Spate Irrigation Network Foundation

World Agroforestry Centre

REPUBLIC OF KENYA
MINISTRY OF WATER AND IRRIGATION

META

Flood-based livelihood systems; the way forward

report on the status and potential of agriculture and FBLS in specific for the Kenyan counties Tana River, Turkana and Samburu

Loes van der Pluijm
December 2016

Acknowledgements

First of all, I would like to thank MetaMeta and Abraham Mehari Haile in specific for introducing me to this amazing project and its partners, giving me the opportunity to join the project-team and supervising me. Without Abraham, I would not have been able to have these amazing and instructive experiences. I would also like to thank ICRAF and Maimbo Mabanga Malesu in specific for making the field visits possible, providing workspace and safety and helping me whenever needed. I would like to give special thanks to Maurice Opondo Oduor from the Kenyan Ministry of Water and Irrigation for assisting me with the preparations and during the field trips, for bringing me in contact with stakeholders and for organising transport and meetings. It was great to work with him; we were a good team and I learned a lot from him. Last but not least, I would also like to thank all the stakeholders involved in the field visits; the drivers, the project-team of the ministry, the farmers that were interviewed and employees of the agricultural county government offices. All of these stakeholders were very open and willing to share their experiences and stories. I learned a lot from them and without them I would not be able to write this report. Special thanks go to Silali, Veronica, Victor and Joseph from the different county government offices (agriculture, water and irrigation) for guiding me through their counties, showing me interesting sites, translating and giving me a lot of useful information.

Abbreviations

EC: European Commission

FAO: Food and Agriculture Organization

FBS: Flood-based Farming

FBFS: Flood-based Farming Systems

FBLS: Flood-based Livelihood Systems

GIZ: Deutsche Gesellschaft für Internationale Zusammenarbeit

ICRAF: International Centre for Research in Agroforestry

IFAD: International Fund for Agricultural Development

IWMI: International Water Management Institute

MoWI: Kenyan Ministry of Water and Irrigation

NDMA: National Drought Management Authority

NGO: Non-Governmental Organisation

NIB: National Irrigation Board

SPNF: Spate Irrigation Network Foundation

TARDA: Athi Rivers Development Authority

TDIP: Tana Delta Irrigation Project

WLE: Water Land and Ecosystems

Table of Contents

Introduction

The past few years, several big floods have occurred across the globe that got a lot of media attention. This contributed to the negative image of floods as a hazard. However, floods are not always a hazard, they are also the main source of irrigation in many parts of the world. 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 are built around and depend on floods. Flood-based Livelihood Systems (FBLS) are forms of adaptive agriculture; 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 hec 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. Some research has been done on spate irrigation in specific by e.g. the SPNF and the FAO. But so far, not much research has been done on other forms of FBLS. 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 like fisheries, flood pastures and timer and bushlands. There is 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. Most of the research on FBLS (spate irrigation in specific) is done by the Spate Irrigation Network Foundation (MetaMeta together with several other partners; SPNF). This research combined with capacity building has recently (since 2010) intensified as the SPNF became more strengthened and acquired several projects including:

- IFAD funded five year (2010 to 2015) project: Spate Irrigation for Rural Economic Growth and Poverty Alleviation. This focuses only on spate irrigation, a system that focuses on direct diversion of flash floods for multiple use. Several solution-oriented research activities were implemented, but also spate irrigation was mainstreamed in regular education and policy in four countries – Yemen, Pakistan and Ethiopia.
- IWMI/WLE supported project: Harnessing Floods for Enhanced Livelihood and Ecosystem Services. This research project identified the trade-offs between upstream investments and lowland development under spate irrigation systems. It is being implemented in Ethiopia and Sudan in the period 2015 to 2016.
- EC and IFAD funded project: Africa to Asia and back again – Testing Adaptation in Flood Based Farming Systems (FBFS). This is designed to solidify the know-how on spate irrigation by building on the above two projects, but also upscale the knowledge-base both geographically and content-wise. The project will operate in eight countries (Yemen, Pakistan, Ethiopia, Sudan, Afghanistan, Myanmar, Malawi and Kenya). It will go beyond spate irrigation and contribute to the building-up of practical knowledge and national and local capacity to systematically and comprehensively support the productive use of all the other types of FBFS.

It became operational in early 2016 and already several overview papers were constructed, meetings were held, videos were made and even a webminar on FBFS was given.

Kenya is one of the focus countries of the Africa to Asia and back again project. So far, not much research on FBLS has been done in this country. This report is part of the project of MetaMeta, the Kenyan Ministry of Water and Irrigation (MoWI) and the world Agro-Forestry Centre (ICRAF) on FBLS in Kenya. The report is based on several interviews, stakeholder-meetings and observations. It gives an overview of the status and potential of agriculture and FBLS in specific for three counties in Kenya (see Figure 1). In three weeks, all three counties were visited to conduct research. But before that, literature research was done on FBLS and discussions with the involved project partners took place to make sure my work was in line with the project outputs. Desk research was conducted to collect all relevant data on the status and potential of FBLS in general and on Kenya in specific. This was validated and enriched with field visits to the Kenyan counties Tana River, Turkana and Samburu. These counties are considered to be among the major areas with the highest potential for FBLS. The main focus of these field visits was on the evolution, current status, opportunities and action research priority areas of FBLS in these counties. Most information was gathered on Tana River County since the field trip to this county was specially organised for the project on FBLS. The field trips to Turkana and Samburu were part of another project and did not specifically focus on FBLS. Despite these circumstances, this report tries to give a clear overview. It is the first step towards the main output of producing a report and country-wide map on the status and potential of FBLS in Kenya.

