STARTER DOCUMENT -SOCIAL STUDY

Envronmental Flow Assessment of the Kilombero Sub-Basin

Technical Assistance to Support the Development of Irrigation and Rural Roads Infrastructure Project (IRRIP2)

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CONSULTANCY SERVICE FOR ENVRON-MENTAL FLOW ASSESSMENT OF THE KILOMBERO SUB-BASIN

Starter document -Social study

SUBMITTED

BY

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ES EXECUTIVE SUMMARY

ES.1 Background

Under the U.S. Government's Feed the Future (FTF) program, CDM International Inc. (CDM Smith) is implementing USAID/Tanzania's Technical Assistance to Support the Development of Irrigation and Rural Roads Infrastructure Project (IRRIP2). Among other activities, IRRIP2 is supporting the development of irrigation schemes in the Kilombero district of Morogoro region.This report presents findings the socio-economic survey in 15 villages of kilombero sub-basin. The report highlights among other things, the dependence of communities' livelihoods to environmental goods and services and the preference flows to sustain the service.

ES.2 Data Collection

The data were collected through both qualitative approach which included PRA exercise, and key informants interviews; And quantitative method using questionnaire survey, (Annex 1). The PRA was done in 16 villages of Mbingu, Kisegese and Mofu which constitute BBM 1, Udagaji and Mgugwe, which constitute BBM 2, Matema, Mlimba, Chisano and Ngalimila which constitute BBM 3, Lukolongo and Merera which constitute BBM 4 and Katindiuka, Kikwawila, Kivukoni, Miwangani and Mavimba which constitute BBM 5. Key informants included VEOs, traditional healers, school children and fishermen. For the quantitative a structured questionnaire was administered through face to face in sixteen villages that were randomly sampled to represent Kilombero sub basin. The study considered villages in 5 BBM sites. Villages in BBM site 1 were Mbingu (Vigaeni-hamlet), Mofu and Kisegese. Villages in BBM site 2 were Udagaji and Mgugwe. Villages in BBM site 3 were Ngalimila, , Matema, Chisano and Mlimba b. Villages in BBM site 4 were Lukolongo and Merera while Villages in BBM site 5 were Katindiuka, kikwawila, Kivukoni, Mavimba and Miwangani. In the two surveys a total of 736 households were consulted. The information from qualitative data were analysed through content analysis whereas those from quantitative survey standard methods were used to determine frequencies and means through Microsoft excel and SPSS. The findings are presented in the form of tables and figures.

To be consistent the study adopted the classification of the riverine resource services for the communities based on the ecosystem services classification system developed by De Groot et al., (2003). The final list of riverine resource services researched and analysed consists of production services (domestic use, fishing, crop cultivation, livestock keeping, animals, birds and insects, natural and cultivated vegetables and fruits,construction materials/weaving/fuel and traditional medicine), regulation services (flooding and water associated problems) and information services (traditional dancing/rituals and swimming).

ES.3 Main results

In general, communities in Kilombero sub-basin are involved in crop cultivation (93 % in BBM site 2 to 100 % in BBM site 4) mainly rice and maize farming. Other crops include sesame, banana and sunflower. However, fishing was the second most important economic activity. It was higher in BBM site 1 (48.4%), BBM site 4 (41 %) and BBM site 5 (43.3 %) than in BBM site 2 (30 %) and BBM site 3 (33.3 %).

Again, the study observed that there was more revenue from fishing large fish than from fishing small fish (dagaa) in BBM sites 1, 2, 4 and 5. In the contrary, for BBM site 3, revenue from fishing was higher from fishing small fish (TZS 1,210,918 per household per year) than from fishing large fish (TZS 315,275 per household per year). However, fish consumption was determined; the observation was that on average for BBM site 1 to 5, 82.75 number of large fish per household per year and 68.44 number of cups (250 ml) of small fish per household per year were consumed. Frequency of fish consumption was assessed in terms of number of days large fish and small fish (dagaa) were consumed per year. It was realized that on average households in BBM site 1 to 5 consumed large fish in about 83 days in a year while small fish were consumed in 68 days in a year.

On average, over 75 % of households depended on natural vegetables in BBM site 1 to 5. The households directly collected natural vegetables, and they were not for sell but rather for food by households collecting natural vegetables. There was no substantial revenue from selling of natural vegetables. However, consumption of natural vegetables was on average 2.63 bunches of natural vegetables per day for BBM site 1 to 5, and per month the average was 18.16 bunches of natural vegetables per month. The study assessed frequency of natural vegetables consumption in study villages. It was found that on average households in BBM site 1 to 5 consumed natural vegetables in 6.75 days in a month.

Besides natural vegetables, households used cultivated vegetables. On average for BBM site 1 to 5, 92.16 % depended on both cultivated leaf and fruit form vegetables, 90.99 % depended on cultivated leaf form vegetables and 78.42 % of households depended on cultivated fruit form vegetables. While natural vegetables were mainly used for food by the household collecting them, cultivated vegetables were (in addition to being used for food were) also for business. It was observed that on average of TZS 849,665.00 per household per year was obtained from cultivated leaf vegetables and TZS 389,900 per household per year was obtained from cultivated fruit vegetables for BBM site 1 to 5.

Assessment of income contribution of economic activities to annual household income in study villages revealed that for BBM site 1, 2 and 3 crop farming contributed 68.46 %, 80.41 % and 71.67 % respectively to annual household income, while fishing contributed 2.53 %. Fishing contributed 80.42 % for BBM site 5 and 37.96 % for BBM site 4. Livestock keeping contributed 13.54 % in BBM site 4

The study also looked at the preferred water level in flood areas. It was revealed that households in the study villages preferred water to be at knee level in inundated areas during wet season.

On the preferences, households preferred Moist and fertile soils for flood recession agriculture and water for domestic purposes among the most important environmental services in all BBM sites. Ranking was between 1 and 2 for the services. On maintenance level, households preferred the same environmental services (preferred) to be maintained but also including controlling of diseases such as malaria, bilharzias and UTI.

ES.4 Conclusions

For all of the BBM sites objective catgeory B is recommended. Dry-medium flow is recommended in BBM site 1, 3, 4, and 5 and status quo shoud be maintained in BBM 2. Per BBM site objectives for livelihoods and objectives for target species are also defined. However, the final volume of water available to maintain the specific livelihoods requirements can only be determined once the stakeholders have agreed on the EFA classification for the rivers.

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1. BACKGROUND AND INTRODUCTION

1.1 General overview of Environmental Flow Assessment

Environmental Flow Assessment (EFA) is intended to assist in determining how much water should be left in streams to maintain aquatic and riparian ecosystems, or species of particular concern. We will use the term "environmental flows" in preference to "in-stream flows," because it more accurately reflects the rationale for setting flow targets in regulated rivers where environmental considerations include concerns that extend beyond the wetted area of the river, such as the adjacent riparian community. The term environmental flow is now the preferred term in most contexts. Environmental flows are defined as, "the quantity, quality and timing of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems" (Global Environmental Flows Network, 2011). This definition acknowledges both environmental and socioeconomic benefits, and is referred to as the "Brisbane Declaration," which was agreed to at the 10th International River symposium and Environmental Flows Conference, held in Brisbane, Australia, on September 3 to 6, 2007

Environmental flow assessments reflect a new and growing science, which is centered on assessing the amount of water needed for sustainable use. Flow assessments can be made for a river where development is planned or, equally, for an impacted one where an improvement in river 'health' (i.e. condition) is desired. The process is not simply a scientific one, but in its entirety should encompass input from all stakeholders on the condition at which the river should be maintained. The final condition decided upon may differ from river to river, according to other priorities within the catchment, and may be expressed in non-scientific terms which need converting to scientifically measurable goals (Rogers &Bestbier 1997). Furthermore, every catchment has its own hydrological character, and each river may have a different blend of valued features that it is wished to protect and therefore the assessment need to be a river-specific.

It is therefore obvious that decisions on water-resource based developments such as irrigation schemes made without the detailed knowledge of EFA may overlook, trivialize, or ignore, the expected impacts on riparian communities. As a result of their vulnerability, ascertaining the socio-economic value of the river resources they use should be part of any EFAs. Only then can the full cost of a water based proposed development project be understood. As per TOR Such an EFA require linking and integrating a number of key components, including the health-related, and economic, impacts of changes in the resource base to peoples' livelihoods, as well as changes in the social dynamics within communities as a result of changes in access to resources with season and time.

2. STUDY OBJECTIVES AND TERMS OF REFERENCE

2.1 Study objectives

Main Objectives
The scope of Work for EFA specialists are set to guide the provision of recommended environmental flow regimes intended to protect the ecological processes and services provided by the major tributaries and main stems of the Kilombero river system, including freshwater requirements for riparian wetlands, floodplains, the delta, estuary and near-shore marine environment.

Specific objectives
The aim of carrying out a social assessment in the BBM sites is to provide information on the use of riverine resources and on the importance of a healthy riverine ecosystem from a community perspective for sustaining their livelihoods. The Socio-Economist used participatory methods when collecting information from people who have extensive knowledge concerning rivers and their associated resources in the Kilombero sub-basins.

Specifically the socio-economic team was instructed to:

1. Conduct a detailed literature review and document all information available related to social, cultural and economic activities in the Kilombero and Lower Rufiji sub-basins.
2. Identify representative villages to be involved in the study area ensuring that the selected BBM sites represent the river resources being used by the corresponding villages.
3. Identify the riverine resources, their use,their priority and their seasonal availability. Also highlight the main users of the resources and the potential areas of conflict around resource uses.
4. Identify the social, cultural, economic and ecological importance of the riverine resources and their links to flow attributes.
5. Assess the level of dependence of rural communities and any other stakeholders on the riverine ecosystem for their subsistence and in terms of their cultural and spiritual activities.
6. Establish the link and relationship between past and present riverine resources and river flow.
7. Elucidate how the timing and magnitude of different kinds of flows (low and floods) affect availability of different riverine resources and how this affects the livelihood of communities.

8. Establish the desired state of the river based on the importance of the various resources used and their links to flow characteristics
9. Describe the linkage between the overall management objectives of the EFA and probable social, cultural and economic consequences that may result at achieving the desired state.
10. In collaboration with other specialists, recommend flows for the maintenance of the social, economic and cultural status of various stakeholders of the sub-basins.
11. Build the knowledge and capacity of Rufiji Basin Water Office social-economic staff on EFA processes and orient them to new approaches and tools.

2.2 Over view of the Study in Kilombero Sub-Basin

The Kilombero sub-basin forms part of the Rufiji basin and drains an area of about 40,330 km2. The Kilombero river sub-basin comprises of a wetland of high ecological and biodiversity importance which was declared a Ramsar site in 2002. Within the wetland also lies a Game Controlled Area with abundance and diversity of both aquatic and terrestrial biodiversity. Kilombero wetland experience degradation mainly from anthropogenic activities such as overgrazing by livestock, agriculture and human settlement. Besides, these wetland areas of the Kilombero valley contribute remarkably to welfare of the communities residing along the river banks. They derive extensive and enormous values from subsistence to commercial foods such as fish, spiritual and religious.

The Government of Tanzania has an ambitious plan to prioritize agriculture for economic growth and has endorsed the development and promotion of the Southern Agriculture Growth Corridor of Tanzania (SAGCOT) as an inclusive, multi-stakeholder partnership to rapidly develop the region's agricultural potential.

USAID/Tanzania has therefore contracted CDM Smith to carry out detailed feasibility studies for four new irrigation schemes in the Kilombero District of Morogoro Region; namely Udagaji, Mgugwe, Kisegese and Mpanga-Ngalimila under the Irrigation and Rural Roads Infrastructure Project (IRRIP). In conjunction with the feasibility studies, USAID has requested that an Environmental Flow Assessment (EFA) be conducted for the Kilombero and Lower Rufiji sub-basins to assess the basic water requirements of communities and ecosystems. Therefore, in a broader part of EFA this study will emphasis more on socio economic part of it to Kilombero sub-basin for empirical study where Rufiji basin will be studied through literature survey.

The EFA component of the project aims at providing recommended environmental flow regimes for the tributaries and main streams of the Kilombero and Lower Rufiji system, including freshwater requirements for riparian wetlands, floodplains, the delta, estuary and near-shore marine environment. The immediate purpose of undertaking EFA, however, will be in response to proposed irrigation schemes in the Kilombero sub-basin, and this sub-basin will therefore be the focus of the EFA. The EFA will be carried

out by a team of international and Tanzanian scientists in consultation with key stake-holders, and will be based on the Building Block Methodology (BBM), which is widely used in Eastern and Southern Africa and is globally well-tested. The BBM sites and communities where this study has focused is tabulated below

3. LITERATURE REVIEW

Natural resources are important to sustaining peoples' livelihoods. This is well recognized for the provision of water for the basic domestic requirements such as drinking, cooking and washing, but it is become more apparent that other resources, eg fisheries or natural fruits, are equally important.

3.1 Social use of riverine resources

In the Building Block Methodology (BBM) the social assessment aims to describe the importance and reliance of communities on river flows for providing resources such as fish, riparian plants for food, thatching, medicinal and other purposes and areas of multiple use such as floodplains and pools (King et al., 2008). It should not only describe the resources used, but also describe the relationship with the river flows. The development of an approach for a social assessment is still in its early stages, but participatory techniques, such as Participatory Rural Appraisal (PRA) are recommended over the questionnaire approach. Additional interviews with key informants can be used throughout the process to clarify and add detail to issues. According to the BBM the overall process for assessing social needs are:

1. Explanation of research and general gathering of information from all participants
    1. Review project objectives and research approach with the participants
    2. Identify what riverine resources are used
    3. Identify who uses them
2. Focus group discussions (fish, medicinal plants, crafts, natural vegetables, wild-fruits, and weaving materials)
    1. Prioritise the relative importance of each resource of use
    2. Describe the location and extent of each resource
    3. Ascertain the seasonality of use
3. Establishment of the link between the resource and flow
    1. Describe the critical water levels associated with each resource
    2. Ascertain which seasons (and hence discharges) are important in terms of use or maintenance of the resource

3. Investigate how the resource may have changed with time and why

4. Plenary session with all participants: summary of information gathered

    1. Collate the above information to develop an understanding of an acceptable Ecological Management Class

There are two categories of riverine resources use:

1. Direct use (resources used directly from the river or riverine zone)

2. Use of the river for agricultural purposes (areas under cultivation, for example within the floodplain and areas for grazing/watering of livestock)

It is valuable to distinguish between resources that are of primary, or supplementary, importance in terms of livelihoods.

Although many EFA have been conducted using the BBM (eg Luvuvhu river, Ruvu river, Wami river), the social assessment has often been limited in scope in describing the population and their domestic water requirements and in general terms the socio-economic activities.

Another environmental flow assessment method which explicitly includes a socio-economic component is the Downstream Response to Imposed Flow Transformation (DRIFT). Its sociological component identifies how the river resources are used by common-property users for subsistence, and the river-related health profiles of these people and their livestock. Additionally the resources used are costed.

3.2 Ecosystem services

Humankind benefits in a multitude of ways from ecosystems. Collectively, these benefits are becoming known as ecosystem services (Wikipedia). Fanaian et al. (2015) summarizes the history of the developing field of ecosystem services: The concept of Ecosystem services has existed since the late 1970s and was introduced to describe public benefits that were provided by ecosystems (Braat and De Groot, 2012; Nahlik et al., 2012). As research on this subject proliferated, so did the consequent explanation of what constituted nature's services. Since then many definitions have been proposed (Table 3.1) and these are still being debated (Fisher et al., 2009). This debate is due to; how the scale of assessment, end user, and ecosystem are defined or classified (Bagstad et al., 2013; Fisher et al., 2009; Haines-Young and Potschin, 2010). Some have suggested that the diversity of definitions and classifications when looked at within a coherent framework, is actually beneficial as it allows us to match our approach to the ecosystem to be assessed based on the usefulness and purpose (Braat and De Groot, 2012; Fisher et al., 2009; Johnston and Russell, 2011). Fisher et al. (2009) go further to say that "…a single or fundamental classification system should be approached with caution".

Table 3.1 Major definitions of ecosystem services (adapted from Braat and De Groot (2012); Nahlik et al. (2012)).

Definition of ecosystem services	Source
"the benefits human populations derive, directly or indirectly, from ecosystem functions."	Costanza et al. (1997)
"the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfil human life."	Daily (1997)
"the capacity of natural processes and components to provide goods and services that satisfy human needs, directly or indirectly."	De Groot et al. (2002)
"the benefits people obtain from ecosystems."	MA (2005)
"components of nature, directly enjoyed, consumed, or used to yield human well-being."	Boyd and Banzhaf (2007)
"the aspects of ecosystems utilized (actively or passively) to produce human well-being."	Fisher et al. (2009)
"Ecosystem Services are the direct and indirect contributions of ecosystems to human wellbeing."	Kumar (2010)
"Ecosystem services are the outputs of ecosystems from which people derive benefits"	UK NEA (2011)

(Source: Fanaian et al., 2015)

The Millennium Ecosystem Assessment report (MA, 2005) brought together and defined clear boundaries and functional groupings to classify ecosystem services. The four categories of ecosystem services are: provisioning, regulating, cultural and supporting services. Provisioning services include products obtained from ecosystems, such as food, freshwater, and fiber. Regulating services include the benefits received from regulation of ecosystem processes, such as climate regulation and water regulation. Cultural services include non-material benefits derived from ecosystems, such as spiritual/religious sentiments and recreational benefits. Supporting services include those services necessary for the production of all other ecosystem services, such as soil formation and nutrient cycling. The MA (2005) acknowledges the existence of complex links between the different categories of services that influence each other and also that such a categorization can lead to overlaps.

De Groot et al. (2002) worked a lot on ecosystem services and based on his work a comprehensive checklist was developed that are supported by environmental flows (table 3.2).

Table 3.2 Comprehensive Checklist of ecosystem services supported by environmental Flows *(cont.)*

Service category	Service provided	Key flow related function	Key Environmental Flow comp indicator
Production	Water for people - subsistence/rural and piped/urban	Water supply	Floodplain inundation
	Fish/shrimp/Brachyura spps (non-recreational)	Habitat availability and connectivity, food supply	Instream flow regime, floodplain tion, flows sustaining riparian ve
	Fertile land for flood-recession agriculture and grazing	Supply of nutrients and organic matter, moisture conditions in soils	Floodplain inundation
	Wildlife for hunting (non-recreational)	Habitat availability and connectivity, food supply	Floodplain inundation, flows su riparian vegetation
	Vegetables and fruits	Supply of nutrients and organic matter, seasonality of moisture conditions in soils	Floodplain inundation, flows su riparian vegetation
	Fibre/organic raw material for building/firewood/handicraft	Supply of nutrients and organic matter, seasonality of moisture conditions in soils	Floodplain inundation, flows su riparian vegetation
	Medicine plants	Supply of nutrients and organic matter, seasonality of moisture conditions in soils	Floodplain inundation, flows su riparian vegetation
	Inorganic raw material for construction and industry (gravel, sand, clay)	Sediment supply, transportation and deposition (fluvial geomorphology)	Instream flow magnitude and va
Regulation	Chemical water quality control (purification capacity)	Denitrification, immobilization, dilution, flushing,	Floodplain inundation, instrea regime,
	Physical water quality control	Flushing of solid waste, flushing/retention of sediment, shading	Floodplain inundation, instrea regime, flows sustaining riparian tion
	Flood mitigation	Water retention capacity	Floodplain inundation, flows su riparian vegetation
	Groundwater replenishment (low flow maintenance)	Groundwater (aquifer) replenishment	Floodplain inundation
	Health control	Flushing of disease vectors	Instream flow regime, water qual
	Pest control	Habitat diversity, disturbance and stress	Instream flow regime
	Erosion control (riverbank/bed and delta dynamics)	Healthy riparian vegetation, erosion, transportation and deposition of sediments	Flows sustaining riparian vegetat
	Prevention of saltwater intrusion (salinity control)	Freshwater flow, groundwater replenishment	Instream flow regime
	Prevention of acid sulphate soils development	Groundwater replenishment	Floodplain inundation
	Carbon 'trapping' (sequestration)	Accumulation of organic material in peat soils	Floodplain inundation
	Microclimate stabilization	Healthy ecosystems	Floodplain inundation, flows su riparian vegetation
Information	Recreation and tourism (incl. fishing and hunting)	Presence of wildlife, aesthetic significance, good water quality	Site specific
	Biodiversity conservation	Sustaining ecosystem integrity (habitat diversity and connectivity)	Natural flow regime
	Cultural/religious/historical/symbolic activities	Site specific	Site specific
Life support	The prior existence of healthy ecosystems	All	Natural flow regime

Source: De Groot (1992), Costanza (2003), Emerton and Bos (2005), Millennium Ecosystem Assessment (2005), Pearce et al. (2006) http://www.eflownet.org/viewinfo.cfm?linkcategoryid=4&linkid=21&siteid=1&FuseAction=display, reprinted with permission.

3.3 Basic human needs

The objective of the Water Resources Management Act (2009) of the Republic of Tanzania is to ensure that the nation's water resources are protected, used, developed, conserved, managed and controlled in ways which take into account the following fundamental principles, including -

1. Meeting the basic human needs of present and future generations;

2. Promoting equitable access to water and the principle that water is essential for life and that safe drinking water is a basic human right;

...

1. protecting biological diversity especially the aquatic ecosystems;

2. providing for systems for managing the growing demand for water use through integrated planning and management of surface and groundwater resources, in ways which incorporate economic, environmental and social dimensions in the planning process;

...

The preference for water allocation is given in Article 6 (2) Subject to subsection (1), and shall be for -

1. domestic purposes

2. environmental reserve

3. socio economic activities depending on the availability of water resources

Part I of the Act, the preliminary provisions, defines the **reserve** as:

The quantity and quality of water required for -

1. Satisfying basic human needs by securing a basic water supply for people who are now or who shall in the reasonably for near future, be -

    1. Relying upon

    2. Taking water from; or

    3. Being supplied from the relevant water resources ; and

2. Protecting to protect aquatic ecosystem in order to secure ecologically sustainable development and use of the relevant water resources.

According to the Act the aquatic ecosystem means those physical and biological features, including land, water, the atmosphere, flora and fauna, which are within, under, over, in contact with, or sustained by the water in water bodies. Sustainable manage-

ment means managing the use, development and protection of water resources in a manner, or at a rate, which provides for the social, economic, sanitation and cultural well-being of the people, while safeguarding the life-supporting capacity of water for the ecosystem both in the present and the future.
Article 33 - (1) The Minister shall, by notice in the *Gazette*, determine the reserve for the whole or part of each water resource which has been classified under this part.
(2) A determination of the reserve shall ensure that adequate allowance is made for each aspect of the reserve.
(3) The Minister, Basin Water Boards and all public bodies shall, when exercising any statutory power or performing any statutory duty take into account and give effect to the requirements of the reserve.
Article 43 (2) a water use permit shall be issued taking into account water needed for non-abstraction uses of for maintaining environmental flow requirements.
So, in Tanzania a reserve has to be set which satisfies basic human needs and secures ecologically sustainable development and use of the relevant water resources. Unfortunately a definition of the basic human needs is missing so it is debatable whether this includes subsistence fishing and/or farming.
In 1971 during the Mar del Plata conference a concept of basic needs was introduced (Gleick, 1996): 'all peoples, whatever their stage of development and their social and economic conditions, have the right to have access to drinking water in quantities and of a quality to their basic needs'. The concept of 'basic needs' is however also defined as 'poverty as deprivation of requirements', including then also non-monetary income, publicly provided services, potable water and sanitation facilities, employment opportunities and even opportunities for community participation (Meijer, 2007).
The sociological component of the DRIFT method recognizes those people who live along the river and use its resources for subsistence, including then river resources such as fish, wild vegetables, casual drinking and crops in the riparian zone but also identifying health threats (King et al., 2003).

3.4 Socio-economics in Kilombero

The Rufiji River basin in the Southern Tanzania is the largest in the country and the most important for many activities, goods and services associated with water and its uses. At the downstream end of the river basin is the lower Rufiji flood plain and Rufiji delta. The Lower Rufiji sub-basin drains an area of about 32,619 km^2. At the lower end, the Rufiji River enters a delta which is similarly rich in biodiversity which include mangrove forests. The Kilombero sub-basin forms part of the Rufiji basin and drains an area of about 40,330 km^2. The Kilombero river sub-basin comprises of a wetland of high ecological and biodiversity importance which was declared a Ramsar site in 2002. Within the wetland also lies a Game Controlled Area with abundance and diversity of both aquatic and terrestrial biodiversity. Kilombero wetland experience degradation mainly from anthropogenic activities such as overgrazing by livestock, agriculture and human settlement. Besides, These wetland areas of the Kilombero valley, the Rufiji floodplain and Rufiji delta contributes remarkably to welfare of the communities residing along

the river bank. They derive extensive and enormous values from subsistence to commercial foods such as fish, spiritual and religious. According to the 2002 National Census results about 1,400,000 people currently live in the Rufiji basin.
The use of the Kilombero Valley wetlands have been researched in detail (Mombo et al., 2011). The Kilombero Valley wetland covers and area of 7,967 km2 and is divided by the Kilombero River. Many rivers, permanent and seasonal, feed the floodplains and the wetland is a designated Ramsar site. Nine randomly selected villages were visited in Ifakara and Ulanga districts and through Participatroy Rural Appraisal (PRA) combined with semi structured questionnaires and checklists the situation of the wetalnd in terms of location, utilization, perception, trends and conservation aspects were analysed. The findings reveal that the wetlands offer a variety of products and services to local households living in and around the valley with water for domestic use, wetlands as source of food and cash (agricultural crops and fishing) as the most important. The average ranking of products and services is presented in Table 3.3. Of the total are under crop cultivation only 23% is cultivated by small scale farming, but at the same time an estimated 87% of the population in the valley depend on it for their livelihood. There are several sources of domestic water for households but the majority (83%) of the local people use yard tap water. Fishing is another important economic activity in the area but negatively affects the integrity of the wetlands due to the way it is carried out (abstracting water from the swamps to reduce water levels and make fishing easier and destroy breeding sides by uprroting the important vegetation Makongo).

Table 3.3 Product/service rank by respondents in Kilombero Valley wetlands coommunities (Mombo et al., 2011)

Rank	Product/sevice
1	Source of domestic water
2	Source of food and cash
3	Source of timber and energy
4	Grazing
5	Habitats
6	Cultural practices
7	Wild game
8	Source of non timber forest products
9	Provides burial grounds

4. METHODOLOGY

The Environmental Flows Assessment, Socio-economic study approach was two pronged and implemented in two phases. Phase one of the study was structured to capture mainly qualitative socio-economic information while phase two was structured to capture quantitative socio-economic information. In phase one a Participatory Rural Appraisal (PRA) technique was adopted to allow for adequate participation of the targeted communities through careful consideration of the sociological contexts in terms of its inherent assumptions and constraints. The method is applicable in developing countries where the education level of most of its people is to the primary level. It uses simple tools including stick to write on the ground and also local available materials i.e stones and tree leaves to describe the availability, location and quality of the physical resources. During PRA, key informants interviews were organized, backed by various tools and group discussion. This technique was used to elicit and capture qualitative information on several aspects on the use of environmental flows for socio-economic needs. Some of the information gathered include resource mapping aimed at general identification of riverine resources, their location and extent, resource use-matrix to ascertain who exactly and how many people use a particular resource, and resource–use prioritization of the various riverine resources. Key informants interviews were contacted to supplement the qualitative information obtained during groups discussion. Group discussion and key informants were guided by the set of checklist that are annexed. In phase one fifteen villages were visited.

As it is difficult to come up with precisely quantified information using a PRA technique, the second round of fieldwork carried out a questionnaire survey in order to quantify and triangulate the information collected through PRA technique. Therefore in phase two questionnaire survey was administered to sixteen villages in Kilombero sub basin. The study considered villages in 5 BBM sites. Villages in BBM site 1 were Mbingu (Vigaeni-hamlet), Mofu and Kisegese. Villages in BBM site 2 were Udagaji and Mgugwe. Villages in BBM site 3 were Ngalimila,Utengule, Matema, Chisano and Mpanga. Villages in BBM site 4 were Lukolongo and Merera while Villages in BBM site 5 were Katindiuka, Mahuntanga and Miwangani. A total of 436 households were interviewed. Data was analysed using SPSS and excel and presented in figures and tables. The sixteen representative sample villages were selectecd using the following criteria:

1. distance from the river
2. accessibility of village
3. location in zone
4. expected variation in riverine resources use
5. population size

6. history of the village

7. diversity in livelihoods

8. expected impact of the extracted water (for zone 2)

The selection of the sample villages included some subjective judgements due to the preference for rural life (as there is more dependency on riverine resources), so more hamlets were included in favour of villages.

This report is mainly intended to present quantitative findings of the survey. The findings contribute to the main goal of determining required water discharge that should be maintained in streams to support aquatic and riparian ecosystems, or species of particular concern in the area

The classification of the riverine resource services for the communities in this study is based on the ecosystem services classification system developed by De Groot et al. (2002). Further refinement was made in some of the services as to allow for a better linkage to the flow dependent and independent and cultivated and non-cultivated resource use. Field data was collected on this final list of nineteen (19) riverine resource services and the results are analysed and presented accordingly.

Table 4.1 Classification of riverine resources services supported by environmental flows

Service category	Service provided	number	Riverine resource service
Production	Water for people-subsistence / rural and piped/urban	1	Domestic use
	Fish/shrimp/Brachyura spps (nonrecreational)	2	Fishing
	Fertile land for flood recession agriculture and grazing	3	Crop cultivation
		4	Livestock keeping
	Wildlife for hunting (nonrecreational)	5	Animals, birds and insects
	Vegetables and fruits	6	Natural vegetables and fruits
		7	Cultivated vegetables and fruits
	Fiber/organic raw material for building/firewood/handicraft	8	Construction materials
		9	Weaving materials
		10	Fuel
	Medicine plants	11	Traditional medicine
	Inorganic raw material for construction and industry (gravel, sand, clay)		
Regulation	Chemical water quality control (purification capacity)		

	Physical water quality control		
	Flood mitigation	12	Flooding
	Groundwater replenishment (low-flow maintenance)		
	Health control	13	Water associated problems
	Pest control		
	Erosion control (riverbank/bed and delta dynamics)		
	Prevention of saltwater intrusion (salinity control)		
	Prevention of acid sulphate soils development		
	Carbon "trapping" (sequestration)		
	Microclimate stabilization		
Information	Recreation and tourism (incl. fishing and hunting)		
	Biodiversity conservation		
	Cultural/religious/historical/symbolic activities	14	Traditional dancing
		15	Rituals
		16	Unyago
		17	Circumcision
		18	Jando
		19	Swimming
Life support	The prior existence of healthy ecosystems		

Adapted from: de Groot, R.; Costanza, R; Emerton, L & Bos, E.; Millennium Ecosystem Assessment; Pearce, D., Atkinson, G., Mourato, S., http://www.eflownet.org/viewinfo.cfm?linkcategoryid=4&linkid=21&siteid=1&FuseAction=display,

5. SOCIO-ECONOMICS

The socio-economic characteristics of the sample villages are presented in Table 5.1. The sampled villages were established between 1910 and 1999 with Mofu and Merera being the oldest villages. The population ranges from 1221 in Utengule to 11,335 in Mbingu. The major ethnic groups are Ndamba, Bena and Sukuma with Ndamba being considered the native population. Sukuma are migrants, moving in for pasture for their cattle and land for cultivation. Other ethnic groups include the Pogolo found in Mahutanga and the Hehe found in Chisano.

Table 5.1 Socio-economic characteristics of the sample villages

	BBM site	Surveyed		Sample villages	Year established	Population	Women	Men	Households	No. Households surveyed	Dominant ethnic groups
		Quant	Qual								
1.	1. Lwipa	X	X	Mofu	1910	10,122	6062	4060	1685	31	Ndamba Sukuma Bena
2.		X	X	Mbingu	1974	11,335	6144	5191	3435	26	Sukuma Ndamba Bena
3.		X	X	Kisegese	1999	3452	1715	1677	705	36	Ndamba Sukuma Pogoro
4.	2. Udagaji	X	X	Udagaji	1999	2216	1187	1029	514	32	Ndamba Hehe Bena
5.		X		Mgugwe						26	
6.	3. Mpanga		X	Utengule	1946	1221	664	557	281		Bena Ndamba Sukuma
7.		X	X	Ngalimila	1975	3200	1650	1550	640	37	Ndamba Bena Sukuma
8.			X	Mpanga	1977	3436	1778	1658	954		Bena Ndamba Sukuma

	BBM site	Surveyed Quant	Qual	Sample villages	Year established	Population	Women	Men	Households	No. Households surveyed	Dominant ethnic groups
9.		X	X	Matema	1999	7570	4150	3420	1250	32	Bena Ndamba Nyakyusa
10		X		Mlimba "b"		5251	2,665	2,586	1,261	25	Ndamba Bena Hehe
11.		X	X	Chisano	1979	3790	1865	1925	738	26	Ndamba Sukuma Hehe
12.	4. Ifwema	X	X	Lukolongo	1996	7503	4163	3340	1650	30	Ndamba Pogoro Bena
13.		X	X	Merera	1910	5031	2991	2040	498	30	Ndamba Sukuma Bena
14.	5. Ifakara Ferry	X		Miwangani	1984	3699	1996	1703	547	30	Ndamba Pogoro Bena Sukuma
15.		X	X	Kikwawila	1975	4776	2763	2013	921	16	55. Wapogoro Wandamba Wambunga
16.			X	Mahutanga	1951	3002	1600	1402	572		Ndamba Pogoro

	BBM site	Surveyed Quant	Qual	Sample villages	Year established	Population	Women	Men	Households	No. Households surveyed	Dominant ethnic groups
17.		X		Katindiuka	1976	2798	1500	1298	558	29	Bena Ndamba Pogoro
18		X		Mavimba	1970	3,816	1,975	1,841	899	14	Ndamba Pogoro
19		X		Kivukoni	1975	7,789	3,893	3,896	1,667	21	Pogoro Ndamba

Field survey 2014/15

The socio-economic characteristics of the respondents are summarised in Table 5.2. The study involved slightly more men (55%) than women (45%), which was similar at the selected villages around the BBM sites. The households include 59% of young people, aged between 18 and 44 years old, 31% middle aged between 45 and 60 years old and 10% elderly people. BBM site 2 and 3 have a different configuration where the households around BBM site 2 have more young people and very few elderly, while BBM site 3 has relatively more elderly people; When this age distribution is compared to that of country's population, does not deviate much from the mean. Acording to National statistics of 2011/12, the proportion of people within 0 to 14 age group comprised about 44 percent of the total Tanzania Mainland population. The proportion of population aged 15-64 years was 52 percent those aged 65 and above was 4 percent. This pattern according to the authors remained unchanged between the three survey periods (NBS, 2012).

The majority of the people in the Kilombero sub-basin received primary education (82%), while a few complete secondary or higher education. The main economic activity of the respondents is crop farming (95.60 %) while many are also fishermen (41.61 %) and/or livestock keepers (39.08 %). 25.83 % are involved in other economic activities, including petty business. Livestock keeping is less present around BBM site 4 and 5 while fishing is less present around BBM site 3. The National Beaural of Statistics (NBS) data revealed that 75.4% of Tanzanians were currently employed in agricultural and fishery occupations with 87.6 percent of them living in rural areas. Besides, the data further indicated that overall, 51.4% of Tanzania Mainland households keep at least one kind of livestock. As would be expected, the proportion of households that kept livestock was high in rural areas at 65.9% and low in Dar es Salaam at 8.1%, (NBS, 2012).

The study revealed that most households (37%) have an annual income ranging between TZS 600,000 and TZS 1,999,000. Very few households earn less than TZS 50,000 per year (1%) while 4% earn more than TZS 4,000,000 per year (Table 5.2). We cannot compare our findings on household income with national data since the NBS computes income through expenditure method. According to the Household Budget Survey, (2012), the Mean annual expenditure per household (nominal price of, 2012) is estimated to be TZS 258,751(NBS, 2012). The mean for rural areas category where the basin falls in is estimated to be TZS 212,600. Moreover the study area's mean estimate is close to that of Dar es Salaam which is indicated to be TZS 442,818. The mean household consumption basket in 2011/12 is still dominated by food, around 55.5 percent. In rural areas where food is produced and not bought, the expenditure method should be expected to underestimate the household cash-income.

Table 5.2 Socio-economic characteristics of respondents

	Mean sample villages (%)	BBM site 1	2	3	4	5
Sex						
Female	**45**	47	45	43	44	45
Male	**55**	53	55	57	56	55
Age						
18-44 years	**59**	65	67	47	54	64
45-60 years	**31**	27	31	36	34	28
> 60 years	**10**	9	2	17	12	8
Education						
None	**8**	3	3	11	15	7
Primary	**82**	86	88	78	79	84
Secondary	**8**	8	9	8	7	9
College/university	**1**	0	0	3	0	0
Other	**1**	3	0	1	0	0
Main economic activities						
Crop farming	96	96	93	91	100	98
Livestock keeping	39	52	40	44	30	31
Fishing	42	51	49	33	42	40
Other	26	20	26	43	15	20
Annual income (TZS)						
< 50,000	**1**	0	2	1	0	3
50,000-199,000	**10**	8	7	12	10	11
200,000-599,000	**24**	18	26	19	28	29
600,000-1,990,000	**37**	46	42	31	38	34
2,000,000-4,000,000	**24**	25	18	32	23	17
> 4,000,000	**4**	3	5	5	2	6

6.0 SOCIAL USE OF RIVERINE RESOURCES SERVICES BBM 1-5

This chapter presents the main findings from the qualitatiave and quantitaive socio-economic surveys. The results are presented per BBM site, with exception of medicinal plants which appears to be the same in all BBM sites all other fows are described in specific. Consequantly the medicinal plants are only described in this chapter. For the remaiming flow related resources the following order is followed; First a general description of the area and its main water bodies is presented followed by the socio-economic characteristics. Then the use and relevance of each of the riverine resource services is described as well as the contribution of these services to the annual income. A seperate paragraph describes the flow related aspects such as water depth, velocities and inun-

dation last as experienced and preferred by the population. Last the preferences of the population for the riverine resource services and the determination of the maintenance level is presented.

6.1 BBM findings at a glance

In this chapter a summary is provided of how people at the different BBM sites depend on the healthy riverine ecosystem of the Kilombero river and its tributaries and what their preferences are.

6.1.1 Socio-economic activities

Crop cultivation is the most important economic activity at all BBM sites (Table 6.1). Fishing and livestock contributes also significantly, but the engagement differs between the different sites, with eg BBM site 1 having large engagement in livestock keeping (40%) and fishing (48%) while BBM site 2 and 3 have less engagement in fishing, 30% and 33% respectively. At BBM site 3 there is a relatively large engagement in other economic activities, such as brick making and petty business.

Table 6.1 Main economic activities at BBM site 1-5

Percentage household engaged in economic activity	BBM sites				
	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)
Crop farming	96	93	93	96	98
Livestock keeping	40	38	44	37	28
Fishing	48	30	33	42	43
others	19	28	39	25	19

The relative contribution of the different activities to the annual household income is presented in table 6.2. For the villages of BBM sites 1, 2 and 3 crop farming is their main source of income, out of which rice is the most important cash crop, while at BBM sites 4 fishing becomes more important and at BBM site 5 fishing is the main source of income.

Table 6.2: Contribution to annual household income

Economic activities	BBM sites				
	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)
Crop farming (Maize, Rice, Sunflower, Sesame and Banana)	69	80	72	47	14
Vegetable cultivation	6	6	10	0	0
Livestock keeping	5	6	7	14	4
Fishing	18	3	9	38	81
Weaving	0	0	1	0	0
others	2	5	1	1	1
Total	100	100	100	100	100

6.1.2 Riverine resources services

Domestic water use

Most people depend on boreholes for the domestic water supply, however at BBM site 2 (villages of Mgugwe and Udagaji) people depend more on water from the small permanent rivers. Also in Merera village (BBM site 4) domestic water needs are complemented from Mpanga and Kihansi river and in Kikwawila village (BBM site 5) water is also obtained from Isomba river. The location of the boreholes and how groundwater is related to flows of the river needs to be analysed further.

Swimming

At all sites people, especially children, swim in ponds and small rivers. It is mostly done during the dry season. A sufficient water quality and water depth and not to high water velocity needs to be maintained.

Crop cultivation

Farming is practiced mainly in the lower and some of the higher parts of the floodplain which inundate annually. Main crops cultivated are rice and maize, but many other crops are cultivated such as sesame, potatoes, cassava and fruit such as banana, mango and oranges. The crop cultivation is both for food (subsistence) and cash (to pay for basic needs i.e school fees, medication and transportation).

Livestock keeping

Livestock is also kept by households to contribute their diet and provide some additional income through the sales of the animals and/or their products. Livestock kept are chicken, cattle, sheep, goats (see figure 6.1) and mainly by the Sukuma tribe. Livestock grazing is mostly free grazing in different areas, including in the flood plain during the dry season. In Mpanga (BBM site 3) and the villages of BBM site 4 (Lukolongo and Merera) grazing areas are stipulated in the village land use plan.

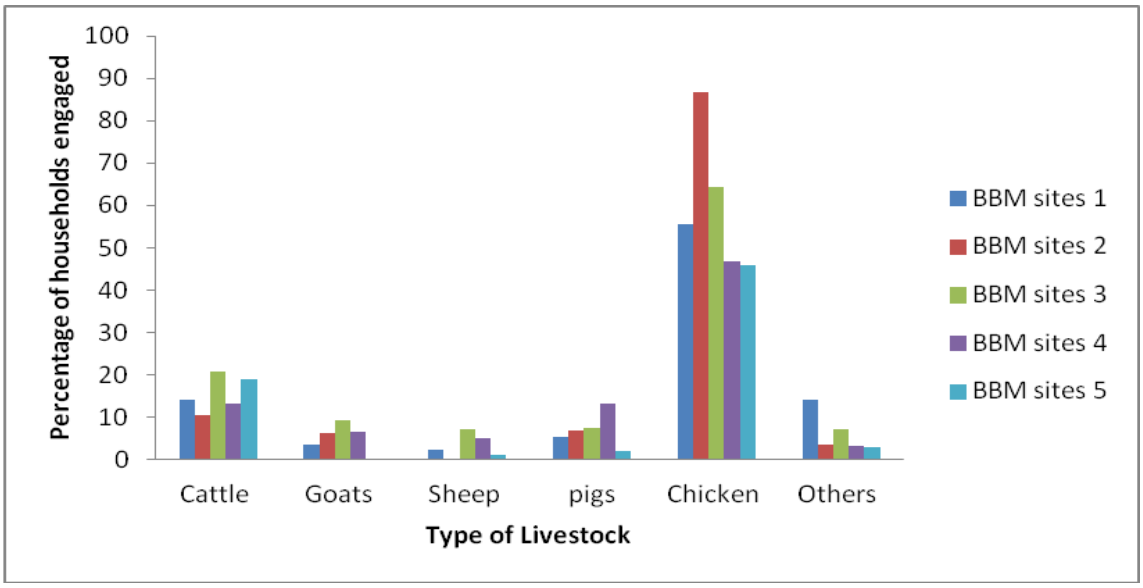

Figure 6.1: Type of Livestock kept at BBM site 1 - 5

Fishing

There is a high dependency on fish consumption for peoples subsistence (Figure 6.2). People obtain the fish in various manners, direct collection, buying or both (Figure 6.3). Fishing takes place by local fishermen in the rivers, ponds and oxbow lakes throughout the year.

