May and the pasture remains greatly underutilised around Sotowesa. During use of the pan, though the uses were limited due to less water availability, management of Sotowesa pan has been found challenging due to distance of settlements from the pan. Since the pan was constructed for the purpose of efficient use of pasture in Sotowesa during early dry season where there is no settlement, it was realised not being realistic to expect desilting by the community during dry period when nobody stay around the pan. Although there was an idea of desilting while the pan is in use, it seems major desilting is not possible with wet soil.

Therefore it was found that the practical operation can be desilting small amount of silt and removing animal dung during their stay around the pan for watering their livestock.

During the short rain in November to December 2014, the area again received only a little rainfall that is not enough to fill up the water pan. The rainfall received remained in silt trap, which enabled pastoralist to camp around the area. Approximately 20 camel herds grazed in Sotowesa area.

Whilst the major desilting of the Sotowesa water pan was found difficult in current situation, other possible options of organising desilting were proposed. Due to a good unused pasture around the area, the area administrators are planning to bring water tank during dry season. With the promise of availability of water tank, some herders settled about 7km from Sotowesa water pan. This indicates possibility of management of the pan although as of February 2015 they have not established any as they just settled after the pan dried up. Another possibility is that the County Government is now on the process of digging a borehole approximately 30km from Sotowesa water pan. If the borehole has enough water capacity, there is a possibility that some people settle around the area, thus the pan can be managed by the settled people. By the end of January 2015, access road was constructed to the borehole site but not yet started drilling. It requires further observation on the influencing factors to judge the possibilities.

6) Impact and Contribution to Drought resilience

As of January 2015, Sotowesa water pan has not been adequately filled up with rain due to current rainfall patterns. It is difficult to assess accurate benefit from the water pan. So far with the water stored in the pan, even a little, some herds benefitted from the pasture around Sotowesa. Many herds express their prospect of further benefit and impact of the water pan once it is filled up with adequate rain.

7) Challenges and Constraints

The major challenge of the management of Sotowesa water pan is distance from any settlements. Although the concept of desilting during use of the pan can be accepted, the feasible desilting during use is minimal and major desilting is difficult when there is water in the pan and soil is wet. Considering the concept of the strategic water pan situated in unused grazing area, it might not be practical to maintain with manpower of herders, and inevitable to require public works to maintain its proper function.

(3) Dololo Dokatu Water Pan in Dirib Gombo

1) Situation before project intervention

Dololo has been a seasonal settled area by herders during rainy season. It has vast grazing areas. Before construction of Dololo Dokatu water pan, livestock could graze for from three weeks to one month after rain.

Dololo Dokatu is rangeland that is managed by Dirib Gombo settlement area which is settled by Borana community. While people at the settlement of Dirib Gombo live with farming with good rainfall during rain season, though in small scale, their major income source is livestock raring. In dry period they can share water pasture with community from other location or even Gabra community when the pasture is scarce at their places.

Although the area where Dololo Dokatu is located is administratively situated in Dirib Gombo Location, bordering Shurr community, which is Gabra community, sometimes claim their ownership of the area. In normal situation, people co-exist and share local resources, it can sometimes cause conflict between the two tribes.

2) Focal issues and approach

Conflict management is one of the key issues in this area, since Dololo Dokatu water pan is located near the border between Dirib Gombo and Shurr Location where Boran and Gabra ethnicities are

coexisting. Considering the dispute of ownership raised from both sides during confirmation of the pilot site, peace building was taken as an issue to be dealt with in establishment of a management system. Although Dololo Dokatu water pan is located in Kachacha sub-location in Dirib Gombo location, it was agreed among the stakeholders of the peace meeting that water shall be shared among all the communities. Therefore, management system including water and pasture use should be set fairly for all the surrounding communities and be agreed among the people concerned before operation.

Along with the claim of water source, pasture use has been a crucial issue between these communities. Conflicts between these communities have often occurred because of violation of rules in pasture use. They have their own regulations in their territory governing with strict definition of permission for particular animals in particular areas at a certain time period. Misunderstanding and less communication among the communities regarding rules and common understanding of each community might be one of the reasons for the incidence that leads to conflict. Pasture management rules shall be discussed based on their on-going rules and structure of conflict management including reconciliation strategy they already have. The project shall intervene in these processes collaborating with peace building process while respecting their own traditional rules and systems.

3) Output Summary

Table AD2.7.5 Summary of Water Pan Operation in Dololo Dokatu

Time	Situation of water pan	Management	O&M progress
Jan - August 2013	During construction Flood in March13 damaged the pan	Formation of WUA Management training for the management committee Monthly meeting	Operation was destructed by flood and damage of the pan
2013 short rain (Nov-Dec)	Pan was filled with water	Management of rangeland by WUA and Aba Herega restricting grazing area 8km away from the pan	Fenced around the pan with local materials Minor desilting using 'meer' and collection of animal dung during use of the pan
2014 long rain (Mar-May)	Pan was filled with water. Heavy rain disturbed access to the pan. Water lasted till July	Watering of livestock was managed in Aba Herega system. Defaulter of the rules were fined	Water pan was used applying 'meer' system. Community desilting work was conducted after the pan dried up.
2014 short rain (Nov-Dec)	Only the silt trap was half filled	Water in the silt trap was used only for human use.	No desilting work has been conducted yet after rain.

Source: JICA Project Team

4) Output of Institutional Development

As the Dololo Dokatu water pan is located near the border to other communities, different disputes rose from the concerned communities regarding ownership and use of the source in the early construction stage. A peace meeting was conducted to reconcile the situation and the relevant stakeholders in the meeting agreed to share the water source in a fair and peaceful manner. After the peace meetings, discussion with the owner community of Dirib Gombo Location was organized in January 2013, in which the representatives agreed to establish a new management committee to manage Dololo Dokatu water pan. Targeting the newly selected water management committee members and other relevant community leaders such as village elders, EMC members, a training programme for establishment of the management committee was conducted. Necessary function of the committee such as registration, constitution of the organization, setting rules for management of the water source and pasture use, were discussed in the training.

The long rain in March-April 2013 caused flood disaster in Marsabit central area. The flood seriously damaged the newly constructed water pan, which discouraged the WUA for their preparation for

management. Although the pan held water during rain, expected operation could not be applied due to the destruction by rain.

In parallel to construction work of the pan, the committee developed their routine management system. Monthly meeting and monthly contribution was started after the formal registration of the WUA to prepare for the operation of the pan for the following season. The monthly committee meeting has been conducted relatively periodically with their own initiatives, discussing issues such as operation of water pan before rain, and desilting work by the community.

5) Output of O&M and Natural Resource Management

After repairing work from the flood damage, Dololo Dokatu water pan was filled by water in the short rain in November 2013. The WUA members together with herders collectively worked to fence around the pan embankment using twigs from nearby bushes. Although the WUA demanded a permanent fence with wires, the WUA finally took their initiative to fence by themselves with local materials.

The WUA agreed with the community to set up their bylaws earlier on regarding the water pan and surrounding pasture management, and people agreed to take action according to their by-laws. Pastoralists had to camp approximately 8km away from the water pan before the pan was officially opened. Their by-laws for pasture management says that whoever is found grazing without permission from Aba Herega shall be fined and whoever refuses to comply with the rules will not be allowed to get water from any source of water in the region. Following to these rules, 13 cattle owners were accused for grazing their cattle without getting permission. A series of meetings were held to compel the defaulters, who finally accepted any action that could be taken against them with respect.

Desilting during the pan use was conducted little by little using buckets from the entrance side. Although desilting tools including wheel barrow were provided, desilting with buckets was preferred because the embankments were still quite steep with loose soils for wheel barrows to pass. Apart from desilting work, herders removed animal dung from watering points to avoid contamination of the water. Although there was a herder who did not follow the rule of watering and desilting using traditional means, such herders were fined by Aba Herega's instruction.

Source: JICA Project Team

Figure AD2.7.2 Herders Desilt and Collect Dung from the Watering Point at Dololo Water Pan

During long rain from March 2014, Dirib Gombo area received a good rainfall and the pan was filled with water. People used Dololo water pan from May 2014 up to the first week of July. The actual management of the pan has been taken care by the Aba Herega and three Aba Goyas, the assistants of Aba Herega. Through a meeting, they count herds and divide them into three watering day accordingly to avoid over-crowding. For the daily management, they appoint an Aba Guya in charges for each day. The herders made traditional small banks called 'meer' to control access to water and make it easier to remove animal dung behind the meer. Defaulters of the watering rules are being dealt with as agreed by all users. During May and June 2014, the number of herds that used the water of Dololo pan was roughly about 60 herds of shoats, 8 cattle herds, and one camel herd[1].

[1] In average the herds of shorts consist of about 200-300 shorts and that of cattle with 40-50 each

The herders were able to graze in Dololo grazing area for seven months from December 2013 to July 2014 because of the new water pan, while Dololo grazing area had been only useful when water in shallow ponds existed after rains. The WUA as well as the community of Dirib Gombo, realising the benefit receiving from the newly constructed Dololo Dokatu water pan for two good seasons, raised a proposal of major desilting operation by the community with support for transportation to carry desilting tools. Seven members participated the desilting on the proposed day. After the desilting, they had another meeting to discuss further action to be taken.

The short rainfall of November 2014 was inadequate around Dololo Dokatu water pan. The little rainfall that area received was good enough for pasture growth. However, it filled only half of the silt trap and not reached to the main pan. Water held in the silt trap was used by human for their domestic use. The silt trap had stayed with water for the period of one month from the first week of November to the first week of December 2014.

Source: JICA Project Team

Figure AD2.7.3 Desilting Work by the Community at Dololo Water Pan

Apart from the water pan, a new borehole was drilled at Dololo Dokatu grazing area, so called Wachu Rukicha borehole by the County government. Since the rainfall was inadequate all over the region, many livestock from Moyale, Sololo, Basir, Wajir and even southern Ethiopia arrived around Dololo Dokatu grazing area. Considering the pasture availability and conservation, those migrants were allocated to different water source like Kubi Qallo borehole, Jaldesa borehole, Gombo shallow wells, and Yamicha area thorough consultation between leaders and elders from each clan.

6) Impact and Contribution to Drought resilience

Since the Dololo water pan received good amount of rain during the project monitoring period, the community and the herders have benefitted from the pan to a considerable extent. Positive impacts gathered from herders are as follows;

- The new water pan located in the previously unused ideal grazing area enabled to graze. This resulted in potential of grazing is expanded by enabling access to unused grazing area and it prolonged duration of grazing around Dololo area.
- Construction of access road has eased access to Dololo grazing area. And the access road also enabled construction of new Wachu Rukicha borehole near Dololo Dokatu pan along the access road.
- Since the new water pan expanded grazing area with water, herders spread into different grazing areas in dry season grazing area and density of population of livestock reduced, which thus reduced overgrazing.
- The new water pan can hold a certain amount of water even with a little rainfall, located in a suitable site to collect water.

These contributed reducing impact of drought damage by improving availability of the pasture.

Adequate integration of traditional Aba Herega system into management made WUA recognised as a management body in the community. This resulted in relatively good understanding and acceptance of introduced management system as well as strengthening traditional management such as utilisation of ‘meer’ that contribute to desilting.

Even though major desilting has not been done in the concerned water pan, initiatives and efforts taken by the WUA to desilt the pan imply the change in mind of people. It can be expected that the benefit of the water pan together with the facilitation and encouragement of the O&M through several discussion enhanced the motivation of people on managing common water resources by themselves not totally depending on the external support. Even if the major desilting is not possible manually and machinery work is necessary, people can seek for support taking action by themselves at adequate timing instead of waiting for the assistance to come.

7) Challenges and Constraints

Although the new water pan expanded options for grazing areas and dispersed herds to different grazing areas, it at the same time, attracted more herds from further area by availing the pasture that could not be utilised before. This caused conflict especially when the rainfall in other area is less. Migrants from other area who are not familiar to the concerned water pan tend to break the rules and ignore Aba Herega. Since it takes time for people to understand new ideas of management such as desilting, conflicts have occurred when herders cannot follow the rules.

Although the concept and necessity of desilting has been accepted and understood relatively well in the Dololo area, desilting is still one of the challenging issue for management. Dololo Dokatu water pan is located about 18km away from the nearest settlement of Kubi Bakasa in Dirib Gombo. The distance from the water pan, though the pan is intentionally situated away from the settlement as a strategic water source, hinder major desilting during dry season when the water pan is not in use. By realising the importance of desilting, the WUA plans to apply and utilise available sources of transportation such as pick-up car allocated for community use by the County government.

(4) Dadach Manchure and Girissa Water Pan in Gar Qarsa

1) Situation before project intervention

Manchure water pan site and Girisa water pan located about 10 kilo metre away from each other. Manchure and Girisa are away from Marsabit town by 20 kilometres and 30 kilometres respectively. These sites belong to a similar vegetation area and generally receive similar amount of rainfall. The area normally receives more rainfall in short rainy season (from November to December) than in long rainy season (from March to June). It is good grazing areas for all kinds of livestock i.e. cattle, goat and sheep, camel, and donkeys. The area has water scarcity, thus it is only suitable for grazing only in wet season when water for drinking is available in natural ponds after rain. It is a Borana grazing zone, though sometimes when rainfall is little in other areas, Gabra community from Bubisa are moving with their livestock seasonally by making request to Borana Elders. When tension between Gabra and Borana community increase due to some conflict occurring even in other parts of Marsabit, it affects water and pasture use in this area.

2) Focal issues and approach

People’s ownership and motivation seems strong in this area as community people have taken initiative to prepare for the management selecting Aba Herega by themselves before project intervention started. This means people are intending to follow traditional management through Aba Herega system, thus it is necessary to come up with effective collaboration between Aba Herega system and management committee in case the committee is to be formed.

Although the water pan is constructed mainly for livestock use, people fetch water for their own use such as local herb cultivation. Management of water use shall be set regarding the situation of water use in the area, including rules for water use by outside pastoralists in consideration of conflict management

3) Output Summary

Table AD2.7.6 Summary of Water Pan Operation in Manchure and Girisa

Time	Situation of water pan	Management	O&M progress
Jan - August 2013	During construction Flood in March13 damaged the pan	Formation of WUA Management training for the management committee Monthly meeting with monthly contribution	Operation was destructed by flood and damage of the pan
2013 short rain (Nov-Dec)	Pan was filled with water	Preservation of the pasture around the pan was difficult due to a larger number of herds from rain scarce area. Aba Herega was changed through consultation with the management committee	Fenced around the pan with local materials Minor desilting using 'meer' and collection of animal dung during use of the pan Conflict affected the desilting work
2014 long rain (Mar-May)	Pan held only a little water due to less rainfall	Planned management of pan and pasture was not applicable due to little water	As there was no major use of the pan, no desilting was done.
2014 short rain (Nov-Dec)	Both pans were filled with water	An elder settling nearby Manchure managed watering order at the pan	No major desilting but minor smearing and faeces collection were done

Source: JICA Project Team

4) Output of Institutional Development

The owner community took initiative on the management of the water pan and appointed Aba Herega by themselves. Through discussions with community members, it was decided to manage the water pan in parallel use of Aba Herega system and management committee structure. After the selection of committee members from the concerned community, a three-day training programme for establishment of management system was carried out by the Project. Community representatives including Aba Herega, committee members as well as village elders and EMC members participated in the training, in which they showed their strong passion to establish their own management system. It was agreed to divide roles between Aba Herega and the Committee, where Aba Herega will supervise the use of pan attending at the pan site while the committee manage the WUA itself handling formation of roles, registration, collection of fees, management of communal work such as fencing and desilting. Steps to establish the formal WUA has been taken after the training, through which they formulated constitutions of the group, moved forwards with registration of the members with collection of membership fees, and started maintaining records of member registration, meeting minutes, and a cash book. As per agreed among the members, they started bi-monthly meetings. The bi-monthly meeting are conducted with their own initiatives, though it is less than once a month.

In Manchure pan, being a new pan, the Aba Herega was reluctant to go to site. The WUA committee therefore replaced him with 4 elders appointed from the present herders who stay near the pan. The committee also recommended that a member of the committee be present on site each day to monitor. This indicates that the traditional

Source: JICA Project Team

Figure AD2.7.4 Dadach Manchure Pan with Cattle: *Cattle leave the pan after watering through a gate constructed with twigs. The twigs act as a deterrent to restrict access to the pan. It also allows for pan access from a single point.*

Aba Herega system is integrated in the WUA. While Aba Herega holds traditional authority and power, the water management committee can work to assure the management including the traditional system to function properly.

5) Output of O&M and Natural Resource Management

Dadach Manchure and Haro Girisa pans were filled with water during the short rains in November 2013. According to the rules made by the WUA it was agreed that livestock move away from grazing areas until the start of the dry season. However, the short rain did not cover Marsabit North where they are supposed to graze during rain season. Migrant livestock herds from Marsabit North moved into the preserved grazing area around Manchure and Girisa water pans due to lack of pasture in northern area. Likewise, livestock from Gar Qarsa could not move to Segel where they are supposed to graze during wet season, as the area did not receive rainfall either. Furthermore, insecurity prevented herders to move to a further forested area. Consequently the huge number of animals and domestic water consumption at the pans resulted in depletion of water at the pans before the pasture could be exhausted.

Source: JICA Project Team

Figure AD2.7.5 Traditional Measures for Pan Management: *Livestock drinking water from pan at the designated point cut off using 'meer', twigs to form a barrier to control livestock during watering.*

O&M training was conducted with on-site practical session for desilting in December 2013 and desilting tools were supplied. Through a community meeting, the community fenced off both Dadach Manchure and Girisa water pans with local materials by themselves. They set up a grazing area around the pans of about 15 km radius and all pastoralists were required to graze outside this area in rainy season. Defaulters would be imposed a fine by the Environmental Management Committee (EMC).

Rules on desilting were also agreed on that each pastoralist would be required to fetch about three wheel barrows of silt from the pan every time they water. However, the desilting works after short rain in 2013 were disturbed mainly due to the conflict between Borana and Gabra. The Borana herders moved their livestock closer home to Gar Qarsa the fleeing Gabra community from Girisa pan. Desilting was also abandoned as Gabra community disregarded the Borana traditional elder of Aba Herega and did not follow their rules.

In the long rain season in March and April 2014 the area received little rainfall and the main water pan had very little water on its bottom. It was only the silt trap that was filled up with water. Rain was not enough even for pastures to grow. Consequently no livestock moved to the area around the pans because of less pasture and little water. Only 19 herds of cattle watered from the silt trap, shortly after the rains. Due to this, less herders benefited from the pans, no desilting works was done during the concerned period. Another situation that might have also affected desilting work was that an NGO had promised the community at Gar Qarsa that they would desilt those two pans. Although the offer of desilting by the NGO never materialised because the timing was inappropriate, this might have negatively influenced the community from desilting by themselves.


Source: JICA Project Team

Figure AD2.7.6 Manchure Water Pan in Use after Long Rain in 2014

Dadacha Manchure and Girisa water pan area had received little rain in the month of November 2014, which was not enough to fill the pans. Only the silt trap was quarter way filled during that time for both pans. However, the area received good rainfall for three days in the second week of the December 2014, which filled both Manchure and Girisa pans. The pans filled with water and sustained many herds and attracted more livestock from other areas. Roughly 70 cattle herds, 90 shoat herds, and 60 camel herds grazed around Manchure water pan, and 60 cattle herds, 90 shoat herds, and 55 camel herds grazed around Girisa water pan in December 2014 and January 2015. Girisa water pan had stayed with water for one and half month, while Manchure water pan has stay with water up to date which is almost about one month and three weeks. Manchure water pan was closely managed by an elder residing nearby the pan who is seriously concerned about effective use of the pan. No major desilting has been done so far apart from the minor smearing and collection of animal faeces.

6) Impact and Contribution to Drought resilience

Some herders expressed that the newly constructed Manchure water pan increased option of grazing area around the pan, which leads to preservation of pasture around permanent water source. When the water pan received a good amount of rain, the water pan contributed to reducing the number of months of dry period due to prolonged grazing in the area.

It has also strengthened planning of the grazing pattern. Although the tribal conflict sometimes affects their grazing pattern, pastoralists can now split and use different water sources to reduce pressure on rangeland. Although the herders started grazing around the water pans at earlier stage of the dry season, grazing around water pan delayed migration to the permanent water source such as Kubi Qallo borehole that herders use during late dry season.

Through the current rain during short rain season in 2014, pans were filled and being used fully. The pans in total served about one and half to two months with average of 130 cattle herds, 180 shoat herds, and 115 camel herds. The new pan reduced congestion of livestock in the nearby grazing area, while the improved Girissa pan served longer period than before.

7) Challenges and Constraints

Although rangeland management was understood as important, it has been difficult to fully control grazing pattern. It is highly depending on the situation of wider area, as rain situation of other are influence a particular water source. As there are some water sources around the area, interrelation of those water sources should be judged for effective use of pasture.

Being close to Marsabit town, Manchure and Girissa area have been easily accessed by external agencies. This has been hindering motivation of the community towards their own action. Even though the effort of the desilting by the users has been understood to some extent, people became reluctant because the more silt accumulate in the pan the more external support it can attract.

CHAPTER D3. MARSABIT: SUB-PROJECT OF REHABILITATION AND UPGRADING OF WATER PIPELINE

D3.1 General

The Outline of the Subproject is as summarized below.

Table AD3.1.1 General Outline of the Arapal Pipeline Improvement Sub-project

1. Objectives		This project aimed to improve sustainable water supply system both for drinking water and their livestock through improvement of existing pipeline system. Further, to improve operation and maintenance activities. Especially repairing of pipe connection and strengthening of water users' association were targeted.	
2. Number of Beneficiaries		Unspecified	
3. Implementation Organization		JICA ECoRAD Project, water users' association and environmental management committee	
4. Project Contents			
	1) Project Outline	1) Increasing capacity and expansion of existing water supply pipeline system through laying additional pipes, and construction of related facilities such as water storage tank, trough and so on. 2) Establishment and strengthening of water users' organization 3) Improvement of operation and maintenance system and regulations through training program.	
	2) Facility / Activity	*Facilities/Activities*	*Implementer*
		1) Construction of additional pipeline system with related facilities	1) Contractor
		2) Organization and strengthening of water users' association	2) NGO and project team
		3) Procurement of O&M tools & spare parts	3) Contractor
		4) Monitoring	4) Project Team
	3) Organization for O&M	Water users' committee and environmental management committee	
	4) Construction Period	Scheduled from January 10, 2013 through June 31, 2014 including defects liability period of 3 months	

Source: JICA Project Team

Most of the villages in the County are facing serious shortage of drinking water supply due to lack of water facilities or insufficient capacity of existing water storage structures, whereas demands for water development are increasing. Under ECoRAD, improvement of water supply systems was therefore one of the major intervention including small scale water harvesting facilities of water supply pipeline system. This sub-project aimed at improving water supply conditions in Arapal Community both for their drinking water and for livestock including pastoralists from other communities, through improvement of existing pipeline to increase discharge, extension of the line and new construction of related facilities, such as an additional water tank and troughs for cattle and goats. Improvement of operation and maintenance activities was also targeted, especially in repair of pipelines and strengthening of water users' association.

D3.2 Outline of the Rehabilitation of Arapal Water Supply Pipeline

D3.2.1 General Conditions of Natural Resources in Arapal Area

Arapal is a sub-location of Mt. Kulal Location of Loiyangalani District, approximately 45 km from district headquarters. The temperatures are generally moderate (22 - 32 ^{o}C) and the annual rainfall is low having two rainy seasons. It has low vegetation cover and the area has undeveloped/unexploited water springs up the mountain, forest and wildlife on the low lands.

Arapal village is covered by the existing water supply pipeline system both for drinking water and for livestock including pastoralists from other communities, of which the source water is taken from springs in the western slope of Kulal Mountains. The water points in and around Arapal are listed as below.

Table AD3.2.1 Existing Water Points in and around Arapal

Water Pan and Dam	Pipeline System
- Arapal Water Pan - Arapal Dam	- Arapal Water Supply Pipeline with 3 water sources in Mt. Kulal

Source: JICA Project Team

D3.2.2 Concept of Improvement

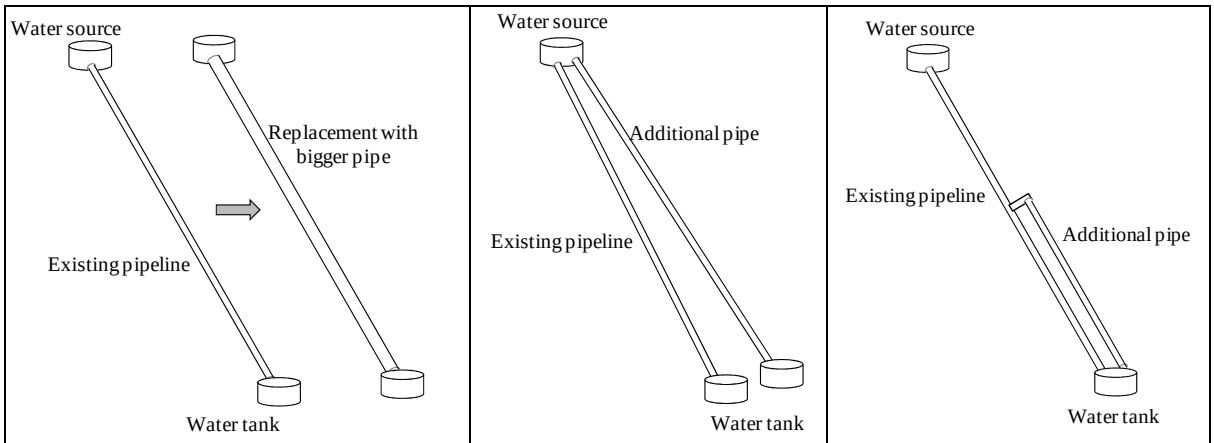
In Arapal community, CMDRR was conducted, and in the CAP various proposed interventions, in which the top priority was given to rehabilitation and improvement of the water supply system. The proposed works were evaluated by the community and the Project during CMDRR. Subsequently, field conditions were inspected and evaluated, especially for additional water source in Mt. Kulal and suitable sites of additional water troughs, taking the existing pipeline network and available grazing area into consideration.

D3.2.3 Plan and Design of Improvement

The water supply pipeline in Arapal Community had the following constraints, i.e., i) insufficient discharge against increasing water demand, ii) insufficient capacity of the existing tanks due to their deterioration, and iii) leakage of the pipes. Out of these constraints, item i) was the most serious one because it's improvement was beyond the capacity of the community, while the other problems could be solved with relatively low cost within their routine maintenance activities. The insufficient discharge was caused by mainly two main reasons) insufficient water source and ii) insufficient capacity of pipeline because of limited pipe size.

During the field investigation, discharge at the source was measured both for the existing and proposed additional sources in the dry and rainy seasons. As a result, it was planned to increase its discharge to more than 50% from the current. Proposed capacity of pipeline was then calculated, for which the following alternative improvement plans are considered.

1) Replacement of entire pipeline with pipes of bigger size
2) Installation of additional pipeline along with or on another route
3) Partial installation of additional pipeline



1) Replacement of entire pipeline with pipes of bigger size	2) Installation of additional pipeline along with or on the other route	3) Partial installation of additional pipeline

Source: JICA Project Team

Figure AD3.2.1 Improvement Works for Pipeline System

As a result of economical comparison, option 3) partial installation of additional pipeline was proposed on confirmation of hydraulic calculation of pipeline.

During the monitoring period after improvement, appropriate technology for planning and design were reviewed as such measuring discharge at source and end, pipe conveyance loss, review of required water demand and storage capacity etc. The local natural environment situations and social customs were also discussed, reviewing present operation status and also through comprehensive examination of the operation and maintenance as well as the costs. These collected data and information utilized to feedback the plan and design for the further sub-projects and would be complied in the guidelines.

After the sub-project implementation, discharge of pipe water increased from 0.5 L/sec to 1.2 L/sec, which is more than 2 times the rate before the sub-project. Due to this increase of water supply, community members were able water their livestock in the dry season, to support their livelihood during drought or long dry season. Basic values used for the design is summarized as below.

The following works were finally planned under ECoRAD.

Table AD3.2.2 Works of the Arapal Pipeline Improvement Sub-project

1) Additional water source	Spring near the existing intake site in Mt. Kulal
2) Existing pipeline	Increasing capacity of pipeline through placing additional pipe along the existing pipeline route
3) Extension of pipeline	Additional pipelines connected from existing pipe to proposed water troughs
4) Related facilities	Additional water tank, intake box at source and water troughs
5) Rehabilitation of existing pipeline	Additional water tank, intake box at source and water troughs

Source: JICA Project Team

As a calculation results of friction loss using the above design values, total required length of additional pipeline is estimated at 2,300 m. Other facilities such as water tank and troughs were designed with reference to the standard design of Ministry of Water and Irrigation.

D3.2.4 Salient Features of Sub-project Works

Under the ECoRAD Project, the following civil works were designed, taking the estimated beneficiaries, water demand and estimated discharge at the source. Salient features of civil works of the sub-projects to be constructed under the Project are summarized below, and their location is shown in Figure BD2.1.1.

Table AD3.2.3 Salient Features of Arapal Water Supply Pipeline Improvement Sub-project

Designed intake discharge	72 L/min.
Length of existing pipeline	8.5 km
Length of additional pipeline to be placed along existing pipeline	2.3 km
Design discharge, diameter, and type of additional pipe	1.2 L/sec, GI pipe (1.5 inch)
Length of extension of pipeline to troughs	2.5 km in total (2 routes)
Design discharge, diameter, and type of extension pipe	0.23 L/sec for cattle trough 0.22 L/sec for goat trough GI pipe (1.0 inch)
Dimensions and capacity of water tank (new)	5.0 m (diameter) x 2.7 m (height) 50 m^3 (capacity)
Dimensions and capacity of water trough (new)	10 m x 0.6 m x 0.4 m (for cattle) 5 m x 0.3 m x 0.2 m x 2 lines (for goats)

Source: JICA Project Team

The final revised design of the pipeline is shown in Figures BD3.2.1 - BD3.2.2.