Figure 1: The three counties that were visited for this research indicated in red (self-made figure based on Google Earth images)

TANA RIVER

Tana River (see Figure 2) is the 6th largest county in Kenya and covers an area of around 35,000 km^2 with a population of roughly 240,000 according to the 2009 census. Hola is the biggest town of the county and also the capital. The Tana River, which is the longest river in Kenya (1,000 km long), runs from Aberdare Mountains through the county into the Indian ocean. The river flows through different counties but mainly through the Tana River County and thus gives its name to this county. Tana River County consists of three sub-counties, or so called constituencies; Tana North (Bura), Tana Center (Hola/Galole) and Tana Delta (Garsen).

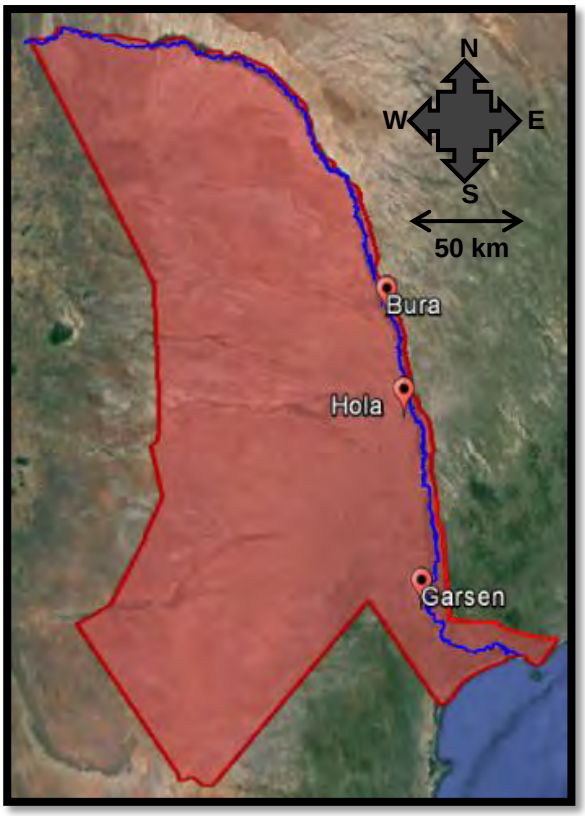

Figure 2: Tana Delta County with its main cities and the Tana River indicated in blue (self-made figure based on Google Earth images)

For this report, the focus will be on the Tana Delta sub-county where many people depend on traditional FBLS. This sub-county can also be called the Garsen constituency and covers an area of around 12,500 km^2. The land is owned by the County Government that sometimes leases small pieces of land to investors and/or projects. The length of the Tana River in this sub-county is around 270 km and the total water mass in the sub-county is around 3,200 km^2. 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 1400 mm/year. Almost 100,000 people live in this sub-county that belong to several tribes; the main tribe is the Pokomo and other significant tribes are the Orma, Malakotes and Giriama. Both agriculture and pastoralism are executed in the Tana Delta.

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 5 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 3, 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.

Most pastoralists are part of the Orma tribe while the farmers are mainly Pokomos. Some of the pastoralists can be called agro-pastoralists since they also cultivate some small pieces of land. The livestock mainly consists of goat, cows, sheep and/or donkeys. During the rainy seasons, the livestock grazes more upstream far from the river. But during the drier periods, the livestock comes closer to the river to graze and drink. Often, they damage or eat the crops on the agricultural land next to the river. This causes a conflict between the pastoralists and the agriculturalists. The County Government tried to solve this by constructing small waterpans (local term: *malkas*) as designated areas for the livestock to graze and drink. However, during the dry spells, there is not enough rainfall to fill the dam and grow grazing land. So the livestock still moves towards the river. Especially this dry season, the livestock is suffering from the drought. Many of them already died because of dehydration or by falling into the river and drowning when taking the risk of drinking water directly from the river.

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). In total, around 760 km^2 of land is used for agriculture, which is less than 10% of the total land and less than 50% of the land currently suitable for agriculture (determined by the agricultural sub-county office). There are three ways of providing water to the crop that are used in this sub-county; rain-fed, conventional irrigation and FBLS. Rain-fed agriculture is not practiced much since the rainfall is often not sufficient to produce a good yield. The crops under rain-fed are mainly maize, green grams, cotton, coconut, cashew nuts and hot chilli's. Conventional irrigation takes place at several locations along the Tana River. Most of the conventional irrigation is not practiced traditionally, but has been implemented by projects that used modern irrigation structures/techniques to divert water from the Tana River (see Annex 2). However, all the irrigation projects that were initiated in the Tana Delta were unsuccessful and suffered significantly from El Niño and the changes of river course. Not only the conventional schemes were affected, but also the FBLS suffered significantly. This will be explained in the next section.

