Flood Based Livelihoods Systems in Kenya

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Status and Potential

Overview Paper

Flood-Based Livelihoods Network Foundation

1. Introduction

Floods can be used to convert destructive nature into productive nature which may be beneficial for a lot of people. The livelihoods of many people all over the world are built around and depend on floods. Flood-based Livelihood Systems (FBLS) are forms of adaptive systems; floods are often highly variable in terms of quantity, duration and periodicity so resilience is very important. Despite the extensive use of FBLS in many parts of the world (estimated at 20-35 million ha in Africa and Asia), FBLS are often unknown and/or neglected. Most attention is going to conventional perennial irrigation systems or rain-fed agriculture. However, many farming systems are neither irrigated or rain-fed but depend on floods. There are many aspects and forms of FBLS that are still quite unknown like floodplain agriculture, recession farming and using floods for pastoralism. There are several benefits of FBLS on agricultural development but also on other productive activities related to fisheries, flood pastures and agroforestry. FBLS are complex schemes that are interdisciplinary and relate to many different natural, human and capital resources.

Kenya has a high amount of rainfall in the highland zones and a good network of rivers. During the rainy seasons, many parts of the country experience flooding. In some places, this negatively affects the livelihoods of people. In other places however, people completely depend on floods to sustain their livelihoods. Many people use rain-fed or irrigated systems, but there are still traditional FBLS in use. Some of these schemes are very beneficial while others suffer from a combination of several environmental and/or human influences. The flood magnitude has increased over the years due to destruction and degradation of catchment areas and river migration. This has negatively influenced many FBLS in Kenya. Until recently, FBLS have not been part of irrigation development in Kenya. But fortunately, there are now several completed, ongoing and/or planned projects focussing on FBLS. Recently, a National Water Harvesting and Storage Policy has been developed to facilitate harnessing and storage of the recurrent floodwaters. The Kenyan Ministry of Water and Irrigation (MoWI) currently has a big project on the construction of water storage systems (small dams and water pans). On top of that, they are participating in a project (in partnership with MetaMeta and ICRAF) focussing on the building-up of practical knowledge and national and local capacity to systematically and comprehensively support the productive use of FBLS. Not only the Ministry, but also several government agencies, organisations and NGOs recently started focussing more on FBLS. Kenya has a huge potential for improving its FBLS, creating new beneficial FBLS and sustaining them so they are and will stay beneficial for many people.

2. Status of FBLS

Different kinds of FBLS are spread across the country of which some are already successfully in use for many years, some are newly developed and others struggle to survive. In general, the status of FBLS in Kenya can be categorized into three different situations. One is the situation of areas where there are traditional FBLS, another is the situation of areas where FBLS have potential and are starting to develop and in the last situation there are areas where there is no need and/or potential for FBLS. These three situations will be described in further detail below.

2.1 Traditional FBLS

When looking at traditional FBLS, the Tana Delta is a very interesting area. The Tana Delta is the southernmost sub-county (or constituency) of Tana River County which owns is name to the 1,000 km long Tana River running through it (of which 270 km in the sub-county, see figure 1). In the Tana Delta, many people depend on traditional FBLS both for agriculture and pastoralism. There are two rainy seasons; the long season which takes place from march till June and the short season which takes place from October till December. The amount of rainfall is estimated between 800 and 1,400 mm/year. The main practice and source of income in the Tana Delta is agriculture. Most agricultural practices take place alongside the banks of the river (to a max of a 10 km strip on each side of the river). The main form of farming in the Tana Delta is flood-based farming (FBF). There are several types of FBF used in this area of which most are traditional and have been used for a long time. The most widely used form of FBF in the Tana Delta is floodplain agriculture (recession farming), both alongside the Tana River and the natural lakes fed by this river. Other types of FBF in the area are spate irrigation by making use of wadi's (wadi's are ephemeral streams that only transport water during the rainy seasons) and FBF making use of inundation canals alongside the Tana River. The Tana River caries a lot of alluvial soils that are carried together with the water towards the fields which makes the fields very fertile. The most cultivated crop under FBF in the Tana Delta is paddy rice. Other main crops are banana, mango and maize. Many people in the Tana Delta depend on FBF and their livelihoods mainly consist of practicing FBF. However, since the late nineties, FBLS have been under pressure and it is estimated that the areas cultivated under FBF reduced with more than 70 %. Stakeholders involved in FBF in the Tana Delta point out that since the late sixties, there have been several events that affected the lives of the people in the Tana Delta significantly:

- Between 1968 and 1988, more than five big hydropower dams have been constructed

upstream of the Tana Delta. These dams significantly affected the regularity and amount of water flowing downstream towards the Tana Delta. Only when the dams are full or filled till a satisfying level, excess water will be released into the lower Tana River. It is however unclear when this will happen, which makes it difficult for the downstream farmers to time their cultivation practices. On top of that, it is said that instead of releasing excess water to provide water for agriculture downstream, it is taken to Nairobi to be used for domestic or industrial purposes.

- The El Niño of 1997 - 1998 had a big impact in the Tana Delta. It damaged several structures like houses, irrigation schemes and road-structures. A lot of rain that fell in the sub-county and also upstream where a big volume of excess water from the dam was released in a short time. This did not only damage structures but also changed the course of the Tana River. Several small brooks (brook is a local term for a side-stream of a main river) became wider and deeper and started to carry more water than the original river. As can be seen in figure 1, the lower Tana River consists of many different brooks. This change of course has affected many livelihoods. Some villages benefited from their location next to the main stream of the river or lakes fed by the river. But now, at some of these places the river does not even pass anymore and the lakes have completely dried up. Several current brooks do not lead to the farmlands anymore but instead provide water to non-cultivated areas (e.g. bushes) that are only beneficial for a few pastoralists.
- On top of that, the frequency and amount of rainfall decreased the past few years while the population increased significantly. So there are less available resources that need to be shared by more people.