D3.3 Implementation process

D3.3.1 Implementation of the Pipeline Improvement

Construction of the sub-project commenced on January 2013 and targeted to be complete by mid April 2013. The sub-contract works in the sub-project were substantially completed and final inspection was also conducted by the project team to clarify outstanding works and minor defects to be rectified during the defects liability period in accordance with the conditions of sub-contract.

D3.3.2 Extension of Construction Period

Though the sub-project was targeted to complete by middle of April 2013 before the long rainy season started in April, the construction works were disturbed and much delayed due to the various reasons, which were mostly evaluated to be force majeure or events beyond the control of the project team and the sub-contractor and which, by the exercise of due diligence, neither party was able to overcome. Reasons of the delay in the construction works were almost same as the other sub-projects, those were; 1) public disturbance during the election period, 2) security conditions and 3) unpredictable heavy rainfall. After evaluation by the project team of the delay due to these events and affected period, the extension of the sub-contract periods for each sub-contract was accepted. The project team and the sub-contractor mutually agreed that the remaining works be completed by October 2013, with the time extension of 6 months.

The construction works was substantially completed in December, 2013 with some outstanding works and defects, and the taking over certificate was issued by the project on December, 2013. All the contract works were finally finished including outstanding works, rectification of the defects.

Arapal water supply pipeline

Water tank

Goat trough of Arapal water supply system

Source: JICA Project Team

Figure AD3.3.1 Arapal Water Pipeline

D3.3.3 Completion of the Works and Handing Over

All the contract works have been completed and the completed water supply pipeline and related facilities and maintenance tools and spare parts have been handed over to Arapal Community, of which major events are summarized as below.

Table AD3.3.2 Completion of the Sub-project Works and Handing Over to the Community

Major events	Date
Substantial completion of the works and issue of taking over certificate	9th December, 2013
Handing over of the facility to the community	10th December, 2013
Completion of outstanding works and issue of defects liability certificate	25th April, 2014

Source: JICA Project Team

D3.4 Monitoring of the Facility after Completion

The community benefitted from increased access to water, and increased volume of water from the new water tank. The community through their own effort and initiative created a new catchment at the water source by building an additional intake chamber. Before the sub-project, they also experienced challenges such as; i) frequent pipe breakages especially along dry river beds. ii) due to frequent adjustments to sockets and union joints, threads on pipe mouths were worn out, resulting leakages and many pipes lying idle. iii) an air valve along the pipeline had a broken pipe, the local plumbers bypassed the air valve using a direct pipe connection.

After handing over to the community, no serious technical problem were reported, except minor repairing works, which were managed by the community themselves by using supplied maintenance tools and spare parts they procured by themselves.

D3.5 Operation and Maintenance of the Pipeline System

D3.5.1 Basic Concept and Approach of Management of Pipeline System

Piped water supply is very minimal in the whole of Northern Kenya. Where it exists, the supply system is confined to the town centres to serve settled communities and the system is often managed by the Ministry of water except in major urban areas where municipalities, city councils, private entrepreneurs/ companies also manage piped water supply system. This means pipelines in rural area managed mainly by the community do not have any established system of O&M unless the institution that installed the pipeline introduced a particular management system.

A primary focus on the management of pipeline is introduction of water charges and their management. Although the pipeline system the Project is dealing with has existing water distributing structures, there has been no water fee charged before, and repair of breakage mostly rely on external supports. To improve this situation, the Project facilitated the community to introduce water charge for sustainability of operation and maintenance of the pipeline without depending on the outsiders. The Project supported each process from setting water charge based on their required costs, drafting the regulation on the water charge and actual implementation of the fee collection with necessary amendment on the ground.

The followings are the necessary outputs to be achieved for establishment of the management of the pipeline.

D3.5.2 Situation of Arapal pipeline before project intervention

A water management committee was formed after construction of the pipeline in 2007. The committee set a kind of common understanding in water and pasture use such as allocation of watering turn, regular check of breakage of the pipe, restriction of grazing area during wet season. Nevertheless, the function of the management committee is quite primitive without clear management structure. Especially regarding maintenance, they totally rely on the external assistance for spare parts in case of breakage though they have plumbers who have a certain level of skills to repair. There had never been fee or charge for water use introduced nor any sort of records kept.

Table D3.5.1 Summary of the Water Management Body for Arapal Pipeline

Items	Situation
Group name	No particular name
Group status	Not registered
Year of establishment	Pipeline was constructed in 2006 and the committee was formed in 2007
Members	There is no specific membership but all members of the community and visitors are considered as users of the pipeline There is a water management committee in place with 14 members
Collection of fees /water charges	There is no collection of water fee
Management of water source	Pipeline is managed by mutual understanding among the community without any written rules The committee members are in charge of regular monitoring and repair of pipeline in voluntary basis, duties are randomly allocated time to time
Other remarkable issues	The community is composed largely of illiterate pastoralists They rely on a few elites such as teachers, pastor and area chief

Source: Key Informant Interviews of JICA Project Team (January 2013)

D3.5.3 Focal Issues and Approach

Although there was a management committee for the existing pipeline, the management was run by mutual understanding without systematic rules. As the project proposed collection of water charge for sustainable operation and maintenance purpose, there was serious need of strengthening the management function. It was particularly important to introduce adequate and feasible financial management system. They had never handled funds as a committee, nor had any record. A challenge in Arapal is distance from major towns where they can access any financial institution like bank for them to deposit their funds and for procurement of any tools and parts for maintenance. Taking into consideration of the geographic location of the area where there were no financial institutions to deposit savings periodically within accessible distance, a system of a box for cash collection with several keys that were to be held by different officials to prevent personal use could be introduced. Other option of storing spare parts instead of saving cash to make the repairing work more effective and save complication of saving money without banking system. Regarding management of water use, rules for outsider considering pastoralists should be carefully arranged as the area is surrounded by the different communities and tribes coming to water during dry season.

D3.5.4. Progress of O&M and Natural Resource Management

The community has also improved their management and taken charge of the pipeline. They have dedicated a team of semi-trained villagers who ensure that the water flow is uninterrupted and leaks are attended to. Water misuse and wastage has also declined. Regarding the maintenance of pipelines, the community has been using the little know how they have on maintenance to keep the water flowing by use of sockets to join pipes and use of natural materials such as roots to seal leakages. There have been frequent pipeline breakages especially caused by wild animals (monkeys) as they swing on the suspended pipeline forcing breakage for them to water. Occasional rock falls also cause breakage to the pipeline. Reflecting on the needs rose from the community, a technical training on maintenance and repair was conducted to the WUA together with CMDRR committee members in December 2013.

Source: JICA Project Team

Figure AD3.5.1 Technical Transfer on Maintenance of Pipeline: *(left :community members being trained on pipeline maintenance, right: a community member cleans the catchment at the springs)*

In spite of the less amount of fee collection, the committee has kept collecting from those who agreed and the collected fees, and has been utilised for general repairs of pipes that quite frequently occur. The fund has been mainly used for purchasing spare parts such as gate valves, air valves and some fitting like union joints, which were used to repair the parts especially where constantly vandalised by wild animals. Maintenance works were carried out by the Community with trained volunteer community member. Repairing work of fixing a leaking pipe was arranged with spare parts (unions) bought from their repair fund, and repairing of a manhole cover was also taken care with material (cement) bought with money from the community repair fund.

Source: JICA Project Team

Figure AD3.5.2 Maintenance Work by the Community

Additional technical maintenance training was conducted in August 2014 to improve repairing skills of the committee and local plumbers. Six community plumbers were trained on the basic repairing skills with basic knowledge about functions of each part, followed by the tactics of how to avoid damage of pipeline.

After the training, the trained technicians have been repairing occasional minor breakage and problem by themselves.

Source: JICA Project Team

Figure AD3.5.3 Technical Transfer on Maintenance of Pipeline2 *(left :community members being trained on pipeline maintenance as practice, right: instruction by a professional technician)*

D3.5.5 Management and Institutional Development

Water charge was introduced in Arapal pipeline water supply where there had been no water fee charged before, in order to enhance self sustainability in operation and maintenance of the water supply system. A series of discussion was made as the concept of paying for water is new to the Arapal community and some have faced difficulty to understand the necessity of water charge. They reached a consensus to establish a registration system of WUA membership with a membership fee as well as payment of fixed monthly water fee. Although there was an option of fee collection as per consumption, monthly fixed rate was introduced due to the following reasons. Firstly as mentioned above, some community people were not comfortable enough to pay for water, thus it was agreed to start with a small amount that could be taken as contribution to be used for any repair work. Secondly since the system did not require major daily operational cost, it was not critical to collect precise charge per use. Thirdly it seemed that people in Arapal, having no experience of paying for water, a fixed rate could be reasonable as everybody bear equal burden of cost for any necessary expense to maintain the same situation as before. Moreover, considering the situation where people do not always keep cash at hand as cash transactions are not very frequent in the Arapal society, it was decided that the payment of monthly fee can be made at once on yearly basis.

The committee took charge of members registration and fee collection. The committee has faced difficulties in collection of fees due to poor understanding of the community on fee collection and low availability of cash among the community. Several community meetings were conducted to familiarise the people on the concept and the importance of fee collection as well as to facilitate the fee payment. Through consecutive meetings, the idea of saving O&M cost for prompt repair in case of any damage of pipeline system was gradually understood by a certain percents of people in Arapal. However, even though every meeting held concluded with a consensus to collect the periodic water fee, actual collection has turned difficult. The original agreement among the community of monthly contribution of Ksh.100 per household was replaced with the monthly contribution of Ksh.20 per household, which was further amended with the payment of Ksh.100 collected in every 5 month. The committee has been seeking for the easiest and the most practical way of payment for the people who normally do not keep cash with them. However, there are a certain amount of people who are not yet willing to pay for water that was free before. The community also came up with some different ways of collection to improve the situation, which include involvement of a women group, members of which are more comfortable to relate with women to contribute fees. With continuous consultation and effort, they had collected about Ksh.36,000 by August 2014. To management of the collected fees easy, they divided roles of accounting between those who collect, the one receive cash, the one who record, and the ones who keep keys to the cash box.

Taking into consideration of the unequal contribution in the community, the Project proposed to have a meeting to discuss among any possible alternative ways of O&M. Even though the options presented by

the Project included ceasing monthly contribution and collect fund whenever maintenance and repair are required, the community insisted on the advance collection and save fund and spare parts so that they can repair immediately when they encounter any problem. This could be because people realized the importance of saving for O&M through their experiences on constant repairs currently conducted, It could also be interpreted to mean that they have been trying to pursue the instruction given at the beginning feeling they should meet requirements. Although the fee collection and procurement of spare parts are slow, the committee has been handling repairing works having capacity of procuring proper parts from Marsabit town, apart from reliable transportation.

Box. Factors influencing on situation of fee collection in Arapal

Arapal community has been showing low fee collection rate even though people agreed in the several community meetings. The following situation can be taken as serious influencing factor.

Arapal community is a relatively new settlement who has settled in the area approximately for about 10 years. Their sole source of water is Nguruset springs in the foot hills of Mt. Kulal ranges. The pipeline was installed by an A.I.C missionary that also supported the community with a lot of spare parts and tools for repair works as well as actual support in repair works. The A.I.C missionary has been coming annually and assisting maintenance and repairing works. Recently it came and agreed to provide extra parts and tools. According to the community, A.I.C missionary is now planning to have a base in Arapal and continue supporting the community. This has disturbed the mind of the community on their self reliance in O&M works. Even though some of the committee members take the importance of community contribution seriously and try to collect monthly fees, Pastor of the A.I.C who is the treasurer of the WUA is particularly reluctant to collect fees.

D3.6 Discussion, Conclusion, and Lessons Learned

D3.6.1 Observation during Implementation

In Arapal Community, there was high interest in this sub-project to improvement water supply conditions in the community, and hence various proposal, requests and comments were sent to the Project Team and also to the sub-contractor during the construction. Though the sub-project was discussed in detail among stakeholders and consensus was built during CMDRR stage prior to the implementation, different opinions were also raised after setting out of the designed facilities, especially the locations of trough for cattle and goats. The Project Team and sub-contractor conducted many meetings with the community member and mutual site inspection to obtain their consensus. This fact evidenced that this community has keen intention to project implementation and strong ownership of the facilities to be constructed. Also the Project experienced difficulties on consensus building in the limited period.

The construction works was commenced in January 2013, targeting to complete by middle of April 2013. However, the works were disturbed and much delayed due to the various reasons, which were mostly evaluated to be force majeure or events beyond the control of the Project Team and the sub-contractor and which by the exercise of due diligence neither party was able to overcome. The reasons of the delay in the construction works were almost same as the other sub-projects in Marsabit County, those were 1) public disturbance during the election period, 2) insecurity conditions, and 3) unpredictable heavy rainfall. After evaluation by the Project Team of the delay due to these events and affected period, the extension of the sub-contract periods for each sub-contract was accepted. Though all the contract works were finally completed including rectification of the defects, the project experienced various difficulties beyond the control which affected smooth and timely completion of the proposed construction works.

D3.6.2 Capability of the Local Contractors

The sub-contractor employed for this sub-project was a small local contractor, having little experience in works under externally funded projects in terms of construction quality and management including

financial, schedules, and safety control. Other constraints were observed, such as i) little understanding on contract conditions, drawings and technical specifications, and ii) quality control of the works.

(1) Little understanding on contract conditions, drawings and technical specifications

The sub-contractor was ignorant to conditions for notice, submission, approval or rejection and so on within the specified time in the contract and therefore started, modified and finished the works without any prior notice or seeking approval of the project team (the Engineer in the sub-contract). The sub-contractor did not clearly understand the design requirement, and many times worked without necessary drawings at hand on sites. This resulted in additional works and repetitions causing delay of the works. These matters created similar difficulties for proper supervision for quality control and keeping time schedule as explained in Section 2.3.3.

(2) Quality of works

Construction works under this sub-project consisted of pipe works, block/stone works and limited reinforced concrete works. The workmanship was not fully acceptable and required various instructions and additional directions were given by the project team. The workmanship observed during the construction is summarized below.

1) Pipe installation

Generally, there was no special problem on piping works, but leakage from joints were sometimes observed during installation, which needed re-setting and replacement.

2) Concrete works

Quality of concrete works was not fully acceptable, which were not constructed in conformity to the technical specifications, especially i) compaction with vibrator and ii) curing after placing concrete. The designed dimensions such as height and width were also neglected in some cases.

D3.7 Impact and Contribution to Drought resilience

A major impact of the improvement of pipeline water distribution system is improvement of water availability. After the sub-project implementation, discharge of pipe water increased from 0.5 L/sec to 1.2 L/sec, which is more than 2 times the rate before the sub-project. Due to this increase of water supply, community members could water their livestock in the dry season, to support their livelihood during drought or long dry season .Increase of water volume made it possible to water animals efficiently in a shorter time. It had taken longer time to water animal before due to the low water discharge from the pipe. This implies that possibility of watering more livestock efficiently during drought period. Efficiency of watering can enable livestock to travel to further grazing area that can expand grazing potential and reduce congestion in a surrounding area. It was mentioned by the community that when there is continuous stable water flow at the troughs, rangeland can be conserved as cyclic grazing is maintained. Herders can now preserve pasture on the hill for use in the dry season because they do not have to go up the hill to water their livestock as they can water from pipe. Furthermore, they will not walk long distances in search of water, as before especially during breakdown of the pipeline. Some people also commented on indirect impacts such as fewer cases of water borne diseases as people can now take a shower comfortably with enough water. As water is always available nearby, women now have more time to attend to other chores, some increasing the family resources such as weaving, fetching poles and making traditional items for sale.

Improvement of maintenance skills and their practice of minor repair enabled continuous supply of water without delay in repair. Even though collection of maintenance fee has been slow and less than the expected, they have used the collected money to procure spare parts for repair. This made some of the community members to realize importance of saving in advance for quick repair in case of problem. Although radical change is difficult, introduction of the new idea has been influencing people's behaviour. Since the idea of saving for operation and maintenance is new and it was hard for people to be accustomed to pay for water that had been free before, fee collection has faced a lot of difficulties and yet not all the household contribute. However, even if there are free riders in communal contribution, the

signs of gradual change have been observed, which will contribute to improvement of skills to cope with difficulties through community's own effort.

D3.8 Challenges and Constraints in Operation and Maintenance

As mentioned above, people faced several difficulties in operation of pipeline in Arapal. Factors that hinder smooth development of sustainable operation can be analyzed as follows;

- Paying for water is a new idea, as they have been using for free.
- Lifestyle of the Arapal people, in which cash are not always available, made it difficult to introduce water fee collection.
- Distance from the major economic infrastructure is another obstruction for maintenance work. As there is no public transportation in Arapal, people need to rely on vehicles of either business lorries or external donor agencies, which do not come frequently. This impedes procurement of necessary commodities for O&M.
- Seriousness of preparing for repair has not been realized as they have not faced the severe problem. For most of the herders, being active and pastoral, they just move away if water is not available, thus they do not take water problem at one site seriously. The critical people who mostly depend on the piped water are women who fetch water for domestic use. Since women cannot raise issues to men in the Samble culture, they just sacrifice themselves and fetch water from farther sources.
- Expectation of support from a Christian missionary made people reluctant to handle by themselves. The pipeline was installed by an A.I.C missionary that also supported the community with a lot of spare parts and tools for repair works as well as actual support in repair works. The A.I.C missionary has been coming in a certain time period and assisting maintenance and repairing works. According to the community, A.I.C missionary is preparing to have a base in Arapal and continue supporting the community. This has disturbed the mind of the community on their self reliance in O&M works.
- Suspected mismanagement of some of the collected fund by the former secretary created mistrust on the management. People were not able to investigate the suspect as the secretary has been attached to the Christian missionary that supports the community.

Understanding of necessity of community contribution for self-sustainable operation of the pipeline system that requires procurement of spare parts has been prevailing among the community. However, mind of preparation in advance is still weak, which result in lower rate of periodical contribution by the community. As it requires a certain period and experience to change people's attitude, current situation where a part of the community contributes for the maintenance can be acceptable situation. Continuation of the minor repair work and experience of major emergency need of repair is expected to facilitate the mind change of people.

CHAPTER D4. MARSABIT: SUB-PROJECT OF NEW CONSTRUCTION OF WATER ROCK CATCHMENT

D4.1 General

General outline of the sub-project is summarized below.

Table AD4.1.1 General Outline of Lokuchura Rock Catchment Construction Sub-project

1. Objectives	This project aimed to improve sustainable water supply system mainly for drinking water through new construction of rock catchment. Further, to improve operation and maintenance activities, especially targeting strengthening of water users' association.		
2. Number of Beneficiaries	Unspecified		
3. Implementation Organization	JICA ECoRAD Project, and water users' association		
4. Project Contents			
1) Project Outline	1) Construction of new rock catchment with related facilities 2) Establishment and strengthening of water users' organization 3) Improvement of operation and maintenance system and regulations through training program		
2) Facility / Activity	*Facilities/Activities*	*Implementer*	
	1) Construction of rock catchment 2) Organization and strengthening of water users' association 3) Procurement of O&M tools 4) Monitoring	1) Contractor 2) NGO and project team 3) Contractor 4) Project team	
3) Organization for O&M	Water Users' Association		
4) Construction Period	Construction started in January, 2013 and completed in June, 2014.		

Source: JICA Project Team

Most of the villages in the County are facing serious shortage of drinking water due to lack of water facilities or insufficient capacity of the existing water storage structures, whereas water demands are increasing. Under ECoRAD, improvement of water supply systems was therefore one of the major intervention including small scale water harvesting facilities like rock catchment. This sub-project aimed at improving drinking water supply in Lokuchura Village, Ngurunit Community, through construction of new rock catchment facilities. The proposed rock catchment was a pilot project with a new design that is; construction of an excavated reservoir under the original ground level at the foot of the rock slope to maximize the storage capacity with minimized construction cost. To improve operation and maintenance activities, water users association is to be strengthened.

In the Ngurunit Community's CAP there are various proposed locations for construction of new rock catchment. Field conditions of the proposed sites were inspected and evaluated by the Project Team, especially in terms of urgency of the necessity, catchment area, conditions of rock slope and soundness of underground conditions, etc. After evaluation, Lokuchura site was selected for construction of a rock catchment under the Project.

In Lokuchura Village, there are 3 existing rock catchments with small tank capacities. Even though the rainfall is sufficient during the rainy seasons, most of water is wasted due to the size of tanks. Therefore, ECoRAD proposes construct the improved type of rock catchment that will have an underground storage reservoir.

D4.2 Outline of the Lokuchura Rock Catchment

D4.2.1 General Conditions of Natural Resources in Ngurunit Area

Ngurunit Location of Laisamis District in Marsabit County is situated at the foot of Ndoto Mountains, about 65 km west of Laisamis town, the district headquarters. It borders Samburu North District to the north. The area has undeveloped water springs up the mountain. The temperatures range between 25 ºC and 32 ºC. Namarei vegetation is characterized by short shrubs with annual grasses and scattered acacia species favorable for camel rearing and has good grazing area for cattle and shoats during rainy seasons.

The proposed rock catchment site is located in Lokuchura village, where the villagers are facing serious shortage of drinking water and are obliged to carry water more than 5 km from other water sources. Meanwhile, there are development potential of rock catchment on some rocky hills. Existing water points in and around Ngurunit are listed below.

Table D4.2.1 Existing Water Points in and around Ngurunit

Water Pan	Rock catchment
- Lokuchura Water Pan No.1 - Lokuchura Water Pan No.2 - Baio Water Pan	- Lokuchura Rock Catchment No.1 - Lokuchura Rock Catchment No.2 - Lokuchura Rock Catchment No.3 - Namarei Rock Catchment - Lengima Rock Catchment

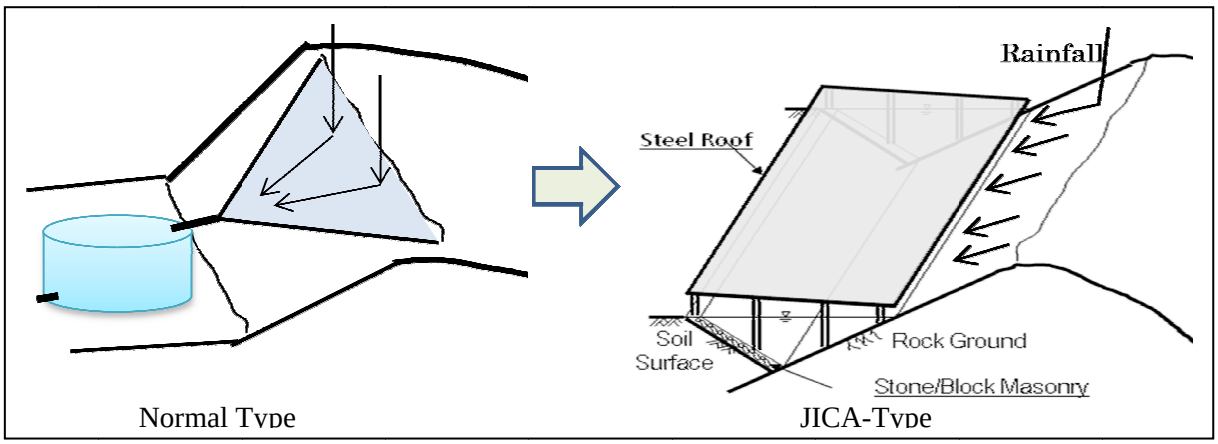
Source: JICA Project Team

D4.2.2 Design of Proposed Rock Catchment

Construction of new rock catchment is proposed in Lokuchura village just near an existing rock catchment in order to increase available storage capacity of drinking water in the village to meet increasing water demand. There are 140 households in the village of which their daily demand are to increase from 20 L/household to 40 L/household, Based on this estimated demand and seasonal rainfall intensity, the rock catchment and the reservoir was designed as discussed in Sub-section 4.3.3 (1). Usually, rock catchment is constructed with water tank that has capacity of 30 to 50m^3. Under the ECoRAD Project, an underground reservoir along the rock slope is proposed instead of water tank in order to increase the storage capacity.

In ECoRAD Project, a new design of rock catchment facility (so called “JICA-type Rock Catchment”, hereinafter) was introduced. In the JICA-type Rock Catchment, an underground excavated reservoir was constructed instead of a tank constructed on ground, in order to increase storage capacity of a reservoir tank and to minimize construction cost.

The sketch of the proposed type of the rock catchment is shown in figure below.



Source: JICA Project Team

Figure AD4.2.1 Sketch of JICA-type Rock Catchment

D4.2.3 Salient Features of Sub-project Works

Under the ECoRAD Project, the following civil works were designed, taking the estimated beneficiaries, water demand, rainfall pattern and estimated discharge from the catchment. Salient features of civil works of the sub-projects to be constructed under the Project are summarized below, and their location is shown in Figure BD2.1.1.

Table AD4.2.2 Salient Features of Lokuchura Rock Catchment Construction Sub-project

Catchment area of rock catchment	9,500 m^2
Dimension of underground reservoir	Length 130 m Width (water surface) 6.5 m on average Effective water depth 1.8 m on average
Capacity of underground reservoir	750 m^3
Related facilities	- Iron roof with support - 2 hand pumps

Source: JICA Project Team

The design of the JICA-type Rock Catchment and related facilities are shown in Figures BD4.2.1 - BD4.2.2.

D4.3 Implementation process

D4.3.1 Implementation of the Construction of Rock Catchment

Construction of Lokuchura Rock Catchment Sub-project was commenced in January 2013 by a selected sub-contractor.

The sub-contract works for Lokuchura Rock Catchment were substantially completed and final inspection was also conducted by the project team for clarifying outstanding works and minor defects to be rectified during the defects liability period in accordance with the conditions of sub-contract.

View of rock catchment

Inside of underground excavated reservoir

Hand Pump installed at Rock Catchment

Source: JICA Project Team

Figure AD4.3.1 Lokuchura Rock Catchment

D4.3.2 Extension of Construction Period

Construction of Lokuchura Rock Catchment Sub-project was commenced in January 2013, targeting to complete by middle of April 2013. However, the works were disturbed and delayed much due to the various reasons, which were mostly evaluated as force majeure or events beyond the control of the project team and the sub-contractor and which, by the exercise of due diligence, neither party was able to overcome. Reasons of the delay in the construction works were almost same as the other sub-projects, these were 1) public disturbance during the election period, 2) security conditions and 3) unpredictable heavy rainfall. After evaluation by the project team on the delay due to these events and affected period, the extension of the sub-contract periods for each sub-contract was accepted.

The sub-contract works of Lokuchura Rock Catchment were substantially completed in November, 2013 with some outstanding works and defects

In October, 2013 in the short rainy season, water leakage from cracks on the rock slope in the reservoir was observed. Therefore, the sub-contractor was instructed to carry out additional remedial works to stop the leakages.

D4.4 Completion of the Works and Handing Over

All the contract works have been completed and the completed rock catchment, related facilities and maintenance tools have been handed over to the Community, of whose major events are summarized as below.

Table AD4.4.1 Completion of the Sub-project Works and Handing Over to the Community

Major events	Date
Substantial completion of the works and issue of taking over certificate	9th December, 2013
Handing over of the facility to the community	10th December, 2013
Completion of outstanding works and issue of defects liability certificate	17th April, 2014

Source: JICA Project Team

D4.5 Observations Regarding Construction Works

D4.5.1 Design Modification due to Underground Rock Slope Condition

Due to limitation of available time and cost for site investigation, topographic survey and facility design before tendering, as well as insufficient technical data and information, such as hydrological data and underground conditions, the project team was obliged to plan and design with various kind of estimation during design stage. In the course of actual construction, design was modified according the actual rock slope.

D4.5.2 Defects Rectification and Improvement

After completion of this rock catchment in the short rainy season 2013, it managed to hold the rainwater sufficiently. The reservoir was filled up with water very quickly reached the design level. However, on next day, it was observed that the water level had drastically dropped by 850 mm. The Project Team visited for investigation and found the reason was that many cracks remained on the rock slope untreated in the reservoir. Subsequently, water level gauges were installed for further monitoring the rate of water loss. The Project Team ordered additional works to the sub-contractor in order to stop the leakage. The works included 1) filling up cracks, 2) mortar plastering and 3) painting with impervious paint material on plastered portion. These additional works was completed in March 2014.

After the completion of these additional works for improvement, monitoring of water level was continued to measure the leakage from the reservoir till and during the short rainy season in 2014. Through the monitoring together with the community members, remarkable improvement was observed. The leakage observed was within the acceptable range that was about 1 cm/day in November 2014. The community accepted the results of improvement works and appreciated the handed over rock catchment.

D4.6 Operation and Maintenance of the Rock Catchment

D4.6.1 Basic Concept and Approach of Management of Rock Catchment

Potential rock catchment areas, having exposed rock surfaces, are fewer due to limited rainfall and high evaporation in the location and there is no common management system for rock catchment observed probably because rock catchment itself does not require much maintenance work. However, many rock catchments have supplemental structure such as water tank, tap and pipes attached to the rock catchment,

thus maintenance work for these structure shall be required. Besides, management of quality of water is another issue of rock catchment water source. Although rock catchment is mainly established for domestic use, hygiene and quality of water are not well maintained.

Key issues in management of rock catchment are management and allocation of water as well as adequate water charge with better utilization of the collected fees. Although there is not much regular maintenance and operational cost required for the rock catchment, water fee can be utilized for attached structures on the rock catchment and to rectify the demanding situation.

D4.6.2 Situation of Rock Catchment Management before Project Intervention

Although the rock catchment constructed through the project is new, there are two existing catchment attached on the same rock. There was a committee that handled management of the existing rock catchments. Reflecting on the cultural norm of harvesting water as women's responsibility, women play crucial roles in management of the rock catchment. Water from existing rock catchments is restricted to domestic use and normally it was sufficient for one month or less. Therefore, they have rules in allocation of water for each household per day and water charge as per amount harvested. Although the water fees were being collected, maintenance works such as fixing leakage of the existing pan and problems in pipes to the water tank had not been carried out.

