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CREATING A GIS DATABASE FOR MAPPING CLIMATE  
CHANGE,  
VULNERABILITY AND ADAPTABILITY

CASE STUDY: SAKAI SUB LOCATION, MAKUENI DISTRICT,  
KENYA

FIELD WORK REPORT

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## **OVERVIEW**

This project was to develop a Geographic Information System (GIS) for displaying, managing and aiding analysis of various demographic, spatial and socio-economic datasets based on the household survey carried out in Sakai sub location in three villages a namely Kathamba, Nthongoni and Linga in Makueni District in Kenya.

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?

## **OBJECTIVES**

The main objective of the project was to come up with GIS database with layers to serve as a baseline datasets for monitoring the effects of the programs to be put place towards increasing community resilience to drought in Makueni District. Other specific objectives were:

- To develop GIS layer maps representing
  - Soil types
  - Land use/ land cover
  - Types of crop grown
  - Population census
- To develop a Digital Terrain Model for Makueni District
- To design, develop, and implement the spatial representation of population, poverty indices, and socio-economic data for Makueni district.
- To perform analysis on the presented data for optimum benefits in decision-making

## **FIELDWORK**

This project was conducted in two phases:

### **Phase one**

To accomplish the task, initially Makueni district was chosen as the baseline where all available data was collected and compiled in a single geodatabase. Amongst other data were population, soil characteristics, poverty indices and other human development indicators, climatic condition (rainfall, ecological zoning, temperature and historical patterns of the same). The project was divided into three main topics, each handled by one person as part of our final year project requirements in Geomatic engineering at JKUAT. These are:

- 1. Land Suitability Evaluation for arable crops using GIS and Remote Sensing(By Felix Mutua)*
- 2. Human induced transformation and landuse / landcover monitoring using GIS and remote sensing (By Kiprop Simion)*
- 3. Climate variability and links to land cover change(By John Gitau )*

Concurrently this phase included an extensive five day ground truthing in which we traversed the district verifying data and our analysis results. This involved collection of the following information

- ✓ soil type , texture and color
- ✓ Landcover / landuse
- ✓ Gps coordinates of sample points
- ✓ Taking of three or more photographs

This information was then used to compare the results that were obtained from the GIS analysis. Analysis was dependent on project topic e.g. for soil suitability, the following was checked: soil type, Existing crops, Relative slope, Information on rainfall (e.g. last rain)

The deliverables included maps showing the various soil crop combinations, population densities, and natural and manmade physical features amongst others. Reports documenting analysis techniques and other procedures are included.

### **Phase two**

This phase include a GPS mapping campaign in which the case study area was Sakai sub location. A questionnaire had been done and so the task here mainly was to geographically show the household characteristics. It took five days to collect information with the households serving as the guideline. With the help of the enumerators who carried out the household survey the data collected included;

