APPLICATION OF GIS IN ASSESSING INTERVENTIONS TOTHE ADAPTATION OF CLIMATE CHANGE

CASE STUDY: SAKAI SUB LOCATION, MAKUENI DISTRICT, KENYA

FIELD WORK REPORT

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1. OVERVIEW

Climate change is a change in the statistical distribution of weather over periods of time that range from decades to millions of years. It can be a change in the average weather or a change in the distribution of weather events around an average (for example, greater or fewer extreme weather events). Climate change may be limited to a specific region, or may occur across the whole Earth. It can be caused by recurring, often cyclical climate patterns such as El Niño-Southern Oscillation, or come in the form of more singular events such as the Dust Bowl (Le Treut, et al. 2007)

The links between climate change and food security have, to date, largely been explored in relation to impacts on crop productivity and hence, food production. Climate change may affect food systems in several ways ranging from direct effects on crop production (e.g. changes in rainfall leading to drought or flooding, or warmer or cooler temperatures leading to changes in the length of growing season), to changes in markets, food prices and supply chain infrastructure (Gregory, Ingram and Brklacich 2005).

It has become clear from famine and hazards research that the key to assessing vulnerability is to develop research frameworks which can explicitly consider the social, economic and political constraints which condition the capacity of human systems (including food systems) to cope with external stressors such as climatic change, along with the magnitude and frequency of environmental stresses imposed on the system. Reducing the risks caused by climate change is an immense challenge. Scientists, policy makers, developers, engineers, and many others have used geographic information system (GIS) technology to better understand a complex situation and offer some tangible solutions. Technology offers a means to assess, plan, and implement sustainable programs that can affect us 10, 20, and 100 years into the future(Dangermond 2010).

1.1. Climate Change Is a Geographic Problem

A GIS-based framework helps us gain a scientific understanding of earth systems at a truly global scale and leads to more thoughtful, informed decision making:

- Deforestation analysis spurs successful reforestation programs and sustainable management.
- Study of potential sea level rise leads to adaptive engineering projects.
- Emissions assessment brings about research into alternative energy sources such as wind turbine siting and residential solar rooftop programs.

GIS users represent a vast reservoir of knowledge, expertise, and best practices in applying this cornerstone technology to the science of climate change and understanding its impact on natural and human systems (Dangermond 2010)Modelling and GIS Applications, calculates the scenarios of climate change and displays them in topographic and land use maps. These maps form the visual basis for the communication process on sea level change. As noted by (Walker and Young 1997)spatially organized data from different disciplinary sources 'can provide a platform much more tolerant of the needs of strategic policy makers and ensure that economists and ecologists are more aware of the spatial and environmental consequences of their recommendations'

1.2. Increasing Community Resilience to Drought

The arid and semi-arid lands that cover approximately 80 per cent of Kenya have long experienced water shortages and drought due to unreliable and poorly distributed rains. Smallholder farmers in these regions are used to coping with variable conditions, but the weather has become even more unpredictable recently—putting lives and livelihoods at greater risk. Accoridng to teh IPCC report 4, all of Africa is very likely to warm during this century. The warming is very likely to be larger than the global, annual mean warming throughout the continent and in all seasons, with drier subtropical regions warming more than the moister tropics.

Climate change will likely make matters worse. It is projected to lead to significant declines in rainfall and river flows in many parts of Kenya, particularly its arid and semi-arid regions. This additional stress further threatens the water and lands upon which smallholder farmers rely for their Livelihoods, health and well-being. Kenya must, therefore, identify and implement policies, processes and technologies to sustainably develop an agriculture sector resilient to current climate variability and long-term climate change. The Makueni District drought resilience project is addressing this challenge (Centre for Science and Technology Innovations - CSTI, 2009).

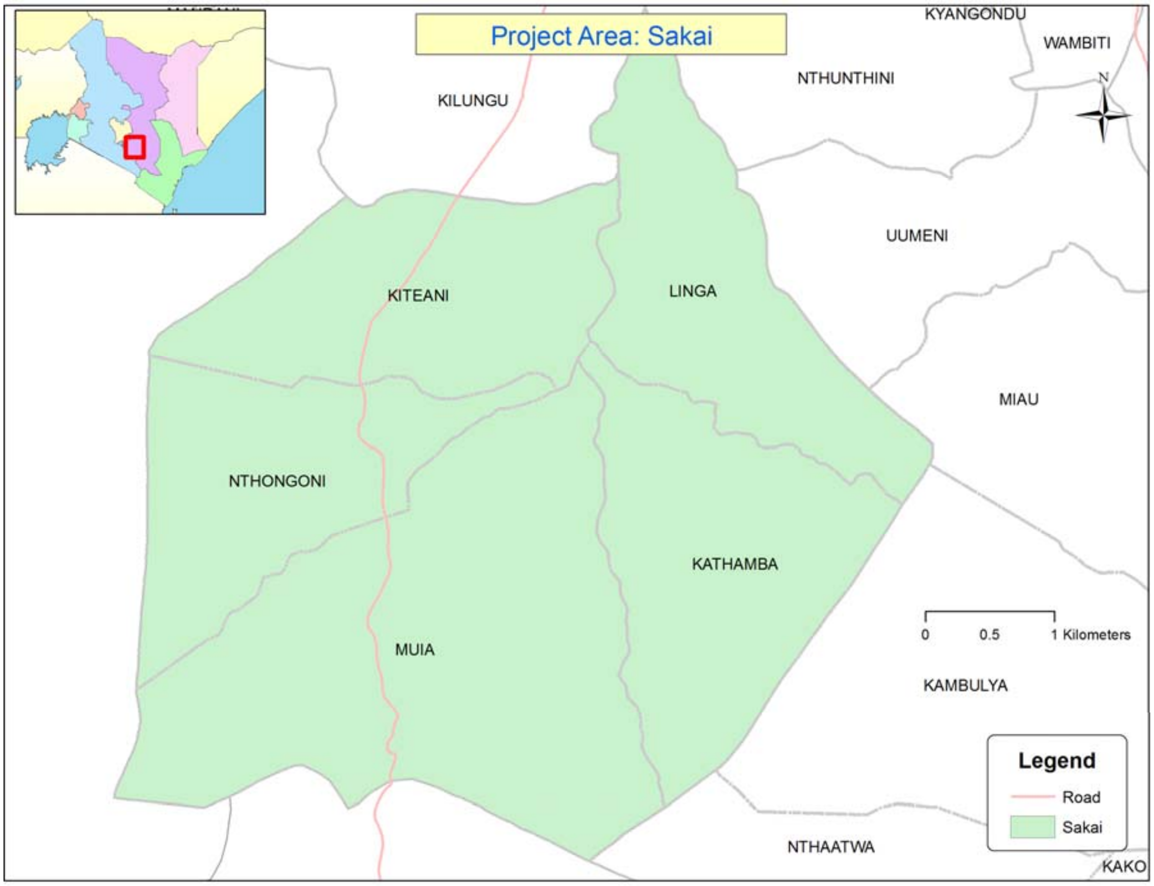
The project seeks to:

- increase food security by enhancing the drought resilience of local agricultural practices;
- reduce poverty through diversification of livelihoods; and
- facilitate the integration of adaptation to climate change into Kenya's sustainable development plans and policies.