Table AD4.6.1 Summary of the Water Management Body for Lokuchura Rock Catchments

Items	Situation
Group name	No name yet
Group status	Not registered
Year of establishment	Not clear
Members (membership, officials)	All members of the community are considered users of the water There is a water management committee in place with a composition of 9 women and 1 man
Collection of fees /water charges	They charge water fee using containers. Ksh. 3 per 30 litres of water fetched. Those who cannot afford to pay cash would pay by work such as cleaning.
Management of water source	Management of water source is done by the management committee with source attendants done by shifts Allocation of water per household is 30 litres per day (depending on the amount of water available) Simple record keeping in place, but school kids assist the members in daily recording due to illiteracy of the members Water source exclusively for domestic use and occasional cleaning of the catchment has been done
Other remarkable issues	

Source: Key Informant Interviews of JICA Project Team (January 2013)

D4.6.3 Focal Issues and Approach

Taking into consideration of the fact of current fee collection for water use, introduction of adequate financial management skill is necessary. However, water management was in the hands of women in this area, most of who were illiterate and recording was done with help of school children. It is necessary to analyze and consider better alternative arrangement of the accounting system that can be handled with their capacity, such as stamping system instead of formal ledger, a box for cash collection with several keys. Further analysis of the capacity regarding accounting shall be made to propose feasible and effective management system that suits this committee. In addition, effective use of the collected water fee especially for the purpose of maintenance is discussed as the existing water supply system of the rock catchment has several problems and requires repair. Currently the committee is able to handle only minor repairs such as exchange of pad lock with their collected fees. Adequate fee setting shall be discussed to revise water charge. Judging from the current situation of the existing rock catchment,

assistance to maintain water quality shall help people to acquire enough and safe water for human beings as it was observed in the existing rock catchment that many shoats stay around water and taking water although the water is restricted for domestic use. Water quality can be improved by improving management of animals around the water and by promoting hygiene in drinking water management.

D4.6.4 Management and Institutional Development

Prior to commencement of the construction work, consensus was made with the community on the construction and management of the new rock catchment at Lokuchura. The community members recognized the importance of proper management and roles of women in the water management in the area. In this area, significantly different from other area, women played crucial roles in management of rock catchment. Women took responsibility in water fee collection as they were responsible in water fetching at households. It was agreed that the whole community would take care of the water source bearing management cost by charging adequate water charge to maintain water source properly. People were willing to pay a certain amount as water charge. Taking the situation of previous management where management had been handled mainly by illiterate women with help of school children, a training programme was designed with elaboration on simplified methods of management, which was executed in March 2013.

After the training, the committee has proceeded with formal registration of the WUA as CBO with their own effort, with partial support from the project in drafting constitutions. They have introduced cash box for collection of water fees with their own initiatives and at their cost. Recognizing importance of the record keeping, they have appointed a nursery teacher as treasurer and started recording the water fee collection on daily basis[1]. Although the newly constructed rock catchment was not completed by the rain in April 2013 due to early start of the rain that disturbed the construction work, they applied their management system introduced through the training to management of the existing water source.

Lokuchura WUA had been collecting water fee for the existing rock catchment as per their consumption with a certain restriction of consumption per household per day due to water limitation in the existing rock catchment. A membership fee, in addition to the water fee, was introduced after registration of the WUA with the Department of Social Services to enhance ownership of the water source and responsibility of the operation and maintenance. Membership fee was set as compulsory to use water from the rock catchment and those who are not registered are not allowed to fetch water from the rock catchment. The following is the summary of the fee collection in Lokuchura rock catchment.

Table AD4.6.2 Water Tariff and Collection Methods at Lokuchura Rock Catchment

Category	Fee collection method	Item / Unit	Tariff
Membership fee	Yearly fixed rate	Household per year	Ksh.100
Domestic use	Fee as per consumption (with limitation of water consumption per day depending on the availability of water)	Water container	-Ksh.2 per 20L jerrican (Ksh.1 per 10 ltr jerry can)-water fetched after every 3 days with each HH allowed 40lts each water supply days -Elderly members of the community allowed to fetch 20lts each water supply days

Source: JICA Project Team

During use of the old water pan, when the new pan did not hold water at the beginning, they would collect water fee set among the community and kept records of payment for the previously available water. Due to high illiteracy in the area, those who could manage record keeping were extremely limited. A pre-school teacher took charge of the recording while another person kept collected fee, applying a box with three keys that are kept by different person. Although they had not have chance to implement the fee collection for the new rock catchment since they have been still judging the management of water

[1] As they have regulation of limitation of water collection depending on the water availability, the records are kept every 3days at the time of monitoring.

use from different water sources they are ready to practice when the ordering of water use get stable with stable water holding in the rock catchments.

Women, being responsible for fetching water for domestic use, have been active and taking responsibility in water management. Women are in a chairing position in the WUA and decision making in management of the rock catchment. Women's opinions were respected and women took large part in maintaining water source. Although the management of hand pump locking was handled by male elders, it was mostly women who participated in the cleaning of the water pan.

D4.6.5 Progress of O&M

Although the rock catchment received an impressive volume of water during the November and December 2013 short rains, it declined due to water seepage through the rock catchment. Even with the short period of the water held in the catchment, the community tried to manage their water source. The community, learnt the importance of hygiene by avoiding animals coming nearby the water source, they made a natural live fence by themselves at the base of the new rock catchment that restricts access to the pan by animals and human beings.

Periodical rain in March 2014 filled the rock catchments of Lokuchura. People decided to save the water of the new rock catchment opting the commencement date for use as June 2014 since there were natural ponds and pools available in surrounding area. The chairman secured the two hand pumps with chains and padlocks. The community has also been sensitized to avoid grazing or entering in the sloping surface of the rock catchment.

The project supplied tools and equipment for use in maintenance of the rock catchment. The tools are kept by the WUA committee in the school buildings and will only be used for water facility maintenance purposes. After the rock catchment dried up, before further repairing work of leakage started, Lokuchura community, mostly women, volunteered themselves to clean the silts in the catchment.

Source: JICA Project Team

Figure AD4.6.1 Desilting and Cleaning of the Rock Catchment by the Community

Short rain in November and December 2014 filled the rock catchment up half way. The community waited to observe the situation and change of water level of each available water sources to decide watering order. They decided to start using water in the old rock catchment, which is not covered thus high in evaporation, and saved water in the new rock catchment. The old rock catchment was rehabilitated with the additional retaining wall by an NGO to increase water capacity. Due to the upgrading, as well as careful water use by the community, water lasted in the old rock catchment for about one and a half month after rain before they started using the new rock catchment.

D4.7 Discussion, Conclusion, and Lessons Learned

D4.7.1 Effect of Rock Catchment with Underground Excavated Reservoir (JICA-type Rock Catchment)

In ECoRAD Project, a new design of rock catchment facility (JICA-type Rock Catchment) was introduced. In the JICA-type Rock Catchment, an underground excavated reservoir was constructed instead of a tank constructed on ground, in order to increase storage capacity of a reservoir tank and to minimize construction cost. By introducing innovative design, the JICA-type Rock Catchment, the facility could realize following advantages:

- The face of rock slope is utilized as side wall and floor to minimize the percolation from the reservoir.
- The opposite side of rock slope will be protected with concrete or stone works to ensure sanitary water quality.
- By excavating the elongated reservoir at foot of and in parallel to the rock slope, the catchment area can be maximized to collect more water.
- Roofing is proposed in order to reduce evaporation from water surface, which will be about 1/3 of that without roof.
- Construction cost is depressed in comparison with other types of rock catchment facilities.

In order to evaluate financial impact of the new design, construction costs of the following 3 types of reservoir tanks were preliminary compared.

Design Comparisons

Design-1) Several small water tanks constructed with concrete blocks (standard design of MWI most prevailing in the project area),

Design-2) One large water tank with reinforced concrete wall, and

Design-3) Underground excavated reservoir tank, JICA-type Rock Catchment

Table AD4.7.1 Summary of Comparison of Construction Cost of Rock Catchments

Design Type	Capacity	Works	Cost (Ksh.)	%
1 Several small water tanks constructed with concrete blocks (standard design of MWI most prevailing in the project area)	53.5 m^3 x 14 nos. combined = 750 m^3	1) Horry block	125,000	
		2) Concrete	81,500	
		3) Reinforcement bar	69,100	
		4) Plastering	68,100	
		5) Form Works	22,900	
		6) Miscellaneous	36,660	
		Sub-total	403,260	
		x 14 nos,		
		Total	**5,645,640**	**149%**
2 One large water tank with reinforced concrete wall	750 m^3	1) Concrete	2,578,100	
		2) Reinforcement bar	890,300	
		3) Form works	603,500	
		4) Roof works	776,000	
		5) Miscellaneous	484,790	
		Total	**5,332,690**	**140%**
3 JICA-type Rock Catchment (Underground excavated reservoir)	750 m^3	1) Clearing	120,000	
		2) Excavation	196,800	
		3) Protection block	420,000	
		4) Roof works	2,714,300	
		5) Miscellaneous	345,110	
		Total	**3,796,210**	**100%**

Source: JICA Project Team

As shown in the calculation above, JICA-type Rock Catchment had remarkable financial advantage in comparison with the costs of the other 2 types of tanks.

The JICA-type rock catchment can lower construction cost by approximately 30% below the normal design. Since this design has a long reservoir along a rock slope, it can collect rain water effectively. In addition, such design can increase capacity of reservoir easily without complicated design calculation and make construction easier and with less funds.

D4.7.2 Leakage from Rock Surface

One of the most serious lessons learned during implementation is a high leakage through cracks on the surface rock that were not found and unforeseeable in the investigation and design stages. As mentioned above, on completion of the rock catchment, the reservoir was filled up very quickly with rain water in a day to reach the almost designed level. Although the rock catchment received an impressive volume of water, water seepage and leakage was high during the experiences in the first rain season in 2013. The reasons and concerned events are summarized as below.

- They had envisioned utilizing the water in the rock catchment during the very dry season,
- The other smaller rock catchment that existed before the new JICA rock catchment was also losing water through seepage, evaporation and domestic animals disturbance especially stray donkeys. The community resolved to use the older and smaller catchment first.
- There was a natural live fence at the base of the new JICA rock catchment that restricts access to the pan by animals and human beings.
- Repair works were undertaken on the surface of the rock catchment in February 2014 to reduce seepage.
- The community at Lokuchura who mainly use the catchment water for domestic purposes were only able to utilize the rock catchment for approximately 4 weeks i.e. end of May and beginning of June 2014.

- The community has raised a huge complaint about the water holding capacity of the rock catchment. This is was largely because they expected to use the rock catchment when all other water sources pans are were dried up yet the rock catchment losses water only after three months

In order to solve the above problem, the Project Team planned and ordered additional works to stop the leakage consisting filling up cracks, mortar plastering and painting with impervious material on plastered portion. These additional works was completed in March 2014, the monitoring results showed that the leakage was drastically reduced to the acceptable range, and appreciated by the community.

D4.7.3 Impact and Contribution to Drought Resilience

Once the new rock catchment is filled up with water, it can serve for about 208 days for 120 household based on the rule of the WUA of Lokuchura that limit the amount of water to be fetched to 30 litre per household per day technically, though actually there are other factors influencing such as evaporation and absorption into the rocks. It is difficult to judge actual amount as the rock catchment has not been filled up after the rehabilitation work. The community mentioned that if the rock catchment is filled up and water can stay, they can have water available nearby their household for a longer period. This can, especially for women, reduce distance to search for water, which contribute to save time for women so that they can spend more time for other activities. Considering the fact that water cannot stay for long due to other factors, people can use water more often. Increase of water use can contribute to improvement of health status of people, through improvement in personal hygiene and clean water intake. Some people evaluated that they can access clean water thanks to the new rock catchment.

D4.7.4 Challenges and Constraints in Operation and Maintenance

Water availability is depending on the rainfalls, with which the community needs to assess the water use. It was difficult for the community to judge how long the rock catchment can hold water, as the different rock catchment has water holding capacity depending on their structure, location, evaporation, rock and ground conditions etc. Since the reduction of water level to some extent is inevitable, the community needs to judge order of use of different water sources and amount limitation to maximize the benefit of water and prolonging the period of water being available in the sources.

CHAPTER D5. MARSABIT: SUB-PROJECT OF INTRODUCTION OF SOLAR POWER SYSTEM IN WATER PUMP FACILITIES

D5.1 General

D5.1.1 General Outline of the Sub-project

Table AD5.1.1 General Outline of the Solar Power Generation System

Item	Contents	
1. Objectives	1. To improve financial condition of the water users committee by reduction of consumption of fuel 2. To provide financial support to the community from a part of project benefit	
2. Number of Beneficiaries	Water users of the boreholes	
3. Implementation Organization	JICA ECoRAD Project, water users' association and environmental management committee	
4. Project Contents		
1) Project Outline	1) Installation of solar power generation system 2) Training of community members 3) Improvement of operation and maintenance system and regulations through training program conducted by NGO	
2) Facility / Activity	*Facilities/Activities*	*Implementer*
	1) Solar power generation system 2) Organization and strengthening of water users' association 3) Monitoring	1) Contractor 2) Project Team / NGO 3) Project Team
3) Organization for O&M	Water users' committee and environmental management committee	
4) Procurement and construction period	5 months	

Source: JICA Project Team

As mentioned in the previous chapter, it was highly recommended to install solar pump systems in the existing diesel pump system in remote areas for sustainable usage of pumping systems.

For installation of solar pump system, the following points should be examined and considered.

- Vandalism: In consideration of vandalism, solar pump systems should not be installed in remote areas where security cannot be guaranteed. Basically it should be installed at the boreholes which are located in residential areas or highly secured places with security guard.
- Alternative Power Source: It is highly recommendable to install a new solar pump system at an existing diesel pump system in order to use existing diesel generator for stand-by purpose in a spell of drought.
- Operation and Maintenance system: Training of water management committee is a key issue for establishing sustainable operation and maintenance system in addition to physical improvement with solar pump systems.

In consideration of the above, 3 existing boreholes with diesel pump systems were selected, such as (1) Shurr Borehole in Shurr, Marsabit North, (2) Kubi QalloBoreholes in Qubi Kallo, Marsabit Central, and (3) Gobore Borehole in Korr, Marsabit South.

D5.2 Outline of the Sub-project

D5.2.1 Shurr Borehole

(1) Present Condition of the borehole

The conditions of pump and diesel generator at Shurr borehole are summarized in the following table, and specifications for solar pump should be selected based on such current condition of the existing facilities.

Table AD5.2.1 Data for Existing Pump System of Shurr Borehole

Item	Unit	Specification	Remarks
(a) Pump			
Pump type	-	SP14A-25 (Grundfos)	The existing pump is old and needs to be replaced.
Pump capacity	kW	7.5	
Phase	-	3	
Pump discharge	m^3/hr	12.0	estimated
Pump depth	m	84	14 pipes x 6m
Well depth	m	105	Based on interview
Water Rest Level(WRL)	m	33	estimated
Yield Capacity of BH	cum/hr	N/A	estimated
(b) Generator			
Diesel Generator	kW	N/A	
	kVA	25	based on the plate on the facilities
	phase	3	based on the plate on the facilities
Casing	inch	6	estimated

N/A: not available

Source: JICA Project Team

(2) Solar Pump System in Shurr borehole

The works executed were:
Installation of (i) submergible pump, (ii) solar panel, (iii) inverter system, (iv) switch box for solar power system and diesel generator system, and (v) accessories.

Major specifications of the solar pump system newly installed in the Shurr borehole are summarized in the following table.

Table AD5.2.2 Data for Solar Pump System of Shurr Borehole

Quantity	Unit	Items	Remarks
1	no.	Grundfos SP 14A-25 c/w 7.5kW 3ph motor	Submergible pump
1	no.	Grundfos RSI 9200 controller	DC/AC inverter 9.2 kW capacity
1	no.	Control Panel Type C307 - MA,PP,CL 72,9	
64	nos.	175W Dayliff solar modules	solar panels for 11.2 kW in total
1	no.	Sensus 405S DN40 Water Meter	water meter-small
2	no.	Sensus WP DN 50 Water Meter	water meter-large
1	no.	40 Amps 4 pole Manual changeover switch	switch between diesel system and solar system
1	set	Solar Panel Support Structure	2.5 m high

Source: JICA Project Team

Feature and functions of the new system after installation of the solar power generation system is as summarized below.

Table AD5.2.3 Data for New Pump System of Shurr Borehole

Item	Unit	Specification	Remarks
(a) Pump and well			
Pump type		SP14A-25 (Grundfos)	New pump was installed since the existing pump was old.
Pump capacity	kW	7.5	
Phase		3	
Pump discharge	m^3/hr	12.0 – 14.0	estimated
Pump depth	m	66	22 pipes x 3m
Strainer position	m	N/A	
Well depth	m	86	estimated
Water Rest Level (WRL)	m	N/A	
Yield Capacity of BH	cum/hr		
Construction year of well	Year	1979	
Riser pipe diameter	inch	2.0	
Casing	inch	6.0	
(b) Generator			
Diesel Generator	kW	n/A	based on the plate on the facilities
	kVA	25	based on the plate on the facilities
	phase	3	
(c) Solar Power System			
Size of Solar modules	W	175	175 W Dayliff solar modules
Number of Solar modules	no	64	
Max. generated power	kW	11.20	= 175W x 64 nos
Inverter controller	kW	9.20	Grundfos RSI 9200 controller, 3phase
Safety factor (Module vs Inverter)	%	122%	= 11.20 kW/ 9.20kW
Safety factor (Module vs Motor)	%	149%	= 11.20 kW/ 7.5kW

Source: JICA Project Team

D5.2.2 Kubi Qallo Borehole

(1) Condition of the borehole before the project

The conditions of pump and diesel generator at Kubi Qallo borehole are summarized in the following table, and specifications for solar pump should be selected based on such current condition of the existing facilities.

Table AD5.2.4 Data for Existing Pump System of Kubi QalloBorehole

Item	Unit	Specification	Remarks
(a) Pump			
Pump type		SP8A-50 (Grundfos)	Condition of the existing submergible pump is good.
Pump capacity	kW	7.5	
Phase		3	
Pump discharge	m^3/hr	6.0 to 7.0	estimated
Pump depth	m	228	38 pipes x 6 m
Well depth	m	-	
Water Rest Level(WRL)	m	168	estimated
Yield Capacity of BH	cum/hr	6.7	estimated
(b) Generator			
Diesel Generator	kW	24	based on the plate on the facilities
	kVA	30	based on the plate on the facilities
	phase	3	
Casing	inch	6	

Source: JICA Project Team

(2) Solar Pump System in Kubi Qallo borehole

The works executed are:

- Installation of (i) solar panel, (ii) inverter system, (iii) switch box for solar power system and diesel generator system, and (iv) accessories.
- Replacement of 228 m (=6 m*38 nos.) of riser pipe from the existing one (1.5 inches) to 2 inches.

Major specifications of the solar pump system newly installed in the Kubi Qallo borehole are summarized in the following table.

TableAD5.2.5 Data for Solar Pump System of Kubi Qallo Borehole

Quantity	Unit	Items	Remarks
1	no.	Grundfos RSI 9200 controller	DC/AC inverter 9.2 kW capacity
64	nos.	175 W Dayliff solar modules	solar panels for 11.2 kW in total
38	nos.	2" GI pipes class C (6m length)	228m in length
1	no.	Sensus 405S DN40 Water Meter	water meter-small
38	nos.	Airline pipes	
1	no.	4 Pole 63Amps Manual Changeover Switch	switch between diesel system and solar system
1	set	Solar Panel Support Structure	2.5 m high

Source: JICA Project Team

Feature and functions of the new system after installation of the solar power generation system is as summarized below.

Table AD5.2.6 Data for New Pump System of Kubi Qallo Borehole

Item	Unit	Specification	Remarks
(a) Pump and well			
Pump type		SP8A-50 (Grundfos)	Condition of the existing submergible pump is good.
Pump capacity	kW	7.5	
Phase		3	
Pump discharge	m^3/hr	6.0 to 7.0	estimated
Pump depth	m	228	38 pipes x 6 m
Strainer position	m	N/A	
Well depth	m	N/A	
Water Rest Level (WRL)	m	168	estimated
Yield Capacity of BH	cum/hr	6.7	estimated
Construction year of well	Year	2005	
Riser pipe diameter	inch	2.0	
Casing	inch	6.0	
(b) Generator			
Diesel Generator	kW	24	based on the plate on the facilities
	kVA	30	based on the plate on the facilities
	phase	3	
(c) Solar Power System			
Size of Solar modules	W	175	175 W Dayliff solar modules
Number of Solar modules	no	64	
Max. generated power	kW	11.20	= 175W x 64 nos
Inverter controller	kW	9.20	Grundfos RSI 9200 controller, 3phase
Safety factor (Module vs Inverter)	%	122%	= 11.20 kW/ 9.20kW
Safety factor (Module vs Motor)	%	149%	= 11.20 kW/ 7.5kW

Source: JICA Project Team

D5.2.3 Gobore Borehole

(1) Present Condition of the borehole

The conditions of pump and diesel generator at Gobore borehole are summarized in the following table, and specifications the solar pump was selected based on such condition of the existing facilities.

Table AD5.2.7 Data for Existing Pump System of Gobore Borehole

Item	Unit	Specification	Remarks
(a) Pump			
Pump type		SP8A-15 (Grundfos)	Condition of the existing submergible pump is good.
Pump capacity	kW	2.2	
Phase		3	
Pump discharge	m3/hr	15-20	estimated
Pump depth	m	52	based on the plate on the facilities
Well depth	m	55	based on the plate on the facilities
Water Rest Level(WRL)	m	N/A	
Yield Capacity of BH	cum/hr	N/A	
(b) Generator			
Diesel Generator	kW	4.3	based on the plate on the facilities
	kVA	N/A	based on the plate on the facilities
	phase	3	
Casing	inch	6	

N/A: not available

Source: JICA Project Team

(2) Solar Pump System in Gobore borehole

The works to be executed are:

- Installation of (i) solar panel, (ii) inverter system, (iii) switch box for solar power system and diesel generator system, and (iv) accessories.
- Major specifications of the solar pump system newly installed in the Gobore borehole are summarized in the following table.

Table AD5.2.8 Data for Solar Pump System of Gobore Borehole

Quantity	Unit	Items	Remarks
1	no.	Grundfos RSI 3000 controller	DC/AC inverter 3.0 kW capacity
29	nos.	125 W Dayliff solar modules	solar panels for 3.6 kW in total
3	no.	Sensus 405S DN40 Water Meter	water meter-small
1	no.	4 Pole 32Amps Manual Changeover Switch	switch between diesel system and solar system
1	set	Solar Panel Support Structure	2.5 m high

Source: JICA Project Team

Feature and functions of the new system after installation of the solar power generation system is as summarized below.

Table AD5.2.9 Data for New Pump System of Gobore Borehole

Item	Unit	Specification	Remarks
(a) Pump and well			
Pump type		SP8A-15 (Grundfos)	Condition of the existing submergible pump is good.
Pump capacity	kW	2.2	
Phase		3	
Pump discharge	m^3/hr	15-20	estimated
Pump depth	m	52	based on the plate on the facilities
Strainer position	m	N/A	
Well depth	m	55	based on the plate on the facilities
Water Rest Level (WRL)	m	N/A	
Yield Capacity of BH	cum/hr	N/A	estimated
Construction year of well	Year	2006	
Riser pipe diameter	inch	2.0	
Casing	inch	6.0	
(b) Generator			
Diesel Generator	kW	4.3	based on the plate on the facilities
	kVA	N/A	based on the plate on the facilities
	phase	3	
(c) Solar Power System			
Size of Solar modules	W	125 & 175	125 W Dayliff solar modules
Number of Solar modules	no	30 (125kW) & 2 (175kW)	
Max. generated power	kW	4.10	= 125W x 30 nos + 175 x 2 nos
Inverter controller	kW	3.00	Grundfos RSI 9200 controller, 3phase
Safety factor (Module vs Inverter)	%	136%	= 4.10 kW/ 3.00kW
Safety factor (Module vs Motor)	%	186%	= 4.10 kW/ 2.20kW

Source: JICA Project Team

D5.3 Installation of Solar Power Generation System

D5.3.1 Procurements

The procurement of required parts and equipment is undergoing at this moment. The DC/AC inverters will be delivered from Europe.

The Contractor dispatched technical team, in the end of February 2013, for final confirmation works at 3 sites prior to sending equipment/devices. Several checks and discussion were made, and finally the Project and the contractor recognized and agreed some additional devices/parts to be included in the shipment to the site.

The shipment and installation works are planned to be at the end of March 2013.

D5.3.2 Site Delivery and Installation Works

Site delivery and installation works for solar power pumping system were done in June 2013 as 3 sites. Since the procurement contract, as mentioned in the previous report, was made in January, 2013, it took a long waiting period before site delivery and installation works. Originally installation work was anticipated in March 2013. However actual installation was made in June 2013 due to difficulty of

equipment of the inverter controller which is newly developed and started to supply to customer from German company recently.

D5.3.3 Trial Operation of the System and Troubles Observed during Operation

The followings are the troubles of operation in the solar power pumping system after installation in June 2013.

Table AD5.3.1 Operation Conditions of the 3 Solar Power Systems

	Shurr	Kubi Qallo	Korr
Mechanical trouble of the solar systems	None	None	Capacity of modules were insufficient*1
Daily operation hours in average	8-10 hours in dry spell	Not fixed hours, depending on the customer's demands	8-10 hours per day

*1: see section 5.4.1,

Source: JICA Project Team

D5.4 Observation during Installation

D5.4.1 Additional Installation of Solar Modules

(1) Troubles and analysis

After installation of the solar system, at Gobore borehole in Korr community, it was found that solar power pumping system did not operate sometimes when sky was covered by clouds even in June, middle of dry season. Thus a small rectification work was additionally made by the contractor. The contractor added 3 more modules, such as a 125kW module and 2 numbers of 175kW to establish stable operation system under cloudy condition in dry season.

The following table was compiled for indicating safety factor between the total maximum power generated by solar modules and required power for pump operation.

Table AD5.4.1 Operation Condition of Solar Power System in 3 Sites

	Shurr	Kubi Qallo	Korr (original)	Korr (rectified)
Capacity of solar power module	175kW / module	175kW / module	125kW / module	125&175kW / module
Total maximum generating power	11.20 kW (=175x64)	11.20 kW (=175x64)	3.63 kW (=125x29)	4.10 kW (=125x30 + 175x2)
Inverter capacity	9.20kW	9.20kW	3.00kW	3.00kW
Required power for pump	7.50kW	7.50kW	2.20kW	2.20kW
Safety factor (Module vs Inverter)	122% (= 11.20 kW/ 9.20kW)	122% (= 11.20 kW/ 9.20kW)	121% (= 3.63 kW/ 3.00kW)	136% (= 4.10 kW/ 3.00kW)
Safety factor (Module vs Motor)	149% (= 11.20 kW/ 7.50kW)	149% (= 11.20 kW/ 7.50kW)	165% (= 3.63 kW/ 2.20kW)	186% (= 4.10 kW/ 2.20kW)

Source: JICA Project Team

The data above mentioned shows that original safety factor, such as 121% (165% against motor capacity), is not so smaller than the others, 122% (149% against motor capacity). Since the solar systems in Shurr and Kubi Qallo do not have any deficits of power and those are operated continuously and smoothly, reasons of deficit of power in Korr may be the followings:

- Generation efficiencies of a 175kW module and that of a 125kW module are different. Since a 175kW module's efficiency is higher than that of a 125kW, the 175kW module's system does not need additional module more than 122%.

- Radiation rate of sunshine between Korr and the other places are different due to cloud condition at site.

Since module efficiencies varies depending on fabricators and type/size of module, it is quite difficult to set safety factor to cope with actual sunshine radiation range properly at various sites where accurate climate data is not available in design stage.

(2) Recommendation and countermeasure

To avoid troubles in the installation stage of the solar power pumping system, it is highly recommended that an installation team should bring proper amount of additional materials, such as modules, cables, pipes and so on, to cope with unforeseeable troubles at site immediately. Taking such unforeseeable troubles into consideration in advance, contract conditions for procurement and installation works should be properly set up for facilitating easy change of contract quantities.

D5.4.2 Procurement of Solar System

(1) Troubles and analysis

In the Project, procurement and installation period was extremely extended from 3 months, originally January-March 2013, to 5months upto May 2013. This was happened due to imported equipment, the high capacity inverters, from Germany.

(2) Recommendation and countermeasure

Period of project implementation, especially procurement and delivery period, should be set at considerably long enough to cope with big delay of delivery.

D5.5 Completion of the Works and Handing Over

After completion of the contract works, the solar power generation system was partially handed over to the community for conditional use. The agreement was made between the project and the community for use of the system under the condition of proper operation and maintenance. After a certain period of monitoring for establishment of management, the solar power generation systems have been handed over to the communities. The major events are summarized as below.

Table AD5.5.1 Completion of the Sub-project Works and Handing Over to the Communities

Major Events	Shurr	Kubi Qallo	Korr
Agreement for conditional use	10th Jul 2013	10th Jul 2013	10th Jul 2013
Handing over of the facility to the community	15th Nov 2014	14th Nov 2014	13th Nov 2014

Source: JICA Project Team

D5.6 Monitoring Works

D5.6.1 Monitoring System

All the administrative works are executed by water users association. Then monitoring works are executed by project team at certain regular interval. At the beginning stage of its activities, weekly monitoring should be made and finally monthly monitoring should be applied.