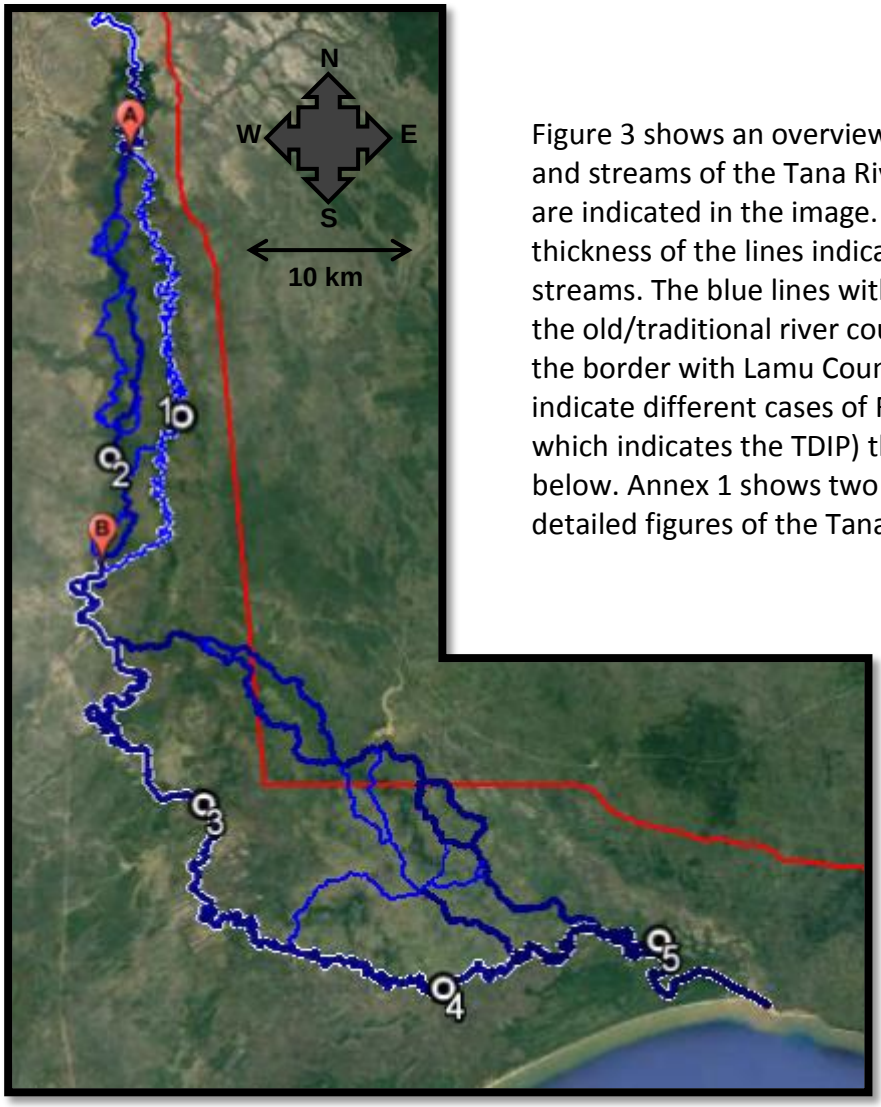

Figure 3 shows an overview of the current courses and streams of the Tana River. Only the biggest ones are indicated in the image. The darkness and thickness of the lines indicates the volume of the streams. The blue lines with a white border indicate the old/traditional river course. The red line indicates the border with Lamu County and the numbers indicate different cases of FBFS (except for number 1 which indicates the TDIP) that will be described below. Annex 1 shows two more zoomed-in and detailed figures of the Tana River and its courses.

Figure 3: Courses/streams of the Tana River in the Tana Delta sub-county (self-made figure based on Google Earth images

Flood-based livelihood systems

The Tana Delta is a very interesting area when looking at FBLS. In this area, floods are mostly used for farming purposes. 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 several reasons for this reduction. The main reason is the change of course of the Tana River and the lowering of its water level caused by climate change and the construction of the

dams upstream. 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.

To provide a better understanding of FBLS in the Tana Delta, four different cases of FBLS will be explained in more detail. 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. The information provided for each case is based on stakeholders meetings and interviews with both male and female farmers.

Image 1: Stakeholders meeting at the county agricultural office in Garsen

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 2 in Figure 3 and Image 3). The village consists of 600 households with an average family size of 6 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.

Image 3: The Tana River (looking downstream), Maziwa is located on the right-bank side just outside the picture on higher grounds

Image 2: Meeting with Maziwa-farmers and village chief on prepared field next to the river

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 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.

Image 4: a traditional hand-how (gembe)

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 Image 4) 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 mango's 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 3 in Figure 3). The village consists of 2,000 households with an average family size of 6 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 4) ; 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).

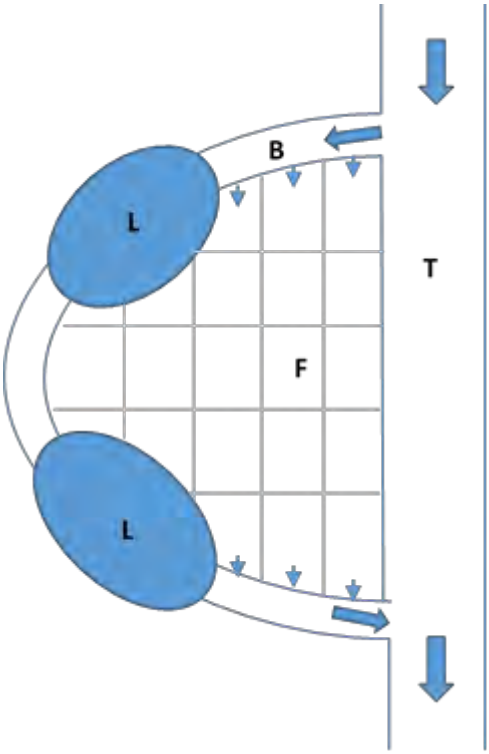

Figure 4: Graphical overview of the FBFS of Ngao (self-made figure)

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.