2. Project area: Sakai Division Makueni District

The area has contrasts between the low-lying, sparsely populated grasslands in its southern reaches, the volcanic Chyulu Hills along its southwest border, and the more densely populated, resource-rich rolling hills found in its north.
In this mainly semi-arid district, rainfall patterns are highly variable in terms of their onset and duration. Drought and food insecurity are always a worry. A swelling population, land fragmentation and the migration of people into the sparser, drier lowlands, all contribute to Makueni's considerable vulnerability to current climate variability and long-term climate change. In response, this community drought resilience project initiated in 2006 in the northern sublocation of Sakai, Kisau Division, one of the regions of Makueni District that is most vulnerable to drought. The approximately 4,800 people living in Sakai rely on marginal mixed farming fed by rains that fall twice a year: the long rains of March/April; and the short rains of November/ December.

However, residents report that the long rains have become less predictable since the 1980s, leaving the community of Sakai increasingly dependent on only one reliable annual harvest. This vulnerability is exacerbated by a heavy reliance on varieties of maize, millet and cowpeas that are sensitive to drought. The project works to reduce vulnerability in Sakai through activities at the field and policy level. At the field level, the project increases household food security by enhancing the resilience of local agricultural practices and reduces poverty through livelihood diversification.



The Area is bordered by hills and some forest reserves as indicated in the image above

2.1. The Application of GIS in this project

The project contributes to the role of data and land information in land use decision-making by purposefully improving the type, quality and availability of land information and analysis. The key questions included: is new information being used, in what form, who is using it, and has the improved accuracy, specificity and availability resulted in different decisions?

2.1.1. Objectives

This project is a follow-up to the baseline study conducted in 2006. Baseline information was collected via the Socio - economic survey. It seeks to compare and contrast the situation as of 2006 and the situation in 2010.

2.1.2. Methodology

Similar to the exercise conducted in 2006, over 150 households were visited and mapped, and the basic information regarding the household was also collected. This included the ownership, membership to self-help groups and the locality. Several projects have been launched by the locals in collaboration with Ministry of arid lands and CSTI. These are:

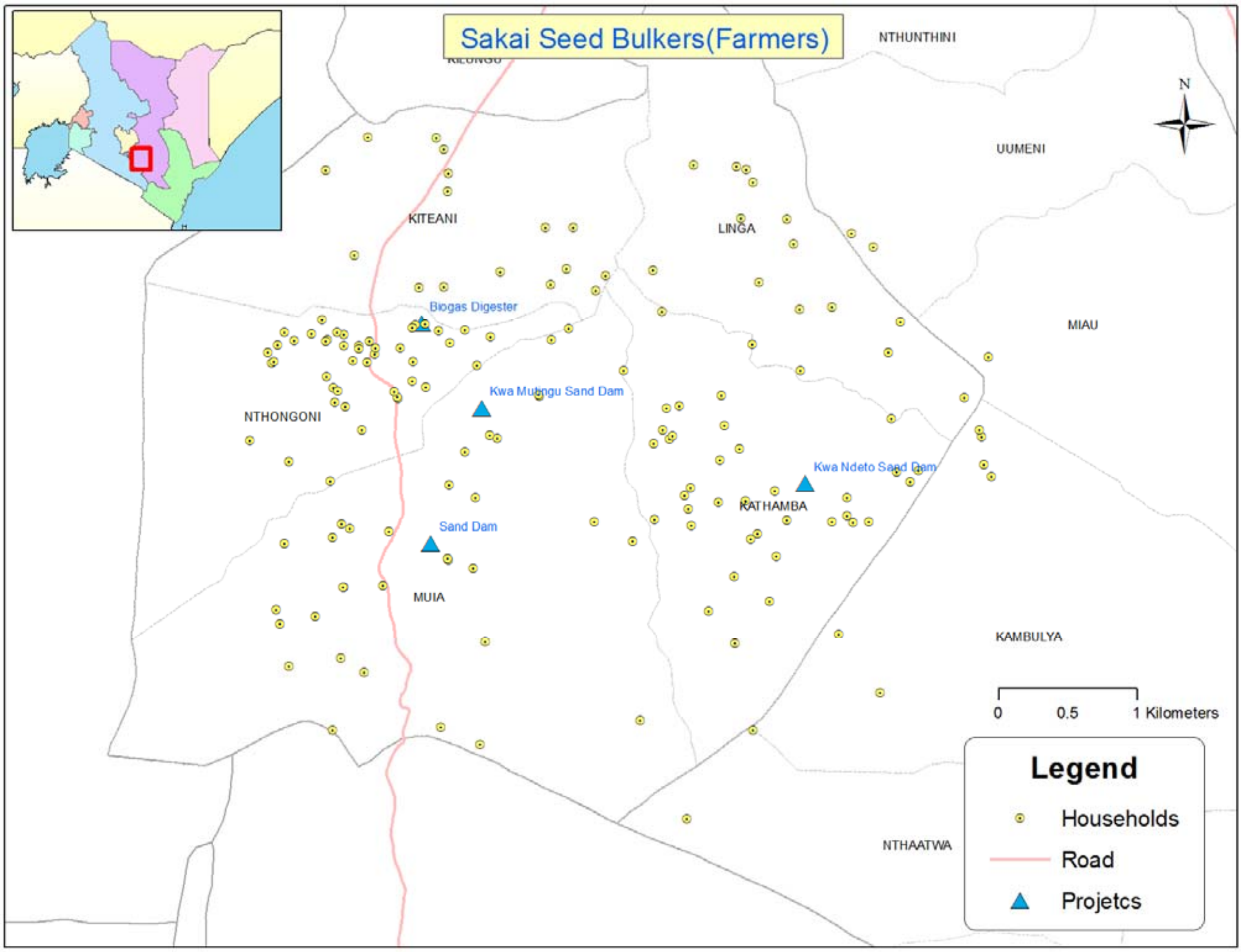
- Seed Bulkers (farmers)
- Biogas Project
- Micro – Finance (thro Women Groups)
- Sand dams

In addition to the households, the sand dams and Biogas locations were also mapped as shown in the maps below. The photographs of all the households and points were also taken and geo-referenced. Finally, a Google earth file will be produced to for sharing of the GIS maps and files on the Google earth and Google map platform on the World Wide Web.

The Biogas project was started in the neighborhood of Sakai primary school. It has a current membership of 20 members but expected to increase upon completion. As part of this project, a bakery will be set up to make baked products for sale. The following maps show the distribution of households as reported to have been registered in this project.

2.1.3. Sakai Seed Bulkers Farmers

In 2006, 75 households were mapped while in 2010 the same households plus about 100 more have been mapped thus providing the comparison characteristics in evaluating the project achievements. The map below shows the spatial distribution of the seed bulkers (farmers).