The followings are monitoring items to evaluate performance of solar power pumping system:

- Water meter readings at several points,
- Operation hours records of solar system,
- Operation hours records of generator system, and fuel consumption,
- Water fee collection records, and collected cash in collection box,
- Bank record, or bank statement,
- Mechanical trouble records of equipment,

- Expenditures for repairing equipment, and
- Expenditures for community development activities

(2) Monitoring Indicators

The followings are monitoring indicators to evaluate performance of solar power system:

Table AD5.6.1 Monitoring Indicators for the Sub-project of Introduction of Solar Power System

Item	Frequency	Data Collector
1) Fuel consumption	Monthly	Water users' association/Project team
2) Occurrence of mechanical trouble	Every time	Water users' association/Project team
3) Financial statement	Every month	Water users' association/Project team

Source: JICA Project Team

(3) Monitoring Result of Occurrence of Mechanical Trouble in the Systems

The following table shows monitoring results of mechanical trouble in the 3 sites in the recent 13 months of period from July 2013 to January 2015.

Table AD5.6.2 Mechanical Trouble Records

Place	Occurrence of Trouble	Remarks	Correction/maintenance
Shurr	None	N/A	N/A
Korr	None	The amount of water pumped up reduced possibly due to lowered water level.	The yield improved after rain due to improvement of ground water recharge
Kubi Qallo	The system worked only a few hours during day time	It was found the transition of current from solar panel to control panel does not connect properly	Problem was rectified by the Davis & Shirtliff technicians during warranty period

Source: JICA Project Team

In Kubi Qallo, it was observed that solar power system has been functioning much less hours comparing to other sites. At the beginning, it was explained as due to lack of sun light because of the location of Kubi Qallo which is close to Marsabit mountain that is often covered by heavy fog.

In April 2014, an abnormal error code was observed on the screen of the control panel. The project team monitor the situation and found the following situation.

Table AD5.6.3 Sample of Monitoring Record of Kubi Qallo Solar Power system Operation in April

Date:15th April 2014				Date:24th April 2014			
Time	**meter reading**	**voltage**	**Weather condition**	**Time**	**meter reading**	**voltage**	**Weather condition**
9:00	12318908	F.50	Misty and raining	8:00	12328229	F.50	Misty
10:00	12318908	F.50	Misty and raining	9:00	12328229	oP.12	Misty and windy
11:00	12320606	F.40	Cloudy and windy	10:00	12328229	oP.14	Drizzling
12:00	12323144	F.43	Cloudy and windy	11:00	12328229	oP.11	Cloudy and windy
13:00	12323920	F.40	Misty and drizzling	12:00	12328229	oP.15	Cloudy and windy
14:00	12325830	F.40	Cloudy	13:00	12328229	oP.13	Sunny
15:00	12327250	F.41	Cloudy	14:00	12328229	oP.09	Sunny
16:00	12328229	oP.12*	Sunny	15:00	12328229	oP.07	Sunny
17:00	12328229	oP.11	Sunny	16:00	12328229	oP.09	Sunny
18:00	12328229	oP.24	Sunny				

*oP means a error code of short circuit, F50-F40 means the system is generating power.

Source: JICA Project Team

The problem was due to short circuit in the submersible cable to the submersible motor. Since it was not a technical problem of the system itself, an electrician from the Ministry of Water of the County

Government repaired it. Afterwards, the error code disappeared and the water volume increased. However, it did not improve as per expected.

To respond to this situation, technicians from Davis & Shirtliff technicians visited and repaired a malfunctioned power cable in June 2014. There has been marked improvement in terms of volume of water discharged with the solar power system. The operator surely confirmed that the power generation of the solar panel was enough to run the BH. However, the wiring and settings of the system was not okay. The technicians reset the system, cleaned the solar modules and rectified the wiring problem. Since this anomaly was corrected at the beginning of August 2014, the system is operating optimally between 7:30 AM to 5:30 PM. After that, the operators rely solely on solar power. They use the diesel generator set approximately 3-4 hours at night (2-3 days a week) when the livestock numbers visiting the BH are high. When there are normal livestock populations, water from solar system fills both reservoir tanks hence no need to use diesel generator set. No further technical problem in solar power generation system has been observed after rectification of the observed problem at Kubi Qallo mentioned above.

(4) Monitoring Result of Fuel Consumption

Due to installation of the solar power systems, it was expected that consumption of fuel were significantly reduced in each site. The following table shows the consumed volume of diesel for the generator sets at 3 sites.

Table AD5.6.4 Fuel Consumption

Place	Consumption of Fuel	Estimated Consumption Rate with a Generator
Shurr*[1]	July'13 – Nov'13: around 60L (10 hours*[2]) Dec '13 – Feb'14 : 0 L Mar '14 – Jul '14 : 0 L Aug'14 – Jan'15: 0 L	1,000 L/month, approximately 3,000-4,000 L/season approximately
Korr	July'13 – Nov'13: 0 L Dec '13 – Feb'14 : 0 L Mar '14 – Jul'14 : 0 L Aug'14 – Jan' 15: 0 L	200 L/month, approximately 600-800 L/season approximately
Kubi Qallo	July'13 – Nov'13: 500-1,000 L Dec '13 – Feb, '14 : 500-1,000 L Mar '14 – Jul '14 : 500-1,000 L*[3] Aug '14 – Jan '15 : 700-1,000 L*[4]	1,000 L/month, approximately 3,000-4,000 L/season approximately

*[1]: Consumption of fuel for the borehole with solar power system, even though Shurr WUA spends for fuel for the second borehole in Shurr town

*[2]: test operation of the generator set

*[3]: fuel consumption before repair of the solar power system

*[4]: fuel consumption for pumping up to newly established kiosk

Source: JICA Project Team

Reduction of use of fuels has been observes in all the three sites. In Kubi Qallo, Fuel consumption for pumping water from borehole was dramatically reduced. However, they have to purchase fuel for generator to pump up water from the main water tank at the borehole to the tank at water kiosk.

Further information about operation of this solar system is described in the following paragraphs.

D5.7 Economical Evaluation and Comparison for Total Costs for 2 Systems

Solar power pumping system needs vast initial investment, but no operation cost is required. On the other hand, diesel generator's power pumping system does not require huge initial investment but it requires continuous expense for fuel. In order to compare economical advantage/disadvantage, economic evaluation was made between the solar power pumping system and the diesel generator's power pumping system.

In the evaluation, lifetimes of pumps and solar modules in the 2 systems was set at 20 years. Then total costs for generating necessary electricity for the 2 pump systems in the period of 20 years were estimated. Those costs include replacement cost of a generator and an inverter controller after 10 years as well as daily maintenance cost. Result of evaluation was summarized in the following table.

Table AD5.7.1 Summary of Economical Evaluation for 2 Pumping Systems (Unit: Ksh)

			Genset 25kW	Solar 11.2kW	Genset/ Solar
1	Procurement Cost	Ksh.	800,000	3,383,114	**0.24**
2a	Fuel consumption in dry season	Ksh./season	691,200	0	
2b	Fuel consumption in wet season	Ksh./season	153,600	0	
3	Maintenance cost	Ksh./year	72,000	36,000	
4	Life time	year	20	20	
5	Total operation cost for lifetime		18,336,000	720,000	**25.5**
6	Replacement cost	Ksh./10years	800,000	1,107,367	
7	**Total cost (1+5+6)**		**19,936,000**	**5,210,481**	**3.8**

Note: Both cases of the calculations do not include the initial cost and Operations and Maintenance (O&M)cost for the submergible pump.

Source: JICA Project Team

As shown in the above table, total costs of solar power pumping system was only 26% of that for the diesel generator's power pumping system. It was concluded that the solar system has big economical advantage in comparison with the diesel generator system.

On the other hand, water fee collection will be continued at the same tariff of the previous diesel generator's power pumping system. Thus it is highly expected that water users association can have enough operation fund for sustainable use of the pumping system. And an excess of such operation fund can be diverted to a fund for community development apart from ground water management and development.

D5.8 Establishing Management of Boreholes with Solar Power Generation System

D5.8.1 Basic Concept and Approach of Management of Borehole with Solar Power System

Most of the existing boreholes run by generators have water fee collection system in place mainly to cover fuel cost for generators. However, many of them do not have proper and effective water charge collection system thus often constrained by inadequacy of funds for effective operation and maintenance activities. The poor water charge collection is attributed to their lack of knowledge in water tariff calculation and setting. O&M activities for the pump and the diesel-run generators at the existing boreholes have not been achieved under the current water charge system, which often require external financial support for maintenance. In addition, delay of payment of water charge has been one of the causes of difficulty for committees to manage their operation. This is mainly due to absence of money economy in the pastoralist community. Pastoralists in the area do not normally keep cash in their hand and they sell livestock to obtain cash whenever they need monetary payment. However it is difficult to find opportunities to sell livestock promptly when they need due to scarcity of livestock market in place. Although complete default of the payment is not very common owing to the mutual reliance among the pastoralists, delay of the payment cause crucial problem to the operation that should be run by diverting money from their income directly to the expenses.

Most of the existing deep boreholes are operated by diesel generator to pump up water. Although there are existing water management committees to manage those boreholes and to charge water fees, they sometimes face serious breakdowns of the facilities that they cannot afford to repair. The committees, in these cases, wait for external assistances for repair. Solar power generation systems in parallel use of the existing generator for pumping up water is introduced by the Project, which save cost of fuel for the generators and reduce risk of water shortage at the time of breakage by alternating the two power source as well as by saving enough funds for repair of the breakage. Although it is expected that the usage of solar power generation system would save cost of generator operation, the Project encouraged the

community to maintain their water charge not only for maintenance cost but also for reserve as contingency fund for emergency cases including drought and for further community development activities.

A significant concern on management of the solar power generation system is financial management as borehole management normally involves relatively a large amount of water charge for diesel cost and maintenance fee. In addition, installation of solar power generation system will enable the community to save the cost of fuel for generators thus proper management of their collected funds is necessary for the funds to be utilized effectively for the community. Confirmation system in terms of physical inspection shall be introduced by installing water meter at each water point accountable for the fee collection. Verification of collected fee accounting for the quantity of water used is expected to work as physical check up of the amount by meter reading at the fee collection to discourage misuse as well as psychological preventive pressure.

Utilization of the funds collected from water charge shall be discussed with the respective communities, encouraging spending them for the activities that will enhance resilience against drought. Furthermore, management of fee collection will be a key issue for the borehole management as most of them have several different water points to be handled.

D5.8.2 Project Intervention on Management of Borehole with Solar Power System

(1) Water Fee Collection Methods

Issues and problems regarding water supply management, water fee collection and financial management differ depending on the type of water sources and different WUAs due to complex water supply connections and variety of users. Water fee collection system should be established wherever there is need of maintenance with monetary cost.

Fee collection system at the water source with necessary costs of operation and maintenance vary depending on the costs of the operation and maintenance to be covered, range of users, number and location of water supply points. Where there is a major operation cost that is closely related with the amount of water used, such as fuel cost for generator for borehole pumping system, water tariff is set based on the consumption. Alternatively, where there is no major constant operation cost, a fixed amount of fee can be charged per a certain period of time. Fee collection for domestic use may be different from that of livestock use. Structure of the water supply facility also determine the fee collection method, as the accurate but complicate fee collection system may not be feasible at the water source where there are several water supply points with mixed users or for the WUA where basic capacity such as literacy level of the members are extremely low.

Table AD5.8.1 Different Fee Collection Methods

Collection Method	Advantage	Disadvantage	Suitable Situation to Apply the Method
Daily collection	Enable to collect actual amount against their use. Can charge fairly even for those who use it temporarily.	Need to assign a person who will collect fees every day at the site; this would entail additional cost. More work and complexity in recording daily payment of small amount each time. Higher risk of mismanagement at the time of collection.	When seasonal short-term users are majority. If there is a collector who can adequately handle the daily recording.
Monthly collection	Simpler in collection and recording. Less mismanagement of the collection as fee can be collected by the treasurer and officials with receipts.	Difficult to set the fee for seasonal and short-term users.	When the users are almost fixed for relatively longer term.
Fee as per consumption	Fair and able to collect adequate amount per consumption. For the livestock use, the number of livestock can be counted instead of measuring water consumption.	Difficult to determine the consumption of each user when there is no proper facility to measure the consumption. Capacity of the collector is required to calculate the fee per use. Need to assign a person to measure the consumption or count the livestock.	When it is necessary to collect fee based on water consumption to cover the increased cost. When the operator can account the estimation of consumption based on the number of livestock. When there is an adequate facility to measure the consumption.
Fixed charge	Simple in collection and recording.	Difficult to judge the adequacy of fee. Less equity and fairness as the charge is same for all regardless of consumption.	When there is no major operational cost to be covered as per increase of consumption. When all the users can agree on the fixed amount. When the rate per use is too complicated to be handled by the community.

Source: JICA Project Team

(2) Introduced Measures for Strengthening Financial System

The following measures have been introduced to improve financial management system.

1) Estimation of amount of water fee against water consumption

Water meters have been introduced to the boreholes with solar power generation system to judge adequacy of water tariff and fee collection against usage of water. Considering the situation of watering from the boreholes, it is not practical to charge water fee according to the water meter because it requires installation of water meter at each tap and as well because some groups of livestock take water at the same time at the troughs. Hence the water meters are used to estimate the approximate amount to be collected that can be calculated from the water consumption and the set tariffs. According to the analysis from the current experience of water use at the concerned boreholes, it was concluded that water tariffs can be set at Ksh.0.1 per litre of water consumption. This enables the WUA as well as the community to estimate an approximate expected water fee to be collected from the consumption of water, which shall work as preventive force from mismanagement and misuse at collection as well as loss of water. Since there must be disparity due to several factors such as difference in water intake by livestock in dry area, inaccurate animal count, and subsidy for

particular livestock such as infants, trend of fee collection shall be observed and informed to the community.

Table AD5.8.2 Water Intake of Livestock and Water Fee

Species	Daily intake (litre)	Frequency of drinking	Consumption per month (litre)	Monthly fee (ksh.)
Sheep	4-5	Once every 2 days	60 - 75	10
Goats	4-5	Once per day	120 - 150	10
Cattle	30-40	Once or twice* daily	900 - 1200	50
Camels	60-80	Once every 4-5 days	360 – 560	50

* Since there has be no case of twice a day in the concerned area, consumption was calculated based on the frequency of once per day

Source: prepared by the JICA Project Team based on the data from Baudelaire, J.P 'Water for livestock in Semi-arid zones' World animal review, FAO 1972, Vol-3,P1-9

2) Operation of water fee collection

Since accumulation of saving will grow based on the concept of saving for emergency and development cases, and it is not required to be spent in daily operation, mismanagement in collection and handling may tend to occur more easily. To reduce the risk and temptation, collection box and saving box were introduced. The saving box has three rocks each of which is held by different officials apart from the treasurer while the box is kept at the treasurer so that box can be open only when all those officials are present. Collection boxes were introduced at each collection point where operator/field clerk collect fees at the site. Payments by the users are to be made by inserting cash in the collection box by the payer under observation of the operator but not going to the operator. The collection box has a lock, the key of which is kept by the treasurer so that the treasurer opens when the operator report and bring the collection box to the treasurer to count and record in the presence of the operator. Although they are not perfect preventive measure against misuse, it reduces temptation to take action by making it more complicated.

3) Financial record keeping

Financial record keeping has been introduced and practiced through hands on training and close monitoring. All the possible financial transactions by the WUA were demonstrated with the relevant records keeping. Although majority of the WUA members are not fully literate in some WUAs, all the members participated in practice so that they can be aware of what will be going on. In addition, CMDRR/CDC committee members were involved expecting the roles of supervision as a community representatives who are responsible on the community development issues. The training and record keeping system were developed with maximum use of practical and visual materials to help understanding by the members with lower literacy level. For example, even though they are not able to read literature, they are able to count, read and write numbers as they can handle cash transaction, thus able to make simple calculation of addition and subtraction. The following practices were dealt with;

- Recording of registration and monthly contribution,
- Issuing receipts and preparing payment voucher,
- Keeping cash book with all the transaction,
- Water tariff setting, practice of water meter reading and estimation of the expected fee to be collected,
- Revenue analysis and budgeting for constant operation costs and saving for development activities,
- Information sharing with the community for accountability (through hands on training).

The training materials used in the session is as per attached as Attachment D6

4) Accountability for the community

After the financial trainings, general meeting with the community were organized to enhance awareness and sense of responsibility among the community over management of the WUAs. Some issues related to fee collection have been observed in some communities In some cases, people do not have any concern on the collected water fees. There was a case that water tariff mentioned by the committee and actual fee charged are different. And in most of the community, community people did not have any means to confirm even if they have doubt and are suspicious about collection and use of water fee and funds. The project encourage and supported the WUA committees to explain and agree on their rules regarding water resource management including water tariff, ways of fee collection, management system and roles of officials, use of collected funds based on priorities of the community and budget analysis. Different ways of displaying the fee collection and financial situation has been considered and demonstrated to identify the most suitable ways to assure understanding of the community people including illiterate people. Some of the suggested methods include periodic community assembly for information sharing, and displaying water tariff for different users, analyzed record of monthly revenue collected, income and expenditure at the Borehole site. These methods will help aid beneficiaries in understanding of such simple and practical information pertaining to the Borehole management thus minimizing suspicion of funds mismanagement by the WUA management committee.

5) Operation and maintenance of solar power generation system

Solar power generation system installed to the target boreholes are basically maintenance free. At the same time, mishandling in operation and self judgement in technical works without specialist may cause crucial damage on the system. Basic operation manual with signals were prepared and displayed on the invertors. Although the solar operator shall be the only one who will operate the system, training on operation was conducted for the WUA committee members so that they can identify when there is any problem to be attended. Signal for the normal operation and failures were explained with emphasis on consultation to the specialists for any investigation and repairing works. To establish the referral system in case of any indication of failure, the project in collaboration with the Davis and Shirtliff, the Solar power generation system installation contractor, conducted a two days-training for two government officers to play the role of identifying problems and necessary repairing works to be done by the technical service providers. Training contents included; 1) Theory of Solar power generation system operation, 2) Solar power generation system operation and maintenance, and 3) Basic programming of solar control panel.

Since the 12 months warranty period of the solar power generation system is assured, referral connection from the WUA to the Ministry of Water in Marsabit and from the WUA to the technical service provider after identification of the required maintenance needs shall be established with support of the project.

D5.9 Output of Operation of the Borehole in each site

D5.9.1 Shurr Borehole

(1) Situation before project intervention

There are two boreholes in Shurr town, both of which are managed by one management committee, representing a Water Users Association with about 350 members, which has been registered as a Self Help Group under Ministry of Gender, Children and Social Development. The WUA has established a system of collection of the water charges, maintenance and repair for the existing borehole. Although basic system of the water distribution and water charge have been functioning, there are some shortcomings in collection of fees and maintenance of the structures, such as debts and defaults of the fee payment, inadequate fee setting and scarcity of saving for maintenance.

Table AD5.9.1 Summary of the Water Management Body for Shurr Borehole before Project

Items	Situation
Group name	Shurr Water Service Provider
Group status	Registered as a Self Help Group under Ministry of Gender, Children and Social Development
Year of establishment	The gen-set was installed at the borehole in 2004 The committee was established in 2007 and registered in 2010
Members (membership, officials)	350 members(household) are registered as members of the association There are currently 11 committee officials with a Chairman, Secretary, Treasurer and a field clerk
Collection of fees /water charges	Water fee is collected by animal head count as follows Camel – Ksh.10/drinking or Ksh.50monthly Cattle – Ksh.10/drinking or Ksh.50monthly Shoats – Ksh.1/drinking or Ksh.10monthly a fixed fee of Ksh.200 per house hold is charged monthly for domestic consumption Pastoralist camps known as 'fora' are charged Ksh.100 per month
Management of water source	The water source is managed by the committee members Animal head count is done by the field clerk at various drinking points served by this borehole
Other remarkable issues	Majority of the committee members are illiterate. Only three are literate

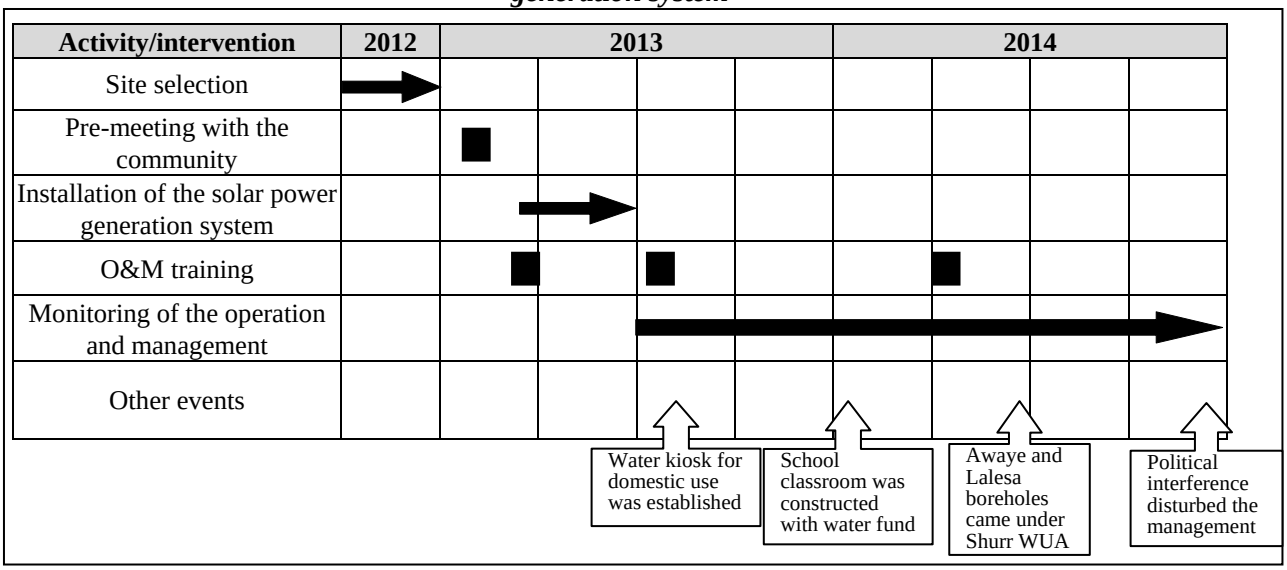
Source: Key Informant Interviews of JICA Project Team (January 2013)

(2) Focal issues and approach

During the preparatory meeting, concerns and doubts about the solar power generation system were raised from the community due to their past experience of failure of pump with a solar power generation system at the nearby area. The project was to support building adequate referral system for maintenance of the solar power generation system in addition to the enhancement of operational skills of the committee regarding management of water, water fee collection from the different water points that draw water from the borehole should be well discussed and supporting measure such as water meter should be introduced to make monitoring easier and clearer. Water meters were installed to measure water usage for different purposes that are domestic, livestock, and institutional use such as school, which enables the committee to confirm the fee collected at each water point with the amount of water used to improve fee collection as well as to avoid misuse during collection process. Furthermore, as mentioned above, usage of funds saved from the reduction of fuel cost by installation of solar power generation system shall be continuously discussed. The funds can be utilized allocation for maintenance purpose to enhance sustainable and independent operation of the water source, and then for promoting the remaining for further community developing purpose.

(3) Output and process of institutional Development and O&M

Table AD5.9.2 Outline of project intervention and activities regarding installation of solar power generation system



Source: JICA Project Team

1) Skill development of the WUA on management

A three-day training programme was accomplished in February 2013 that was carried out by a local NGO called PACIDA to strengthen the management system of the existing water users association. Since the borehole management involves handling of relatively large amount of money, financial management was focused on in the training. Considering the major shortcomings of the previous financial management that were cashbook management and fee collection, it was emphasized in the training to improve expenditure records, calculation of water charge based on the necessary expenses, and accountability to the members. Following to the discussion and action plan prepared in the training, the committee members revised their constitution with re-calculated water charge, and finalized it with other members through a community meeting.

The water fee for livestock has been charged based on the number of the livestock on monthly basis. There is a fixed tariff for each animal per head per month. For the Shurr herders, the amount of monthly payment is determined by counting and reporting the number of livestock each herder has at the beginning of the season of borehole use (dry season), which will be applied for the whole season. A community meeting is organized every year to confirm how many livestock each herder has and decide the order and dates of watering for each herder. Since the community people know how many livestock each herder has, fee can be fairly set as per the number of animals. Monthly fees are paid directly to the treasure at the beginning of each month with receipts. The herders can water their livestock by showing the receipts of the monthly payment. Since receipts are issued to every payment and the operators of water supply do not handle money, there is less risk of mishandling of money at the collection. Herders from outside are charged in the similar way. When they arrive at the water point, the operator counts the number of livestock and report to the treasurer. The herder pay to the treasurer based on the number of livestock counted by the operator and water their animals with receipts of the payment.

A water kiosk was newly introduced at the Shurr borehole in 2013 with support of an NGO called Food for Hungry, Kenya, with which domestic water is separately fetched from the animal use. After discussion with the community in consideration of the advantages and disadvantages of different fee collection systems, the community decided to collect fees for domestic use as per consumption based on the number of water containers on daily basis. The WUA first showed concern on the daily collection as per consumption as they have experience of failure in daily collection as per container. However, as the water meter installed at the water supply point enables to estimate the expected amount of fees to be collected, they decided to charge as per consumption considering the advantage

of fairness. An operator was appointed and has been engaged to supply and collect water user fee on daily basis. Meter recording has been adopted as a monitoring tool to ensure transparency and accountability. The operator records the meter reading daily to aid calculation of the money collected based on daily water consumption rate. The rules of the fee collection and the water fees are as explained in the table below.

Table AD5.9.3 Rules Regarding Management of Fee Collection in Shurr

Category	Users	Rules	Operation
Livestock use	Registered members	The number of the livestock is registered at the beginning of the season (no change from previous rules)	Monthly fee for each animal is paid at the beginning of the month and receive receipts. Water at the trough by showing the receipts as a proof of payment
	Non-members (pastoral herders)	The field clerk counts the number of livestock at their arrival and report to the treasurer. The herder pay the monthly payment to the treasurer (some possibility of daily payment for short term users) (no change from previous rules)	Water at the trough by showing the receipts as a proof of payment
Domestic use	Domestic use from trough	Previous rule)Monthly fee should be paid at the beginning of the month	Fees are paid to the treasurer in exchange with receipt
	Water kiosk users	New rule) Water kiosk will be operated twice in the morning and in the evening at a certain period of time. Fee should be paid at the kiosk as per their use per container	A fee collector collect fees and handover to the treasurer with record

Source: JICA Project Team (based on the discussion by the Shurr WUA committee)

A further financial management training was conducted in July 2013 to improve management skills of the committees as well as to enhance accountability by involving Community Development Committee (CDC) as supervisors of the WUA. Practical sessions with demonstrations enabled participants to understand the fee collection management. The following is the summary of water tariff agreed at the Shurr borehole;

Table AD5.9.4 Revised Water Tariff and Collection Methods at Shurr Borehole

Category	Fee collection method	Items	Tariff	
			previous	new
Livestock use	Monthly collection	Camel	Ksh.50 per head per month	Ksh.50 per head per month
		Shoats	Ksh.10 per head per month	Ksh.10 per head per month
		Cattle	Ksh.50 per head per month	Ksh.50 per head per month
		Donkey	no charge	Ksh.40 per head per month
Domestic use	Monthly fixed fee/ Fee as per consumption	Household / Water container	Monthly fixed fee of Ksh.200 per household	Ksh.2 per 20L jerry can

Source: JICA Project Team

During the financial training, action plan was prepared based on the estimation of the water fee collection and budget of the each planned activities. The following is the plan prepared by the Shurr WUA committee during the training.

Table AD5.9.5 Estimation of Saving for 3 Months in Shurr Borehole*

	Item	July	August	September
		(Domestic use only)	(Domestic and livestock)	(Domestic and livestock)
Expected revenue	Water fee collection	Ksh.25,000	Ksh.200,000	Ksh.200,000
Estimated expenditure	Operator/guard fee	Ksh.6,000	Ksh.12,000	Ksh.12,000
	Maintenance & repair (average per month / saving for repair)	Ksh.6,000	Ksh.6,000	Ksh.6,000
	Administration cost	Ksh.500	Ksh.1,000	Ksh.1,000
	Fuel**/oil/service for generator	-	Ksh.78,000	Ksh.78,000
	Transportation	-	Ksh.10,000	Ksh.10,000
	Payment for procurement and other major works	-	Ksh.6,000	Ksh.6,000
	Total expense	Ksh.12,500	Ksh.113,000	Ksh.113,000
Estimated saving	Saving of each month	Ksh.12,500	Ksh.87,000	Ksh.87,000

*Estimate of total revenue and expenses of two boreholes in Shurr, one of which is with the installed solar power generation system.

**Fuel is still necessary for the second borehole pump as well as some night time use.

Source: JICA Project Team (based on the discussion during the financial training in July)

Shurr has two boreholes and solar power generator system was installed in one of them. The other borehole is operated with generator, which is in use during dry season when the number of livestock increases. Revenue is expected to be high during late dry season with larger livestock use while that in wet season and early dry season is low due to limited use for domestic purpose. Since they use the second borehole during dry season, it requires relatively large amount of expense for fuel and other operational cost of generator. It was recommended to save a certain amount as repairing cost separately from the general saving for the development activities.

2) Observation and progress on fee collections and use of the collected fund

After installation of the solar power generation system in July 2013, the Shurr WUA has saved their water revenue with fairly maintained record. Even though a certain amount of loss of water that could not be accounted for fee collection due to delay of animal count, a remarkable amount of revenue was received and saved. The community through facilitation from the Project Team has allocated the savings for the benefit the community namely:

- Minor repairs on the system, fuel and other lubricants
- Major long term repairs such as replacement of solar power system or diesel generator
- Community development activities (returning back benefit to the community)

After accumulation of a certain amount of saving during dry season in 2013, the community through the WUA and the CDC set aside the saving for community development fund. Meetings were conducted with the community members to decide a project based on their needs. The community prioritized construction of a classroom at Shurr primary school which they regarded as a most immediate need. The community has implemented the community project of classroom construction for Shurr primary school with the saved revenue from water fee. The details of the community project are described in the later section (5).

