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Livelihood strategies of small scale farmers in a community based irrigation project

The case of the Kiandego Irrigation Scheme



Woman tending her cabbages, grown with water from the Kiandego irrigation scheme (Source: Own picture 2018)

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Abstract

The Kiandego is a community-based irrigation project in Thuti village, located in Nyeri County, southwest of Mt. Kenya. Based on a case study of the Kiandego, this report aims to assess how the irrigation project affects farmers' livelihoods. To support the assessment, fieldwork was conducted to understand which stakeholders are involved, which livelihood strategies farmers pursue, and how farmers perceive water availability and weather patterns. Through an interdisciplinary approach, it is determined that irrigation affects farmers' livelihoods differently, because of differences in the range of assets each farmer has. Many farmers use irrigation to secure maintained subsistence farming, while a few uses it to expand their strategies and increase income. Some of the challenges that hinders farmers from commercialization are lack of knowledge and training about farm inputs, and difficulties in organizing and managing a community project. Farmers use irrigation as an adaptive strategy to changing rainfall patterns, and members feel less vulnerable to climatic changes when connected to irrigation. An identified gap in the multi-level water governance means that water supply monitoring is not being carried out in the catchment area. Combined with changing rainfall patterns that are expected to make water levels more scarce, the lack of monitoring could potentially negatively affect farmers' livelihoods, as their livelihoods become dependent on irrigation.

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Conclusion and recommendations	Philipa, Laurits	All

Abbreviations

FGD: Focus Group Discussion IC: Informal conversation KSH: Kenyan Shillings PO: Participant observation PRA: Participatory Rural Appraisal SSI: Semi-structured interview

Introduction

The agricultural sector in Kenya plays a vital role in the country's economy, as 26 % of the GDP is based on agriculture, and another 27 % linked indirectly to agriculture through other sectors (FAO, 2018). More than 40 % of the population is employed in the agricultural sector which includes around 70 % of Kenya's rural people. Agriculture has been considered a key to steady development of the country, as agriculture accounts for 65 % of the total export earnings, as well as ensuring food security and livelihoods of many Kenyans (FAO 2018).

Current global climate changes, which result in global warming leading to longer droughts and less rainfall, are starting to directly affect people's livelihoods. Climate change models and predictions suggest temperature increases between 3°C to 4°C in Africa by the end of the 21st century. Changing weather patterns in Africa are more significant, in comparison to the global mean (Bryan et al. 2013), which makes Kenyan people more vulnerable. Recently Kenya was listed one of the most water-scarce countries in Africa (Parry et al. 2012), and rainfall patterns are likely to become less predictable, increase in intensity, and occur over a shorter period of time (Bryan et al. 2013). Climate related hazards can have a significant impact on the economy, development and food security of Kenya, as the agricultural sector relies mainly on rainfed farming (UNDP Kenya 2017).

Previous research on how agriculture can adapt to climate change in Kenya, suggest that irrigation schemes can greatly reduce vulnerability to climate change (Bryan et al. 2013). As well as leading to a reduction in crop-production risk, irrigation has the potential to generate increased incomes for smallholders (Freeman & Silim 2000: 265; Kay 2001: 1). In order to enable this potential, and attain increased incomes, several skill sets are required of smallholders, such as improved farming practices, knowledge of inputs, and markets (IWMI 2002:ix). Studies show that smallholders using irrigation in Kenya, are challenged by market constraints, and that problems with operation and maintenance are common for irrigation systems (Freeman & Silim 2000: 28; Kinyua et al 2015: 138).

Irrigation schemes take place in an institutional context, and are affected by governance at multiple levels. Water governance in Kenya has changed since 2002, to a decentralized and multilevel governance system, with local agencies (Dell'Angelo et al. 2014). This is believed to produce more adaptive and robust governance regimes, and initial research from the Mt. Kenya region shows that local-level institutions are successful in conflict resolution (ibid.). Other scholars suggest that they might not be an ideal institutional arrangement to meet rural poor end-users' needs (Mumma 2005; Robinson 2010, cited in Dell'Angelo et al. 2014). Research highlights how multi-level water governance can have diverse and unpredictable outcomes, with implications for equity in water distribution (Franks et al. 2013).

There has been substantial research on the outcomes of smallholder irrigation schemes in sub-Saharan Africa (Kay 2001). Scholars suggest that understanding the physical and material resource base, the arrangements for access and political processes of water governance, is essential to support rural development through water resources (Franks et al. 2013). The *Sustainable Livelihoods Framework* (DFID 1999), likewise suggests how both individual people's assets, the vulnerability context, and the structures and processes shape what livelihood strategies are pursued, and determine which livelihood outcomes are obtained.

Irrigation is proposed as a means to achieve positive livelihood outcomes for farmers, by possibly enabling adaptation to climate change, and increase cash incomes. Considering the research on unpredictable and conflicting outcomes of multi-level governance, and the identified constraints of rural development through water resources, it is imperative to research what changes in livelihoods rural farmers are experiencing, with access to irrigation. And does access to irrigation actually lead to climate change adaptation and community development, as intended?

Based on a case study of the Kiandego irrigation scheme in Nyeri County, Kenya, our aim is to assess if a community based irrigation scheme positively affects livelihood outcomes. This leads us to the problem statement:

How is the Kiandego irrigation project affecting farmers' livelihoods?

The following research questions will help us answering the problem statement:

- 1) Which institutions and organizations are involved, and how?
- 2) Which livelihood strategies do farmers pursue, and what determines these?
- 3) What are the perceptions of water availability and weather patterns?

Background information

The Kiandego irrigation project

The Kiandego irrigation project (from here 'Kiandego'), was initiated in 1998, as a community project, by 25 neighboring farmers in the village of Thuti, Nyeri County in Kenya. The study area of Thuti is located southwest of Mt. Kenya, in a highly fertile, temperate zone (Bryan et al. 2013:6-8). A stream runs from the nearby Karima Forest, down through the sloping lands of the village, connecting with Thuti River (see figure 1). The group of villagers established an intake at the stream and laid down pipes, leading the water to their farms by gravity. In 2000, the group of 25 members was registered as a self-help group. In 2016, the Nyeri County government funded the extension of the pipe from 600 m to 1.3 km, resulting in 40 new members to use the irrigation. At the same time, the government established a greenhouse, located at the end of the Kiandego pipe.

Now the project has the potential to supply more than 160 households, but only around 65 households are connected. In order to become a member, there is a registration fee of 200 Kenyan shillings (KSH) and a connection fee of 8100 KSH. Those who contributed labor for the construction of the pipeline, pay a connection fee of 1500 KSH. Some of the members have only paid the registration fee, which defines them as 'members', without actually being connected to the pipe and having access to the water.

Kiandego is managed by a committee of 9 members: a chairman, vice chairman, secretary, treasurer and 5 general members of committee.

Kiandego irrigation project



Figure 1: Map of the village of Thuti, showing the stream, the intake, the pipeline and Thuti River, together with our questionnaire respondents, both members and non-members of Kiandego. The pipeline runs slightly downhill from the intake to the end of the pipe, explaining how Kiandego is fed by gravity. From the pipeline towards the river is a steep slope (Own data, made in QGIS, 2018)

Water governance in Kenya

Governance of water resources in Kenya, including irrigation, was fundamentally changed with the Water Act in 2002. Before this shift, policies and official governance of water had not been changed since the 1950's, when Kenya was still a British colony. The colonist policies were focused on central administration, where permits for water extraction had to pass through both local and national officials, which could take several years, and often resulted in illegal extraction of water resources. Being far from the watersheds, the central administration had issues with enforcing compliance of permits, securing sustainable extraction. With the 2002 Water Act, regulatory authority was divided into a multi-level governance system, with local, regional and national actors (Dell'Angelo, J. et al. 2014). With this multi-level governance system, shown in figure 2, formulating policies and securing water availability and quality throughout Kenya's watersheds is retained on a national level within the Ministry of Water and Irrigation (MWI). Permit issuance and planning now takes place at the watershed level, from regional offices of Kenya's Water Resources Management Authority (WRMA) at six main catchment areas throughout Kenya. A whole new element was implemented in the Act, being recognition of the rights of Water Resource Users' Associations (WRUA's) to "[...] create forums for community water projects and other users in a given water body to communicate, implement policies, monitor water usage, and prevent or resolve conflicts" (Dell'Angelo, J. et al. 2014:334-335). The WRUA's have responsibility over a defined water catchment area, such as Gura, where Thuti sublocation and Kiandego is located.



Figure 2: Chart showing the multilevel governance of water resources in Kenya

Applied methods

In the field, we applied various methods through our data collection. An overview of the applied methods is found in appendix 1.

Transect walk

One of the first applied methods was a transect walk through the village of Thuti, and along the pipeline of Kiandego, to achieve an overview of the extent of the irrigation project. This method allowed us to explore the project area, by walking with, and listening to, the local guides and village elder. The walk was 4 hours, where we started by the water intake (see image 1), and finished at the end of the pipe. We also tracked GPS waypoints during the transect walk, which were used for creating the map (see map on figure 1). The pipeline is dug into the ground, so we walked across the farms that the pipeline runs through. Passing through farms led to spontaneous interviews, farm walks and informal conversation with a few farmers, as well as the chairman of Kiandego, who joined us for the last half of the transect walk. During the following days, especially conducting questionnaires, we were also able to do transect walks of shorter length, on individual farms.



Image 1: Transect walk to the intake of Kiandego (Source: Own picture 2018)

Questionnaires

We carried out 32 questionnaires in total (see appendix 5 for questionnaire guide), reaching 26 members and 6 non-members of Kiandego. Of those, 18 were women and 14 men. The aim was to learn about the conditions of individual households. We divided our group into two teams, each team consisting of two students from University of Copenhagen, one student from University of Nairobi

and one local guide. The questionnaires were conducted both in homes and on farms. In order to achieve even spatial distribution, the teams started conducting the questionnaires from opposite ends of the Kiandego pipeline, coming towards the middle. We managed to reach households along the whole pipeline. We also tracked waypoints on the GPS at every household we visited. Our sample can be seen on the map (Figure 1). Our guides conducted the questionnaires in the local language of Kikuyu (see image 2), and the process was translated to us, so we could follow, give suggestions and clarify misunderstandings. This enabled us to continue into SSI's or transect walks on farms, as we understood what was at stake for the respondents. It took two full days to conduct questionnaires.