2.1.4. Micro finance - Women Groups

As part of gender empowerment and adaptation to resilience, the project in collaboration with donors is helping organized women groups by providing low interest loans to start and run income generating projects like small scale grain stocking / selling as well as merry go rounds.

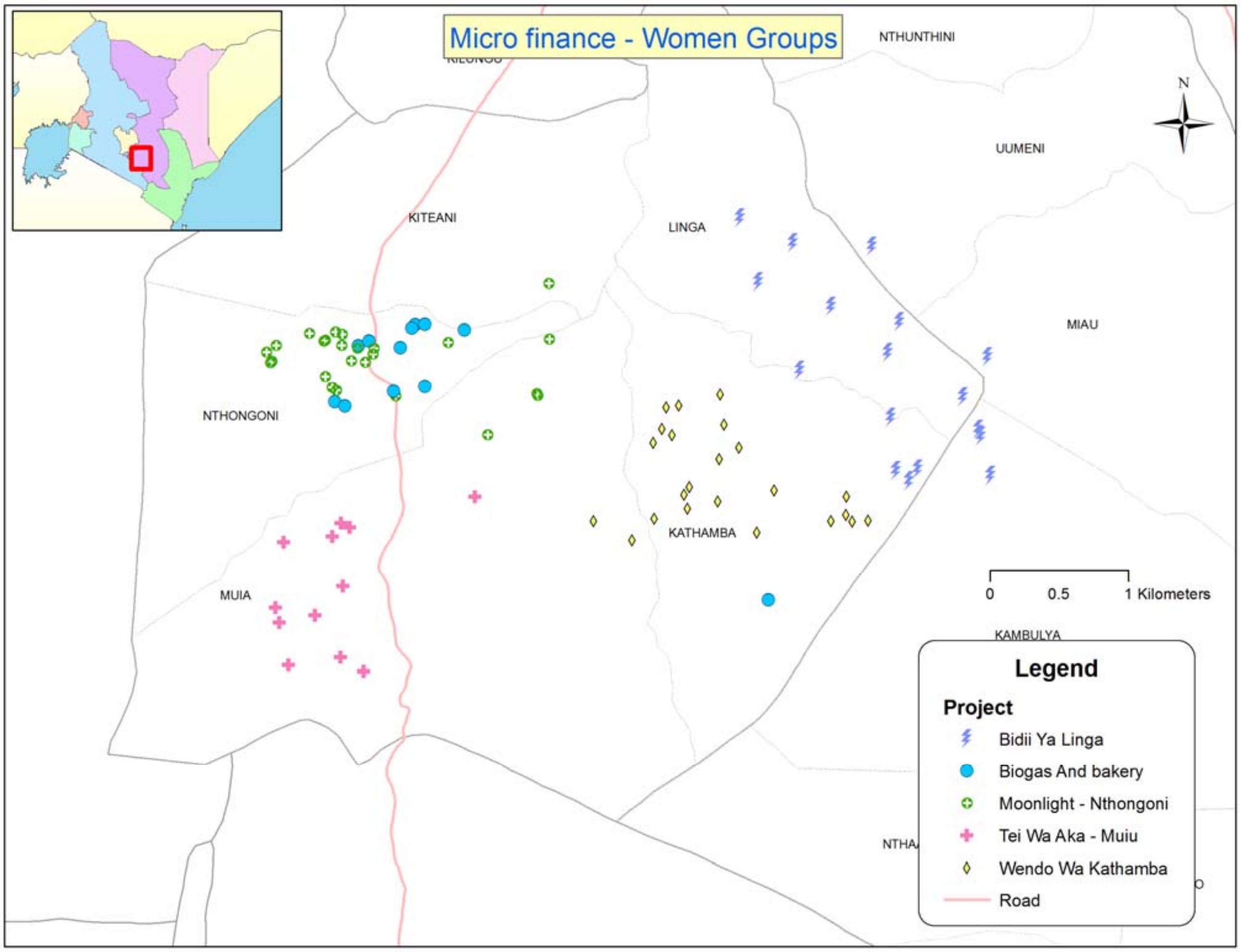
There are 5 women groups in Sakai area and all their individual households were mapped. These are:

- Bidii ya Linga – Linga / mba Village
- Tei wa Aka – Muiu Village
- Wendo wa kathamba – Kathamba Village
- Moonlight – Nthongoni Village
- The Biogas group

Group / Project	Members
Bidii Ya Linga	18
Biogas and Bakery	20
Moonlight - Nthongoni	43

Seed Bulkers	80
Tei Wa Aka - Muiu	12
Wendo Wa Kathamba	24

The map below shows the distribution of the households per group



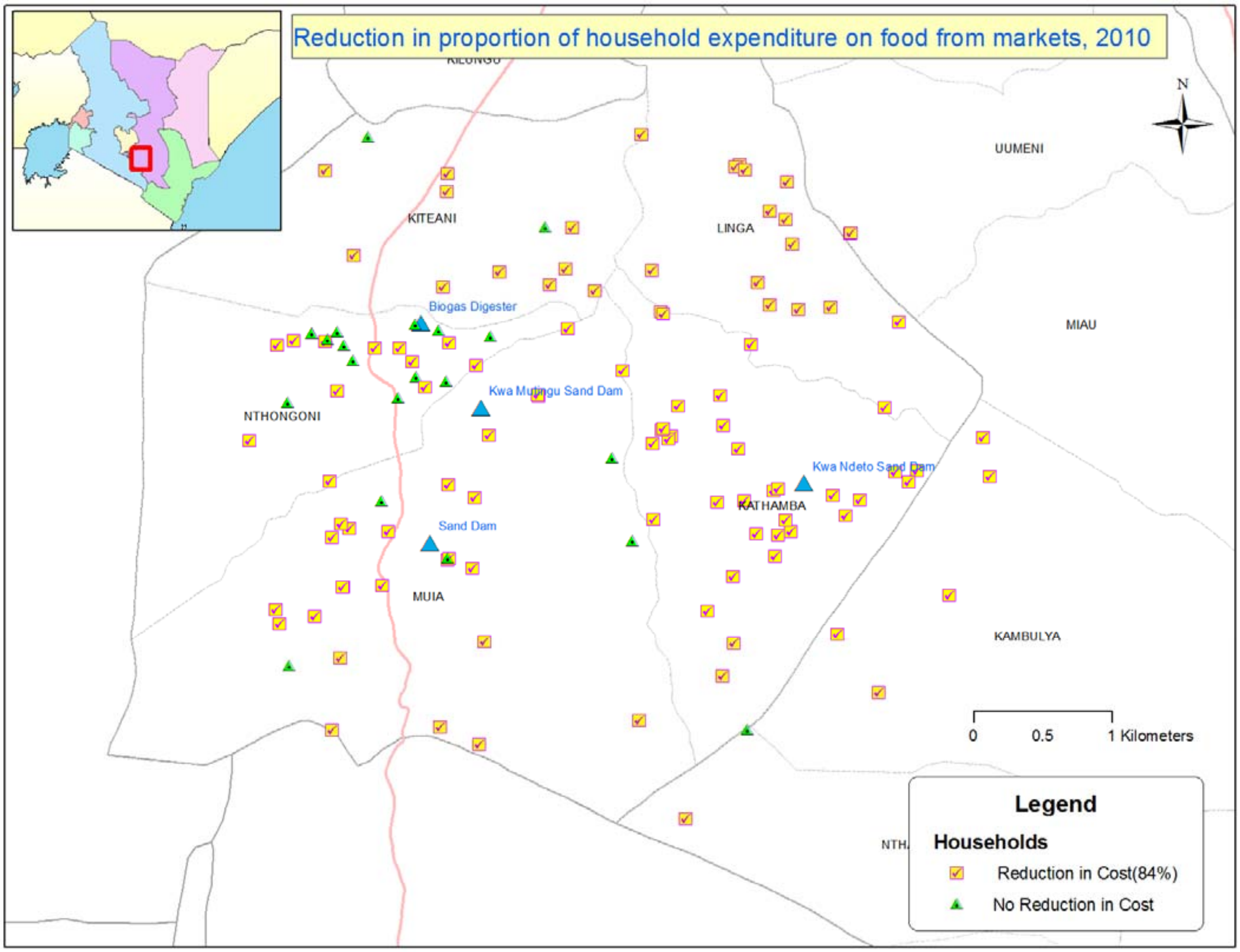
2.2. Integration of GIS into the Socio-economic Survey