In the past, communal work was mandatory and controlled by village chiefs. When not participating, there were strict consequences. Now there are no organisations and formal rules, people can make their own decisions and FBF is most of the time not controlled. In the past, farmers used to move to other places to look for floods. But nowadays, people do not want to leave their village because of insecurity and comfort (not willing to take the risk, leave family and friends, etc.). Most people are not willing to change their lifestyle by moving to other areas or shifting to other practices or ways of providing income. Until now, there have been only a few projects in the sub-county that focused on agriculture, but none of them focussed on FBF in specific. Farmers mention that FBLS do not get the attention it requires and that if it would, it could be beneficial for many people. Figure 1 shows an overview of the current courses and streams of the Tana River. Only the biggest ones are indicated in the figure. The darkness and thickness of the lines indicates the volume of the streams. The blue lines with a white border indicate the old/traditional river course and the red line indicates the border with Lamu County. To provide a better understanding of FBLS in the Tana Delta and its history, four different cases of FBLS will be explained in more detail (indicated by the numbers in figure 1). Each case has its unique aspects and uses a different type of FBF. Some of the schemes are still in practice while others are not used anymore or struggle to survive.

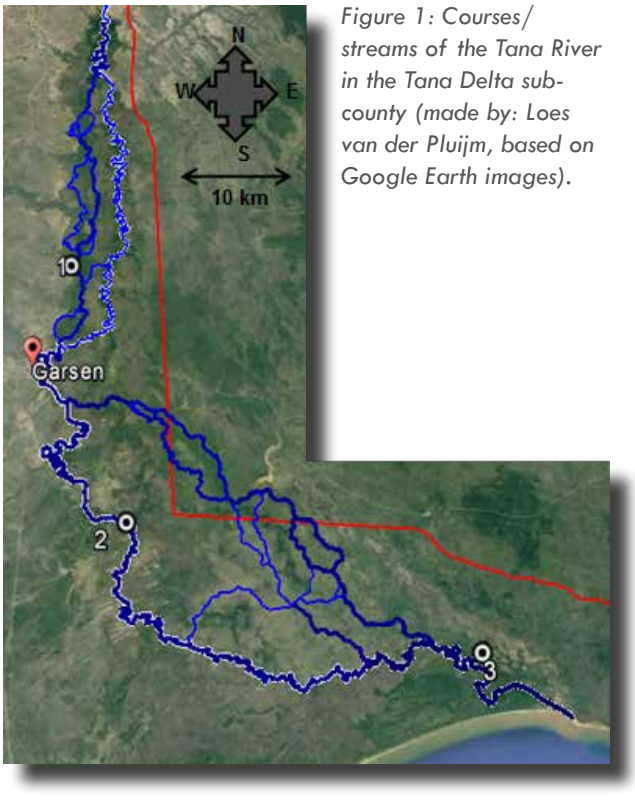

Figure 1: Courses/ streams of the Tana River in the Tana Delta sub-county (made by: Loes van der Pluijm, based on Google Earth images).

Kone

In the lower part of the Tana Delta where most FBF is practiced, there are no wadi's. To find wadi's, you will have to look more upstream in the watershed closer to the mountains. In the north of the sub-county around Kone, there are a few wadi's that are used for FBF. These wadi's mostly collect the run-off water from its higher surroundings (mountain catchments) during the rainy seasons and feed this water to the Tana River. Two types of FBF are used by making use of these wadi's; both flood recession farming and spate irrigation. For the flood recession farming, farmers wait till the water in the wadi's recede and then start planting their seeds. At that time, the soil stored sufficient water to grow crops like maize and mangos. As regards the spate irrigation, farmers divert flood water from the wadi's by constructing diversion canals. These canals lead to their fields that they prepare before the rainy season starts and is flooded as soon as the rains arrive. When the fields received sufficient water, the diversion canals are blocked with natural materials like stones, branches and leaves. Maintaining the spate irrigation

system is a very labour intensive task. Especially when the floodwater carries a lot of sediment, the canals are silted up. At moments when the floods are very big, many of these canals are damaged and need to be reconstructed.