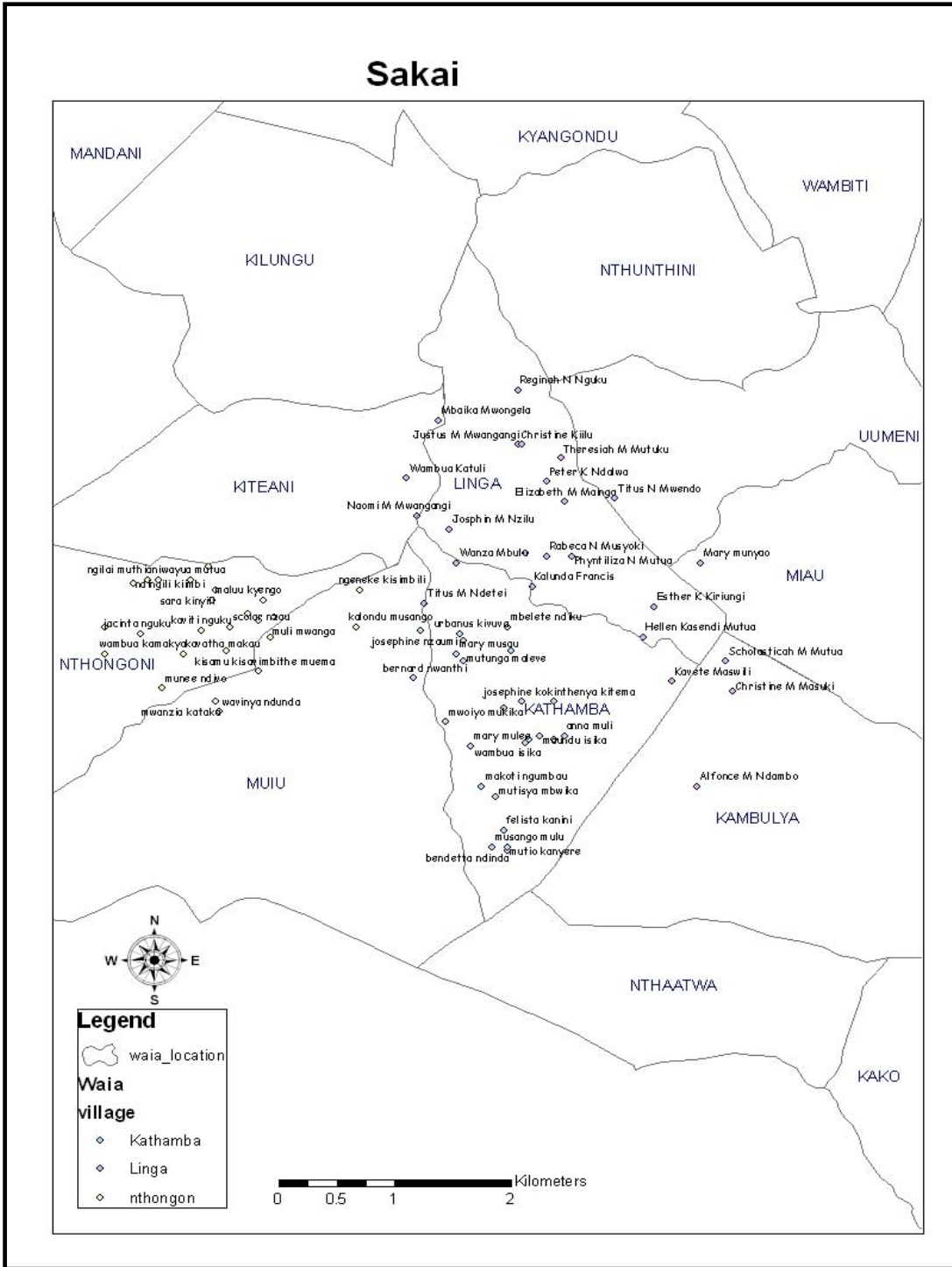
- GPS coordinates of the households that had been surveyed
- At least three photographs at each household
- Any other relevant information from the residents

### **ANALYSIS**

Procedures carried out included development of GIS layers depicting various socio-economic themes based on the variables collected in the household survey with the GPS coordinates giving the Spatial (location) aspect of the data.

### **Maps**

The following are examples of the maps that show the various data themes depending on the household survey



**Fig. 1.** A map showing the households used in the study

## **SPATIAL REPRESENTATION**

Different aspects of the study area were considered in the study. These include:

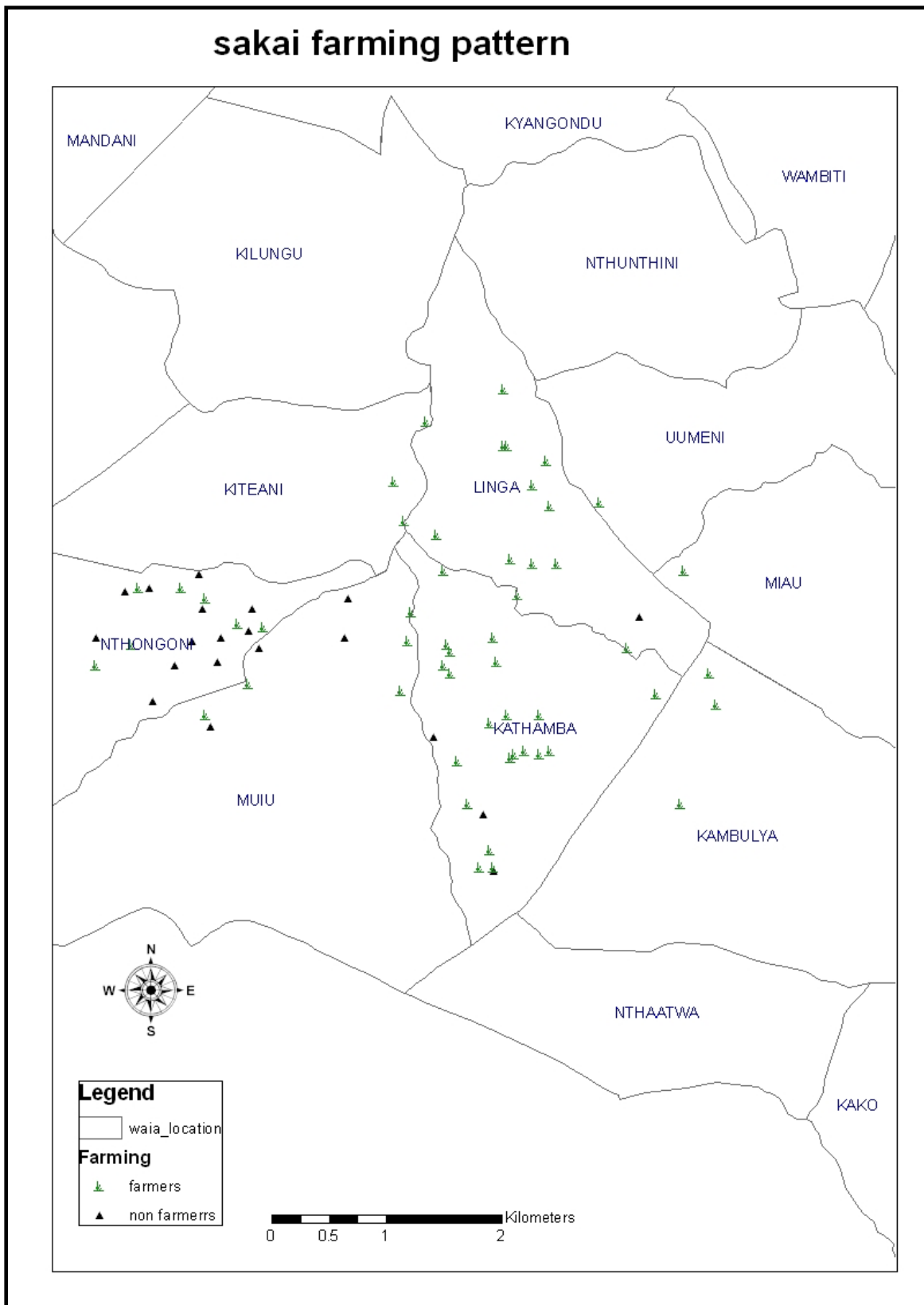
- Source of income
- Sources of water and their relative distances
- Market distance
- The seasons of rainfall
- Information on planting and tilling the land,
- Frequency of droughts
- Fertilizer usage
- Crops grown
- Sources of assistance

All these themes were then linked from the SPSS format to a GIS environment (database). This database is based on the normal windows access and thus presented as an access (.mdb) format. From this database different layers can be extracted for different themes mentioned above.

Depending on the data that was collected from the questionnaires and filed GPS points, it is possible to show the results graphically in terms of maps as shown here below. respectively, maps were then developed for each theme as has been indicated below.

### **1. Household incomes and expenditure patterns**

The analysis indicates that farming is the major source of household income closely followed by casual. Those who rely on farming as a source of income depend on it entirely (100%).