In 2006, socio economic data was integrated with GIS data to produce spatial representation of the various household characteristics of the survey findings. This led to the production of maps which were used for dissemination. As a follow up, similar maps have been produced to provide visual comparison.

3. Findings

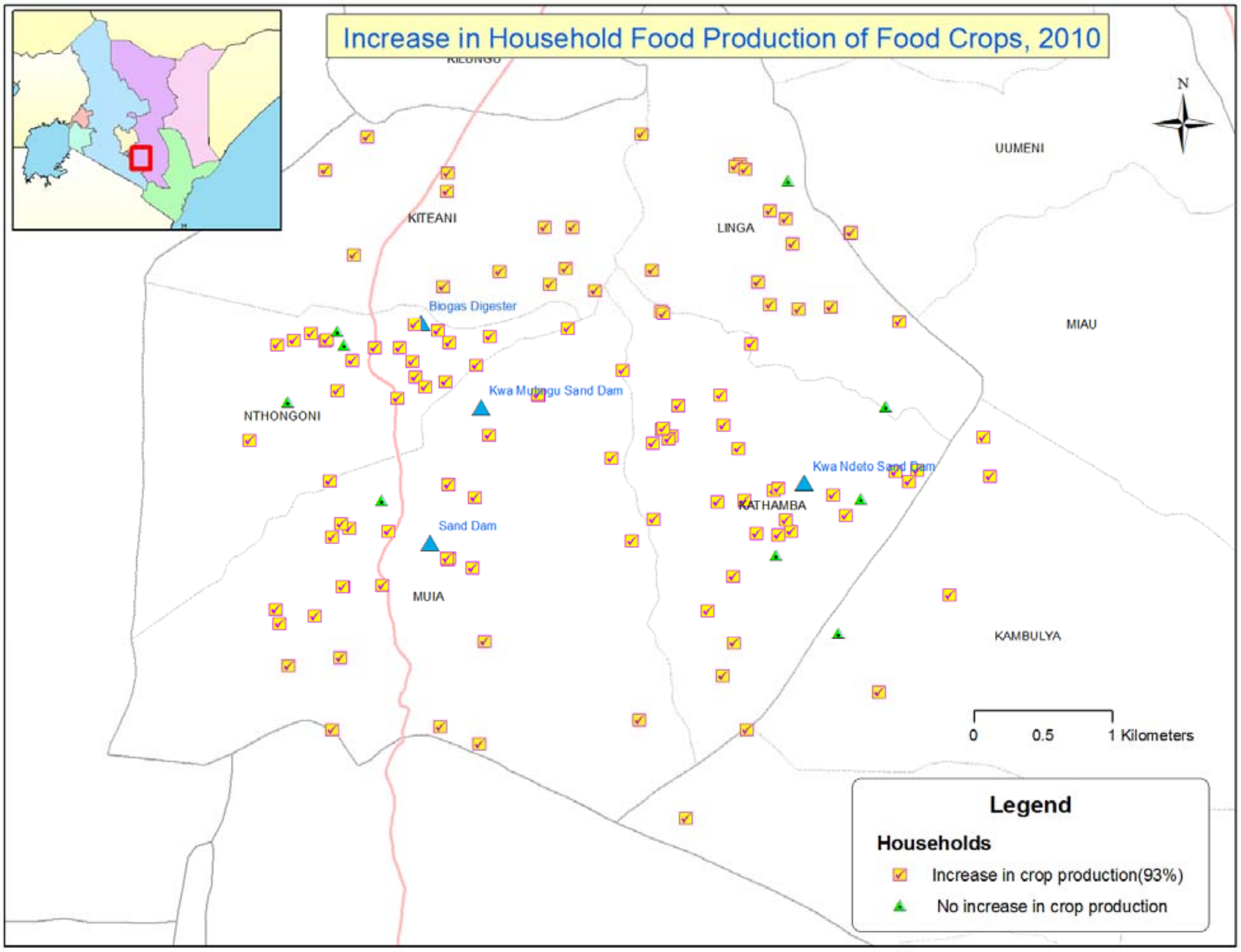
3.1. Reduction in proportion of household expenditure on food from markets

137 farmers were interviewed in the follow-up study. 84% of those surveyed indicated that since the Sakai project begun, there was a considerable reduction in household expenditure on food purchases. Only 22 farmers responded to the contrary.