Maziwa

Maziwa is a village located on the right-bank side of the west-wing of the Tana River (see number 1 in figure 1 and figure 2). The village consists of 600 households with an average family size of six people. The inhabitants are part of the Pokomo tribe and are farmers from origin. Since 1963, people started to move into this area. They came to this area because there was more available land for cultivation than in the place where they used to live before. When they arrived, there were only a few hunters and gatherers living near the area. The people live together in the village for security reasons and have their farmlands outside the village. The village is located higher than the fields to protect from floods and people live together to protect themselves from wildlife and bandit attacks. The word Maziwa means milk or many lakes in the local language. In this case, it is called Maziwa because many lakes used to surround the village. However, from the 70's onwards, small brooks started to flow towards the lakes and connected them. After some years, the small brooks grew into a big river and took the water from the lakes. Especially after El Niño, the west-wing river became big and the lakes disappeared. The farmers already used to practice FBF before they came to this area and traditionally combine fishing and farming practices. Now, they use the river to practice recession farming and fishing. Farmers have small plots with an average of two acres per household. Before the rainy season, the farmers prepare their lands. There are two methods of preparing the lands; completely clear the land or letting remain some grasses on the land. For the second method, the farmers cut the grasses till the height where they expect the water to reach. During the rainy season, the river overflows (mainly caused by rainwater run-off from the highlands) and floods a big strip of land on both sides. The grasses will be completely covered by water and will thus not receive any oxygen and start rotting. As soon as the water starts receding, the farmers go inside their self-made wooden canoes (they do not go into the water because of crocodiles) to cut the grasses. These grasses are later on used as manure on their fields. When the water gradually recedes, the farmers gradually start planting. This planting is done the same way for both methods. The flood water carried alluvial soils that makes the land very fertile. After flooding, the soil contains sufficient water to cultivate crops like maize, banana, mango, beans, green grams and peas. For the cultivation of watermelons, extra water needs to be pumped from the river. When the crops are completely grown, the farmers harvest and start preparing their fields for the next rainy season. The farmers have a traditional and very unique way of predicting when the rains start and the floods come. They look at one specific star; when this star is located high in the sky, the rains will come soon. So far, this way of predicting has been very accurate and most farmers trust on it. Another, more straightforward method, is to look at the clouds close to the mountains to see whether there is lightening and rain. During the long rainy season, a big area is flooded and many fields can be cultivated. It takes on average two months for the water to completely recede. During the short rainy season however, the water in the river is not enough to flood all the fields and usually within two weeks the water already completely receded. At the moment, the rainy season is late and the star is still located low in the sky. The farmers already prepared their lands but they are worried that the rains will come too late or not at all

Figure 2: The Tana River (looking downstream), Maziwa is located on the right-bank side just outside the picture on higher grounds.

Figure 3: A traditional hand-how (gembe).

and that the flood will not be sufficient to produce a good yield. The time in between the preparation of the fields and the start of the rainy season, farmers do not plan any activities but just wait for the floods to come.

The FBF practices in Maziwa are traditional and did not change over time. The most used tool is the hand-how (local term: *gembe*, see figure 2) which is used for many practices like seeding and weeding. The farmers do not use fertilizers since these are too expensive and the soil is already very fertile by only making use of manure. Herbicides are only used by financially able farmers that spray the weeds before planting their crops. However, most farmers do not have the financial means to buy herbicides. In this area, no rice is cultivated because of the slope near the river and the high water flows. The farmers mention that on top of that, there is not a good market for rice which is also the case for mango's. Even though mangos are less vulnerable to variations in water supply and are not damaged as much as bananas when receiving too much water, the farmers still prefer to cultivate bananas because of its good market and bigger popularity as staple crop. There is no farmers organisation in Maziwa and the farmers can make their own decisions. Most households farm, but a few do not have land and depend on support from family and friends. Since they live closely together as a community, they are willing to share resources and so far, no major conflicts have occurred.

Ngao

Ngao is a village located on the right-bank side of lower part of the Tana River (see number 2 in figure 1). The village consists of 2,000 households with an average family size of six people. The inhabitants are part of the Pokomo tribe and are farmers from origin. Ngao used to neighbour two other villages. But because of floods, these villages moved further away; Ngao itself is located higher and thus did not move. All three villages still share common interests (e.g. using same farming practices, traditions and having inter-marriage). The people live in the villages and have their farmlands outside the village. Only during harvest season some farmers live in huts next to the farmlands. Ngao was one of the first villages in Kenya where the German missionaries settled (in 1886). They build one of the first schools which made Ngao a very important and unique place. FBF has already been practiced for many years in the area most households depend on it. Already before the Germans came, people used to practice FBF. They had different ways of using FBF for agriculture (see figure 2) ; during the long rainy season, the brook (B) on the right-bank side of the Tana River (T) was filled with water. Farmers created several openings in this brook and furrows to let the fields (F) flood with water for the cultivation of paddy rice. The fields were separated with banana trees and bunds/dikes made of natural materials like leaves, branches and soil. The fields close to the brook on the northern part were flooded with water first. As soon as the water reached a sufficient level to cultivate the paddy rice, the next fields (southwards) got a chance to receive the water. When all the fields were flooded sufficiently, the excess water was released into the brook and flowed back into the Tana River. When the water in the fields started to recede/evaporate and the paddy rice was ready to be harvested, the farmers planted a second crop. The soil was often wet enough to cultivate maize, beans or green grams. In this way, the land and water was used very efficiently. This was a unique and successful way of controlled FBF that has been used traditionally for many years. During the short rains, there was not sufficient water to cultivate paddy rice, so during that time only maize, beans and green grams were cultivated. There were also two big lakes (L) that were used for recession farming (mainly for the cultivation of maize, beans and green grams), fishing and hunting on crocodiles and hippo's for meat consumption. There were wise village elders that had their own science (unknown by the others) to predict floods. The farmers depended on these elders for the timing to prepare their fields. There were no official farmer organisations; people organised themselves in social unions without written rules (see Box 1).