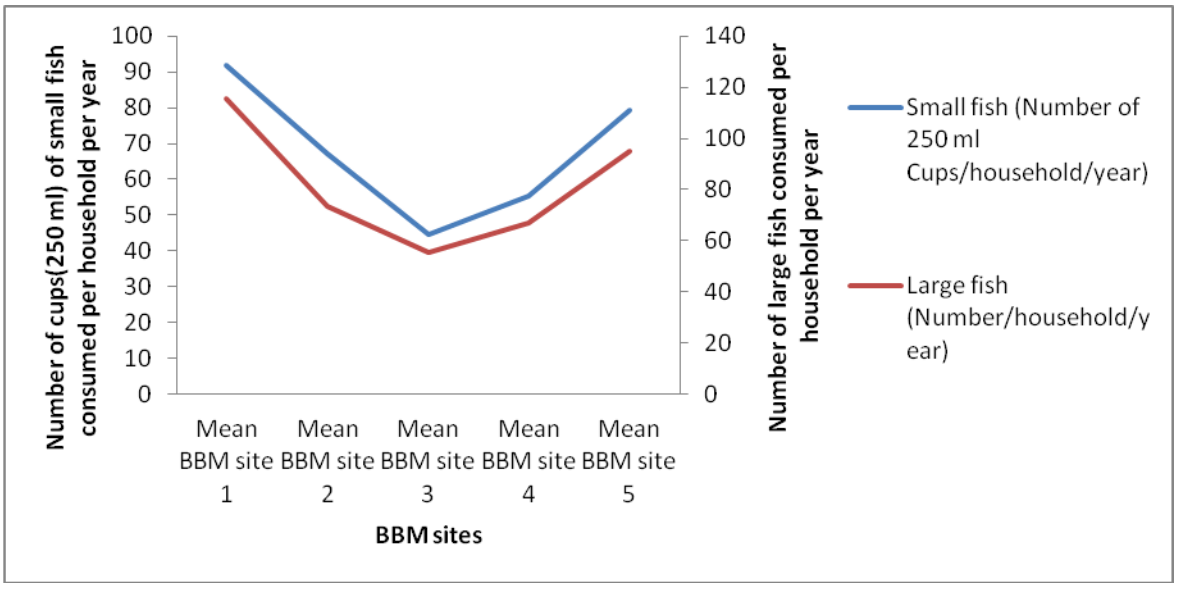

Figure 6.2: Consumption of fish at BBM site 1 - 5

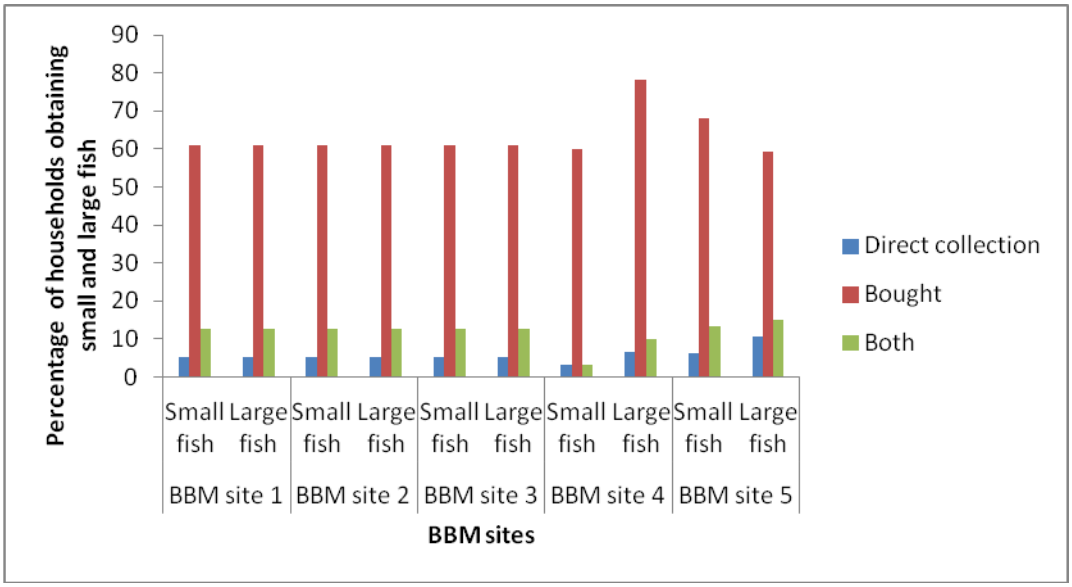

Figure 6.3: Means of obtaining Small and Large fish at BBM site 1 - 5

The most preferred fish species are *Clarias, Tilapia* and Bagrus followed by other species (Table 6.3). These are however also the fish which are mostly available. People indicate they prefer *Alestes* (BBM site 3 and 4), but also say it has become rare nowadays. At BBM site 4 clams are reported. At BBM site 4 fish variety is very high and fish is readily available especially during the wet season when the water and the fish reach close to the homes. At BBM site 2 fish species are few and fish are not readily available anymore so people buy most fish or go to Kihansi river for fishing.

Table 6.3 Respondents preferences for fish

Fish species	BBM site				
	1	2	3	4	5
Clarias	3	1	1	1	1
Tilapia	1	2	2	2	2
Bagrus	2	3		3	3
Mormyrus	4		5	4	
Alestes				5	
Synodontis	5		3	3	
Brycinus		4			
Hydrocynus			4		

Animals, birds and insects

Besides fish other aquatic animals such as hippos, Crocodylus niloticuss, Lutra lutra, kindasi (type of Chelonia spp), python and lizards occur in the rivers. Their presence brings both benefits as some of these are consumed by local people and especially hippo pools are good breeding sites for fish while people also indicate not to prefer them as

they are dangerous. Also Brachyura spps (BBM site 2) and snails (BBM site 4 and 5) are reported.

Natural and cultivated vegetables and fruits

Different types of natural and cultivated vegetables and fruits are consumed by the local population (Figure 6.4) and amount of natural vegetables consumed (Figure 6.5). People obtain the vegetables and fruits in various manners, direct collection, buying or both (Figure 6.6).

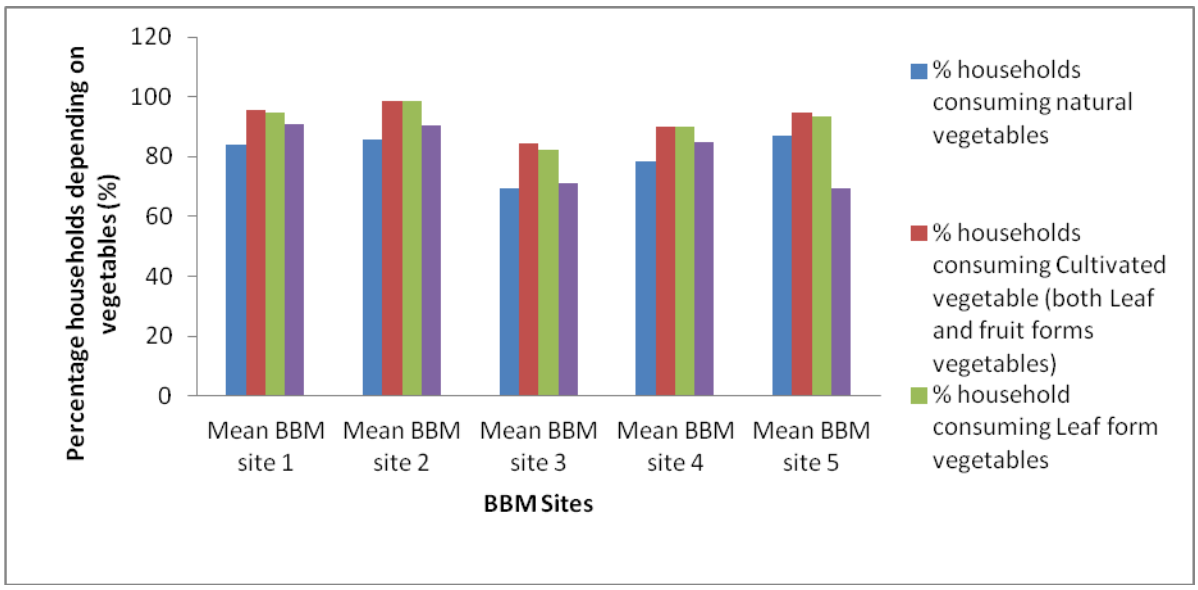

Figure 6.4: Percentage of households depending on vegetables in BBM site 1 to 5

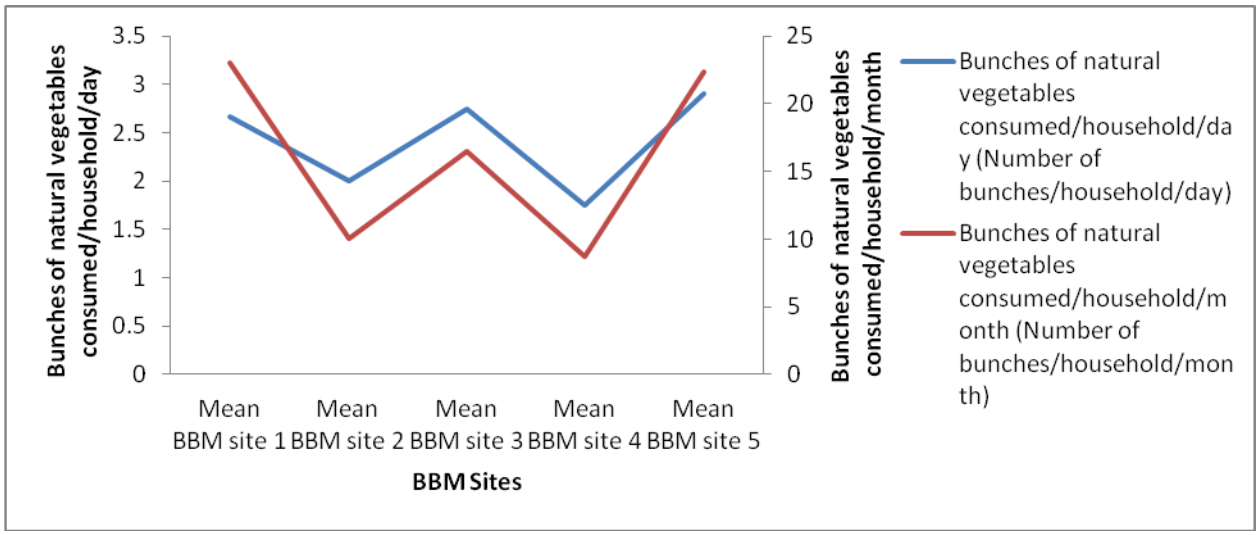

Figure 6.5: Consumption of natural vegetables and fruits at BBM site 1-5

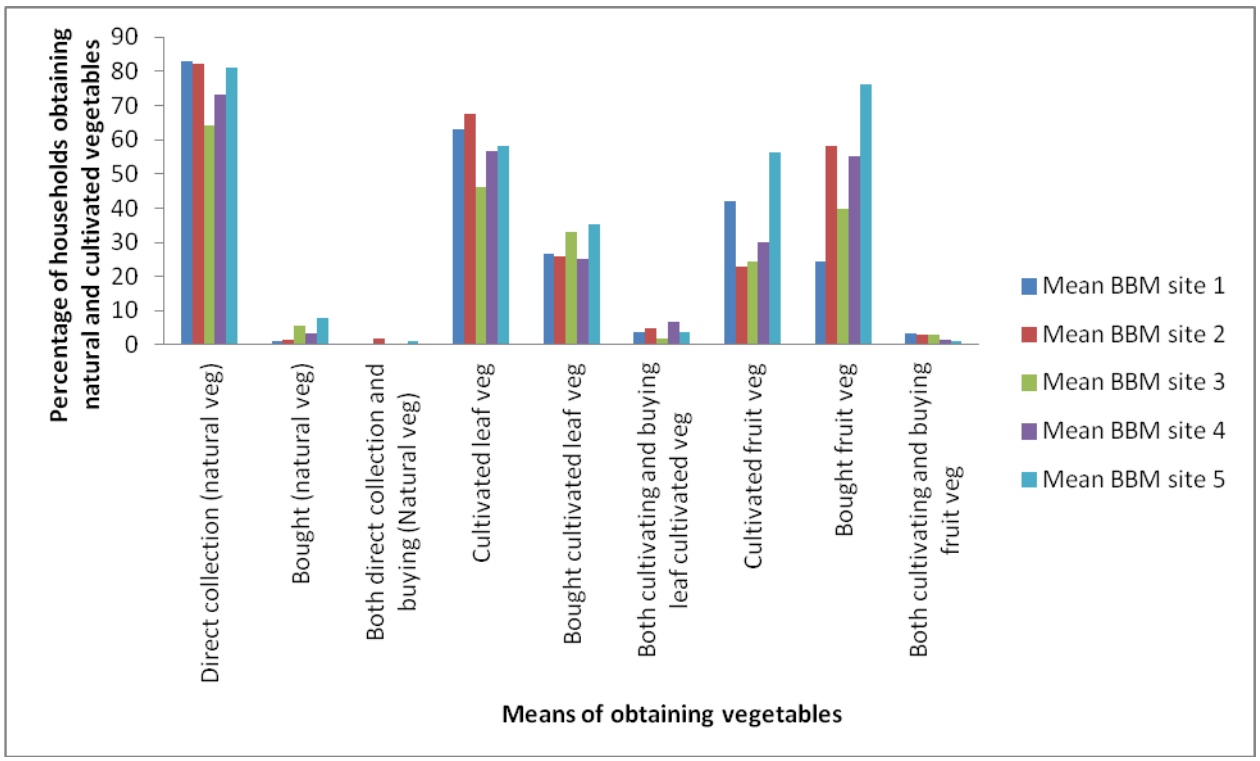

Figure 6.6: Means of obtaining natural vegetables and fruits at BBM site 1 - 5

The most preferred natural vegetables and fruits differ from location to location (Table 6.4), which is possibly related to the availability.

Table 6.4: Respondents preferences for natural vegetables and fruits

	BBM site				
Natural vegetables	**1**	**2**	**3**	**4**	**5**
Barleria submollis		4	1	2	
Sesbania sesban		1		3	
"Lidadangala"		1			
Aeschynomene uniflora			2	1	
Amaranthus sp		3			
"Namgange"				5	
"Mushroom"			3		
Kambelege		2			
Corchorus triloculares			4	4	
Amaranthas sp			5		
Natural fruits					
Vitex doniana			1	1	
"Madongadonga"			2	3	

Mikusu	1			
Bwegela	4			
Parinari curatellifolia		2	4	
Misada			2	
Tamarindus indica		3	3	
"Mtopete"	3	4	4	
"Mapingipingi"	3			
Vitex payos		4		

Weaving materials

Weaving is an important socio-economic activity for the population. At all sites people mostly use is Ukindu (*Phoenix reclinata*) and Malala (*Hyphaene petersiana*), which they obtain through direct collection and buying. The majority of the mats produced are for own household purposes.

Construction materials

Thatching grasses (eg Mbasa, Lusano) are widely used and are found at the higher parts of the floodplain. Also construction materials from Matete and Mianzi are used. These trees can be found in the forest area (BBM site 2) or further away in the floodplain, not in the riparian zone.

Water associated problems

Pair-wise ranking was done in the villages of the different BBM sites to rank the water related diseases and problems (Table 6.5). At all sites malaria is perceived to be the most problematic.

Table 6.5 Ranking of water associated problems and diseases

	BBM site				
Diseases	**1**	**2**	**3**	**4**	**5**
Malaria	1		1	1	1
Fungus	4		2	8	2
Diarrhoea	8			5	5
Typhoid	5		3	2	4
Amoeba	8			7	6
Cholera	3		4	4	
Bilharzias	6		5	6	3
UTI	7		6	3	3
Problems					
Flooding	2		4	2	
Aquatic animals			7		
Accidents in water			8		

Traditional medicine
The traditional healers found in all villages obtain their medicinal plants mainly from the forests. Some obtain medicinal roots from swamp areas, eg the roots from locally known species which were not identified including Mchelemela, Chilemela ndembo, Afzelia sp, Mzahabu, Lubugu and Mkole or from the valleys, eg grass species such as Mwosha fede grass. Some traditional healing activities require water, eg to prepare the medication, but the carrying out of the traditional healing is not done in the rivers due to the presence of animals such as Crocodylus niloticuss.

Flooding
Flooding occurs annually and is much needed to replenish the soils and inundate the rice fields. However depending on the extent and duration it can also become problematic for the people, especially those villages which are located in the lower parts such as Ngalimila and Chisano (BBM site 3). At BBM site 2 flooding is not common.

Navigation
People need to cross the rivers to eg access local markets, hospitals, schools so water depth needs to sufficient and velocity not too high. At most BBM sites people make use of canoes to get across. At BBM site 5 people also use the ferry across the Kilombero and at BBM site 2 people depend more on roads for transport.

6.1.3 Preferences of the local population

Water levels, inundation and velocity
The study assessed water depth, inundation area and velocity in both the main channels and inundated areas. In general the most respondents (%) recommended water depth in main channels not to go below knee level during dry period and breast height during wet seasons. This was mentioned important to enhance fishing activity.

The depth in inundated areas during wet seasons should not exceed knee level and in areas where their farms are located the period should not exceed three weeks to enhance rice farming which is their main crop grown in almost all the BBM sites. The area to be covered by inundation depended on where the household farm is located. However they did prefer the flooding not to reach their homesteads.

The majority (above 55%) also preferred a medium velocity of water in their rivers to enhance fishes' survival that are velocity dependent. But they were specific on water velocity in inundated areas especially in their farm areas where they recommended a slow movement to avoid destruction to their crops.

Riverine resources services

The respondents were also asked for a prioritization and preference of the riverine resources services. Their preferences are presented in Table 6.6. Generally, the production services have the highest preferences, with domestic uses, flood recession agriculture and cultivated vegetables and fruits as the most preferred services. Health control, a regulation service, is also considered very important, even more important than fishing, fuel woods, and flood mitigation. People give very low preference to services as aquatic animals, recreation and tourism and sites for cultural and ritual activities.

In general the preferences indicated are very similar for the different sites, but there are some distinct differences. Livestock keeping is perceived not so important at BBM sites 1, 4 and 5 while at BBM sites 2 and 3 it is more preferred. Flood mitigation is ranked higher at BBM sites 1 and 5 indicated flooding gives more problems in these areas.

Table 6.6: Preferences of ecosystem services at BBM site 1-5

Service provided	**Riverine resource service**	**BBM sites**				
		1	**2**	**3**	**4**	**5**
Production						
Water for people-subsistence / rural and piped/urban *(Water for domestic uses)*	Domestic use	2	1	1	2	2
Fish/shrimp/Brachyura spps (non-recreational) *(Fish and fishing grounds)*	Fishing	6	6	5	4	5
Fertile land for flood recession agriculture and grazing *(Moist and fertile soils for flood recession agriculture)*	Crop cultivation	1	2	2	1	1
Fertile valley plains for grazing	Livestock keeping	12	8	6	11	15
Wildlife for hunting (nonrecreational) *(Aquatic animals such as hippopotamus, Crocodylus niloticuss and snails)*	Animals, birds and insects	16	16	17	15	17
Vegetables and fruits	Natural vegetables and fruits	10	10	10	9	8
	Cultivated vegetables and fruits	3	3	3	3	3
Fiber/organic raw material for building/firewood/handicraft	Construction materials	5	4	7	6	6
	Weaving materials					
	Fuel					

Medicine plants	Traditional medicine					
Inorganic raw material for construction and industry (gravel, sand, clay) *(Soils for brick making)*		9	7	9	7	10
Water for navigation		13	14	13	14	12
Regulation						
Chemical water quality control (purification capacity)						
Physical water quality control		7	9	8	8	9
Flood mitigation	Flooding	8	11	14	10	7
Groundwater replenishment (low-flow maintenance)						
Health control *(Malaria, bilharzias and UTI control)*	Water associated problems	4	5	4	5	4
Pest control						
Erosion control (riverbank/bed and delta dynamics) *(Sedimentation and erosion control)*		11	12	11	12	14
Prevention of saltwater intrusion (salinity control)						
Prevention of acid sulphate soils development						
Carbon "trapping" (sequestration)						
Microclimate stabilization						
Recreation and tourism (incl. fishing and hunting)		17	15	16	17	16
Information12						
Biodiversity conservation		14	13	12	13	13
Cultural/religious/historical/symbolic activities *(Sites for cultural and ritual activities)*	Traditional dancing	15	17	15	16	11
	Rituals Unyago Circumcision Jando Swimming					
The prior existence of healthy ecosystems						

6.2 BBM SITE 1 - Lwipa

6.2.1 Introduction

Three sample villages were selected around BBM site 1 namely Mbingu (Vigaeni hamlet), Kisegese and Mofu (see Figure 6.7). This site is located in the Kisegese irrigation scheme. The Luipa is a perennial river and passes through the three villages. During the wet season the river inundates the floodplains covering a width of approximately 15 km from the main channel, filling the seasonal streams, ponds and oxbow lakes. The river has a lot of fish species, Crocodylus niloticuss, hippos, Chelonia spps and other small animals including snails. In the upper part the land is covered with different tree species whereas in the lower part it is covered with woodland and grasses.

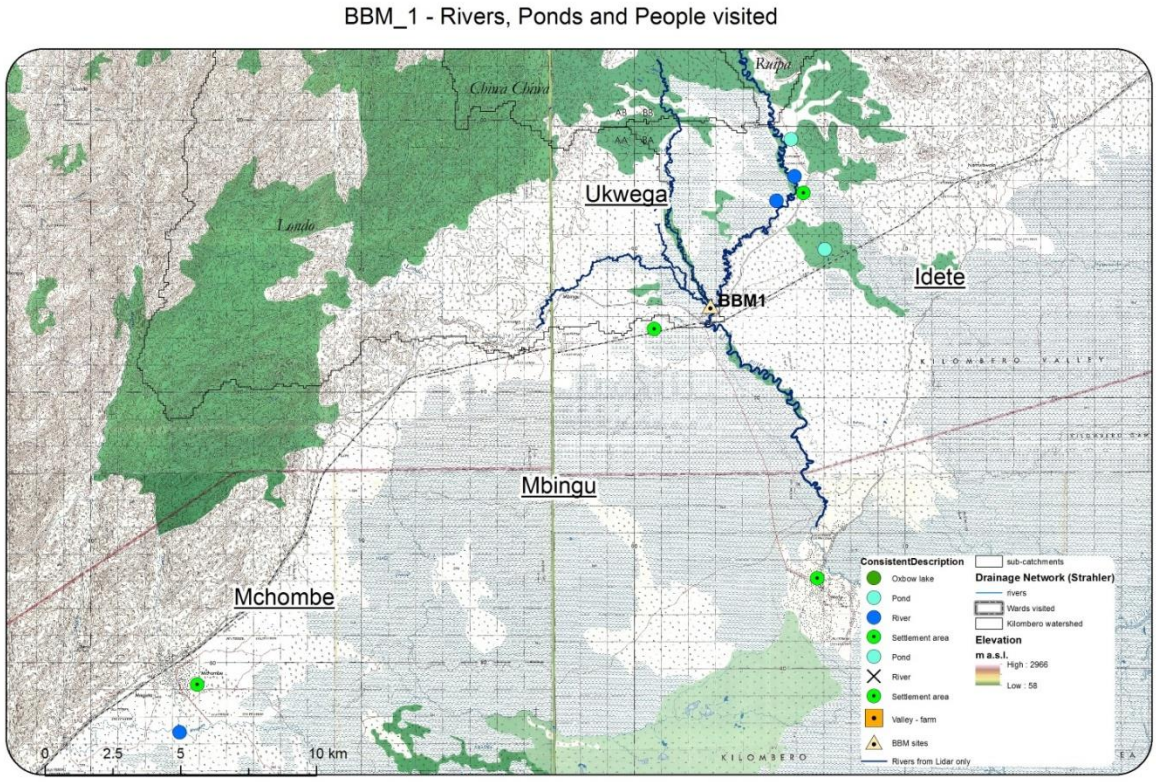

Figure 6.7 Villages visited at BBM 1 – Lwipa

Historic changes of biophysical features

Luipa River passes through the three villages of BBM site 1 which comprises of Mofu, Mbingu and Kisegese. The river is permanent with its water flowing water throughout the year. Apart from Lwipa the site has also other permanent rivers including, Chiwachiwa, Lwondo and Kisegese. In all the three villages there are also seasonal rivers including Ngumbingumbi, Lwipa hafiri, Chikongoli, Chamamba, Mbusi, Ifakara, Kiwale, Kokoto and Indandu. The villages have also many ponds and swamps. Kibasila which is the biggest swamp is located at Mofu village where as other ponds include lutelekelo, Lidovinaswala and Nyaudidi. Rivers, swamps and ponds are important biophysical features for fishing.

Valleys and oxbow lakes were also mentioned as important biophysical features in this site. Villagers revealed that they use the valleys for rice farming and grazing of animals. These oxbow lakes have special linkages with drainage networks where there is take and receive kind of relationship that enhances the flooding and water flows throughout a year. The features are also important for providing breeding sites for some species of fishes that exist in the Kilombero river. Such kind of relationship is illustrated in Figure 6.8.

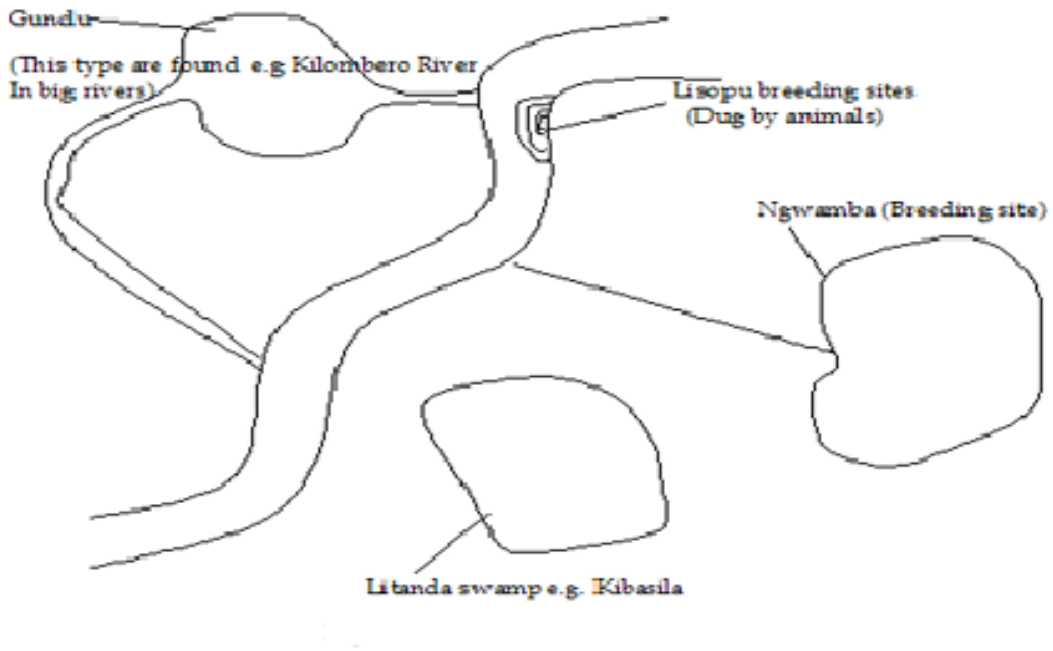

Figure 6.8 Types of ponds/oxbow lakes

It was mentioned by key informants that, historically most rivers that exist in the village had water throughout a year, until during president Mkapa's ruling regime i.e. 1995 onwards when they started seeing some of these changing their status from permanent to seasonal rivers. They went on explaining that it was from that time when drought started to gradually increase. As a consequence to drought most of the ponds have decreased in size, an example to these is Kibasila Swamp

In the village there are also several forests which include Namwai, Naniikolowa, Kibasila and Mapela.

6.2.2 Socio economic characteristics

Household population in BBM site 1 is composed of 65% youth aged between 18 to 44 years old which is above average (59%) of similar age group for households in BBM sites 1-5. About 27% are middle aged group (45-60 years old) and 9% are above 60 years. Majority (86%) of the population have received primary education. The major occupations in BBM site 1 are farming, fishing and livestock keeping (see table 6.7). Of the three major occupations, 96 % are crop farmers similar to the average for the five BBM sites (96 %), while 51 % are fishermen and 52 % are livestock keepers (Table 6.7). Percentages for fishermen and livestock keepers in this BBM sites 1-5 are above average (42 % and 39 % respectively). People in the areas are also involved in some petty businesses.

Table 6.7 Main economic activities in Mbingu, Kisegese and Mofu

Percentage household engaged in economic activity	Mbingu (Vigaeni) (%)	Kisegese (%)	Mofu (%)	BBM site 1 (%)	BBM Sites 1- 5 (%)
Crop farming	100	100	87	96	96
Livestock keeping	65	33	58	52	39
fishing	65	17	71	51	42
others	27	22	10	20	26

6.2.3 Determination on the extent of Environmental Flows (goods and services) uses and the expected losses

6.2.3.1 Water use

People depend mainly on bore holes for their cooking, drinking and washing (60%). The average consumption is estimated at 136 liters/household/day.

Swimming is also done in the villages in the rivers and ponds, including by children. In Mofu swimming is mainly at Kenjahile pond but between September and December also at Kabalya and Kaboke as at that time the water level is low in the rivers.

Navigation: Rivers were used for navigation in BBM site 1. It was revealed that 37 % used rivers for navigation during wet season, 43 % during dry season and 20 % during both seasons (wet and dry seasons). On the frequency of navigation it was revealed that 20 % travelled daily, 10 % travelled once per week, 13 % travelled once per month but 57 % responded that navigation was not often.

Water quality and use of farm inputs

Water quality was assessed by water quality expert under EFA study, however this study observed that farm inputs including pesticides and herbicides were used for crop farming. Potentially such farm inputs could have impact to water quality. It was revealed that households mainly used herbicides (Roundup and 2,4D -noted herbicides'

trade names) during crop cultivation. On average 81% of the households applied herbicides during crop cultivation while only 1 % applied chemical fertilizers in BBM site 1 (Figure 6.9).

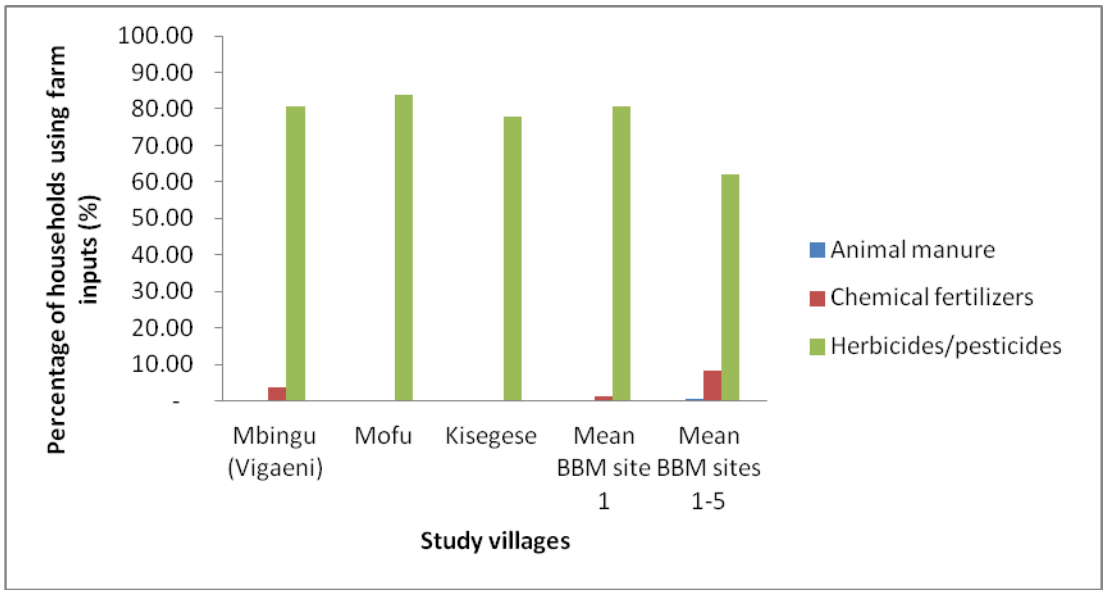

Figure 6.9: Percentage households using farm inputs and types of farm inputs used

Also on average 4.70 litres of herbicides/household/acre was applied while amount of chemical fertilizer applied was 84.18 Kg/household/acre in BBM site 1 (Figure 6.10).

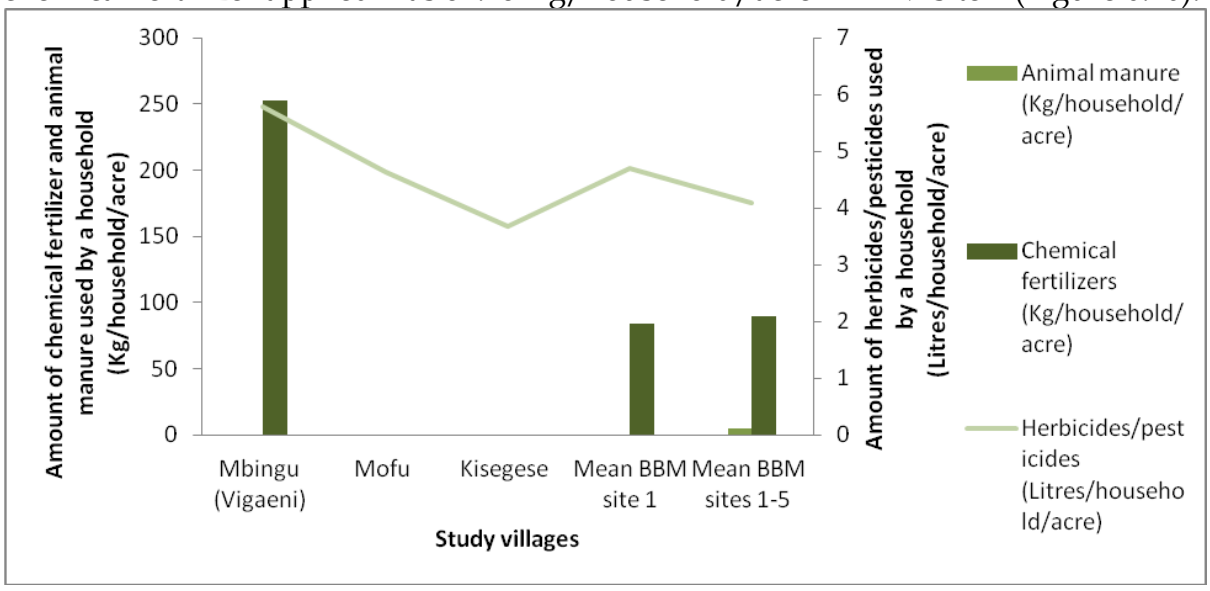

Figure 6.10: Amount of chemical fertilizer, animal manure, herbicides and pesticides used by a household per acre

Water associated problems

Diseases related to water can also be found in the area. Households mention the problems with malaria, Typhoid, Fungus, Bilharzia, Amoeba, Diarrhoea, Dysentery, Cholera and Ancylostomiasis (Safura). People indicate that the Malaria is the most problematic, followed by Fungus (Table 6.8).

Table 6.8 Ranking of water associated problems in villages of BBM site 1

Problems/Diseases	Mbingu	Kisegese	Mofu	Mean	Overall rank
Malaria	2	1	2	1.7	1
Flooding	1	9	1	3.7	2
Cholera	6	4	4	4.7	3
Fungus	4	9	3	5.3	4
Typhoid	3	9	5	5.7	5
Bilharzias	5	5	9	6.3	6
UTI	9	2	9	6.7	7
Dysentery	9	3	9	7.0	8
Amoeba	9	6	6	7.0	8

Flooding

Flooding occurs almost every year and causes great problems for the population, including causulties and destruction of crops and houses. Pair-wise ranking was done in the villages to rank the problems mentioned by the population. In Mofu and Mbingu flooding was ranked highest followed by malaria (Table 6.8).

Crop cultivation

Crop cultivation is the most important activity for BBM 1. Rice (98%) and maize (77%) are the most cultivated crops by the households, while banana (11%) and sesame (2%) is less cultivated and sunflower not at all in BBM1. Other crops include potatoes, cassava, sesame and sugar cane. Rice is cultivated in the flood plain from December until June, whereby inundation is needed during March. Most other crops are cultivated year round, whereby maize is cultivated in both the floodplain after the rice and in the upland part of the floodplain which doesn't inundate yearly. Annex 4 provides a detailed overview of the different crops cultivated, its period of cultivation and location of cultivation. This table includes cultivated vegetables and fruits.

Farm sizes are shown in Figure 6.11, for sunflower its nil. The average farm size for rice is 3.4 acres and for maize it is 1.4 acres. On average a household harvests 606.76 Kg/acre of rice per year and 36% is consumed by the household. For maize this is about 527.58 Kg/acre harvested per year out and 49% of harvested maize is consumed by the

household. Rice brings however most revenues compared to other crops. So the crop cultivation is both for food and cash.

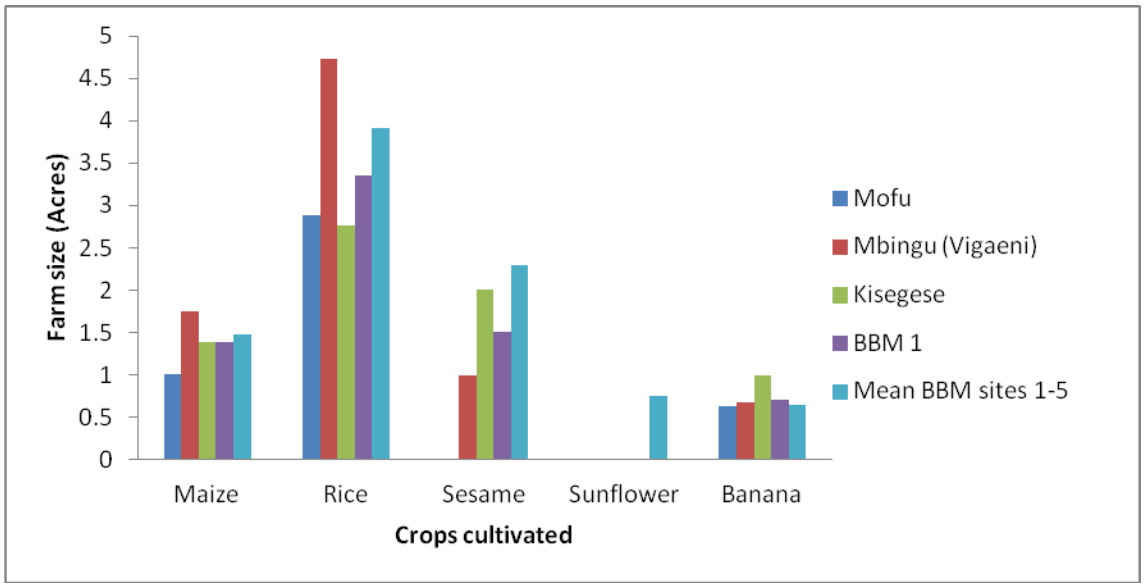

Figure 6.11 Farm sizes BBM site 1 versus average for the BBM sites 1-5

Livestock keeping

Households in BBM 1 are involved in livestock keeping. Types of livestock kept are cattle, goats, sheep, pigs, chicken and others. Most of the households keep chicken (56 %). On average about 14% keep cattle in BBM site 1, while average of cattle keepers in the five BBM sites was 17 % (see Figure 6.12). The average number of cattle per household is 2.4, which is below the average of sites BBM 1-5 which is 9.0 cattle/household. For chicken the number is highest, with 25.8 chickens/household.

Livestock grazing during the rainy season takes place in the upland part of the floodplain, those areas which do not inundate annually. During the rest of the year the livestock can also be found in the floodplain. There is little revenue from livestock keeping for a household, only pigs provide higher revenues.

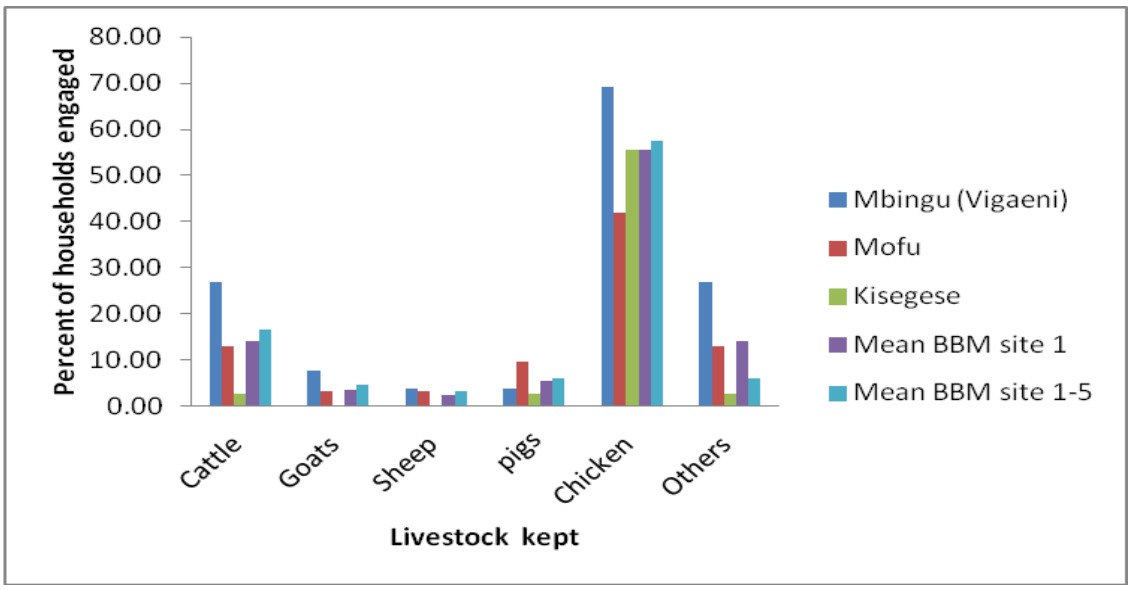

Figure 6.12 Percentage households engaged in livestock keeping and type of livectock kept

Fishing

There is a high household dependence on fish consumption for subsistence and peoples livelihoods. Fishing takes place in Luipa river and is carried out throughout the year. Fishing also takes place in other rivers such as Kilombero river (Kisesgese), Idunda (Kisegese, Londo (Mbingu) and Chiwachiwa (Mbingu). In Mbingu and Mofu fishing also occurs in ponds.

Perege and Kitoga are the most preferred fish species, followed by Kambale, Sulusulu and Ngogo. These fish are highly available in the rainy season (Dec/Jan until June), except for Kitoga which is highly available from June until Sept. Availability is low only in November. According to the local fishermen breeding takes place mostly in ponds as that water is generally warm enough and forms an undisturbed environment. Annex 3 provides a detailed overview of the different fish species, its availability in the seasons, the favourable habitat and preferred water condition.

Most household consume both small (61%) and large fish (67%) obtained through buying from fishermen or middlemen (Figure 6.13 and 6.14). On average a household consumes 116 large fish per year and 920 cups (250 ml) of small fish per year (Figure 6.15). 48% of the households are involved in fishing. The income from fishing large fish contributes about 87% of the total annual household income of the fishermen. Small fish contribute about 4%. On average a household in BBM site 1 obtains approximately 1 million TZS per year from fishing large fish and approximately 48,000 TZS per year from small fish. In Mofu the percentage of people who fish themselves is higher than in the other villages, which is supported by information that middlemen often buy from Mofu village.