Box 1: water-sharing in Ngao

Image 5: Meeting with Ngao-farmers and representatives in the village

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 5 in Figure 3). The village consists of 280 households with an average family size of 6 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 Image 6). 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.

Image 6: earthen furrow used to lead water from the Tana River to the fields

Besides using the tidal effects, the farmers also use FBF 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.

Image 7: Kilunguni-farmers showing their fields

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 Image 8). 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 1/4th 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 8 fields (so 2 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.

Image 8: A rice field separated with banana trees

Challenges in the Tana Delta

As already pointed out above, there are several challenges that the farmers that practice FBF face. The main challenge is the supply of water for FBF which has two extremes. On one hand there is not sufficient water because of the change of course of the Tana River and the lowering of its water level caused by climate change (less and more unpredictable rains) and the construction of dams upstream. But 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. Besides the water supply, there are several other challenges that negatively influence the FBLS. All farmers that we talked to mentioned the wildlife as one of their major problems. In the Tana Delta, there are a lot of wild animals like baboons, buffalo's and hippo's that damage the fields and eat the crops (see Image 9). Another challenge are insects that eat the crops. Mostly farmers that practice recession farming 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 Image 10). So far, the 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. Farmers mention that their crops (mostly bananas) sometimes do not grow as good as the way they should and that the yields reduced significantly over the past few years. It is however unclear what the exact causes of this are. According to some farmers the water is contaminated upstream and affects their soils and crops. A possible explanation for the decrease in yields could be sodicity of the soil and salinity of the water. Especially close to the sea, the tidal effects bring water upstream that mixes with the water from the Tana River. 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.

Image 9: A paddy field damaged by Buffalo's

Image 10: left; crab holes, right; a crab

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 river to eat and drink. The agriculturalists are however not happy with this since the livestock feed on and/or damage their crops. The interventions done to solve this conflict have not been effective so far. agriculturalists complain that they do not get enough support to improve their situation. At the moment, only the national government is concerned about improving agricultural practices in the sub-county. Local politicians mostly focus on 'directly visible' improvements like infrastructure instead of more sustainable and long-term investments in agriculture. An important underlying reason for this could be that the leading politicians in the area want to earn 'quick votes' and are not from an agricultural background (not Pokomos), but from a pastoralist background.

The way forward

There are several possible solutions to the challenges described above; both pointed out by the farmers and me. The solutions below are an output of discussions together with the farming communities. Since it is very difficult to change the political situation and decisions made upstream, the possible solutions focus more on measures on-ground and by using the available local resources in the most beneficial way. First of all, a good intervention would be to divide the water more equally between the main streams of the Tana River and close the small brooks that take water from these main streams. By constructing a modern structure at point A (see Figure 3), the water could be equally split into both the east and west-wing of the river. In this way, it will still be possible to practice recession farming on the west-wing while the schemes on the east-wing will receive enough water to be used again (e.g. the TDIP). For the part of the Tana River downstream of Garsen, closing the small brooks would increase the water level in the main river course significantly. At the moment, the small brooks are not having any beneficial purpose while the people along the river course struggle with water shortage. Closing the brooks could result in a significant rise of water level of the main river and this can maybe even make sure that the FBFS of Ngao can be used again and the lakes will again be filled with water. More downstream, closing of the 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 especially the area downstream of Garsen is 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 intervention possible, outside expertise and investment is needed. For the fields further from the river 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.

There are also several possible solutions that were not discussed with the communities. Below I will present several suggestions based on my own analysis. These are only initial suggestions and need more research for specification. First of all, solutions should be found to prevent the 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. 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 the Tana Delta, 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 Tana River (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.

Opportunities

Besides solving the current problems, it is also good to look at the opportunities and potential for FBLS in the Tana Delta. There is more than enough land available and at the moment and not all the available water is used for beneficial purposes. there are still some parts alongside of the Tana River that are not used but that are suitable for practicing FBF like depression agriculture. On top of that, there are several wadi's and low areas that capture water during the wet season that are not used at the moment but do have potential to be used for several beneficial purposes. Besides using the water that is already captured, there are also possibilities to capture more water by for example constructing small reservoirs and water pans. Another option is to optimize the use of shallow groundwater by for example using hand drilled shallow tube wells. This technique can use local labour and local markets for the needed materials which encourages local businesses development and entrepreneurship. At the moment, a lot of water that was used to flood the fields is lost to lands that are not used. 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. First of all, the area under FBF can be extended. There are several forms of FBF 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. 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. 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.

Action research priority areas

Most farmers mention that they do not have enough knowledge to truly understand and solve the problems that occur. During the interviews and meetings, there were several action research areas pointed out and discussed. There are a lot of things that can be researched in the Tana Delta 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.).