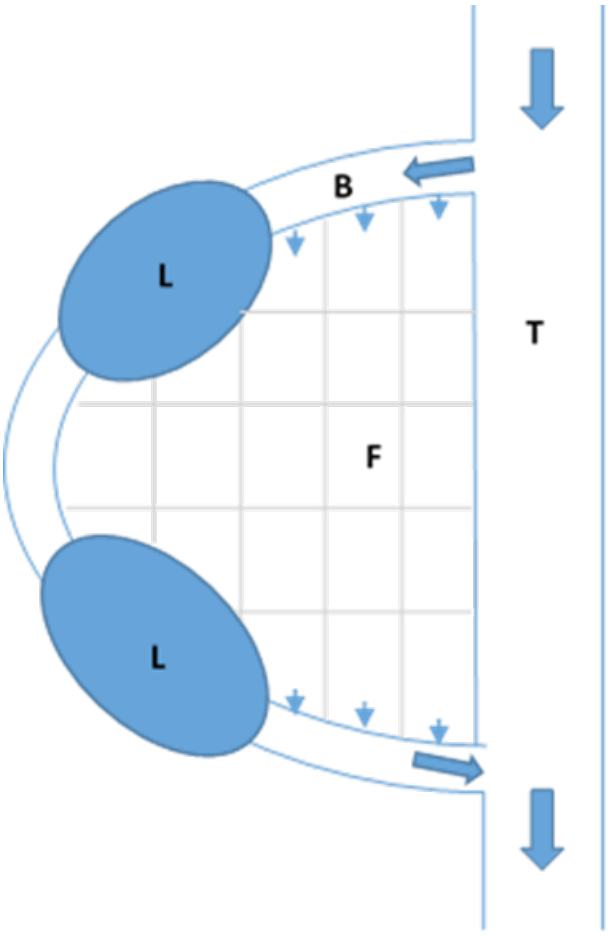

Figure 4: Graphical overview of the FBFS of Ngao (made by: Loes van der Pluijm).

Box 1 – Water-sharing in Ngao

In Ngao, the farmers managed the timing and water distribution among themselves without the use of any formal rules and regulations. They shared the water peacefully and equally by using unwritten rules that were known and respected by everyone. The farmers closest to the brook where the water entered, received water first. The other farmers helped those farmers to prepare and flood their fields. When these fields were flooded sufficiently, it was turn to the next group of farmers (which had their fields adjacent to the first fields) to flood their fields. They also worked together with the other farmers to prepare and flood their fields. This practice continued until all fields were flooded sufficiently. So, the farmers worked closely together and in the end every field received the same amount of water rand every farmer invested the same amount of time in labour. This system worked very well, was according to the concept of equality and avoided conflict.

However, things changed after the construction of the dams upstream and El Niño in 1997-1998. The water level in the Tana River decreased significantly and several brooks upstream took water that used to flow into their brook. Because of this, there was not enough water to fill their brook and flood the fields. Even the two big lakes dried up completely. The scheme is now completely left dry and for the last three years the farmers were not able harvest any yield. FBF has always been the main practice of the farmers, but now people are forced to change to different farming methods. There is only little and very unreliable rainfall, so rain-fed farming is not a very reliable option. Farmers that have sufficient financial resources now buy pumps to take the water directly from the river into their fields. Others found different sources of income and started working in the business and employment sectors, some even decided to leave the area. However, most farmers are not willing to change their lifestyle and/or still have some hope. These farmers keep on praying and waiting for the floods to come and depend on the small amount of food supplied by the government. The case of Ngao clearly shows that because of climate change and human decisions upstream, a very successful scheme can transform into a scheme that is not even able to provide enough food for the people to sustain themselves.

Kilunguni

Kilunguni is a village located on the left-bank side of lower part of the Tana River close to the Indian ocean (see number 3 in figure 1). The village consists of 280 households with an average family size of six people. The inhabitants are part of the Pokomo tribe and are farmers from origin. The village is located in a very remote area close to the sea which is difficult to access (especially when high tides and/or high rainfall). In this area, FBF has been practiced already for many years. Some people say it started before the British colonisation when there were still sultans ruling in the area. Because of their beneficial location close to the sea and next to the part of the Tana River which carries the biggest volume of water (downstream of the place where all brooks merge), they always have sufficient water available for agriculture. There are two different systems used to flood their fields. Because of their location close to the Indian ocean, they can make use of the tidal effects. Every 14 days, the tidal effect pushes sea water into the Tana River which makes the water level of the river rise. This happens at the start of each month and halfway the month; for each time, it usually takes three days for the water in the river to recede again. The farmers constructed their own furrows on the banks of the river that lead to their fields (see figure 5). So, the 1st, 2nd and 3rd and 12th, 13th and 14th of each month between 2 - 6 pm and 1 - 5 am (of which the first three days the tidal effect is usually stronger), water flows into these furrows to flood their fields. There are also daily tidal effects, but these are not strong enough to fill the canals and flood the fields. Besides using the tidal effects, the farmers also use FBF

Figure 5: Earthen furrow used to lead water from the Tana River to the fields.

to flood their fields during the rainy seasons. Because of their location far downstream where all brooks come together, the Tana river carries a lot of water during the rainy seasons which causes big floods. Often the floods bring too much water to cultivate. Instead, it damages the fields, crops, furrows and villages. There were even two years (during El Nino in 1997 - 1998 and during the Gharka flood in 1961 which was even bigger than El Niño) where the floods where so big that people had to evacuate the area. The people that stayed depended on aid from the UN that dropped food from airplanes. However, when the floods recede, the farmers start planting and are often able to cultivate several crops successfully. But since the floods are very unpredictable and often cause more damage than benefit, the farmers mostly depend on the tidal effects for agriculture.