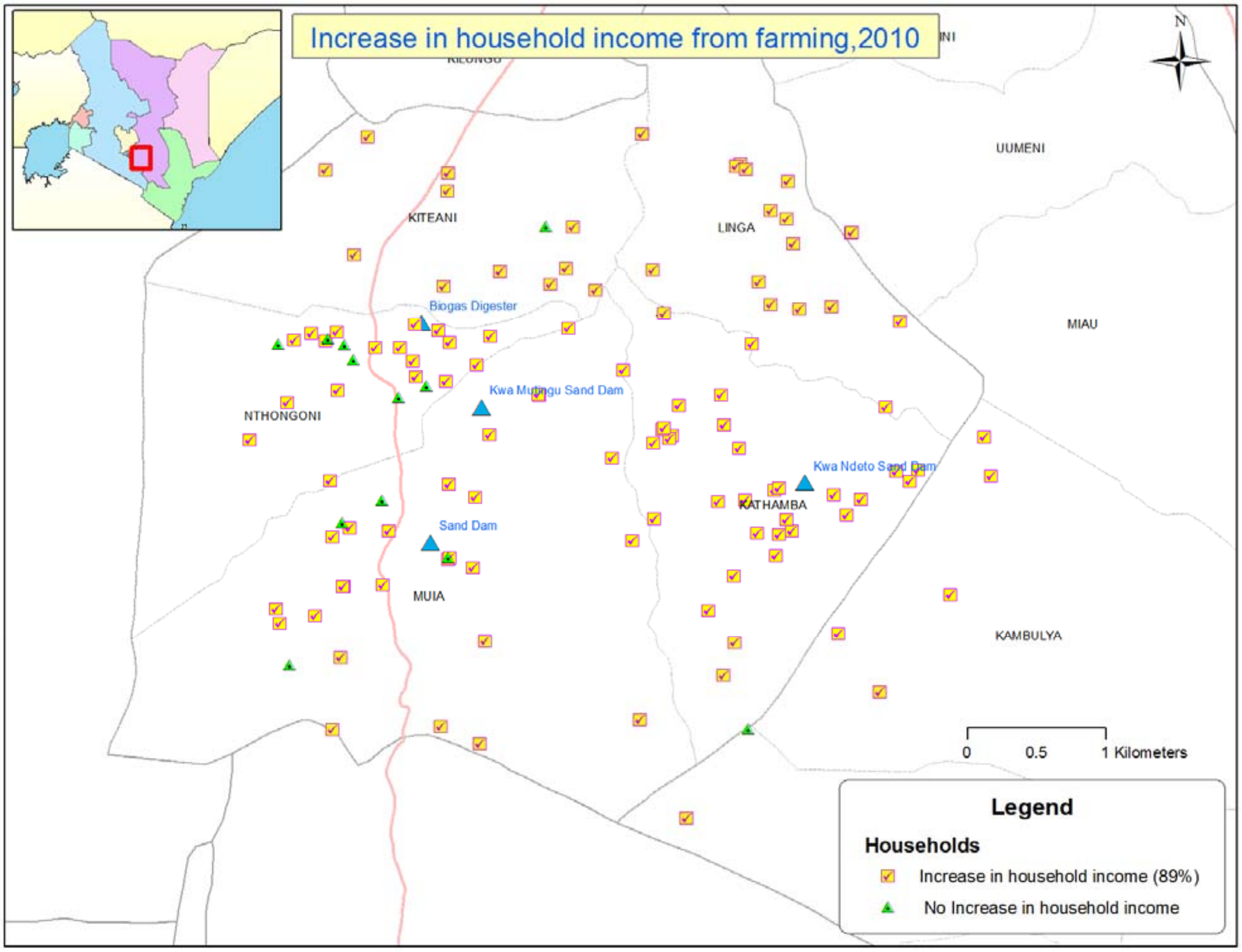
3.2.Increase in household food production of food crops

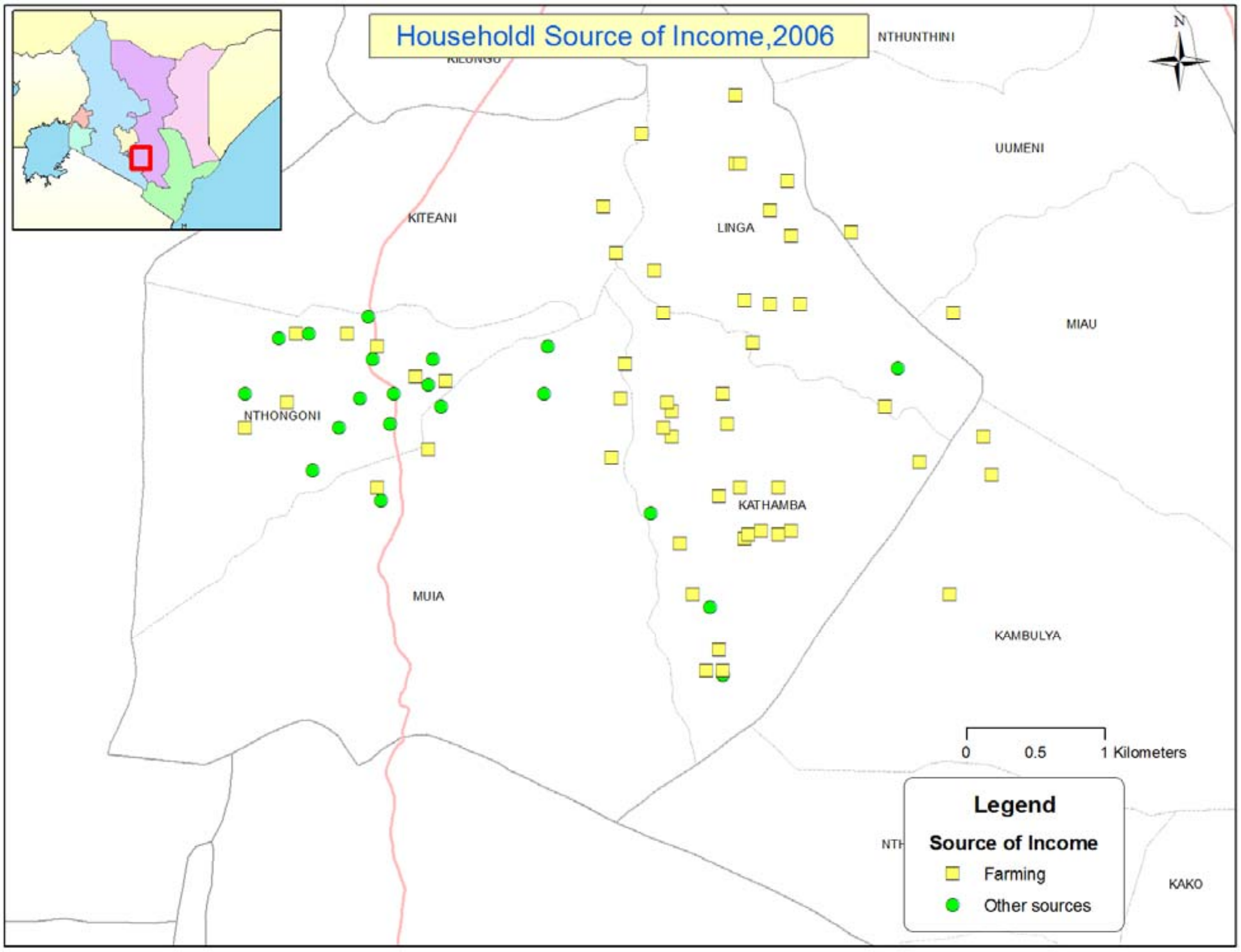
With regards to crop production, 93% of the farmers reported a notable increase in crop production. This was attributed to improved farming methods, training and drought resistant crops. Similarly, 97% reported to have experienced an increment in household crop yields.



3.3.Increase in household income from farming

The project was aimed at improving income resilience of Sakai population. Increases in household income from farming were reported in 122 of the 137 households representing89% of those interviewed. Further, 77% of the households reported an increase in the sources of household income. This is a departure from the pattern in 2006 where nearly all farmers depended on farming for source of income.