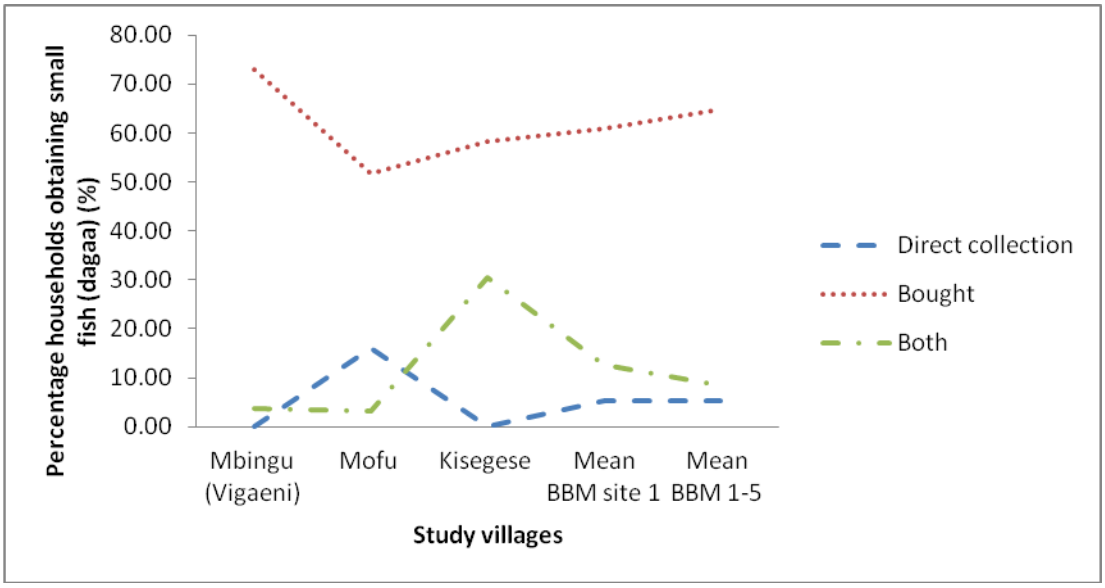

Figure 6.13 Means of obtaining small fish for household consumption in BBM site 1

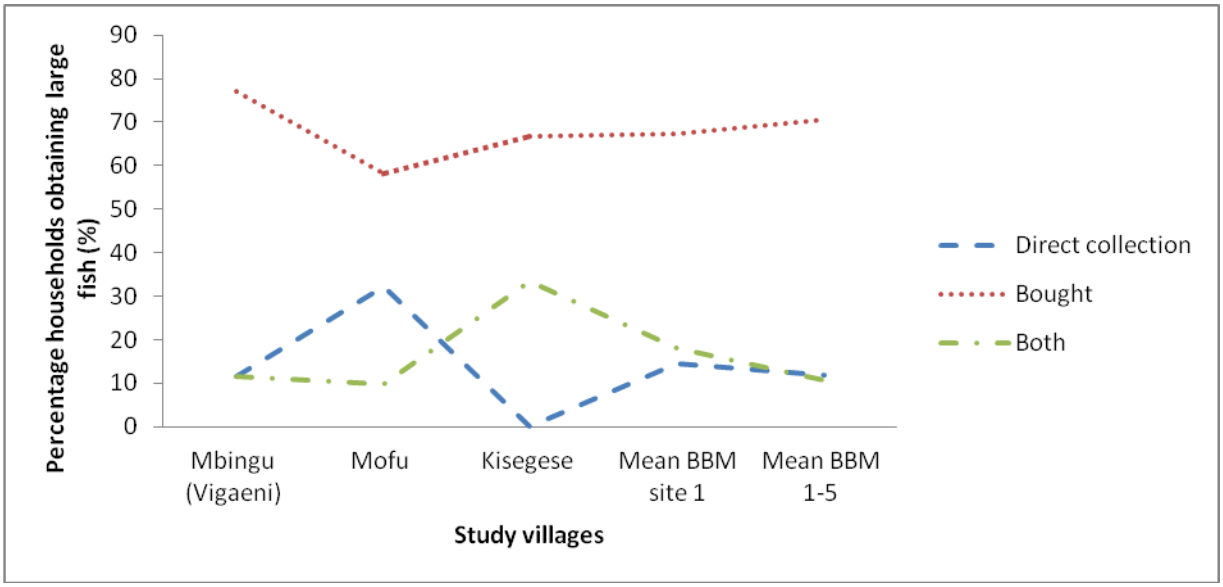

Figure 6.14 Means of obtaining large fish for household consumption in BBM site 1

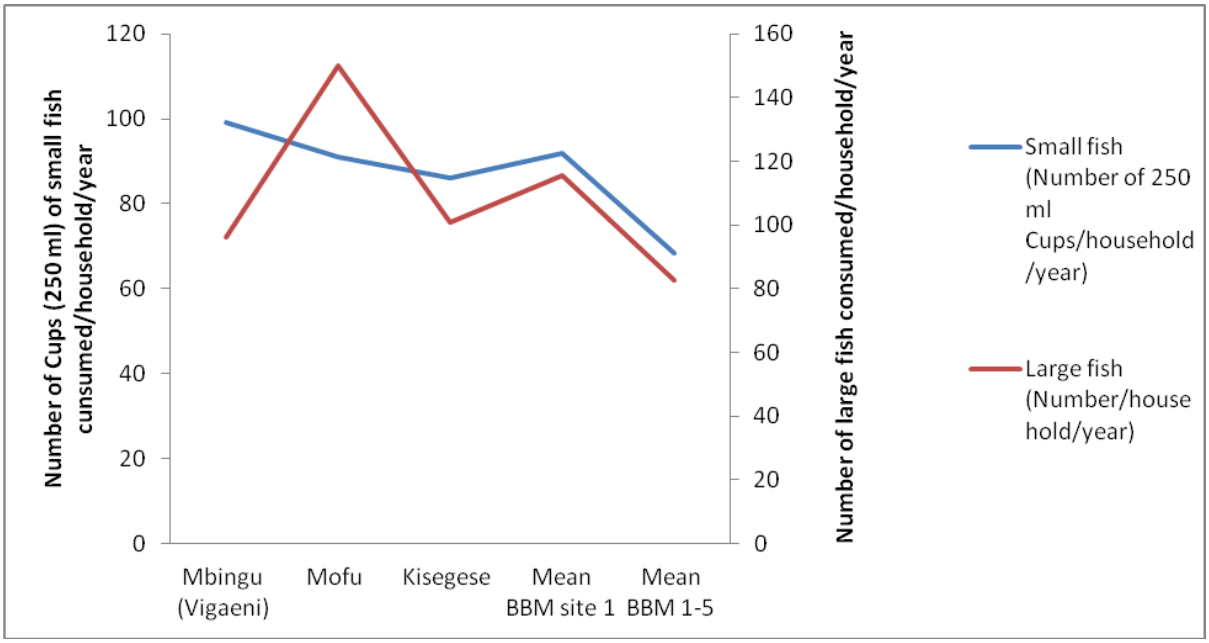

Figure 6.15 Amount of small fish and large fish consumed by a household per year in BBM site 1

Animals, birds and insects

Besides fish, other aquatic animals such as Hippopotamus amphibius, Crocodylus niloticus (Mbingu), Chelonia spps (Mofu and Mbingu), Lutra lutra (all three villages), kindasi (Mofu) and lizard (Mbingu and Kisegese) are used as source food. These animals are found in both rivers and ponds in the three villages villages. In addition, children in Mofu village identified animals for food including njapuli, sheshe and ndezi which they find in the wilderness. In Mofu birds were hunted such as dove, Twangu, Ndalendale, filiwili and kimsambi as well as insects such as maswa and vijoholo. The birds are found in valleys, rivers and ponds whereas insects are found during during the rain season. Most of these hunting activities are done between June and August

Natural and cultivated vegetables and fruits

Households dependence on natural and cultivated vegetables is very high accounting to 84% and 96% respectively (Figure 6.16). Dependence on vegetables at BBM 1 is high and above average for BBM site 1 to 5. Many different natural vegetables and fruits are consumed by the local population including *Sesbania sesban*, *Aeschynomene uniflora, Amaranthus sp* and "Namahangi" which are the most preferred vegetables. Vegetables are found in different places. For example *Sesbania sesban* grows in areas with still water, *Aeschynomene uniflora* in ponds and valleys while *Amaranthus sp* can be found in upland areas in forests. Most vegetables can be found throughout the year. On average a household consumes about 3 bunches of natural vegetables per day. Natural vegetables and fruits are not collected for business but rather for food for the household.

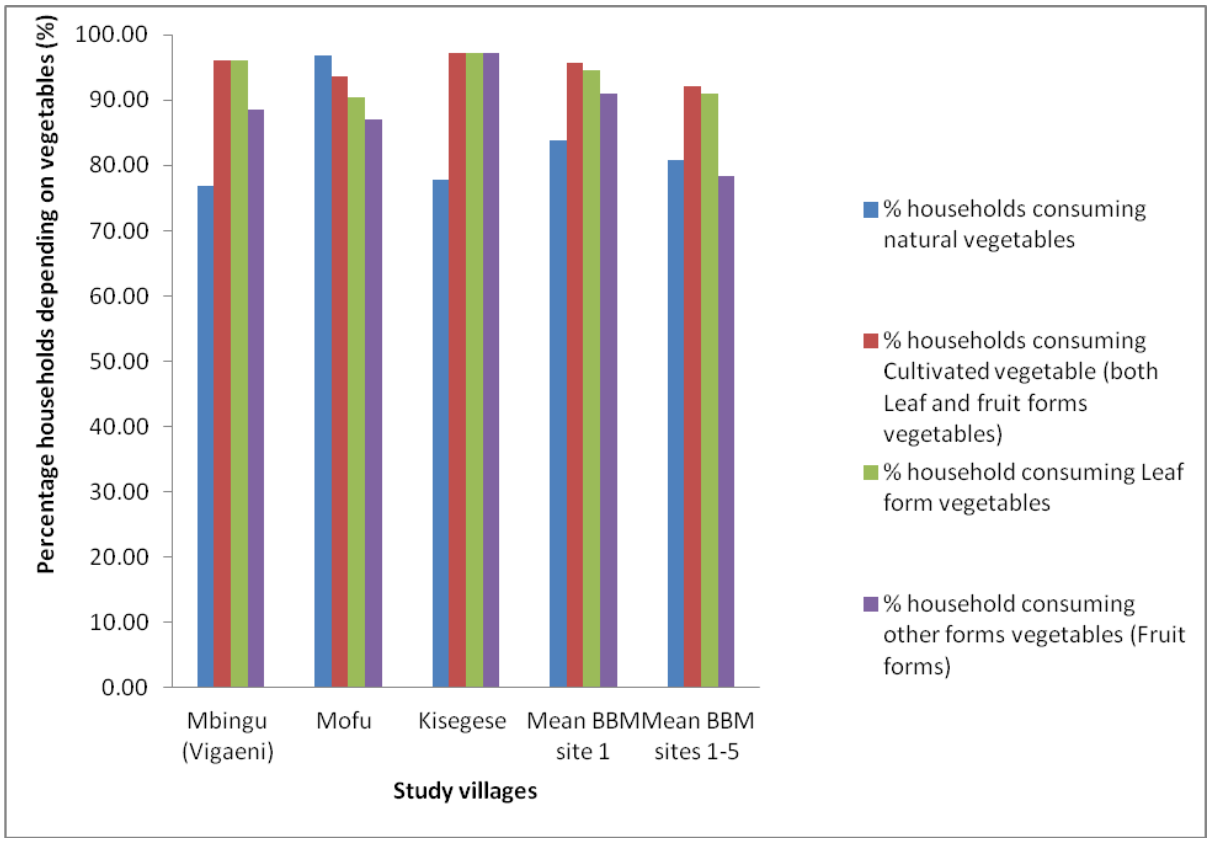

Figure 6.16 Households depending on natural and cultivated vegetables in BBM site 1

Weaving materials

Weaving is an important socio-economic activity for the population. Resources used for weaving materials include raffia / wild-date palm leaves (*Phoenix reclinata*), "miboro", mifame, malala (*Hyphaene petersiana*) and 'makumbalale'. These resources can be found in different locations, valleys (miboro and mifame) or forests (malala and makumbalale). About 72% of the households use Ukindu versus 34% Malala (Figure 6.17). The households obtain the materials through direct collection and buying. The selling of mats provides some revenues to the households, but the majority of the mats and carpets are for own household purposes.

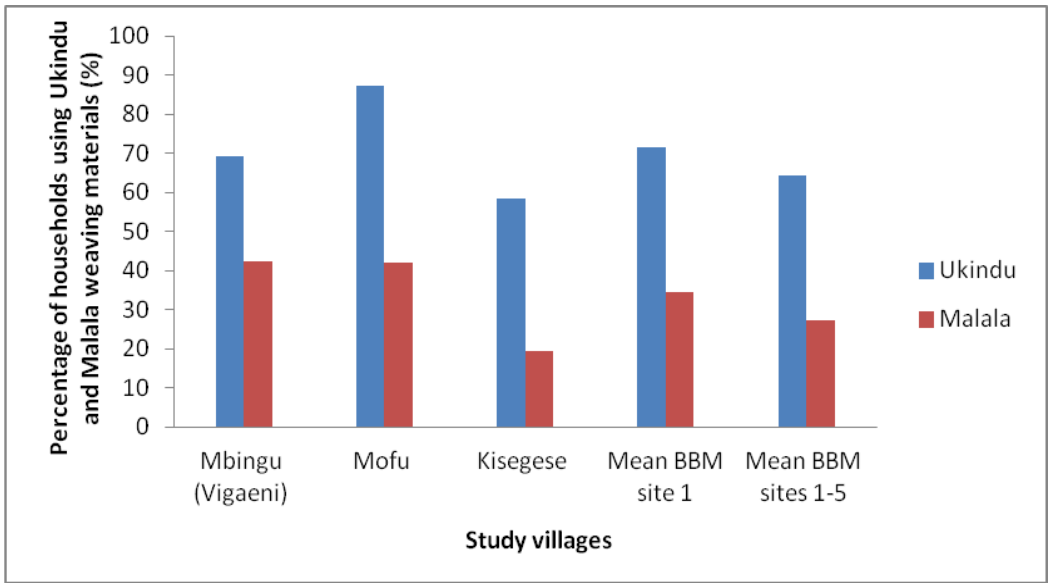

Figure 6.17 Percentage of households using weaving materials in BBM site 1

Construction materials

Households refer to use of bamboo, miwanga, mpingu and msonobari and different grasses for thatch materials. Most preferred thatching materials are mbasa and mikangaga which can be found in the valley.

Fuel

Dry wood is collected from the forest area and used as firewood. Trees that are used in all villages are bamboo (*Phyllostachys sp*), mfulu (*Vitex doniana*) and mpingu which are available throughout the year. *Phyllostachys sp*, "migugu" and "mihimbilikiti" are the most preferred fuel materials.

6.2.4 Contribution of income generating activities to household annual income in BBM1

In BBM site 1 villages households, acquire more income from crop farming (69%) than other income generating activities. The highest contribution of annual household income comes from rice farming which contributes 58% followed by fishing which contributes 18% to annual household income. However, on income contribution from fishing, a large percentage (18%) was income from large fish fishing while small fish fishing contributed 0.2% to annual household income. Vegetables cultivation contributes 6% of annual household income. Leaf vegetables cultivation contributed 6% while fruit vegetables contributed 1% of annual household income. It can be argued from the results that a household could lose 18% of its annual income in BBM site 1 in case large fish disappear and only 0.2 % of its annual income in case small fish (dagaa) disappear. The results also suggest that in case water to support vegetables cultivation becomes insufficient households can lose 6% of their annual household incomes.

6.2.5 Water levels and velocity in wet and dry seasons

Water levels and inundation levels during wet and dry seasons
Water depth in areas inundated with water from main rivers during wet season in BBM site 1 were investigated. 52% of households in BBM site 1 revealed that water level in inundated areas was above breasts. An average of 43% of households for BBM site 1 to 5 had similar response. However, 53% of households in BBM site 1 prefer that water in inundated areas be at knee level. An average of 49% of households for BBM site 1 to 5 had similar response on the preferred water level (Figure 6.18).

Water depth in inundated areas with water from small/seasonal rivers during wet season was revealed to be at waist level by 62% of households. An average of 42% of households for BBM site 1 to 5 had similar response. However, 54% of households prefer that water in inundated areas be at knee level (Figure 6.19).

Water depth during dry season in main rivers was revealed to be above breast level by 52% of households.An average of 44% of households had similar response for BBM site 1 to 5. Nevertheless 5% of households preferred water level in rivers during dry season to be at breast level (Figure 6.20).

Inundation level in distance for water coming from the main rivers during wet season was estimated to be above 15 km by 46% of households. An average of 27% of households for BBM site 1 to 5 had similar response. Nevertheless 32% of households in BBM site 1 prefer that inundation level remain to be more than 15 km from main rivers (Figure 6.21).

Inundation level in distance for water coming from small/seasonal rivers during wet season was estimated to be above 15 km by 39% of households in BBM site 1. An average of 19% of households for BBM site 1 to 5 had similar response. However, 31% of households in BBM site 1 prefer that inundation level remain to be more than 15 km from small/seasonal rivers (Figure 6.22).

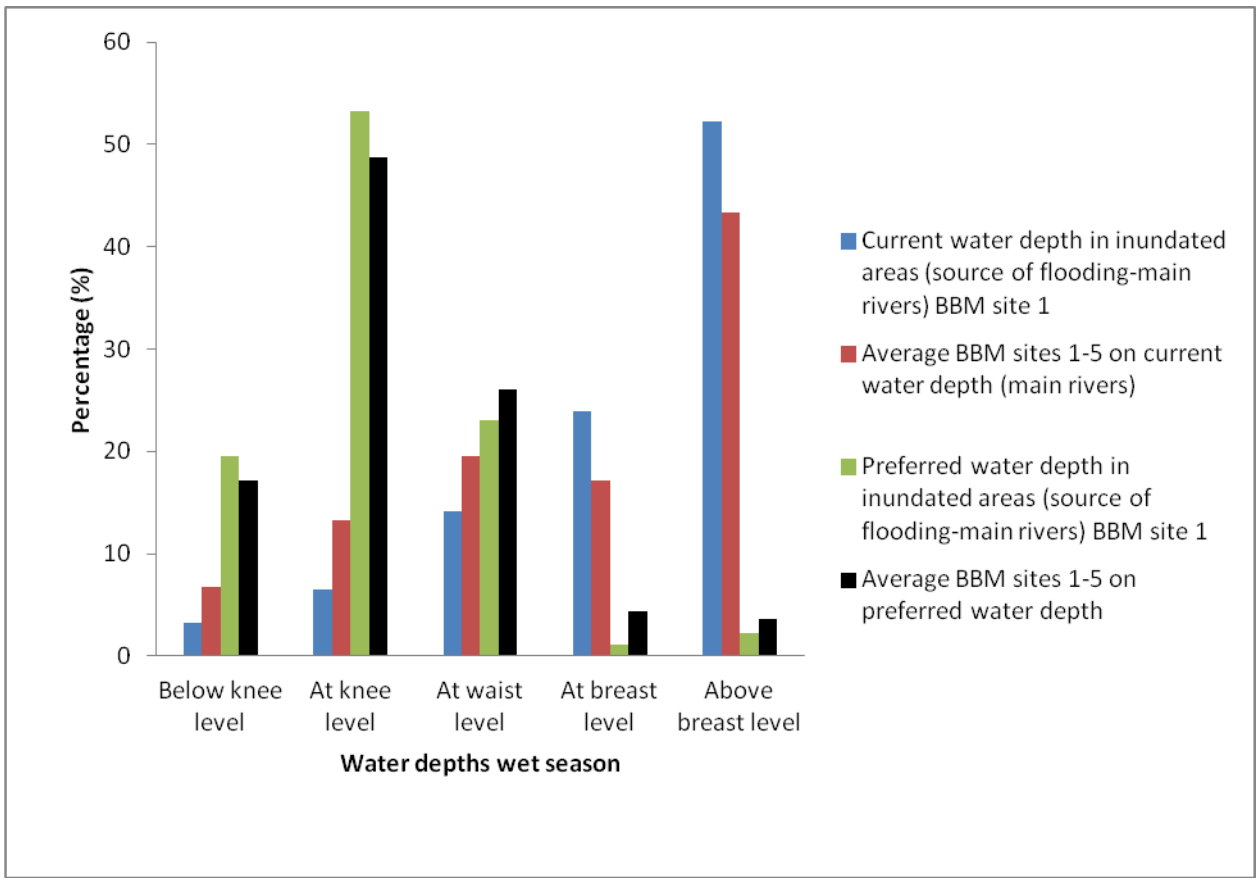

Figure 6.18 Water depth in inundated area for water from main rivers during wet season

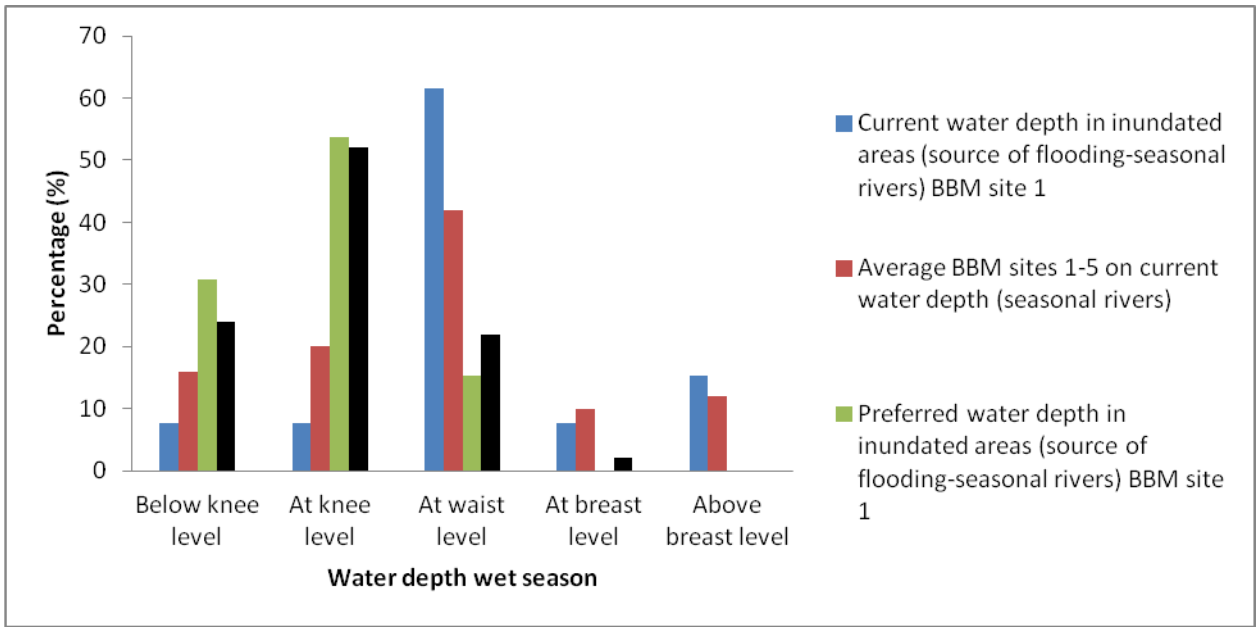

Figure 6.19 Water depth in inundated area for water from seasonal rivers during wet season

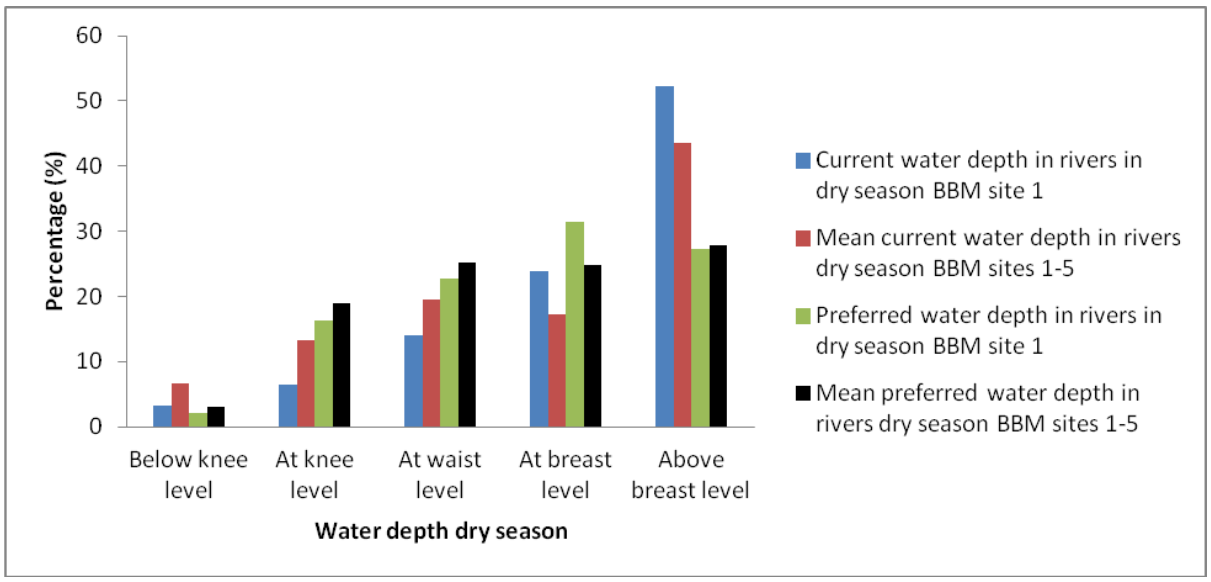

Figure 6.20 Water depth in main rivers during dry season

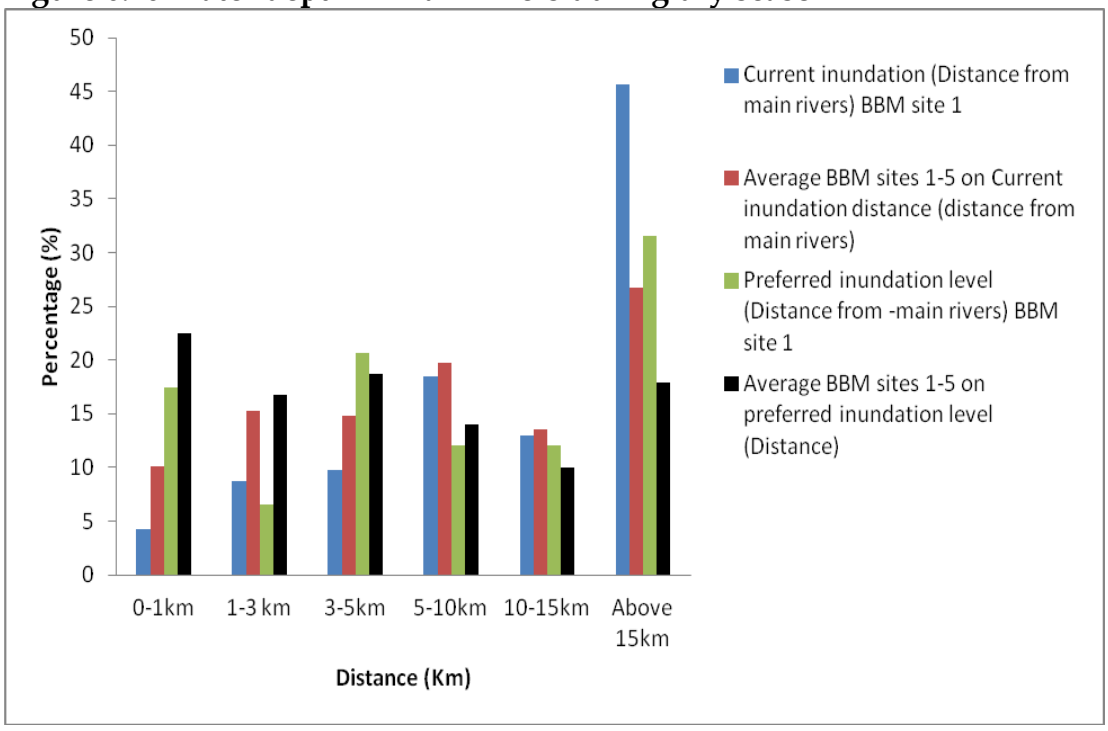

Figure 6.21 Inundation level in distances from main rivers during wet season

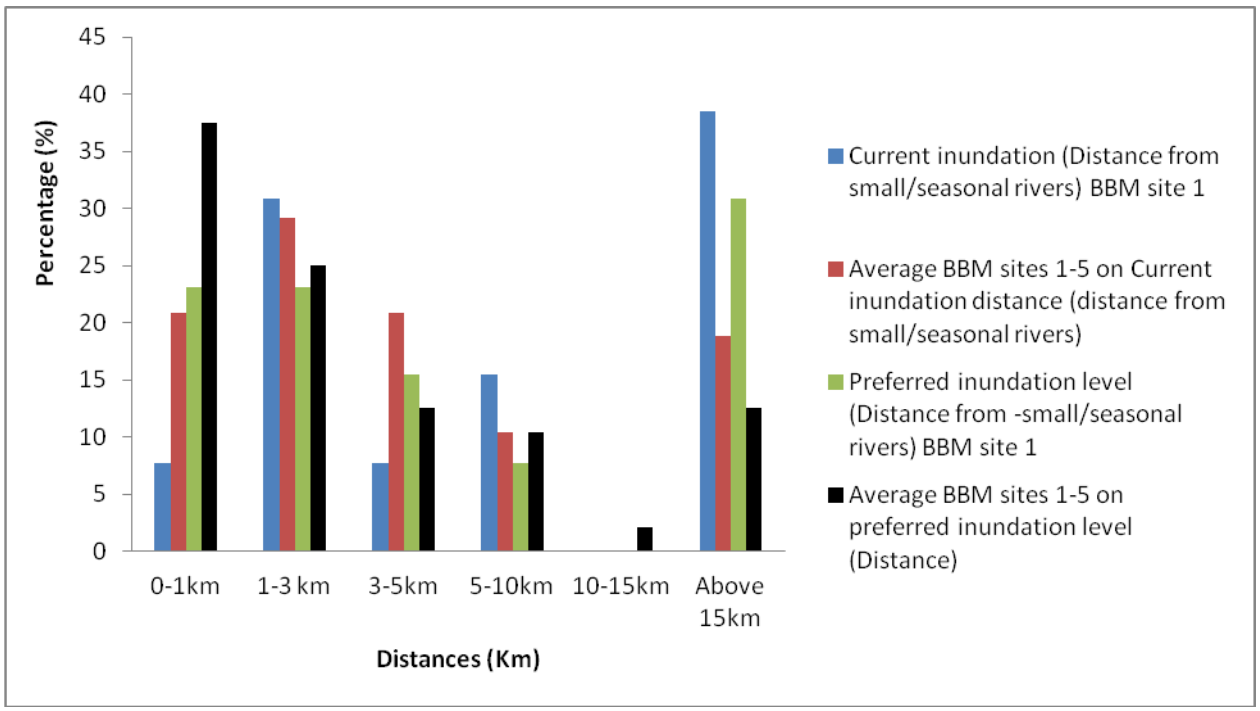

Figure 6.22 Inundation level in distances from small/seasonal rivers during wet season

Water velocity in wet season

Water velocity for small/seasonal rivers during wet season in BBM site 1 was revealed to be slow and mediun by an equal percentege of households (39%). An averages of 30 % and 42 % respectively of households for BBM site 1 to 5 had similar response. However, 85% of households in BBM site 1 prefer low water velocity, 15% preferred medium water velocity and none preferred high water velocity (Figure 6.23).

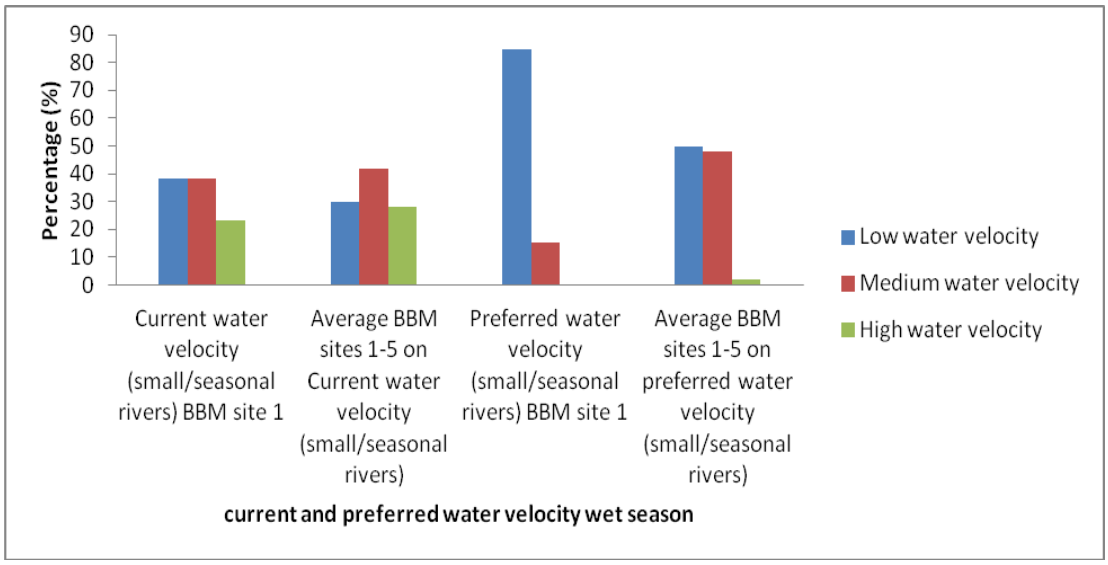

Figure 6.23 Current and preferred water velocity for small/seasonal rivers during wet season

Water velocity for main rivers during dry season in BBM site was revealed to be high by 69% of households. An average was 61% of households for BBM site 1 to 5 has similar response. However, 80% of households in BBM site 1 prefer medium water velocity, 15% preferred low water velocity and 5% preferred high water velocity (Figure 6.24).

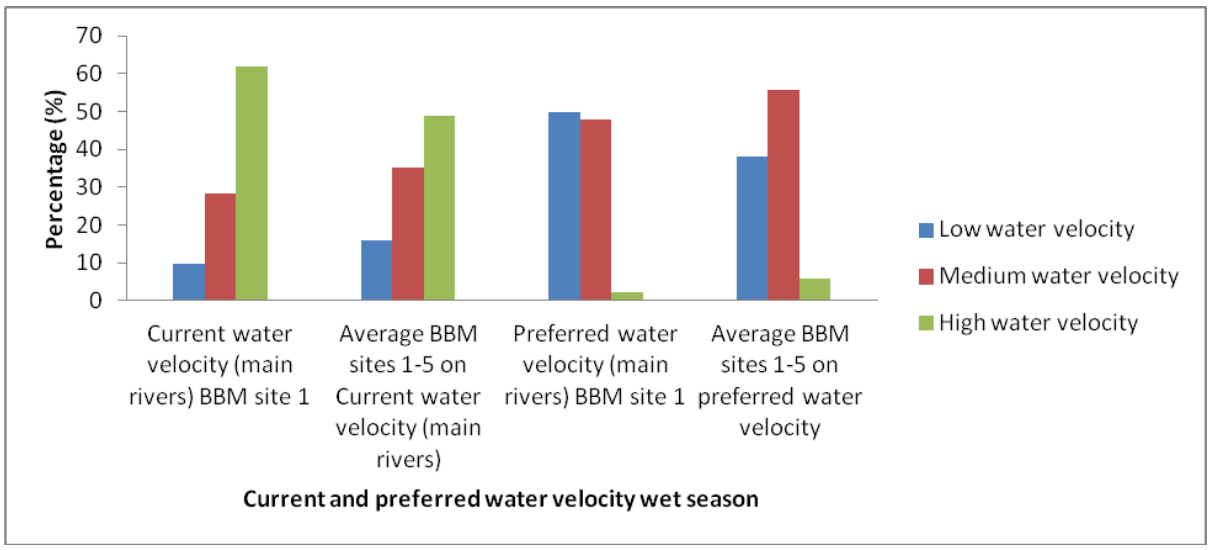

Figure 6.24 Current and preferred water velocity for main rivers during wet season

6.2.6 Determination of the preferences of the locals on selected environmental flows

Table 6.9 shows the preference of ecosystem services attached by respondents during questionnaire surveys. The services were categorised into Production, Regulation and Information ecosystem services. Generally, the production services have the highest preferences, with flood recession agriculture (99%), domestic uses (89%) and cultivated vegetables and fruits (62%) as the most preferred services. This implies that agriculture is the most important economic activity for their livelihood. Health control with respect to Malaria, bilharzias and UTI, a regulation service, is also considered very important (62%), even more important than fuel wood, weaving mats and poles/timber and fishing. The least preference is given to services such as aquatic animals and information services such as recreation and tourism (72%) and sites for cultural and ritual activities (69%). Reported importance on biodiversity conservation is 70%.

Table 6.9 Respondents' preferences on ecological services in BBM site 1

Category	Ecosystem service	Mean BBM site 1 Preferences in Percentages				Preference ranking	Ranking according to E. category
		Not preferred	Less Preferred	Preferred	Most preferred		
Production	Fertile valley plains for grazing	46	25	22	8	12	8
	Moist and fertile soils for flood recession agriculture	0	0	1	99	1	1
	Water for domestic uses	1	1	9	89	2	2
	Fish and fishing grounds	2	11	40	47	6	5
	Aquatic animals such as hippopotamus, Crocodylus niloticuss and snails	63	27	9	1	16	10
	Cultivated vegetables and fruits	1	13	24	62	3	3
	Natural vegetables and fruits	17	23	48	12	10	7
	Fuel woods, weaving mats and poles/timber	2	17	20	60	5	4
	Soils for brick making	12	31	41	16	9	6
	Water for navigation	55	32	9	4	13	9
Regulation	Flood mitigation	10	30	43	17	8	3
	Sedimentation and erosion control	24	44	26	7	11	4
	Physical water quality control	10	24	50	17	7	2
	Malaria, bilharzias and UTI control	0	9	21	62	4	1
Information	Biodiversity conservation	16	70	11	3	14	1
	Recreation and tourism	72	25	2	1	17	3
	Sites for cultural and ritual activities	69	16	13	2	15	2

Determination of the maintenance level on the selected ecosystem services

Out of nine ecosystems services tested, four services were preferred to be increased as reported by more than 50% respondents. 89% prefer increase in the current service towards control of Malaria, bilharzias and UTI, followed by 75% for moist and fertile soils for flood recession agriculture which is a primary activity on which many people depend. These findings support the preference attached to Malaria, bilharzias and UTI control, implying that, water related diseases are problematic to this area and therefore efforts to control them are vital for the community's livelihoods. Other services preferred to be increased are flood mitigation in inundated areas (56%) and Sedimentation and erosion control (54%). Again this suggests that during rainy seasons, flooding and erosion is detrimental to sustainable livelihood activities.

Similarly, 52% of respondents reported preference for maintenance of the current services offered by Game controlled areas. 47% and 43% prefer the maintenance and increase of the current service respectively on physical water features such as ponds, natural springs and oxbow lakes. This finding implies that physical water features has important role to the communities livelihoods.

Accordingly, Table 6.10 show that majority of the respondents (51%, 44% and 42%) prefers decrease in the current services on Crocodylus niloticuss, hippopotamus, snails and their riverine habitats, sites for cultural and ritual activities and fertile valley plains for grazing respectively. These findings implies that, these services are either less important to them, harmful or they facilitate negative effects to the communities livelihoods. Moreover these animals are report to be important for fish breeding since they create breeding areas(ding holes) in the water bodies forexample in big rivers, ponds and swamps.

Table 6.10 Respondents' preferences on ecological service maintenance levels in BBM site 1

Ecosystem service	Mean BBM site 1 Preferences on maintenance level in percentages (%)		
	Maintain the current service	Decrease the current service	Increase the current service
Fertile valley plains for grazing	29	42	29
Moist and fertile soils for flood recession agriculture	25	0	75
Crocodylus niloticuss, hippopotamus, snails and their riverine habitats	41	51	9

Physical water features such as ponds, natural springs, oxbow lakes	47	10	43
Game controlled areas	52	25	24
Control of malaria, bilharzias and UTI	3	8	89
Flood mitigation in inundation areas	26	18	56
Sites for cultural and ritual activities	40	44	16
Sedimentation and erosion control	32	14	54

6.3 BBM SITE 2 - Udagaji

6.3.1 Introduction

Two sample villages were selected for BBM site 2 namely Udagaji and Mgugwe (see Figure 6.25). This site is located in the Udagaji Mgugwe irrigation scheme. Kihansi and Udagaji river flow around Udagaji. The area also has a number of ponds including Dibwe, Kiyoli, Kisewe and Bisausi. In the past the village would flood with water coming from the Kihansi river, but currently this doesn't occur anymore. A number of natural springs have also disappered. The changes started to be seen during president Mkapa regime (1995-2005). The villagers relate these changes to the Kihansi powerplant (constructed in 1995, commissioned in 2000), but also to the increase in water abstractions due to the many immigrants who use the water for irigatd farming. The main economic activities of the three villages are crop farming, livestock keeping and fishing (see Table 6.11). Small businesses also exist, including selling and buying of vegetables, fruits, local brewing, cultivated crops such as rice and maize.

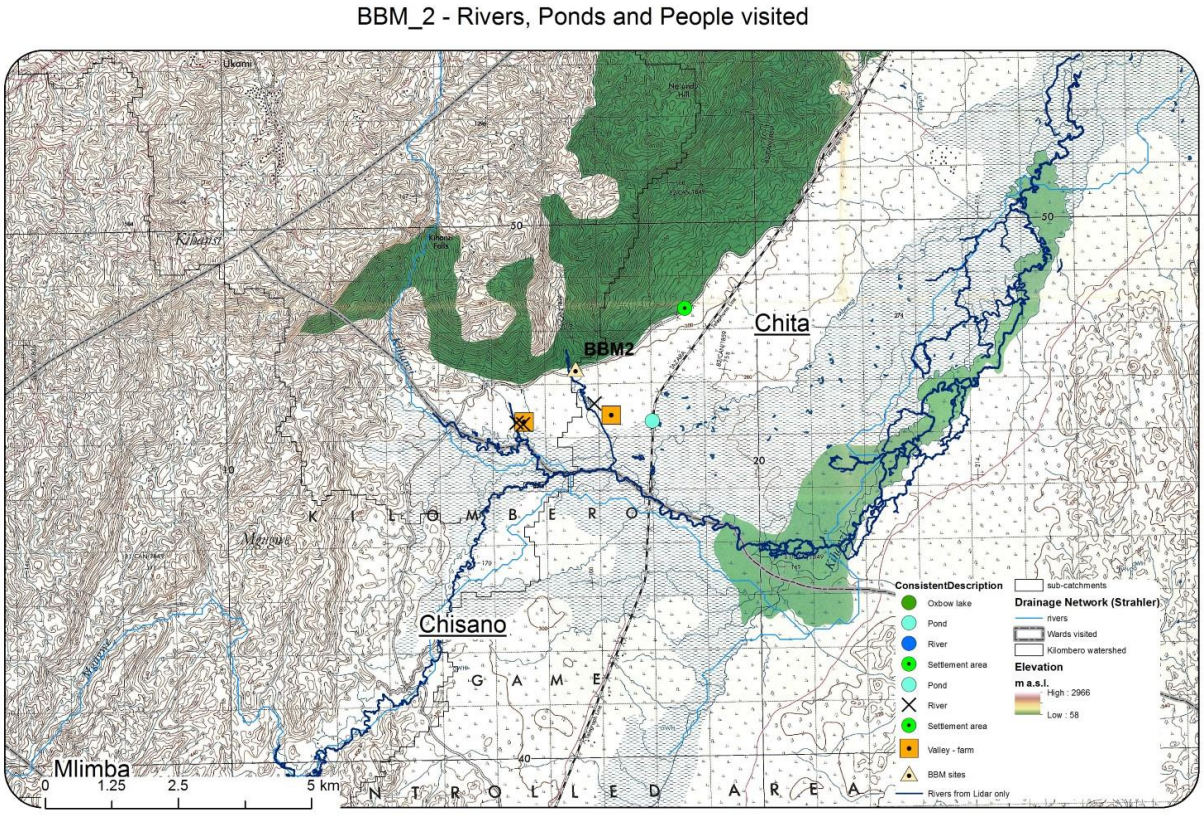

Figure 6.25 Villages visited at BBM 2 - Udagaji

Table 6.11 Main economic activities in Udagaji and Mgugwe

Percentage household engaged in economic activity	Udagaji	Mgugwe	Mean BBM site 2	Mean BBM Sites 1- 5
Crop farming	97	89	93	96
Livestock keeping	22	58	40	39
fishing	56	42	49	42
others	44	8	26	26

Historic changes of biophysical features

In this BBM site there are three important permanently flowing rivers which are Kihansi and Udagaji and Mgugwe rivers. Ugadaji Rivers which is the main reference in this site originates from the southern western part of the udagaji village and pours its water in Kihansi River. In the western part of the Udagaji village there is Udzungwa Mountains. The site has also other small rivers including that of Ngundu that is in the northern part of the Udagaji village. There are also ponds such as Dibwe, Kiyoli, Kisewe and Bisausi. In This site also there are drought problems started from 1995 and kept on increasing gradually. The locals revealed that in the past, the Udagaji river during flooding seasons, when it poured its water water to Kihansi, the River could flood reaching settlement areas in Udagaji village. As time went by, now days the flood does not reach areas where there are houses in Udagaji village. Again it was explained by the locals during the discussion that, previously in the site there had been water springs which are now drying up.

6.3.2 Socio economic characteristics

Households in the study villages in BBM site 2 include 67% of youth aged between 18 to 44 years old which is above average (59%) of similar age group for households in BBM sites 1-5. Also 31% are middle aged group (45-60 years old) which is comparable to the average (31%) for households in BBM sites 1-5. Only a few have an age above 60 (2%) and are below average (10%) for similar age group for households in BBM sites 1-5. The study revealed that most households (42%) had an annual income ranging between TZS 600,000/- to 1,999,000/-.

6.3.3 Determination of the extent of envioronmental flows (goods and services) and expected losses

6.3.3.1 Water use

Water is used by the people for domestic purposes including cooking, drinking and washing. Water is obtained from dug bore holes, but also from the Mgugwe and Udagaji river for watering gardens and the rice fields between September and December. Unlike other sites people rely on water fetched from the rivers.

Swimming is done in Udagajij in the dry season. Children revealed that they swim in the Udagaji river at any time of the year and perform Kamdala (a recreational activity for children in the water). Kihansi river is also accessed but specifically those places

where less velocity is occurring. The water is nice cold and clean entertaining for swimming especially upstream of the bridge.
Navigation: Rivers were used for navigation in BBM site 2. It was revealed that 30 % used rivers for navigation during wet season, 50 % during dry season and 20 % during both seasons (wet and dry seasons). On the frequency of navigation it was revealed that 10 % travelled daily, none travelled once per week, 10 % travelled once per month but 80 % responded that navigation was not often.

Water quality and use of farm inputs

Use of farm inputs that have potential impact on water quality was assessed. On average in BBM site 2, 45 % of the households applied herbicides (Roundup and 2,4D -noted herbicides' trade names) during crop cultivation. Average application of chemical fertilizers in BBM site 2 was 9.7 % whereas only 2 % of households used animal manure (Figure 6.26).