Conclusion

There are several challenges in the Tana Delta regarding agriculture and FBLS in specific. Several households are in a very vulnerable position, are not able to sustain themselves and have a very insecure future. But luckily, most people still have hope and support improvements. Many farmers recognize both their good practices and challenges and see the need and potential for improvement. There are many opportunities to improve the livelihoods of the people. However, to make optimal use of these opportunities, investments are needed. The 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.

A good start has already been made by the project of MetaMeta, ICRAF and the MoWI on FBLS in Kenya. This is one of the first projects focussing on learning about FBLS and improving them. This project made it possible to come to this area, talk to the people about their practices and challenges and discuss possible solutions, opportunities and action research priority areas. However, this report is only based on a few interviews, meetings and field visits. In order to fully understand the situation and come up with solid recommendations, more research needs to be done. There are many more things to learn and see in this area that should be documented. 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 the Tana River, but also on a national and even global level.

Image 11: Stakeholders that are involved in FBF in the Tana Delta (and me) being hopeful for the future of FBF in their sub-county after having a meeting where the history, situation, challenges and opportunities of FBF were discussed

TURKANA

Turkana (see Figure 5) is the largest county in Kenya and covers an area of almost 77,000 km^2 with a population of roughly 860,000 according to the 2009 census. Lodwar is the biggest town of the county and also the capital. Turkana County consists of six sub-counties; Turkana north, central south, west, east and Loima. On the east part, Lake Turkana is located which is named after the county. Lake Turkana is the largest permanent desert lake and alkaline lake in the world and the fourth largest salt lake with an surface area of 6,400 km^2 and a water volume of over 200 km^3. There are several perennial rivers in Turkana of which Omo, turkwel and Kerio are the main ones and flow into Lake Turkana Most rivers in the county are seasonal. Turkana is one of the driest counties of Kenya with an annual rainfall between 115 and 600 mm and frequent drought years.

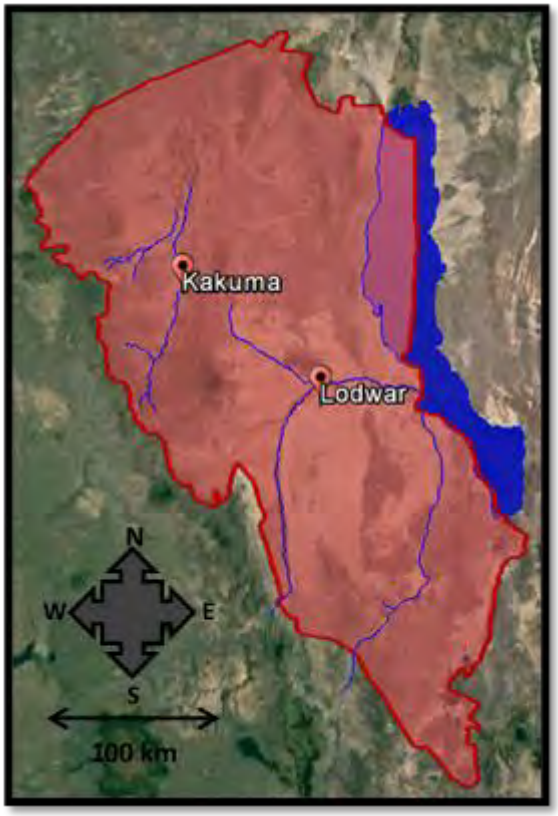

Figure 5: Turkana County with its main cities and Lake Turkana and main rivers indicated in blue (self-made figure based on Google Earth images)

The people that live in Turkana are called the Turkana people. They are pastoralists from origin and usually do not practice agriculture. Livestock herding is their main activity and their whole lifestyle is built around it. 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 as bride-price when a couple gets married. Some bride families receive over 200 goats as bride-price. Marrying is an important tradition and many men have more than ten wives. Most Turkana people have a nomadic lifestyle and travel around in search for water for their livestock. They live together in small villages of thatched huts that are enclosed with thorn-branches (see Image 12) . The men take care of the cattle and start with this already as young boys (see Image 13) while the women have to bear children, take care of the children, manage the household and construct and maintain the huts.

Image 12: left: a pastoralist hut, right: a pastoralist village

Image 13: A young pastoralist letting his livestock drink from a water pond

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 so far this year (November, 2016), there has only been one rain event. This rain event was the 16th of March and caused a lot of damage. The population in Turkana is growing rapidly (not only by propagation of the Turkana people but also by the entering of a big number 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.

The past few years, there have been many Non-Governmental Organisations (NGOs) and government teams focussing on improving the lives of the Turkana people. Many schools and healthcare facilities were build and there are several projects focussing on providing more water for the cattle and promoting agriculture. Because of these developments, the lifestyle of the Turkana people is slowly changing from nomadic to a more settled lifestyle. Villages expand rapidly and money flows start to increase significantly. The National Government is having projects on constructing water pans, small-dams and boreholes to increase the availability of water that can be used for both livestock and agriculture (see Image 14). There are also several NGOs and government agencies like the National Drought Management Authority (NDMA) that have projects to promote agriculture in the county like for example projects on constructing boreholes and using them to cultivate cash-crops with drip-irrigation techniques (see Image 15).