Image 2: Our guide conducting a questionnaire (Source: Own picture 2018)

Semi-Structured Interviews

Throughout the fieldwork, we conducted SSI's with both institutional stakeholders and farmers. We followed interview guides, prepared before the fieldwork. Many of the interviews gave us differing views and perceptions of Kiandego, which gave insight into the complexity and difficulties of the project. We conducted many SSI's with farmers along the pipeline, both non-members and members of Kiandego, on their farms or in their homes. Some were continuations of questionnaires, some were planned, and some happened by walking around and meeting farmers on our way. Often SSI's were combined with 'walk and talk' around the farm. This was very helpful, as collecting data *in situ*, made it easier for the farmers to remember and explain, and for us to ask relevant questions and understand. The knowledge and observations from SSI's with farmers, was of great importance to understand their perceptions and use of Kiandego, and the constraints they face in improving their livelihoods further.

Focus Group Discussion

In order to have members of Kiandego discuss challenges of farming and of the Kiandego, we arranged an FGD. The sampling strategy was to invite respondents from our questionnaires and SSI's, aiming for a balance of upstream/downstream members (which also match the dichotomies new members/founding members and two different clans), different point of views, and gender, avoiding committee members.

We conducted the FGD at the clan meeting place in Thuti, an outdoor public venue, which we considered to be somewhat neutral (see image 3). To start, 12 participants were present; 8 men and 4 women, and later 3 more men joined. Participants were seated on benches around a table. Joyce Nthuku, our Kenyan counterpart, facilitated the discussion, while the rest of us were observing and taking notes, from the interpretations done by our guides. We included PRA exercises, where participants first had to list the challenges they face in farming in general, and then rank them. Thereafter we asked them to identify and list possible solutions (see results in appendix 2).



Image 3: Focus group discussion, at the clan meeting place (Source: Own picture, 2018)

The listing, grouping and ranking of farming challenges facilitated a discussion amongst the participants, enabling them to contribute with their inputs and perspectives, on how the challenges relate to each other.

Participant observation and informal conversation

Observing and taking part in the community was done throughout our stay in the field. Although we didn't arrange for formal participant observation on farms, our stays with local host families served as participation in everyday home life in Thuti. Almost daily, we had a group meeting where our local

guides and elder also participated. Most days the setting was informal, with no set agenda or minutetaking. This created a space for informal conversation, which was helpful to understand the context of the community.

Results

Conceptual framework

The concept of livelihoods has been widely used in literature about poverty and rural development in the last couple of decades. In a definition provided by Ellis (2000), a livelihood "comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living". The sustainable livelihoods approach seeks to understand the factors that lie behind people's choice of livelihood strategies, to identify where to support rural people to succeed in their intended livelihood outcomes (DFID 1999). To understand how the Kiandego affects farmers' livelihoods, the Sustainable livelihoods framework (SLF, figure 3) is applied to structure our results as follows:

First, the section *Institutions and organizations* will deal with stakeholders, institutions and governance.

Then, the following section *Livelihood strategies and outcomes* will classify four broad categories of categories pursued by farmers.

The proceeding section on *Livelihood Assets*, will identify different constraints within the five types of capital, that determine which strategy members undertake.

Lastly, the section *Vulnerability and Perceptions of water availability and weather patterns*, deals with the vulnerability context.



Figure 3: The sustainable livelihoods framework (Source: DFID 1999)

Institutions and organizations

The results in this section intend to show which stakeholders are involved, and how. Results are mainly based on data from SSI's with committee members, institutional informants, the FGD, as well as informal conversation with guides.

The results show which institutions and organizations are involved with the Kiandego, to understand the existing structures and processes, which affect livelihood outcomes (DFID 1999:19-21). Though not exhaustive, the visualisation includes institutional elements such as markets and public sector stakeholders which affect the practice of the Kiandego.

Key stakeholders	Roles and responsibilities to Kiandego
Committee of Kiandego	 Facilitate operation and maintenance of pipeline Hold meetings to discuss intake and fees Write proposals (e.g. greenhouse)
Members of Kiandego	 Benefit from irrigation Optional participation in member meetings
Nyeri County Government	 Financial support for 2016 expansion Provide agricultural extension officers

Table 1: Identification of key stakeholders and their main roles and responsibilities (Source: SSI's, FGD)

The visualization of the stakeholder landscape in figure 4, centers around the Kiandego. The key stakeholders, shown in table 1; committee, members and Nyeri county government, are placed closest to the issue, in the orange circle. Primary and secondary stakeholders are placed in the surrounding outer circles, indicating that the further away from the center, the further away the stakeholders are from Kiandego, in terms of experienced influence. The visualization also includes a division of the three tiers of society; civil society, public sector, and private sector.



Figure 4: *Stakeholder landscape. Visualisation and graphic elements from GTZ stakeholder analysis.* Own figure. (Source: SSI's and FGD)

The graphic elements symbolize different types of relationships between the stakeholders (appendix 3). The solid lines symbolize a close relationship, e.g. between the committee and members of Kiandego. The thicker a line, the closer the relationship. Nyeri county government and Othaya water officials are shown as two separate stakeholders, since our respondents referenced them as two separate entities, and because they have influenced the project differently.

The relationship between the committee and Othaya water officials is shown as a close relationship, based on statements indicating that the officials in Othaya were useful when starting the project, as well as with conflict resolution (SSI 2, 5). This is also the reasoning behind placing the Othaya water officials as a primary stakeholder in the landscape. Brokers set prices for the market, which is why they have a close relationship on this map, further indicated by the arrow, which symbolizes dominance. However, brokers and market are currently secondary stakeholders to the Kiandego. The market, as a concept, and the local schools are visually grouped together in this stakeholder landscape, although brokers only set prices for some markets, and not the schools.

Dotted lines symbolize weak or informal relationships, such as between the Gura WRUA and the irrigation project, and the Nyeri County government. The question mark is added because the relationship between these public institutions is unclear. The placement of the WRUA as a secondary stakeholder is because, as the Othaya irrigation officer stated, *"the WRUA's are not known by the*

farmers." (SSI 3). The weak relationship between the county government and the members of Kiandego is based on the county government not living up to its responsibilities, according to the chairman and results from FGD (SSI 2, FGD). Namely the county is lacking in providing agricultural extension officers, as well as acting on proposals made from the committee. The relationship between the members and the market, including schools, is suggested as weak, based on indications that members don't have sufficient knowledge, cooperation or access to markets (SSI 2, 7; FGD).

Downstream users of the stream are deemed as being secondary stakeholders, that are negatively affected by Kiandego. The lightning bolt represents a conflict-laden relationship, based on statements from downstream users about low water levels since the expansion, as well as rumours about a vandalism attempt on the Kiandego intake (SSI 17, 19).

Agro-chemical companies are placed as a secondary stakeholder to the Kiandego, based on statements about their involvement with selling fake seeds and pesticides to the farmers, as well as training agricultural officers (FGD). However, their relationship to other stakeholders has not been visualized, partly because it was unclear whether these companies trained public or private agricultural officers.

Many different stakeholders are involved in the Kiandego, to differing degrees. The members and committee have the closest ties to the project. The Kiandego and the committee have relatively close relationships with Nyeri county and Othaya water officials, but no connection to the WRUA. Brokers and markets are secondary stakeholders, with ties to each other, and with a weak relationship to the members. Downstream users of the stream have a conflict-laden relationship to Kiandego.

Livelihood strategies and outcomes

It is possible to divide the members into four broad groups in terms of their livelihood strategies, presented in table 2. The strategies are based on data obtained from questionnaires, SSI's, observations, transect walks, and informal conservations.

Livelihood strategies Description		Experienced benefits
1. Commercial farming and for own consumption	Irrigation is used to intensify production and to grow crops off- season. Main incomes are from coffee and horticulture crops such as cabbage, kale, maize, and bell peppers. Includes innovative farmers (flower producer, wedding garden).	 Less dependent on unreliable rainfall Convenient supply of water (compared to carrying from river) Increased food security from more stable production of crops and fodder Intensified production Substantial cash incomes
2. Farming for own consumption and small markets	Irrigation is used to grow crops off-season and to support current production. Small incomes from coffee and surplus production. Produce is often sold to other members in the community.	 Less dependent on unreliable rainfall Convenient supply of water (compared to carrying from river) Increased food security from more stable production of crops and fodder Small cash income from slight increases in production
3. Subsistence farming	Irrigation is used to secure a maintained production. Production is not intensified, and crops are not sold to the market.	 Less dependent on unreliable rainfall Convenient supply of water (compared to carrying from river) Increased food security from more stable production of crops and fodder
4. Subsistence farming and use of Kiandego water for domestic purposes	Irrigation is used to secure a maintained production and as a cheap source of drinking water. Production is not intensified and crops are not sold to the market.	 Less dependent on unreliable rainfall Convenient supply of water (compared to carrying from river) Cheap source of domestic water

Table 2: Typology of the 4 different livelihood strategies of Kiandego members, conceptualized from data (Source: SSI's, FGD)

A general feature in the area is a high level of self-sufficiency. All our respondents farmed for own consumption, but the amount of produce, that they sold to the market, varied. Especially for the older farmers, the Kiandego water is mainly used as a cheaper source of domestic water, and not for irrigating crops (SSI 5, 10; IC). The difference between strategy 1 and 2, is the amount of cash income from farming. Strategy 3 is only growing for own consumption and use irrigation to have a more secure and stable production. Strategy 4 is also subsistence farming, but uses the water for domestic purposes, and does not, or to a limited degree, use the water for irrigation.