There are several crops grown like bananas, coconuts, mango's and arrow roots. These crops are both used as food crop but also as cash crops that are sold on the market. The main crop that has been traditionally cultivated for a long time and made this area very beneficial is paddy rice (see figure 6). Kilunguni and its surroundings are known for having a lot of know-how on rice cultivation and producing very good yields. Rice fields have a size of ¼th acres and are separated by soil-bunds and banana trees (that benefit from the water provided to the rice fields). On average, each household owns eight fields (so two acres), there is however a big variety since some farmers only own one field while others own more than 16 fields. The farmers use three different techniques for planting rice. One technique is to plant a part of one field (nursery) to produce seedlings. After the seedlings started to grow, they transplant them to other fields and equally spread them over other these fields. Another technique is to buy seedlings from outside and directly plant their fields. Both these techniques are mainly used during the dry season when the farmers depend on the tidal effects. The last technique, which is used during/shortly after the rainy season, is to wait for the floods to recede to a certain level and then directly plant the rice. The period from planting till harvesting the rice is usually around four months. The farmers use different local rice varieties; *kadonte*, *mwate* (both the tall and the short type) and *sindano* (both *sindano bahari* and *sindano mai*). The farmers found out that the *sindano* variety is more salt-tolerant than the other varieties, so they are trying to plant more of it. The FBF practices in Kilunguni have not changed much over time and are still very successful (except for the years with heavy floods). The community shares the water and land peacefully and equally without the use of any organisation.

2.2 Developing FBLS

The Tana Delta shows some good examples of traditional FBLS in Kenya. In many other parts of Kenya however, there are no traditional FBLS. Most of these areas are arid or semi-arid and the lifestyle of its people is mainly based on pastoralism and not agriculture. Turkana and the north and south-east of Samburu are good examples of this. These parts of Kenya have an annual rainfall less than 700 mm and frequent drought years. The people there are pastoralists from origin

Figure 6: A rice field separated with banana trees.

Figure 7: A young pastoralist letting his livestock drink from a water pond.

and usually do not practice agriculture. Livestock herding is their main activity and their whole lifestyle is built around it. They have a nomadic lifestyle and travel around in search for water for their livestock. They mainly have goats, sheep, donkeys and camels that are used for their meat and milk. On top of that, these animals also play an important cultural role. Many pastoralists struggle to survive since the area is getting dryer and dryer because of climate change. Especially in central Turkana, there is often not enough water for the livestock to survive and also the people themselves suffer from the little supply of water. Only during the rainy seasons, there is usually sufficient supply of water. The long rainy season (long in terms of duration of one rain event) is usually around March and the short rainy season (short in terms of duration of one rain event) is usually in October and November. The rainfall pattern is very unpredictable and in 2016, there has only been one rain event which caused a lot of damage. The population is growing rapidly (not only by propagation of the people but also by the entering of a big number

Figure 8: Above: Trapezoidal bunds at the border of a dry river bed; below: Construction of water reservoir.

Figure 9: Images of different Spate irrigation projects using structures to take water from wadi's towards the fields.

refugees from different east-African countries), which will make the competition over resources even stronger. At the moment, especially competition over livestock is big and heavily armed livestock-rustling is nowadays part of the daily life of the pastoralists.

Even though there are no traditional FBLS in these areas, there is a huge potential for it. FBLS could be used to start doing agriculture but could also be used to provide water and pastures for the livestock. There are several projects at the moment that are implementing and promoting new FBLS. Most of these projects are taking place in Turkana county. The Turkana County Government and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) have several projects on promoting spate irrigation by giving trainings and constructing trapezoidal bunds at the borders of seasonal rivers/wadi's (see figure 8). The Turkana County Government also has a project with the NIB and several NGOs on spate irrigation systems that divert water from seasonal rivers/wadi's

Figure 10: Community involvement in different project phases and trainings.

by constructing furrow systems that lead the water to the fields for flooding (see figure 9). On top of that, the Turkana County Government is constructing a big water reservoir that will capture water from a big seasonal river for the cultivation of 140 hectares of land with by using an earthen furrow system (see figure 8). On this land, local people will cultivate different kind of vegetables both for own consumption and selling.

Most of the projects on FBLS have close involvement of the community for all project phases; planning, construction, maintenance, evaluation, etc. (see figure 10). Since the people are pastoralist from origin, several trainings are given to teach them several farming practices (see figure 10). After the construction is completed, the schemes are usually completely handed over to the community. Only big maintenance activities that need machines are executed by the government/contractors since the community does not have the available resources for this.

2.3 No FBLS

Above, examples were given on areas without traditional FBLS but with a lot of potential and/or need for it. There are however also areas without traditional FBLS and no potential and/or need for it. These areas usually have a more suitable climate for practicing agriculture since they are located higher (in the Kenyan highlands) and receive more rain (> 700 mm/year). Nakuru county and the central and west of Samburu are good examples of this. In these zones, the main lifestyle is farming and not pastoralism. There is however no FBF practiced. There are two aspects that play a role in this; the potential for FBF and the need for FBF. There is a high population density and most land is private and already cultivated or used as residential area. Because of the location close to the Rift Valley, there are steep slopes and many trees. So, there is little available and suitable land for practicing FBF. On top of that, many areas are very rich in resources and have mostly perennial rivers flowing and almost no seasonal rivers. In these areas, using irrigation techniques like drip and sprinkler irrigation is prioritized over practicing FBF. The need for practicing FBF here is very low since the farmers have the luxury of practicing other methods that are more beneficial and efficient. So, in these areas there are also no projects on FBLS.