In 2014 long rain season, rainfalls in the Marsabit North area was irregular and improper. This rain situation greatly affected the use of the boreholes. Most parts of Marsabit North did not receive the long rains. Shurr however, received sufficient rain. While most of Shurr herds had moved towards Wajir and Isiolo counties during the rainy season to preserve Shurr grazing area, livestock from other Gabbra community in Marsabit North such as Bubisa, North Horr and Gas migrated into Shurr in search of pasture and water. From June 2014 onwards, the boreholes received a huge number of livestock due to drought situation in other area. In spite of a large amount of the livestock using the boreholes, the collection of water fee was lower due to the drought situation, according to

the committee, in which animals are emaciated and not enough market to sell those animals to earn cash for fee payment.

In July 2014, a new borehole at a place called Awaye was established by the County Government, at the distance of about 30km from Shurr, where plenty of grasses are available. Most of the Shurr herds moved to the new borehole to graze around it because of better grasses. In addition, another borehole in Lalesa that covers Shurr area was open in the similar time, which has been existing but abandoned for a while due to dispute between Gabra and Dogotia communities. Shurr boreholes, Awaye borehole, and Lalesa borehole were then included under Shurr WUA management. Awaye and Lalesa boreholes formed interim committees managing them. Shurr borehole committee plays the supervisory role over all the boreholes.

In October 2014, accumulating some amount from fee collection during dry period, Shurr community decided to utilize the saving from water fee to pay for PA teachers who are employed by parents to complement shortage of government employed teachers. Two teachers were employed with salary paid from the water fees.

The following is the summary of the maintenance and community development activities utilising the water fee saved from solar power generation system.

Table AD5.9.6 Summary of Maintenance and Community Development Activities with Water Fund in Shurr

	Activity	Timing	Achievement	Expenses
1	Covering of the exposed water pipes (6km)	September 2013	The community contributed their labour to backfill the eroded pipe lines	Community contribution
2	Primary school classroom construction	December 2013	One classroom was constructed with the water fund	Ksh.426,730
3	Hiring PA teacher for primary school	September 2014 and onwards	Two PA teacher was hired with salary payment from the water fund	Ksh.20,000 per teacher per month

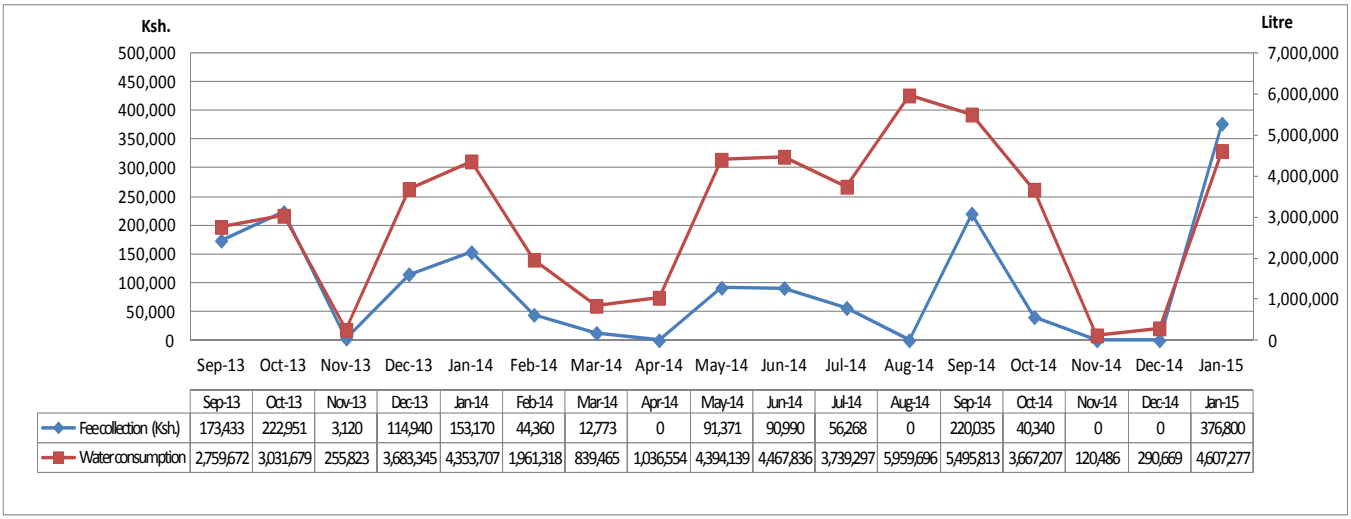
Source: JICA Project Team

3) Disturbance on the management

In December 2014, political influence caused conflict between the clans that resulted in dysfunction of the management. The borehole management in Shurr has been growing due to solar power generation system and establishment of a new borehole as well as revitalization of the abandoned boreholes. As it grows, there were attempts of expanding and centralizing the management of wider range of natural resources. The three borehole committees have been pushed further to the formation of an umbrella body of WRUA. Shurr Conservancy committee, that was founded to manage surrounding natural resources being funded by Northern Rangeland Trust, took strong initiative to form WRUA under their control. During the process of developing the WRUA, politically influential leaders manipulated to control resources by stimulating conflict among clans in Shurr. Shurr community had been relatively united being established recently by a Gabra (a clan called Galbo), later mixed with Rendille clan (Odhol clan), which is now taken as Gabra through intermarriage. The manipulation tried to the majority clan of Galbo to retrieve control on all the resources from the minority Odhol clan from Rendille. The Shurr community came under conflict and the management of water sources was abandoned by youths from Galbo who tried to take over the management from the current committee, some of the officials of which are from Odhola clan. Security forces were deployed and the Minister of Water of the County Government came to make order to functionalize the water management. It was approved in the meeting that the Galbo youths will manage the borehole for a month of January to assess the situation. The youths together with some elders took over the management from the WUA committee and manage the borehole in January 2015. They seemed to have intention of officially takoing over the management by revealing the inefficient function of the previous committee. As a consequence, fee collection carried out by the youths during the month of January was remarkable. The community is met in early February to judge whether they are going to elect new committee to take over the management.

4) Monitoring of financial situation and records

The following shows the record of operation of Shurr boreholes.

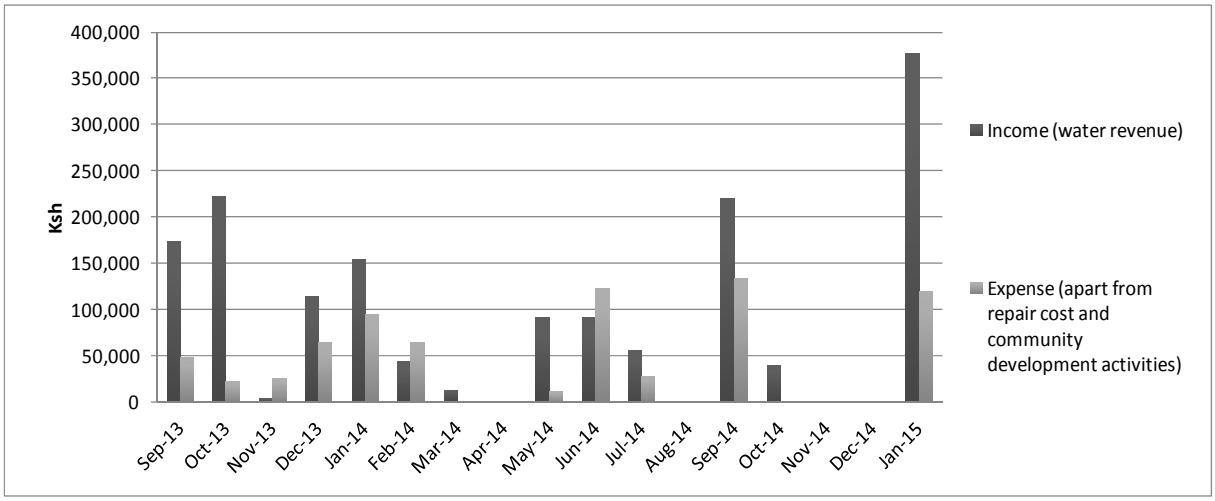


	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	Jan-15
Fee collection (Ksh.)	173,433	222,951	3,120	114,940	153,170	44,360	12,773	0	91,371	90,990	56,268	0	220,035	40,340	0	0	376,800
Water consumption	2,759,672	3,031,679	255,823	3,683,345	4,353,707	1,961,318	839,465	1,036,554	4,394,139	4,467,836	3,739,297	5,959,696	5,495,813	3,667,207	120,486	290,669	4,607,277

Source: JICA Project Team

Figure AD5.9.1 Monthly Water Fee Collection against Water Consumption in Shurr Borehole from September2013 to January 2015

The following shows the trends of income and expense of Shurr borehole.



Source: JICA Project Team

Figure AD5.9.2 Income and Expense of Shurr Borehole from September 2013 to January 2015

(4) Community project with the saving from the water fee

A mentioned above, Shurr community managed to implement community development activities with their own efforts.

An action plan for development work utilizing the saving from the water fee collection was discussed after the financial management training. Committee was encouraged to come up with activities that can be achieved relatively easily in a short period of time with small cost expecting to raise motivation for proper fee collection and management through accomplishment of a small activity instead of starting with challenging activity. The following is the action plan prepared for Shurr.

Table AD5.9.7 Short Term Trial Action Plan Prepared at Shurr Borehole

	Activity	Timing	Required resource	Budget
1	Covering of the exposed water pipes (6km)	July-Aug	Labour (Ksh.50*1000pipes)	Ksh.50,000
2	Fencing around solar area	July	Labour (voluntary community contribution with supply of tea)	Ksh.500
3	Water tank repair (4 tanks)	September	Sand, gravels, cement, transport, artisans, labour, paints, waterproof cement, chicken wire, nails	Ksh.265,000 (Ksh.66,250 per tank)

Source: JICA Project Team (based on the discussion during the financial training in July)

The followings describe the details of the activities implemented by the community in Shurr.

1) 1st activity:

The idea of utilizing the water revenue from solar power system for community development project was well accepted by the community in Shurr. At the beginning of the project, WUA has been requesting further support to repair their water system that they raised as priority activity. After the April 2013 long rains, a six km of pipeline in Shurr that send water from Shurr borehole to Ergemsa and Badan water points were exposed due to erosion and the community requested for funds to backfill the eroded trenches with estimation of Kshs.250,000. During the O&M training in August 2013, the community was sensitized that the benefits gained from utilization of solar energy is their own resource for them to utilize depending on their needs. Thinking how they can allocate their precious resource to maximize their benefit, they lowered the cost of backfilling to Kshs.50,000 from the amount of Kshs.250,000. Furthermore, on realizing that they would cater for the cost from their savings, they opted to make some community arrangement to backfill the trench through community mobilization. The WUA mobilized community members to back fill the 6 km of eroded trench in September 2013. Each community member contributed in terms of labour and food. All the exposed pipes were covered.

2) 2nd activities:

After the first major use of solar power system during dry season, nearly Kshs.300,000 was saved from water revenue. WUA together with CDC had conducted a meeting with Shurr community people to discuss on how they can use the saving of water revenue to improve the situation of the community. After active discussions, the community decided to spend the fund to construct a classroom in the Shurr Primary School as their priority. People determined that it is important to protect children from harsh environment and prepare preferable condition for study for their future. In Shurr primary school, lower standard pupils have been studying under the tree where strong sun and heavy sand storm attack children. The project assisted in figuring out the necessary budget. Although the estimated budget exceeded their available fund at the time, the community was so keen to accomplish the classroom construction that they decided to allocate some water fee from the following months.

Table AD5.9.8 Situation of the Shurr Primary School before the Community Project

Geography	Shurr primary school is the only public government school in Shurr location.
Staffing	The school has five [5] government employed teachers, and two [2] volunteer teachers
Classrooms	The primary school has pupils from nursery and classes 1to 6.
Study environment	The school buildings include four of the permanent classes occupied by pupils in classes 3-6. The only remaining room is used by teachers as a staffroom. Pupils from classes 1to 2 and nursery learn under the shelter of rare acacia trees.

Source: JICA Project Team

The project monitored process of the project in order to enhance their management capacity to implement their own project. During the classroom project planning stage, the community appointed

a steering committee composed of the WUA chairman, the CDC chairperson, the school committee chairperson, the area chief and a village elder. Five members in the committee was mandated with procurement of materials, labour and technical expertise to complete the classroom. The classroom was projected to cost approximately Kshs.388,900. During the school holiday in December 2013, a person who is a member of the steering committee contracted a hardware technician in Marsabit town to do the works at a cost of Kshs.400,000 without consulting other steering committee members. The chairman of WUA thus summoned the other WUA signatories and made a down payment of Kshs.300,000 to the contractor. The other steering committee members, on learning that the work had been singularly issued to one person, demanded an explanation from the person and the contracted business person. By the time the meeting was held, the contractor had started work on the classroom. It was therefore agreed in the meeting that, since the committee was not made aware of the agreement between the person and the contractor in advance, the contractor and the committee shall follow the conditions mentioned below in monitoring of the work and making payment transaction.

・ ***Table AD5.9.9 Conditions to be Followed for Subcontracted Work for Classroom Construction***

Condition for the Contractor	Role of the Committee
・ To provide receipts for all materials supplied at the current market price, ・ To provide receipts for other services such as transport to site, pay the skilled and non-skilled labourers for the works, ・ To undertake the construction according to the plan provided to completion.	・ To scrutinize all receipts and claims laid by the contractor against work done and current market rates, ・ To pay all receipts due to the contractor upon satisfactory completion of the project and agreement with the contractor, ・ To make available the receipts and all transactions culminating to the completion of the project to the Shurr community ・ To convene a community meeting to showcase the achievements arrived at through utilisation of the solar power generation system as a substitute to diesel engines.

Source: JICA Project Team

The project has completed in January 2014 before starting of the new school year. Although some mismanagement occurred during the implementation, it can be taken as their learning process. The issue was made open to the community to discuss for their solution. And they came up with their counteraction, which will help them to manage similar projects by themselves avoiding the same mistake to happen.


Source: JICA Project Team

Figure AD5.9.3 Shurr Community Project of Classroom Construction (left: classes under tress before the project, right: the classroom constructed by the community)

D5.9.2 Kubi Qallo Borehole

(1) Situation before project intervention

Kubi Qallo Borehole has a high yield of water being operated by two generators. A management committee has been established with relatively firm management rules. For example they have a regulation that allows only the pastoralists who have a receipt of the payment for water fees to water their animals. However, close observation revealed that financial management has been operated without updated record. It was also found that they sometimes face problem of fee payment for their workers, as well as fuel for generator. Consequently, it was assessed inevitable to improve their management.

・ ***Table AD5.9.10 Summary of the Water Management Body for Kubi Qallo Borehole***

Items	Situation
Type of water source	Borehole
Group name	Kubi Qallo water users association
Group status	Not registered
Year of establishment	Not clear
Members (membership, officials)	All community members are eligible to be a member as long as There is a 9 committee members There are officials comprising of Chairman, Secretary, and a Treasurer
Collection of fees /water charges	Water charges are as follows; **Members;** Cattle – Ksh.30/head/ month Shoats – Ksh.15/head/month Camel – Ksh.60/head/month Donkeys – free Households – free * Non – members are charged Ksh.5/= above member charges in each category. **Water bowsers** 10,000 litres – Ksh.2,000/= 15,000 – 20,000 litres – Ksh.3,000/= Less than 10,000 litres – Ksh.1,500/=
Management of water source	Livestock count is done monthly at the borehole by the operator. The operator sends the number of livestock to the treasurer who then issues a receipt for payment made. Only pastoralists with proof of payment (receipts) can water their animals at the borehole
Other remarkable issues	They pay water levy to WRMA – Ksh.12,000/= annually (this is a flat rate since the water metre is faulty- normal charge is calculated at 50 cents per every 20litres of water pumped.)

Source: Key Informant Interviews of JICA Project Team (January 2013)

(2) Focal issues and approach

Existing fee collection system by the water management committee seems to be functioning for fee collection and operation of the generator. However, there are some unclear issues in management such as missing financial records, and delay of payment for the workers. Financial record presented by the committee had not been updated, even though the recording was relatively adequate. Delay of payment for workers and fuel might be due to inefficiency in handling cash flow that requires systematic improvement. In addition, as the concerned borehole has a relatively high yield of water that attract huge amount of fund, strong political interference can be suspected in their management. Making use of the higher capacity of the existing management, more formal auditing system with confirmation of appropriate financial records shall be introduced to avoid mismanagement.

(3) Output and process of institutional Development and O&M

1) Institutional management training

Institutional management training was carried out in February 2013, in which members of the existing committee, EMC members, administrators, village elders, and peace committee members participated. The training was sub-contracted to the local NGO called PISP. One of the core issues discussed in the training was effective utilization of the fund saved through use of solar power generation system. Views of the participants were relatively pessimistic and tended to stick to spend on improvement of maintenance and operation that includes repairing cost, payment for routine workers, and expenses for emergency cases like drought.

2) Reformation of the management committee

It has been concerned that there are several local political power relation has been involved in the borehole management at Kubi Qallo. It was observed during the training that financial records have not been updated since 2008 and it was strongly requested to start record keeping in all the transaction including registration, fee collection and expenses. Furthermore, there have been oppositions from some community members against the committee management. Those unstable situations caused dismantling of the committee in July 2013. Committee election was conducted with the initiative of the administration and process of election and handing over from the previous committee to the new committee was monitored with necessary input during discussion to ensure fair procedure for establishment of the new committee. The new committee successfully elected their five officials of Chair, deputy chair, secretary, deputy secretary and treasurer for their effective operation. A two days training was conducted for the new committee on; roles and responsibilities, financial management, solar power generation system operation and maintenance and community action planning. Representatives of CDC and CMDRR committees were included in the training to enhance mutual support and working relationship for the effective development of this area. Handing over from the old management committee to the newly elected committee was done, which involved intense debate between the old and new committee, especially with specific regard to a 10 million of funds spent by the old committee without present documentary evidences. The new committee expressed their dissatisfaction and vowed to follow it up through the community members. Despite this, the leadership transition was concluded and the new committee has taken the full control of the borehole management.

3) Re-establishment of management system

The newly elected WUA management committee revised the existing livestock charges. Payment system for livestock remained monthly while at newly constructed kiosk will be paid on daily basis. Revised water tariff agreed during the WUA management training and at community meeting is as shown in below Table AD5.9.11. Kubi Qallo borehole has been serving only for livestock and water fee collection system was similar to the one in Shurr, until the pipeline was established by the County government that introduced domestic use of the borehole water. They have fixed tariff for each animal per head per month and monthly fees are collected as per arrival of the herders who water their animals by presenting their payment receipts.

Table AD5.9.11 Revised Water Tariff and Collection Methods at Kubi Qallo Borehole

Category	Fee collection method	Item	Previous tariff		Revised tariff	
			Member	Non-member:	Member	Non-member:
Livestock use	Monthly payment	Camel	Ksh.60 per head	Ksh.65 per head	Ksh.50 per head	Ksh.60 per head
		Cattle	Ksh.30 per head	Ksh.35 per head	Ksh.20 per head	Ksh.25 per head
		Shoats	Ksh.15 per head	Ksh.20 per head	Ksh.10 per head	Ksh.15 per head
		Donkey	No charge		-No charge at the borehole -At the new kiosk - Ksh.10 per head	-At the new kiosk - Ksh.15 per head
Domestic use (water kiosk)	Daily payment as per use	Water container	No charge (not mucHousehold use at the borehole as there was no pipe to the kiosk)		Ksh.10. per 20L jerrican	Ksh.15. per 20L jerrican
Commercial	As per use		▪ 10,000 L truck = Ksh.2,000 ▪ 15,000-20,000 L truck=Ksh.3,000 ▪ Less than 10,000 L truck=Ksh.1,500		▪ 10,000 L truck = Ksh.2,000 ▪ 15,000-20,000 L truck=Ksh.3,000 ▪ Less than 10,000 L truck=Ksh.1,500	

Source: JICA Project Team

Even though fee collection by the new committee had been improved after close intervention, financial mismanagement remained as a big challenge even after reformation of the committee. Lack of transparency and accountability with poor record keeping was revealed such as a payments and purchases made without records. In addition, there were many defaulters that accumulated debts. Many of the committee members did not commit the committee responsibility being busy with their personal business thus follow up was not made on management progress and financial records have not been updated.

4) Conflict between two communities

In order to improve this situation, the committee, together with the area chief, called for a community meeting to report the situation to come up with solution. Around 50 people took part in the meeting and concluded with the solution of charging the treasurer to recover the amount of unclear expense, the treasurer to be replaced, and the whole committee to take responsibility on accounting.

While the election of the new treasurer, the conflict reappeared between the two communities that are main users of the Kubi Qallo borehole, Qilta Korma and Sagante community. Discussion was made together with elders and it was proposed to shift the post of treasurer from Qilta Korma to Sagante. Qilta korma people were defending the post while Sagante people were agitated struggling to retain the post. Following a lengthy discussion, Qilta Korma community agreed to give back the treasurer post to Sagante community, considering the situation where other current committee officials are all from Qilta Korma Location. Even though the WUA chairman stated that during election of officials what they mainly look at is the personal principles of leadership in community, people's concern was drugged by power balance in administrative zone. This kind of situation was also observed during the training conducted by an NGO, in which balance of the participants invited from each sub-location was not equal and the minority side boycotted the training.

5) Observed defect of solar system

In April 2014, reviewing the financial record that was handed over to the new treasurer, the committee raised the issue of fuel consumption. Diesel consumption is much higher and almost half of the collected fee was spent for diesel purchase. It was pointed out that the solar power system has been functioning only a few hours during daytime, which is much less compared to other solar power systems. The malfunction of the solar power system was confirmed and adjusted in July 2014 by the contractor who installed the solar power system.

6) Review of management system

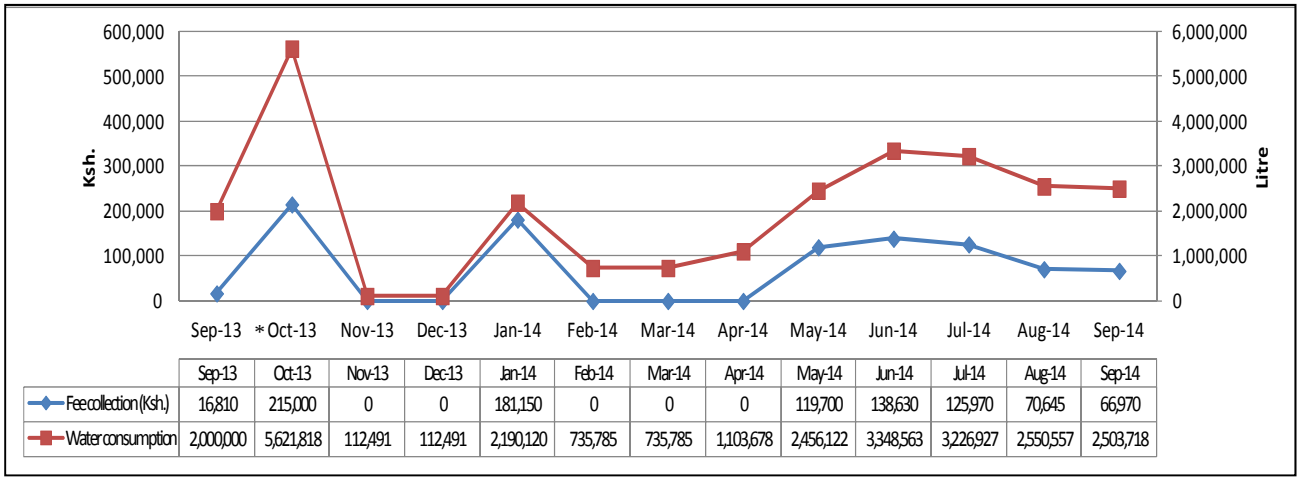
In July 2014, monitoring almost one year after installation of the solar power system, review of management was conducted with the community. The borehole management committee was reformed, with further replacement of officials, but still has not established proper management judging from their record. Opinions of the community was that the community have been receiving benefit from the solar power system through the reduced water fee rate that was revised after installation of the solar power system, but they also know the management has been facing several challenges. By sharing the situation, some other options to enhance benefit of the community were proposed to the community, such as further reduction of the fee that can simplify the management avoiding misuse. However, the community concluded that it is still important to save maintenance cost even if diesel cost was largely reduced, thus they prefer paying fee and save some money for maintenance.

7) Further development of the borehole system

In October 2014, new pipeline system with water kiosk was established to supply water from Kubi Qallo borehole towards a settlement area near Gar Qarsa. Water fee of Kshs. 5 per 20 litre jerry can was introduced. After starting operation of the water kiosk, it was observed that there was a lot of water wastage along the new pipeline due to frequent breakage and leakages. The committee also cited a problem with a new settlement of around 200 households along the new pipeline at Dadach Kambi where there is a reservoir tank. These newcomers together with other community members from neighbouring Ilman Gufu settlement are drawing water from the reservoir without payment. While the committee agreed that solar power generation system at borehole was sufficient to supply water, they required diesel to pump water to the reservoir at Dadach Kambi and water Kiosk. At the starting of the water pipe operation, diesel was donated by NDMA. When the provided fuel finished, the committee consulted the community to appoint a separate committee to run the kiosk due to high burden of the fuel to pump up water without enough fee collection. Expense for fuel to cover pumping up water to the kiosk was paid from the Kubi Qallo borehole management.

8) Financial monitoring of the Kubi Qallo borehole management

The following graph summarizes the fee collection of Kubi Qallo borehole.



	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14
Fee collection (Ksh.)	16,810	215,000	0	0	181,150	0	0	0	119,700	138,630	125,970	70,645	66,970
Water consumption	2,000,000	5,621,818	112,491	112,491	2,190,120	735,785	735,785	1,103,678	2,456,122	3,348,563	3,226,927	2,550,557	2,503,718

* Estimated reference value

Source: JICA Project Team

Figure AD5.9.4 Monthly Water Fee Collection against Water Consumption in Kubi Qallo Borehole from September 2013 to September 2014

D5.9.3 Gobore Borehole at Korr

(1) Situation before project intervention

Although there was a management committee for Gobore Borehole, the committee had not been registered and its function and capacity were weak facing problems in fee collection. The borehole serves four different water points; the owner community (Gobore village), neighbouring community (Nebei village), Korr town and a school, which makes management of fee collection difficult. They had been facing problems of fee collection from each water point and that resulted in suspension of water delivery to particular water points. Sometimes they operated the pump only when someone brings fuel for the generator due to scarcity of funds paid as a fee for the committee to purchase fuel. When they faced any needs of repairing the facilities, the committee had collected contribution for repair from the community. Moreover, the Gobore WUA has never recorded their financial and administrative transaction. It was also observed that there has been disparity in information of water tariff heard from the committee and that from the users. Risk of mismanagement could be due to poor management system and lack of ownership of the community towards the borehole and its management.

Table AD5.9.12 Summary of the Water Management Body for Gobore Borehole

Items	Situation
Group name	Gobore
Group status	Not registered
Year of establishment	Not clear
Members (membership, officials)	All community members are considered users of the Borehole There are 8 committee members No specific membership
Collection of fees /water charges	Water fee is collected as follows Camel – Ksh.8/drinking or Ksh.400 per 50 camels/drinking Cattle – Ksh.7/drinking or Ksh.300 per 45 cattle/drinking Shoats – Ksh.1/drinking or Ksh.200 per 200 shoats/drinking At the other 3 water points people are assigned to collect money. But currently they bring fuel to the borehole for water to be pumped to the water points The amount collected is not clear
Management of water source	Collected water fee is mainly used for purchasing fuel for generator and maintenance work is done by collecting additional contribution from the villagers when it occurs.
Other remarkable issues	The committee has a bank account but the WUA is not registered. Water charge is collected by individuals hence there is an accountability problem

Source: Key Informant Interviews of JICA Project Team (January 2013)

(2) Focal issues and approach

To avoid mismanagement in the borehole management, establishment of fee collection system with proper record and saving arrangement was urgent requirement at the Gobore borehole. Since the borehole supplies water to four different communities and each water point has its own charging and management system, consistent charging system shall be introduced with proper record keeping. Although the owner community is Gobore village, and committee members are from the three water points. It is necessary to involve all the communities in decision making for efficient management. As proposed for the Shurr, effective measures such as installation of water meters to control water distribution and fee collection shall be introduced. The purpose of the water meter is the same as that of Shurr to verify the fees collected at each water point with the amount of water delivered. However, in Gobore borehole, confirmation of water allocation would be more crucial and sensitive as fee collection of each water point is handled by respective responsible persons at each site who collect fee at the site with their own system of collection and brings to pay to the committee. Installation of water meter is expected to help the committee to assure water charge from those water points with different

fee collection system, thus intervention from the project to establish the effective operation system to make use of this measure shall be crucial.

(3) Output and process of institutional Development and O&M

1) Consensus making and management training

Considering the situation that the borehole serves different communities, a meeting with all the concerned communities involving different villages and communities of beneficiary of the borehole was conducted prior to the installation of the solar power system. Consensus was made among all the villages on improvement of management of the water source with necessary contribution as water fee. Management training was conducted by PISP in March 2013, to strengthen the management system especially financial management and fee collection.

2) Establishment of new operational regulations

A further intensive financial training was conducted as a two-day programme in July 2013. The following summarize the rules in fee collection discussed at Gobore borehole during the training.