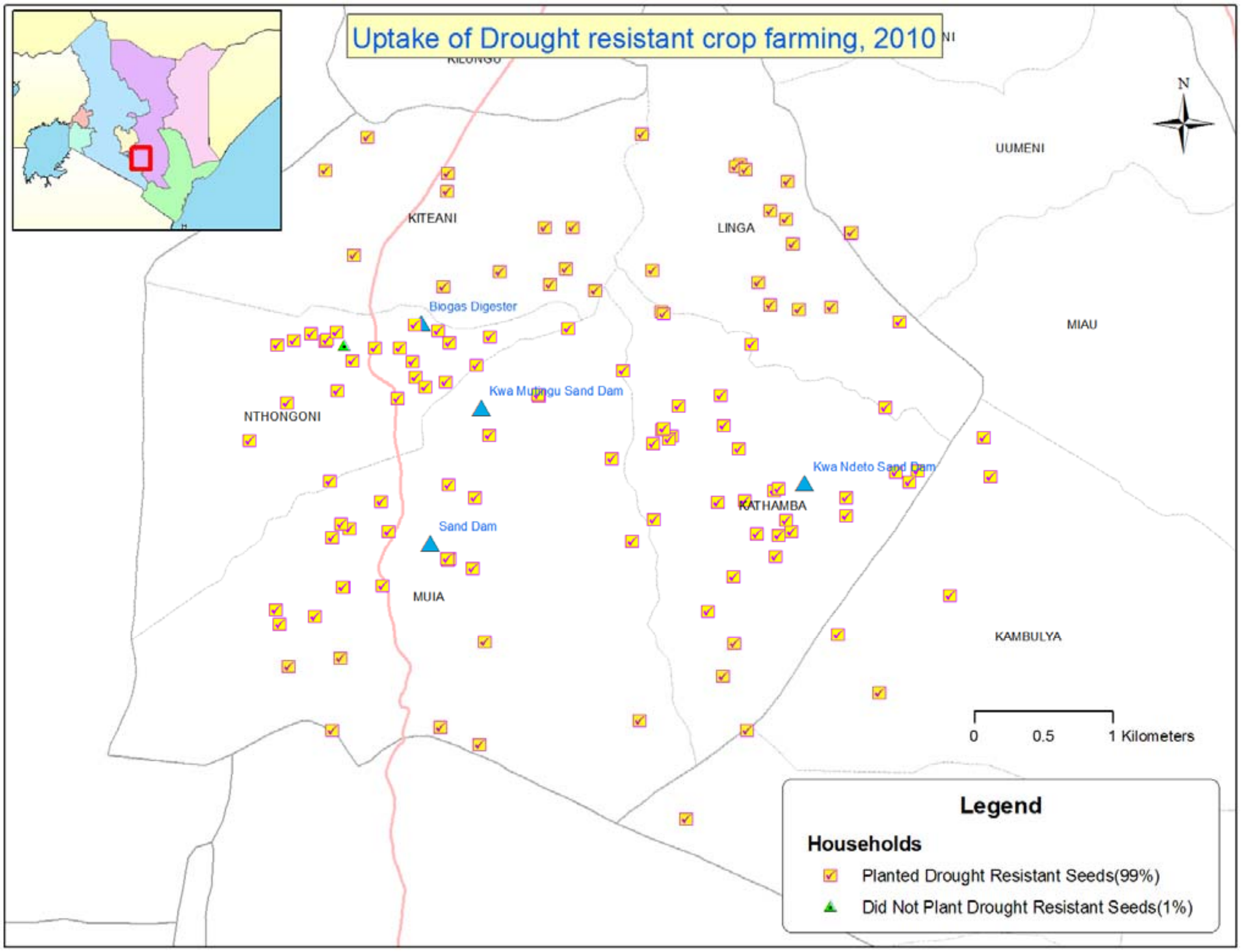




Householdl Source of Income,2006
NTHUNTHINI
UUMENI
KITEANI
LINGA
MIAU
NTHONGONI
KATHAMBA
MUIA
KAMBULYA
0 0.5 1 Kilometers
Legend
Source of Income
Farming
Other sources
KAKO

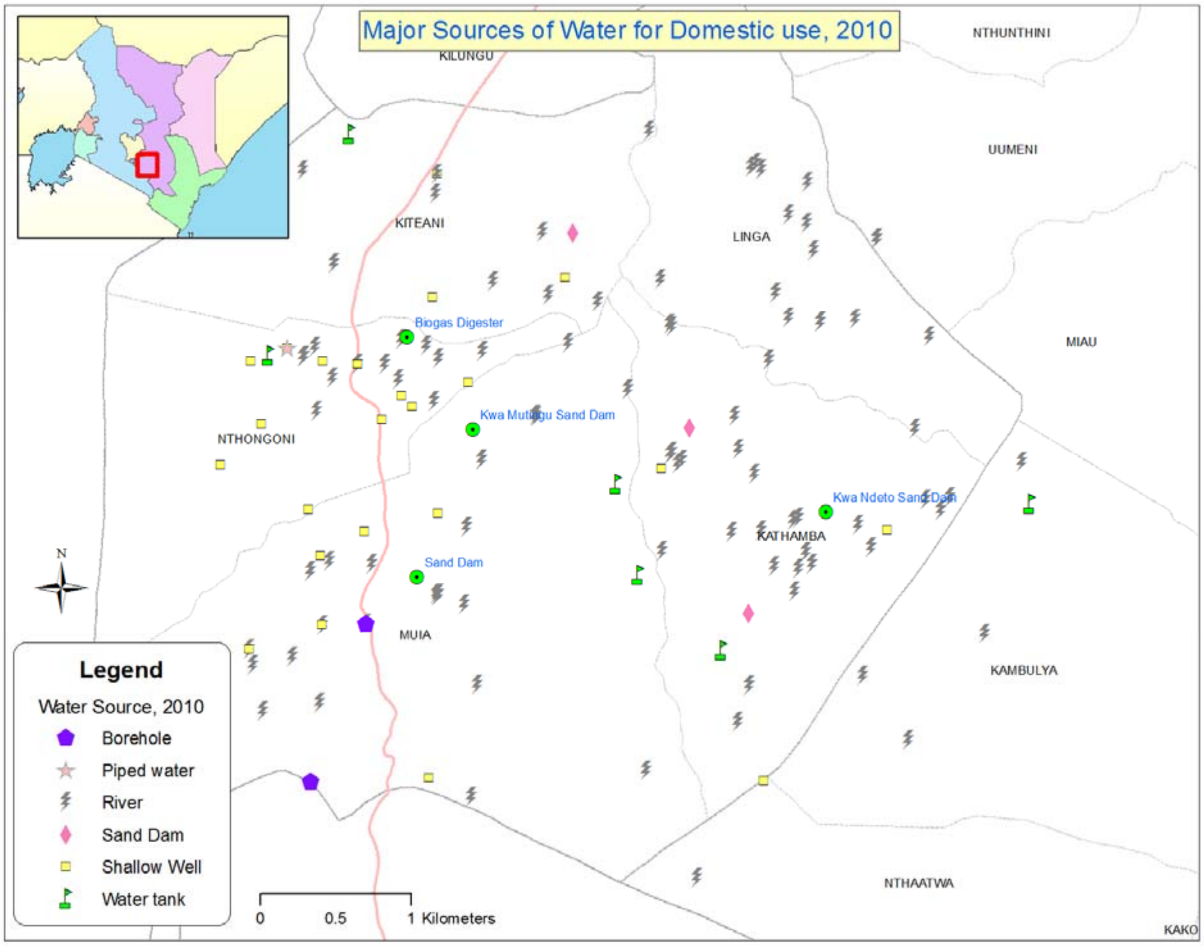
3.4.Drought resistant crop farming

As indicator to improved resilience with respect to climate change, nearly all the farmers (99.3%) reported the adoption of drought resistant crops (seeds)