Image 4: A member of Kiandego (belonging to strategy 1) showing his production of flowers (Source: Own photo 2018)

All interviewed members stated that they benefit from the irrigation in some way, and in the FGD, there was a consensus that the project overall was beneficial. As one farmer puts it, "*It has really impacted life positively, now people are engaging themselves into farming, because it is easier*" (SSI 13).

A committee member stated that the community at large benefits, that lives have improved, and that people have more food for themselves (SSI 7). Although the general perception was positive, farmers had different motivations for joining the scheme, utilized the irrigation in different ways for different purposes, and the way the project impacted farmers' livelihoods varied. When asked in the questionnaires, how their livelihoods had been affected by Kiandego, all indicated positive changes, and the answers can be categorized under five topics of experienced benefits as seen in figure 5. Of the 32 respondents, 6 were not members, one was member but not connected, and two respondents did not answer the question. Of the remaining 23, the most frequent experienced benefits are increased income (7 respondents), increased productivity and food security (6 respondents), and the ability to farm throughout the year (6 respondents). Three respondents answered that farming has become easier, as they no longer have to fetch and carry water from the river. One answered that the community at large has improved from Kiandego.



Figure 5: Chart showing the experienced impact of Kiandego on members' livelihoods. Topics are coded from statements made in the questionnaire, at the open ended question: "Has your livelihood changed since you joined the irrigation scheme?" Because of the open ended question, the answer from one respondent could fit into two of the topics, after coding, allowing "multiple answers" (Source: Questionnaires)

Having access to irrigation allows the farmers continuous planting throughout the year, whereas no access to irrigation restricts production in the dry seasons. For some, irrigation has meant a change in farming practices. Irrigation allows farmers to switch from perennial cash crops, such as tea and coffee, to more labour intensive horticulture, to get income several times a year, instead of annually (SSI 3: Irrigation Officer). The increased potential for farm production seems to be utilized in different ways as reflected in the different livelihood strategies. For some of the farmers, irrigation has allowed them to increase production to substantially increase their cash incomes. As put by one of the more successful farmers, who belongs to livelihood strategy 1: "The difference is that people can sell now, people come from far away to buy cabbage, onions... People are empowered economically" (SSI 13: Flower producer). For most farmers the project has not provided substantial increases in cash income. For example, a female farmer, who joined the project with a wish to intensify production and raise income, has only experienced a slight increase in monthly surplus and cash income (SSI 16). For many, irrigation has meant a more stable supply of water. This should be understood in the context of increased water shortages, which will be elaborated in the results section on "Perceptions of water availability and weather patterns". The benefit of having access to irrigation has thus meant not just increased production and cash incomes, but secured and sustained production as well. One farmer mentions that after joining the project, she is able to save money on food, because she is now selfsufficient (SSI 14).

Another benefit that farmers mentioned is ease of farming. One participant at the FGD stated that "the benefit is that water is closer now" (FGD). Being a part of the project gives them easy access to water, where previously they had to depend on rainfall, or carry it from the river. For many, especially the older farmers, transporting water was a strenuous effort in the undulating terrain. According to one farmer, the challenge of fetching water from the river, was part of the motivation for the community coming together and creating the project, and stated: "A woman could get 2 gallons, and then the day is gone. Rainwater was not enough. Most people didn't have the capacity to buy the tanks for collecting rainwater. They sometimes even had to take the cows to the river, but now they can use the water for domestic use" (SSI 13). The Kiandego water is a cheaper alternative to the piped

domestic water, because it requires a one-time contribution, whereas the piped water supplied by a water company requires a monthly fee. A number of households use Kiandego as a supply of domestic water for purposes including cooking, cleaning and drinking. This could be a potential health risk, as the water is untreated, and the intake is inadequately filtered. One committee member even suggested treatment of the water so that it could be used safely for domestic purposes (SSI 5).

Livelihoods of non-members of Kiandego

There are indications that Kiandego is impacting water availability of downstream non-members negatively. There are several other water projects from the same stream as Kiandego. Some people downstream are using furrows to redirect the water from the stream to their farms, and less than 200 meters downstream from the intake of Kiandego, is another intake to a gravity-fed pipeline for irrigation, that supports seven households (see figure 1, with the map of the area). Before the pipeline was expanded in 2016, the old intake of Kiandego used to have overflowing water at the catchment, but since the expansion, water levels in the catchment have dropped, and no longer spill over. This has resulted in less water downstream, for both furrow users and for the small irrigation project. As the furrows have less water, and some are drying up, they have become an unreliable source of irrigation (SSI 17).

A family from the small irrigation scheme stated that water availability had dropped since Kiandego expanded (SSI 18). This was confirmed by a farmer, also using the smaller irrigation scheme, who conveyed how water availability has dropped significantly since the Kiandego expansion, and that he no longer has adequate water for his crops (SSI 19). A farmer living close to the Kiandego intake stated how he one night had stopped a group of men trying to sabotage the intake, and he was certain that it was non-member downstream users feeling frustrated about the decreased volumes of water available to them (SSI 9). This belief was shared by another member, who even said that "*They are our enemies*", when talking about the smaller downstream irrigation scheme, and claimed that there were many conflicts between the two irrigation schemes (SSI 17).

Accordingly, there are indications that the Kiandego has resulted in disputes and has had negative impacts of the livelihoods of downstream users.

The issue of the full potential of irrigation

Many informants, in either government, leading or managing positions or high-productive farmers, emphasize how the Kiandego project is not used to its full potential. It seems to be the general perspective, that there is an advantage to be taken of the irrigation, that people do not realize (SSI 1, 2, 8, 10). As the chairman simply puts it: "The water has not been used for its full potential" (SSI 2). It is his perception, that only five or six farmers are currently using the full potential of irrigation to intensify their production, sell to the market and improve their livelihoods. According to a committee member, not a lot of members produce for the market. A few farm cabbages, some peppers, but not many (SSI 7). This was confirmed in the FGD and through informal conversations and participatory observations. With some individuals and some of the more productive farmers, there was a feeling of frustration, that not more people were intensifying their production and entering the market. The project engineer implied that livelihood improvement is ready and available, by stating: "People have not seen the potential of improving their livelihoods with this almost free water, and farm all year round instead of depending on the rain" (SSI 1). The assistant chief held the same view: "The members are able to grow cabbages, tomato, arrowroot... but not many do it! For many it is basically assisting the napier grass. Only a few people take full advantage of the irrigation" (SSI 8). This frustration seemed to stem from a wish to see their community grow and develop. The experience of the full potential not being used is further supported by the FGD and SSI's with individual farmers, where they stated that they face several constraints in their general farming and experience barriers of entering the market.

Livelihood assets

Access to irrigation affects the members differently, because members of Kiandego do not pursue the same livelihood strategies, nor obtain the same livelihood outcomes. The SLF suggests that people require a range of assets to achieve a positive livelihood outcome. It is important to consider if a certain sequence of assets is necessary to enable development, and if some assets are sufficient to escape poverty (DFID 1999: 5-16).

By analysing assets and capitals, we can understand what factors determine the members' different livelihood strategies, and the way they benefit differently from irrigation (ibid.). From our data, we are not able to identify which particular assets enable a certain livelihood strategy. Instead, our data is on barriers constraining the use of irrigation, which is categorized under the five capitals, shown on figure 6. Issues within each capital will be elaborated below the figure.



Figure 6: Barriers constraining the use of irrigation, categorized as issues under the five capitals from SLF (Source: SSI's, FGD)

Human capital

The SLF points out that human capital, being e.g. knowledge and labour, is a prerequisite to make use of any of the other types of assets, but not in itself sufficient to facilitate a positive livelihood outcome (DFID 1999:7). The farmers generally experience their lack of knowledge as lack of training (FGD). One farmer indicated the necessity of human capital to make use of other assets, by stating: *"You can*"

have finances and access [to irrigation], but if you don't have knowledge, your soil will maybe go bad, and you cannot pay back the capital you rented. You need training" (FGD). The lack of knowledge and training is mainly associated with the absence of the agricultural officer, and most members can't remember the last time they saw one. It is believed that the agricultural officer should assist with knowledge on the best inputs for the area and climate, as the farmers don't know what the best seeds are, and they experience pesticides not working (FGD). In the FGD, lack of markets and exploitation by brokers came up as an issue, as the farmers experience that the government has abandoned the farmers, letting the brokers set low prices and bring fake pesticides. They feel that they don't have knowledge about the market and how to market their produce, making farming unprofitable (FGD).

A minority of members experience adequate access to knowledge. One member states that an agricultural officer is catering for their needs, by bringing seeds and pesticides (SSI 13:Flower producer). Also, a committee member explains, that the committee has met with the county agricultural officer, and been given advice on planting flowers in their greenhouse (SSI 5).

Members of Kiandego stated the issue of ageing households, that cannot provide enough labour for intensive farming (SSI 9, 15). The former chairman confirms, by stating that *"the project could really help people, but there are no young people with skills, capacity and knowledge for using the potential"* (SSI 10).

From this, we can argue that, within the group of members, there are different degrees of access to knowledge and labour, setting the foundation for how the members are able to use other types of assets.

Social capital

Social capital in SLF is understood as "the social resources upon which people draw in pursuit of their livelihood objectives" (DFID 1999: 9). The Kiandego group of members can be seen as a formalized group, with agreed upon rules and regulations. In the self-help group, where members and committee are relatively close (see stakeholder map, figure 4), there is some degree of social capital. Despite this, resourceful farmers, committee members, and government stakeholders, point out the difficulty of mobilizing the community, mainly in terms of collective action to enter the market together (SSI 2, 3, 8, 13). The chairman of Kiandego believes that there is a general resistance to change, amongst the members of Kiandego, and expresses his frustrations, in the way that: "The project is meant to bring change, potentially decreasing poverty levels. Bringing something new, like the irrigation scheme, would expect to change farming practices, but there is lack of will" (SSI 2). The chairman has undergone training and has tried to train the members, be an example, motivate and inform them of the option of commercializing their farming, and cater for a market together. Still he experiences that the members don't want to let go of what they know, and venture into commercial farming (SSI 2). The assistant chief confirms, by stating that "Whatever their forefathers did, they will do [...]" (SSI 8). According to SLF, social capital can develop through networks between people with shared interests, that increase people's ability to work together (DFID 1999: 9). As mentioned earlier, many different motivations for joining Kiandego came up in the questionnaires, reflecting different interests, that may decrease their ability to work together. As one of the resourceful farmers state: "Not all have a passion for the same, a passion for farming" (SSI 13), and these different interests might influence the buildup of social capital for the members.