Table AD5.9.13 Rules Regarding Management of Fee Collection in Korr

Issues	Rules	Operation
Membership and water tariff	Membership tariff is applied to the registered members who paid annual membership fee of Ksh.200	Non members are charged higher levy
Uniform water charge	Uniform water tariff for all the water point is to be clearly shared to the community	Water tariff is to be shared and agreed in community meetings
Fee payment	-Fee shall be put in a collection box kept by the operator instead of handing to the operator	Payment mode shall be shared with the community to make sure they pay in the box
Fee collection	- Water fee shall be collected at each water point by an appointed operator and each operator shall handover the collected fees to the treasurer on weekly basis	Operators to record daily water meter reading and report to the treasurer with collected fees
Storing of cash	-Cash shall be kept in the community saving box kept by treasurer	keys of the box are kept by different committee members
Bank account	-Cash kept in the saving box shall be periodically deposited to the bank.	Withdrawal of cash can be done through agreement of the community and with signature of the three signatory.
Expense	All the expense shall be done from the treasurer with proper proof documents	Operational expenses shall be approved by the chairman and irregular expenses should be approved by the community

Source: JICA Project Team (based on the discussion by the Gobore WUA committee)

Since the livestock use at the Gobore borehole is periodical and irregular, daily collection system with fee per use was selected as water fee collection system, except for the primary school that is applied with a monthly fixed charge subsidized based on the concept of the public facility that serves the community. Korr town water point and Nebei village mainly serve for domestic use with a small exceptional livestock use at Nebei village. Water fee for domestic use is charged per water container. Gobore water point has irregular periodical livestock use with a small amount of domestic use by the nearby villagers, thus fees for livestock are set based on the number of livestock with fixed rate per animal per watering, while the fee for domestic use is the same as other water point. Reasonableness of the fee collection can be confirmed by comparison with water meter reading to a certain extent. The followings are the agreed water tariff for the Gobore borehole.

Table AD5.9.14 Revised Water Tariff and Collection Methods at Gobore Borehole

Category	Fee collection method	Item	Tariff	
			Member	Non-member:
Registration fee	Annual fixed rate	Member / household	Ksh. 200	-
Livestock use	Daily collection	Camel/cattle	Ksh.8 / head	Ksh.10 / head
		Shoats	Ksh.1 / head	Ksh.1 / head
		Donkey	Ksh.2 / head	Ksh.2 / head
Domestic use	Fee as per consumption	Water container	Ksh.30 / 200L container	Ksh.50 / 200L container
Commercial	Fee as per consumption	Water container	Ksh.2 / 20L jerrican	Ksh.4 / 20L jerrican

Source: JICA Project Team

During the financial training, action plan was prepared, through the similar approach as the one conducted in Shurr, based on the estimation of the water fee collection and budget of the each planned activities. The prepared estimation of revenue and operational budget is as shown below.

Table AD5.9.15 Estimation of Saving of Gobore WUA

	Items	Low season (Domestic and livestock)	High season (Domestic and livestock)
Expected revenue	Water fee collection (Gobore)	Ksh.12,000	Ksh.45,000
	Water fee collection (Town)	Ksh.8,000	Ksh.8,000
	Water fee collection (Nebei)	Ksh.8,500	Ksh.8,500
	School	Ksh.500	Ksh.500
	Total	Ksh.29,000	Ksh.62,000
Estimated expenditure	Operator/guard fee (Ksh3,500*2, Ksh.3,000*2)	Ksh.13,000	Ksh.13,000
	Minor repairing (average per month)	Ksh.300	Ksh.300
	Fuel/oil/service for generator (average for emergency use only)	Ksh.500	Ksh.500
	Transportation/ Administration cost	Ksh.3,000	Ksh.3,000
	Total expense	Ksh.16,800	Ksh.16,800
Estimated saving	Saving of each month	Ksh.12,200	Ksh.45,200

Source: JICA Project Team (based on the discussion during the financial training in July)

Action plan draft was prepared based on the needs raised by the committee members. Since the committee members were not confident enough to conduct activities by themselves, they agreed to start with small repairing work and improvement of water supply system. The followings are the plan prepared by the Korr WUA committee during the training.

Table AD5.9.16 Short Term Trial Action Plan Prepared at Gobore Borehole

	Activity	Timing	Required resource	Budget
1	Repair of water pipes (Gobore and town kiosk)	July	Labour and fixing material	Ksh.2,000
2	Repair of elevated tank at Gobore	July	Labour and fixing material	Ksh.1,000
3	Fixing horse pipes at Nebei and town	July	Horse pipes	Ksh.1,000
4	Replacing gate valves for town and Nebei	End August	Gate valves, labour	Ksh.14,000
5	Registration as CBO and renewal of registration in bank account	October	Registration fee, transportation, documentation cost	Ksh.17,500
6	Repair of generator	November	Repairing cost	Ksh.78,000

Source: JICA Project Team (based on the discussion during the financial training in July)

3) Maintenance works conducted by the committee

A community Baraza was convened in August 2013 to share action plan and to have endorsement for its implementation. Upon sharing by the WUA chairman, the community approved the implementation of the action plan by the management committee. The repairing works of water elevated tank and fixing of horse pipes were carried out immediately after the planning. During the process of the implementation, the operator made payment directly from his fee collection without going through the procedure of expense by treasurer. Further discussion was made among the committee to confirm procedure of expenses as a committee with approval process and proper financial records. Process of implementation of each activity was followed especially to establish clear and accountable procedure for expenditure.

Although management of Gobore boreholes had often faced problem of lack of revenue to run the borehole covering operational expenses including fuel for generator, installation of solar power generation system together with strengthening of management improved their financial status dramatically. The WUA saved more than Kshs.100,000. The WUA had also managed to spare their savings for repairing of water supply system such as water tank repair and replacement of gate valves. A part of the saving was used to develop a shoats' trough using oil drums cut into half and welded together in series.

Source: JICA Project Team

Figure AD5.9.5 Water Fee Collection of Gobore Borehole (Left: counting and recording the fee collected from each water point, right: the fee collector using collection box)

4) Conflict regarding water distribution

Drought situation of the long rain in 2014 seriously affected the Gobore borehole. It is suspected that lack of rain exacerbate water level of the borehole. It seemed the pump was not fully working due to lack of water, as a result, enough water could not have sent to each water point. This water scarcity caused conflict among user communities of the Gobore borehole. Five communities in Korr are the main users of the Gobore borehole at the four different water distribution points. When the water level lowered, distribution of water became critical. The operator of the borehole started prioritizing Gobore water point where he charges and collects fee. This caused lack of water delivered to other water points, which resulted in complaints from users of other water points. Complication occurred when people came up with the idea of repairing the generator that has been left unrepaired as it was not required due to solar power system. As people tried to solve problem of water scarcity by using generator at night to pump water to other water points, increase of water fee for domestic use were introduced by a few members of the committee to cover repairing cost without consensus of the members. In addition, renewal of membership was also proposed to collect membership fee for the coming year. The main complaint raised from the community was against increase of the domestic water fee. Some proposed to use saving from the fee collection for repair of the generator instead of increasing the fee, which the WUA committee did not agree. The situation became chaotic and several community meetings were organized. In the meeting, where elders from each village, the WUA committee members and the Assistant chief took part in, distribution of water and increase of

domestic water fee was the focus of the discussion. This is mainly because these are the issues they are facing in daily basis and they can recognise easily at a glance. On the other hand, the problems that do not immediately nor directly affect their daily life or issues that involve larger community in longer time period are not recognised as critical problem. The project assisted with potential options to improve management of fee collection for them to revise and choose, explaining all the observed problems. The provided options with advantage and disadvantages are as follows.

・Table AD5.9.17 Advantage and Disadvantages of Different Fee Collection Methods

Advantage	Disadvantage
Daily charge (current operation)	
- Enough amount for operation and maintenance can be saved - Fee rate is fair depending on amount used	- Difficult to monitor and supervise fee collection and accounting - Risk of misuse and loss of fund without proper supervision
Monthly charge (collected per village and bring to the treasure	
- Easier to manage - Less risk of loss of fund during collection as the amount of collection can be expected with the fixed fee - Operator does not need to handle money	- Some people may not pay?? - Fee may not be fair as everybody pay the same amount regardless of the amount of use - Can make exemption to people who cannot afford?? - Challenge in distribution if other users such as livestock and water tank are charged differently - Challenge in how to charge livestock (it is difficult to charge monthly for livestock as they are mobile and do not stay for long period??) - Need recalculation of fee to set adequate monthly charge
Reduction of fee (or make it free and collect only operator payment)	
- Direct benefit for the users by reduced fee - If no charge, no need to employ fee collectors (can save cost of operation)	- Challenge in distribution (if they can still charge outside livestock and water tanks - Maintenance cost should be covered by additional collection when it is required which may take time

Source: JICA Project Team

However, it seemed difficult to understand these issues systematically for the elders, almost all of which are illiterate and unable to calculate properly. This was borne out by the discussion, in which some elders proposed monthly contribution of Ksh.100 per household to reduce domestic fee, which many agreed, even though what they have been paying in current system is less than Ksh.100 per month. Another difficulty in sorting out the preferable fee charge is that the concerns of the elders are what they face everyday, which is daily payment, but not on how it can be managed. After a few meetings, the consensus they came up with was to keep daily charge as it was without any annual registration fee, under the condition that the operator sends water to each water distribution points on the agreed days.

There had been a little improvement in water distribution during the months of August and September 2014. This fair distribution can be attributed to the following two reasons. Firstly, after the community discussion on their role in water allocation and distribution, some members of the community became proactive and ensured water to be sent to their respective watering points during designated days. Secondly, there had been some erratic rains around Korr, which made the most of the livestock to move away from the settlements to the plateau. There was thus no congestion at the main borehole.

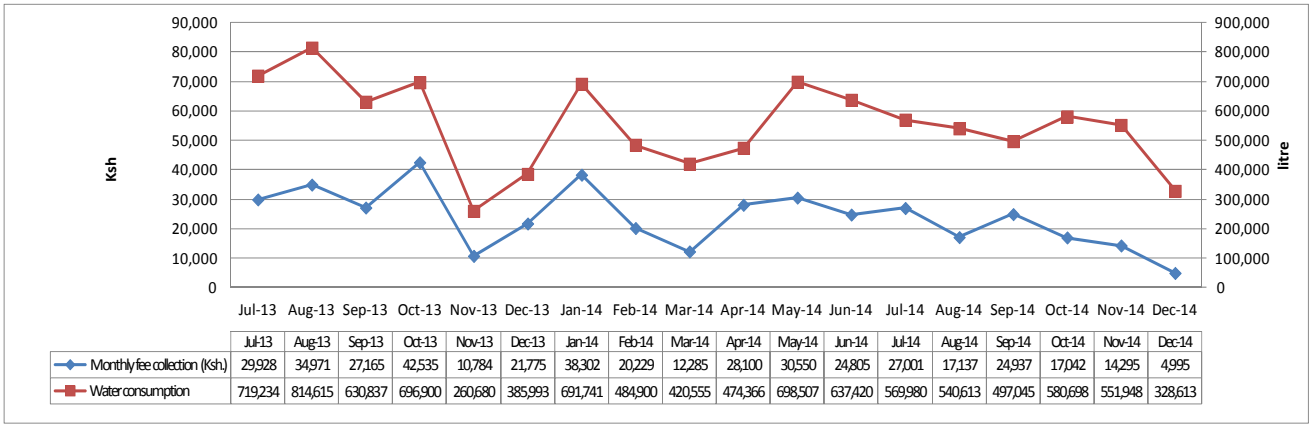
5) Review on the operation and management

Through observation and interaction in November 2014 with the community, it was reveal that most of the end users of water did not have a clue as to how the borehole is managed. Some thought that the borehole belonged to the Operator at Gobore while some others did not know of the existence of the committee while knowing about operators. In addition to the detail explanation of borehole management and fee collection to individuals during information collection, discussion and

awareness was done in a community meeting. It was further explained how the borehole has been ran, how much they have collected and spent on wages and maintenance, and how much money they have saved. In the meeting the committee promised to let the community evaluate their performance and if the community was not impressed with their performance they were ready to step aside to allow for a new committee to conduct the borehole affairs. This however, faced resistance from the chairman and Gobore operator who feared losing their positions. The other members however, managed to convince them that this was the only fair way to let the community manage their own resource and avoid a backlash in case any thing went wrong. In a meeting with elders, local leaders, administrators and politicians, it was resolved that the community should meet and decide on their own management plan. Gobore elders were of the opinion that the resource should be shared but there cannot be outsiders (elders from other villages/clans) directly managing the borehole. Although some elders claimed to change the committee, the committee still remains the same because of power relation between clans with support of political leaders.

6) Financial monitoring of Gobore borehole management

Gobore borehole serves different water points at Gobore main borehole, Korr town, Nebei village and a primary school. Fee collection was done by assigned fee collector at each water point. Collected fees at each point are handed over to the treasurer with recording in the committee meeting. The summary of the monitoring of water fee collection of Gobore borehole is as follows.



	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14
Monthly fee collection (Ksh.)	29,928	34,971	27,165	42,535	10,784	21,775	38,302	20,229	12,285	28,100	30,550	24,805	27,001	17,137	24,937	17,042	14,295	4,995
Water consumption	719,234	814,615	630,837	696,900	260,680	385,993	691,741	484,900	420,555	474,366	698,507	637,420	569,980	540,613	497,045	580,698	551,948	328,613

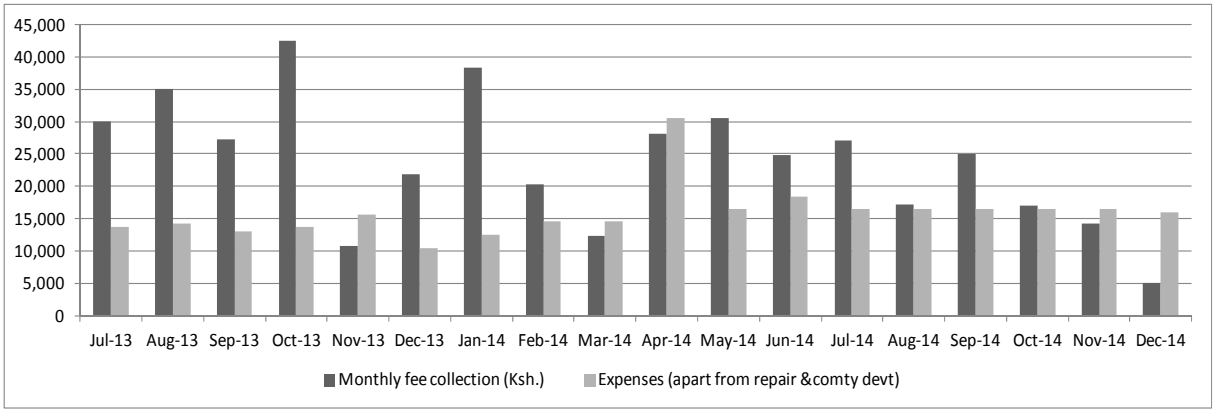
* Fee collection in December 14 was much less due to misplacing of the collection box. This was to be solved by deducting penalty from the salary of operators decided by the elders.

Source: JICA Project Team

Figure AD5.9.6 Monthly Water Fee Collection against Water Consumption in Gobore Borehole from July 2013 to December 2014

Because of the scattered distribution point, the management cost is high in Gobore WUA, as each point has a fee collector, while the water volume is much smaller compared to other boreholes that the Project has been supporting. Although the accumulation of saving is slow due to both less water yield and high administrative expenses, the Gobore WUA has managed minor repairs of water facilities such as repair of tank and gate bulbs.

The following figure indicates the trend of income and expense of Gobore borehole. In order to assess the potential of savings as well as soundness of their operation, the expense of the following graph does not include maintenance and community development activity costs.



Source: JICA Project Team

Figure AD5.9.7 Income and Expense of Gobore Borehole from July 2013 to July 2014

Even though the current management is not preferable with high expenses for operation especially payment for workers, Gobore borehole saved about Ksh.120,000, among which about 20,000 was used for repairing works of water points and water tanks.

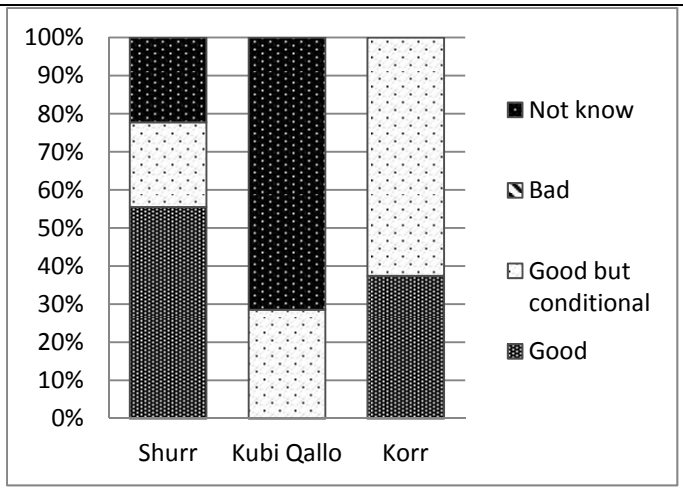
D5.10 Discussion, Conclusion, and Lessons Learned

The solar power generation system enabled the community to acquire water without any disturbance of scarcity of fuel or breakage of generators. This also implies that the solar power generation system can continue pumping to supply water even during drought when people cannot afford to pay for fuel. This is the biggest contribution of the solar power generation system to drought resilience, even though it could not be proved as far as the area has not faced serious drought during operation of solar power system.

D5.10.1 Concept of Communal Fund

Although it is expected that the usage of solar power generation system would save cost of generator operation, the Project is encouraging the community to maintain their water charge not only for maintenance cost but also to reserve for emergency cases including drought and for further community development activities. The concept of communal fund was innovative in the area. It was concerned that as it will enable to accumulate a large amount of fund proper management of their collected funds is necessary. The concept of maintenance cost has been well understood by many people through intervention of the Project. However, the benefit from the collected fee highly depends on the management of the fund. Difference in understanding of fee collection and management of fees are drawn from the interview in the concerned pilot sites.

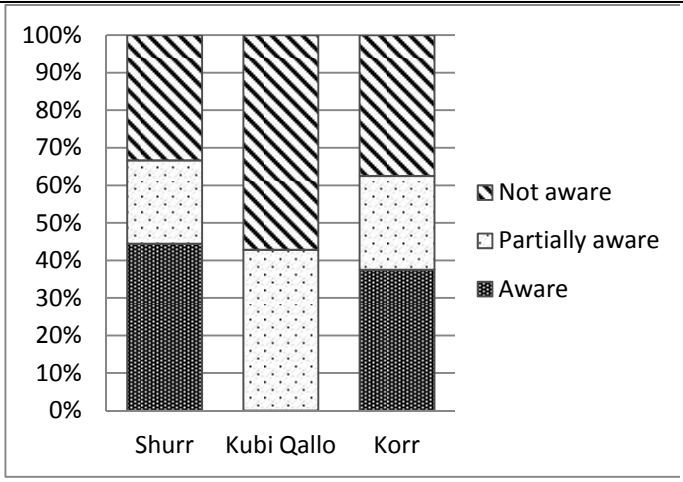
Although the interview sample is limited to eight to ten people in each pilot site, a certain tendency was observed. The interview was open-ended question and the result was analyzed quantitatively. The graphs in Figure AD5.9.8, Figure AD5.9.9, and Figure AD5.9.10 show the opinion on the fee collection for the borehole with solar power system, the awareness on the financial management and decision making structure in each pilot site.



Source: JICA Project Team

Figure AD5.9.8 Opinion on Communal Fund

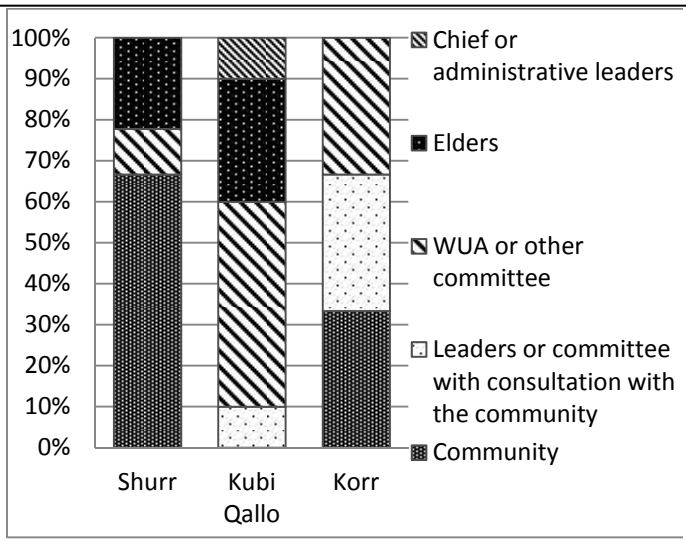
Regarding the fee collection for maintenance and community development, many of Shurr and Korr feel it is good to collect fee even if the solar does not require any fuel, while Kubi Qallo commented that the collection and idea of communal fund is ok as long as it can be managed well. This result can be understood from the observation that Kubi Qallo community have not received benefit from the communal fund due to the repeated mismanagement and change of the committee. On the other hand, Shurr people recognized that it is good as they accomplished and experienced tangible benefits from community development activities utilizing the communal fund, even though the management has not been perfect.



Source: JICA Project Team

Figure AD5.9.9 Awareness on Financial Status of WUA

Recognition of benefit from the communal fund also depends on the accountability of financial management. The awareness on the financial status differs in pilot sites. Awareness of the financial status is high in Shurr and Korr. None of Kubi Qallo people answered they are aware of the financial status even though the committee, with support of the project shared the information with a good number of the community. There are several answers from Shurr and Korr communities that although they were informed it is difficult to remember and recall. Similar tendency can be seen in decision making structure of each site. Shurr shows the high involvement of the community in decision making reflecting the fact that they have decided community development activities through decision made in the community meeting. Korr people feel a certain involvement, which could be due to a series of meetings during implementation, while certain number of people still feel the committee is the one to make decision. In Kubi Qallo, perception that the WUA makes decision is strong.



Source: JICA Project Team

Figure AD5.9.10 Major Decision Makers for Water Management

These result can be analyzed that process of establishing management system remarkably influenced people's understanding and actual practice of management. This shall be further analyzed to draw recommendation for project implementation.

D5.10.2 Impacts and Lessons in Each Pilot Site

Each pilot site shows different feature in operation and management of solar power generation system for the borehole. Further lessons learned from each pilot site are discussed below.

(1) Shurr Borehole

1) Impact and Contribution to Drought resilience

Solar power generation system provides continuous water supply, which has increased the numbers of herds using the borehole in Shurr. Users evaluated that they are benefitting from availability of water without worrying about shortage of fuel. Uninterrupted water supply saves time for the live stock watering and brought more immigrants since there is no fear of lack of water. Reduced rates of water fee by 25 percent discount brought financial benefit and made herders more accessible to water. Although water fee has been charged during normal period, solar power generator system can serve even without collection of fee during drought situation, in which herders face difficulty in acquiring cash due to emaciation of livestock. Although it is difficult to judge exact contribution of the solar power generation system during drought since it has not faced severe drought yet, the major advantage shall be availability of water without expenses during drought, while water fee collection enable maintenance during normal period.

Community development activities of classroom construction as well as employment of PA teacher with the community fund from the water fee contributed to better education environment of children. Improvement of learning environment can enhance health status of the children and improve their learning. Water fee saved through solar power generation system was also used for employing PA teacher. Although enhancement of education is not direct resilience against drought, it is one of the fundamental elements to improve community resilience in the area where people lack basic education to manage necessary resources such as financial resources. Learning from the experience in the most of the target area, where financial management is controlled by limited personnel without adequate accountability and supervision by the rest of the community due to lack of ability, improvement of education shall be crucial factor for future resilience.

Furthermore, accomplishment of the community project introduced an idea of improving situation of the community, which cannot be achieved by individuals. It has generated confidence of the community to meet their needs with their own effort.

2) Challenges and Constraints

Diversification of the available water resources seemed to have made the management difficult in Shurr. Shurr herders that have grazed around the newly opened Awaye borehole enjoyed water without payment partially because there has been free support from the County government on generator and fuel, and also the distance from the settlement made it difficult to manage by the community. Even though they formed different committees for the newly opened boreholes in Awaye and Lalesa, it is still challenge to manage boreholes with fee collection where there is no settlement around.

Another crucial issue occurred in Shurr is destruction of the management due to power struggle over the resource management and disunity of the community. It seems that rich natural resources with generation of benefit especially in terms of monetary profit, created power struggle in the area. A large scale water resource infrastructure helps tremendously pastoral community. However, it can attract arrogant power struggle and cause conflict in the community. Although leadership is necessary and an umbrella organization that can be superior body for decision making with representative of the community is important for effective use of resources, concentration of power always contain danger of the conflict especially in the immature community with weak supervision on the management and unstable coexistence of different group of people.

(2) Kubi Qallo Borehole

1) Impact and Contribution to Drought resilience

The major benefit people mentioned from the solar power generation system in Kubi Qallo borehole is continuous supply of water without disturbance from breakage of generator or lack of fuel. Apart from that, the herders also received a partial benefit from reduction of water fee from the

previous water charge, although the community decided to continue paying for water fee understanding importance of the operation and maintenance cost. However, even though the solar power generation system saved a lot of expenses for fuel, the committee, which had management problems and been reformed several times, could not manage to increase their community fund savings. While the latest committee managed to increase their saving from the reduced amount by misused of the previous management, the total saving is still negative.

Indirectly, the availability of water without cost enabled extension of pipeline to the settlement towards Gar Qarsa. Although generator is necessary to pump up the water from the borehole to the water kiosk, water pumped with solar power system helps supply of water for domestic use. After the extension of pipeline, a new settlement appeared around the water distribution points. This kind of development further creates issue for the community to manage. Therefore it is necessary for the community to equip capacity not only to manage with the provided system but to handle newly emerging issue by themselves.

2) Challenges and Constraints

Realizing the benefit and contribution of the solar power generation system to drought resilience, the impact and benefit of the solar power has not been fully received by the community. Even though the community enjoy the lower rate of water fee thanks to solar power, people still pay a certain amount of fees. Poor management in the committee ruined the effective use of the collected fees. Even though the current situation of the latest committee improved the situation, it was observed difficult to fully avoid mismanagement of communal fund. Community people have different opinions by each other. Some say the community was involved in decision making, while others say only the committee make decision and other community members are not informed fully. Although educational level in Kubi Qallo area is high being close to Marsabit town, and record keeping can be done satisfactory, the community yet not have capacity to audit the accounting records properly especially when it is manipulated to conceal misuse.

Another issue observed in Kubi Qallo was a struggle for power between the communities of Qilta Korma and Sagante. For example, people always disagree on the distribution of the post of the committee officials between the communities. It was also observed in the training conducted by an NGO, the minority side boycotted the training in which balance of the participants invited from each sub-location was not equal. There is a possibility that this kind of power balance can work as mutual inspection on other community to make the management more accountable. However, so far in Kubi Qallo, it has been only working to attack the other community and/or to gain more benefit than the other. Management in the water committee has been thus established not for effective operation but to maximize benefit of the concerned community.

(3) Gobore Borehole at Korr

1) Impact and Contribution to Drought resilience

Even though the committee still needs further capacity building to establish farm management and there is room for improving fee collection, it is important to indigenise the fee collection system as their own being supervised by the community. Compared to the starting period, they are now operating with lesser intervention by the Project, gathering water fee by themselves to handover the collected fee from each distribution point to the treasurer periodically. The fee collection records have been maintained with less assistance by the Project, which has never been made at all before the Project. Information shared in the community meeting has been distributed in the concerning communities and people are aware of the rough picture of the financial status after the meeting, even though high illiteracy made judgment of the situation difficult.

2) Challenges and Constraints

A yield of water at Gobore borehole is not sufficient to the all users, especially in late dry season. Such water scarcity has not been observed before installation of solar power generation system due to lack of fuel to run generator in fulltime basis. It was not observed until they use the solar power

system to run the borehole for a whole day. Amount of water is not enough to serve all the livestock and human being when there are many herds using the borehole. Water distribution is predominantly in the hands of the operator, the only person who can handle valves, even if the rules on water distribution are agreed among all the stakeholders. The operator is powerful enough to refuse to send water to the supposed water points while he provides water to the users who pay directly to him, when water is scarce.

Judging from the discussion in the meeting, as well as informal information, it seems the Gobore community, where the operator and a chairman come from and where the borehole is located, is authoritative enough to decline the opinions of the other communities. Gobore people is claiming that the borehole belongs to their village, even though they have agreed that it belongs to the bigger community of Korr among stakeholder meetings. Since clan autonomy is strong in Korr area, it is culturally not acceptable to interfere issues in other clans. Even though people understand the resources should be shared, management is taken as domestic issue in the clan. It is therefore difficult for people of the other clans to blame or change the management handled by the owner community of Gobore clan.

Women, who are the one to fetch water for domestic use, revealed that water scarcity has been observed and that livestock are given preference over human beings. Rendille communities are mainly patriarch societies where men make most of their decisions. Since men also own the livestock, preference is mainly given to livestock over women and children for domestic use.

Another salient problem is that most of the revenue collected from sale of water is used to pay committee allowances and wages. The community however, does not take this matter seriously. Their major concern is availability of water for both livestock and human being. Some herders do not concern how the finances are handled thinking that it is the role of the operator. To them as long as they find water they can always negotiate how to access it, through paying or organized arrangement between them and the person in charge of the water source. If water cannot be reached, they move on to another water source. This kind of people's mentality affects decision of people in water management. It seems that those people concern only the issues which they face in a daily basis and/or which can be recognized easily at a glance. On the other hand, they do not concern the problems that do not immediately nor directly affect their life or issues that involve larger community in longer time period. Under such way of thinking, people do not mind about the water fee once they pay to the operators as long as they receive enough water.