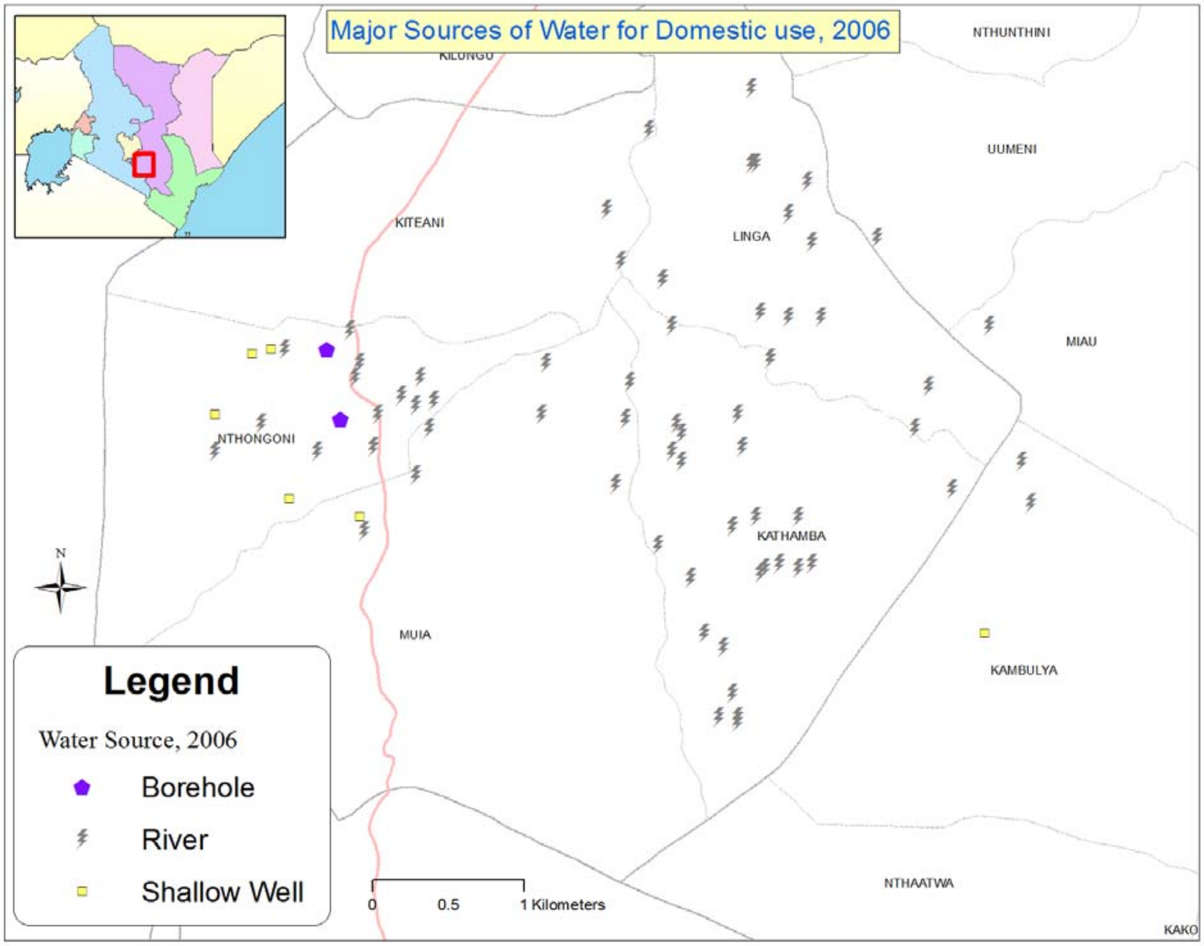


3.5.Sources of water for Domestic and farminguses

Majority (74%) of the households reported to acquire water from the river for domestic use from the river. Of the remaining respondents, 17% use water from shallow wells while the rest acquire water from other sources.



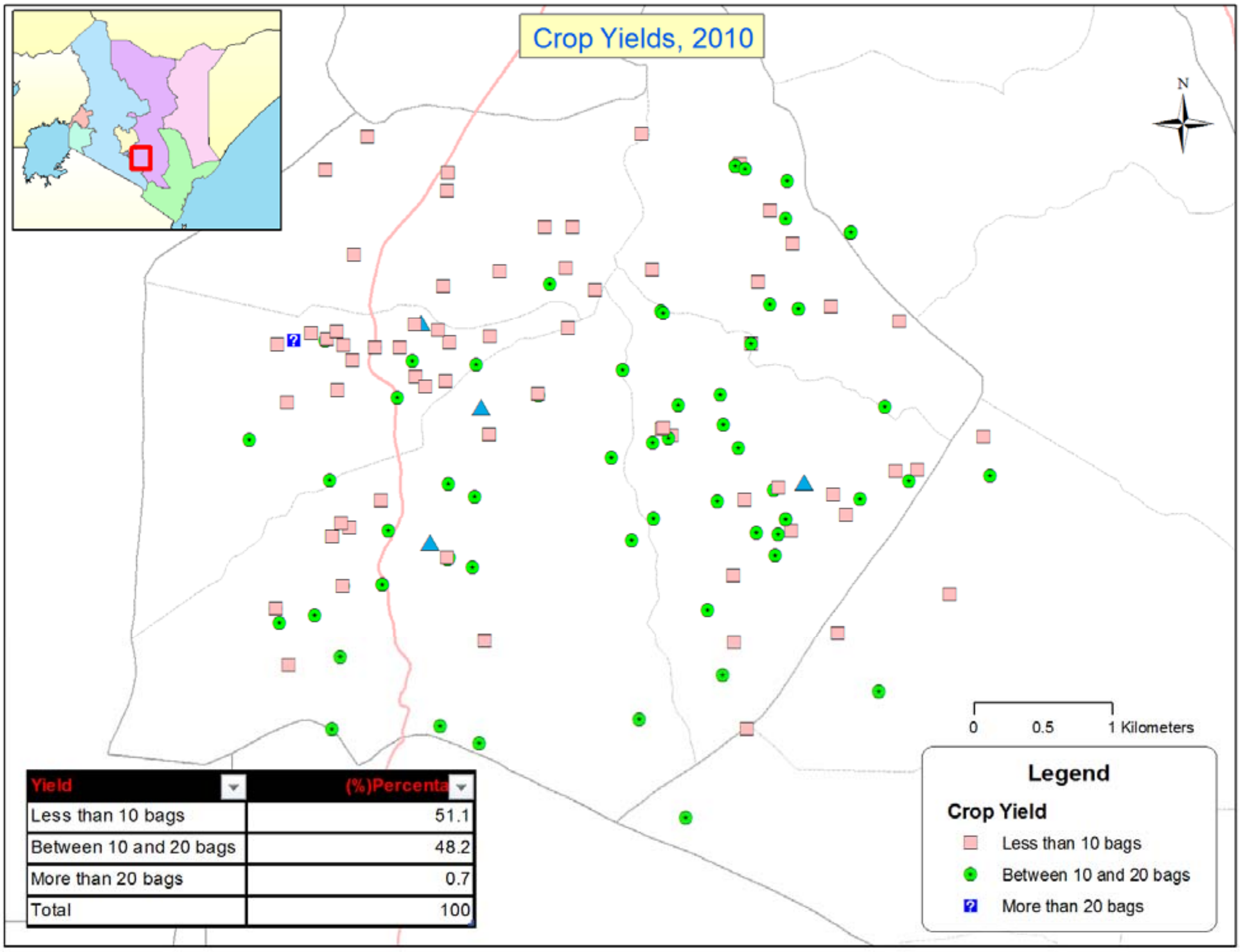
In 2006, the most common sources of water for domestic use during the dry season were rivers/streams (72%), wells (28%) and boreholes and dams (2.7%) (See map below)