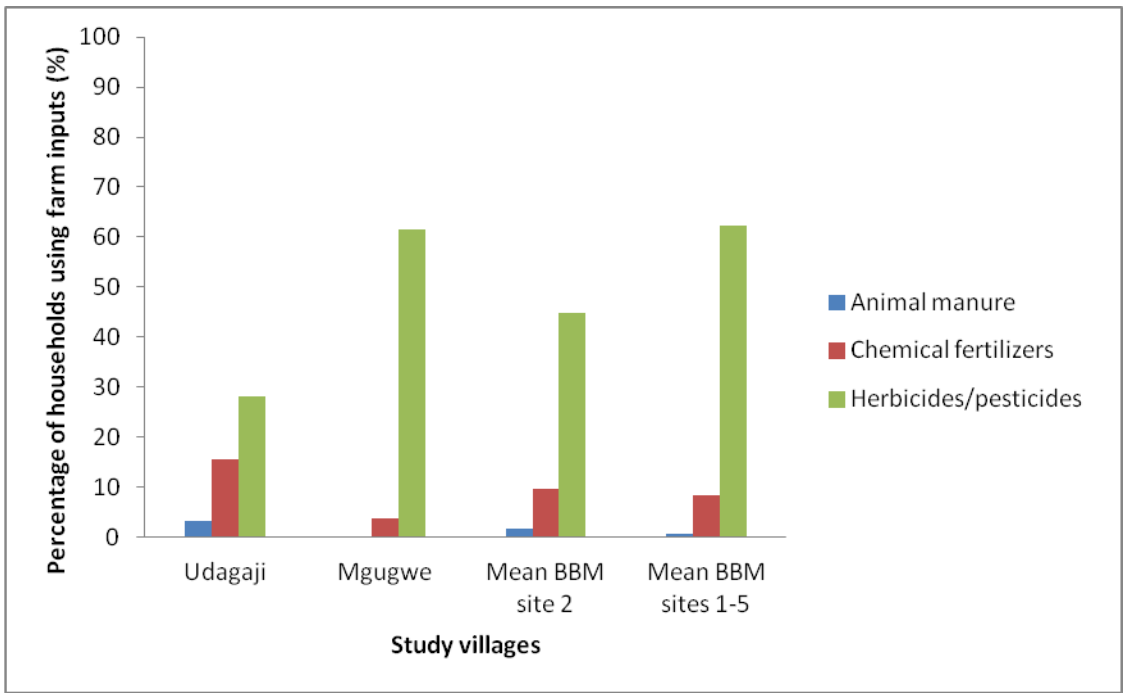

Figure 6.26: Percentage households using farm inputs and types of farm inputs used

The study revealed that 121.11 Kg/household/acre of chemical fertilizer was applied in BBM site 2 which was above average of 89.39 Kg/household/ acre for BBM sites 1 to 5. Also on average 6.64 Litres of herbicides/household/acre was applied in BBM site 2. The curve in Figure 6.27 reveals that there was more application of herbicides in

Mgugwe village (8.08 Litres/household/acre) than in Udagaji village (5.79 Litres/household/acres) (Figure 6.27).

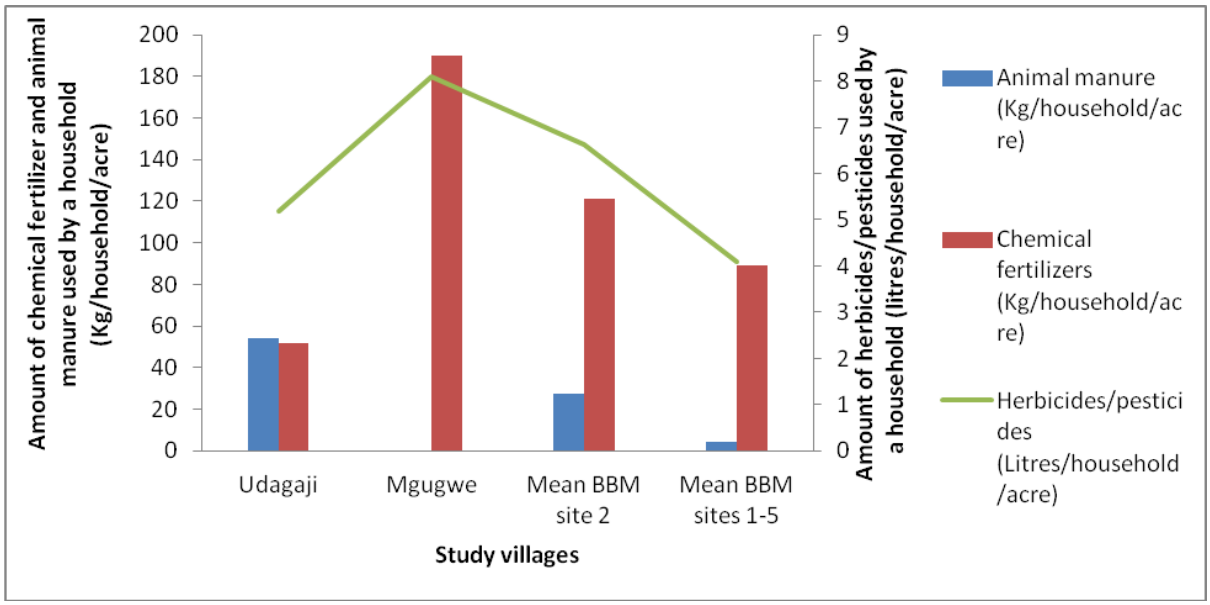

Figure 6.27: Amount of chemical fertilizer, animal manure, herbicides and pesticides used by a household per acre

Water associated problems

Diseases related to water can also be found in the area. Households mention problems with Typhoid, Bilharzia, Safura (disease cased by hookworm), Malaria, Fungus and Cholera. People indicate that Malaria and Typhoid are the most problematic, followed by Bilharzia. They indicated also that most of these diseases are more a problem than the flooding.

Flooding

Flooding is not common in this place, also not during wet seasons.

6.3.3.2 Crop cultivation

Crop cultivation is the most important activity for BBM 2 site communities. Rice (100%), maize (81%), banana (9%) and sesame (9%) are the most cultivated crops by the households. Rice is cultivated in the flood plain from December until April, whereby inundation is needed during March, while maize is cultivated from December to March and June to October. Percentages for households involved in rice, maize and banana cultivation are above the average of all five BBM sites, while households involved in sesame

cultivation are just below average of the 5 BBM sites. No households are involved in sunflower cultivation. Rice generates the largest part of the income for farmers, on average 715,000 TZS per household per year. Sesame contributes another 202,500 TZS, while sunflower and bananas do not provide much income. Annex 4 provides a detailed overview of the different crops cultivated, its period of cultivation and location of cultivation.

The average farm size for rice is 3.5 acres and for maize it is 1.6 acres (Figure 6.28). On average a household harvests 562 kg/acre of rice per year out of which 37% is consumed by the household and sells the remaining 63%. For maize this is about 202.5 kg/acre of maize harvested per year out of which 54 % is consumed by the household. Rice generates the largest part of the income for farmers, on average 715,000 TZS per household per year. Sesame contributes another 202,500 TZS, while sunflower and bananas do not provide much money.

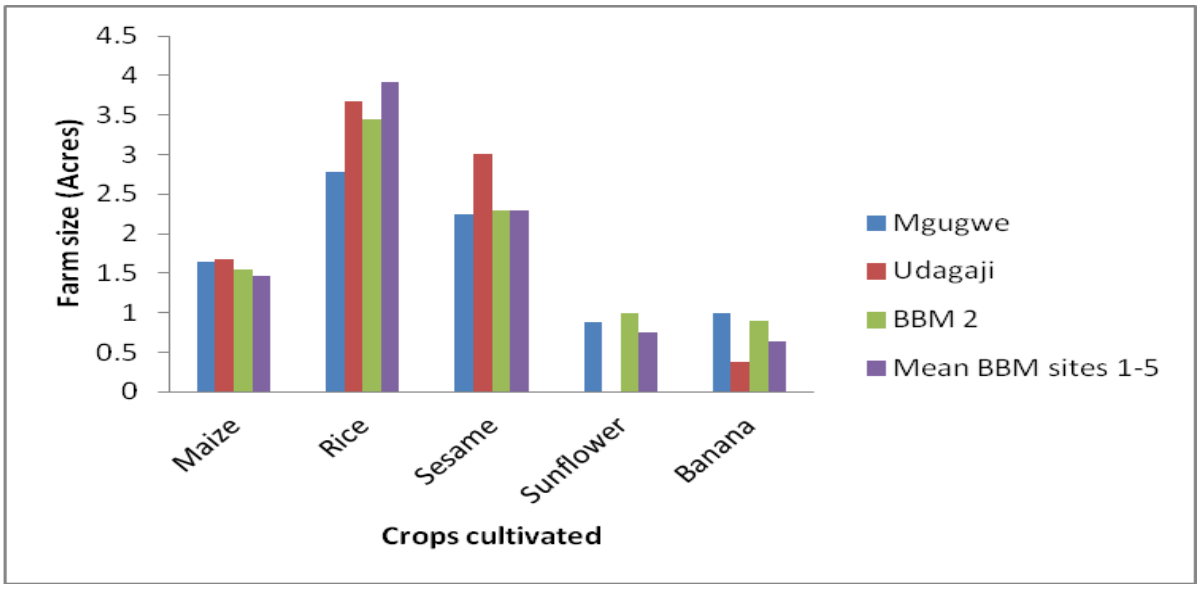

Figure 6.28 Farm sizes BBM site 2 versus average for the BBM sites 1-5

6.3.3.3 Livestock keeping

Very few households keep livestock. On average about 10% keep cattle in BBM site 2, while average of cattle keepers in the five BBM sites was 17%. Livestock are used for milk (cows) and ploughing the farms. Most of the households keep chicken (87%). Livestock grazing during the rain season takes place in the upland part of the floodplain where there is no innundation. During the rest of the year the livestock can also be found in the floodplain. There is little revenue from livestock keeping for a household, only pigs provide high revenues at Mgugwe while chicken provide some revenue in Udagaji.

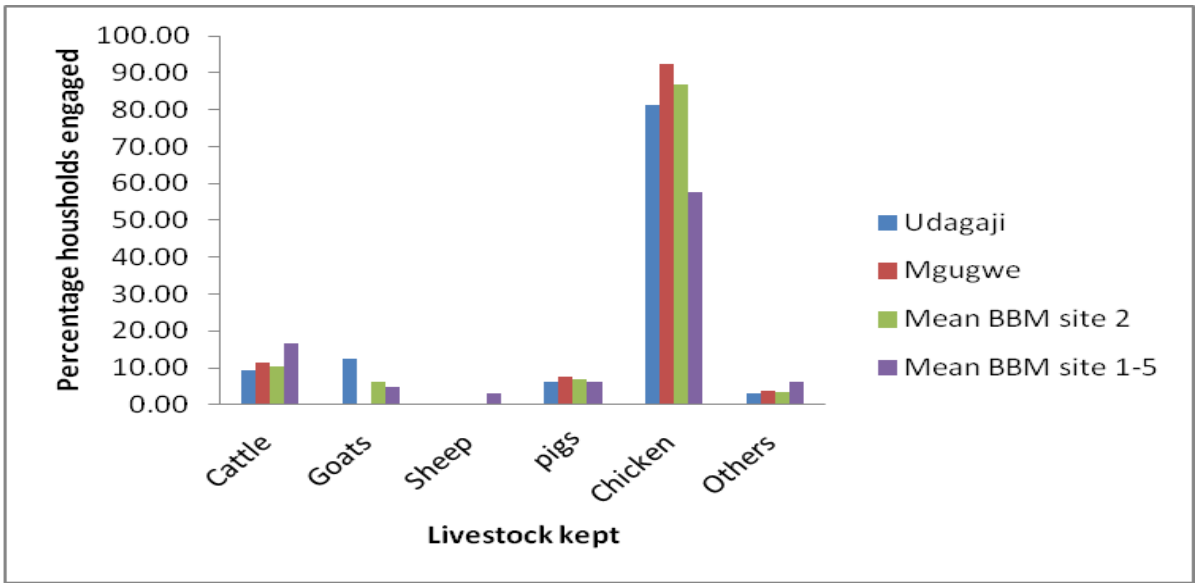

Figure 6.29 Percentage households engaged in livestock keeping and type of livectock kept

6.3.3.4 Fishing

Fishing is done in the Kihansi river, however villagers claim that that the river is now polluted with oil and cement from the Kihansi power plant. Fishing is mainly done in the rain season by very few villagers. Main fish to be found during the rain season is Kambale. Fish can also be found in the smaller ponds and are used for home consumption. The ponds are also important breeding sites. Some villagers have created artificial fish ponds for fish farming. Kambala, Perege and Kitoga are the most preferred fish species, followed by Njuju. Annex 3 provides a detailed overview of the different fish species, its availability in the seasons, the favourable habitat and preferred water condition.

There is a relatively high dependence on fish for subsistence consumption in BBM site 2. The amount of fish consumed by a household per year is on average 74 number of large fish/household/year and 67 number of cups (250 ml size) of small fish per household per year (Figure 6.30). However the amount of large fish consumed in BBM site 2 is below average of 83 large fish/household/year BBM sites 1 to 5 by 11%. The average revenue from fishing large fish was observed to be TZS 630,000 per household year in BBM site 2, which was much lower (by 75%) than average revenue of TZS 2,513,123.26 per household per year for BBM sites 1 to 5.

Most of the people in the villages buy the fish (71% for small fish and 89% for large fish) from fishermen or middlemen in the villages. Only about 9% of the households practice fishing themselves (Figure 6.31 and Figure 6.32). The income from fishing large fish and small fish contributes about 26% and 3% respectively of the total annual household income of the fishermen.

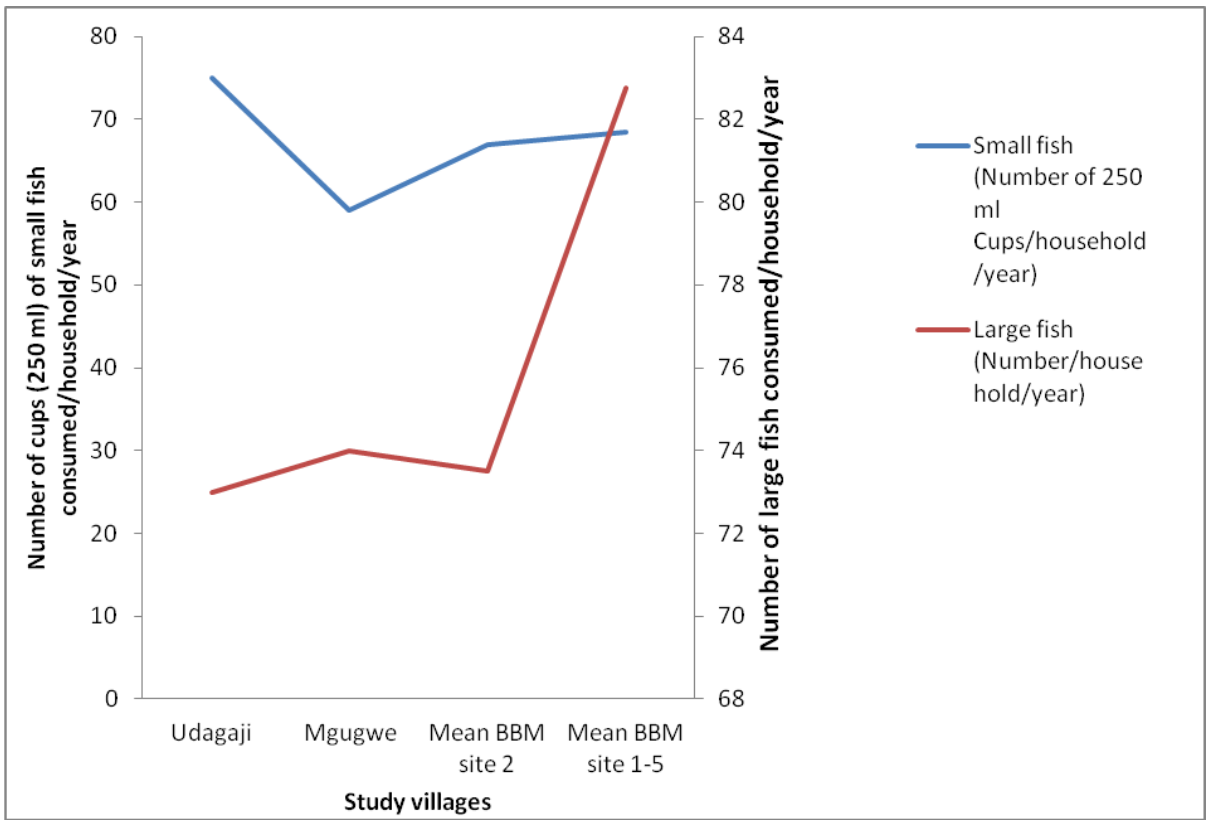

Figure 6.30 Amount of small fish and large fish consumed by a household per year in BBM site 2

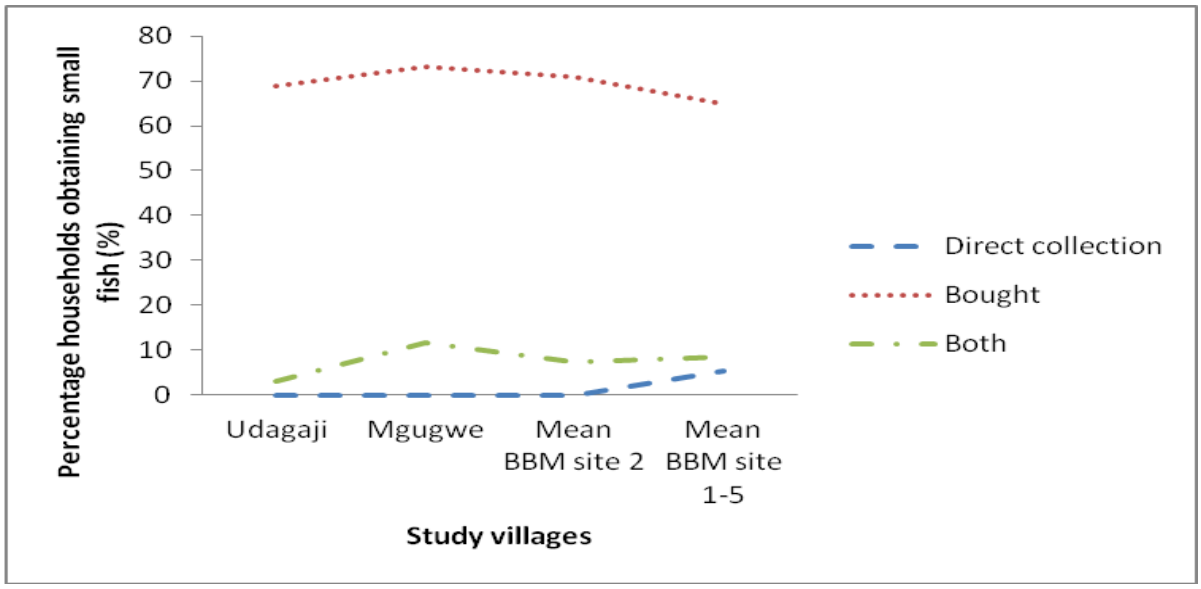

Figure 6.31 Means of obtaining small fish for household consumption in BBM site 2

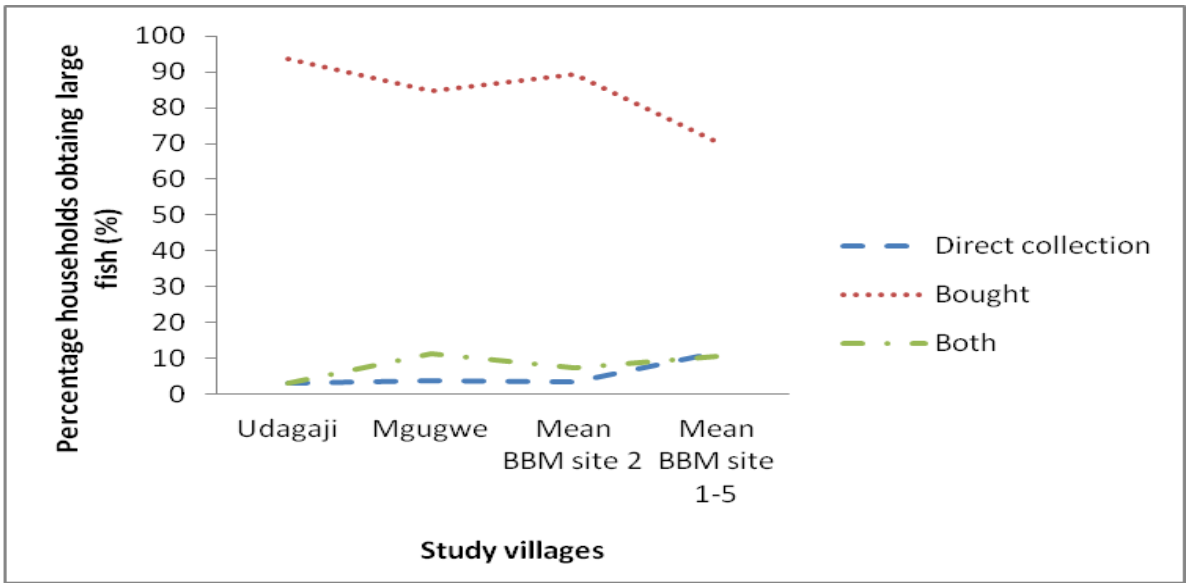

Figure 6.32 Means of obtaining large fish for household consumption in BBM site 2

6.3.3.5 Animals, birds and insects

Besides fishing, other aquatic animals, birds and insects are reported to be sources of food. Animals including Hippopotamus (found in Kihansi river in rain season), Ndezi (found in valleys throughout the year), Sheshe (found in valleys throughout the year), Wild pig (found in valleys and uplands in rainy season), Hyrax (found in the mountains throughout the year), Brachyura spp (found in rivers and valleys) and Ndasi (found in ponds) are used for food by villagers in Udagaji. Also birds including Mamatele (found in valleys throughout the year), Dove (found in forests and in valleys throughout the year), Ngulaku (found in Valleys and mountains throughout the year), Kamyoyolo (found in valleys throughout the year), Kongojole (found in valleys throughout the year) and Guineafowl (found in valleys especially during the period of sowing rice between December and January, but it available throughout the year), Kware (found often in valleys during rice harvesting period in April) and Kimsigili (found in valleys and mountains between January and December). Children in Udagaji revealed that they also obtain insects such as Senene in valleys during rainy season, Cyptotermes spp (termites) in valleys and in termite-mounds during rainy season, Pangopango in valleys between May and June which they use for food.

6.3.3.6 Natural and cultivated vegetables and fruits

Many different natural and cultivated vegetables and fruits are consumed by the local population. Vegetables such as Liwowo, Lidadangala, Kamdelega (Kambelege), Mchicha Pori (Nafungo) and Mwidu are the most preferred vegetables. They are found in different places and different times of the year, eg Liwowo grows in the valleys and in ponds throughout the year, Kamdelega in the valley and upland areas between January and June, Linyala and Kamdedeleka in ponds during the dry season, Mchicha Pori can be found in upland areas during the rainy season. Natural fruits include Pingipingi (in upland areas between December and June), Kikusu (in upland areas in November

and December), Mafulu and Mbwegele (in valleys and upland areas. Preferred fruits are Mikusu, followed by Mafulu (Table 6.12). The details of location and seasonal availability can be found in Annex 5.

Table 6.12 Respondents' preferences on natural and cultivated vegetables and fruits in BBM site 2

Natural vegetables	**Rank**
Sesbania sesban	1
"Lidadangala"	1
"Kamdelega (Kambelege)"	2
Amaranthus sp	3
Barleria submollis	4
Natural fruits	**Rank**
Ouparka Kirkiana	1
Vitex doniana	2
"Mapingipingi"	3
"Matopeta"	3
"Bwegela"	4
Cultivated vegetables	**Rank**
"Pumpkin leaves"	1
"Chainizi (Chinese)"	2
Amaranthus sp	3
"Green bean leaves"	3
"Okra"	4
"Nyanya Chungu"	5

The study observed that on average most of the households depend on natural vegetables (86%) and cultivated vegetables (98% depending on both leaf and fruit form vegetables, 98% depending on leaf form vegetable and 90% depending on fruit form vegetables) (Figure 6.33). On average in BBM site 2 the dependency on natural and cultivated vegetables is high and above average for BBM site 1 to 5. 82% of the households collect the natural vegetables themselves (Figure 6.34).

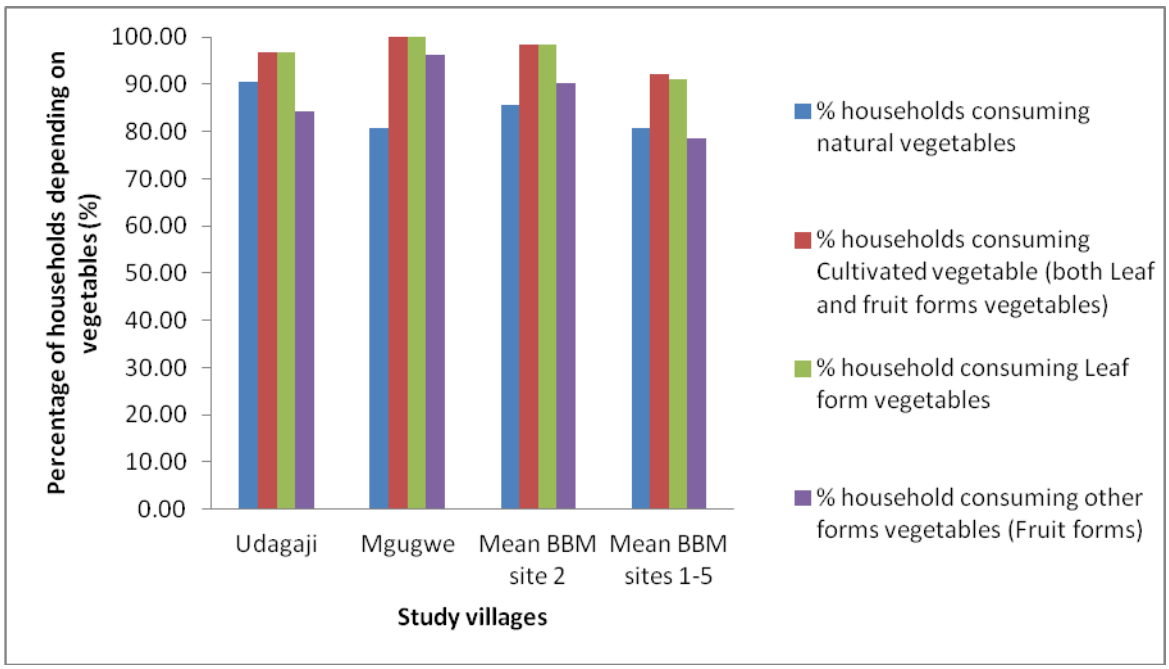

Figure 6.33 Households depending on natural and cultivated vegetables in BBM site 2

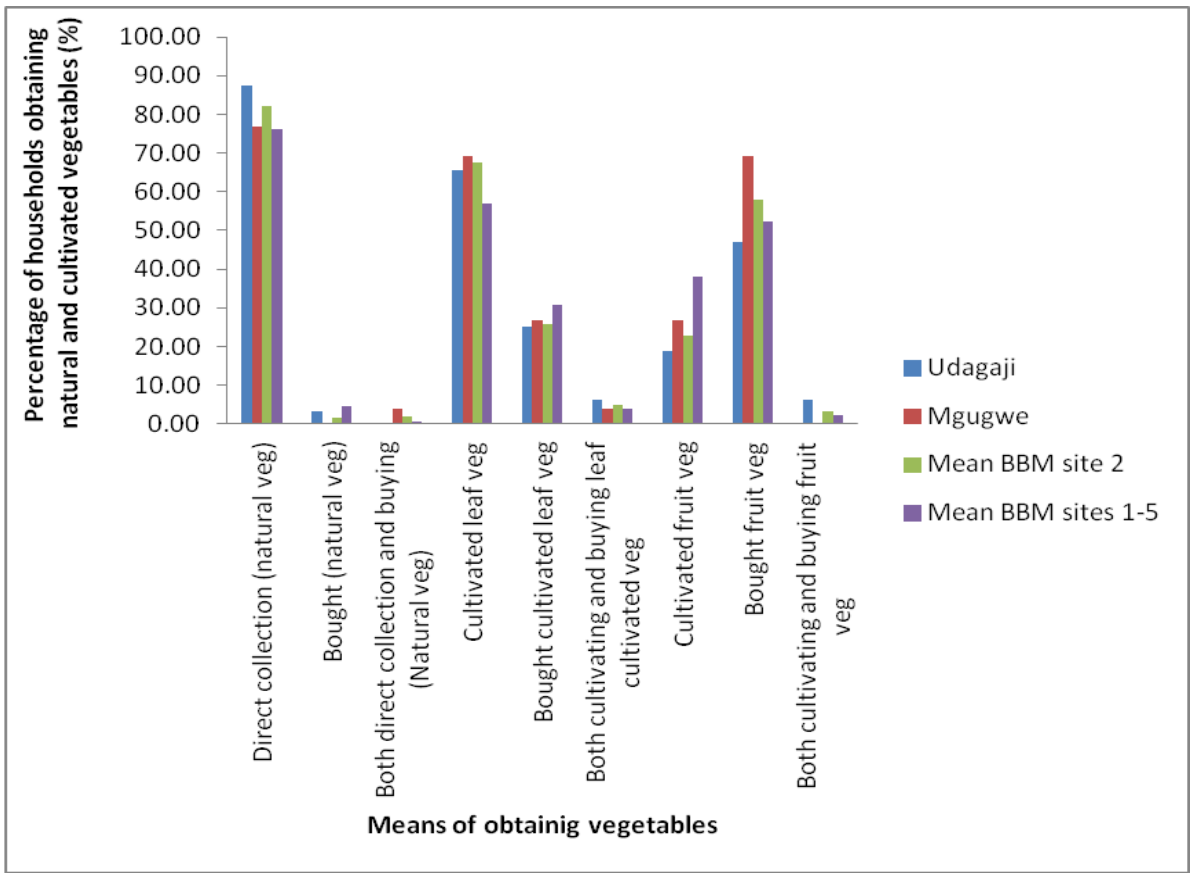

Figure 6.34 Household means of obtaining natural and cultivated vegetables in BBM site 2

6.3.3.7 Weaving materials

Weaving materials are extensively used in BBM site 2. The study found out that 52 % of the households use Ukindu (*Phoenix reclinata*) while 21% of households use Malala (*Hyphaene petersiana*) weaving materials (Figure 6.35). The percentages households using *Phoenix reclinata* and *Hyphaene petersiana* (Annex 5.) weaving materials are below averages of 64% for Ukindu and 27% for *Hyphaene petersiana* for households in BBM site 1 to 5 (Figure 6.35). The households obtain the materials through direct collection and buying (Figure 6.36). The selling of mats provide some revenues to the households, but the majority of the mats and carpets are for own household purposes.

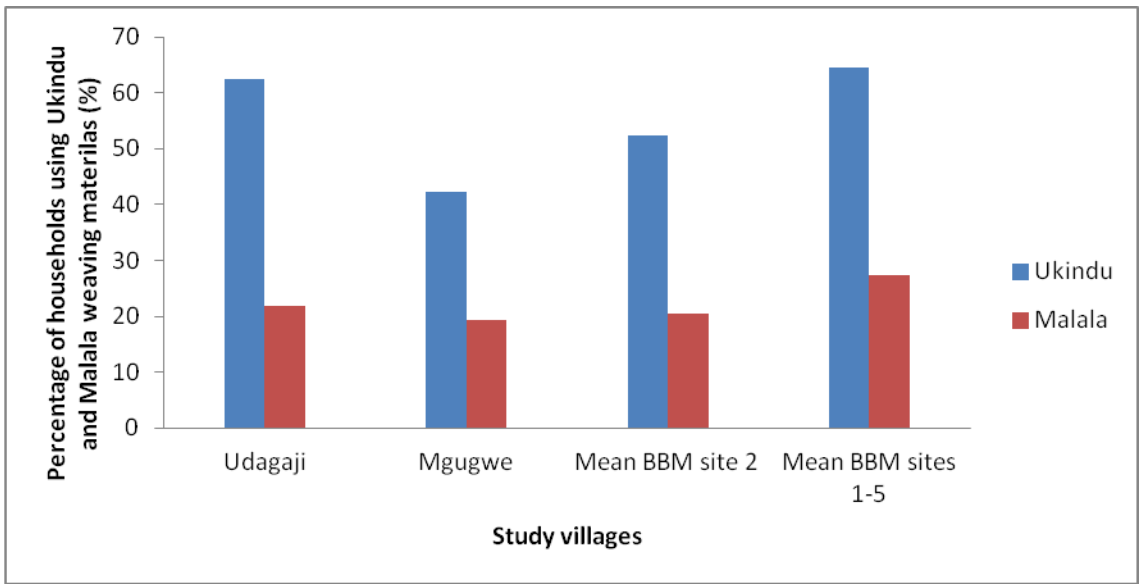

Figure 6.35 Percentage of households using weaving materials in BBM site 2

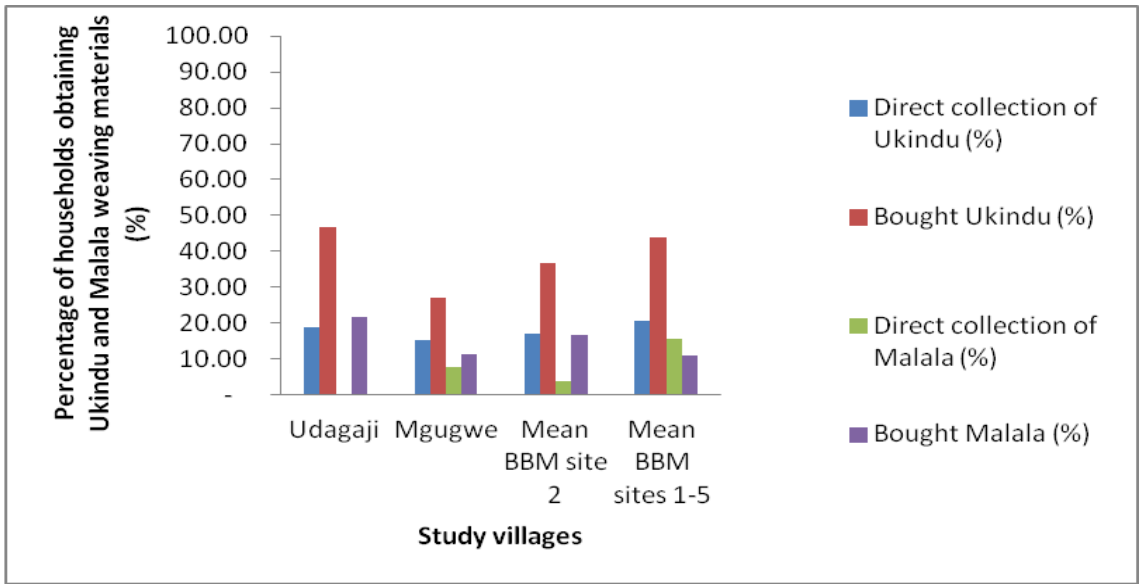

Figure 6.36 Means of obtaining weaving materials BBM site 2

6.3.3.8 Construction materials

Brick making is also an important activity in Udagaji, 35-40% of the households make bricks and use for this process water from the Udagaji river and seasonal rivers such as Kisata. They obtain wood for construction from the forests (Annex 5).

6.3.3.9 Fuel

Dry wood is collected from the forest area and used as firewood. Trees that are used in all villages are "bamboo", *vitex doniana, mihimbilikiti, migugu* and *Dalbergia melanoxylon* which are available throughout the year. *Phyllostachys sp*, "migugu" and "mihimbilikiti" are the most preferred fuel materials.

6.3.4 Contribution of income generating activities to households annual Income

In BBM site 2, households acquire more income from crop farming (80%) than other income generating activities (Table 6.13). Rice farming contributes the most of the household income by about 65% (Table 6.13). Other sources contributing to the income are vegetable cultivation (6%), livestock keeping (6%), fishing (3%) and weaving (0.3 %). Analysis from the results show that household could can lose 2% of its annual income in BBM site 2 in case large fish disappear and only1% of its annual income in case small fish (dagaa) disappear. Equally results suggest that in case water to support vegetables cultivation becomes insufficient to allow vegetables cultivation, a households in BBM site 2 could lose 6% of their annual household incomes.

Table 6.13: Contribution of income generating activities to annual household income BBM site 2

Activity	Mean household income in BBM site 2 (TZS/household/year)	Percentage of annual household income in BBM site 2 (%)
Crop farming		
Maize	100,862.07	8.00
Rice	824,310.34	65.41
Sesame	67,068.97	5.32
Sunflower	689.66	0.05
Banana	20,431.03	1.62
sub-total	**1,013,362.07**	**80.41**
Vegetables		
Cultivated leaf vegetables	40,489.66	3.21
Cultivated fruit vegetables	33,905.17	2.69
Sub-total	**74,394.83**	**5.90**
Livestock keeping		

Cattle	689.66	0.05
Goat	8,448.28	0.67
Sheep	689.66	0.05
Pig	11,034.48	0.88
Chicken	52,094.83	4.13
Other livestock	689.66	0.05
Sub-total	**73,646.55**	**5.84**
Fishing		
Large fish	22,413.79	1.78
Small fish	9,310.34	0.74
Sub-total	**31,724.14**	**2.52**
Weaving		
Mats	2,224.14	0.18
Carpets	1,068.97	0.08
Sub-total	**3,293.10**	**0.26**
Other income sources	63,827.59	5.06
Mean annual household income	**1,260,248.28**	**100.00**

6.3.5 Water depth and velocity during wet and dry seasons

Water levels and inundation levels during wet and dry season

Water level in inundated areas in BBM 2 were reported to be above breast level during the wet season. However, 58% of households in BBM site 2 preferred that water in inundated areas be at knee level. An average of 49% of households for BBM site 1 to 5 had similar response on the preferred water level (Figure 6.37). For seasonal and small rivers the preferred water depth by households in BBM 2 is at knee (43%) and below knee level (43%) (Figure 6.38). Water depth during the dry season in main rivers in BBM site 2 is above breast level during dry season and 35% of households prefer water level in rivers during dry season to be at waist level (Figure 6.39).

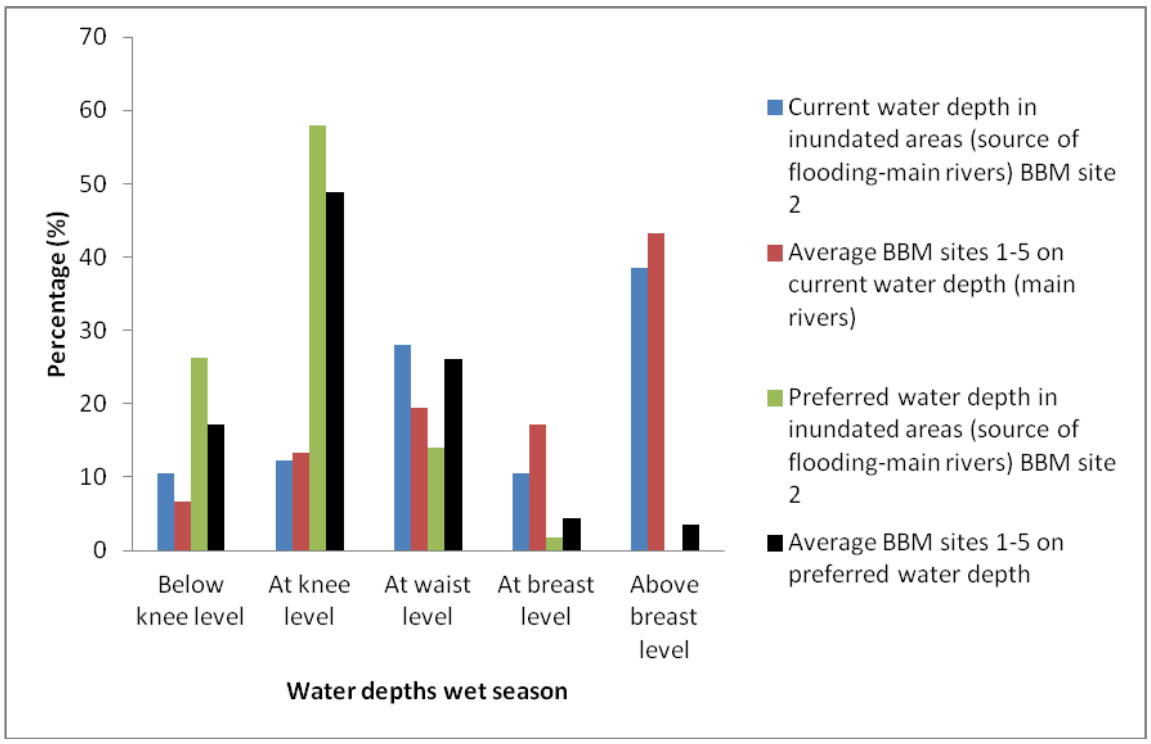

Figure 6.37 Water depth in inundated area for water from main rivers during wet season

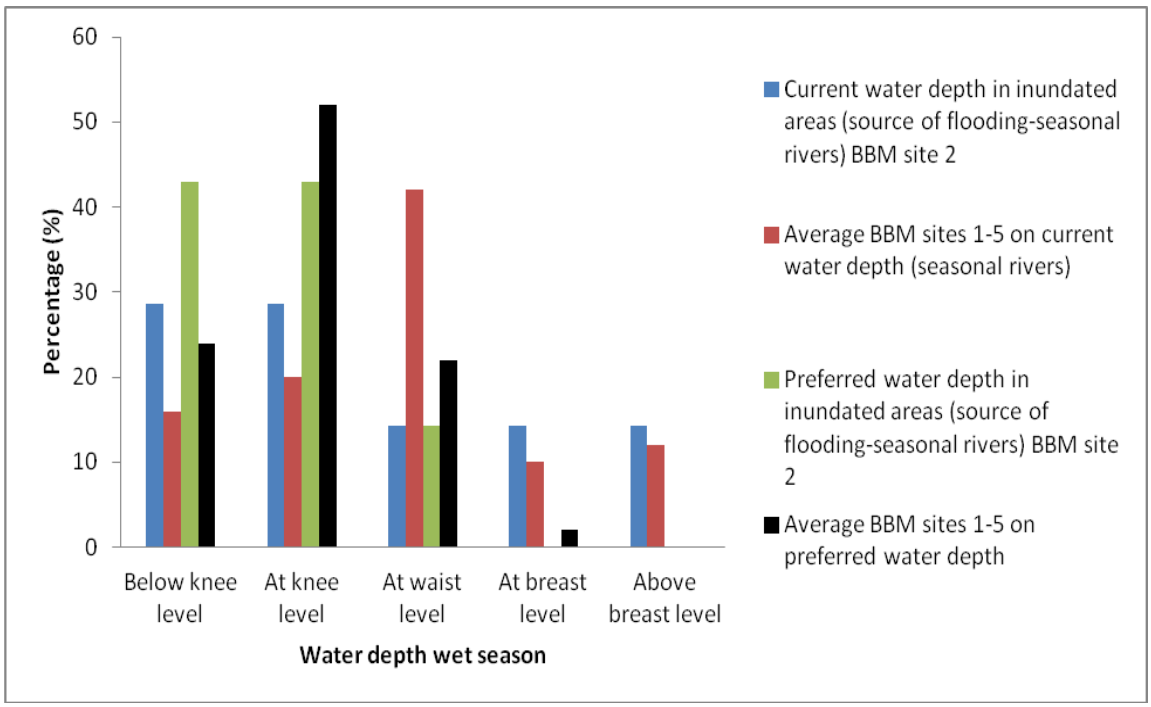

Figure 6.38 Water depth in inundated area for water from seasonal rivers during wet season

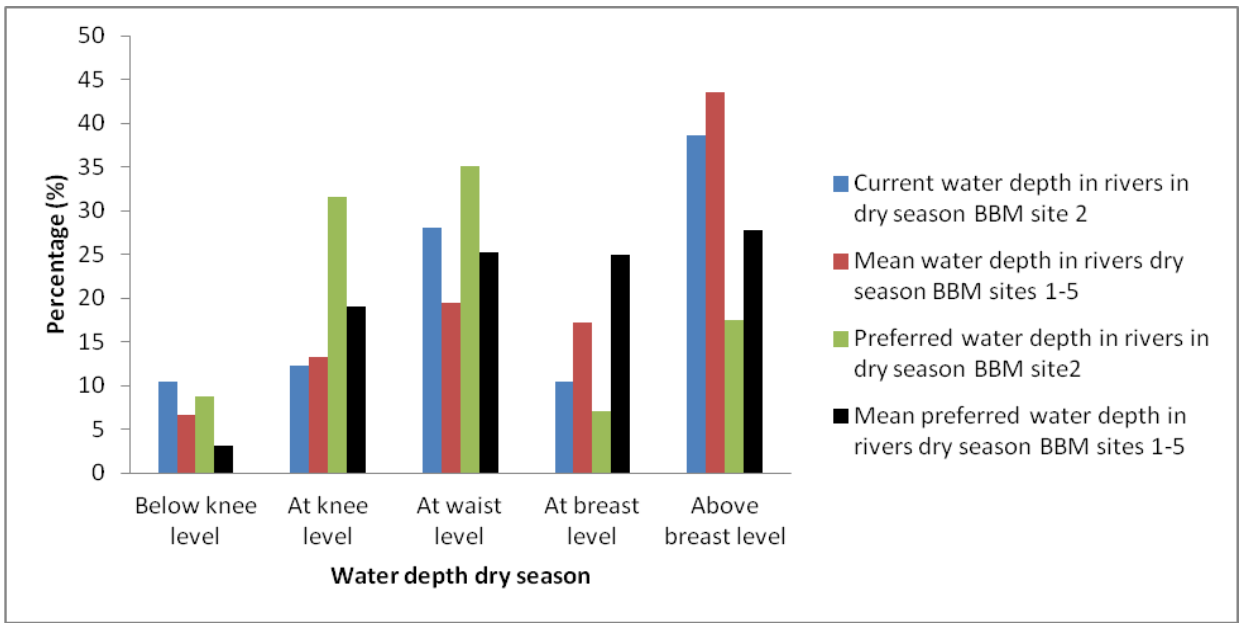

Figure 6.39 Water depth in main rivers during dry season

The inundation level distance for water coming from the main rivers during wet season in BBM site 2 was recorded to be between 10 to 15 km. 24% of households in BBM site 2 revealed that inundation level was 10 to 15 km from main rivers. An average was 14% of households for BBM site 1 to 5 with similar response. The preferred innundation distance by households in BBM 2 is between 0 to 1 km (Figure 6.40).