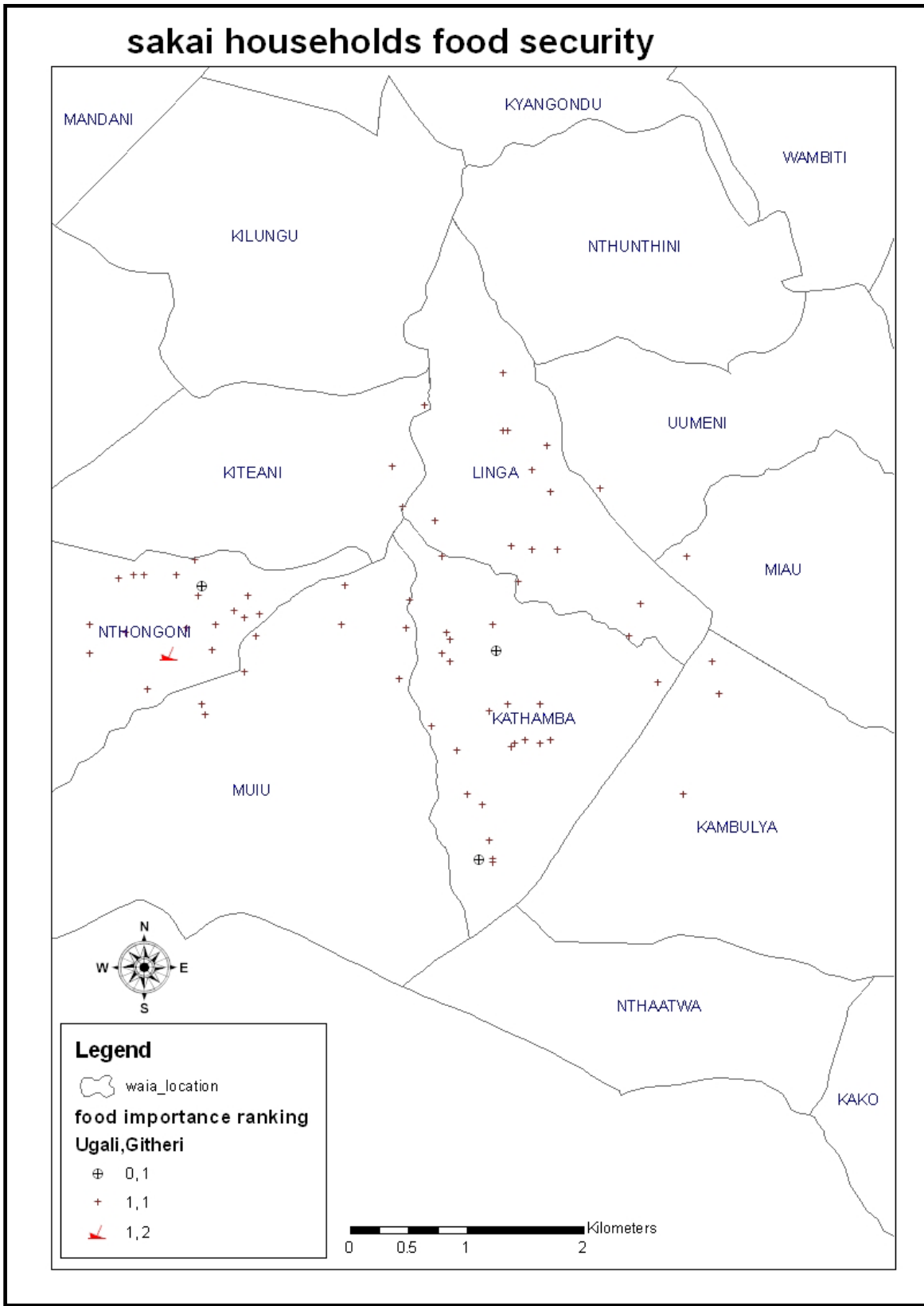


**Fig. 2.** A map showing the farming pattern as a source of income

## **2. Household food (in)security**

The type of food and frequency of meals that a household has is a good measure of household food (in) security. The most commonly consumed staple foods are githeri (60%) and (ugali (57.3%) source questionnaire report.