Throughout the data collection, the difficulties of organizing and managing a community project came up. Members point to issues of the management of the project. As a member and former vice chairman states; *"There is still a problem in management. The chairman goes to the meetings, but maybe the secretary doesn't come... and he has the books"* (SSI 12). This results in no minutes being

taken, and no records. When the committee is not functioning, it reflects on the members. As a member puts it: "*Most of the time, the committee is not together - and then the members are never together. The management is not in unity*" (SSI 16). In the FGD, members commented that there are clear rules and regulations, but that the management doesn't follow the constitution and its bylaws. This gives the members an experience of lack of transparency and accountability, e.g. on how money is spent (FGD, SSI 12).

Another issue identified, is how members take part in the project. The former vice chairman has experienced that *"there was more cohesion, cooperation with only 25 people* [before the expansion in 2016]. *Everyone took part and it was easier to make decisions"* (SSI 12). In the SLF, it is pointed out that *"social capital can also be actively, though often unintentionally, destroyed through heavy-handed interventions that impose new social relations without taking into account the strengths of the old"* (DFID 1999: 10). The expansion of the project through government intervention, has created a division of 'new members' and 'founding members', which also happen to be two different clans (IC). The former vice chairman has experienced, that because of the way the pipes are connected, the founding members closer to the intake often lack water whereas the new members, further away, always have enough. According to him, the new members see no need to cooperate, because they have a steady supply of water, and hence do not show up for meetings (SSI 12). On one hand, the expansion of the project may have decreased the social capital of members, in terms of relationships of trust and connectedness within the group. On the other hand, it can be argued that Kiandego has brought people together in a community project, positively influencing social capital.

Natural capital

Natural capital is a term describing *"the natural resource stocks from which resource flows and services* [...] *useful for livelihoods are derived*" (DFID 1999: 11). For assets in the natural capital, it is important to consider access and quality of the natural resources, and how both are changing.

As most members base their livelihood on farming, they strongly depend on natural capital, being land and water. The issue of small land size was mentioned during the FGD, as the small plots of land are considered insufficient for large-scale farming for a bigger market. During transect walks, it was clear that a substantial part of the farmers' land was not used for crops, despite access to water all year round. The quality of land is an issue in itself, since farms in the area are situated on very sloping land, making the cultivation challenging, and also impacting the efficiency of sprinkler irrigation (PO). Besides land, the members have access to the water source from the stream, through the pipeline (physical capital), which increases the value of the land. Natural capital is closely related to '*the vulnerability context*' in the SLF, as it is affected by e.g. climatic and ecological shocks, trends and seasonality. The status of the water resource from the stream, is elaborated in the section "*Vulnerability and perceptions of water availability and weather patterns*".



Image 5: View of the undulating landscape of the Kiandego area, looking down towards the river. (Source: Own photo 2018)

Physical capital

In the FGD, a participant declared: "*Let's start with the intake. Everything needs water to grow. Forget about pesticides, seeds, fertilizer*" (FGD). The issue of the intake was ranked as one of the most impactful challenges by the other participants as well (FGD), indicating how water for irrigation is considered vital for success in farming. Several issues with the intake were brought up, both in the FGD and SSI's. Respondents mentioned several issues with the intake; that it's small, in bad condition, lacks a lock, and lacks a filter to avoid blockage and to secure quality of the water (FGD, SSI 5, 7, 13). The intake from the stream and the pipes to the farms can be identified as physical capital, based on SLF's definition of physical capital as infrastructure that has changed the physical environment, and helps people meet their basic needs and be more productive (DFID 1999: 13). A challenge of physical capital, such as the intake and pipes, is that they both require initial investment, and a commitment to ongoing human and financial capital to cover the costs of operation and maintenance.

Financial capital

Lack of financial capital was expressed as a barrier for members (SSI 5, 9, 13, 16, FGD). Both committee members and ordinary members of Kiandego comment that initial financial capital to buy farming inputs and labour, is a barrier of using the full potential of irrigation. As put by a member: *"Sometimes we have shortage of seeds and fertilizer, so even when we have the water, it is a challenge"* (SSI 16). The lack of financial capital seems to challenge both the individual use of the potential of irrigation, but also the coordination of farming across households, to produce a steady supply of horticultural crops for a local market (SSI 5, 9, 13, 16).

Summary of livelihood assets

It is argued that the issues and barriers of farming, identified through the data collection, are expressions of lack of different capitals. As assets and capitals interlink and set conditions for each other, their extent for the individual farmer limits and determines the livelihood strategy, that the farmer can pursue.

Vulnerability and perceptions of water availability and weather patterns

The vulnerability context in the SLF deals with the external environment of people's livelihoods. It includes factors of trends, shocks, and seasonality. The factors are important because they directly affect people's lives by impacting on asset status and the options available for them in pursuit of livelihood strategies (DFID, 1999: 3). In the area of Kiandego, people's livelihoods are shaped by a wider context of trends including ageing households, urban-rural migration, fluctuations in domestic and export markets, and climate change. This section will focus on water availability and increasingly unreliable weather patterns, as they are experienced by the farmers.

The perception of water supply among villagers in the Kiandego area is rather positive. The majority of the respondents (90,6 %) indicate, that they feel secure in regards to water resources (figure 7). Many point out that the stream, from where the water of Kiandego originates, runs at all times: *"Even during the most severe droughts the stream is always running and it will run forever"* (IC with member). However, some of the farmers mentioned that during the dry season, there is a problem of water availability and not enough water to meet the demand of all the members (SSI 10, FGD). As mentioned previously, it is believed that a reason for inadequate water supply is the small intake. A challenge with Kiandego is that the water resources remain unknown. There is currently no quantified data on the water supply. As the irrigation officer said: *"Water conservation programs and conservation efforts are really behind"* (SSI 3). This happens because of lack of knowledge about the resources as well as lack of control of the water flow through the pipe and water use of all the members. Gura WRUA, when asked about the water resources that supply Kiandego, indicated that they are planning to assess the water volumes of the water reserves below Karima Forest assisted by a hydrologist (SSI 6).



Perceptions of water and food security



Generally, people in the Kiandego area, are aware of the climate change issue, and express notions of changes in water volumes, as well as weather patterns. The chairman of the Gura WRUA states that: *"All the small streams used to be big rivers"* (SSI 6). Also, the assistant chief points out that: *"The spring comes from Karima Hill. When we were growing up there were so many streams. Now they are all underground"* (SSI 8). The irrigation officer had similar thoughts about levels of water in the Othaya region, and states that *"the rivers are drying up"* (SSI 3).

Most of the farmers and officials related to Kiandego, believe that the main driver of climate change that results in longer droughts and less rainfall, is deforestation. The general perception is that planting trees can mitigate changing rainfall patterns, and restore water resources (SSI 6). Some of the farmers mentioned that there used to be much bigger glaciers and more snow on the top of Mt. Kenya, showing that they notice climatic changes (SSI 8). Nonetheless, they are certain that the water stream that serves Kiandego, is unlimited.

From our questionnaires, 42% of the respondents stated that 'farming off season during dry period' (22,6%) and 'having enough water for farming when there is no rain' (19,4%), were the main motivations to join Kiandego (figure 8). Other motivations were: passion for farming, source of income, increased production, the burden of fetching water from the river, secure supply of drinking water, passion to do social work and development, and opportunity of irrigation. The distribution of all the motivations is presented in figure 8. This indicates how people try to adapt to the changes of the environment and climate. They believe that connection to the irrigation scheme will decrease their vulnerability to climate change. This is supported by the words of the engineer, one of the founding members of Kiandego: *"With changing rainfall patterns and the realization of climate change, irrigation is a way to meet the changes"* (SSI 1).



Motivations for joining Kiandego Irrigation Scheme

Figure 8: Chart showing the distribution of motivations for joining Kiandego. Categories are derived from thematic coding of answers in the questionnaire at the question: "If a member, what motivated you to join the irrigation scheme?", allowing multiple responses from coding of one respondent's answer. The chart is based on 32 responses from 26 members (Source: Questionnaires)

Discussion

Methods

Gate keepers and interpretation

Our interpreters being well known in the local community was beneficial when conducting research, as the informants were comfortable speaking with them. However, we can't be sure that vital points didn't go missing through interpretation. An example of this was during the FGD, when the guides were conducting simultaneous translation, sometimes when several people were speaking. It was a hot day, and our interpreters naturally became tired towards the end of the discussion.

Positioning and ethics

During our fieldwork, we were aware of our position as outsiders, getting only a snapshot of the situation and a simplified understanding of the culture in Thuti. Our guides and elder were of great importance, as gatekeepers to the community, alleviating the negative impacts of being outsiders.

We were often perceived as researches, not simply students, when interacting with informants, which may have affected what people told us, in hope of receiving donations or other assistance.

Our Kenyan counterparts are, besides being students, full-time government officials. They often took the position of a government official, made recommendations, and asked confrontational questions, which may have affected some of the interviews.

Reflections on applied methods

When considering what influenced the results from the questionnaire, we can recognize in hindsight that some of the questions could have been asked in a clearer manner, to make the results easier to use for generalization purposes (Harrison, C. 2007). E.g. a yes or no question asking, "*Do you feel secure in regards to food and water*?" should have been two separate questions.

When using SSI's, we decided not to record and transcribe interviews, to save time. Instead, multiple group members took notes, which helped to confirm that we all understood the same points. However, when writing our report, quoting paraphrased notes is not as exact as if we had the direct quotes. Another main reflection on carrying out SSI's in the field, is that we had not always made our roles clear, which may have disrupted the flow of conversation.