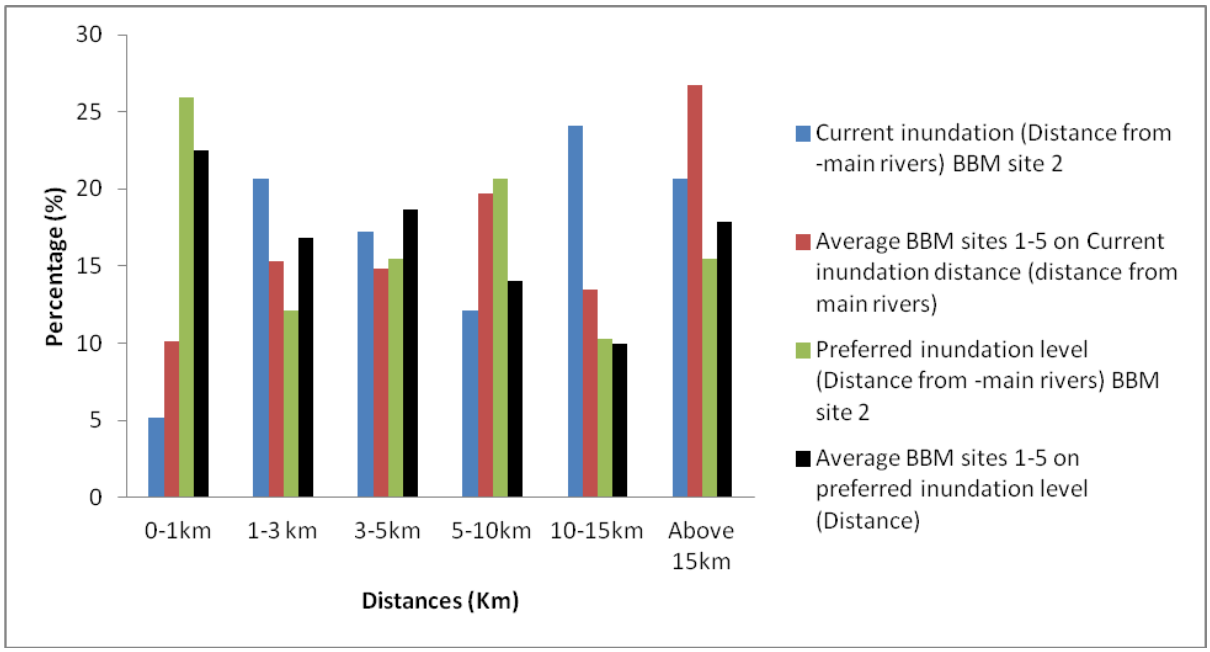

Figure 6.40 Inundation level in distances from main rivers during wet season

Water velocity during wet and dry seasons

Water velocity during the wet season is very high as assessed by 57 % of households in BBM site 2. 50% of households in BBM site 2 prefer medium water velocity, 45 % prefer low water velocity and 5% prefer high water velocity. For small/seasonal rivers 57% and 43% prefer low and medium water velocity respectively (Figure 6.41 and 6.42).

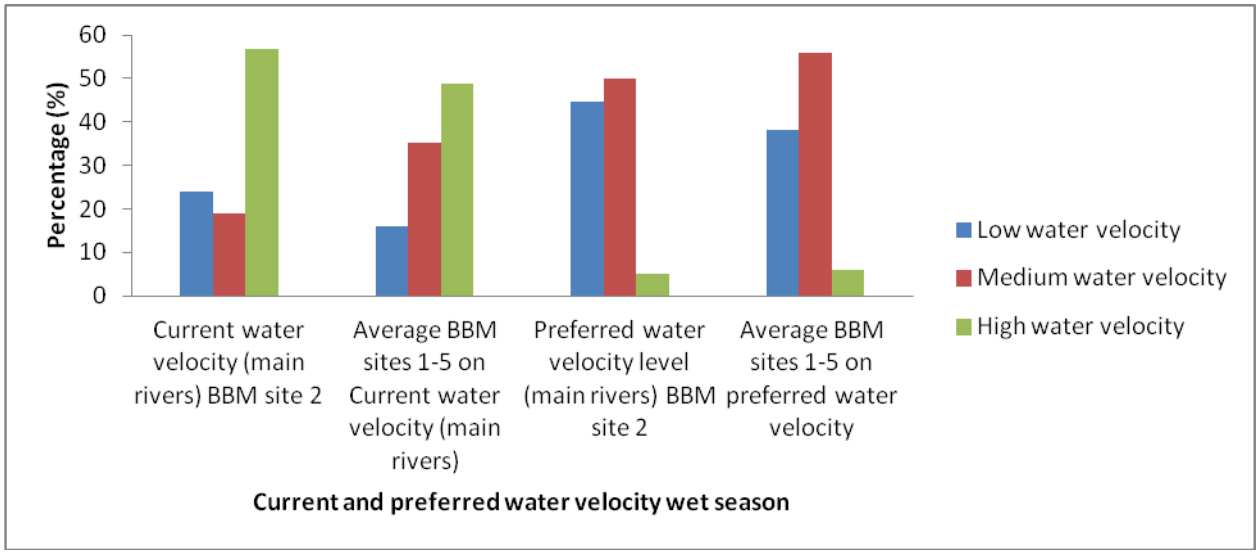

Figure 6.41 Current and preferred water velocity for main rivers during wet season

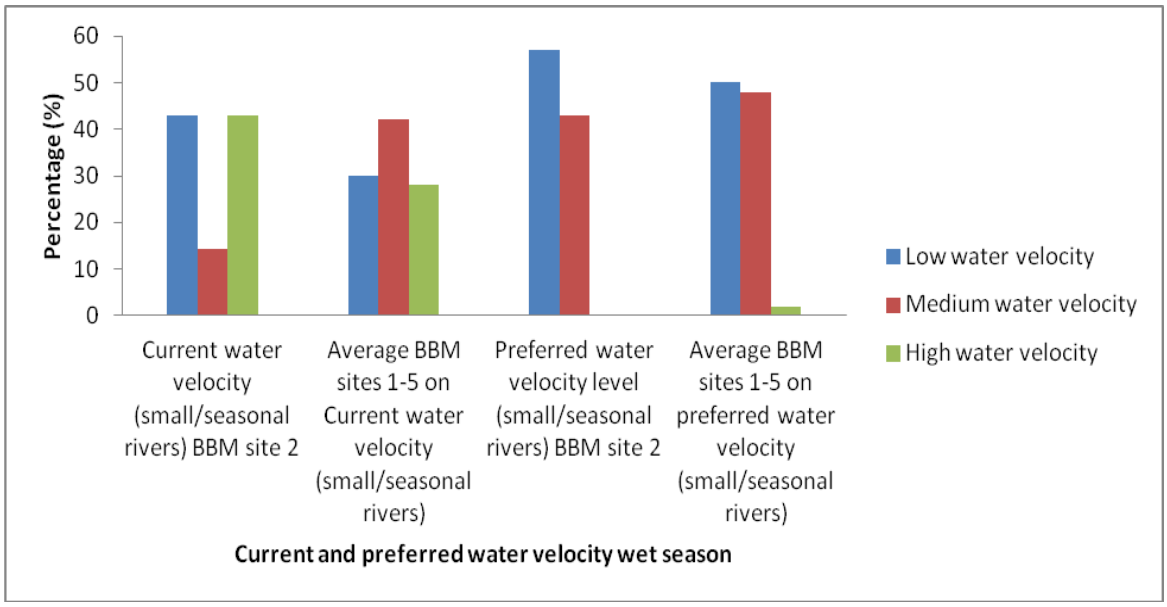

Figure 6.42 Current and preferred water velocity for small/seasonal rivers during wet season

During the dry season the water velocity for main rivers in BBM 2 is perceived to be medium. 68% of households in BBM site 2 prefer medium water velocity, 25% preferred low water velocity and 7% preferred high water velocity (Figure 6.43).

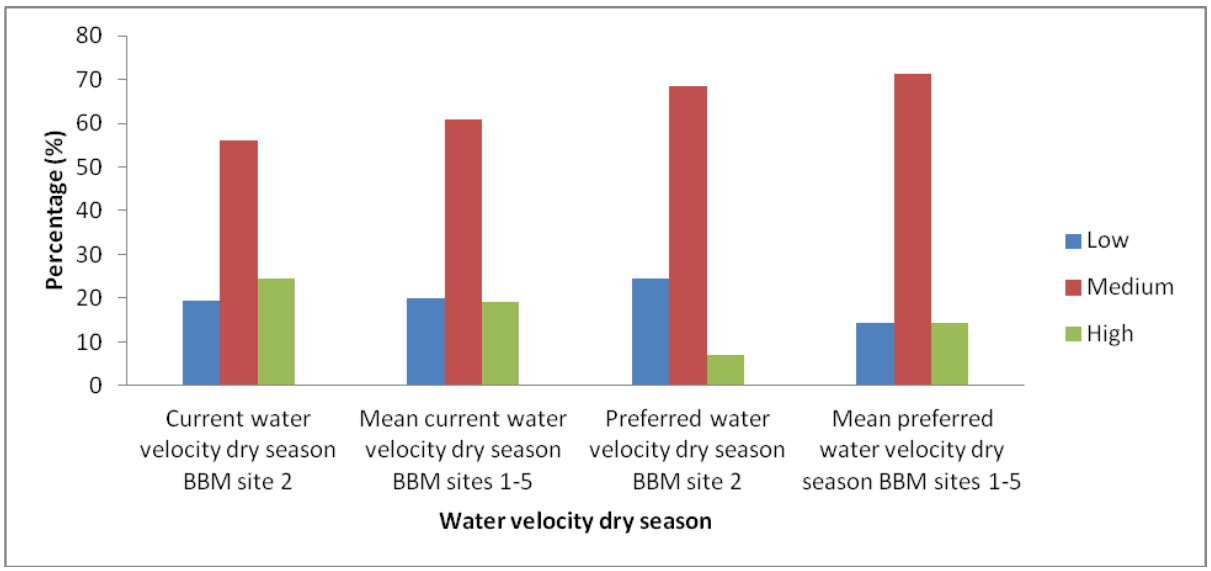

Figure 6.43 Current and preferred water velocity during dry season

6.3.6 Determination of the preferences of the locals on selected environmental flows

Generally, preference ranking (Table 6.14) shows that, production ecosystem services are more preferred, followed by regulation and information ecosystem services. This implies that communities attach relatively high importance to production ecosystem services than other categories of ecosystem services.

95% of the respondents attach high preference to water for domestic use. Equally, 93% and 66% of the respondents attach importance on moist and fertile soils for flood recession agriculture and cultivated vegetables and fruits respectively. In addition Malaria, bilharzias and UTI control were preferred by majority (36%) of respondents. This suggests that, water related diseases such as Malaria, bilharzias and UTI are a seriuos problem to the area and therefore control measure are of high importance. Accordingly, flood mitigation and physical water quality control were preferred by 41% and 38% of the respondents respectively. Sedimentation and erosion control were less preferred by 33% of the respondents. Generally, information ecosystems services are relatively less or not preferred at all. This is justified by 83% of the respondents who did not prefer sites for cultural and ritual activities and 59% of respondents who did not prefer recreation and tourism. Less preference on bidodiversity conservation was reported by 48% of respondents.

Table 6.14 Respondents preferences on ecological services in BBM site 2

Category	Ecosystem service	Mean BBM site 2 Preferences in Percentages				Preference ranking	Ranking according to E. category
		Not preferred	Less Preferred	Preferred	Most preferred		
Production	Fertile valley plains for grazing	14	35	27	26	8	7
	Moist and fertile soils for flood recession agriculture	0	2	5	93	2	2
	Water for domestic uses	0	0	5	95	1	1
	Fish and fishing grounds	5	22	38	35	6	5
	Aquatic animals such as hippopotamus, Crocodylus niloticuss and snails	72	19	5	3	16	10
	Cultivated vegetables and fruits	2	7	26	66	3	3
	Natural vegetables and fruits	9	26	48	17	10	8
	Fuel woods, weaving mats and poles/timber	7	16	40	38	4	4
	Soils for brick making	10	24	40	26	7	6
	Water for navigation	55	33	9	3	14	9
Regulation	Flood mitigation	10	35	41	14	11	3
	Sedimentation and erosion control	24	33	31	12	12	4
	Physical water quality control	3	36	38	22	9	2
	Malaria, bilharzias and UTI control	3	28	33	36	5	1
Information	Biodiversity conservation	29	48	16	7	13	1
	Recreation and tourism	59	31	7	3	15	2

Sites for cultural and ritual activities	83	12	2	3	17	3

Accordingly, Table 6.15 shows that an increase in current services is a preference of a majority of respondents (86%) in control of Malaria, bilharzias and UTI, followed by moist and fertile soils for flood recession agriculture (78%). This finding supports the preference attached to Malaria, bilharzias and UTI control, implying that water related diseases are a problem to this area and therefore efforts to control it are vital for the community's livelihoods. Likewise moist and fertile soils for flood recession agriculture on which economic activities dependent must be maintained. Other services preferred to be increased are sedimentation and erosion control (50%). Again this suggests that during rainy seasons, erosion is detrimental to their livelihoods activities. Moreover, 52% of respondents prefer the maintenance of current services offered by physical water features such as ponds, natural springs, and oxbow lakes. 45% and 33% prefers the maintenance of the current service on Game controlled areas and fertile valley plains for grazing respectively. However, the same number of respondents also prefers the decrease in current service offered by fertile valley plains for grazing. This implies that livestock keeping has both positive and negative effects. The negative side is probably centered on the land use practice which conflicting with majority crop farmers, it is therefore evident that farmers would likely prefer decrease in the current services so as to discourage pastoralists. The majority of respondents (78%, 55% and 36%) prefer a decrease in the current services on Crocodylus niloticuss, hippopotamus, snails and their riverine habitats, sites for cultural and ritual activities and flood mitigation in inundation areas respectively. These findings imply these services are either viewed as not important to them, harmful or they may have negative effects on community's livelihoods.

Table 6.15 Respondents' preferences on ecological service maintenance levels in BBM site 2

Ecosystem service	**Mean BBM site 2 Preferences on maintenance level in percentages (%)**		
	Maintain the current service	Decrease the current service	Increase the current service
Fertile valley plains for grazing	33	33	35
Moist and fertile soils for flood recession agriculture	22	0	78
Crocodylus niloticuss, hippopotamus, snails and their riverine habitats	19	78	3

Physical water features such as ponds, natural springs, oxbow lakes	52	7	41
Game controlled areas	45	33	22
Control of malaria, bilharzias and UTI	3	10	86
Flood mitigation in inundation areas	28	36	36
Sites for cultural and ritual activities	36	55	9
Sedimentation and erosion control	33	17	50

6.4 BBM SITE 3 – Mpanga

6.4.1 Introduction

Four sample villages were selected around BBM site 3 namely Matema, Utengule, Chisano and Ngalimila (see Figure 6.44). This site is located in the Mpanga-Ngalimila irrigation scheme. The areas is endowed with many rivers. About 38 rivers were identified in the area and they form the most important biophysical features for the surrounding communities. Fifteen of these river are perennial while the other 23 are seasonal. In addition to the rivers, most villages also have seasonal ponds in their immediate vicinity except for Ndola pond in Utengule. During the rainy season the rivers and ponds connect with river Mpanga. People indicated that the water volumes have decreased dramatically over the past three decades, lower volumes are now experienced in the ponds and rivers and some rivers have become seasonal such as Mwala, Kihofu, Kichangani and Kitolange). People attribute these changes to increase in population and their associated activities as well as climate change. The main economic activity in BBM site 3 is crop farming (91%) (see Table 6.16). This is complemented with with fishing and/or livestock keeping where the different villages have a preference. In Matema more households engage in fishing while Chisano more people are engaged in livestock keeping. Fishing is the second most important activity. Other economic activities include weaving, brick making and petty business.

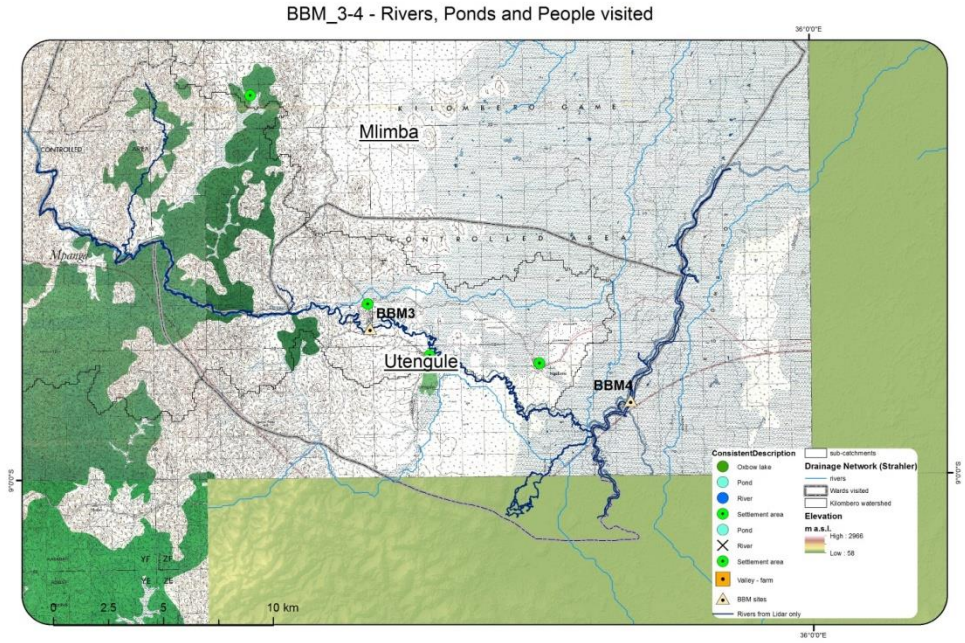

Figure 6.44 Villages visited at BBM 3 - Mpanga and BBM 4 - Ifwema

Table 6.16 Main economic activities in Matema, Mlimba, Ngalimila and Chisano

Percentage household engaged in economic activity	Matema	Ngalimila	Chisano	Mlimba	Mean BBM site 3	Mean BBM Sites 1- 5
Crop farming	100	97	100	68	91	96
Livestock keeping	59	38	39	40	44	39
fishing	22	41	58	12	33	42
others	47	0	50	76	43	26

Historic changes of biophysical features

Thirty eight (38) rivers were identified as important biophysical feature in the villages of BBM three. Out of those, 15 pass the water throughout the year i.e. permanent where as 23 were reported to be seasonal. It was noted during the study that Chisano village had relatively large number (9) of rivers while Ngalimila had relative large number of permanent Rivers (5) than other villages. Permanent rivers from Ngalimila village Includes Mpanga, Mnyela, Luhoji, Kihansi and Kilombero. However, Mpanga River was noted to be the commonly passing in all villages in the BBM site three.

Other biophysical features that were mentioned to exist and are important in the site were 20 ponds of which 19 were seasonal and one (1) that is permanent. The permamnet pond known as Ndola pond is located in Utengule village. It was further reported that during rainy season the permanent rivers connects the ponds on one side to form the network with river Mpanga.

It was generally noted from discussion that, the history of these rivers revealed that the water volume has decrease drastically over the past three decades. For example, High flow of water was reported to Mpanga and Mnyela Rivers in the past 3 decades compared to medium water flow during the late of 1990s to early of 2000s. Relatively, lower volume is now experienced to most of the rivers and ponds. Accordingly, significant reductions in water flow were reported in Rivers such as Mwala, Kihofu, Kichangani and Kitolange which were seasonal and start to be un-seasonal streams from the late of 2005. Likewise to ponds such as Mkuyanga, Tandika, Nyamigumbi and Lyang'ando in Ngalimila and Kalukalange, Vatwasa and Mkwekwea in Chisano has turned to be seasonal from un-seasonal in the past. However, different from other rivers, river Mbuli in Utengule which were un-seasonal was revealed to change to be seasonal river; this could be due to decrease in river bank to the associated network of connected ponds and rivers as a result of siltation derived from anthropogenic activities. Abundance and diversity of the associated aquatic biodiversity including fish is also reported to decline accordingly. From the discussion it was revealed that the main reason of dynamics being increase in population and their associated activities as well as climatic change.

A part from the water bodies, the are two (2) forests from Ngalimila and one from Utengule which are also reported to be the important biophysical features in the BBM three.

6.4.2 Socio-economic characteristics

Population distribution in BBM site 3 is composed of 48% of youth aged between 18 to 44 years old which is below average (59 %) of similar age group for households in BBM sites 1-5. Middle aged group (45-60 years) make up 36% and 17% of the household population are above 60. In this part of Kilombero sub-basin, the majority of the people (78 %) have received primary education, and the percentage is below average (83%) for households with similar education level in the five BBM sites. The major occupations are in BBM 3 are farming, livestock keeping and fishing. The study revealed that 91.33 % are crop famers comparable to the average (95.60 %) for the five BBM sites. 43.93 % of household are livestock keepers and 33.03 % of households are fishermen. 43.23 % of households are involved in other occupations inclusing petty businesses.

Many of the households in BBM 3 have annual incomes ranging between TZS 600,000/- to 1,999,000/- and between TZS 2,000,000/- to TZS 4,000,000 comparable to 31% and 32% respectively. Households obtaining annual income of TZS 50,000/- to TZS 199,000/- make up around 12%. In this site 1 % of households have annual income of less than TZS 50,000/-. Only 5 % have incomes of over TZ 4,000,000/-

6.4.3 Determination of the extend of envioronemntal flows (goods and services) and expected losses

6.4.3.1 Water use

People depend on water from small permanent rivers and boreholes for their cooking, drinking and washing. The replenishment service (aquifer) is not known exactly nor is there a good overview of the locations of the boreholes.

Swimming

Swimming is mostly done by children during the dry season when water levels have decreased in ponds and rivers (see Figure 6.35). In Mpanda it is mainly at Vambaya pond and the river Mpanga while in Chisano it is at Bwakwambi pond and in the river Mgugwe. Swimming is not common in the river as there are many animals.

Figure 6.45 Children swimming at Vambaya pond in Mpanga village (photo: Nyanghura)

Navigation: During the rainy season small stream emerge and link with the Mpanga river providing a network facility for people, goods and services within and between villages. So during the rainy season villagers travel to other villages by canoes, eg Mpanga to Ngalimila, Ngomo to Chisano, across the river to connect the two sides of the river, widely used for access to the Lugola hospital, and transportation of fish to the markets. It was revealed that 14 % of households used rivers for navigation during wet season, 32 % during dry season and 54 % during both seasons (wet and dry seasons). On the frequency of navigation it was revealed that 2 % travelled daily, 6 % travelled once per week, 16 % travelled once per month but 72 % responded that navigation was not often.

Water quality and use of farm inputs

Use of farm inputs that have potential impact on water quality was assessed in BBM site 3. On average 58 % of households used herbicides whereas 6 % applied chemical fertilizers and while 2 % applied animal manure. There was more households in Ngalimila village that used herbicides (68%) than Chisano village (62 %), Mlimba b village (56 %) and Matema (47 %) villages. In Matema village, no household was observed to have applied chemical fertilizers. However, few households in Matema (3 %) and Chisano (4 %) villages applied animal manure, and average manure application was 2 % for BBM site 3 and 1 % for BBM sites 1 to 5 (Figure 6.46).

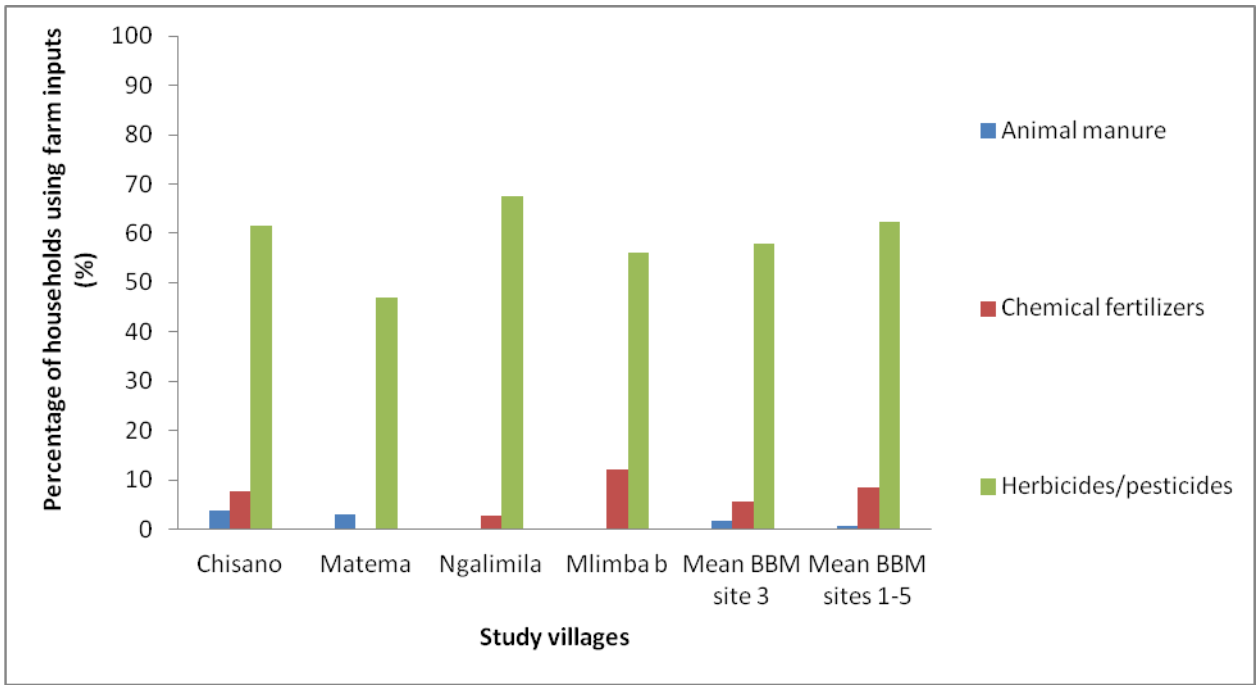

Figure 6.46: Percentage households using farm inputs and types of farm inputs used

It was also revealed that 98 Kg/household/acre of chemical fertilizer was applied in BBM site 3 which was above average of 89.39 Kg/household/ acre for BBM sites 1 to 5. There was more chemical fertilizer applied in Chisano village (299.54 Kg/household/acre) than in Ngalimila village (69.12 Kg/household/acre) and Mlimba b (23.04 Kg/household/acre) (Figure 6.47). Also on average 4.47 Litres of herbicides/household/acre was applied in BBM site 3 which was also above average of 4.08 litres/household/acre for the BBM sites 1 to 5 (Figure 6.47). The curve in Figure 3.20 reveals that there was more application of herbicides in Mlimba b (7.08 Litres/household/acre) than Ngalimila village (4.90 Litres/household/acres), Matema village (2.90 Litres/household/acres) and Chisano village (2.30 Li-

tres/household/acres) (Figure 6.47). The curve in Figure 3.20 also shows that herbicide application in Mlimba b was also above average for BBM site 3 and BBM sites 1 to 5.

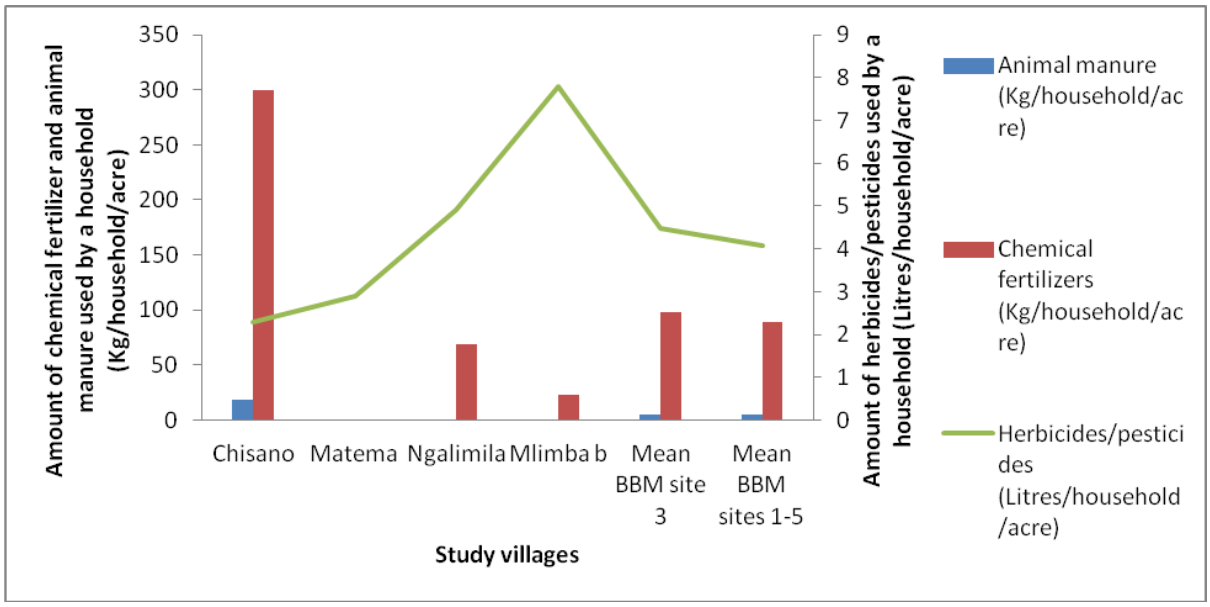

Figure 6.47: Amount of chemical fertilizer, animal manure, herbicides and pesticides used by a household per acre

Water associated problems

Diseases related to water can also be found in the area. Households mention the problems with malaria, Typhoid, Fungus, Bilharzia, Amoeba, Diarrhoea, Dysentery, Cholera and Ancylostomiasis (Safura). People indicate that the Malaria is the most problematic, followed by Fungus. Flooding is also indicated as an important problem.

Pair-wise ranking was done in the villages to rank the problems mentioned by the population (see Table 6.17).

Table 6.17 Ranking of water associated problems in villages of BBM site 3

Problems/Diseases	Mpanga	Matema	Utengule	Ngalimila	Chisano	Mean	Overall rank
Malaria	5	1	1	1	1	1.8	1
Fungus	1	2	2	4	2	2.2	2
Typhoid	4	3	4	2	3	3.2	3
Flooding	3	4	3	3	6	3.8	4
Cholera	2	5	4	5	3	3.8	4
Bilharzias	9	6	5	4	4	5.6	5
UTI	9	9	2	9	9	7.6	6
Aquatic animals	9	9	6	9	6	7.8	7
Accidents in water	9	9	9	9	5	8.2	8

Flooding: During the group discussion an attempt was made to elicit the extent of inundation and its effect to the communities' livelihoods. Because of time shortage, this was only done for the most dependent river: Mpanga River. The extent of inundation was noted to vary from low, normal and high rainfall levels at Mpanga village. During the high rainfall levels the overflow of the river Mpanga causes to extend the inundation to valleys areas all the way along to Ngalimila village which is about 14km from the reference point of the river. However, during the low rainfall levels, it was reported that the overflow of the Mpanga river doesn't cause flooding to the plain (farms/valley) but rather, the water just follow the stream of river Pombwe. An estimate of about 200 m distance was noted as point where inundation ends from the river Pombwe during the normal rainfall. Accordingly, the time taken for inundation to exist was reported to range from 3 to 5 days, differently from the past three to four decades which takes relatively longer time of 1 to 3 weeks. However, this was experienced differently at Utengule Village where the time taken for inundation to exist was reported to range from 3 to 7 days, different from the past three to four decades which takes relatively shorter time. Probably, these could be due to anthropogenic activities which cause siltation and therefore decreasing the river banks. Overflow of river Mnyera and Lohoji were also reported to inundate areas in Ngalimila Village. Annex 6 shows coordinates for different extent of inundation as a result of different flooding levels from low, normal and high rainfall.

6.3.3.2 Crop cultivation

Farming is the most important activity practiced by all social groups in all BBM 3 villages and constitutes both subsistence and commercial farming. Farming is practiced mainly in the floodplain and in the valleys. The most commonly cultivated crops are rice, maize, sesame vegetables and fruits (Annex 4). Households involved in rice and maize cultivation are 78% and 70% respectively. Households involved in rice cultivation are below average of the five BBM sites (93%). Sesame is cultivated by 30% of households in this area, which is far above the average of the five BBM sites (11%).

On average a household harvests 379.48 kg/acre of rice per year out of which 44 % is consumed by the household. For maize this is about 220.45 kg/acre of maize harvested per year out of which 62% is consumed by the household. Rice brings however most revenues compared to other crops. So the crop cultivation is both for food and cash, where sesame seems only for cash in these villages and sunflower to a large extent as well.

Figure 6.48 shows the average farm size for a household, indicating that rice cultivation the area is 5.8 acres, which is approximately 2.5 times that of maize (2.2 acres), and almost 3 times that of sesame (1.9 acres). Farm sizes for sunflower (0.5 acres) and banana (0.5 acres) cultivation are quite small, almost 10 times less than those of rice. Most of the farming is carried out in the valleys, making use of the moist valleys and the available water in the rivers Mpanga, Mnyela and Lumumwe. Some farmers have also constructed boreholes for irrigation purposes.

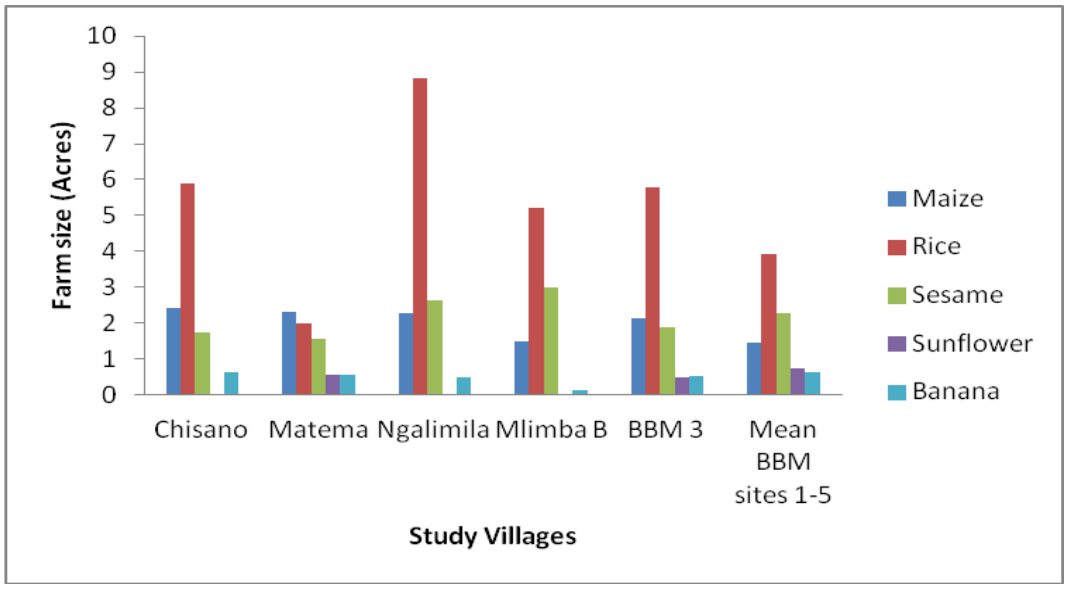

Figure 6.48 Farm sizes BBM site 3 versus average for the BBM sites 1-5

6.4.3.3 Livestock keeping

About 45% of the households in BBM 3 are enagaged in livestock keeping. Livestock kept are chicken, cattle, sheep and goats mostlty by sukuma tribe. On average 20% of households keep cattle which is above average of 17% for BBM sites 1 to 5. On average 64% of households keep chickens (Figure 6.49). Livestock grazing is mostly free range grazing in different areas including areas close to the river Mpanga and Mnyela and around ponds such as Vambia in Mpanga (see Figure 6.50). In Mpanga pastoralists have grazing areas as stipulated by the village land use plan. However, most livestock graze beyond these stipulated areas causing conflicts with farmers. On average a household obtains 321,875 TZS per year from cattle keeping.

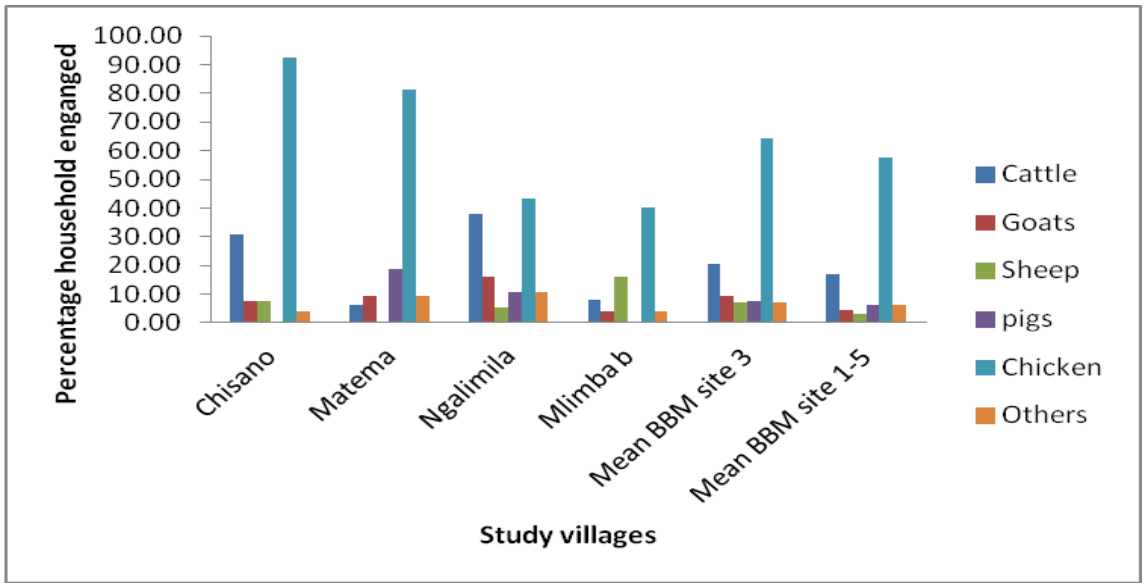

Figure 6.49 Percentage households engaged in livestock keeping and type of livectock kept

Figure 6.50 Livestock grazing around Vambia pond in Mpanga village (photo: Nyanghura)

6.4.3.4 Fishing

Fishing mainly mainly takes place in river Mpanga, Mnyela and Kilombero as these have water throughout the year. During the rainy season fishing activities also take place in the seasonal streams and ponds. River Mpanga is the most common river as it passes through all the sample villages. Kambale is the most preferred fish specie, followed by Perege, Ngogo and Njege. Kitoga, Ngogo and Sulusulu. These are fish species that do not stay much in ponds and swamps, but stay in the main rivers. Kambale, Perege and Dagaa are more preferred as they are most available (about 90% of the total fish) and at the time the water level starts to decrease and they can easily be found in the rivers and ponds. During the rainy season, March to July, fish is much more availa-

ble because flooding brings fish offshore. Ndungu, Mjongwa and Mgundu are species are scarce.
Fish consumption for subsistence is high in BBM 3 site. On average a household consumes 56 large fish per year and 45 cups (250 ml) of small fish per year, which is well below the average of the consumption of other BBM sites (Figure 6.51). The amount of large fish consumed is high in Mlimba, followed by Ngalimila village, Matema village and lowest in Chisano village. Majority of the people in the villages buy the fish (65% for small fish and only 46% for large fish) from fishermen or middlemen in the villages. 15% of the households collect large fish themselves which is above the average compared to the other BBM sites (Figure 6.52 and 6.53). The income from fishing small fish contributes about 30% of the total annual household income of the fishermen, large fish only contribute about 8%. On average a household in BBM site 3 acquire approximately 1315,275 TZS per year from fishing large fish and approximately 1.2 million TZS per year from small fish. In Utengule fishing is reported to be of less importance and fishing is mainly done by outsiders.

According to the local fishermen the favorable habitat for certain fish (such as "Ndipi", *Brycinus*, "Sheka", *Synodontis*, "Ningu") are ponds, while the rivers harbors a diversity of fish species. River Mpanga provides habitat for C*larias*, *Tilapia*, *Hydrocynus*, *Distichodus*, *Bagrus* and *Labeo sp*. Preferable breeding sites are small streams, flood plains (inundated areas) and ponds. Most preferred locations are reported to be the wetland vegetation and edges of Vambia, Myamifama, Lengela and Ngatambwa ponds in Mpanga village. However breeding sites differ from specie to specie, eg Kambala mostly breeds in flood plains (farms) and not in ponds, *Tilapia* in ponds, *Hydrocynus* at river banks and Kunga under stones/caves in river beds. Breeding mostly occurs during the dry season when there is less water and plenty of still standing water, except for some fish species; Njege and Kitoga (breed during rainy season, March and April). The most preferred fish species are those found in cold water (rivers). Annex 3, provides a detailed overview of the different fish species, its availability in the seasons, the favourable habitat and preferred water condition.