As reported in the 2010 survey, there was no discernible change reported with regards to water sources. Of those interviewed, only 31 % indicated to have switched to different sources of water. With regards to sources of water for farming, 71 % reported that sand dams and shallow wells are their main sources of water. There's evidence of limited irrigation as few farmers (12%) were reported to practice drip and sprinkler irrigation.

3.6. Crop yields

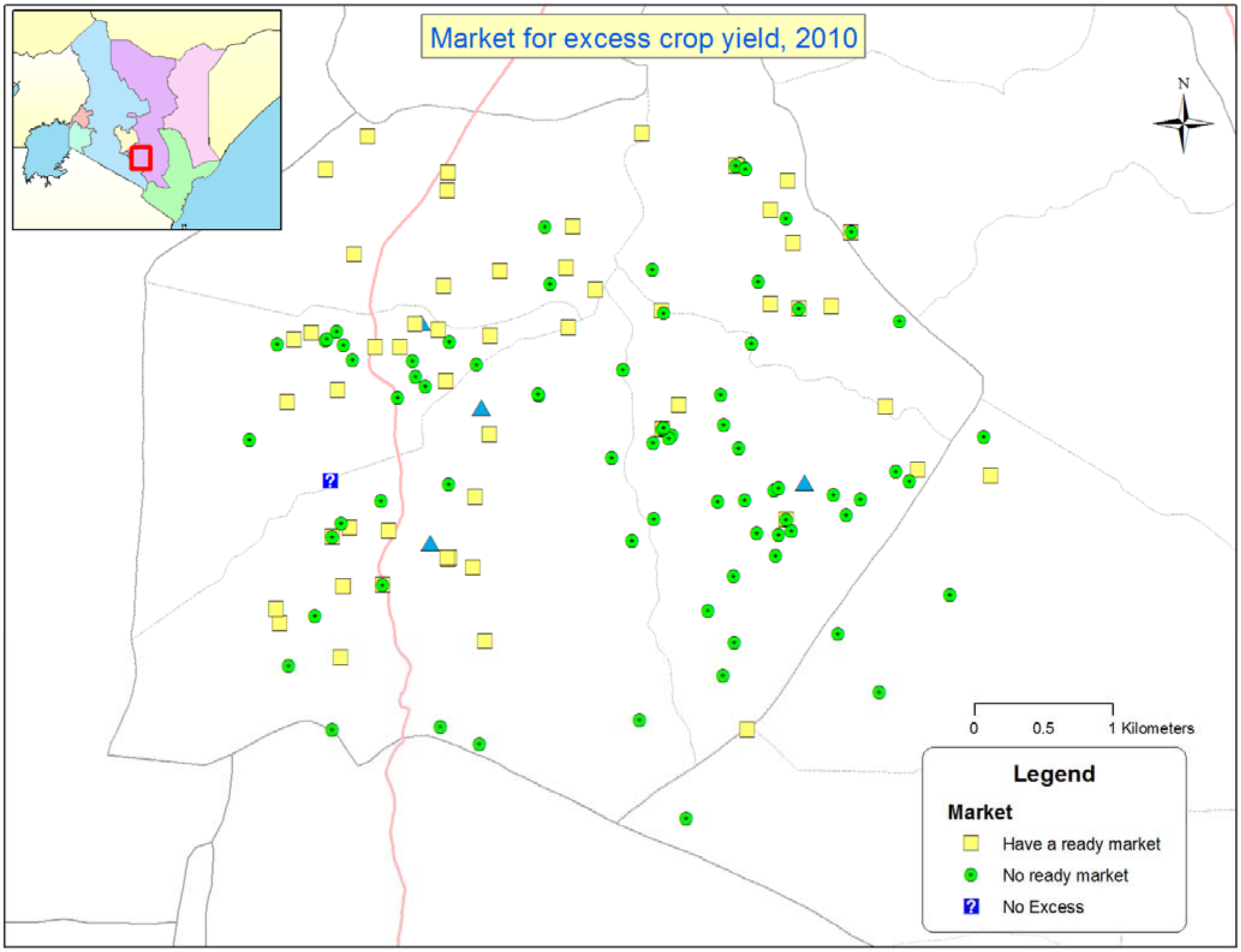
Majority of the farmers (51%) reported to have an average productivity of less than 10 bags. However a considerable 48 % were reported to have harvests of between 10 and 20 bags. Only 1 farmer was reported to harvest more than 20 bags.



Yield	(%)Percenta
Less than 10 bags	51.1
Between 10 and 20 bags	48.2
More than 20 bags	0.7
Total	100

3.7.Market for excess crop yield

For the few farmers who had more than enough harvest for consumption, 42% reported to have a ready market for the excess production. However a, majority of 57 % could not find markets for the excess produce.



4. Conclusions

The use of GIS in this project has proved useful in many perspectives. The achievements of the projects and the views of the respondents have been spatially represented. In addition, the locations of ongoing projects (Sand dams, Biogas, etc.) have been shown and the maps will be used to assess the need for expansion and newer development to meet the needs of strengthening adaptability to climate change in Sakai. The baseline comparison in 2006 and 2010 were possible by assessing the spatial representation of socioeconomic indicators then and now. The application further forms a strong basis for analysis areas to improve, strengthen and introducing new interventions.

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