Image 14: accessing suitability of locations for the construction of water pans and small-dams together with the pastoralists

Image 15: Different irrigation projects initiated and funded by the NDMA and several NGOs

Flood-based livelihood systems

Since the Turkana people are pastoralists from origin, there is no traditional FBLS in the county. There are however several projects at the moment that are implementing and promoting new FBFS in the 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 Image 16). 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 by constructing furrow systems that lead the water to the fields for flooding (see Image 17). 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 Image 16) . On this land, local people will cultivate different kind of vegetables both for own consumption and selling.

Image 16: Above: Trapezoidal bunds at the border of a dry river bed, below: Construction of water reservoir

Image 17: Images of different Spate irrigation projects using structures to take water from wadi's towards the fields

Most of the projects on FBF have close involvement of the community for all project phases; planning, construction, maintenance, evaluation, etc. (see Image 18). Since the people are pastoralist from origin, several trainings are given to teach them several farming practices (see Image 18). 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.

Image 18: Community involvement in different project phases and trainings

Challenges in Turkana

The change from only pastoralism as main lifestyle to also doing agriculture as a new lifestyle, involves several challenges. First of all, many pastoralists are used to their traditional lifestyle and are not willing to change. This should not be a problem as long as they respect the people that are willing to change. This is however not always the case; some pastoralists do not apreciate agriculture and see agriculturalists as enemies that take their land and water. So far, this did not result in many problems since there is not much agriculture yet and the competition over resources is still low. But in the future it is likely that the amount of agriculturalists will increase significantly which may

Image 19: Children taking water from a contaminated pan filtering through the ground for drinking purpose

result in several conflicts between the pastoralists and the agriculturalists. 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 Image 19). Even though the people sometimes filter it trough the soil, it is still contaminated and harmfull for their health.

Image 21: Sign of saltification on dripline

Since agriculture is a new practice in Turkana, 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 Turkana people do not speak Swahili but only their local language and because many areas are very remote and difficult to access. Saltification is also a problem for practicing agriculture and can damage the crops. Especially when using techniques like drip-irrigation, the salt can have negative effects since it clogs the driplines (see Image 21). When looking at FBLS in specific, there are also several challenges. First of all the rains and its floods are highly unreliable and unpredictable. Because of climate change the river flows are usually very low or occasionaly too high and cause damage. On top of that, the course of many rivers and wadi's changes all the time. There were several spate irrigation schemes constructed that are now left dry and useless because the course of the wadi's feeding the schemes has changed. There is another big problem that these spate irrigation schemes face; the floods bring many sediments into the system that 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 Image 20). 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 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. At the moment this is not considered as a problem yet, but since FBLS are about to become more important, it good to take this into account.

Image 20: Maintenance on furrows which requires hard labour work, dedication and a lot of time investment

The way forward

So far, the shift from pastoralism as main practice to also agriculture has been quite successful. There are already several positive practices and opportunities on agriculture observed throughout the county (see Figure 6) But there are a few small problems taking place that may become more severe with the development of agriculture in the county. On top of that, there are several other challenges that may arise. This is why it is good to already think of these possible challenges and solutions to 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).

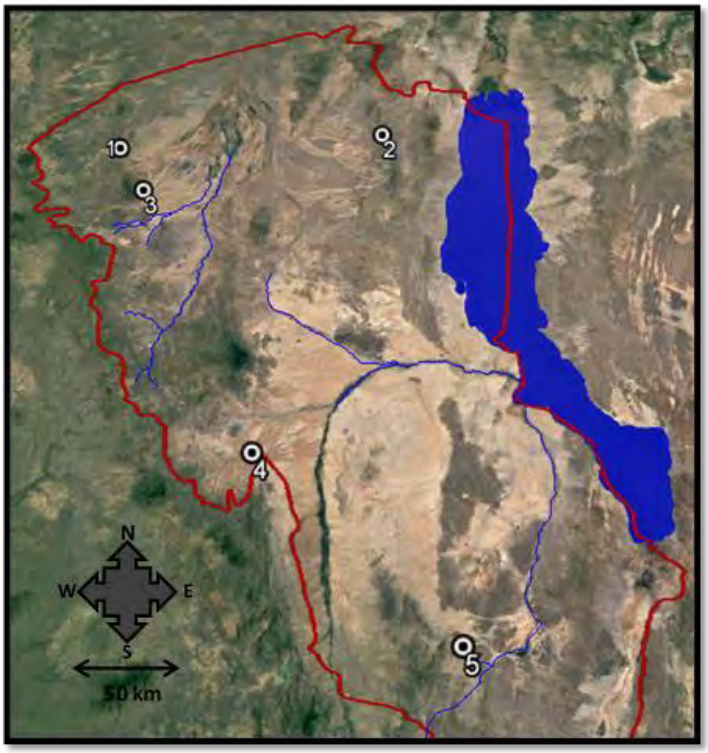

Figure 6: Several locations that show positive practices and opportunities; 1= construction site of big reservoir for FBF, 2= drip irrigation system, 3= trapezoidal bunds, 4 and 5 = useful wadi's (self-made figure based on Google Earth images)

Possible conflicts between pastoralists and agriculturalists could be prevented by separating water for different purposes by fencing ponds and assigning a pond for only one purpose. Also farming fields and grazing fields should be separated so that the livestock will not feed on and damage the agricultural crops. Clear rules on trespassing should be made with strong sanctions. The conflicts could also become less if agriculturalists start producing fodder crops like grasses and sorghum by using FBF to support the pastoralists. This would then be a win-win situation and on the long term agro-pastoralism could become the main livelihood. When the situation of the livestock improves, and more people will be able to keep livestock, the cattle rustling will also become less. Regional and administrative borders should be taken into account when constructing new FBFS. Creating new FBFS on border areas may result in social conflicts. 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 (reference…). At the moment there is already a lot of charcoal produced (from other trees/plants) 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.