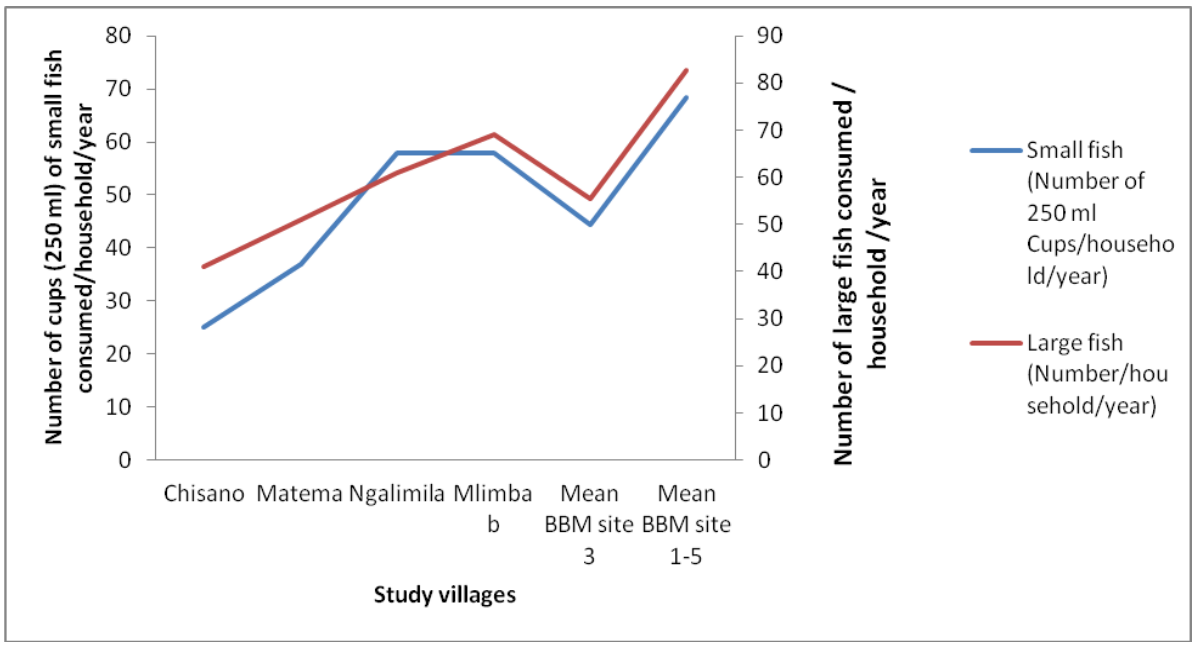

Figure 6.51 Amount of small fish and large fish consumed by a household per year in BBM site 3

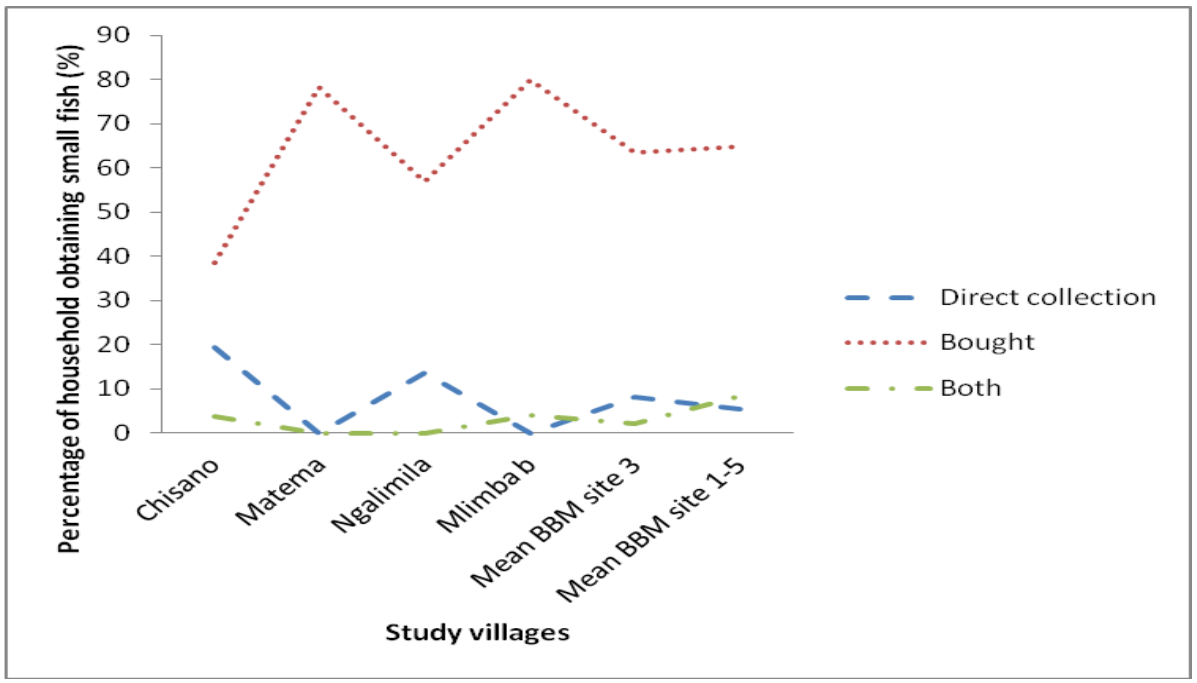

Figure 6.52 Means of obtaining small fish for household consumption in BBM site 3

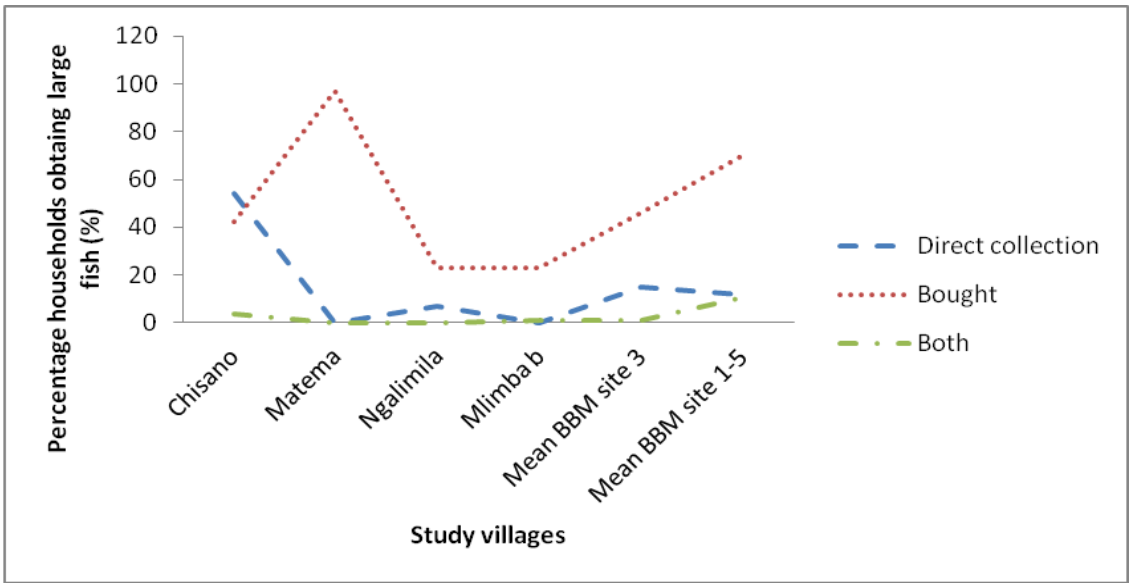

Figure 6.53 Means of obtaining large fish for household consumption in BBM site 3

6.3.3.5 Animals, birds and insects

Other aquatic animals such as Hippopotamus amphibius, Crocodylus niloticus, Lutra lutra, kindasi and lizard are reportedly used as a source food. Hippopotamus is eaten by majority while Lutra lutra only by a minority. These animals were found in both rivers and ponds in the villages.

6.3.3.6 Natural and cultivated vegetables and fruits

There is a relatively high dependence on natural and cultivated vegetbles in BBM 3 site and contribute substantially to household diet. About 70% (Figure 6.54) of the households depend on natural vegetables which they themselves collect or buy (Figure 6.55). Dependence on cultivated vegetable vary according to type (84% depend on both leaf and fruit form vegetables, 82% depend on leaf form vegetable and 71% depend on fruit form vegetables) (Figure 6.54). However consumption of vegetables in BBM site 3 is lower and below average for BBM site 1 to 5.

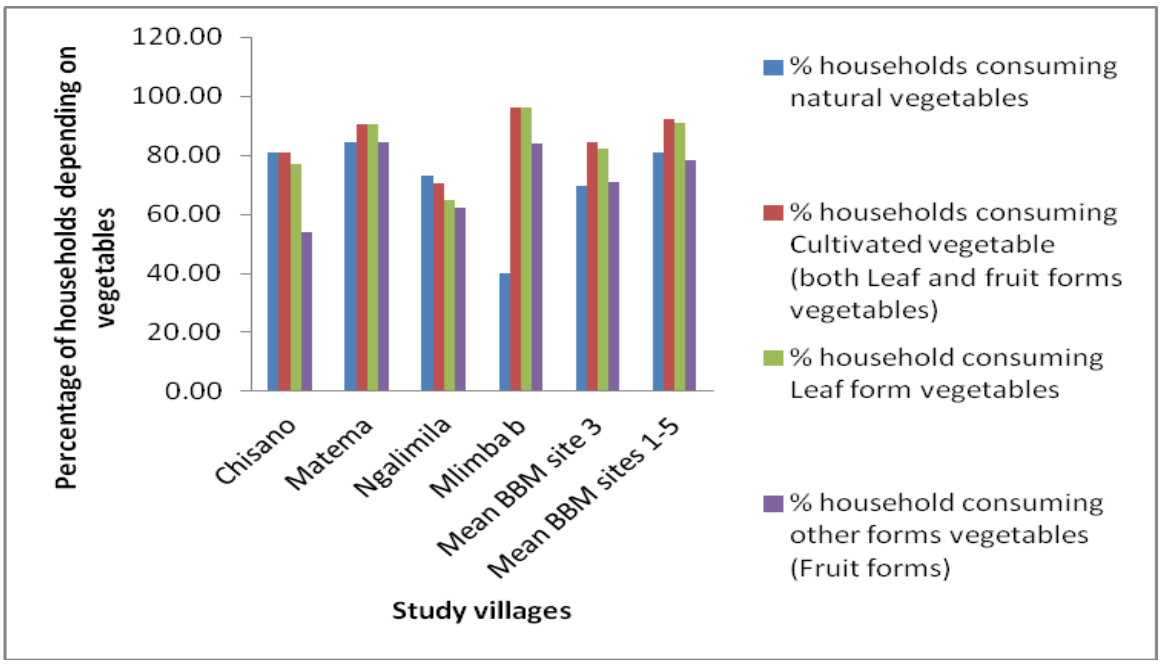

Figure 6.54 Households depending on natural and cultivated vegetables in BBM site 3

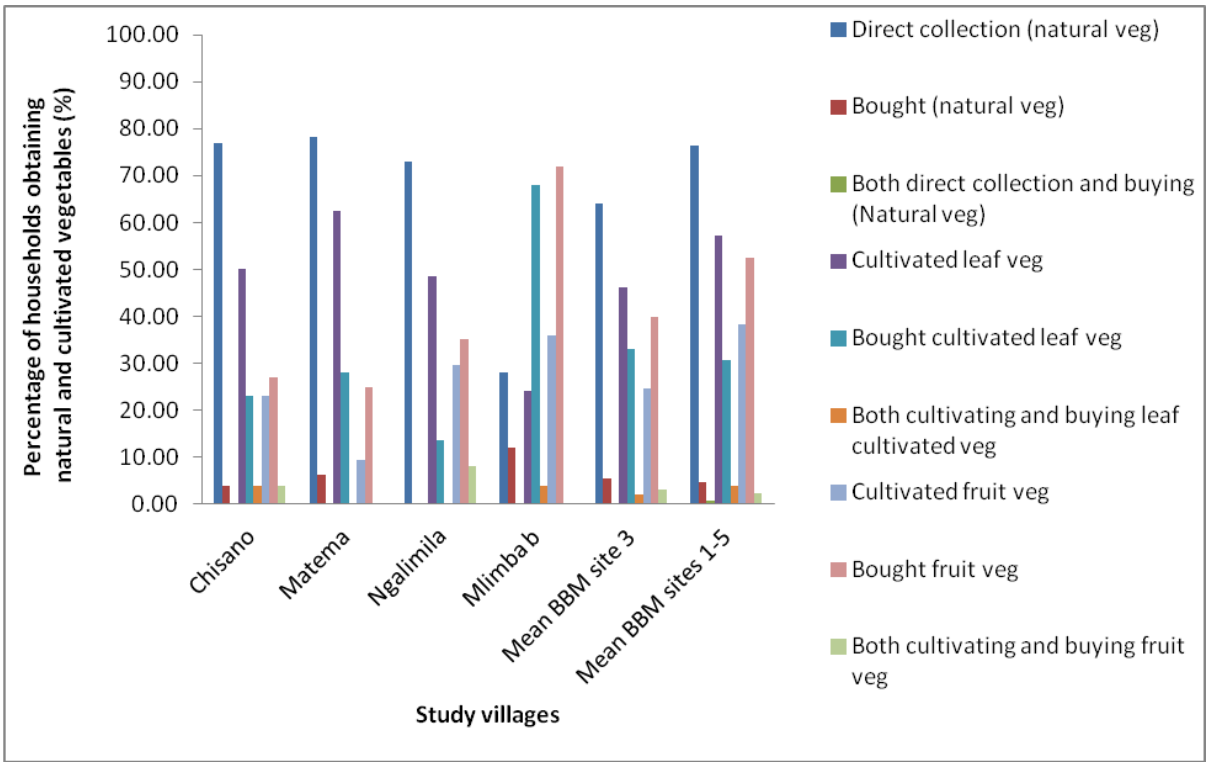

Figure 6.55 Household means of obtaining natural and cultivated vegetables in BBM site 3

Many different natural vegetables and fruits are consumed by the local population (see Annex 5). *Barleria submollis*, *Aeschynomene uniflora* and "mushroom" are the common and most preferred vegetables collected by all villages of BBM 3, while *Vitex donianna*,

Strychnos cocculoides, Parinari curatellifolia and *Tamarindus indica* are the most preferred fruits collected. The natural vegetables and fruits are acquired through direct collection and trading at village markets. Vegetables can be found year round in the valleys, during the rainy season in maize farm lands and during the dry season in the forest and around the ponds. Most of the fruits are found in the uplands and valleys and high availability is during the dry season. On average a household consumes 2.8 bunches of natural vegetables per day, with Chisano village well above this average with a consumption of 4 bunches per day. Also at BBM site 3 natural vegetables and fruits are not really collected for business but rather for food for the household.

Table 6.18 Respondents' preferences on natural vegetables and fruits in BBM site 3

Natural vegetables	Rank
Barleria submollis	1
Aeschynomene uniflora	2
"Mushroom"	3
Corchorus trilocularis	4
Amaranthas sp	5
Natural fruits	**Rank**
Vitex doniana	1
Strychnos innocua	2
Parinari curatellifolia	2
Tamarindus indica	3
"Mtopete"	4
Vitex payos	4

6.4.3.7 Weaving materials

Weaving materials are extensively used in BBM site 3. Materials used for weaving include wild date palm leaves Ukindu (*Phoenix reclinata*) and Malala (*Hyphaene petersiana*) which are normally collected in the valleys. The study found out that 54% of households use Ukindu while 29% of households use Malala for weaving (Figure 6.56). The households obtain the materials through direct collection and buying, with more households buying. *Phoenix reclinata* and *Hyphaene petersiana* are used to make mats and carpets which generate some revenue to the households however the majority of the mats and carpets are for own household purposes. On average a household can get TZS 95,416.67 per household per year from selling mats and TZS 24,125.00 per household per year from selling carpets. The situation is different in Mlimba and Ngalimila where a household makes on average TZS 214,333 TZS and TZS 100,000 respectively per/year by selling mats.

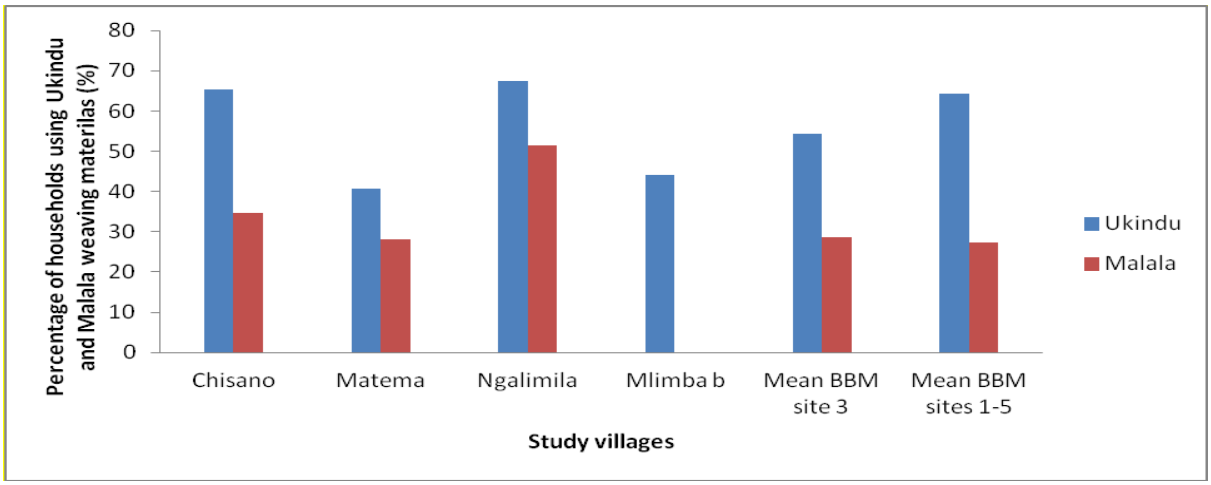

Figure 6.56 Percentage of households using weaving materials in BBM site 3

6.4.3.8 Construction materials

Households use different trees, grasses and reeds for house construction. *Phyllostachys sp* trees are the most common tree used for construction and *Cymbopogon nardus* grass for roof thatching. Most grasses are available in the valleys from June to August. Brick making (Figure 6.57) is done by individual persons for their own home constrcution and/or for commercial purpose. In Mpanga village brick making is also organised through the village council for public buildings such as school and police station.

Figure 6.57 Brick blocks along Vambia pond in Mpanga village (photo: Nyanghura)

6.4.3.9 Fuel

Dry wood is collected from the forest area and used as firewood. Trees that are used in all villages are almost similar in all BBM sites that include, *Phyllostachys sp*, *Vitex donianna, Dellonix regia,* "migugu" *and* "mihimbilikiti" which are available throughout the

year. *Phyllostachys sp,* "migugu" and "mihimbilikiti" are the most preferred fuel materials.

6.4.4 Contribution of income generating activities to household income in BBM site 3

Households derive more income from crop farming (72%) than other income generating activities. In particular rice farming contribute 53% of annual household income Vegetables cultivation contributed 11% (leaf vegetables cultivation contributed 9% while fruit vegetables contributed 1%) of annual household income and fishing contributed 9% to annual household income. Income contribution from fishing is large for small fish (7%) and low for small fish (2%). It can be concluded that households are likely to lose 7% of its annual income in BBM site 3 in case small fish disappear and 2% of its annual income in case large fish disappear. Equally results suggest that in case water to support vegetables cultivation becomes insufficient, a household in BBM site 3 could lose 11% of its annual household income.

6.4.5 Water levels and velocity in wet and dry seasons in BBM site 3

Water levels and inundation during wet and dry season

Water depth in inundated areas with water from main rivers during wet season in BBM site 3 was revealed by 49% of households to be above breasts. Average was 43% of households for BBM site 1 to 5 with similar response. However, 37% of households in BBM site 3 preferred that water in inundated areas end at knee level (Figure 6.58). Regarding water depth in inundated areas with water from small/seasonal rivers during wet season in BBM site 3, 46% of households in BBM site 3 revealed that water level in inundated areas was at knee level. Average was 20 % of households for BBM site 1 to 5 had similar response. However, 46% of households in BBM site 3 preferred that water in inundated areas remain at knee level. Average was 52% of households for BBM site 1 to 5 had similar response on the preferred water (Figure 6.59). Water depth during dry season in main rivers was revealed to be above breast level in BBM site 3. 43% of households preferred water level in rivers during dry season to be above breast level. An average of 28% of households had similar response for BBM site 1 to 5 (Figure 6.60). Inundation level in distance from main rivers for water coming from the main rivers during wet season was observed to be 1 to 3 km. However, 34% of households prefer that inundation level be between 0 to 1 km from main rivers (Figure 6.61). Inundation level in distance from small/seasonal rivers during wet season in was revealed to 3 to 5 km from small/seasonal rivers. However, 36% of households in BBM site 3 preferred that inundation level be between 1 to 3 km from small/seasonal rivers (Figure 6.62).

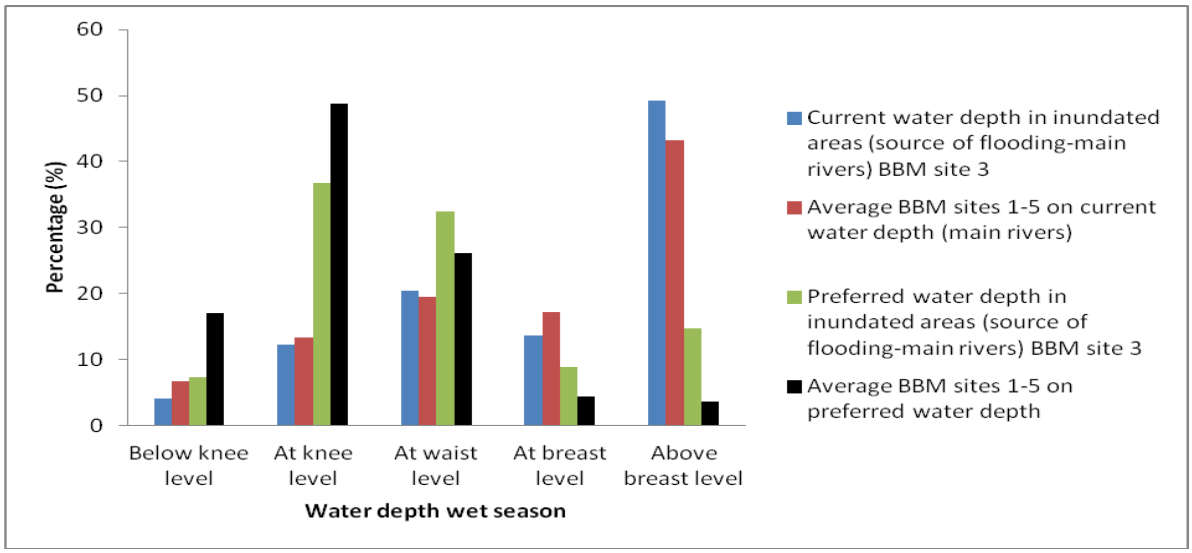

Figure 6.58 Water depth in inundated area for water from main rivers during wet season

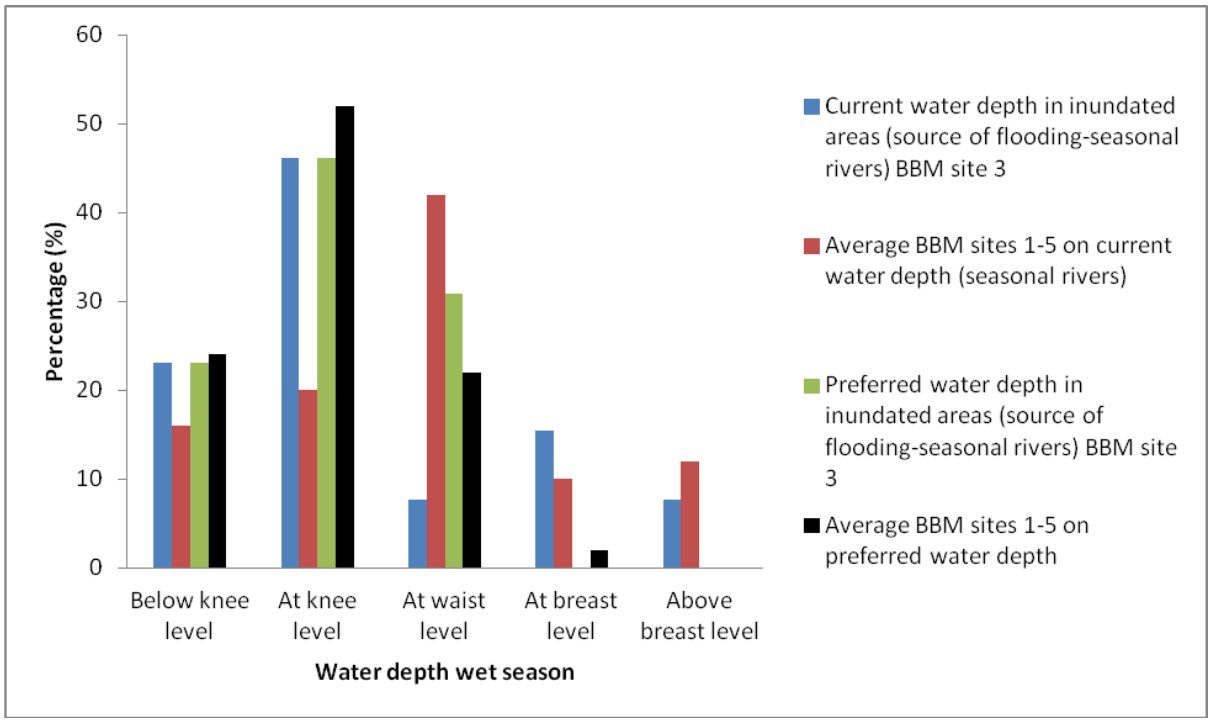

Figure 6.59 Water depth in inundated area for water from seasonal rivers during wet season

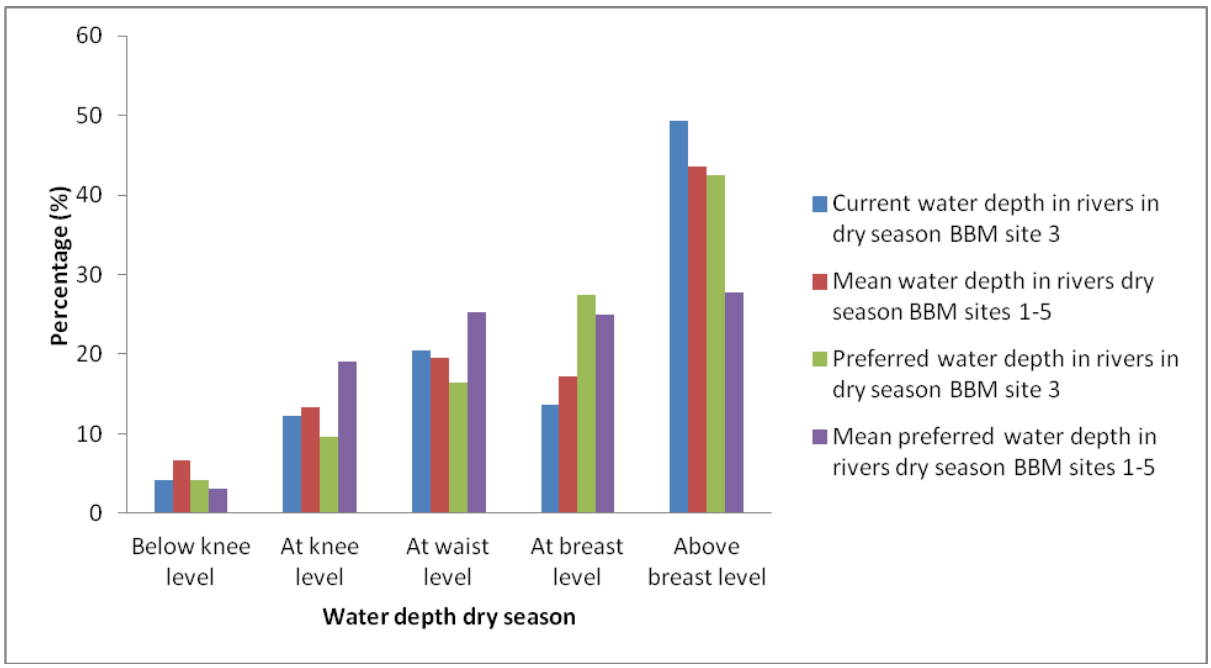

Figure 6.60 Water depth in main rivers during dry season

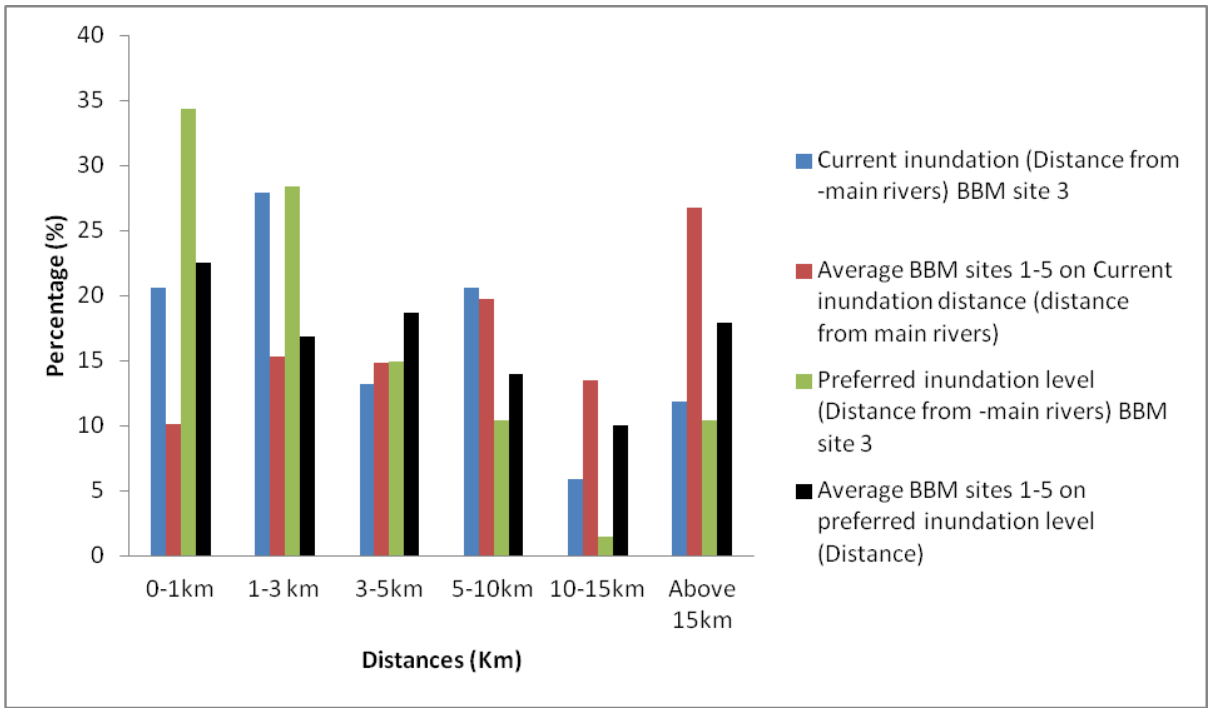

Figure 6.61 Inundation level in distances from main river

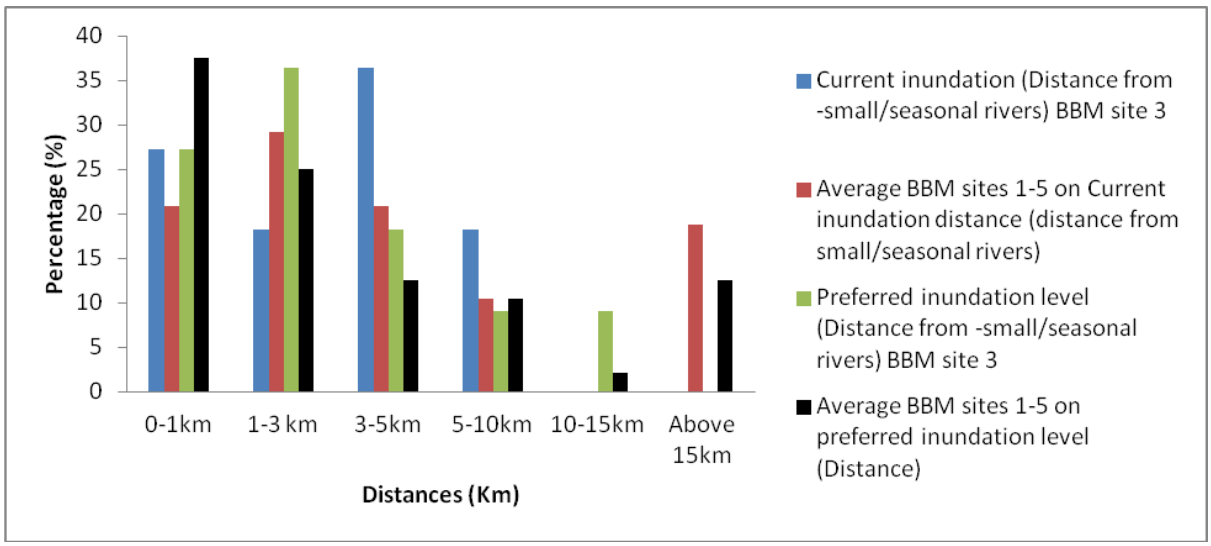

Figure 6.62 Inundation level in distances from small/seasonal rivers

Water velocity during wet and dry seasons

Water velocity for main rivers during wet season in BBM site 3 was revealed to be medium. Responses from households show that 65% of households in BBM site 3 prefer medium water velocity, 25% prefer low water velocity and 10% preferred high water velocity. Averages of 56%, 38% and 6% respectively of households for BBM site 1 to 5 had similar responses on the preferred water velocity (Figure 6.63). Water velocity for small/seasonal rivers during wet season in BBM site is medium. However, 69% of households in BBM site 3 prefer medium water velocity, 31% prefer low water velocity while none prefer high water velocity. Averages were 48%, 50% and 2% respectively of households for BBM site 1 to 5 have similar responses on the preferred water velocity for small/seasonal rivers (Figure 6.64). Water velocity for main rivers during dry season was shown to be medium. On average 61 % of households for BBM site 1 to 5 had similar response. However, 65% of households in BBM site 3 prefer medium water velocity, 24% prefer high water velocity and 11% prefer low water velocity. On averages 71%, 14% and 14% respectively of households for BBM site 1 to 5 had similar responses on the preferred water velocity during dry season (Figure 6.65).

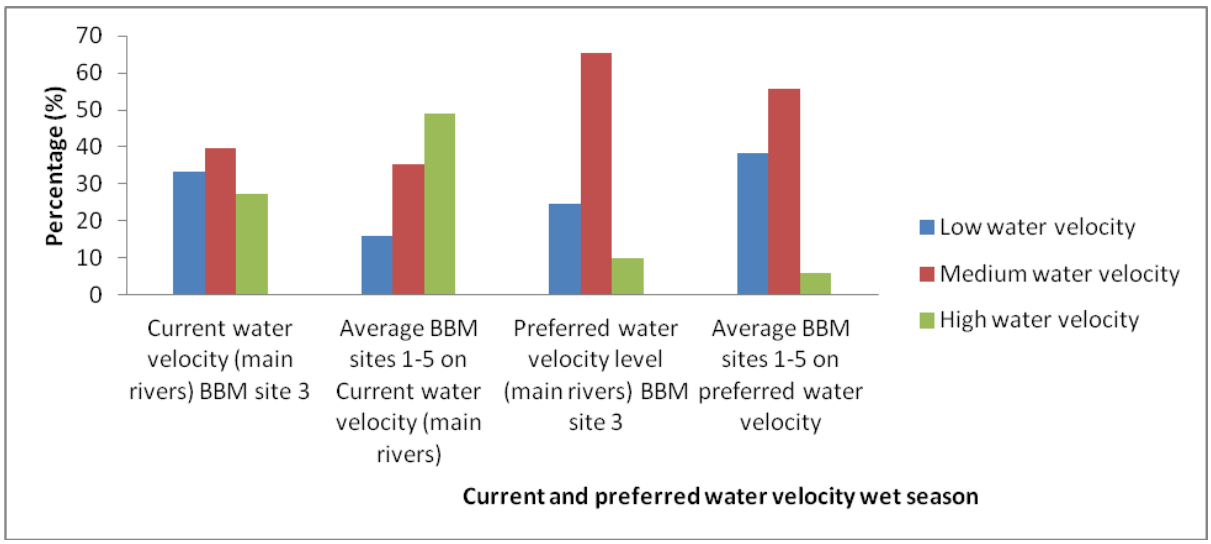

Figure 6.63 Current and preferred water velocity for main rivers during wet season

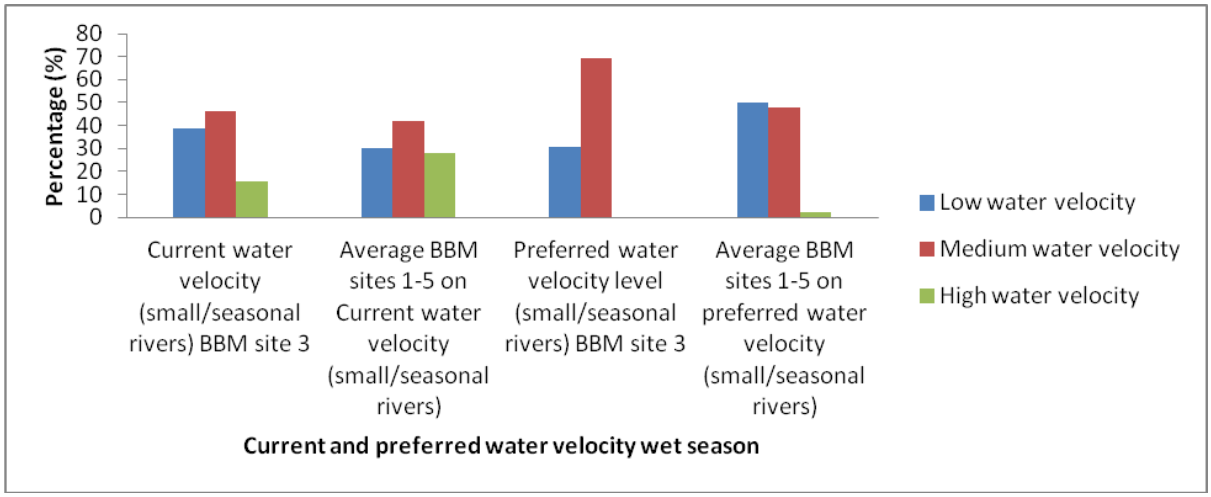

Figure 6.64 Current and preferred water velocity for small/seasonal rivers during wet season

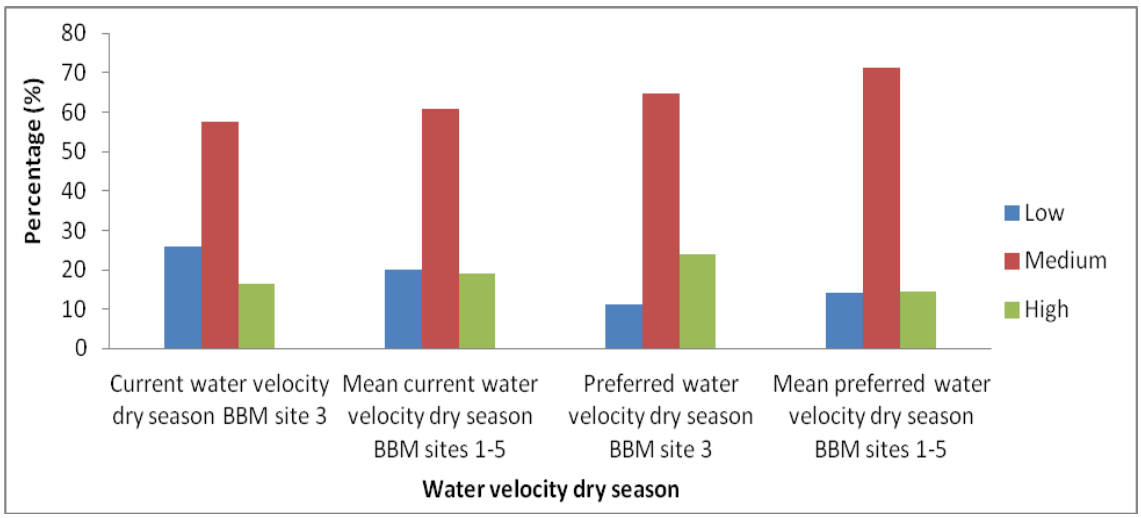

Figure 6.65 Current and preferred water velocity for main rivers during dry season

6.3.6 Determination of the preferences of the locals on selected environmental flows

Generally, preference ranking (Table 6.19) shows that, production ecosystem services were relatively more preferred, followed by regulation and Information ecosystem services. This implies that community's attach relatively high importance to production ecosystem services than other categories of ecosystem services. Relatively high preference is attached to water for domestic use, as reported by 97% of the respondents. Similarly, 94% and 56% of the respondents attach high preference to moist and fertile soils for flood recession agriculture and cultivated vegetables and fruits respectively. This implies that water is of greater importance for domestcic uses followed by moist and fertile soils for flood recession agriculture being the main economic activity for their livelihood. However, compared to other preferences, fish and fishing grounds were relatively most preferred by 47% of the respondents. High importance and demands are attached to fishing as fish are the main source of protein to home diets and for commercial purposes as fish is sold to the population of Kilombero district as well outside the district.

Malaria, bilharzias and UTI control is also much preferred by 48% respondents. This suggests that, water related diseases such as Malaria, bilharzias and UTI are the most prevalent and troubling problems of the area and therefore control measures are of great importance. Accordingly, physical water quality control and flood mitigation were preferred by 53% and 44% of the respondents respectively. Sedimentation and erosion control were less preferred by 39% of the respondents. Probably, this implies that the flooding that occurs in their area deposits some fertile soild beneficial to their agricultural activities. Generally, Information ecosystems services were relatively less and/or not preferred as reported by more than 50% of the respondents This is illustrated through eg 63% of respondents who do not prefer recreation & tourism, and 60% of the respondents who do not prefer sites for cultural and ritual activities. Accordingly,

less preference was reported by 45% on Biodiversity conservation. Out of nine ecosystems services tested, two services were preferred to be increased as reported by more than 50% respondents. Table 6.12 shows that, increase in current services was a prefered by majority (86%) in control of Malaria, bilharzias and UTI, followed by Moist and fertile soils for flood recession agriculture (77%). This findings support the preference attached to Malaria, bilharzias and UTI control, implying that, water related diseases are problem to this area and therefore efforts to control them is vital for the community's livelihoods. Equally, there is high preference on moist and fertile soils for flood recession agriculture which is the main economic activity on which people depend. Other services preferred to be increased is sediment and erosion control (45%) and fertile valley plains for grazing (39%). However, the same number of respondents also prefers the maintenance in current service offered by fertile valley plains for grazing.

Table 6.19 Respondents preferences on ecological services in BBM site 3

Category	Ecosystem service	Mean BBM site 3 Preferences in Percentages				Preference ranking	Ranking according to E. category
		Not preferred	Less Preferred	Preferred	Most preferred		
Production	Fertile valley plains for grazing	21	18	24	38	6	5
	Moist and fertile soils for flood recession agriculture	0	1	5	94	2	2
	Water for domestic uses	0	1	3	97	1	1
	Fish and fishing grounds	3	11	39	47	5	4
	Aquatic animals such as hippopotamus, Crocodylus ni-	67	24	9	0	17	10

	loticuss and snails						
	Cultivated vegetables and fruits	2	8	35	56	3	3
	Natural vegetables and fruits	11	45	29	15	10	8
	Fuel woods, weaving mats and poles/timber	5	17	48	31	7	6
	Soils for brick making	3	39	41	17	9	7
	Water for navigation	43	31	21	6	13	9
	Flood mitigation	26	45	24	5	14	4
	Sedimentation and erosion control	32	31	28	10	11	3
Regulation	Physical water quality control	18	29	36	18	8	2
	Malaria, bilharzias and UTI control	6	15	29	50	4	1
	Biodiversity conservation	28	45	21	7	12	1
Information	Recreation and tourism	63	27	8	3	16	3
	Sites for cultural and ritual activities	60	19	15	6	15	2

Determination of the maintenance level on the selected environmental flows

About 50% of respondents prefer the maintenance of the current services offered by sites for cultural and ritual activities. In this part rituals are an important socio-culural activity. Similarly, there is preference for maintenance of current service offered by physical water features such as ponds, natural springs, oxbow lakes and flood mitigation in inundation areas by about 48% respondents (see table 6.20). Accordingly, majority of respondents (69%, and 42%) prefer decrease in the current services on Crocodylus niloticuss, hippopotamus, snails and their riverine habitats and Game controlled areas respectively. These findings implies that, these services are either not important to them, harmful or they may facilitate negative effects to the communities livelihoods. For example, Crocodylus niloticuss and hippos are reported to be problematic animals to the people's property and their general livelihoods.

Table 6.20 Respondents' preferences on ecological service maintenance levels in BBM site 3

Ecosystem service	**Mean BBM site 3** Preferences on maintenance level in percentages (%)		
	Maintain the current service	Decrease the current service	Increase the current service
Fertile valley plains for grazing	39	22	39
Moist and fertile soils for flood recession agriculture	23	1	77
Crocodylus niloticuss, hippopotamus, snails and their riverine habitats	26	69	5
Physical water features such as ponds, natural springs, oxbow lakes	48	8	44
Game controlled areas	39	42	20
Control of malaria, bilharzias and UTI	7	8	86
Flood mitigation in inundation areas	48	14	38
Sites for cultural and ritual activities	50	41	9
Sedimentation and erosion control	42	13	45

6.5 BBM SITE 4 - Ifwema

6.5.1 Introduction

The study in BBM site 4 targeted two villages namely Lukolongo and Merera (see Figure 6.44). This site is located in the Kilombero floodplain, whereby Merera is considered to be in the primary zone (area close to the irrigation scheme) while Lukolongo is in the secondary zone (not very close to irrigation scheme, but expected to be impacted by extracted water). River Kihansi is used by the people in both villages, but many other perennial and seasonal streams exist in the immediate vicinity of the villages such as Mpanga and Mbelele for Merera village and Mngeta and Mchombe for Lukolongo village. Both villages also make use of several ponds as perennial source of water for vegetable irrigation and other important livelihood activities. Biophysical description of this site is included in the BBM site 3 since they are more related (Section .

6.5.2 Socio-economic characteristics

The main economic activities of the two villages are crop farming, fishing and livestock keeping (see Table 6.21). Merera village had relatively large percentage of the households (40 %) is engaged in livestock keeping than Lukolongo village. Other economic activities include weaving, brick making and charcaol making and petty business. Households population distribution in in BBM site 4 villages included 54% of youth aged between 18 to 44 years old which is below average (59%) of similar age group for households in BBM sites 1-5. Middle aged group (45-60) make up 34% of the population whereas 12% are aged above 60 years. Primary school leavers make 79% of the household popilation. About 15% have received no formal education at all. Most of the households (100%) are crop farmers above the average (96%) for the five BBM sites whereas 31 % are livestock keepers and 41% are fishermen. Percentages for fishermen are comparable to the average (42%) of BBM sites 1-5. Other occupations include petty businesses. Most households (38%) have annual incomes ranging between TZS 600,000/- to 1,999,000/- This is above average (37%) for households with similar annual income for BBM sites 1-5. 23% and 2% earn have incomes between TZS 2,000,000/- to TZS 4,000,000/- and over TZS 4,000,000/- respectively. About 10% of the households have incomes between TZS 50,000/- to TZS 199,000/-.