3. Challenges

FBLS in Kenya face many different challenges. First of all the rains and its floods are highly unreliable and unpredictable. The main challenge is the supply of water which has two extremes. On one hand, there is often not sufficient water because of the change of course of many rivers and wadi's and the lowering of its water level caused by climate change (less and more unpredictable rains). In many areas, the construction of dams upstream of the FBLS also have a negative impact on the water supply. Many places where traditional FBF (like recession farming) took place and spate irrigation schemes were constructed, are now left dry and useless because the course of the wadi's feeding the schemes has changed. On the other hand, there are moments when there is too much water and floods damage the crops, fields and structures. Both these scenarios have caused situations where the people were depending on food aid. Another problem is that floods transport many sediments. For FBLS that use recession farming, this is not really a problem since these sediments make the lands more fertile. But for e.g. spate irrigation schemes, sediments can cause heavy siltation. The sediments can accumulate in the scheme, damage the structures and/or block the water from reaching the fields. Often the floods are not big enough to flush the sediments out of the scheme, so extra maintenance is needed. This maintenance requires a lot of labour investment, dedication and time (see figure 11). This maintenance is often not done properly. Many agriculturalists are also still pastoralists and give priority to their pastoralism activities over maintaining their FBFS. They often leave their schemes in the dry season and the people that stay left do not have the knowledge or motiavation to maintain these schemes. So when the floods come, many schemes are not prepared and will not function properly. Another challenge is the structure of the soil. Several projects focus on constructing small-dams or reservoirs that need to be strong enough to hold and store the water. The soil is however sandy and thus not very strong, so constructers have to or change

Figure 11: Maintenance on furrows which requires hard labour work, dedication and a lot of time investment.

the design/size or import (clay) soil from other areas. Another thing that should be taken into account is the abundant presence of Prosopis Juliflora (also called mesquite). This is a plant that often encroaches on river and canal beds and can block them and may shift drainage patterns uncontrollably.

Kenya is a country that is very rich in wildlife. Wildlife and the tourism involved in it however do not combine well with agriculture. In wildlife-rich areas, wildlife is mentioned as one of the major problems for FBLS. Wild animals like baboons, buffalo's and hippo's that damage the fields and eat the crops (see figure 12). Another challenge are insects that eat the crops. Mostly farmers that practice recession farming (e.g. in the Tana Delta) have troubles with cutworms and small snails that eat the young crops that just started growing after the floods receded. Farmers close to the sea also have problems with crabs that eat the crops (see figure 13). So far, most farmers have not found any good technique to prevent this damaging by animals and insects and they do not get any outside support to solve these problems. Another problem is the water quality and/or soil quality. Crops (mostly bananas) sometimes do not grow as good as the way they should and the yields reduced significantly over the past few years. It is however unclear what the exact causes of this are. A possible reason could be contamination of the water upstream which affects the soils and crops. A possible explanation for the decrease in yields could be sodicity of the soil and salinity of the water. Especially in areas close to the sea (e.g. the Tana Delta), the tidal effects bring water upstream that mixes with the water from the rivers or wadi's. This mixed water dries up the rice and damages the banana trees since they are not salt-tolerant. Another reason for the bad growth of banana trees could be over-irrigation since banana trees are known to be negatively affected when receiving too much water.

Figure 12: A paddy field damaged by Buffalo's.

Besides these environmental challenges, there are also several social, economic and political challenges. Most farmers do not have any savings/financial resources and live from day to day (or rather from season to season). This makes it challenging for them to change to and invest in different practices and for example start using pumps. Also, after harvesting, they directly need to sell their crops in order to survive and pay e.g. the school fees for their children. But since most farmers cultivate the same crops with the same cultivation cycle, they all want to sell their produce at the same time. Another problem are the social conflicts between the pastoralists and agriculturalists. Because of scarcity of resources like land and water, the competition over these resources becomes bigger. Pastoralists often have no option than keeping their livestock close to the rivers or wadi's to eat and drink. The agriculturalists are however not happy with this since the livestock feed on and/or damage their crops. It is also important that water used for livestock is seperated from water used for other purposes (like domestic and agricultural). There are several pans that are contaminated by the livestock, but since water is scarce, this water is still used as for example drinking water (see figure 14). Even though the people sometimes filter it trough the soil, it is still contaminated and harmfull for their health. Also politics are involved when looking at the challenges of FBLS. In general, promoting and investing in FBLS is not really high on the agenda of most political parties. Especially local politicians focus more

Figure 13: Left; crab holes; right; A crab.

Figure 14: Children taking water from a contaminated pan filtering through the ground for drinking purpose.

on 'directly visible' improvements like infrastructure instead of more sustainable and long-term investments in agriculture because they want to earn 'quick votes'. If politicians do invest in and/or promote FBLS and are involved in it, it is often for their own benefit. In many areas, powerful politicians use their power to let themselves or their familiy, tribe and/or friends benefit more from FBLS than other people/groups (which is also related to the conflicts between pastoralists and agriculturalists). These politicians try to be closely involved in the decision-making of new projects. In many places in Kenya (especially places where FBLS are new), there is a need for outside involement and investment for the supply of resources like knowledge, materials and money. This is sometimes challenging because many people do not speak Swahili but only their local language and because many areas are very remote and difficult to access.