Image 22: Wadi's, above: top-view (based on google earth), below: side-view

There is a lot of potential in Turkana County for FBLS. There is a lot of available land that is very suitable for agriculture 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 Image 22). 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. Floods cannot only be used for agricultural purposes but also to grow grazing land for livestock and to fill fishing ponds and start producing fish. It seems as if the people in Turkana have good will to improve and start practicing FBLS which makes the potential even bigger. At the moment, the focus is mostly on the shift from pastoralism to agriculture/agro-pastoralism. But I think part of the way forward is to focus more on measures to improve the pastoral livelihoods. Pastoralism is part of the Turkana culture 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.

Conclusion

Using floods effectively can bring very positive developments to Turkana County. By only little inputs like for example making using 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 Turkana 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 in Turkana 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 county. This report is however only based on a short field trip and a few interviews. There are many projects and interesting sites that were not visited but could give interesting and useful information. More research should be done and also the opinion of the pastoralists and agriculturalists should be taken into account.

SAMBURU

Samburu (see Figure 7) is the 10th largest county in Kenya and covers an area of over 20,000 km^2 with a population of roughly 224,000 according to the 2009 census. Maralal is the biggest town of the county and also the capital. Samburu County consists of three sub-counties; Samburu East, Samburu Central and Samburu North.

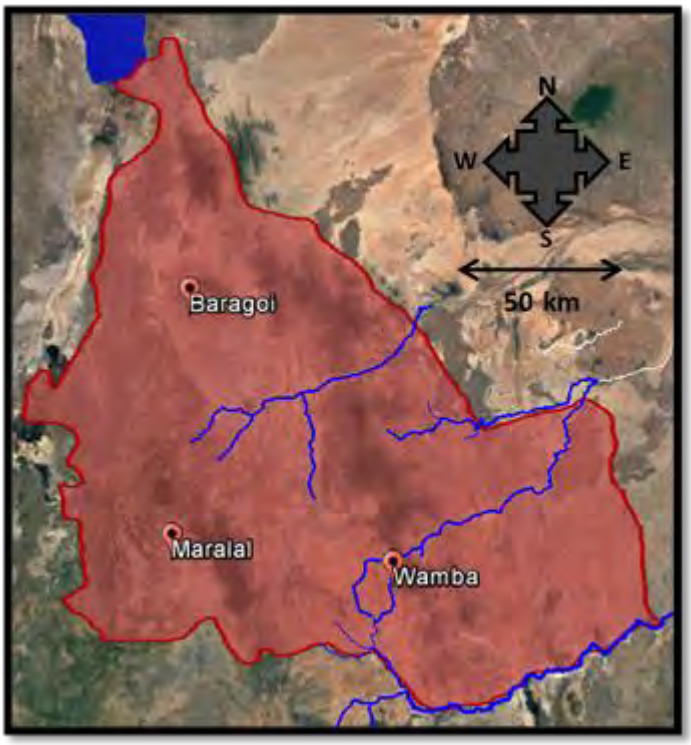

Figure 7: Samburu county with its main cities and Lake Turkana indicated in blue (self-made figure based on Google Earth images)

The county is divided into five ecological zones. The upper highland zone covers an altitude of 2,150-2,600 m above sea level and has an annual average rainfall of 900-1000 mm. This zone is suitable for wheat and barley cultivation, forestry farming and holding sheep and dairy cattle. The Tropical Alpine zone covers an altitude of 1,980-2,040 m above sea level and has an annual average rainfall of 600-800 mm. This area is too cold to grow crops so is mainly used for sheep and cattle grazing. The lower highland zone covers an altitude of 1,800-1,980 m above sea level and has an annual average rainfall of 750 mm. In this zone, agriculture is the main activity and the main crops are sorghum and maize. Also some livestock keeping is done. The lower midlands zone covers an altitude of <1,300 m above sea level and has an annual average rainfall off 720 mm. Just like the lower highlands zone, agriculture is the main activity but also livestock keeping is done. The last zone is the lowlands zone which covers an altitude of 600-1,450 mm above sea level and has an annual average rainfall <700 mm. This is the largest zone and covers almost 80% of the county. This zone is very dry, so there are mostly pastoralists and almost no agriculturalists.

In Samburu County, there are several different tribes living together. The main tribe is the Lokop, these people are also called the Samburu people and are closely related to the Masaai (see Image 23). They are semi-nomadic pastoralists and livestock keeping is their main activity. Their lifestyle is very comparable to the lifestyle of the Turkana and Masaai people. Especially close to the western border of the county, these different tribes live peacefully together and have almost the same lifestyle.