There are a few considerations from the FGD that may have affected our results. The data collected at the FGD only reflects the views of those who participated, who as a group seemed interested in commercializing. This risks the erroneous conception of community (Brockington & Sullivan 2003: 62-63), as some of our results are based on the statements of the few, on behalf of the community. It may have affected our results, by making a few generalizations based on statements of a not necessarily representative group.

Our findings in a broader context

Management of irrigation projects

A paper published by the International Water Management Institute in 2002, from the collection "*The changing face of Irrigation in Kenya*" states that operation and maintenance is one of the weakest links in irrigation systems (Freeman & Silim 2000:265). Some of the reasons are shortage of funds and poor management of catchments (ibid.), which coincides with our findings.

More recent research on community managed water projects in Kieni West district of Nyeri County, also state that long-term success of any water program depends on effective arrangements for operation and maintenance (Kinyua et al 2015:126). The research indicates that there generally seems to be inadequate financial management skills with water management committee officials, resulting in resources being inappropriately or ineffectively spent (Kinyua et al 2015:136). Our findings about the management of the Kiandego coincide with these research results. Although the study is from a different district in Nyeri, there are several factors making the Kiandego a comparable case to these results, including a high degree of community involvement during the construction phase, and the type of water technology being gravity fed, which was also most prevalent in the study.

As presented in the results section, the Kiandego has experienced challenges with management, such as lacking transparency and record-keeping. The committee of the Kiandego are working on introducing monthly fees for operation and maintenance costs, but are challenged both by members lacking financial capital, and trust issues because of alleged misappropriation of funds. When connecting the findings of the Kiandego to the research from Kieni West district, the lack of efficient management could potentially affect the project negatively. However, lack of transparency and a coordinated management effort does not necessarily stem from a lack of motivation. The research from Kieni West states that village level rural operation and maintenance needs ongoing support to succeed, since the services cannot always be managed by the community alone (Kinyua et al 2015:125). Lack of support from e.g. agricultural extension officers and the Gura WRUA could negatively affect the ongoing success of Kiandego. Furthermore, lack of training the committee in financial management could also hinder the viability of the project.

Irrigation as adaptation to climate change

In the study from Bryan et al. (2013), 94 % of the farmers interviewed perceived an increase in average temperature, and 88 % observed a decrease in average precipitation over the past 20 years. Furthermore, Bryan et al. (2013) found that 50 % of the farmers believe that the implementation of an irrigation system, is the best way to adapt to climate change. As shown in the results section, most of our respondents had experienced changes in weather patterns. Still, they perceive that the water in the stream is abundant. Based on this belief, farmers that are connected to Kiandego feel more secure in terms of water availability and less vulnerable to changing rainfall patterns, in accordance with the results from Bryan et al. (2013). The main challenge with adapting to climate change through irrigation is that it is expensive and not everyone can afford it (ibid.).

When it comes to future climate scenarios, several papers, indicate that the temperature will rise and rainfall patterns will change, which will most likely result in less rainfall (Bryan et al., 2013; Parry et al., 2012; Vision 2030). This implies that in the future the case of water resources might be a problem, as the water volumes will be more scarce. With this awareness it is very important to have data on the water resources that supply irrigation schemes, as it is a key to sustainable management of the water use. In the near future, in the case of scarce water, the demands of the farmers may not

be met, and they will again be more vulnerable to climate change, undermining their livelihood assets and challenging livelihood strategies.

Main challenges for adaptation to climate change in Kenya are lack of quantitative and sectorspecific data, lack of downscaled regional and local results of global circulation models, low capacity to conduct adaptation analyses, difficulty coordinating between actors and low technology development (USAID, 2012). Although the members of Kiandego feel less vulnerable, there is a lack of quantitative data about water volumes, and it is uncertain if this could negatively affect their adaptation to climate change if water levels in the streams drops in the future. If farmers base their livelihood strategy on irrigation, and changing rainfall patterns make water levels in the stream scarcer, this could undermine adaptation and potentially make them more vulnerable.

Livelihood pathways

Investigations of rural poverty and the application of the SLF have been criticized for being too static; that they are capturing merely a snapshot of assets, resources and strategies, and neglecting that these are dynamic and changing over time (Scoones 2015: 41). Yet, livelihoods are constantly changing as people have different aspirations, accumulate assets, invest, diversify, and go in new directions; they must find ways to cope with unexpected shocks, deaths of family members, market collapses, harvest failures, or political unrest. The concept *sustainable* implies that livelihoods are stable over time, are robust, and are resilient to external shocks and internal stresses (Scoones, 2009: 188). Research and development interventions should therefore undertake approaches that try to understand the future or the different pathways of livelihoods.

Poverty alleviation can be understood both as a poverty decrease, where people are becoming better off over time, and as poverty prevention, where people are not falling deeper into poverty (Angelsen & Wunder, 2003). Building on a dynamic conceptualization of poverty, Dorward et al. (2009) propose a framework, that classifies three, simplified livelihood pathways of the poor: 'hanging in', 'stepping up', and 'stepping out'. As touched upon earlier in this report, members have different motivations for joining the project, which reflects different livelihood aspirations. Some were pursuing a 'hanging in' strategy, where irrigation would allow them to maintain their current welfare by increasing farm security in a climate with increased unreliability of rainfall patterns. Others had adequate assets and capabilities to pursue a 'stepping up' strategy, where they invested and expanded their current strategy of farming to increase production and income, to improve their livelihoods.

Our study did not observe any households 'stepping out', which refers to existing activities being used as a 'launching pad' into other, different activities. A study by Franks et al. (2013) done in Usangu Plains in Tanzania over a 40 year-period, investigate how water governance and access to water and irrigation can affect rural development. They found that some water users, who prosper season after season, use their increased resource base as a launching pad for further expansion and investments in new landholdings. As for Kiandego, long-run aspirations of the successful farmers might include a wish to take advantage of their increased incomes to engage in non-farm activities.

A literature review of case studies from Asia shows strong linkages between irrigation and poverty reduction (Hussain & Hanjra, 2004). Access to irrigation has the potential to alleviate poverty in several ways. Smith (2004) identifies four ways in which irrigation can alleviate rural poverty:

- (1) Improvements in the levels and security of productivity, employment and incomes for irrigating farm households and farm labour
- (2) Linkages in the rural economy and multiplier effects

- (3) Increased opportunities for rural livelihood diversification
- (4) Multiple uses of water supplied by irrigation infrastructure.

Our study confirms the points 1 and 4. Regarding (1), members of Kiandego experienced increased security and raised incomes. Regarding number (4), apart from irrigation, some farmers also used the water for drinking, washing, and cooking, and some of the older farmers did not use the water for irrigation at all, only for domestic purposes. As for number (2), it is unclear how Kiandego links to the rural economy and affect the community at large, and would require further research, but since most members are 'hanging in', and not 'stepping up' or 'out', we can speculate that multiplier effects are minimal.

The ability to benefit from irrigation

A number of constraints inhibit farmers from pursuing a 'stepping up' or a 'stepping out' strategy. Through the analysis, it is clear that assets and capitals interlink and set conditions for each other simultaneously. The physical infrastructure of Kiandego gives members access to water. But the access to water does not support the full use of irrigation, unless it is coupled with development of access to other capitals. The lack of social capital, such as skills and capacities within the committee, and trust between the members, undermines the foundation for the group to work together effectively, and overcome financial, maintenance and market barriers, constraining the build up of financial and physical capital. With this insufficient social capital, lack of cohesiveness within the group, and following lack of attendance at meetings, they are not able to facilitate the development and sharing of knowledge, to increase human capital. As well, the issue of inadequate land size (natural capital) for commercialization, could be alleviated by coordinating production within the group.

To understand why the members pursue different livelihood strategies, it is necessary to consider the existing structures and processes, that enable or disable the strategies. Social capital is closely tied to 'structures and processes' in the SLF, since social capital can be understood as a product of these structures and processes (DFID 1999: 9). The donation of the irrigation infrastructure from the county government, has not been coupled with training through the agricultural officer or regulation of markets, being part of the reason why the intended outcome or full potential has not yet been achieved. As DFID (1999: 14) points out, "Assistance for basic infrastructure provision is most effective when it is part of a broader plan for improving the effectiveness and coherence of government", implying that structures and processes not only create assets, but also determine who benefits from these assets, through governance, to favour development.

Since members of Kiandego do not pursue the same livelihood strategies, nor obtain the same livelihood outcomes, it is clear that access to irrigation affects the members differently. In *Theory of Access* by Ribot and Peluso (2003), they distinguish between property, as 'the right to benefit' and access as 'the ability to benefit'. This supports how *the right* to benefit from 'things', such as an irrigation system through paid membership, does not necessarily result in members deriving benefits from irrigation. It is evident why the full potential of irrigation is not utilized, as the ability to benefit from irrigation is supported or constrained by the individual member's access to assets and capitals, and dependent on structural and relational access mechanisms, which must be taken into account, when researching and understanding outcomes of a rural development project, such as Kiandego (Ribot & Peluso, 2003).

In line with our results, a study from Meru, Kenya found that smallholders using irrigation face several market constraints, including lack of infrastructure, lack of quality inputs, post-harvest

losses, high assembly costs, market fluctuations and uncertainties, and lack of adequate information about markets (Freeman & Silim, 2000).

As mentioned, social capital affects how people organize and mobilize. A study by Kelly et al. (2017), on management in rural, community-based water-systems in Kenya, Ghana, and Zambia, found that social capital and sense of ownership are inherently linked, and that they facilitate different forms of community participation. Social capital can play a role in water committee elections, resource mobilization, and information sharing, and sense of ownership can affect organizing and enabling water system decision processes, and participation in physical labor. In Kiandego, the cohesiveness of the group was lessened after the expansion, resulting in challenges of participation, communication, attendance of meetings, and mobilization to overcome market barriers.