CHAPTER D6. TURKANA: SUB-PROJECT FOR GROUNDWATER DEVELOPMENT

D6.1 General

Table AD6.1.1 General Outline of the Ground Water Development Sub-project

1. Objectives	Development of water resource has been critical issue for enhancing resilience of the pastoral community in Northern Kenya. In Turkana, ground water has high potential for use by pastoralists with optimal intervention. This sub-project aimed to improve utility of ground water resources through establishment of 20 new boreholes with introduction of an optimal operation and maintenance scheme. In order to enhance management by the community, communities are involved from the early stage of the project.		
2. Number of Beneficiaries	Unspecified		
3. Implementation Organization	JICA ECoRAD Project, water users' association		
4. Project Contents			
1) Project Outline	1) Electrical sounding survey 2) Drilling and well development 3) Hand pump installation with animal trough construction 4) Activities for operation and maintenance		
2) Facility / Activity	*Facilities/Activities*	*Implementor*	
	1) Drilling of borehole	1) Contractor	
	2) Installation of hand pump with animal trough construction	2) Contractor	
	3) Registration to O&M scheme	3) Project team	
	4) O&M training	4) Project team	
3) Organization for O&M	Water users' committee (or responsible community representatives) and community drought management committee		
4) Construction Period	3 months for construction with defects liability period of 3 months		

Source: JICA Project Team

The aim of sub-project for groundwater development was to supply water for pastoralist as stable water resource even in drought spell. The sub-project composed of following works:

1) Electrical sounding survey
2) Drilling and well development
3) Hand pump installation with animal trough construction
4) Activities for operation and maintenance

In general, the host community designs the well operation plan and carries out daily maintenance of the well. However in Turkana County, there are many cases of non-functional broken down well or hand pump broken down within a few months of operations because of inadequate operation and maintenance. Integration of construction works and activities for operation and maintenance was a key feature of this sub-project.

D6.2 Electrical Sounding Survey

D6.2.1 Survey Sites

Based on the analysis of previous study, the results of field survey and meeting with stakeholders, 26 areas for groundwater development survey were selected and electrical sounding surveys were carried

out to decide the recommended point for drilling. These areas are plotted on the map (Figure BD6.2.1) and the information of the areas is summarized in Table AD6.2.1. The point shown in Figure BD6.2.1 and coordinate shown as northing and easting in Table AD6.2.1 is representative survey point in every area.

To assess the local sub-surface characteristics, at least 2 Vertical Electrical Sounding (VES) curves in every community were carried out on a horizontal spread of 150m for every site. Under VES, current is introduced to the ground using two outer electrodes A & B and the potential difference measured using the inner electrodes M & N. Resistivity readings are then taken at predetermined spacing and plotted on a log-log graph. An ABEM SAS 1000 Geophysical set was deployed and the Shlumberger Array adopted.

Table AD6.2.1 Electrical Sounding Survey Areas in Turkana County

No	District	Area Code	Survey Date	Village name	Location	Northing			Easting			Elevation
						Deg.	Min.	Sec.	Deg.	Min.	Sec.	(m)
1	North	N1	13/11/2013	Kaabilikeret	Milimatatu	4	12	45.5	35	28	36.1	692
2		N2	14/11/2013	Lokwakel	Milimatatu	4	8	59.2	35	20	9.8	582
3		N3	14/11/2013	Ngaukon	Kangakipur	4	3	35	35	31	53.5	738
4		N4	15/11/2013	Kaituko	Kanakurdio	3	46	11.5	35	33	15.4	558
5	West	W1	26/11/2013	Natuol	Lokichoggio	4	6	59.6	34	17	20.5	713
6		W2	25/11/2013	Nakeruman	Lokichoggio	4	19	19.1	34	18	34.9	696
7		W3	24/11/2013	Oropoi	Oropoi	3	47	2.2	34	26	39.6	783
8		W4	23/11/2013	Loreng	Kakuma	3	31	49.2	34	37	51.2	737
9		W5	22/11/2013	Nakoros	Kakuma	3	40	8.1	34	48	14.8	624
10		W6	30/11/2013	Kokurio	Loritit/Oropoi	3	21	26.4	34	43	18.4	750
11	Central	C1	21/11/2013	Kangirisae	Kerio	2	35	39.3	36	10	23.7	472
12		C2	11/11/2013	IDP camp	Central	3	6	9.5	35	33	49.1	513
13		C3	31/10/2013	Natapar Angidomou	Eliye	3	12	31.1	35	59	16.9	491
14		C4	30/10/2013	Losagam	Kerio	2	56	29.5	36	1	41.2	421
15		C5	16/11/2013	Chokchok	Central	3	8	5.5	35	45	40.7	477
16	Loima	L1	7/11/2013	Kakromosing	Lokiriama	2	46	14.8	34	51	8.8	916
17		L2	8/11/2013	Lotilo	Urum	2	56	29.6	34	41	59.9	1000
18		L3	9/11/2013	Kalokutany	Lorengippi	2	32	11.3	34	58	56.1	911
19		L4	7/11/2013	Kaidir	Namoruputh	2	50	7.9	34	59	56.6	751
20	South	S1	2/11/2013	Lochor Edome	Lokichar	2	20	37	35	39	39.8	762
21		S2	1/11/2013	Kakali	Lokichar	2	19	15.2	35	39	1.6	792
22		S3	4/11/2013	Loreng	Lochwaangikamatak	2	39	2.7	35	41	59.3	664
23		S4	3/11/2013	Nakejuamosing	Lochwaangikamatak	2	32	9.5	35	30	0.1	794
24		S5	3/11/2013	Ngimamki	Lochwaangikamatak	2	36	21.2	35	42	46.5	676
25	East	E1	27/11/2013	Lopii	Lokori	2	4	18.8	35	52	36.4	760
26		E2	27/11/2013	Kaaruko	Lokori	2	6	20.6	36	4	4.1	586

Source: JICA Project Team

D6.2.2 Results of the Survey

VES curves are shown in Figure BD6.2.2 - BD6.2.8 and their interpretation is summarized in Table BD6.2.1 and Table BD6.2.2. Most of the sites surveyed had medium to high groundwater potential. Based on this result, request from stakeholders, spatial balance of borehole distribution, accessibility to the sites and general priority, 25 drilling sites were identified (see Table AD6.2.2).

Table AD6.2.2 Drilling Sites in Turkana County

No	District	Site Code	Village name	Location	Recommended Depth (m)	Aquifer Type	Groundwater Potential	Drilling method	Access -bility	Pilot Project	Remarks/Priority
-	North	N1-2	Kabilikeret	Milimatatu	130	Volcanics	Midium-High	DC	Normal	●	Pature land/Midium
1		N2-2	Lokwakel	Milimatatu	120	Volcanics	Midium-High	DC	Normal		Pature land/High
2		N3-2	Ngaukon	Kangakipur	150	Volcanics	Midium-High	DC	Normal	●	Pature land/High
3		N4-1	Kaituko	Kanakurdio	100	Volcanics	Midium	DC	Normal		Market/High
4	West	W1-1	Natuol	Lokichoggio	100	Alluvial/Volcanics	Midium-High	DC/Mud	Normal	●	Pature land/High
5		W2-2	Nakeruman	Lokichoggio	150	Volcanics	Midium-High	DC	Good		Pature land/highest
6		W3-1	Ng'asoge	Oropoi	130	Alluvial/Volcanics	Midium-High	DC	Normal		Pature land/High
7		W4-3	Loreng	Kakuma	100	Alluvial/Volcanics	Midium-High	DC/Mud	Normal		Market/Midium
8		W5-1	Nakoros	Kakuma	130	Alluvial/Volcanics	Midium-High	DC/Mud	Good		Market/Midium
9		W6-4	Kokurio	Loritit/Oropoi	130	Alluvial/Volcanics	Midium-High	DC/Mud	Bad	●	Pature land/High
10	Central	C1-1	Kangirisae	Kerio	110	Alluvial	Midium	Mud	Bad		Pature land/High
-		C2-2	IDP Camp	Red Banner	100	Alluvial	High	Mud	Good		Low
11		C3-3	Atapar Angidomou	Eliye	130	Alluvial	Midium-High	Mud	Good	●	Pature land/High
12		C4-1	Losagam	Kerio	150	Alluvial	Midium	Mud	Good	●	Pature land/High
13		C5-3	Chokchok	Central	110	Alluvial	Midium	Mud	Good		Near river/Low
14	Loima	L1-1	Kakromosing	Lokiriama	150	Alluvial/Basement	Midium-High	DC	Bad	●	Pature land/High
15		L2-4	Lotilo	Urum	150	Alluvial/Volcanics	Midium	DC	Bad		Market/Highest
16		L3-1	Kalokutany	Lorengippi	130	Alluvial/Volcanics	Midium-High	DC	Bad	●	Pature land/High
17		L3-4	Lokiriamet	Lorengippi	100	Alluvial/Volcanics	Midium-High	DC	Bad		Pature land/High
18		L4-6	Kaidir	Namoruputh	100	Volcanics	Midium-High	DC	Normal		Village/High
19	South	S1-3	Lochor Edome	Lokichar	100	Basement	Midium	DC	Normal	●	Pature land/Midium
20		S2-5	Kakali	Lokichar	130	Basement	Midium-High	DC	Normal		Pature land/High
21		S3-1	Lolupe	Lochwaangikamatak	130	Basement	Midium	DC	Good		Pature land/Midium
22		S3-4	Loreng	Lochwaangikamatak	130	Alluvial/Basement	High	DC	Normal	●	Pature land/Midium
23		S4-2	Nakejuamosing	Lochwaangikamatak	130	Basement	Midium-High	DC	Bad		Pature land/High
24		S5-1	Ngimamki	Lochwaangikamatak	130	Basement	Low-Midium	DC	Normal		Pature land/Midium
25	East	E1-3	Lopii	Lokori	150	Volcanics	Low-Midium	DC	Good	●	Market/Midium
-		E2-2	Kaaruko	Lokori	120	Volcanics	Low-Midium	DC	Good		Market/Midium

Source: JICA Project Team

D6.3 Drilling Works

D6.3.1 Outline of Drilling Works

Flow chart of drilling works is shown in Figure AD6.3.1. Main works consisted of the following 3 stages:

1) Borehole construction: rotary drilling, geological logging, casing and screen installation, gravel-packing, grout-sealing, borehole development and cleaning and head-works

2) Test pumping: preliminary test, step-drawdown test, constant-discharge test, recovery test and water sampling for laboratory analysis

3) Hand pump installation and construction of animal trough

Meetings with local community were held 2 times; 1st meeting is the timing before commencement of drilling works and 2nd is the timing during test pumping or before the hand pump installation. Purpose of 1st meeting was to inform local community of drilling works procedure and their schedule. In case that borehole construction is successful, the drilling works proceed to test pumping process. Simplified water quality analysis is carried out before test pumping to grasp rough water quality of the drilled borehole. The purpose of 2nd meeting was to discuss how to use the well based on the information of drilled borehole and water quality measured onsite.

Source: JICA Project Team

Figure AD6.3.1 Flow Chart of Drilling Works

The target specifications for a successful borehole are as follows:

a) The minimum discharge: 0.33 m^3/hr

b) The water rest level: 90 m

c) The water quality:

Fluoride content < 3.0 mg/L

Arsenic content < 0.05 mg/L

TDS < 2000 mg/L

If it was found out that the borehole did not satisfy the above criteria, the data is disclosed to the local community and relevant organizations to discuss the use of the groundwater.

D6.3.2 Drilling Works

Drilling works were continued until the successful borehole reaches 20. General features of drilled wells under this sub-project are summarized in Table AD6.3.1. As a result, 7 boreholes out of 27 were unsuccessful because they did not yield any water within the recommended depth which was estimated based on electrical sounding survey.

Table AD6.3.2 lists dry boreholes with geological features. There are some common points in the geology and their distribution. Ngimamki and Loreng at Lochwaangikamatak are situated over the east side of major fracture which lies north and south along National Route A1. This fracture is located on the western edge of the graben filled with very thick alluvial deposit seem to be favourable lithologic condition to define areas of good groundwater aquifer with enough recharge. The existing 3 dry boreholes around Lochwaangikamatak area were all in the east side. Although drilling sites were decided carefully based on the interpretation of vertical electrical sounding (VES) data and previous drilling report, it was unfortunate that Ngimamki and Loreng failed to yield water because the aquifer is much deeper than supposed depth. Natapar Angidomou and Lopii were almost same geological situation as Ngimamki and Loreng. Deep alluvial deposits disturb groundwater exposure. There was no functional well in Lopii when drilling works were carried out.

D6.3.3 Test Pumping

The criteria for successful borehole for hand pump installation, from basic design studies and previous implementation review, was set at 0.33m^3/hr and above.

Discharges during test pumping, shown in Table AD6.3.1, are enough for hand pump except for Kaidir (0.25m^3/hr). Kaidir also had water quality problem since its water is not suitable for domestic use because TDS is beyond the recommended levels. Local community, however, strongly requested the Project Team to install hand pump and construct animal trough when they were asked how to deal with the borehole in the meeting. Finally, the Project Team agreed with Kaidir community that they was able to use groundwater for livestock under the appropriate management, then the Project installed hand pump and constructed animal trough. At Kaituko, groundwater overflows from a mouth of the borehole because the borehole has highly confined aquifer. Yield of the borehole is about 1.1m^3/hr.

Table AD6.3.1 Drilling Works Summary

No	District	Site Name	Drilled Date		Drilled Depth (m)	Aquifer Geology	Water Struck Level (m)	Water Rest Level (m)	Tested Yield (m^3/hr)	Hand Pump Type	Pump Chamber Depth (m)	Evaluation	
			Start	End								Yield	Water Quality
1	North	Lokwakel	3/20	3/20	96	Volcanics	48	28.0	1.88	India Mark II	42	Enough	Fresh
2		Ngaukon	4/13	4/14	128	(Volcanics)	dry						
3		Kaituko	4/15	4/16	91	Volcanics	80	overflow	10.00	Afridev	-	Enough	Saline (Livestock OK)
4	West	Natwol	3/5	3/7	72	Basement	38	22.8	1.50	India Mark II	39	Enough	Fresh
5		Nakeruman	3/9	3/13	120	Volcanics	96	45.6	N/A	India Mark II	82	Enough	Fresh
6		Ng'asoge	3/1	3/1	84	Basement	54	42.7	1.85	India Mark II	51	Enough	Fresh
7		Nakarimon	2/25	2/26	24	Alluvial	16	13.5	2.50	Afridev	17	Enough	Fresh
8		Nakoros	4/19	4/20	65	Volcanics	33	12.5	1.20	India Mark II	30	Enough	Fresh
9		Kokurio	2/20	2/22	78	Volcanics	55	47.0	7.00	India Mark II	54	Enough	Fresh
10	Central	Kangirisae	3/27	4/2	93	Volcanics	84	15.6	6.50	Afridev	30	Enough	Saline (Livestock OK)
11		Natapar Angidomou (1)	4/25	4/27	72	(Alluvial)	dry						
12		Natapar Angidomou (3)	4/28	4/30	120	(Alluvial)	dry						
13		Losagam	4/6	4/8	72	Volcanics	43	14.5	21.60	India Mark II	30	Enough	Saline (Livestock OK)
14		Chokchok	4/14	4/15	108	Alluvial	54	13.7	36.00	India Mark II	30	Enough	Saline (Human OK)
15	Loima	Kakromosing	2/28	3/1	80	Basement	65	34.2	0.33	India Mark II	63	Enough	Fresh
16		Lotilo	3/3	3/5	70	Volcanics	42	15.0	9.00	India Mark II	30	Enough	Fresh
17		Kalokutany	5/25	5/29	25	Alluvial	23	22.0	8.30	Afridev	22	Enough	Fresh
18		Lokiriamet	6/17	6/18	78	Basement	26	14.7	7.70	India Mark II	33	Enough	Fresh
19		Kaidir	2/21	2/22	90	Volcanics	64	24.0	0.25	India Mark II	76	Insufficient (only for daytime)	Saline (Livestock OK)
20	South	Lochor Edome	6/9	6/9	60	Basement	50	28.0	5.14	India Mark II	45	Enough	Fresh
21		Kakali	3/27	4/2	100	Basement	52	13.4	1.20	India Mark II	27	Enough	Fresh
22		Lolupe	3/27	3/27	81	Basement	45	23.5	1.80	India Mark II	45	Enough	Fresh
23		Loreng	4/6	4/7	120	(Alluvial)	dry						
24		Nakejuamosing	3/19	3/19	85	Basement	28	16.0	2.00	India Mark II	36	Enough	Fresh
25		Ngimamki 1	3/21	3/22	100	(Alluvium)	dry						
26		Ngimamki 3	3/25	3/26	100	(Alluvium)	dry						
27	East	Lopii	6/9	6/13	130	(Alluvium)	dry						

Source: JICA Project Team

Table AD6.3.2 Information of Dry Borehole Sites

Site Name	Sub-location	Drilled Depth (m)	Geological Feature
Ngaukon	Kangakipur	128	Fresh Volcanics
Natapar Angidomou	Eliye	120	Alluvial Deposit
Loreng	Lochwaangikamatak	120	Alluvial Deposit
Ngimamki	Lochwaangikamatak	100	Alluvial Deposit Including Thick Clay Layer
Lopii	Lokori	130	Alluvial Deposit and Volcanics

Source: JICA Project Team

D6.3.4 Water Quality Analysis

In accordance with the above criteria, the judgment for successful borehole was made. Groundwater in this project area sometimes indicated high concentration of Flouride (F^-) and total dissolved solid (TDS). Therefore the following principles were applied:

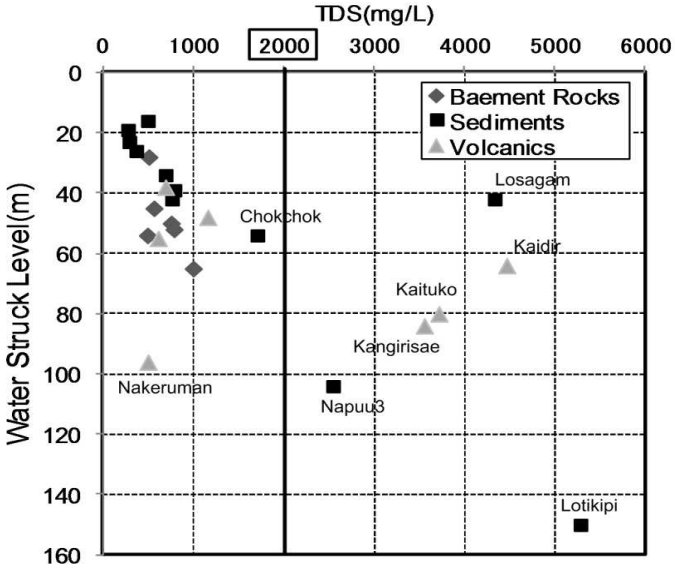
1) Boreholes with Arsenic concentration (As) and F^- concentration exceeding the recommended health significance values were defined as failed and were abandoned,

2) Boreholes with TDS level exceeding 2,000mg/L were defined as livestock use only, and

3) In case that other physical and chemical parameter levels exceeded the Kenyan Government standard or WHO standard (in case of no Kenyan standard), the Project Team provided the result of water quality test and discussed with local community on how to use the borehole.

Result of water quality analysis is shown in Table BD6.3.1. There were no boreholes which As or F^- has the concentration beyond the criteria. However, TDS values at 4 sites, Losagam, Kaidir, Kaituko and Kangirisae as shown in Figure AD6.3.2, exceed the criteria. Lotikipi and Napuu3 are reference data drilled by UNESCO. The plots in Figure AD6.3.2 classified by geology shows clear relationship between water level and TDS. That is, the values of TDS become higher when water level is deeper. On

the other hand, TDS values are also affected by locality, aquifer structure and geology. For example, Lotikipi and Napuu3 are situated in deep basin area, Kangirisae and Losagam belong the Lake Turkana coastal zone, and Kaidir and Kaituko boreholes belong to Volcanics. Nevertheless, Nakeruman shows low TDS value, water struck level is deep because it is situated near mountain range which is a recharge area.



Source: JICA Project Team

Figure AD6.3.2 Relationship between Water Struck Level and TDS with Geology

In terms of water quality for livestock there is no authorized guideline in Kenya, which leads to dispute sometimes. However, various livestock drinking water guidelines are published in the countries where livestock industry flourishes such as USA, Australia and New Zealand. For example, guideline in USA provides recommendations for levels of upper limit: F^- = 2.0mg/L, As = 0.2mg/L, and TDS = 10,000mg/L. Table AD6.3.3 shows one of the guidelines, by FAO, of saline water for livestock and poultry. Highest value in the Project (Kaidir: 4464.0mg/L) is still within satisfactory level as indicated in the table.

Table AD6.3.3 Guideline to the Use of Saline Waters for Livestock and Poultry

TDS (EC)	Uses
Less than 1,000 mg/L (EC < 1,500 ?S/cm)	**Relatively low level of salinity. Excellent for all classes of livestock and poultry**
1,000 - 3,000 mg/L (EC = 1,500 - 5000 ?S/cm)	Very satisfactory for all classes of livestock and poultry. May cause temporary and mild diarrhea in livestock not accustomed to them; may cause watery droppings in poultry.
3,000-5,000 mg/L (EC = 5,000 - 8,000 ?S/cm)	Satisfactory for livestock, but may cause temporary diarrhea or be refused at first by animals not accustomed to them. Poor waters for poultry, often causing watery feces, increased mortality, and decreased growth, especially in turkeys.
5,000-7,000 mg/L (EC = 8,000 - 11,000 ?S/cm)	Can be used with reasonable safety for dairy and beef cattle, sheep, swine, and horses. Avoid use for pregnant or lactating animals. **Not acceptable for poultry.**
7,000-10,000 mg/L (EC = 11,000 - 16,000 ?S/cm)	**Unfit for poultry and probably for swine.** Considerable risk in using for pregnant or lactating cows, horses or sheep, or for the young of these species. In general, use should be avoided although older ruminants, horses, poultry, and swine may subsist on them under certain conditions.
Over 10,000 mg/L (EC > 16,000 ?S/cm)	Risks with these highly saline waters are so great that they cannot be recommended for use under any condition

Sources: Environmental Studies Board, Nat. Acad. of Sci., Nat. Acad. of Eng., Water Quality Criteria, 1972 Ayers, R.S. and D.W. Westcot. Water Quality for Agriculture. Food and Agriculture Organization of the United Nations, Rome, 1976

D6.3.5 Hand Pump Installation and Animal Trough Construction

Hand pumps were installed in the 20 boreholes with animal trough constructions using 2 types of hand pump; India Mark II Extra Deep for deeper well and Afridev for shallower well. Basic design of the facilities is shown in Figure BD6.3.1 and specifications of these pumps are shown in Table AD6.3.4.

The type of hand pump installed was decided based on test pumping data and drilling log. It was supposed that water rest level may draw down in dry season, and India Mark II Extra Deep was installed preferably. Only drain pipe was equipped with animal trough at Kaituko borehole where water is overflowing.

Table AD6.3.4 Specifications of Hand Pumps

Name of Hand Pump	India Mark II Extra Deep	Afridev
Type	Plunger Type	Plunger Type
Riser Pipe	GI Pipe with threaded socket at both ends (DN32mm)	PVC Pipe with spigot socket cemented joints at both ends (DN63mm)
Connecting Rods	AISI-304, galvanized steel with threaded connectors	AISI-304, 10mm x 2,78mm ±55mm
Maximum Hydraulic Head	90m	45m
Internal Diameter of Cylinder	63.5mm	50.0mm
Water Amount Taken by 1 Stroke	0.79L	0.44L

Source: JICA Project Team

D6.4 Activities for Operation and Maintenance

D6.4.1 Basic Strategy for the Borehole Maintenance

The concept of establishment of good management for borehole management is not a new issue in most of the areas in Turkana County. Water Users Associations (WUA) or management bodies have been formed to manage water sources including boreholes. There several relatively smaller water sources within the locations, which, in some cases, managed by different WUAs. In other cases, one WUA covers several water sources in the area. The prevalent management arrangement of the WUA is collection of membership fees as the financial source for minor O&M, even though most of the major repair works has been done by external support.

In terms of borehole pump management; there are some unique maintenance service schemes available in Turkana. Diocese of Lodwar has been operating a cost sharing O&M scheme of borehole hand pumps. Under the scheme, genuine damages and breakages of hand pump can be repaired without any extra charge, as long as a water resource management body registers with an annual fee of Kshs.3,500. Although this scheme has been operated for more than 10 years, not many WUAs have made use of it. Another available scheme, though covering only Lokichoggio and Lokichar areas, is maintenance scheme provided by Water Service Providers (WSP), registered as local CBOs under Water Service Regulatory Board. Those WSPs have scheme of borehole pump maintenance service without any charge from the borehole management body, utilizing their revenue from water tariff collected through their water service delivery. However, both WSPs have not been able to spare enough fund for borehole repair having a long list of borehole with outstanding maintenance and rehabilitation issues.

Considering the above situation, the project proposed to register the newly established boreholes under the scheme provided by the Dioceses of Lodwar as the most feasible maintenance scheme. Responsibility of the O&M was discussed and agreed on with the concerned communities with the support of the Chiefs and Drought Management Committees (DMC) before starting drilling works. Contribution of maintenance fee was agreed as a precondition for installation of the pump system for the newly dug boreholes. An institutional body for O&M of the borehole was decided by the community

through discussion led by the DMC. Some communities appointed the existing WUAs to take care of the new borehole and the others formed new committee from the surrounding community.

D6.4.2 Approach and Process on Community Involvement in O&M

A series of meetings was planned to be organized in each borehole site to enhance ownership and responsibility on O&M in the community. A preparatory consultation was conducted during preparation of the site to enlighten about importance of maintenance and community's responsibility on O&M with necessary contribution for registration to the O&M scheme. After a certain time for the community to decide and consent on fully taking their responsibility, the first meeting with larger community in the concerned area is organized. In this meeting, they discussed and confirmed their willingness to take their responsibility in monitoring of the construction work and O&M of the borehole including collection of registration fee for O&M scheme. The second meeting with the community was organized after confirmation of water availability through drilling and test pumping, where results of water tests was shared, they confirmed roles of the WUA in charge under facilitation of DMC and registration for the O&M scheme. If the community requires time for contribution for registration, the borehole shall be locked to avoid use without registration. Once the borehole is registered keys of the lock shall be handed over to the concerned community. Handing over shall be done with the confirmation of necessary maintenance and actions to be taken in case of the problem.

D6.4.3 Output of the O&M activities

(1) Community Meetings

The consultation meetings mentioned in the above have been conducted according to the progress of the borehole establishment works. Further follow-up visit and discussion with the communities were done for the registration fee collection where it was found difficult.

The major concern raised during the meeting was fee collection for registration to the O&M scheme, apart from which it was observed that location of the borehole was a crucial issue in some areas. In the first meeting with larger community, a case was observed that a person who resides nearby the proposed borehole site was worrying about influence by the newly established borehole. It was also found that water and land were related with tradition and spiritual powers, which, in some cases, give reason for the resistance and prevent people from confronting the resistance fearing of making sin. Further follow-up visits and several meetings have been held at the site together with DMC as well as Area Chiefs in order to settle the issue.

In Turkana East Sub-county, some communities wanted to register under Lokichoggio Water Service Provider (WSP) that also provides maintenance of borehole. The registration to the WSP does not cost and the parties have a common understanding that the water sources in the area should be registered with the WSP. Through discussion with the concerned communities as well as WSP, it was concluded that the borehole should be registered under the Diocese scheme to ensure maintenance work for two years, while it is not restricted to be under the WSP and the community will review in two years.

(2) Registration Fee Collection

Situations of fee collection for registration in the O&M scheme varied in communities as well as collection methods. In some sites, fee was easily collected within the given period, while others faced difficulties.

The collection method was decided by the community in each site. In many cases, the committee allocated amount per beneficiary village where village elders took responsibility to collect from villagers. In some other areas, a few capable persons paid as temporary payment on behalf of the community and recover it later through water user fee to be collected monthly. There were also cases where some people contributed their goats to pay for the fee. The common difficulty in the communities was availability of cash during dry season, during which it is difficult to sell livestock both because livestock has been taken to far grazing areas and because the price is low. It seems more complicated to collect contribution for the borehole located far from any settlement. In this case, it was difficult to identify beneficiary community that would also be in charge of management of the borehole. The

arrangement of fee collection in each site was studied. It was realised that contribution was done by a limited number of people in many sites, while amount was allocated equally per use households or villages in other sites. The description of arrangement in each site is as shown below.

In 16 sites of the boreholes that require pump maintenance, registration was completed and people have started using the boreholes. The remaining three boreholes (Natwol, Nakeruman and Kalokutany) have been abandoned temporarily as people have been evacuated due to insecurity.

Table AD6.4.1 Arrangement of Community Contribution for O&M Registration

BH site	Collection of O&M registration fee (who and how it was contributed, including allocation. Difficulties they faces in the collection)
Nasogae	Yes, it was contributed promptly by the households using it. Kshs. 7000 was distributed among those households and equal amount was contributed.
Nakalimon	The money was collected in public gathering where every household was allocated amount to be contributed. Kshs. 500 per village that summed up to Kshs. 7000.
Nakoros	Collection of contribution took long as many people could not pay not having cash. Registration money was paid by their political leader (Member of County Assembly) due to low economic status in the area as most people purely depend on relief aid.
Natwol	It has been difficult to collect registration because of insecurity and migration
Nakeruman	No contribution has been done yet *(by the time of the interview)* because of insecurity and migration
Kaituko	N/A (Kaituko borehole is artesian and the overflow was measured to be 1.4 m3/hr. As a result, it was not necessary to install a hand pump in this particular borehole. The community was therefore not required to contribute the operation and maintenance fee.
Lokwakel	We never faced any difficulties, 120 households agreed to contribute Kshs.180 each.
Kangirisae	The amount was divided by the beneficial villages. They had contributed Ksh.5000 and registered for one year to start with.
Losagam	The money was contributed by 15 households with Kshs.500 each. It was divided equally according to the households.
Chokochok	It was paid by the MCA members of county assembly
Kokorio	Each house hold contributed one hundred shillings.
Kakali	Four village elders contributed voluntarily, two donated Ksh.2000 each and other two donated Kshs.1500 each. No difficulties faced in fee collection.
Lochor edome	10 households donated a total of Kshs.10000 which they used Kshs.7000 for registration and Kshs.3000 for transportation to and fro to Lodwar. No difficulties in fee collection.
Nakejuamosing	10 people contributed Kshs.1000 each, Kshs.7000 was used for registration while Kaha.3000 was used as transportation cost and to purchase chain and padlock
Lolupe	Each household contributed Kshs.300 *(contradicting information on the number of household)* though some community members refused to contribute.
Kalokutany	Not yet collected *(at the time of interview)*. People who should contribute migrated to other areas due to insecurity
Lokiriemet	20 people contributed Ksh.350 each though it took a while to collect.
Kakromosing	So far *(at the time of interview)* the 10 household have contributed Ksh.500 each, a balance of Kshs.2000 remains. The difficulty is that people do not have money to contribute. The borehole was registered by Jan 2015.
Lotilo	75 people contributed Ksh.100 each to raise Kshs.7500. Kshs.500 was used as transport by the person who went to register. No difficulties.
Kaidir	Four community members contributed Kshs.2000 each. The extra was used for transport. No difficulties.