A further indicator of household food insecurity is the fact that evening tea is only the preserve of a select few of the households (4%), and thus a luxury that poorer households cannot afford. Similarly, although 12% of the households have snacks which ideally is a luxury – but the type of snack is predominantly fruits particularly for those households that have fruit trees. It is instructive that the fruits and not bread is the predominant mode of snacks. Although only 9.3% have fruits for snacks this is still higher than those who have bread (1.3%) for snacks since to have the latter households have to incur costs.



**Fig. 3.** A map showing food type consumption in Sakai

### **3. Land use characteristics**

Although 60% of the respondents have access to agricultural land, it is mainly for farming purposes and only one-third actually own the land that they cultivate. The size of land that the households own vary from 0.25 – 49 acres, however the average size of land holding is 3.03 acres. The majority (64.2%) of the smallholders in Sakai sub-location own between 1-5 acres of land, only about one-third (31.2%) of the farmers have title deeds. Buying and selling of land appears not to be coping strategy because most farmers bought or sold land for:

- investment purposes;
- due to family disputes;
- increasing farm acreage; and
- Paying school fees.

The main food crops grown are maize (60%); beans (60%); pigeon peas (37.3%); and green peas (37.3%). On the other hand, sorghum despite its drought resistance characteristics is only grown by 13.3% of the households as a food crop. The most significant cash crops that are grown include maize (48%) and sorghum (26.7%). Surprisingly fewer of the households grow sorghum as a food crop

Nearly three-quarters (72%) of the households are located at 1-5km away from the nearest market, i.e. a bicycle distance. This is significant since motorized public transport is rare

The majority (93.3%) of households keep livestock – the most commonly kept livestock are cows (72%); poultry (52%); and goats (41.3%). About two-thirds of the households keep livestock for milk (45.3%); eggs (44%) and manure (41.3%) respectively. More than half (50.7%) keep livestock for commercial purposes, and about one-third for meat (36%) and ploughing (34.7%) respectively. A significant proportion (86.7%) keeps livestock for subsistence purposes, but given that meat and poultry are not eaten frequently, this is probably for milk and eggs