In a review of smallholder irrigation technology, Kay (2001: iv) argue that modern irrigation technology can possibly enable smallholders to move from subsistence farming to growing cash crops. It is found that the technology uptake is influenced by many external factors, and that the most successful irrigation projects, are the ones improving existing farming systems, rather than introducing radically new ideas (Kay 2001: iv). He points out that *"Smallholder irrigation schemes develop through a slow incremental process of improvement, usually in response to farmer demand"* (Kay 2001: iv). This reiterates in our findings, as the farmers' absorption capacity by Kiandego, bringing possible change, is taking place in a context of many other issues related to farming and the broader society, stagnating the intended change.

Conclusion and recommendations

This report focuses on the Kiandego irrigation project, and how it affects farmers' livelihoods. From our findings, irrigation through Kiandego can provide a pathway out of poverty by increasing production, incomes, and living standards, and it can prevent people from falling deeper into poverty by increasing resilience and security. Most Kiandego members use the irrigation to 'hang in' with subsistence farming, while a few uses the potential to 'step up,' by expanding their strategies and increasing income. Irrigation affects the members' livelihoods differently, because of differences in the range of assets each farmer has, in order to achieve positive livelihood outcomes. Collectively, the members of Kiandego experience challenges constraining the use of irrigation to increase outcome; such as lack of knowledge about farm inputs and markets, limited financial capital, insufficient construction of water intake, as well as difficulties in organizing and managing a community project.

We identified a gap in the multi-level governance, between the Kiandego and the local-level WRUA, which has the responsibility of monitoring water usage and preventing conflict. The governance gap between the WRUA and Kiandego could negatively affect farmers' livelihoods, because the lack of monitoring the water supply could have unfortunate repercussions for the water resources available. Changing rainfall patterns are expected to make water levels more scarce in the future, making monitoring and conservation efforts crucial for securing livelihoods dependent on irrigation. The issue of lacking water supply monitoring also has negative consequences for livelihoods of downstream users of the stream, not connected to Kiandego.

We have argued that irrigation in general and membership of Kiandego also can be seen as an adaptation strategy. Although the water supply has not been quantified, farmers feel less vulnerable to climatic changes when connected to Kiandego. Since irrigation decreases dependence on rain-fed agriculture, they are less vulnerable in a changing climate of prolonged droughts and increasingly unreliable rainfall patterns.

Based on our findings, we have identified a set of recommendations for improving the utilization of Kiandego. To achieve higher incomes while avoiding exploitative markets, farmers could organize in small groups, and sell horticulture crops to the local schools. Since the farmers experience lack of knowledge and training, they could collectively arrange for a visit from the agricultural extension officer. To support the success of Kiandego, we recommend that the Nyeri county government supply agricultural extension officers, as well as facilitate management training for the committee. Lastly, monitoring of the water source should be carried out by the WRUA, to assess water availability in the future.

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List of SSI respondents

- SSI 1: Engineer and founding member
- SSI 2: Chairman of Kiandego, Zachary
- SSI 3: Othaya Irrigation Officer, Godfrey Mathu
- SSI 4: Male committee member
- SSI 5: Female committee member
- SSI 6: Gura WRUA (Secretary, treasurer and chairman)
- SSI 7: Female committee member
- SSI 8: Assistant chief of Thuti sublocation, Peter Maina
- SSI 9: Non-member, with own irrigation system
- SSI 10: Former chairman of Kiandego
- SSI 11: Female farmer, non-member,
- SSI 12: Former vice chairman, respondent 24
- SSI 13: Male member, flower producer, and former chairman
- SSI 14: Female farmer
- SSI 15: Old male member
- SSI 16: Female farmer, member
- SSI 17: Male farmer, member of Kiandego, using furrows as well
- SSI 18: Female farmer and her daugther, part of the downstream irrigation scheme
- SSI 19: Male farmer, part of the downstream irrigation scheme

Appendices

Appendix 1: Table of overview of applied methods Appendix 2: Results from FGD Appendix 3: Page 15 from GTZ Tools for Stakeholder analysis (visualisation of stakeholder mapping) Appendix 4: Synopsis Appendix 5: Applied questionnaire

Appendix 1 Table of applied methods

Transect walk	1 of pipeline (+ GPS) Several on farms
Questionnaires	32 respondents (+ GPS)
SSI	20 informants
FGD	1
Participatory Rural Appraisal (PRA)	1, during FGD: Problem ranking
Participatory observation (PO) & informal conversations (IC)	Numerous

Appendix 2 Results from the focus group discussion

Ranking	Challenges
1	Exploitation by brokers Lack of capital to carry out farming Lack of markets Intake not adequate Training
2	"Fake chemicals" by brokers No soil analysis, to know the right seeds and fertilizers
3	Income does not succeed price of input Agricultural extension officer absent (visited 30 years ago) Fungal infections in horticultural crops and soil (because of fake chemicals) Soil will be bad in future because of overuse of of pesticides (it is cheaper than digging)
4	Produce, especially from greenhouse, gives cancer because of pesticides Small land size
5	Young people abandoning farming, leaving it to old people, because of expenses in farming

PRA exercise - identifying and ranking challenges related to farming

PRA exercise - identifying solutions to challenges

- Enlarging the intake
- Rationing install a water lock at the middle of the pipeline, to share water between upstream and downstream
- Having meetings with all members
- Planting trees at the intake
- More greenhouse, with fewer members using each
- Request the government to analyse their soils
- Alternative energy sources and biogas

Procedure: Stakeholder mapping

Two examples of visualisation:



Onion:

Has the advantage that stakeholders can be allocated initially to three sectors, public sector (state), civil society, private sector.

 Identification of stakeholders, representation of the individual stakeholders by circles and squares of different sizes.

Graphic elements:

V

The circles represent the primary and key stakeholders who have a direct influence on the project; the size of the circle stands for the degree of influence this stakeholder has in relation to the issue and the change objective. The letter V means that this is a veto player.

The squares represent secondary stakeholders who are not directly involved but still (potentially) have an influence.



Issue and change objective

Rainbow:

Has the advantage of greater clarity. Stakeholders can be allocated to the three sectors using three rainbows. This gives rise to a network architecture and explicitly raises the question of the interfaces between the sectors.

2. Representation of relationships between the stakeholders (strength of relationship, alliances, cooperation, conflict, etc.) using lines and arrows:

Basic graphic elements:



Solid lines symbolise close relationships in terms of information exchange, frequency of contact, compatibility of interests, coordination, mutual trust, etc. Dotted lines symbolise weak or informal relationships. The question mark is added if the relationship is unclear. Tramlines symbolise alliances and cooperation that are organised contractually or institutionally. Arrows symbolise the direction of relationships of dominance. Solid lines crossed by a bolt of lightning symbolise tensions, clashes of interest and conflict-laden relationships. Short lines crossing a solid line symbolise relationships that have broken down either temporarily or irreparably.

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Photo of cabbage in irrigated field, Karima location. Christian Pilegaard Hansen

Kiandego irrigation scheme

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Introduction

Climate change models and predictions suggests temperature increase between 3°C to 4°C in Africa by the end of 21st century (Bryan et al., 2013). It means that changes of climate will be more significant in Africa compared to the global mean. Rainfall patterns are likely to change in the way that are less predictable, having a shorter time of precipitation and more intense (Bryan et al., 2013). Shortening of the rainy seasons leads to longer dry periods which puts a pressure on food suppliers. Those changes, which are already occurring, are having a strong impact on the level of agricultural productivity. Kenya, just like other African countries, is highly vulnerable to climate change because of limited capacity to adapt. Only 17% of the whole land in Kenya is suitable for rain fed agriculture, which is a dominant source of staple food and cash crop (Bryan et al., 2013). That is why, with changes in precipitation and population growth, the irrigation schemes are of high importance regarding adaptation to climate change as well as food security. Irrigation systems are implemented to increase yields and gives opportunities to grow crops off season.

Governance of water in Kenya was fundamentally changed with the Water Act in 2002. Before this shift, policies and official governance of water had not been changed since the 1950s, when Kenya was still a British colony. The colonist policies were focused on central administration with some local offices, and permits for water extraction had to pass through both local and national officials, which could take several years, and often resulted in illegal extraction of water resources. Even though bottom-up community projects were taking place, coordination between schemes in different communities, sharing the same watershed, did not occur, and the centralized water governance, being far from the watersheds, therefore had issues with enforcing compliance of permits, securing sustainable extraction. With the 2002 Water Act, regulatory authority was divided into a multi-level governance system, with local, regional and national actors (Baduri et al., 2014).

In 2002, same year as the Water Act was implemented, some community members living in Karima location near Othaya constructed a water intake with open canals, to irrigate their land. Despite a considerably high rainfall in the area and suitable agricultural land, a need to diversify livelihoods from coffee growing to other cash crops was urgent, since the price on coffee was dropping. In 2014, the villagers requested the Nyeri county government for assistance to pipe the irrigation scheme, and at the same time, a communal greenhouse was established. After piping, the irrigation scheme now has a capacity of 120 households, and a committee of 9 members is managing the scheme. The piping has also resulted in payments and fees for registration, as is common in most irrigation schemes throughout Kenya (Kinyua et. al. 2015). The piping has apparently enhanced the level of conflicts surrounding the Kiandego irrigation scheme, compared to before, when open canals were the only infrastructure, and no fees were collected.

The Kiandego irrigation scheme can be seen as an example of a common pool resource (CPR), which is managed in a common property regime. Since Hardin (1968) argued that state ownership or private property regimes were necessary to avoid a 'tragedy of the commons', a growing body of literature now suggests that common-property institutions and community-based management schemes may be appropriate for sustainably managing CPRs. Community-based management are promoted for addressing two goals: environmental sustainability and improved livelihoods (Sick, 2008). Common property regimes have a number of theoretical advantages that makes them appropriate for managing CPRs: it strengthens local participation and democracy and increases equity and fairness. Moreover, local users are presumed to possess greater knowledge of the resources upon which the depend for their livelihoods, and a greater concern for protecting that resource. Establishing clear common property rights, can thus create incentives for environmental stewardship (Sick, 2008). However, reality can be different than the frameworks indicate. Social relations and local institutions often play a significant role in shaping the distributions of benefits. Common property regimes have the potential to consolidate local unity and collective action or to exacerbate existing inequities and contribute to conflict and environmental degradation.