Source: JICA Project Team

There were delays of the registration in Lokicchogio and Lorengippi area due to insecurity at the areas. People migrated to avoid insecure situation that made the collection of the contribution difficult. Situation should be judged whether the community contribution is possible in the concerned insecure area. Security situation of the concerned areas were as follows:

Lokichoggio area had no cases of insecurity for a better part of the project period as a peace agreement existed between the Turkana community and the Toposa community from Sudan. However, bandits from the Toposa community raided Natwol village on the 17th of July 2014 and fled away with livestock. This forced the communities at Natwol and Nakeruman to migrate to other secure places like Lokichoggio centre for fear of more attacks.

In Lorengippi, the security situation was unstable due to cattle rustling between the Turkana and Pokot Communities. However, the situation got worse when Turkana raiders from Urum attacked the Pokot community in Alale and fled away with livestock. This incident forced the Lorengippi community to abandon the grazing lands at Kalokutany and Lokiriemet for fear of revenge attacks from the Pokot community.

(3) Borehole and Resource Management Training

Trainings on borehole and relevant resource management were conducted. The first training was conducted in July for the communities that had completed the registration in O&M scheme. The second training was conducted in November for the rest of the communities including those not registered, as it was expected that the training would make the participants understand the importance of the O&M and encourage them to register. The two-day trainings were carried out for two representatives of each WUA and 1 representative of the respective DMC. The training covered the following issues:

- Expected impact analysis of newly established borehole
- Water and sanitation
- Technical maintenance of hand pumps
- Rangeland management
- How to manage borehole and resource based on the expected impact analysis

The training module is attached as Attachment D6.

The training adopted demonstration, technical practice, and discussion to enhance understanding of the participants. Regarding maintenance of the pump, the training focused on daily care and identification of the problem instead of actual repairing work. It is not recommendable for the community to try to repair by themselves without enough technical skills. And the O&M scheme of Diocese also instructed them not to try to repair by themselves as they had observe the situations are made worse by the community trying to repair by themselves.

Source: JICA Project Team

Figure AD6.4.1 Technical Practice on Hand Pump in Borehole Management Training

Borehole management was discussed from different aspects such as technical management, security management, rangeland management, and hygiene management. Positive and negative impacts of the newly established boreholes were discussed to assess necessary management. The following table shows the result of discussion.

Table AD6.4.2 Expected Positive and Negative Impacts of New Boreholes

Positive Impact	Negative Impact
• New settlement in the area • Water accessibility • Possibility of kitchen gardening around the borehole. • Trekking distance to water sources is reduced • Accessibility of pasture • Gathering point for dissemination of information. • Encouraged business activities • Reduced cases of drowning and death as a result of digging traditional wells. • Improved plant species through animal seed dispersal. • Improved hygiene	• Human/ Animal conflicts through scrambling • Transmission of diseases through congestion and migration • Population increase • Trees around the hand pump can cause blockage to the springs hence contamination. • Insecurity around the boarder/ Turkana- Uganda/ Turkana- Sudan • Animal theft from neighbouring • Misuse/ damage of water facilities. • Overgrazing leading to reduced pasture and forage.

Source: JICA Project Team (based on the discussion in the borehole management trainings)

Based on the raised possible impacts, necessary managements were sorted out. The following shows the opinions of necessary managements raised by the participants during the training.

After the training, some borehole management committees took action based on the action plan they prepared during the training. Some committees shared what they learned in the training such as how to maintain the hand pump, hygiene issues, and water fee collection. They also prepared rules such as use of borehole with a set time and cleaning of facilities including the animal trough.

Table AD6.4.3 Necessary Management Based on the Expected Impact

Issues	Necessary Actions to be taken
Technical management	• Operation hours and time should be set and followed by the community • Locking up the hand pump periodically • Assigning a pump attendant to guard the hand pump • Preparing fence around borehole both for avoiding breakage and for hygiene • Animals to be watered in shifts to keep order
Hygiene (congestion) management	• People being classified in different days to avoid congestion or overcrowding • Daily/frequent cleaning of the cattle trough • Giving medications to the sick animals • Bush clearing • Separating sick animals from healthy animals • Dialogue between community elders with the owner of the sick animals hence reaching to mutual agreement on the way of watering animals • Water management committee to take a leading role on the positive resolutions on watering of sick animals • Management committee to seek help from veterinary personnel on immunization of the sick animals • Sensitize community with water and hygiene
Security management	• Dialogue/meetings with people to resolve conflicts with people from other area • Watching over the hand pump • Reporting to the government on the issues of insecurity to take action

Issues	Necessary Actions to be taken
Rangeland management	• Rules and regulations to be communicated to the community/ users and should be community opinions • Delegating various committees on their roles, such as rangeland management committee • Using extra water for planting fodder, reseeding, kitchen gardening
General	• Formation of rules and regulations • Teaching other community members on importance of not cutting trees or observing environment, personal hygiene

Source: JICA Project Team

(4) Progress in O&M

After the training, information about O&M was shared with the community especially on daily maintenance and rules in watering. A questionnaire survey conducted in each borehole site shows that people understood what they are supposed to do as daily maintenance and care of the boreholes that are in use. Certain personnel were appointed to keep order during watering and security of the borehole. Some communities decided to make monthly contribution for further maintenance, while others planned to prepare contribution for extension of registration for O&M scheme after two years starting before the expiry of the current registration. Problems were observed in borehole sites in Lokichar sub-location where management committee asked for monthly contribution which is much more than necessary without consultation and clear explanation to the community. The project intervened to make sure that the correct information about necessary contribution for the O&M scheme by Lodwar Diocese would be delivered to the community for them to make decisions for themselves. Through the community meetings in Kakali and Lochor edome where inappropriate fee collection was observed, users of the boreholes came to understand the situation of maintenance with limited needs of community contribution. People, unanimously, decided to collect a limited amount of contribution for future registration other than the current registration period. Lochor edome users decided to collect money to pay for pump attendances who were appointed to maintain security and to keep order in borehole use. The Project basically proposed minimal contribution for registration of O&M scheme at the appropriate time considering the lack of capacity of the communities to manage contributed money. However, the decision of the community was respected with warning of difficulty of management in order not to destroy mind set of initiative and self reliance of the community through contribution from the community.

D6.4.4 Discussion, Conclusion, and Lessons Learned

Impacts of the boreholes as well as its management established in the target areas were assessed through questionnaire interview and actual use of the boreholes. As a physical impact, total beneficiaries of the 20 boreholes established range from 1,000 to 1,500 household and from 89,000 to 137,000 livestock so far, even though the estimate of the household and livestock was drawn from the explanations in the community interviews and may not be quite accurate due to different understandings in counting. Boreholes are expected to serve more especially during drought period, as most of them were established as strategic boreholes located in the dry season grazing areas. The summary of the questionnaire interviews is shown in the attached Table BD6.4.1

Regarding the O&M of the borehole, 16 boreholes out of 19 that require maintenance of pumps have been registered under the O&M scheme of Diocese of Lodwar. By the April 2015, Five boreholes received maintenance and repair services from the Diocese of Lodwar O&M scheme after minor problems were observed and the committee contacted Diocese of Lodwar.

The approach of registering with the available O&M scheme seems to be a feasible and practical way of maintenance. Even though it still relies on external support, it is a workable option to be considered in the current situation where neither the community can cater maintenance work by themselves.. With the small amount of community contribution as a form of registration fee for the O&M scheme, it can

generate sense of contribution among the dependent community with minimum mismanagement that could occur when the community tries to manage a common fund.

The issue of the community's fund contribution is controversial. Community contribution is necessary to enhance self reliance and avoid dependency on external supports. On the other hand, in the target communities in which management of money is crucially difficult due to lack of capacity mainly due to illiteracy and influence of powerful leaders who sometimes try to manipulate to gain personal benefit from other people. Considering the difficulty and lack of capacity of the community, it shall be more sensible at this stage not to promote community contribution in terms of money to avoid exploitation by a certain local influential persons. In order to establish sustainable and self reliant management of communal resources that requires monetary burden, enhancement of basic capacity of people such as basic education is inevitable. In cases where people are not capable and there is risk of mismanagement, it is realistic to utilize available external support with necessary capacity building until the community equips with enough competence to handle their own contribution.

CHAPTER D7. TURKANA: SUB-PROJECT OF NEW CONSTRUCTION AND REHABILITATION OF WATER PAN

D7.1 General

General outline of the sub-project is summarized as below.

Table AD7.1.1 General Outline of the Water Pan Construction and Improvement Sub-project

1. Objectives	This sub-project aimed to improve sustainable natural resources management both of water and pasture in the grazing area through new construction and improvement of an existing water pan in the grazing area. Further, to improve operation and maintenance activities, especially strengthening of water users' association was targeted.	
2. Number of Beneficiaries	Unspecified	
3. Implementation Organization	JICA ECoRAD Project, water users' association	
4. Project Contents		
1) Project Outline	1) Construction of new water pan and related facilities, such as intake, inlet channel, silt trap, spillway, etc. 2) Improvement of existing water pan with new construction of additional pan (Cascade system) and other related facilities 3) Rehabilitation of damaged portion and improvement of existing water pan such as desilting and shaping, etc. 4) Strengthening of water users' organization 5) Improvement of operation and maintenance system through training program to the community with support of maintenance tools	
2) Facility / Activity	*Facilities/Activities*	*Implementator*
	1) New construction and rehabilitation of water pan	1) Contractor
	2) Organization and strengthening of water users' association	2) Project team
	3) Procurement of O&M tools	3) Contractor
	4) Monitoring	4) Project team
3) Organization for O&M	Water users' committee and community drought management committee	
4) Construction Period	(Original schedule) 3 months for construction with defects liability period of 3 months	

Source: JICA Project Team

The sub-projects under natural resource management, aimed at improving sustainable natural resources management both for water and pasture in grazing areas through new construction and improvement of existing water pans. Target areas for water pan development were selected taking into consideration basic concepts of strategic distribution of water points for efficient management of grazing areas, which were (1) extension of pastoralists' migratory route at the end to new grazing area, (2) slow-down of moving speed to another grazing area, and extension of grazing time on the same migratory route, and (3) providing additional water source at halfway points among grazing areas.

In selected target communities, community managed disaster risk reduction (CMDRR) was conducted, and community action plans (CAPs) have been formulated The CAPs proposed various interventions including new construction and improvement/upgrading of civil structures and facilities. During CMDRR, 4 sites have been selected for construction and improvement of the water pans. During the final determination of the distribution of water pans under the Project, combination of water points as natural resource development belt was taking into consideration (natural resource development belt), where several water points lies in line beside rich rangeland as discussed in Section D1.4.3. The proposed sub-project sites were re-considered, and finally selected as listed below.

Table AD7.1.2 List of Water Pan Construction and Improvement Sub-project

Name of Water Pan	Community	Type of Civil Works
Kaabilikeret Water Pan	Milimatatu Sub-location	Improvement
Nasikiria Water Pan	Mogila Sub-location (Lokichoggio Location)	Improvement
Edukon Water Pan	Nanam Sub-location (Nanam Location)	Improvement
Kaalale Water Pan	Lorengippi Sub-location	New construction
Nachuro Water Pan	Nachuro Sub-location	New construction
Kasuguru Water Pan	Milimatatu Sub-location	Improvement

Source: JICA Project Team

D7.2 Outline of Construction and Improvement of Water Pan Facilities

Outline of the water pan to be implemented under the Project is summarized in the followings, and their locations are shown on Figure BD7.1.1. Basic concept of designs of the water pans are the same as those of Marsabit as described in Chapter 2. As the major problem in existing water pans was siltation in the pan, a silt trap structure was included in the design of each pan, which prolongs the life span of the pan and makes desilting easier.

D7.2.1 Improvement of Kaabilikeret Water Pan

The grazing system currently used in the Turkana North Sub-county is seasonal livestock movement. Rainy season grazing areas are east of Yapakuno, Kaeris Locations and Lotikipi plains. Nakalale and Gotome Rivers flow into the Lotikipi plain, and riverine forests have formed along the river banks. During the dry season livestock especially cattle migrate to Lorionotom ranges, Lokwanamor range and, Moru-Eris ranges within this sub-county, Pelekech and Songot ranges in Turkana West Sub-county and Loima ranges in Loima Sub-county. In years of severe drought, the crossing is made over to the Uganda.

The proposed sub-project is located in Milimatatu Sub-location of Yapakuno Location, about 120 km north from Lodwar Town. This sub-project aimed to improve natural resources management both of water and pasture in the grazing area through expansion and improvement of existing Kaabilikeret Water Pan that was constructed in year 2007 by the Lokitang Catholic Mission. Further, improvement of operation and maintenance activities, especially for desilting works in the pans, structural improvement of silt trap facility and strengthening of water users association are also targeted.

The existing Kaabilikeret Water Pan had a storage capacity of about 5,200 m^3, which was utilized for livestock use mainly during the rainy seasons. The pan dried up within one month after rainy season ends due to insufficient storage capacity. Therefore, increase of storage capacity of existing water pan was required.

Kabilikeret Water Pan

Inlet of Kabilikeret Water Pan

Source: JICA Project Team

Figure AD7.2.1 Present Conditions of Existing Kabilikeret Water Pan

D7.2.2 Improvement of Nasikiria Water Pan

Turkana West Sub-county, constituting the hilly area of the upper Tarach River serves as the northern gateway to the prominent Loima range dry season grazing area of Turkana. During the dry season, a large number of livestock gather from the eastern and northern lowlands to the Loima range and foot slope of the Uganda escarpment. The rainy season grazing area of north-western Turkana is the expansive Lotikipi plain rich in grass resources.

The proposed sub-project site is located in Mogila Sub-location of Lokichoggio Location, about 20 km north from Lokichoggio Town. This sub-project aimed to improve natural resources management both of water and pasture in the grazing area through expansion of Nasikiria Water Pan that was constructed in year 2004 by AMREF. Improvement of operation and maintenance activities, especially for desilting works in the pans, structural improvement of silt trap facility and strengthening of water users association are also targeted. The existing Nasikiria Water Pan had a storage capacity of about 12,000 m^3, which was utilized for livestock mainly during the rainy seasons. The pan dried up within one month after rainy season ends due to insufficient storage capacity. Therefore, increase of storage capacity of existing water pan was required.

Nakisira Water Pan

Silt Trap of Nakisira Water Pan

Source: JICA Project Team

Figure AD7.2.2 Present Conditions of Existing Nakisira Water Pan

D7.2.3 Improvement of Edukon Water Pan

The rainy season grazing area of north-western Turkana is the expansive Lotikipi plain rich in grass resources. From the end of the rainy season to the beginning of the dry season, livestock begin to migrate to the Mogilla range and the Songot Mountain.

The proposed sub-project site is located in Nanam Sub-location of Nanam Location, about 20 km northeast from Lokichoggio Town. This project aimed to improve natural resources management both of water and pasture in the grazing area through expansion and rehabilitation of Edukon water pan which was constructed in year 1989 by the Ministry of Works. The existing pan had a storage capacity of about 4,300 m^3, which was utilized for livestock use mainly during the rainy seasons. The pan dried up within one month after rainy season finishes due to insufficient storage capacity. Therefore, increase of storage capacity of existing water pan was required.


Edukon Water Pan


Inlet River of Edukon Water Pan

Source: JICA Project Team

Figure AD7.2.3 Present Conditions of Existing Edukon Water Pan

D7.2.4 New Construction of Kaalale Water Pan

In Loima Sub-county grazing during the rainy season takes place in the eastern lowland plains, and during the dry season the vegetation rich area from the hilly region around the centre to mid-way up the Uganda escarpment (close to the national border) serves for grazing area. Cattle graze on the Loima range where graminaceous species are widely distributed. In years of drought, migration occurs over the Ugandan border towards Mt. Moroto despite security issues and also migration towards Pokot North Sub-county in Kenya which is south of Loima Sub-county.

The proposed sub-project is located in Lorengippi Sub-location of Lorengippi Location, about 2 km northeast from Lokichoggio Town. There is rich rangeland that is not fully utilized in dry season due to no water point. This sub-project aimed to improve natural resources management both of water and pasture in the grazing area through new construction of water pan. There is no river that has certain discharge even during the rainy season. However, it was observed that runoff from the catchment is inundated according to the local topography and sufficient water source is available during the rainy season at the lowest area, and hence the new construction of water pan proposed at this area.


Proposed Water Pan Site


River around Proposed Site

Source: JICA Project Team

Figure AD7.2.4 Present Conditions of Proposed Site for Kaalale Water Pan

D7.2.5 New Construction of Nachuro Water Pan

The proposed sub-project is located in Nachuro Sub-location, about 50 km northeast from Lodwar Town. There is rich rangeland that is not fully utilized in dry season due to no water point in this area. This proposed site is also important location of strategic distribution of water point in the natural resource development belt as discussed in the previous report.

This sub-project aimed to improve natural resources management both of water and pasture in the grazing area through new construction of water pan. There are some river streams that have certain discharge during the rainy season, according to the interview to the pastoralists.

D7.2.6 Improvement of Kasuguru Water Pan

The proposed sub-project is located in Milimatatu Sub-location of Yapakuno Location, about 100 km north from Lodwar Town. Though there are several water pans including Kaabilikeret Water Pan to be improved under the project in Milimatatu, these pans are scattered with certain distance among each other, which will contribute the effective utilization of rich grazing area in northern Turkana. This sub-project aimed to improve natural resources management both of water and pasture in the grazing area through expansion and improvement of existing Kasuguru Water Pan. Further, improvement of operation and maintenance activities, especially for desilting works in the pans, structural improvement of silt trap facility and strengthening of water users association are also targeted.

D7.3 Design of Water Pans

For detailed design of the proposed works, topographic survey and investigation and design were continued during this period. Salient features of civil works of the sub-projects are summarized below. The design drawings of the water pan and related facilities are shown in Figures BD7.1.2 – BD7.1.6.

Table AD7.3.1 Salient Features of the Water Pan Construction and Improvement Sub-project

Name of Water Pan	Kaabilikeret	Nasikiria	Edukon	Kaalale	Nachuro	Kasuguru
Sub-location	Milimatatu	Mogila	Nanam	Lorengippi	Nachuro	Milimatatu
Proposed storage capacity of water pan, including both existing and proposed new pans	24,000 m^3	25,000 m^3	23,000 m^3	19,000 m^3	23.000	7,000 m^3

Source: JICA Project Team

D7.4 Implementation of Construction Works for Water Pans

The works were commenced mostly in June or July after waiting for drying up of water in the pans after the long rain in 2014. The progress of the works especially at Edukon and Kaabilikeret Water Pans were affected and obliged to stop due to unforeseen issues particular unexpected rainfall out of rainy season in July and August, 2014. After these rains, the works satisfactory progressed and all the pans were substantially completed by August 2015.

Source: JICA Project Team

Figure AD7.4.1 Construction Photos of Water Pans

D7.5 Observations

D7.5.1 Affects by Unforeseen Rainfall and Flush Flood during the Dry Season

Construction works of some pans were affected by unforeseen rainfall and subsequent flush flood causing long inundation in pans during the dry season in July and August, 2014. Though it was understood that no or minimal rainfall was observed during these months in normal years, it rained heavily in northern and western hilly areas of the county on 10th July, 2014, and north, central and south-eastern area of the county on 25th August 2014, which affected the various on-going construction works, especially Nasikiria, Edukon, Kaabilikeret Water Pans under this sub-project. Though the data on rainfall and river runoff discharge at these areas were not available, the rainfall was observed to be about 30 mm on 10th July and about 10 mm on 25th August in Lodwar Town, which meant the hilly areas had more.

The flood affects on the works are summarized below.

Table AD7.5.1 Damages to On-going Water Pan Construction by Unforeseen Rainfall and Flush Flood

Name of Pan	Date of Rainfall	The works affected
Nasikiria	10th July, 2014	1) In the excavated area of silt trap, water was pooled and some parts were buried under mud and debris brought by flush flood. 2) On-going stone works were suspended. 3) Main pan was not damaged because the excavation works had been substantially completed.
Edukon	10th July, 2014 and 25th August, 2014	1) In the main pan, water was pooled with almost full water level before commencement of the works , due to which proposed excavation works were long suspended.
Kaabilikeret	25th August, 2014	1) In the main pan, water was pooled just after started excavation works , due to which proposed excavation works were long suspended.

Source: JICA Project Team

The damages made by the flood were classified as *force majeure* that was beyond the responsibilities of the Contractors in these cases. Protection works against flood, temporary diversion and dewatering costing had not been included in the bill of quantities under the technical specifications, which had not envisaged the rainy days and flood in the construction period during the dry season. Thus the additional works to clean and compensate the loss was considered.

D7.5.2 Design Modification

Due to the water impounding in the existing Edukon and Kaabilikeret Water Pans before or just after commencement of excavation works, design of the works was modified. These pans were originally designed as rehabilitation of the existing pans by means of additional excavation of the bottom of the pans. Due to the limitation of the working period, commencement of the works could not be awaited till natural drying up in the pans. On the other hand, many herds of livestock had returned to the pans for watering, after water impounding in the pans during the dry season. In such case, pastoralists were negative to accept dewatering with pumps or by other measures.

Taking these circumstances into consideration, design modification were considered to apply a cascade system, so that the contractors were able to start the works without waiting for the drying up of the pans, and current watering of the livestock around the existing pans. The cascade system by placing several pans in series, has many advantages, such as, the upstream pan can be expected to function as a silt trap for the downstream new pan. In addition, this system has another advantage that is i) the works can start without awaiting drying up in the pan, and ii) the works can be continued without interrupting the current utilization of pans both by livestock and villagers. Finally the design of Edukon, Kaabilikeret and Kasuguru Water Pans were modified into the cascade system. The modified designs are shown in the attached drawings.

D7.6 Completion and Handing Over

All the contract works have been completed and the water pans have been handed over to the communities. The major events are summarized as below.

Table AD7.6.1 Completion of the Sub-project Works and Handing Over to the Communities

Major Events	Kaabilikeret	Nasikiria	Edukon	Kaalale	Nachuro	Kasuguru
Substantial completion of the works and issue of taking over certificate	Feb 2015	Feb 2015	May 2015	Feb 2015	Feb 2015	Apr 2015
Handing over of the facility to the community	Apr 2015	May 2015	May 2015	May 2015	June 2015	Apr 2015
Completion of outstanding works and issue of defects liability certificate	-	-	Aug 2015	-	-	Jun 2015

Source: JICA Project Team

D7.7 Improvement of Operation and Maintenance Works

In comparison to the situation of Marsabit, where people, especially Gabra and Borana people, have traditional management system of water pan, Turkana people do not have established management system. In addition, most of the water pans constructed or improved in Turkana are located far from settlement areas. In consideration of these situations, it was observed that management of water pan especially when the pan is not in use is difficult. To improve siltation problem, both newly constructed water pans and those rehabilitated pans have structure of silt trap, which enable desilting works while the main pan is still in use. After completion of the construction works, a technical instruction and training was provided at each site to the concerned people such as WUA, DMC committee members on desilting and basic management of the structure. Maintenance tools were supplied through the training for further maintenance.

D7.8 Discussion, Conclusion, and Lessons Learned

All the water pans constructed and rehabilitated were filled up with water during monitoring period. A significant amount of herds have watered in the water pans. The newly constructed water pans expanded grazing areas making the previously unused pasture land accessible during early dry season, which will also contribute to saving dry season grazing areas around permanent water sources. Rehabilitation of water pans enlarged their capacity. This enabled herds to graze around the area longer, which also results in conservation of pasture around permanent water sources.

However, it was found that desilting of water pans is still difficult to be conducted totally by the community especially where the water pans are established as strategic water source. In consideration of strategic allocation of water sources, if the water source is developed in the middle of wet season grazing area where there is no settlement, it is less likely to be managed by unspecified community. However, those water pans established where there is no settlement are important to enhance resilience of pastoralists against drought by making currently unused pasture land accessible during dry season. Therefore, if the water pan has the purpose of serving for dry season grazing area locating far from settlements, alternative way of management should be proposed, as it is unfeasible to expect the unspecified communities to manage.

CHAPTER D8. TURKANA: SUB-PROJECT OF REHABILITATION OF SAND DAM

D8.1 General

General outline of the sub-project is summarized in the following table, and the location is shown on Figures BD7.1.1.

Table AD8.1.1 General Outline of Sand Dam Rehabilitation Sub-project

1. Objectives	The sub-project aims to improve the water supply conditions in Kangakipur area both for livestock and domestic water through rehabilitation of existing Nakipi Sand Dam.	
2. Number of Beneficiaries	Unspecified	
3. Implementation Organization	JICA ECoRAD Project, water users' association	
4. Project Contents		
1) Project Outline	1) Rehabilitation of damaged portion and improvement of existing sand dam and related facilities 2) Strengthening of water users' organization 3) Improvement of operation and maintenance system and regulations through training program	
2) Facility / Activity	*Facilities/Activities*	*Implementator*
	1) Rehabilitation of sand dam	1) Contractor
	2) Organization and strengthening of water users' association	2) Project team
	3) Procurement of O&M tools	3) Contractor
	4) Monitoring	4) Project team
3) Organization for O&M	Water users' committee and community drought management committee	
4) Construction Period	(Original schedule) 3 months for construction with defects liability period of 3 months	

Source: JICA Project Team

The sub-project aimed to improve the water supply conditions in Kangakipur area both for livestock and domestic water through rehabilitation of existing Nakipi Sand Dam that was constructed in year 2007 by the Lokitang Catholic Mission. The sand dam then was not functional as designed especially on the upper dam side due to heavy damages by flood overflow on the left bank. In Kangakipur Community, community managed disaster risk reduction (CMDRR) was conducted, and community action plans (CAPs) have been formulated. CAPs proposed rehabilitation of this sand dam.

Existing Weir

Damaged Embankment

Source: JICA Project Team

Figure A8.1.1 Present Conditions of Nakipi Sand Dam

D8.2 Design of the Sand Dam

For detailed design of the proposed works, topographic conditions were surveyed, and the following civil works were designed. Salient features of civil works of the sub-projects constructed under the

project are summarized below, and the design drawings prepared for the sand dam and related facilities are shown in Figures BD8.2.1.

Table AD8.2.1 Salient Features of the Sand Dam Rehabilitation Sub-project

Catchment area of water pan at intake point	59.5 km^2
Height of exciting dam	2.5 m (EL. 697.8 m)
Crest length of exciting dam	17m
Height of proposed wall for closing damaged portion at left bank	2.5 m (EL. 698.0 m)
Width of proposed wall for closing damaged portion at left bank	15 m

Source: JICA Project Team

D8.3 Implementation process

D8.3.1 Implementation of the Rehabilitation of Sand Dam

The works were commenced in August 2014. The sub-contract works of Nakipi Sand Dam were substantially completed and final inspection was also conducted by the project team toclarify outstanding works and minor defects to be rectified during the defects liability period in accordance with the conditions of sub-contract.

Source: JICA Project Team

Figure AD8.3.1 Construction Photos of Nakipi Sand Dam

D8.4 Completion of the Works and Handing Over

All the contract works have been completed and the sand dam and related facilities have been handed over to the Community, of which major events are summarized as below.

Table AD8.4.1 Completion of the Sub-project Works and Handing Over to the Community

Major events	Date
Substantial completion of the works and issue of taking over certificate	Apr 2015
Handing over of the facility to the community	Apr 2015
Completion of outstanding works and issue of defects liability certificate	-

Source: JICA Project Team

D8.5 Observations

D8.5.1 Delay due to Unforeseen Flood

Construction works of Nakipi Sand Dam was affected by unforeseen rainfall and subsequent flush flood during the dry season in August, 2014. Though it was understood that no or minimal rainfall were observed during these months in normal years, it rained on 25th August 2014, which affected the on-going excavation works and preparation of foundation concrete slab. Though the data on rainfall

and river runoff discharge at these areas were not available, the rainfall was observed to be about 10 mm on 25th August in Lodwar Town, which meant the hilly areas had more.

The damages made by the flood were classified as *force majeure* that was beyond the responsibilities of the Contractors in these cases. Therefore the additional works to clean and compensate the loss was considered, because the technical specifications of the contract had not envisaged the rainy days and flood in the construction period during the dry season, hence protection works against flood and dewatering cost had not been included in the bill of quantities.

D8.5.2 Misunderstanding on the Design and Function by the Community

The main purpose of the sub-project was to repair the damaged structure that made the dam dysfunctional. However, some community members misunderstood the functioning of sand dam being confused with that of water pan which raised dispute asking for the desilting of the dam. Even though the project had several meeting and explanation of the functions and structure of the sand dam, it was difficult for the community to fully understand them.

D8.6 Discussion, Conclusion, and Lessons Learned

After completion in the long rain season, the sand dam held a good amount of water due to rehabilitation of the damaged of structure. The sand dam was revived and functioned as designed. It was observed a large amount of herds have watered at the dam, even though the exact numbers were not monitored.