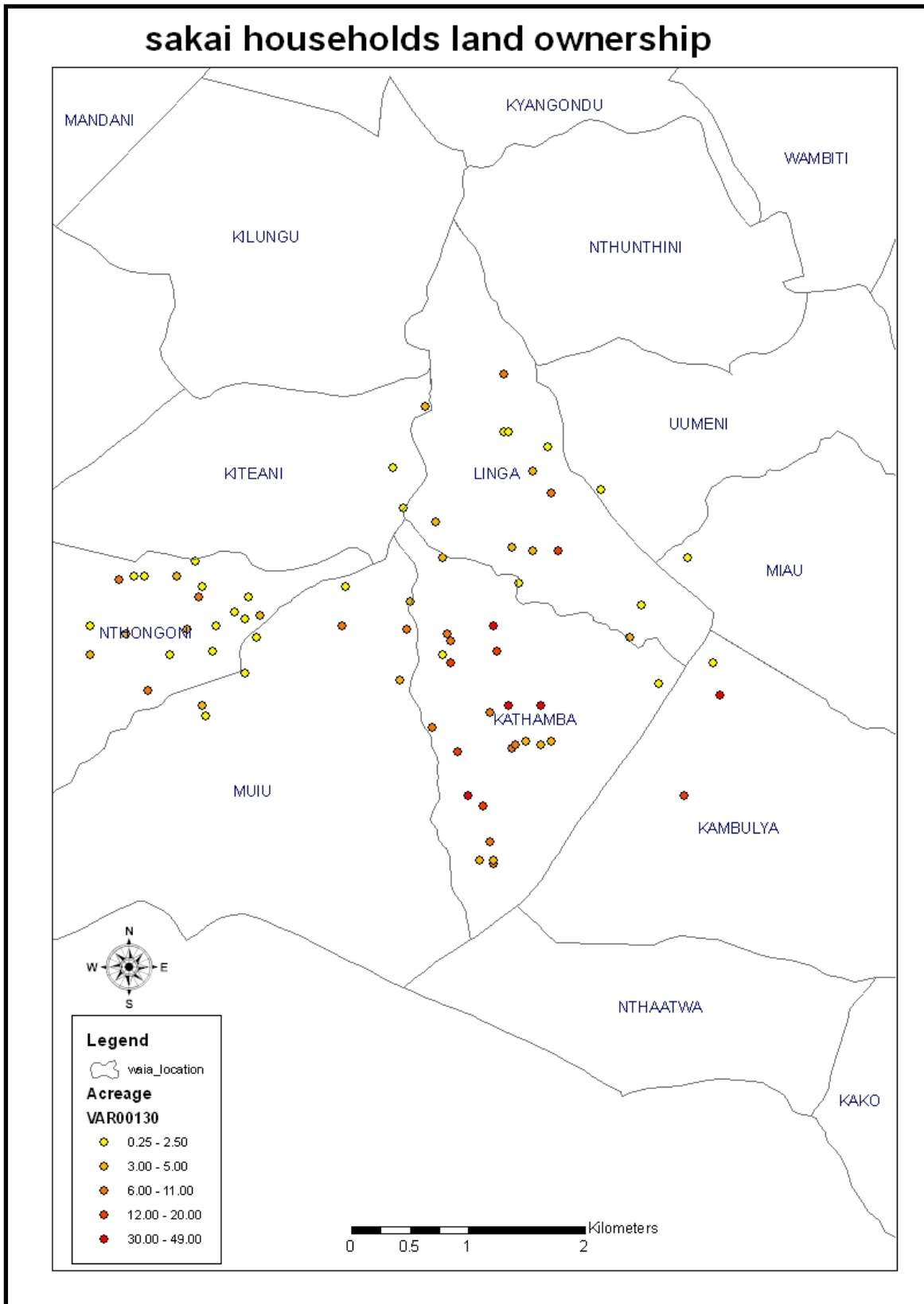


Fig. 4.A map showing land size ownership in the area of study

#### **4. ACCESS AND AVAILABILITY OF WATER**

The most common source of water for domestic use during the dry season are rivers/streams (72%), wells (28%) and boreholes and dams (2.7%). Conversely, tap water, rain water harvesting and lakes are not a source of water at all during the dry season. Indeed this is confirmed by the 89.4% of the households' whose major source of water during the dry season is streams/rivers. Although during the wet season rain water harvesting is a significant source for 46.7% of the households, rivers/streams (82.7%) still dominant. Wells on the other hand account for 16% of the sources of water during the wet season.

Alternatively, dams (93.3%) and rivers/streams (69.3%) are the most important sources of water for farming during the dry season. Whilst in the wet season it is rivers/streams (62.7%) and rainwater harvesting (61.3%). The major source of water for farming purposes is rainfall

Generally it appears that most of the water sources are located in close proximity to the households. A majority of the wells (70.7%) are located within or around the homesteads. While river/stream distance for 54.7% of the households is 0-0.5km but the longest distance is 3 km. Overall, there is no significant difference of river, well, dam distance in the dry and wet seasons.