Because of the structure of common property regimes, local communities and committees have the main role in managing irrigation systems. Previous research on water systems in Nyeri County indicate that many water systems fail due to inadequate arrangements for operations and maintenance (Kinyua et al 2015, p. 138). The same study indicate in their conclusion, that the Kenyan government focuses more on building new facilities, rather than ensuring the viability of existing systems. Other studies on irrigation by smallholders confirm that benefits for some, lead to loss of benefits for other water users (Franks et al 2013, p. 10). These results suggest that irrigation schemes may not be a sustainable means of securing livelihoods, if they often fail due to poor management, and if the benefits to some negatively affect others.

Many factors are important to consider, when aiming for long-term sustainability of water systems, such as the Kiandego irrigation system. Irrigation has long been implemented as a means to fulfill food security in Kenya. In order to support rural development through water resources, it is essential to understand both the physical materials, and the arrangements for access, including the political processes of water governance (Franks et al 2013, p.14). The knowledge gap we aim to fill, is assessing the potential of the Kiandego irrigation scheme, as a means of sustainable development for the community. This leads us to our overall research objective:

Problem Statement:

Overall research objective:

To research governance, livelihood strategies, and biophysical aspects, in order to assess the sustainability of the Kiandego irrigation scheme.

Research questions:

1) Governance: How is the governance of the irrigation scheme?

1.1 Who are the different stakeholders and what roles do they play in the governance?

1.2 What are the informal and formal property rights at play?

1.3 What informal and formal institutional drivers and barriers determine who has access, and who doesn't?

2) Livelihood strategies: How is the irrigation scheme affecting farmers' livelihood strategies, both those connected and not connected?

2.1 Who is connected and who is not?

2.2 What are the household/livelihood characteristics of members of the irrigation scheme, and how have they changed over time?

2.3 Does the irrigation scheme affect the livelihoods of people not connected and how?

2.4 Has the irrigation scheme affected farmers' resilience?

3) Biophysical aspects: How is the irrigation scheme and water availability affecting each other?

3.1 Which types of irrigation practices exists?

3.2 What are the water supplies at source, and the status of availability?

3.3 Is the irrigation scheme affecting water availability in the community?

3.4 What are the local perceptions of climate change and changing rainfall patterns? Have they changed over time?

Methodology

"Good research, whether qualitative or quantitative, is basically that one is friendly and engaging with people and open to learning from what they tell you and from what you observe and experience." (Brockington and Sullivan, 2003)

Transect walks

We plan to begin our research with transect walks. Transects are maps or diagrams of an area, constructed together with local informants, by walking through the area of interest, while observing, interviewing and discussing. Transect walks can give an overview of the different aspects of the research such as topography, farming practices, cropping systems, farm management as well as general knowledge of the community (Mikkelsen, 2005). We consider this method relevant to begin with, to grasp what might be going on in the community. We think it could be beneficial to do transect walks with people from different generations or genders in order to see different perspectives and point of views, on the community.

Questionnaire

A questionnaire is a structured research tool with written questions that aim for gathering standardized information from many respondents using few well-defined variables. We plan on conducting a survey to identify different stakeholders, to get information about household and farm characteristics, and irrigation practices.

Sampling will take departure in a transect walk of where the pipeline is situated, so we can approach households near the irrigation scheme for questionnaires. We aim towards responses from an equal division of members and non-members, possibly 30 in total.

We will conduct the survey in the first days, and use it as a way to get around, see the village, to meet people, and introduce ourselves. It is our hope that we will identify key informants, who we might wish to return to for further interviewing. In agreement with our Kenyan counterparts, we will each do a draft questionnaire, which we will finalize and test when we meet in Nairobi and again with the interpreters in Othaya

Stakeholder analysis

The objective of a stakeholder analysis is to identify, and map, which stakeholders play a role in the given issue or project. It can be used to identify the importance of different stakeholders' roles, as well as shed light on their goals and interests, and how they seek to obtain their agenda. The method can also be used to assess the stakeholders' mutual relationships and networks (GTZ 2007 p. 9). The chosen framework for composing a stakeholder map is the GTZ method of multi-stakeholder management which includes 10 building blocks, that can be applied separately or in combination, depending on the relevance for the project. The starting point is the first building block, which is identification of key stakeholders. Identifying key stakeholders starts with speaking with local resource persons. Mapping stakeholders includes determining positions and core functions, based on three markers; roles and legitimacy, resources and responsibility, and relationships and networks (GTZ 2007 p. 13).

Composing a stakeholder map requires analyzing the landscape of stakeholders, which can be achieved through researching the governance of the irrigation scheme. We aim to achieve understanding of the stakeholders through information gained via semi-structured interviews with key informants, as well as general respondents. The framework includes a matrix for stakeholder mapping, which acts as a structured overview (see appendix). We plan to be able to fill out the matrix in the report-writing phase, based on the data and interview results collected in the field work.

Semi-structured Interviews (SSI)

SSI's are a useful method to apply, when seeking to understand the world through interaction and interpretation (Brockington & Sullivan 2003, p. 57). The format typically includes an interview guide of open-ended questions, combined with follow-up questions when relevant issues present themselves. This gives respondents the possibility of fully expressing themselves (Kasley & Cumar 1989, p. 14).

We plan to use SSI to help us understand both governance, livelihoods strategies as well as biophysical aspects of the irrigation scheme. Key informants, who can provide relevant insight on the Kiandego irrigation scheme, may include members of the secretariat and WRMA regional officers. General respondents, who can provide information about their everyday lives and experiences, include farmers in the area, both members and non-members of the irrigation scheme. When relevant, SSI will be combined with PRA. This could e.g. be relevant when seeking to understand the history of the irrigation scheme, where SSI's could be coupled with historical timeline diagrams. We will determine which PRA are appropriate to combine with SSI in the field.

Participatory Rural Appraisal (PRA)

We see a great potential in applying various approaches from the catalogue of different methods within PRA, to elicit conversation, loosen up and break down barriers, both linguistic and cultural. PRA is usually applied in order to enable the informants to somehow participate in the research process. Through the different methods, they are invited to lead and determine the content of the research and share their knowledge and perceptions of their own situation (Brockington and Sullivan, 2003).

As we are planning to map out the stakeholders surrounding the irrigation scheme, we find it valuable to assess how the members of the irrigation scheme perceive the institutional landscape. As a group exercise, we would like to invite respondents to draw a Venn diagram/Chapati diagram, which is a relational method that seeks to have respondents

mapping what they consider to be the social groups existing in their community, here in relation to the irrigation scheme. Also, the respondents will try to relate the social groups to one another, as in which groups have more influence than others, in terms of managing the water resource and the irrigation scheme (Mikkelsen, 2005). Comparing this to SSIs with officials will hopefully give us ideas of both formal and informal governance, and if there exists a discrepancy between how the water resource and irrigation is managed on paper and in reality.

It would be interesting to facilitate the making of historical timelines and seasonal diagrams with a group of respondents to elicit discussion and get an understanding of respondents' perceptions on changing climate and weather, the water resource and related security or scarcity over time.

When looking into the household characteristics of the members of the irrigation scheme, in order to assess livelihood strategies, we could combine SSIs with Resource Flow Mapping (RFM) and cultural mapping. As Strang (2010) puts it, moving through places, while interviewing people, can elicit memory, and thus give advantages in terms of data quality. A walk with farmers, on their own land *in situ*, is suggested to be more informative than static interviews that are out-of-context (Strang, 2010).

Participant observation

Participant observation is a highly ethnographic approach. Taking part in a situation or activity, while at the same time distancing yourself, noting and analysing, is demanding, but can give insight in the situation from the respondent's point of view. For triangulation purposes, participant observation provides insight into what the respondents actually experience, compared to results from questionnaires and interviews (Bernard, 2011). If possible we would like to join a farmer in irrigating his fields, understanding what actions and considerations are going on, what problems he might encounter and how he deals with them. As we stay with host families, they will probably provide useful information about way of life and community during informal conversations, as we take part in household chores, which could be classified "participant observation".

<u>GPS</u>

GPS method will be used to map individual households who are members of irrigation scheme, as well as those who are not. We want to map the whole Kiandego main irrigation pipe. Using GPS, we are planning to measure the area of different farms that we can combine with transect walks. Based on data extracted from GPS, our aim is to create a map which will contain the whole Kiandego irrigation scheme, members and non-members of the scheme, distances between households and the pipe, and areas of farmlands. We believe that such a map will give us an overlook of the whole situation in the area around the irrigation scheme. Our map can be a great basis to make further assessments.

GPS tracking will be combined with observation of water flow in the irrigation pipe. These observations can give us information about water availability and perhaps water supply at source. It can also give us information about use of water, which may be helpful in assessing the biophysical sustainability of the irrigation scheme.

Focus group discussion

The main goal of a focus group discussion is to get participants to converse among themselves, questioning, challenging and answering one another, rather than with the researcher. The method is relevant for achieving group-level data on perceptions and norms through observing inter-respondent interaction (Jakobsen, 2012). It is appropriate to apply where it is instructive to learn from the way people discuss, as much as what they actually say (Brockington and Sullivan, 2008).

We plan on conducting 2-3 focus group discussions. One group would be with members of the irrigation scheme and have them discuss the benefits of being connected and issues of decision-making processes, operation and maintenance. Focus groups discussions can be seen as "enactments" of social life, and another session could be with a mixed group of members and non-members, to uncover power dynamics and observe potential conflicts. If there are conflicts, the nature and severity will determine whether we decide to do this mixed group or not. A third option is to do a group of strictly non-members to potentially uncover controversial views and perhaps sensitive feelings of exclusion.