4. The way forward

4.1 Possible solutions

There are several possible solutions to the challenges described above. Since it is very difficult to change the political situation and decisions made upstream, solutions should focus on measures on-ground and using the available local resources in the most beneficial way. The main solutions should focus on increasing the water availability and water reliability. In some areas (like the Tana Delta), small brooks are not having any beneficial purpose and instead take water from the main river/streams. This is why in some places people along the river course struggle with water shortage. Closing these brooks could result in a significant rise of water level of the main rivers/streams and this can maybe even make sure that some of the FBFS that were not in use anymore could be used again. In areas that are located close to the sea, closing of brooks can prevent salty water from entering the river. On top of that, by constructing flood-spreading weirs and/or gabion-weirs the flood water can be spread. It is predicted that in the future El Niño will have a big impact and many parts of Kenya are very vulnerable to heavy flooding. These weirs can prevent El Niño from being destructive and create possibilities to use this flood-water for FBF or other beneficial purposes. It is important that the weirs are strong and sustainable. It would be easier and cheaper to construct it out of local materials, but these materials are not strong enough to survive big floods. So, in order to make these interventions possible, outside expertise and investment is needed. For the fields further from the river/wadi's where the water is not able to reach by gravity, pumps could be used. This however also requires financial resources which most farmers do not have. A solution for this could be to instead of motorised pumps, start using manpower to lift the water by using e.g. treadle pumps, water wheels, spine pumps, bucket swings, balanced scoops, rotary drive hand pumps or rower pumps. These techniques will use less financial investment but hence require more labour investment.

Solutions should be found to prevent animals and insects from damaging the fields and eating the crops. For the wildlife, fencing the fields with local materials could be a solution. This will however need quite some labour investment and could cause conflict with wildlife protection organisations. To prevent the insects from eating the crops, the farmers could use insecticides or natural insect-killers. This however needs financial investment and a certain knowledge which most of the farmers do not have. It is also important to prevent the prosopis juliflora from growing at unwanted places. Instead of seeing it as a challenge, it could be seen as an opportunity. The plant can be used very beneficially as/for fuel, timber, wood chips for mulching, fodder, bio-fuel, biomass to generate power, production of honey and gum and charcoal as fuel or for land reclamation. To improve the market situation for the farmers, it would be good to look at options to start diversifying crop production. There are a lot of different crops cultivated in Kenya, but most farmers only focus on two or three. Farmers could share their experiences about cultivating crops and start cultivating more different crops to improve their nutrition and market position and spread their risks. Another possible option could be to create a cooperative that gives loans to the farmers so that they are able to invest in farming inputs and decide to store their crops and sell them when there is a better market. As regards the water quality, it should first be clear how the water quality is and what are the causes for it. Then it will be possible to look at solutions like treating the water, preventing pollution and/or finding crops that are more tolerant to the water composition. For example, in the areas close to the sea, it would be an option to use more salt-tolerant crops (e.g. the local rice variety called sindano that has proven to be more salt-tolerant than other rice varieties). Also, the conflict between the pastoralists and agriculturalists should be addressed. There should be separate areas for

livestock that are able to provide water and grass the whole year around and not only during the wet season. An option could be to create small reservoirs and water pans to store water and/or to assign designated areas close to the rivers or wadi's (where the slope is weak) for the cattle to drink and graze. It is important that the farming fields and grazing lands and water used for cattle and water used for agriculture are clearly separated (e.g. by using fences) and that rules with strong sanctions are made for trespassing. On top of that, not only crops for consumption should be cultivated by using FBF but also fodder crops like sorghum and grasses. This could also reduce the conflicts between the pastoralists and agriculturalists and make them work together.

In places where FBLS are developing quickly, it is good to take into account the possible challenges that may arise and which possible solutions could prevent problems from occurring. One way to do this is to look at the situation in other places where agriculture and FBF in specific is taking place and learn from their challenges and good practices. For example, when looking at FBLS in Tana River County, there are several challenges there that are likely to also develop in Turkana (like conflicts between pastoralists and agriculturalists). But there are also good practices in that county that can be copied by farmers in Turkana (like the using different forms of FBF to make use of the resources effectively). When constructing new FBLS, it is important to take regional and administrative borders into account since creating new FBLS on border areas may result in social conflicts.

4.2 Opportunities and potential

Besides solving the current problems, it is also good to look at the opportunities and potential for FBLS in Kenya. In many places in Kenya (especially Turkana), there is a lot of available land that is very suitable for practicing FBLS since it is fertile, has a small slope and is located next/close to wadi's. There are many wadi's that carry water during the rainy seasons that can be used for agriculture (see figure 15). Several forms of FBF can be used like spate irrigation, flood-water spreading and recession farming. Small reservoirs and water pans can be constructed to store water for use during the dry season. There is quite some water that was used to flood the fields is lost to land that is not used beneficially. By draining this water back into the river or into ponds, it can be re-used again. So, there are definitely opportunities to get access to water that can be used for several beneficial purposes. There are several FBL practices used that are/were successful and can be copied by other farmers. For example, the farmers in Ngao that made use of FBF in different ways to use the floodwater as efficient as possible. Besides using the floods for agriculture, there are several other possible purposes. One of these is the potential to use the floods for fishing and aquaculture. Fishing ponds can be constructed close to the river that will be flooded during the rainy seasons and can be used as fisheries. Fish culture has proven to require less inputs for protein production compared to agriculture and has great potential for improving nutrition. Floods can also be used to feed forests and bushlands that can be used to provide fuel wood, timber products and leaves. At the moment, there is already a lot of charcoal produced that is only sold as fuel. It is a very good opportunity to use this charcoal as bio-char to rehabilitate acidic degraded land and improve the physical, chemical and biological properties of the soil.