Table 6.21 Main economic activities in Lukolongo and Merera villages

Percentage household engaged in economic activity	Lukolongo	Merera	Mean BBM site 4	Mean BBM Sites 1- 5
Crop farming	100	100	100	96
Livestock keeping	20	40	30	39
fishing	53	30	42	42
others	13	17	15	26

6.5.3 Determination of the extent of envioronemntal flows (goods and services) and expected losses

Water use

People depend mainly on bore holes for their cooking, drinking and washing which is assumed to be groundwater dependent. At Merera village water can be complemented from Mpanga and Kihansi river. Washing is done in the Kihansi river when the water is still.

Swimming

Swimming is done regularly in the villages during the dry season (September - January) by children when water volumes in the rivers and ponds have significantly decreased. Occasionally small ponds of Kombo, Chilia, Kahanya, Nkerewere and Igumbiro were also useful for swimming especially during rainy seasons. In the dry season they do swim in Kihansi River, specifically in the areas where there is less water with relatively less velocity. In Lukolongo village swimming was reported to be done by children in Mchombe, Kwamakunja and Libambako Rivers.

Navigation: Many people need to cross the rivers to eg access local markets, hospitals, schools. It was revealed that 61 % of households used rivers for navigation during wet season, 10 % during dry season and 29 % during both seasons (wet and dry seasons). On the frequency of navigation it was revealed that 5% travelled daily, 20 % travelled once per week, 15 % travelled once per month but 60 % responded that navigation was not often.

Water quality and use of farm inputs

Use of farm inputs that have potential impact on water quality was assessed in BBM site 4. Percentage number of households involved in herbicides application was the same (76.66 %) for Lukolongo and Merera villages, and therefore equal to the average for BBM site 4 (76.66 %). However, the percentage was above average for BBM sites 1 to 5 (62.20 %). Application of chemical fertilizers involved 10 % of households in Lukolongo village while the use of chemical fertilizer was not observed for households in Merera village in BBM site 4. On average percentage of households using chemical fertilizers in Lukolongo village was above average of 5 % for BBM site 4 and 8.38 % for BBM sites 1 to 5 (Figure 6.66).

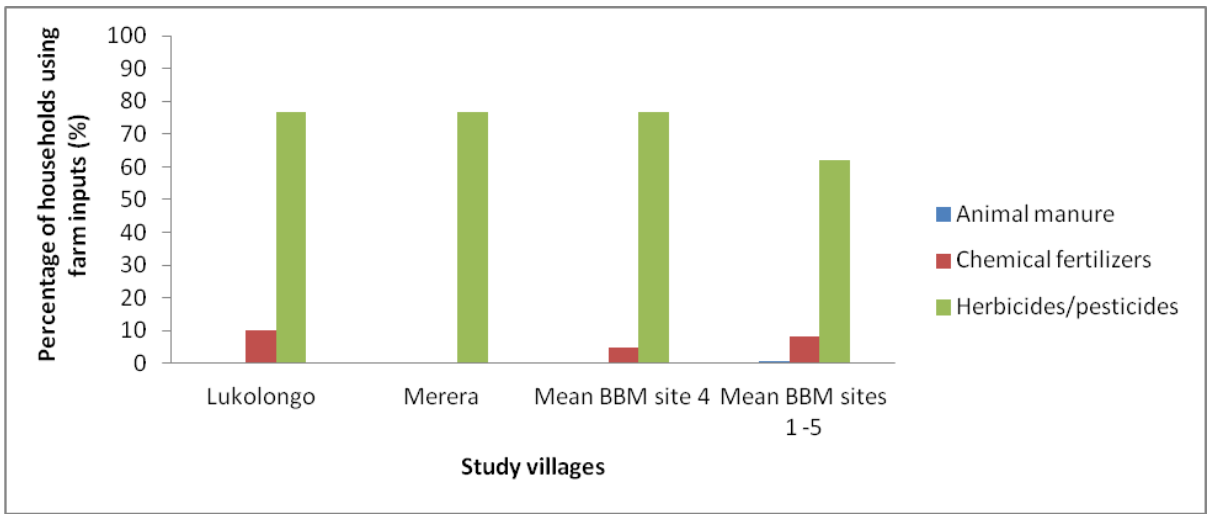

Figure 6.66: Percentage households using farm inputs and types of farm inputs used

Amount of herbicides application in Lukolongo village was observed to be 2.57 Litres/household/acre while in Merera village was 4.98 Litres/household/acre. The amount of herbicide application in Merera village was greater the average amount of herbicide application per household per acre in BBM site 4 of 3.78 Litres/household/acre and average of 4.08 Litres/household/acre BBM sites 1 to 5. Chemical fertilizers application in Lukolongo village was 65.68 Kg/household/acre (Figure 6.67).

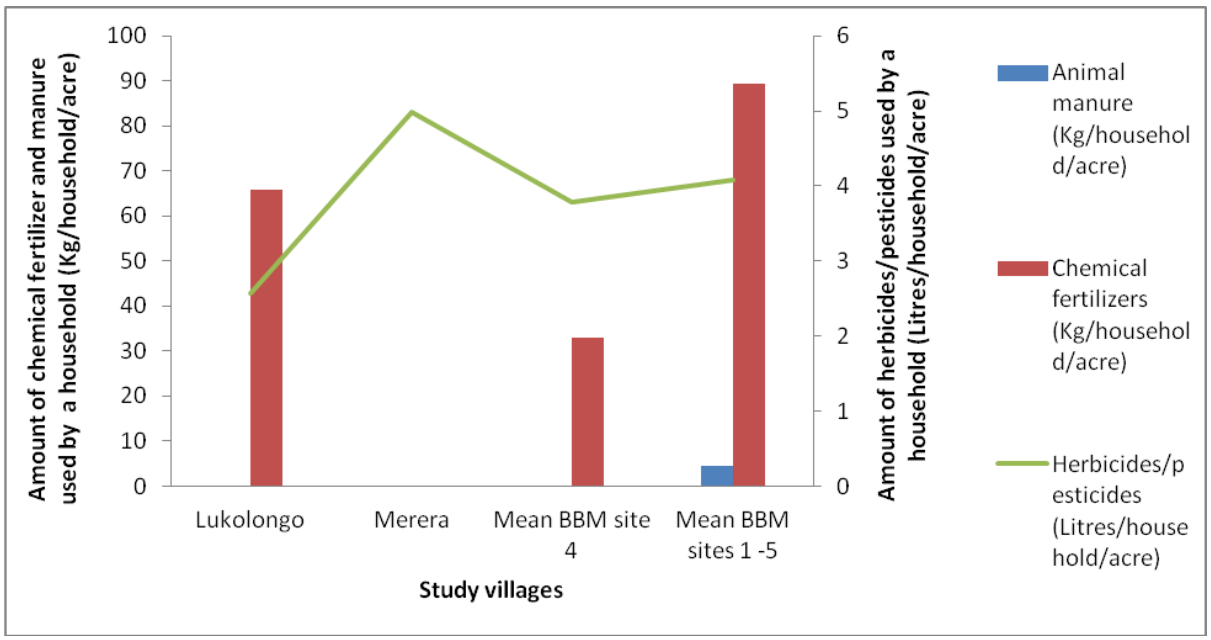

Figure 6.67: Amount of chemical fertilizer, animal manure, herbicides and pesticides used by a household per acre

Water associated problems

Diseases related to water can also be found in the area. Households mention the problems with malaria, Typhoid, Fungus, Bilharzia, Amoeba, Diarrhoea, Dysentery, Cholera and Ancylostomiasis (Safura). People indicate that the Malaria is the most problematic, followed by flooding as it damages houses, roads and leads to extreme inundation of farm land.

Pair-wise ranking was done in the villages to rank the problems mentioned by the population (see Table 6.22).

Table 6.22 Ranking of water associated problems in villages of BBM site 4

Problems/Diseases	Merera	Lukolongo	Mean	Overall rank
Malaria	1	1	1	1
Typhoid	3	3	3	2
Flooding	4	2	3	2
UTI	4	3	3.5	3
Cholera	2	9	5.5	4
Dysentery / Diarrhea	9	4	6.5	5
Bilharzias	9	6	7.5	6
Amoeba	9	5	7	7
Fungus	9	7	8	8

Flooding

During the group discussion an attempt was made to elicit the extent of inundation and its effect to the communities' livelihoods. Because of time shortage, this was only done for the most dependent river: Mngeta River at Lukolongo village. The extent of inundation was noted to vary from low, normal and high rainfall levels at Lukolongo village. During the high rainfall levels the overflow of the river Mngeta causes to extend the inundation to valleys areas. However, during the low rainfall levels, it was reported that the overflow of the Mngeta River was reported to be at less distance compared to years with normal and relatively high rainfall.

According to the local population the water volume has decreases drastically over the past three decades. For example, High flow of water was reported to Mpanga and Kihansi Rivers in the past 3 decades compared to medium water flow during the late of 1990s to early of 2000s. Relatively, lower volume is now experienced to most of the rivers and ponds. Accordingly, significant reductions in water flow were reported in Rivers such as Mngeta and Mchombe. Likewise to Ponds such Uliyangumui, Mhumbu, and Nganewa found at Merera village and Lusoma Lumuangoloke Pond at Lukolongo village. However, different from other rivers, river Mbelele in merera have changed from an un-seasonal to a seasonal river. This could be due to decreases in river bank as a result of siltation derived from anthropogenic activities to the associated network of connected ponds of Nganewa and Ulyangumu pond.

Crop cultvation

Crop cultivation is the most important economic activity and is practiced by all social groups in all BBM site 4 villages. Farming is both for both subsistence and commercial purposes and is practiced in flood plain areas, and in the valleys especially for vegetables and rice. Crops grown include rice, maize and sesame. Rice is most preferred, followed by Maize, cassava and Potatoes (see Table 6.23). All households (100%) cultivate rice. Average for rice cultivation is 93% for all the five BBM sites followed by maize. Most of the revenue is acquired from rice farming. Lukolongo and Merera obtain an average of TZS 904.67 and TZS 889.33 per household per year respectively.

Table 6.23 Preference for cultivated crops and vegetables in villages of BBM site 4

S/no	Cultivated Crops/Vegetables	Villages Lukolongo	Merera	Mean rank	Overal rank
Crops					
1	Banana	6	6	6	5
2	Maize	2	2	2	2
3	Mihogo	4	3	3.5	3
4	Millets	5	5	5	4
5	Potatoes	3	4	3.5	3
6	Rice	1	1	1	1
Vegetables					
1	Amaranthas				
2	Bamia	1	1	1	1
3	Biringanya	3	2	2.5	2
4	Chinese	5	5	5	4
5	Kalubwagila	2	3	2.5	2
6	Tomatoes	3	3	3	3

Crops are cultivated in both upland areas and in valleys/low land in different seasons of the year. Most of the vegetables are cultivated in the valleys, where they use moist soil. In very dry periods locals use irrigation water from Kihansi River. During dry seasons, vegetables are mostly collected around the river Mngeta and Nchombe and Lusoma Lumuangoloke Pond in Lukolongo Village. Most vegetables are cultivated from May- August because then there is enough moist soil condition as a necessary condition for the horticultural growth. On average 90% of the households depend on cultivated fruits and vegetables. Households who sell the cultivated fruits or vegetables can get a revenue of about 200,000 TZS/year.

The average farm size for rice is 4.15 acres and for maize it is 1.45 acres (Figure 6.68). On average a household harvests 572.77 kg/acre of rice per year out of which 37% is con-

sumed by the household. For maize this is about 211.72 kg/acre of maize harvested per year out of which 54% is consumed by the household. Rice brings however most revenues compared to other crops. So the crop cultivation is both for food and cash, except for sesame and banana which are almost entirely for cash (100% and 97% respectively).

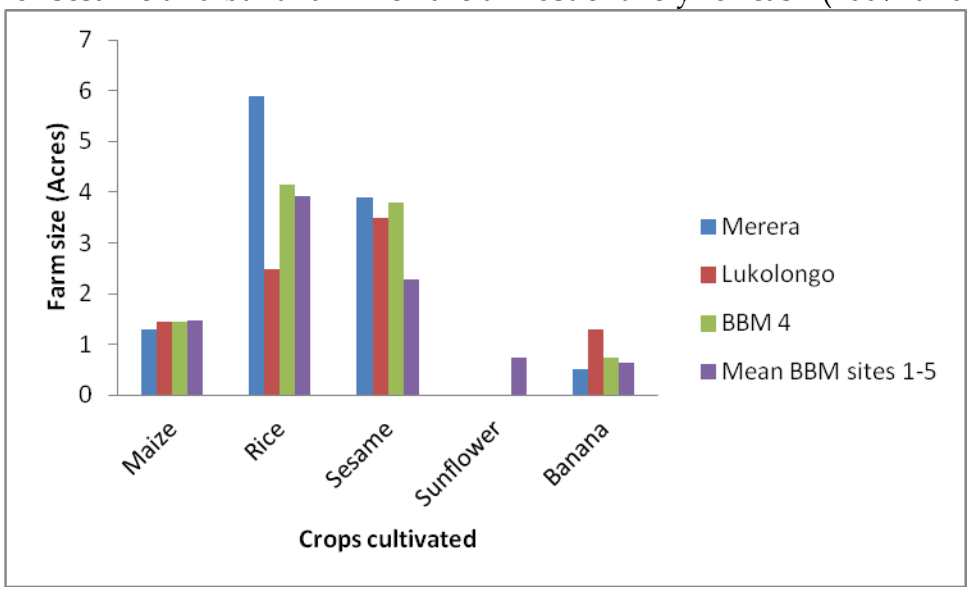

Figure 6.68 Farm sizes BBM site 4 versus average for the BBM sites 1-5

Livestock keeping

On average 13% of households in BBM site 4 villages keep cattle and 47% of households keep chicken other livestock kept include goats, sheep and pigs (Figure 6.69). There are more cattle in Merera than in Lukolongo. Livestock contributes to their diet and income through the sales of live animals and their products. Cows and goats are freely graze in the valley close to River Mngeta in Lukolongo village and Kihansi and Mpanga river in Merera village. These areas are designated by the village for livestock keeping. Grazing do also takes place outside these areas which cause conflicts with the farmers. Cattle and pigs provide some revenue to respective households. In Merera village the revenue from cattle is on average 2.6 million TZS/household/year and from pigs on average 1 million TZS/household/year.

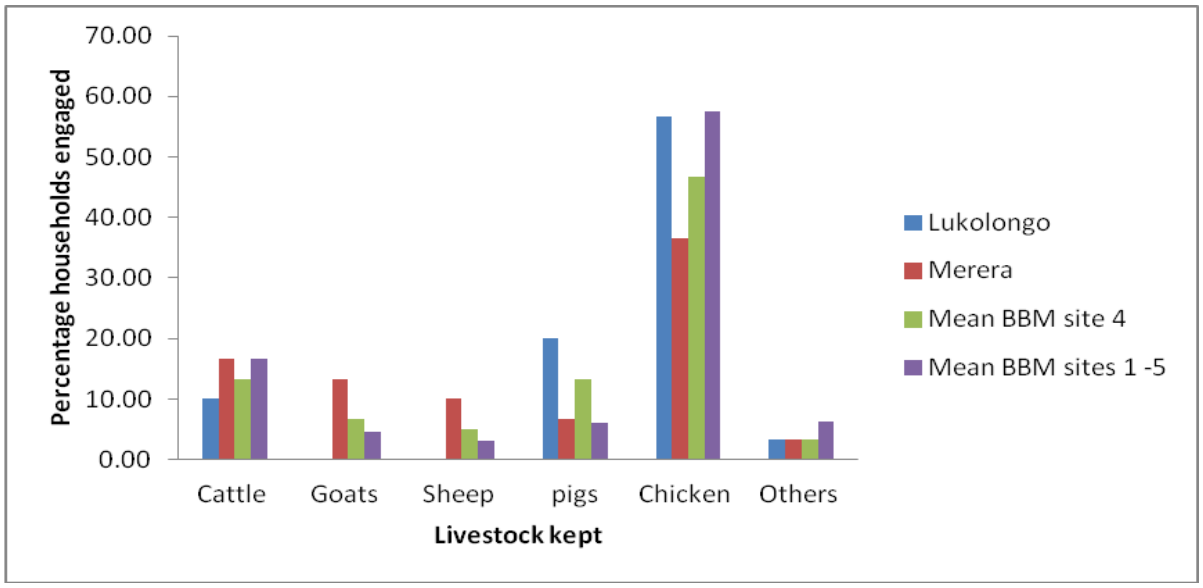

Figure 6.69 Percentage households engaged in livestock keeping and type of livectock kept

Fishing

Fishing is the second most important economic activity in BBM site 4 villages, mainly practiced at Lukolongo village in Mngeta, Kihansi and Kilombero Rivers and the permanent ponds of Lusoma Lumuangoloke during the dry season. Other rivers and ponds are also used for fishing. Fish consumption is high for most households (60% consume small fish and 78% consume large fish) obtained through buying from fishermen or middlemen in the villages (Figure 6.70 and 6.71). On average a household consumes 67 large fish per year and 56 cups (250 ml) of small fish per year, which is below average when compared to the other BBM sites. In Lukolongo fish is however more consumed (95 large fish per year and 73 cups of small fish per year), which is above the average of all BBM sites. The average revenue obtained from fishing is TZS 3,283,625.00 per household per year for large fish and TZS 39,000.00 per household per year for small fish. On average fish revenue is high in Merera village than in Lukolongo.

There are several specie varieties in BBM site 4 including Kambale, perege, sulusulu, Mgundu, Kitoga, Ngogo and Njege. Kambare is the most preferred fish followed by Perege, whereby Kitoga is most preferred commercially (Table 6.24). The preference seems to be related to their availability as these fish species are about 90% available especially during the rain season when people can collect them themselves as a result of flooding instead of buying them. Most of fish species are fished throughout the year from river Mpanga and Kihansi for the people of Merera Village and for the Lukolongo the main rivers used are Mngeta, Kihansi and Mchombe. Moreover there are a lot of ponds where fishing is practiced. The commonly fish species found in ponds included Sheka and Perege. Other species are Kambare, Nyongololo, Ngongo, Sulusulu, Ndipi, Mbewe, Nkuta, Mbala and Njunju. Ningu are relatively available in the ponds during rainy season. Breeding takes place in small streams, flood plains (inundated areas) and ponds. In Merera village on the edges of Uliyangumui, Mhumbu, and Nganewa ponds

among others were reported to be the most preferred fish breeding sites. Breeding sites vary depending on species type. For example the breeding sites for Kambale and Perege were claimed to be located along the rivers and ponds/ponds banks where there were plenty vegetation type called Mafufu or makongo. Others fish like Kitoga, Njege, Bula, Ngungu and Mtuku require clean water for breedings. Less and still water is sufficient and enable fishes to manage and control their eggs before hatching. The waters also enhance the fishes to raise up their fingerlings. Annex 3 provides a detailed overview of the different fish species, its availability in the seasons, the favourable habitat and preferred water condition.

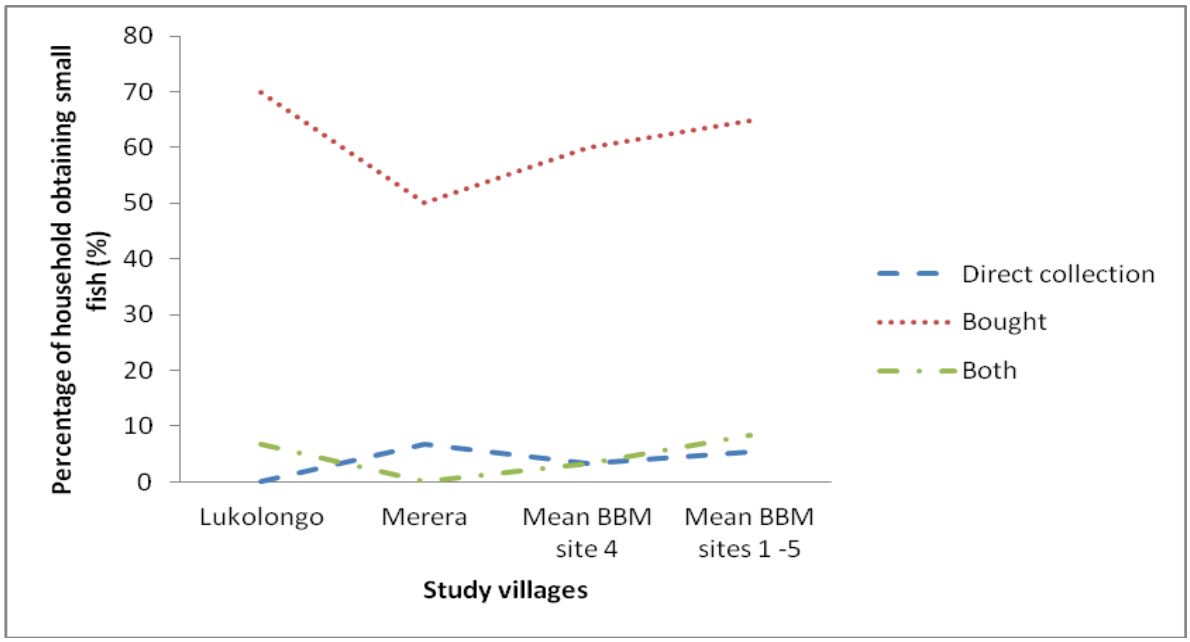

Figure 670 Means of obtaining small fish for household consumption in BBM site 4

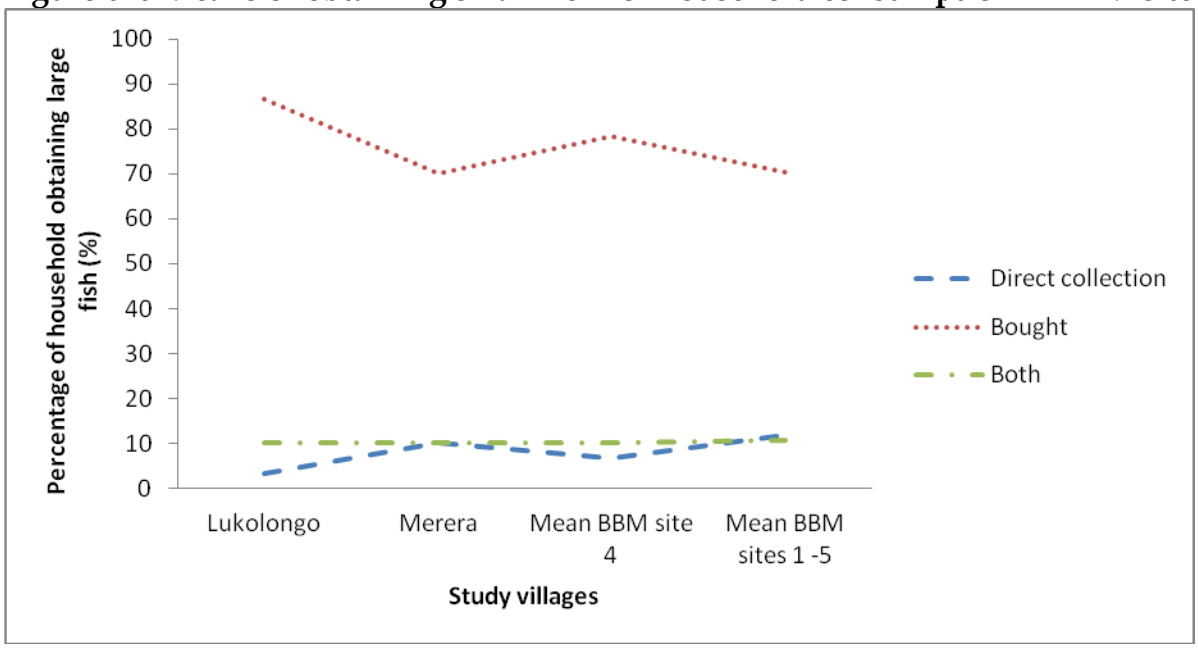

Figure 6.71 Means of obtaining large fish for household consumption in BBM site 4

Table 6.24 Preference of fish species in vilages of BBM site 4

S/No.	Fish species	Ranking of fish preferences in BBM site 4 villages		Mean rank	Overal mean
		Merera	Lukolongo		
1.	*Clarias*	1	1	1	1
2.	*Tilapia*	3	2	2.5	2
3.	*Mormyrus*	4	7	5.5	4
4.	*Alestes*	7	5	6	5
5.	*Bagrus*	5	3	4	3
6.	*Synodontis*	2	6	4	3
7.	*Hydrocynus*	7	4	5.5	4

Animals, birds and insects

Besides fish, other aquatic animals such as Hippopotamus amphibius, Crocodylus niloticus, Lutra lutra, kindasi, python and lizard exist in the rivers. Most people eat Kindasi and Hippopotamus, while few traditional households eat Crocodylus niloticus and Lutra lutra. A specific characteristic of this site is the occurrence of snails. Snails are important for breeding site and protection of some of sensitive species of fish.

Natural and cultivated vegetables and fruits

There is high house holds dependence on natural vegetables, fruits and cultivated vegetables in BBM 4 villages. On average, percentage households depending on natural vegetables (78%) and cultivated vegetables (90%) depending on both leaf and fruit form vegetables, 90% depending on leaf form vegetable and 85% depending on fruit form vegetables) in BBM site is very high but below average for BBM site 1 to 5 (Figure 6.72). Households depending on natural vegetables are higher in Merera (80%) than Lukolongo (77%) (Figure 6.58) and most of the households (73%) collect the vegetables themselves (Figure 6.73). The commonly found and eaten natural vegetables are *Barleria submollis*, "Namgange", *Aeschynomene uniflora*, *Amaranthus sp*, *Ipomoea aquatica*, "Lidadangala", *Commiphora sp*, *Sesbania sesban*, and "Mhaka" were reported to be common vegetables eaten by all villages in BBM four. Linyala are the most preferred natural vegetable followed by Mwidu, Liwowo and *Corchorus trilocularis* while Mushrooms are less preferred. On average a household consumes 1.8 bunches of natural vegetables per day. Vegetables are found valleys and in the maize farms during the rainy season and in the forest and around the ponds during the dry season. Most vegetables are found during the rainy season. The commonly found fruits in villages are Mizambarau pori, Misada, and Mafuru. Most fruits can be found in the uplands and valleys with high availability during dry seasons. Mifuru are most preferred fruits followed by Misada, Madongadonga and Ukwaju. The details of location and seasonal availability can be found in Annex 5.

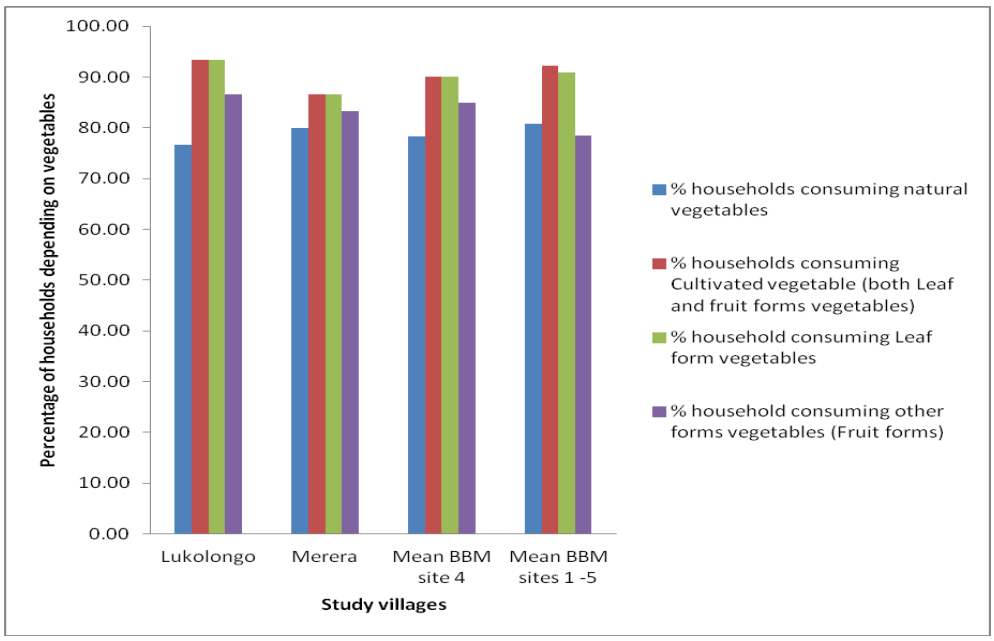

Figure 6.72 Households depending on natural and cultivated vegetables in BBM site 4

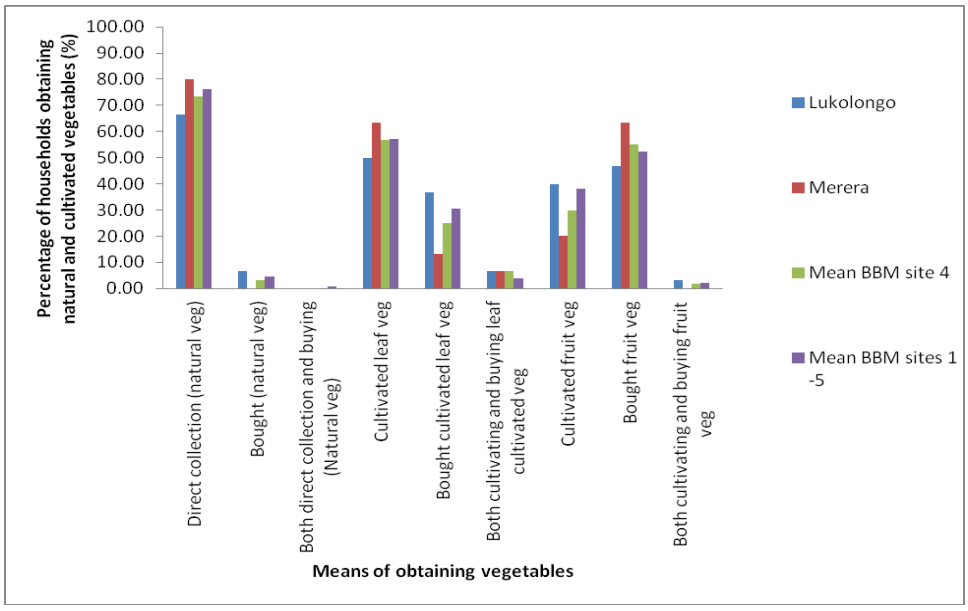

Figure 6.73 Household means of obtaining natural and cultivated vegetables in BBM site 4

Vegetables are as well extensively cultivated in BBM 4 site villages. It has been found out that 57% of households cultivate leaf vegetables comparable to 57% for BBM site 1 to 5% of households buy vegetables. Households do also cultivate fruits vegetables (30 %). This is however below the mean (38%) for BBM site 1 to 5 (Figure 6.72). No revenues is accrued by households from natural vegetables which suggests that natural vegetables are not for business but rather food for the household collecting it. However there is some revenue from cultivated leaf vegetables and cultivated fruit vegetables. It is es-

timated that households obtain TZS 163,000.00 per household per year and TZS 35,000.00 per household per year for cultivated leaf vegetables and cultivated fruit vegetables respectively.

Table 6.17 Respondents' preferences on natural vegetables and fruits in BBM site 4

Natural vegetables	**Rank**
Aeschynomene uniflora	1
Barleria submollis	2
Sesbania sesban	3
Corchorus trilocularis	4
"Namgange"	5
Natural fruits	**Rank**
Vitex doniana	1
Vangueria infausta	2
Strychnos innocua	3
Tamarndus indica	3
"Mtopete"	4
Parinari curatellifolia	4

Weaving materials

Weaving materials are used in BBM site 4 villages. Ukindu (*Phoenix reclinata)* and malala (*Hyphaene petersiana*) are the most preferred weaving materials. About 57% of the households use *Phoenix reclinata* against 10% using *Hyphaene petersiana* (Figure 6.74). The households obtain the materials through direct collection and buying (Figure 6.75). These resources are collected from the valleys. *Phoenix reclinata* and *Hyphaene petersiana* are used to make mats and carpets. The selling of mats provides some revenues to the households, but the majority of the mats and carpets are for own household purposes.

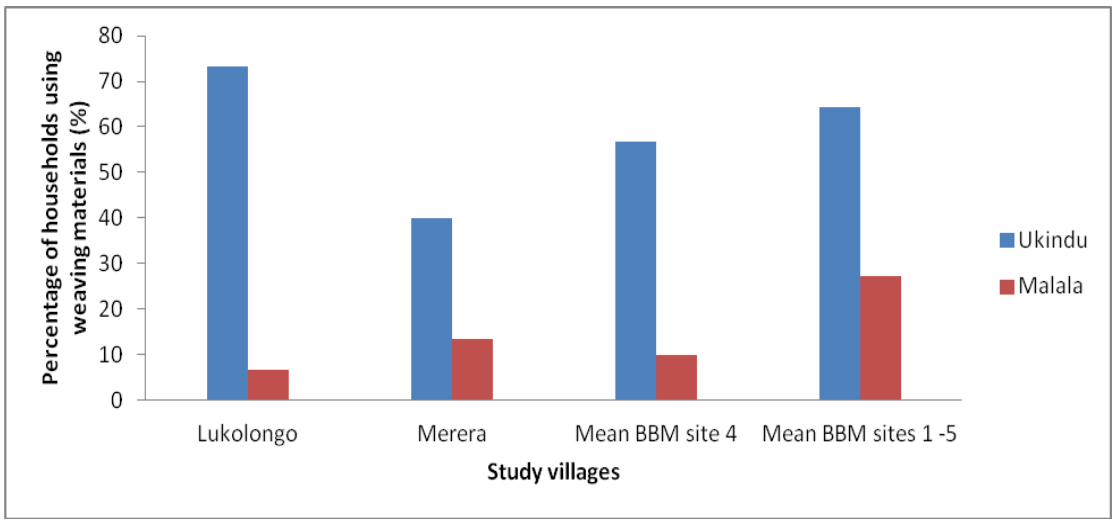

Figure 6.74 Percentage of households using weaving materials in BBM site 4

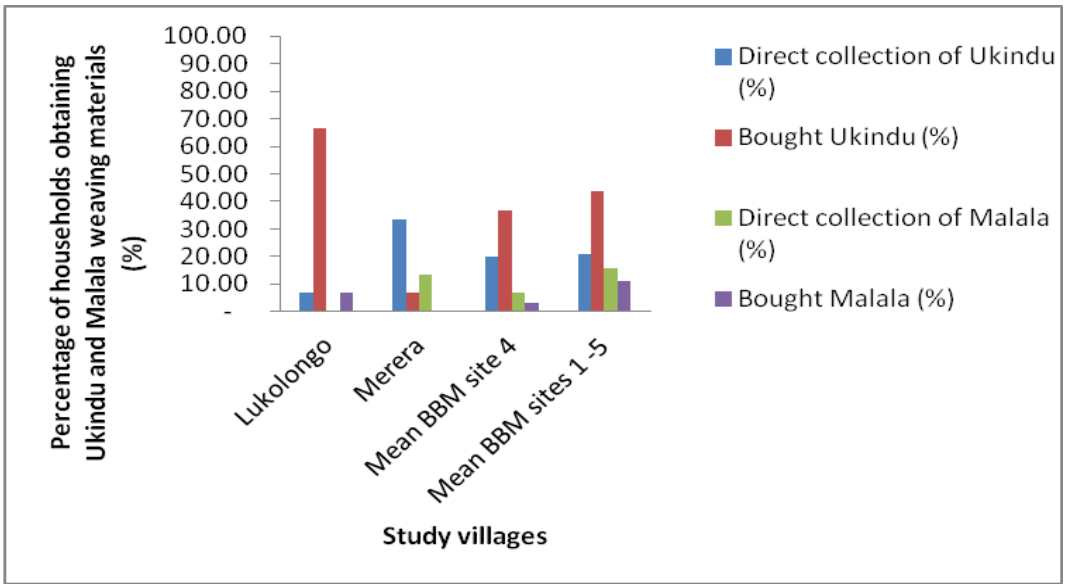

Figure 6.75 Means of obtaining weaving materials BBM site 4

Construction materials

Households refer to use construction trees (Matete, Mianzi and Mnanga) and thatching grasses (Mbasa, Michelele and others) for their homes. Most commonly used tree is Mianzi while for grasses this is Mbasa, followed by Lusano and Myanganga. Most grasses are found in the uplands and valleys and mostly available and collected from June to August.

Fuel

Dry wood is collected from the forest area and used as firewood. Trees that are used in all villages are *Phyllostachys sp, Vitex sp* and *Dillonix regia* which are available throughout the year. Bamboo, migugu and mihimbilikiti are the most preferred fuel materials.

Traditional medicine

The traditional healers found in all villages obtain their medicinal plants mainly from the forests. Some obtain medicinal roots from swamp areas, eg the roots from locally known species including Mchelemela, Chilemela ndembo, Afzelia sp, Mzahabu, Lubugu and Mkole or from the valleys, eg grass species such as Mwosha fede grass. Some traditional healing activities require water, eg to prepare the medication, but the carrying out of the traditional healing is not done in the rivers due to the presence of animals such as Crocodylus niloticuss.

6.5.4 Contribution of income generating activities to annual household income

Households income comes from farming, fishing and livestock keeping. Crop farming contributes 47% of annual household income followed by fishing which contributes 38 %. In particular from crop farming, rice farming contributed 39% of annual household income. As for fishing, almost all income from fishing is contributed by large fish fish-

ing (38%) with small fish contributing 0.1% of annual household income. Livestock keeping and vegetable culitivation contributes 14% and 0.3% of annual household income respectively. These finding suggest that households could lose 38% of its annual income in case large fish disappear and only 0.1% of its annual income in case small fish (dagaa) disappear. Again, the results suggest that in case water to support vegetables cultivation becomes insufficient to allow vegetables cultivation, a household in BBM site 4 could lose 0.3% of its annual household income.

6.4.5 Water levels and velocity during wet and dry season

Water levels and inundation levels during wet and dry season

Households (31%) in BBM site 4 revealed that water level in inundated areas from main rivers in wet season is usually at waist level. An average of 20% of households for BBM site 1 to 5 had similar response. However, 56% of households prefer that water in inundated areas be at knee level (Figure 6.76). About 67% of households revealed that water depth in inundated areas with water from small/seasonal rivers during wet season was at waist level. A average of 42 % of households for BBM site 1 to 5 had similar response. However, 50% of households prefer that water in inundated areas be at waist level and another 50% preferred it to be at knee level (Figure 6.77). Regarding water depth during dry season in main rivers, it was revealed by 31% of households that water depth in main rivers during dry season was at at waist level. Average of 20% of households had similar response for BBM site 1 to 5. However 40% of households prefer water level in rivers during dry season to be at waist level (Figure 6.78). Inundation level in distance from main rivers for water coming from the main rivers during wet season is 5 to 10 km from main rivers. An average of 20% of households for BBM site 1 to 5 had similar response. However, 28% of households prefer that inundation level be between 3 to 5 km from main rivers (Figure 6.79). Inundation level in distance from small/seasonal rivers for water in wet season was revealed to be 0 to 1 km from small/seasonal rivers. An average of 21% of households for BBM site 1 to 5 had similar response. However, 67% of households in BBM site 4 prefer inundation level to remain between 0 to 1 km from small/seasonal rivers (Figure 6.80).