We plan on integrating PRA-elements, such as Venn-diagramming, seasonal mapping, and timeline-mapping in the focus groups. More on these methods under PRA.

Collaboration with counterparts

During the preparatory weeks before the field work, we have had beneficial communication with our Kenyan counterparts, Joyce and Harrison. We have corresponded over e-mails, held a skype meeting, as well as WhatsApp chat and phone call. We have very similar overall research objectives, especially reflected in our mutual interest for researching the governance aspect of the irrigation scheme. This will be interesting to research with our Kenyan counterparts, as they have great knowledge and experience on Kenyan governance, both academically and professionally. We look forward to in-person collaboration, where we see huge potential for interdisciplinary learning.

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Data matrix

Oreran objective.

To research governance, livelihood strategies, and biophysical aspects, in order to assess the sustainability of the Kiandego irrigation scheme.

Research questions/themes	Sub questions	Data required/Output	Methods
Governance 1. How is the governance of the irrigation scheme?	1.1 Who are the different stakeholders and what roles do they play in the governance?	Stakeholder map Knowledge about power dynamics, decision-making hierarchy, accountability Knowledge about governance over time	Stakeholder analysis Semi-structured interviews with: - Members of secretariat - WRMA regional office - Farmers in/out of the scheme PRA: Venn-diagram with members
	1.2 What are the informal and formal property rights at play?	Knowledge about existing laws and rules, legal framework, titles	Semi-structured interviews with: - Members of secretariat - WRMA regional office Possible observation in - Joining secretariat meetings
	1.3 What informal and formal institutional drivers and barriers determine who has access, and who doesn't?	Info on fees, requirements	 Semi-structured interviews with: Members of secretariat WRMA regional office Farmers in and out of the scheme
Livelihoods strategies 2. How is the irrigation scheme affecting farmers' livelihood strategies, both those connected and not connected?	2.1 Who is connected and who is not?	 GPS tracking Waypoints of members and non-members of irrigation system roads, fields, crops 	Mapping with secretary members of members and non-members - GPS and PRA GPS

	2.2 What are the household/livelihood characteristics of members of the irrigation scheme, and how have they changed over time?	Information about household and farm characteristics (crops) at members Off-farm Historical timeline, changes in crops Future prospects	Questionnaire SSI with farmers connected - cultural mapping PRA: Historical timeline or seasonal diagrams Focus Group Discussion: - Members: What strategies and benefits do they experience? with PRA: Venn diagram. Participant observation - Joining irrigating fields
	 2.3 Does the irrigation scheme affect the livelihoods of people not connected and how? 2.4 Has the irrigation scheme affected farmars' resiliance? 	Information about household and farm characteristics (crops) at non-members Future prospects Perceptions on farm security	Questionnaire SSI with farmers not connected Focus group discussion: - Non-members: Performing social norms and perceptions? SSI with members
			Focus group PRA
Biophysical characteristics 3. How is the irrigation scheme and water availability affecting each other?	3.1 Which types of irrigation practices exists?	Technological attributes of irrigation systems GPS waypoints of different types of irrigation system Impact on soil and water?	Questionnaire SSI Transect walks GPS mapping of irrigation system

3.2 What are the water supplies at source, and the status of availability?	Map of water spring Perceptions on water supply security	GPS mapping of spring/section of irrigation scheme PRA - historical timeline SSI with WRMA, AEO, secretariat - quantifying?
		Observing water flow, water intake
3.3 Is the irrigation scheme affecting water availability in the community?	Perceptions on irrigation scheme impacts	Observing water flow, water intake FGD: - Group of members - Non-members - Mixed group?
3.4 What are the local perceptions of climate change and changing rainfall patterns? Have they changed over time?	Rainfall patterns data.	PRA - historical timeline, seasonal diagrams SSI with farmers

Draft semi-structured interview guide:

Key informants - WRMA and Agricultural Extension Officer

Waypoint nr.:	Interviewer:
Note taker:	Interpreter:
Picture:	Data and time:
Key informant:	Others present:

Introductory

- Introduce ourselves, give thanks for their time, present research objectives
- Polite general conversation

Themes/questions

- 1. Which organizations and institutions play a role in the water governance and management in Nyeri County/Othaya? How has this changed over time?
- 2. What is the extent of irrigation in Nyeri County/Othaya?
- 3. What problems do you experience with managing water resources?
- 4. What problems do you experience with implementing and maintaining irrigation schemes?
- 5. What is the potential of irrigation in the region?
- 6. How do you enforce regulations?
- 7. Have you experienced any conflicts over water? Related to irrigation?

<u>Outro</u>

- Thank you!
- Contact information needed in case we would like to contact you again

Draft semi-structured interview guide:

Key informants - Secretariat of irrigation scheme

Waypoint nr.:	Interviewer:
Note taker:	Interpreter:
Picture:	Data and time:
Key informant:	Others present:

Introductory:

- Introduce ourselves, give thanks for their time, present research objectives
- Polite general conversation
- 1. Which organization and institutions play a role in the water governance in Nyeri Country/Othaya?
- 2. How did the Kiandego irrigation scheme start?
- 3. Who is in charge of maintenance?
- 4. Who decides the fees?
- 5. How is it ensured that the members uphold regulations?
- 6. How often do you hold meetings?
 - a. Who is invited?
 - b. Who participates?

Outro

- Thank you!
- Contact information needed in case we would like to contact you again

Draft semi-structured interview guide:

For general respondents: (ie farmers: members and non-members)

Waypoint nr.:	Interviewer:
Note taker:	Interpreter:
Picture:	Data and time:
Key informant:	Others present:

Introductory: Introducing ourselves and research objectives, polite general conversation

Members:

- 1. When did you first enter the irrigation scheme?
- 2. What motivated you to join?
- 3. Tell us about your membership.
 - a. Fees, requirements
 - b. Attend meetings?
- 4. What type of irrigation practice do you use?
- 5. How have your farming practices changed since connected to irrigation?
- 6. How has connection to the irrigation scheme affected your well-being?
- 7. How do you experience rainfall patterns in this area, presently?
- 8. How have you experienced changes in rainfall patterns?
- 9. How do you experience the maintenance of the irrigation scheme?
- 10. Have you experienced breakdowns or vandalism?
- 11. Do you know who to go to in case of breakdowns?
- 12. What are your future plans for your farm?

Non-members:

- 1. What are the livelihood activities in your household?
- 2. Has there been any major changes in your households' livelihood activities?
- 3. You're not a member of Kiandego irrigation scheme, do you use any other supplementary water collection?
- 4. What could motivate you to join?
- 5. Have you experienced any problems when farming? Have you done anything to improve?
- 6. How do you experience rainfall patterns in this area, presently?

Outro

- Thank you!
- Contact information needed in case we would like to invite you to participate in focus group discussion?

Appendix: Stakeholder mapping

To find key informants: start by asking resource persons:

- "(i) Who would you go to in order to learn more about the given issue?
- (ii) Who defines the rules in relation to the given issue?
- (iii) Who has particular knowledge and important resources in relation to the given issue?
- (iv) Who has a variety of relationships to other actors concerned with the given issue?" (GTZ 2007 s. 12)

Procedure: Identifying key stakeholders Putting the interview results into the matrix					
Potential key stakeholders in relation to issue and/or change objective	Position and ROLES AND LEGITIMACY	CORE FUNCTIONS OF RESOURCES AND RESPONSIBILITY	the Stakeholder RELATIONSHIPS	Discussion on forms of key stakeholder involvement	
Stakeholder 1			-		Í
Stakeholder 2					
Stakeholder 3			-		
Stakeholder n					
			As	sessment: strong medium weak	

Questionnaire

Waypoint nr.:	Interviewer:
Note taker:	Interpreter:
Picture:	Date and time:

Introductory:

- Introducing ourselves and research objectives
- The information will be treated confidentially

Personal data:

- 1. Name_
- 2. Relationship to the household: _____
- 3. Gender
 - Male
 - Female
- 4. Age_
- 5. Marital Status
 - Married
 - Never married
 - Divorced
 - Widowed
 - Other, please specify ____
- 6. What is your highest level of education?
 - None
 - Primary school
 - Secondary
 - Bachelor
 - Master
 - Other:

Household/Livelihood characteristics

7. How many members are there in your household?8. List the main sources of income of your household:

9. How big is your farm? _____ acres 10. How big is your farm compared to the rest of the community?

- Low
 - LowAverage
 - AveragHigh
 - High
 - Don't know/ don't want to answer
 - Do you feel secure in regards to food and water?
 - Yes
 - No

11.

• Do not want to answer

Check off which of the following farming practices you use:

- Commercial fertilizer application
- Manure

12.

13.

- Compost
- Pesticides
- Irrigation
- Collection of rainwater
- Intercropping
- Agroforestry
- Mulching
- Others:

Do you rent or own your land?

- Rent
- Own
- 14. If Rent, how much:_
- 15. Which levies do you pay? (list types and amount)

16. What are the main crops you grow? (List max. 5)

17. Please state any livestock in your household, and how many you own. Cattle:

- Goat: _____
- Sheep:
- Chicken:

Others:

18.

How much do you earn from your farm? (List source and incomes)

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Irrigation 19.

20.

21.

Are you a member of the Kiandego irrigation scheme?

- Yes
- No
- Have been, no longer
 - If yes, did you hold a managing position?
- Yes:____
- NO
 - Which irrigation practice do you use?
- Drip
- Cannals
- Sprinkler

22. scheme?_	Other, please specify: IF member, What motivated you to join the irrigation
23.	Has your livelihood changed since you joined the irrigations scheme? please state how:
24.	If not a member, would you like to join the irrigation scheme?YesNo
25.	Please state why:
26.	If you would like to join, what prevents you from joining the Kiandego irrigation scheme? • Land size

- Finance •
- geography •
- Don't know how to become a member •
- Other, please specify: _____

Outro

- •
- Thank you! Would you be willing to see us again? Contact information needed for follow up interview