Image 23: Left: Samburu men, right: Samburu women

There are several projects in Samburu of which most are focussing on healthcare and education. There are only a few projects focussing on agriculture in the county that are initiated by several NGOs. Most of these projects use boreholes to pump up groundwater for irrigating small fields (see Image 25). Just like in Turkana County, the National Government is also having projects on constructing water pans, small-dams and boreholes to increase the availability of water that can be used for both livestock and agriculture (see Image 24 and Image 27)

Image 24: accessing suitability of location for the construction of a small-dam together with the pastoralists

Image 25: project on cultivating crops with groundwater

Flood-based livelihood systems

In Samburu, there are no FBLS. The situation in the lowland zone which is located mainly in the north and south-east of Samburu, is very similar to the situation in Turkana. The people are pastoralists from origin, so there is no traditional FBF taking place in this area. However, just like in Turkana (see part on Turkana for clarification), there are great opportunities for FBLS. There is a lot of available and suitable land, there are many wadi's and a lot possibilities to capture and store flood-water for different purposes (see Image 27 and Image 26). When looking at the other zones of Samburu that are mainly located at the central and west part of the county, the situation is different. These zones are located higher and have a more suitable climate for practicing agriculture. So 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 FBLS and the need for FBLS. 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.

Image 27: accessing suitability of location for the construction of a small-dam together with the pastoralists, this location is at a dry river bed and has potential for FBF

Image 26: Area in the North of the County which has potential for FBF

Conclusion

When looking at Samburu as a whole, there is need and potential for FBLS in some areas while in other areas this is not the case. When comparing to Turkana County, the situation in a big part of Samburu County is the same. But since the potential area for FBLS and the amount of people that could benefit from FBLS is much bigger in Turkana, practicing and promoting FBLS in Turkana is prioritized.

Annex 1: Detailed figures of the Tana River course

Figure 8: Upper part of the Tana Delta catchment (self-made figure based on Google Earth images)

Figure 9: Lower part of the Tana Delta catchment, the red line indicates the border with Lamu County (self-made figure based on Google Earth images)

Annex 2: Conventional irrigation in the Tana Delta

Image 29: Rubber dam when inflated

The TDIP is a project from the Tana and Athi Rivers Development Authority (TARDA). With assistance from the Japanese government they constructed a modern irrigation scheme that converted approximately 2,000 hec of fertile floodplain into commercial rice production from 1991 till 1999 (see white coloured area in Figure 8) . The objective of the project was to open up the delta area to farming and produce about 24,000 tonnes of white rice per year under a double cropping programme. In 1992 a rubber dam was constructed (see number 1 in Figure 8 and Image 29) with a lifespan of 30 years. This dam was designed to capture water from the original river (east-wing) for rice farming. The dam inflates (by the use of a gas-pump) to tap water into the irrigation scheme which consists of one big main concrete canal (see light blue line in Figure 8) and several concrete secondary and tertiary canals with modern diversion gates (see Image 28 and Image 30). When the fields are flooded with enough water to cultivate the paddy-rice, the dam deflates so that the water is released again into the river. The land is owned by the project, but local farmers are paid to work on the land. In the end the yield is sold on a commercial level by the project.

Image 28: Secondary canal, note the dry fields on the background

Image 30: Main canal with secondary off-takes/gates, note the amount of settled sediments

At the moment however, this system is not in use anymore. As can be seen in Figure 8, the river splits at point A into two main courses that again unite at point B. The east-wing used to be the original river course while the west-wing was only a brook. The TDIP was designed to take about 10% of the rivers volume, but because of El Niño in 1997-1998, the west-wing river became deeper and wider and took all the water that used to flow into the east-wing. Now the east-wing is mostly dry, except for some days during the long rainy season. On top of that, El Niño damaged several structures and left a lot of sediments. Normally the water flowing into the system removes the sediments naturally, but at the moment the system is left completely dry. This makes it impossible to cultivate paddy rice and produce a yield. According to the project management, the scheme used to be very successful and provided a good income for the community. The community however mentions that the relation

between the project management and the community was not good and that the community did not directly benefit from the project. So only few people depended on the TDIP which explains why the non-functioning of the scheme did not have a big effect on the community.

Besides the TDIP, there was another big project that used modern irrigation structures to divert water from the Tana River. This project was constructed by the Dutch in 1996 and was located downstream of Garsen on the left-bank side of the river (at the area close to point 4 in Figure 9). This system used to divert water from the river by using concrete canals and division structures. It was however completely destroyed by El Niño. Both the TDIP scheme and the Dutch scheme were mainly used for the cultivation of paddy rice. Already a long time ago, around 1953, the National Irrigation Board (NIB) initiated the Tana Irrigation Scheme. This scheme used to irrigate over 4,000 hectares of land by using pumps that took water from the Tana River to irrigate crops like cotton, ground nuts, maize, cowpeas, soya beans, green grams and several fruits. But since El Niño came and changed the course of the Tana River, almost the entire scheme collapsed.

At the moment, there are still a few farmers that make use of pumps to take water from the river into their own earthen furrow system to irrigate maize, green grams, cowpea, tomato, watermelon, kale, banana and/or sugarcane. Most of these farmers are refugees that came from Somalia around 40 years ago and settled downstream of Garsen on the right-bank side of the Tana River (see point 4 in Figure 9). They are lucky that the course of the Tana River is still adjacent to their fields. They however do have the problem of a small natural brook close to their fields that takes salt water from the sea (during high tides) that mixes with the water from the river.