On top of that, floods can not only provide water for agricultural crops and trees, but also for grasslands that can be used for cattle grazing. Different grasses can also be grown during the rainy seasons and conserved for fodder during the dry season. Another good crop to cultivate by using FBF is sorghum. This crop is drought-tolerant and very suitable as fodder. When looking at new projects on FBLS, the focus is a lot on the shift from pastoralism to agriculture/agro-pastoralism. Agriculture has a lot of benefits but it is

Figure 15: Wadi's, above: top-view (based on google earth), below: side-view.

also important to focus on measures to improve the pastoral livelihoods. Pastoralism is part of the culture in many parts of Kenya and has been done traditionally for many years. There are a lot of opportunities to improve the livelihoods of the pastoralists of which making beneficial use of floods is an important aspect. FBLS do not only consist of FBF and are not only beneficial for agriculturalists; they can also significantly improve the livelihoods of pastoralists.

By using floods for multiple purposes, the people can rely on more sources of income and spread their risks. On top of that, it will give a greater variety in food supply which can improve the diet and health of the people. There is also potential to use the crabs close to the Indian ocean for household consumption and selling purposes. This will solve the problem of them damaging the crops and will provide another source of food and income. However, in order to make use of the potential that is there, the lifestyle and mind-set of many people will have to change. In order to make optimal use of the resources, it would be beneficial for some people to move to other areas where more water is available. On top of that, some farmers will have to start using different practices to generate different sources of income and spread their risks. Instead of praying and waiting for the floods to come, they could get involved in other activities. Changing will definitely be a challenge since people are used to stay at the same place and do the same practices for many years. But by providing hands-on and interactive trainings and letting the farmers learn from each other, they will get more motivation to improve their practices. When farmers see the good outputs of others, they will be more likely to copy these practices. Talking to the farmers about their current practices, challenges and possible solutions already made them think about it and motivated them to improve.

4.3 Action research priority areas

Most farmers mention that they do not have enough knowledge to truly understand and solve the problems that occur. There are a lot of things that can be researched in Kenya related to FBLS and in this section, the most prioritized action research areas are discussed. First of all, research should be done on the impact of El Niño on the livelihoods of the people and specifically on the FBLS. The next step is to research possible adaptation strategies to minimize the future impacts of El Niño. On top of that, research could be done on strategies to adapt to the recurrent droughts. Research on adaptation strategies should be done from different perspectives (social, technical, environmental, economical, etc.). Another action research priority area is the conflicts between pastoralists and agriculturalists. These conflicts could evolve quickly and can become an even bigger problem in the future. Research should be done on the exact causes for these conflicts and to find out the interests and needs of both groups. Then, possible solutions could be found on how to move forward and avoid/solve these conflicts. Also, research could be done on the soil and water quality. In order to solve the problems related to soil and water quality, it first needs to become clear what the composition of the soil and water is and what causes which problems. After this step, research can be done on options to improve the soil and water quality and/or find ways to deal with the current soil and water composition. Research could be done on finding out which crops are more tolerant to a certain soil and water composition like salt-tolerant crops. On top of that, the effect of water quantity on crops should be researched. Not only research on the suitability for growth of these crops but also on their market opportunities should be done. There are opportunities to start cultivating different varieties to improve the income and nutrition of the people. It is however necessary to first find out the market-situation to make the right decisions on crop-choice. On top of that, these crops should not only have a good market but should also be appreciated by the people to use as staple crop. Also, research could be done on the market opportunities for fish and crabs. So far, the farmers did not find effective ways to control the animals, insects and weeds that affect the performance of their crops. Research could be done on the opportunities and suitability to use different control methods and its related investments (e.g. labour, costs, etc.).

5. Conclusion

Kenya is a very interesting country when looking at FBLS. There are several areas where there are traditional FBLS in use. Some of these schemes are still very beneficial while others struggle to survive because of a combination of several environmental and/or human influences. There are also many areas where there are no FBLS yet but where there is a huge potential for it. Using floods effectively can bring very positive developments to Kenya. By only little inputs like for example making use of easy and low cost FBLS-techniques and effectively making use of the resources that are available, big outputs can be achieved. Risks can be spread, health can be increased through a varied diet and clean drinking water and the economy can be boosted. On top of that, it can create possibilities to improve the situation of Kenyan women and make them more independent. Combining different aspects of FBLS like capturing and storing flood-water for multiple uses can really improve the situation and as soon as people see the positive effects, they will copy it and invest in it. There are already several positive practices, ongoing projects and opportunities observed throughout the country. There is however a need for addressing and improving practical problems that farmers face regarding FBLS and the need for creating

more knowledge on FBLS and sharing this knowledge. Good practices and challenges that are observed in some areas of the country could be shared with areas where FBLS struggle to survive or areas where FBFS are developing so that problems could be prevented. To make optimal use of the opportunities regarding FBLS in Kenya, investments are needed. Most local people do not have sufficient resources themselves (e.g. money, knowledge, etc.) to make these investments. So, on top of community-support, outside support from the national and local government, organisations and research institutes is needed. These can provide support in the form of solution-oriented activities, targeted interventions on the ground, research, finance (e.g. loans), knowledge-sharing and training. The work done so far already created awareness and attention on FBLS by the farmers, county government and national government. Hopefully this will be a start of more involvement and focus on FBLS that will initiate solutions and make use of the opportunities that are there. Not only to improve the livelihoods of the people in Kenya, but also on a global level.

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The Flood-Based Livelihoods Network (FBLN) supports and promotes appropriate programmes and policies to improve flood-based livelihoods systems (FBLS) through a range of interventions, assists in educational development and knowledge-sharing, creates networks and supports the implementation of projects on FBLS.

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