# sakai households sources of water

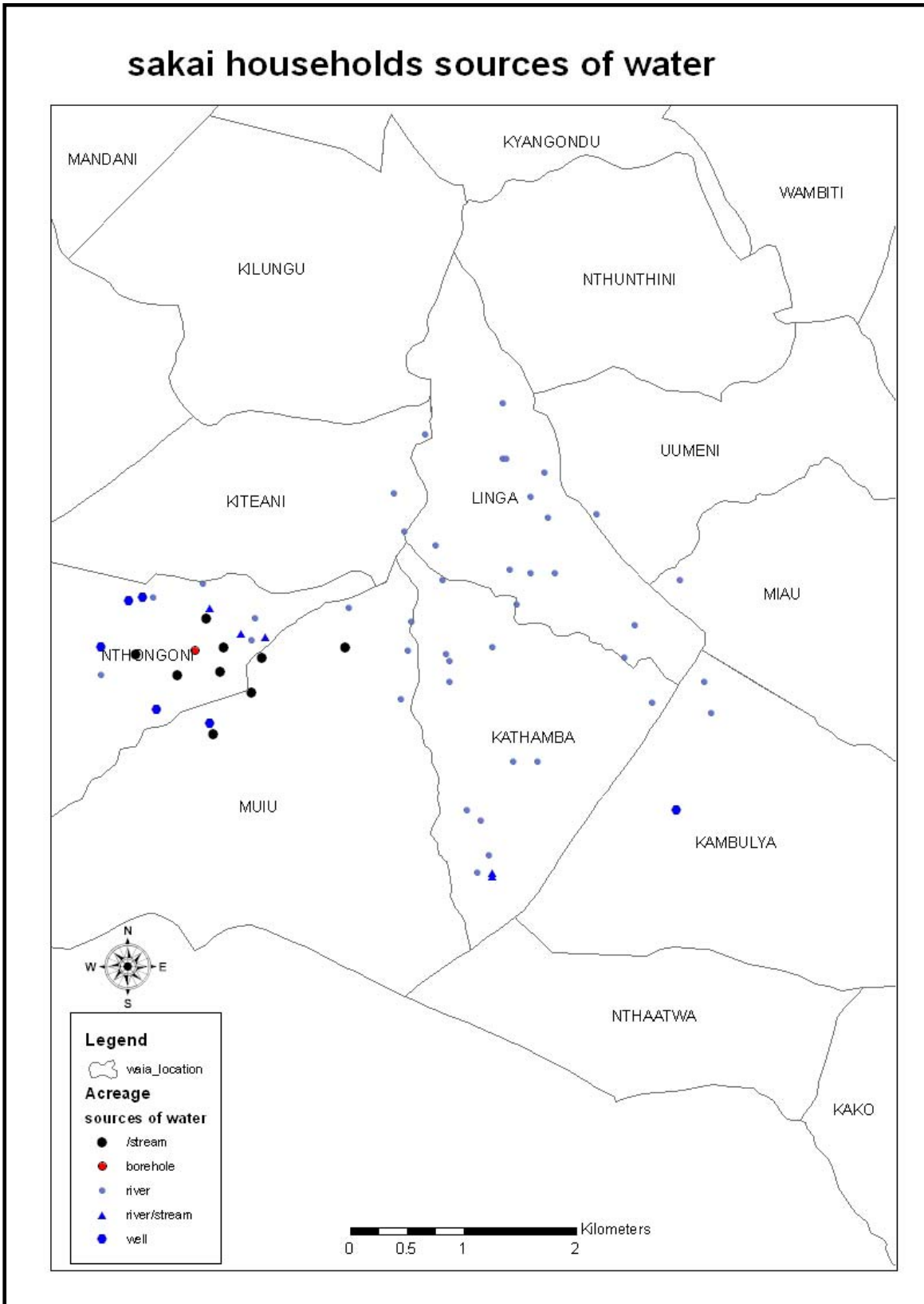


Fig. 5.A map showing water sources in the household area

## **FUTURE CONSIDERATION**

For a complete and accurate representation, if resources do allow, high resolution satellite imagery preferably a “Quickbird” should be used to regularly monitor the changes in Sakai as time goes on. This will in essence be an accurate tool to monitor any positive or negative impacts that result as the project activities and interventions are put in place

## **CONCLUSION**

The GIS provided reliable and accurate information for this Project which will enable prioritizing issues and channeling attention to the most appropriate areas. High resolution satellite imagery will be required to establish the “as is” baseline information for future analysis and comparisons.