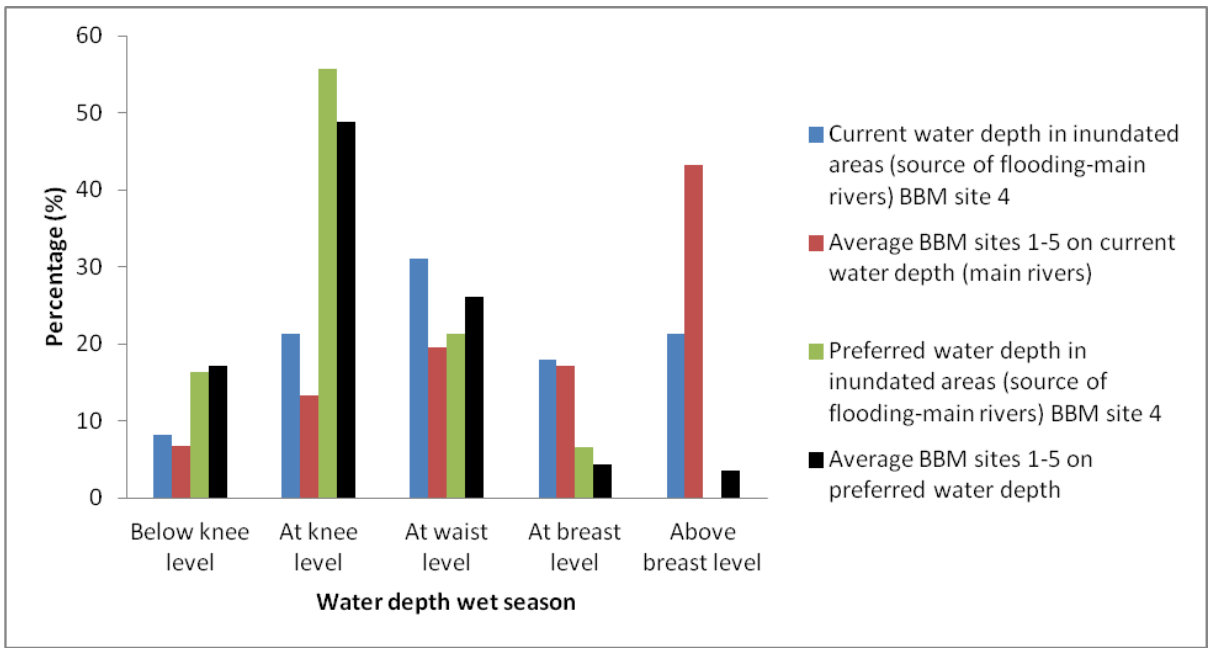

Figure 6.76 Water depth in inundated area for water from main rivers during wet season

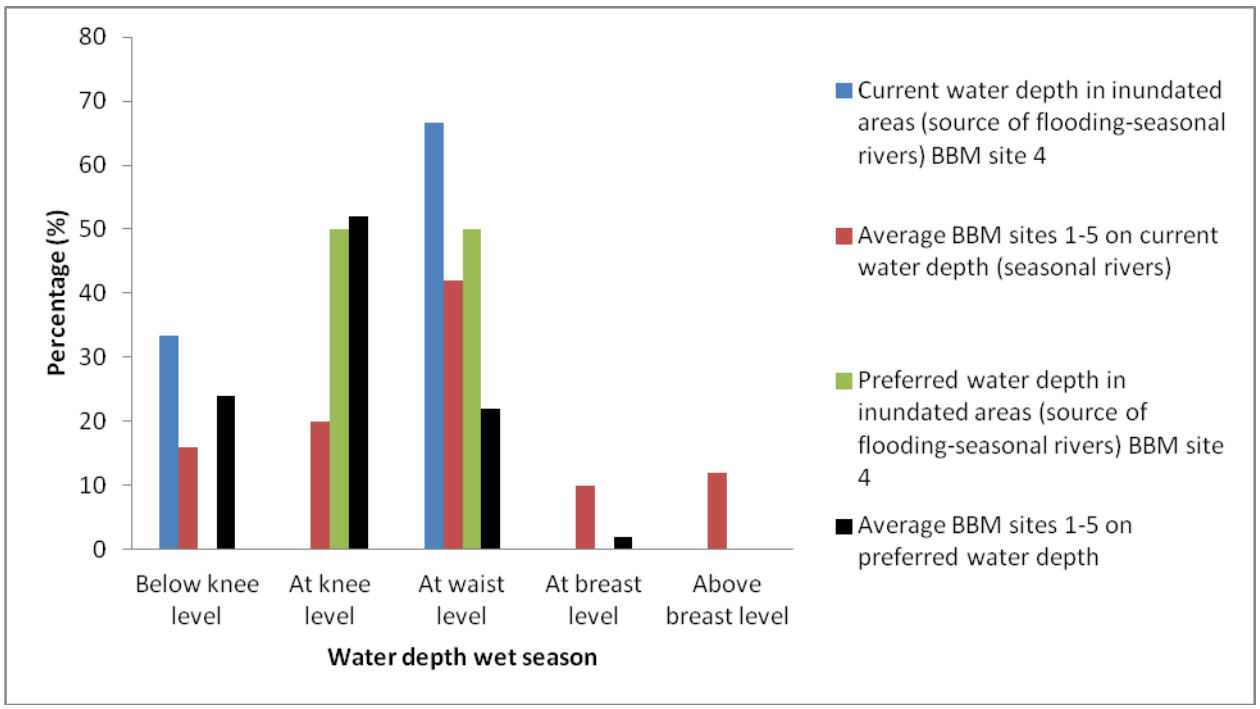

Figure 6.77 Water depth in inundated area for water from seasonal rivers during wet season

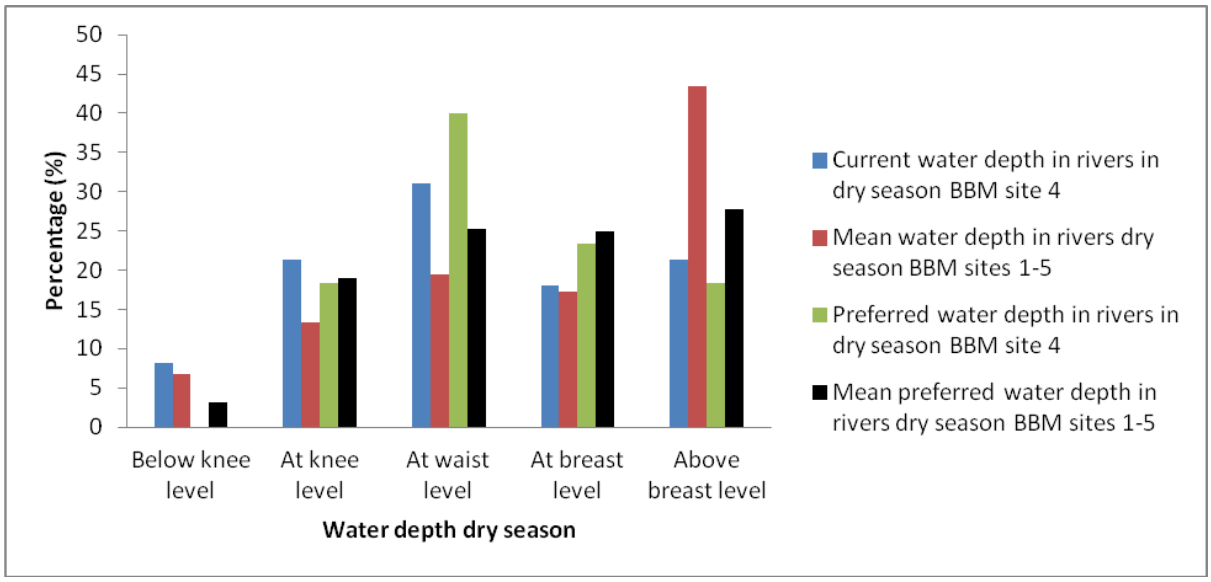

Figure 6.78 Water depth in main rivers during dry season

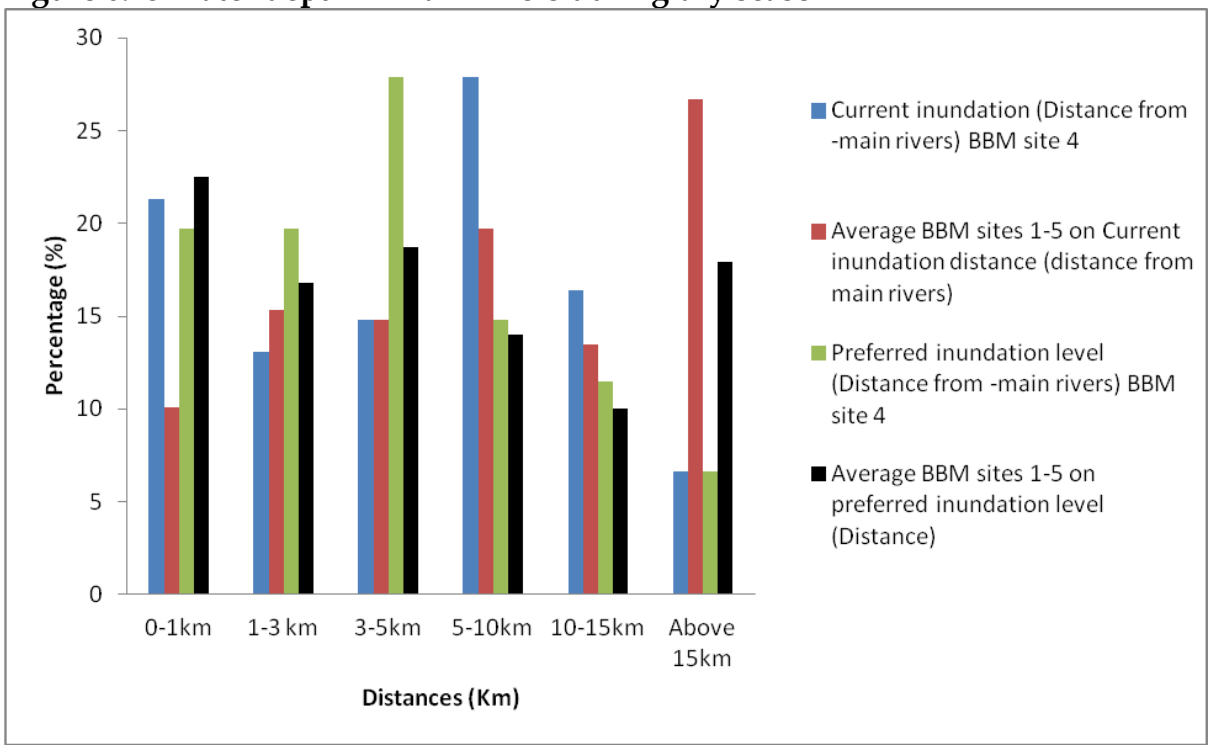

Figure 6.79 Inundation level in distances from main rivers

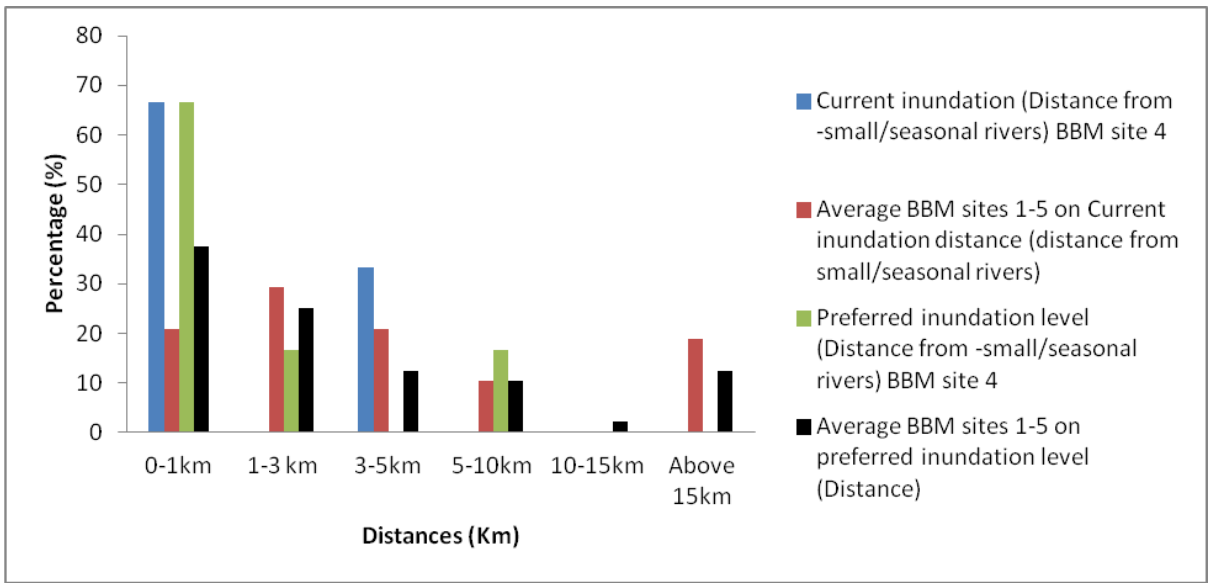

Figure 6.80 Inundation level in distances from small rivers

Water velocity during wet and dry seasons

Water velocity for main rivers during wet season in BBM site 4 was revealed to be medium by 56% of households. An average of 35% of households for BBM site 1 to 5 had similar response. However, 61% of households in prefer medium water velocity, 30% preferred low water velocity and 10% preferred high water velocity (Figure 6.81). Water velocity for small/seasonal rivers during in wet season was revealed to be medium by 67% of households. An average of 42% of households for BBM site 1 to 5 had similar response. However, 67% of households in BBM site 4 prefer medium water velocity, 33% prefer low water velocity and none prefer high water velocity (Figure 6.82). Water velocity for main rivers during dry season was revealed to be medium by 57% of households. An average of 61% of households for BBM site 1 to 5 had similar response. However, 74% of households in BBM site 4 prefer medium water velocity, 18% preferred high water velocity and 8% preferred low water velocity (Figure 6.83).

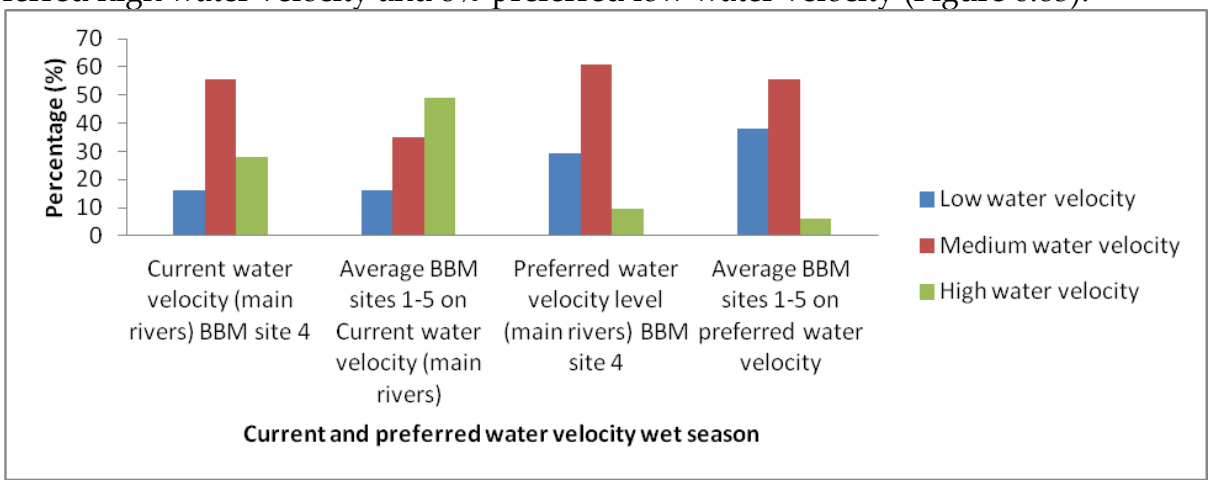

Figure 6.81 Current and preferred water velocity for main rivers during wet season

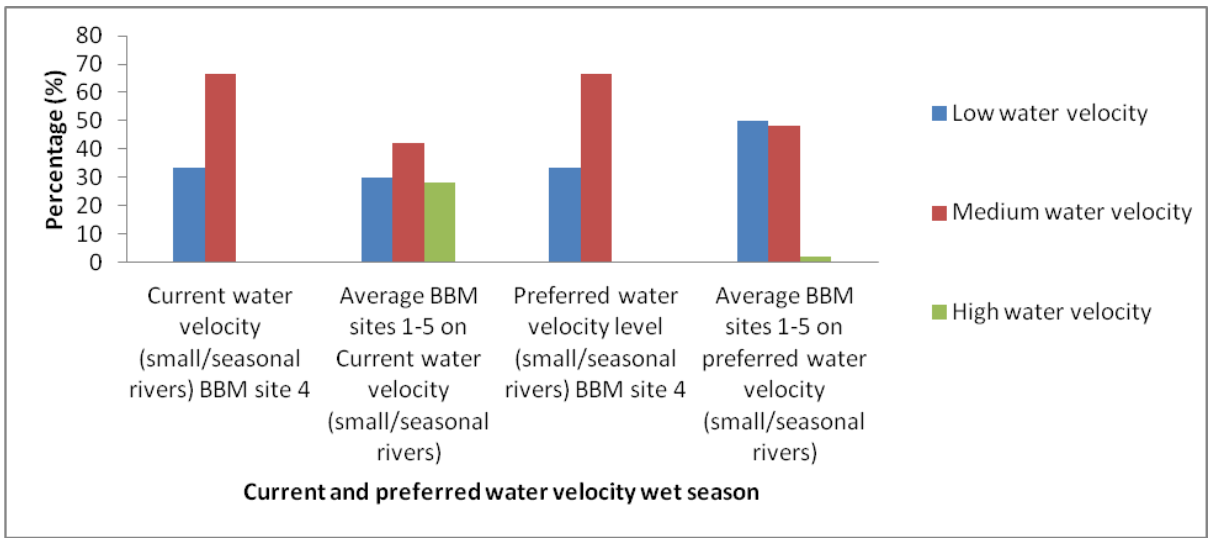

Figure 6.82 Current and preferred water velocity for small/seasonal rivers wet season

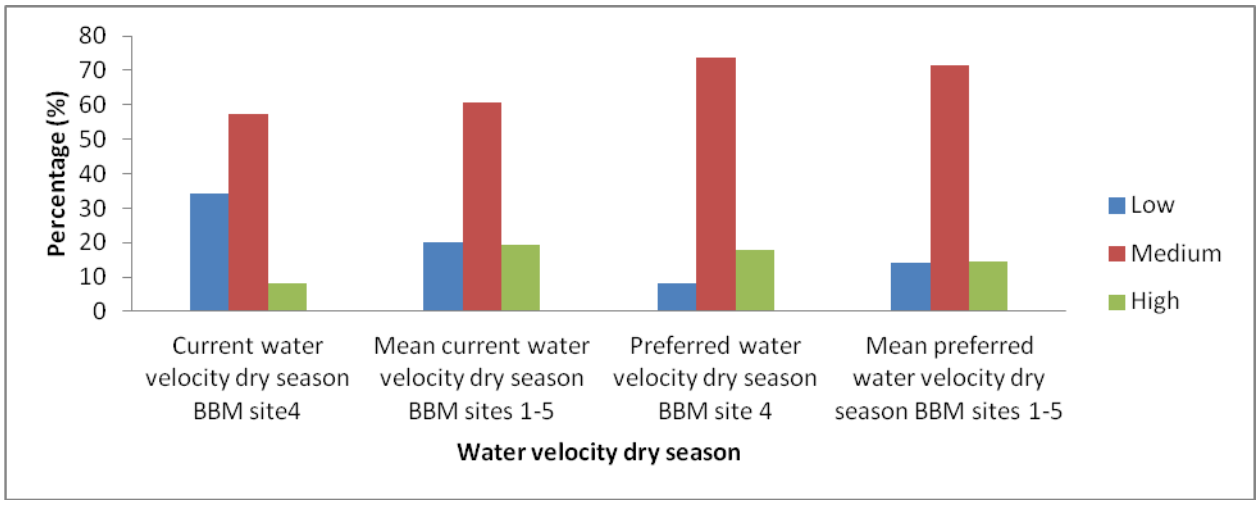

Figure 6.83 Current and preferred water velocity for main rivers during dry season

6.5.6 Determination of the preferences of the locals on selected environmental

The services are categorised into Production, Regulation and Information ecosystem services. Preference ranking (Table 6.25) show that, production ecosystem services were relatively more preferred followed by regulation and Information ecosystem services. This implies that the attache relatively high importance to production ecosystem services than other categories of ecosystem services. Out of eleven (11) productions ecosystem services tested, 4 services are most preferred by more than 50% of the respondents. Relatively, high preference is attached to moist and fertile soils for flood recession agriculture and water for domestic use as reported by 95% of the respondents.This implies that water for domestic uses is important to community's livelihoods and moist and fertile soils are key for flood recession agriculture which is the main economic activity. Moreover 59% and 57% of the respondents attach high preference to fish and fishing grounds and cultivated vegetables and fruits respectively. Out of four (4) regulation

ecosystem services tested only Malaria, bilharzias and UTI control are the most most preferred by majority (48%) of respondents. This suggests that, water related diseases such as Malaria, bilharzias and UTI are major problems in the area and control measures are of high much importance. Physical water quality control and flood mitigation are preferred by 53% and 44% of the respondents respectively whereas sedimentation and erosion control are less preferred by 39% of the respondents. Probably, this imply that the flooding which occur in this areas is beneficial to their agricultural practices. Generally, Information ecosystems services are relatively less and/or not preferred as reported by more than 50% of the respondents. This is justified by 62% of respondents who did not prefer recreation & tourism, and 61% of the respondents who did not prefer sites for cultural and ritual activities (Table 6.25). Accordingly, less preference were reported by 44% on Biodiversity conservation.

Table 6.25 Respondents preferences on ecological services in BBM site 4

Category	Ecosystem service	BBM site 4 Preferences in Percentages Not preferred	Less Preferred	Preferred	Most preferred	Preference ranking	Ranking according to E. category
Production	Fertile valley plains for grazing	39	26	16	18	11	8
	Moist and fertile soils for flood recession agriculture	0	0	5	95	1	1
	Water for domestic uses	2	0	3	95	2	2
	Fish and fishing grounds	12	8	21	59	4	4
	Aquatic animals such as hippopotamus, Crocodylus niloticuss and snails	53	34	10	3	15	10
	Cultivated vegetables and	5	8	30	57	3	3

	fruits						
	Natural vegetables and fruits	10	44	36	10	9	7
	Fuel woods, weaving mats and poles/timber	8	12	43	38	6	5
	Soils for brick making	20	28	36	16	7	6
	Water for navigation	53	31	15	2	14	9
	Flood mitigation	15	30	44	12	10	3
	Sedimentation and erosion control	26	39	25	10	12	4
Regulation	Physical water quality control	13	18	53	16	8	2
	Malaria, bilharzias and UTI control	0	23	30	48	5	1
	Biodiversity conservation	25	44	25	7	13	1
Information	Recreation and tourism	62	31	7	0	17	3
	Sites for cultural and ritual activities	61	25	7	8	16	2

Determination of the maintenance level on the selected Ecosystem services

Out of Nine (9) Ecosystems services tested, four (4) services were preferred to be increased as reported by more than 50% respondents. Table 6.4.5 shows that, increase in current services was a preference by majority (92%) in control of Malaria, bilharzias and UTI, followed by moist and fertile soils for flood recession agriculture (74%). This finding supports the preference attached to Malaria, bilharzias and UTI control, implying that, water related diseases are problem to this area and therefore efforts to control them is vital for the community's livelihoods. The same applies to moist and fertile soils for flood recession agriculture which is the main economic activity on which people depend. Other services preferred to be increased by relatively majority respondents are sedimentation and erosion control (57%) and physical water features such as ponds, natural springs and oxbow lakes (51%). Flood mitigation in inundation areas is most preferred by 41% of respondents. Moreover the study indicates that 54% of respondents prefer the maintenance of the current services offered by sites for cultural and ritual activities similarly to services offered by Game controlled areas. A relative majority of respondents (59%, and 53%) prefer decrease in the current services on Crocodylus niloticuss, hippopotamus, snails and fertile valley plains for grazing respectively. These imply that thses services are either not important to them, harmful or they facilitate negative effects to the communities livelihoods. For example, Crocodylus niloticuss and hippos are reported to be problematic animals to the people's property and their general livelihoods (Table 6.26).

Table 6.26 Respondents' preferences on ecological service maintenance levels in BBM site 4

Ecosystem service	BBM site 4 Preferences on maintenance level in percentages (%)		
	Maintain the current service	Decrease the current service	Increase the current service
Fertile valley plains for grazing	30	53	18
Moist and fertile soils for flood recession agriculture	26	0	74
Crocodylus niloticuss, hippopotamus, snails and their riverine habitats	33	59	8
Physical water features such as ponds, natural springs, oxbow lakes	43	7	51
Game controlled areas	54	30	16
Control of malaria, bilharzias and UTI	5	3	92
Flood mitigation in inundation areas	39	20	41
Sites for cultural and ritual activities	54	33	13
Sedimentation and erosion control	34	8	57

6.6 BBM site 5 - Ifakara Ferry

6.6.1 Introduction

Five sample villages were selected around BBM site 5 namely Katindiuka, Kikwawila, Kivukoni, Mavimba and Miwangani (Figure 6.84). This site are located in the Kilombero floodplain and is considered to be the secondary zone (not very close to irrigation scheme, but expected to be impacted by extracted water). Three main rivers were identified as important biophysical feature in the villages namely Kilombero, Idete and Idandu rivers. The history of these rivers shows that the water volume has decreased drastically over the past three decades. An adult persons' height was used to describe decreasing water levels in the rivers. Moreover, villagers associate observed frequent breakdown of canoes to decreasing water volume in the rivers. Villagers were also keen to show that some areas in their villages have more fertile soils such as Miwangani,

Ng'andaiponehe and Nambofu because they receive flood waters with fertile alluvial soils from the rivers. In addition to Kilombero river, seasonal rivers and ponds are also widely used for different purposes.

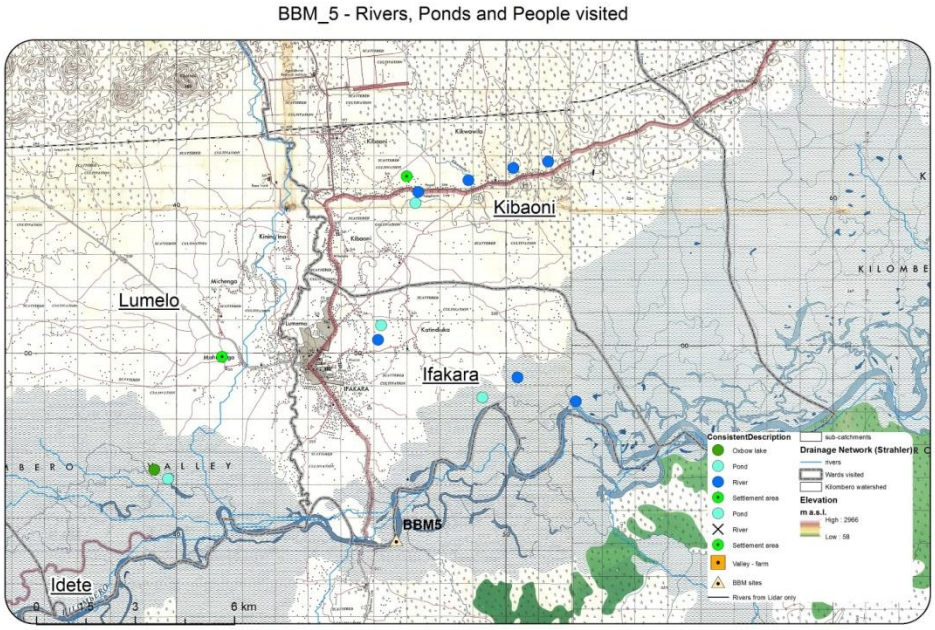

Figure 6.84 Villages visited at BBM 5 - Ifakara Ferry

Historic changes of biophysical features

Three main rivers were identified as important biophysical feature in the villages. These were Kilombero, Idete, and Idandu Rivers. Villagers revealed that some areas in their villages have more fertile soils in comparison to other areas, for example in Miwangani village Ng'andaiponehe and Nambofu areas were mentioned to have more fertile soils. The areas are close to Kilombero river and receive flood water from the river. The flood water make alluvial soil available therefore adds fertility in these particular areas.

In addition to presence of Kilombero river, some seasonal rivers and ponds were revealed in Mahutanga village. They included Manjecha river, Doko river and Magulupesa river. Ponds included Lukwandala pond, Kitandala pond, Ndogi pond, Kilala pond, Tangutangu pond, Namitasi pond, Mbunga pond, Rufuji pond, Nangogo pond, Ipumbi pond, Akilimali pond, Magulupesa pond, Njecha pond and Lukanga pond. In Miwangani village, Ndambali pond was found and fishermen had their camp in the area.

On the history of the rivers, it was reported that water level was very high during President Nyerere regime that can be estimated a period from 1960s to end of 1980s. During that time water tended to reach at Mahutanga Primary School during high tide. Great changes on decrease of water level started to be seen in during the President Mkapa's regime (starting from 1995 to 2005), and now (2014) water does not reach at the school area anymore. In addition, number of fishermen has greatly increased compared to president Nyerere's regime (1960s).

It was also reported that as for now during the rainy season (Masika), water stays in farm land for long, this happens because trapped water at Kihansi Hydroelectric Power station for power generation is released during the rainy season when Kilombero river has plenty of water and the additional water floods rice farms and stays for longer period than normal. This contributes to decreased in rice harvest and sometimes destroy the farmed crops.

6.6.2 Socio-economic characteristics

Households in BBM site 5 study villages are composed of 64% youth (18 to 44 years old) and 28% of middle aged group (45-60 years old), 8% are elders (above 60 years). Majority of the population have received primary eduation (84%). The major occupations are farming, fishing and livestockkeeping. Majority of the people are crop farmers (98.36%), followed by fishermen (39.62%) and livestock keepers (30.62%) (see Table 6.27). Other economic activities include weaving and brick making. As far as annual income is concerned most households (34%) have annual incomes between TZS 600,000 to TZS 1,999,000/- followed by 17% with annual income between TZS 2,000,000/- to TZS 4,000,000/-. Households with annual income ranging from TZS 200,000/- to 599,000/- account for 29% of households. Only 3% have annual income below TZS 50,000.

Table 6.27 Main economic activities in villages of BBM site 5

Percentage household engaged in economic activity	Katindiuka	Kikwawila	Kivukoni	Mavimba	Miwangani	Mean BBM site 5	Mean BBM Sites 1- 5
Crop farming	96.60	100.00	95.20	100.00	100.00	98.36	95.60
Livestock keeping	24.10	43.80	19.00	42.90	23.30	30.62	39.08
fishing	37.90	0.00	47.60	50.00	63.30	39.76	41.61
others	20.70	31.20	0.00	21.40	26.70	20.00	25.83

6.6.3 Determination on the extent of Environmental Flows (goods and services) uses and the expected losses

6.6.3.1 Water use

People depend mainly on bore holes and small streams for their cooking, drinking and washing. For example, in Kikwawila, water is also obtained from Isomba river.

Swimming takes place during the dry season (September – October) by women and men when the water level in the ponds and rivers have decreased. However, some

people use the small streams for swimming, eg in Kikwawila village Isomba River is used for swimming and other activities such as washing.
Navigation: People need to cross the Kilombero to eg access local markets, hospitals, schools. It was revealed that 22 % of households used rivers for navigation during wet season, 32 % during dry season and 46% during both seasons (wet and dry seasons). On the frequency of navigation it was revealed that 18% travelled daily, 11 % travelled once per week, 21 % travelled once per month but 51 % responded that navigation was not often. Water depth should be of sufficient water depth. In addition to navigation by canoes, people also take the large ferry across, so water depth should be sufficient to let it sail.

Water quality and use of farm inputs

Use of farm inputs that have potential impact on water quality was assessed in BBM site 5. On average, the study observed 55.56 % of households using herbicides in BBM site 5. The percentage was below average of 62.20 % for households using herbicide in BBM sites 1 to 5. In this site, large percentage (92 %) of households in Miwangani village applied herbicide than for other villages (48.28 % for katindiuka village, 37.5 % for Kikwawila village, 42.86 % Kivukoni village and 56.14 % for Mavimba village) (Figure 6.85).

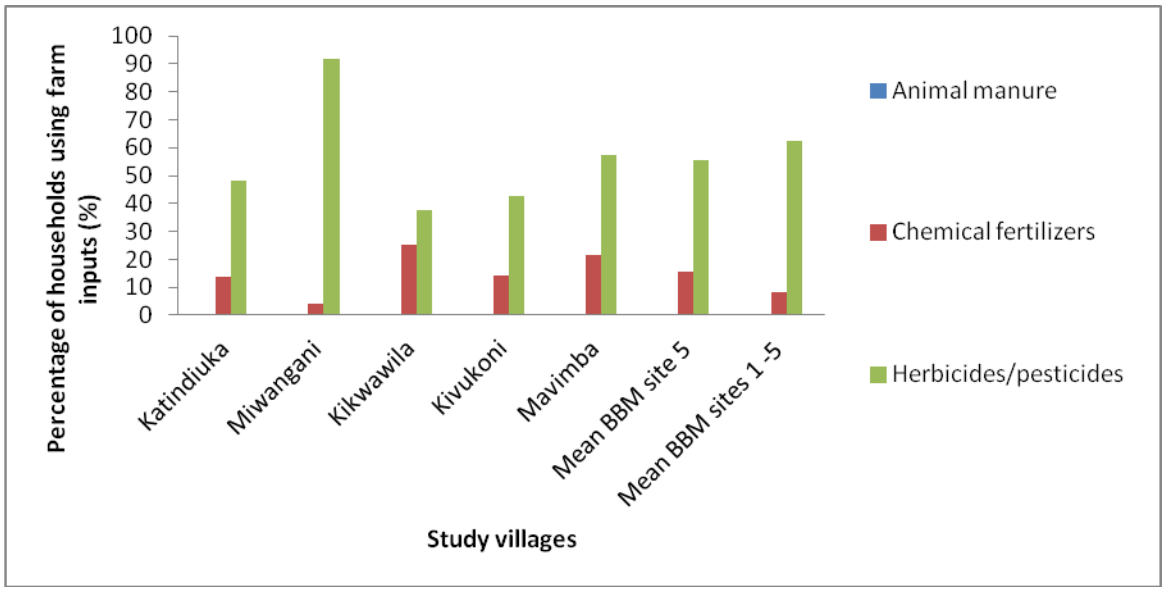

Figure 6.85: Percentage households using farm inputs and types of farm inputs used

It was observed that 293.13 Kg/household/acre of chemical fertilizers was used in Miwangani village. The amount was highest and above average of 95.62

Kg/household/acre for BBM site 5 and 89.39 Kg/household/acre for BBM sites 1 to 5. In Katindiuka 115.16 Kg/household/acre was applied, while in Kikwawila and Mavimba, 41.88 Kg/household/acre and 27.92 Kg/household/acre were applied respectively. However, the study did neither observe application of chemical fertilizers in Kivukoni village, nor application of animal manure in villages of BBM site 5 (Figure 5.22). Herbicides application in BBM site 5 was on average 2.49 Litres/household/acre which was below average of 4.08 Litres/household/acre for BBM site 1 to 5. The curve in Figure 5.22 shows that there was more herbicide application in Mavimba (3.36 Litres/household/acre) than in Kikwawila (2.82 Litres/household/acre), Kivukoni (2.77 Litres/household/acre), Miwangani (1.60 Litres/household/acre) and Katindiuka (1.88 Litres/household/acre), but was still lower than the average for BBM sites 1 to 5 (Figure 6.86).

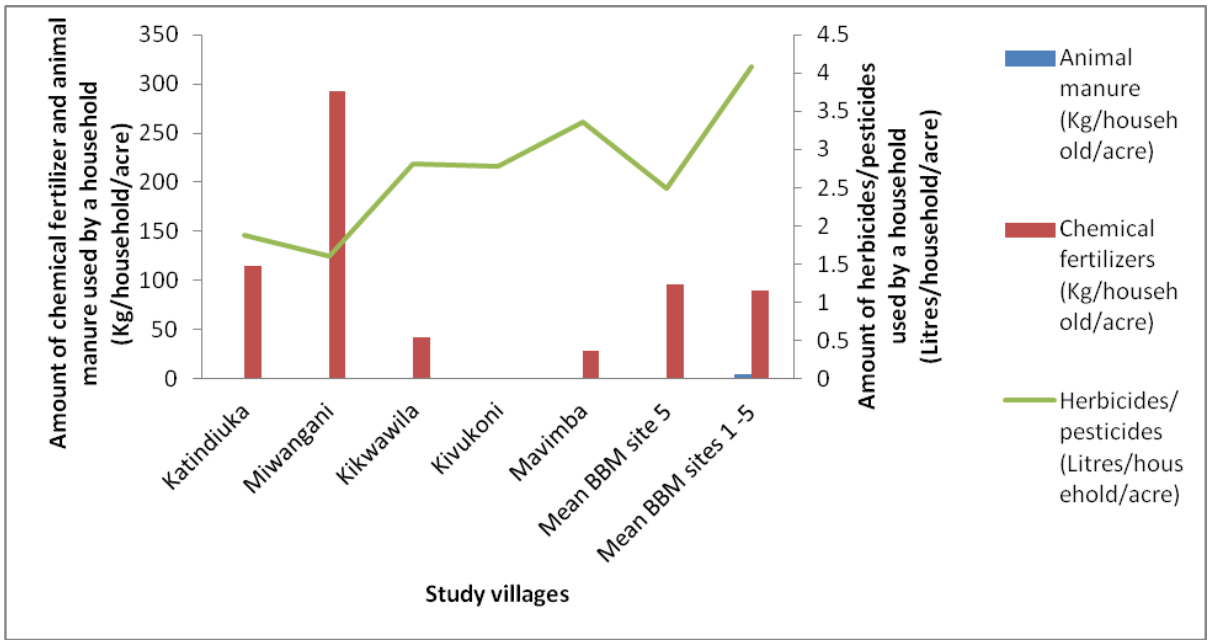

Figure 6.86: Amount of chemical fertilizer, animal manure, herbicides and pesticides used by a household per acre

Water associated problems

Diseases related to water can also be found in the area. Households mention the problems with malaria, Typhoid, Fungus, Bilharzia, Amoeba, UTI, Dysentery and Cholera. People indicate that the Malaria is the most problematic, followed by flooding as it damages houses, roads and leads to extreme inundation of farm land.

Pair-wise ranking was done in the villages to rank the problems mentioned by the population (see Table 6.28). Flooding was reported to be the most important problem and among the diseases it is malaria.

Table 6.28 Ranking of water associated problems in villages of BBM site 5

S/No.	Diseases	Villages				Mean Rank	Overal Rank
		Ma-hutanga	Katindi-uka	Miwan-gani	Kikwaw ila		
		Rank	Rank	Rank	Rank		
1	Malaria	1	1	1	1	1	1
2	Bilharzias (Schistosomia-sis)	2	4	3	2	2.75	3
3	Diarrhoea	3	2	6	5	4	5
4	Urinary Track Infection (UTI)	2	3	3	3	2.75	3
5	Fungus	3	2	2	2	2.25	2
6	Typhoid	3	3	4	4	3.5	4
7	Amoeba	3	5	7	6	5.25	6

Flooding: During the group discussion an attempt was made to elicit the extent of inundation and its effect to the communities' livelihoods. Because of time shortage, this was only done for the most dependent river: Mngeta River at Lukolongo village. The extent of inundation was noted to vary from low, normal and high rainfall levels at Lukolongo village. During the high rainfall levels the overflow of the river Mngeta causes to extend the inundation to valleys areas. However, during the low rainfall levels, it was reported that the overflow of the Mngeta River was reported to be at less distance compared to years with normal and relatively high rainfall.

According to the local population the water volume has decreases drastically over the past three decades. For example, High flow of water was reported to Mpanga and Kihansi Rivers in the past 3 decades compared to medium water flow during the late of 1990s to early of 2000s. Relatively, lower volume is now experienced to most of the rivers and ponds. Accordingly, significant reductions in water flow were reported in Rivers such as Mngeta and Mchombe. Likewise to Ponds such Uliyangumui, Mhumbu, and Nganewa found at Merera village and Lusoma Lumuangoloke Pond at Lukolongo village. However, different from other rivers, river Mbelele in merera have changed from an un-seasonal to a seasonal river. This could be due to decreases in river bank as a result of siltation derived from anthropogenic activities to the associated network of connected ponds of Nganewa and Ulyangumu pond.

6.6.3.2. Crop cultivation

Crop cultivation is the most important economic activity for all villages in BBM site 5 villages and between 93% and 100% of the households are engaged in farming. Farming is for both subsistence and commercial purposes and is practiced in flood plain (inundated) of Kilombero valley. The most common crops grown include rice, maize, cocoa, banana and vegetables. Rice is most preferred. In this part of the subbasin 95% of the households are involved in rice farming which is above average of all BBM sites (93%). 45% of households are involved in maize farming. On average, household in this BBM site 5 obtain more revenue from rice cultivation than other crops. Vegetables and fruits are also cultivated in this part of the basin between May and August due to moist soils in the valleys.

The average farm size for rice is 2.8 acres and for maize it is 0.86 acres (Figure 6.87). These are smaller areas than in the villages of the other BBM sites. This can possibly be attributed to less land available as more land is used for settlements as the villages are close to Ifakara town. On average a household harvests 420.71 kg/acre of rice per year out of which 44% is consumed by the household. For maize this is about 140.70 kg/acre of maize harvested per year out of which 79% is consumed by the household. Rice brings however most revenues compared to other crops. So the crop cultivation is both for food and cash.

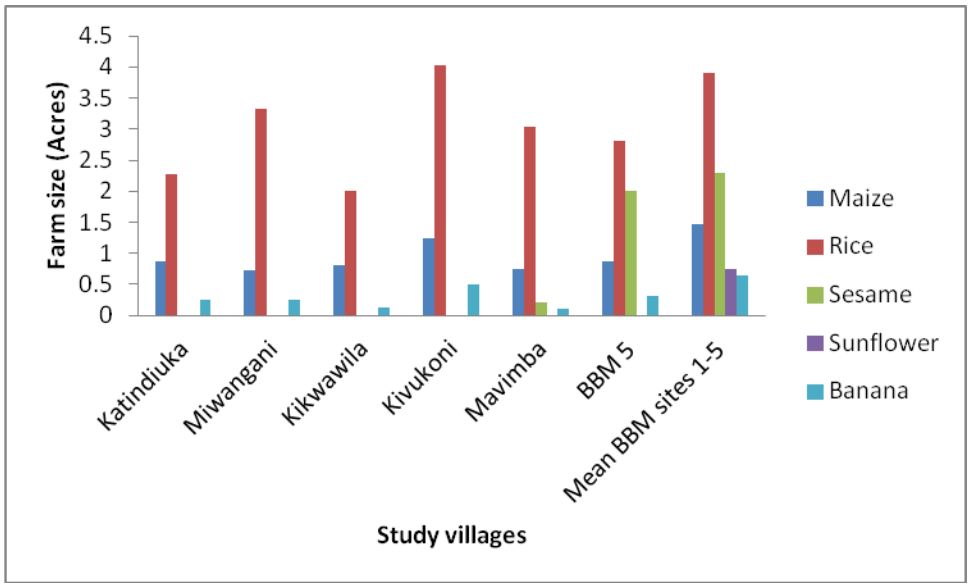

Figure 6.87 Farm sizes BBM site 5 versus the average for BBM sites 1-5

6.6.3.3 Livestock keeping

Households are engaged in Livestock keeping in BBM 5 villages. On average 19% of househouse holds keep cattle in this part of the subbasin and the percentage of livestock kept is above average (17%) of BBM site 1-5. There are however big variations between one village and the other. In Mavimba for example, 71% of the households keep cattle, with the majority keeping chicken (Figure 6.88). Livestock keepers belong to Wasukuma tribe, mainly keeping cows. Livestock kept in the villages included cows, goats, sheep,

pigs, chickens and ducks. On average, each household in BBM 5 keeps 13 cattlle only second to BBM 4 site.

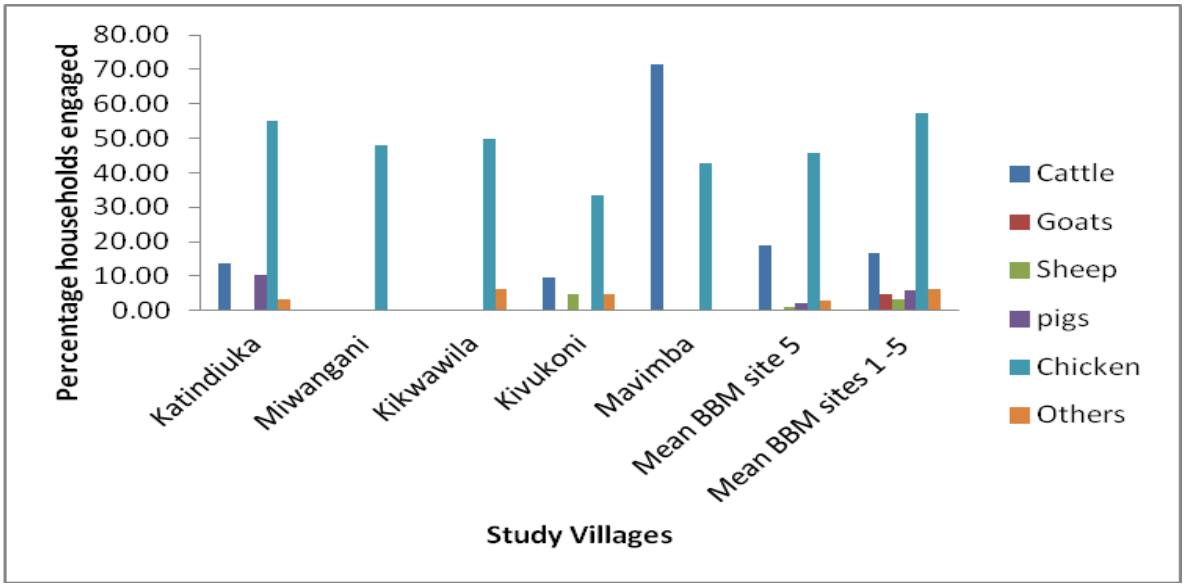

Figure 6.88 Percentage households engaged in livestock keeping and type of livectock kept

Livestock grazing is done in the floodplains along Kilombero River during dry season and in mountain areas during rainy season. There is little revenue from livestock keeping for a household, except in the villages of Kivukoni and Mavimba. Cattle and sheep provide each more than 1 million TZS per year for a household.

Fishing

Fishing is considered the second most important economic activity in BBM site 5 villages. Between 10%-35% of households are enaged in fishing. Kilombero River is the main fishing ground, however ponds and smaller streams in the villages are also used for fishing. Most households (65%) consuming small fish (dagaa) and 59% of households consume large bought from fishermen or middlemen (Figure 6.89 and 6.90). Fish consumption is high in the villages and on average a household consumes 95 large fish per year and 79 cups (250 ml) of small fish per year (Figure 6.91). Many different fish species are found in this part including Kambale, Perege, Kitoga, Ngogo, Bula, Njege, Ndungu, Mbala, Mgundu, sulusulu, Ngulufi and ndipi. Kambale is the most preferred fish followed by Perege, whereby Kitoga is the most preferred commercially. The income from large fish contributes about 49% of the total annual household income of the fishermen and small fish contribute about 33%. On average a household in BBM site 5 obtains approximately 5.6 million TZS per year from fishing large fish and approximately 3.8 million TZS per year from small fish. This is well above the revenues from the villages around the other BBM sites.

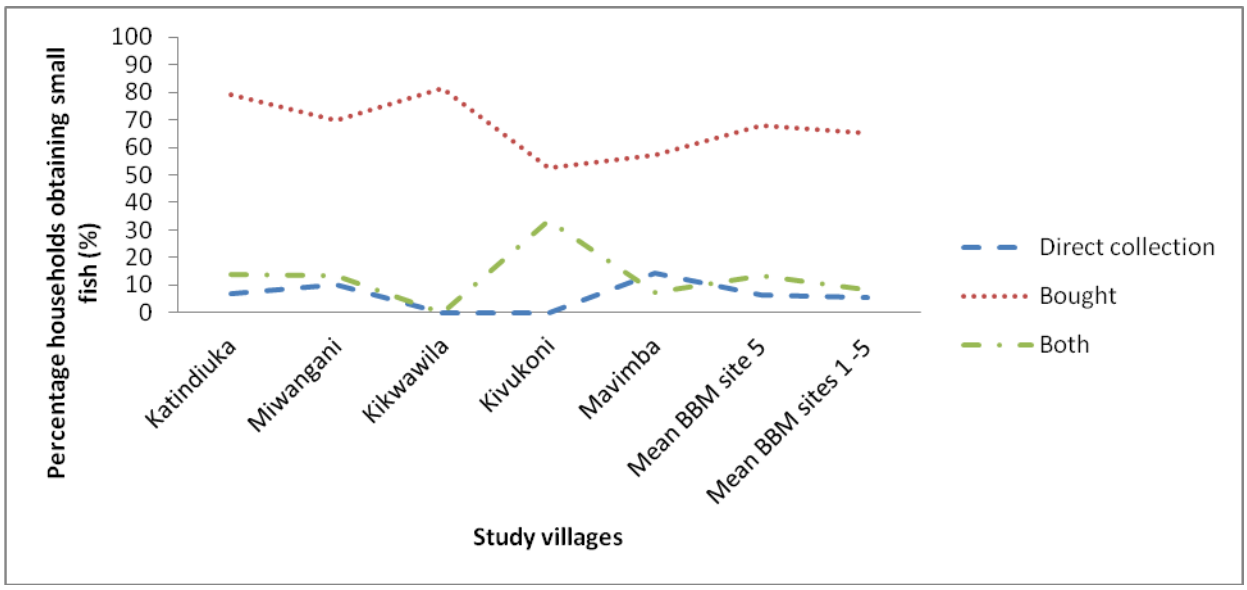

Figure 6.89 Means of obtaining small fish for household consumption in BBM site 5

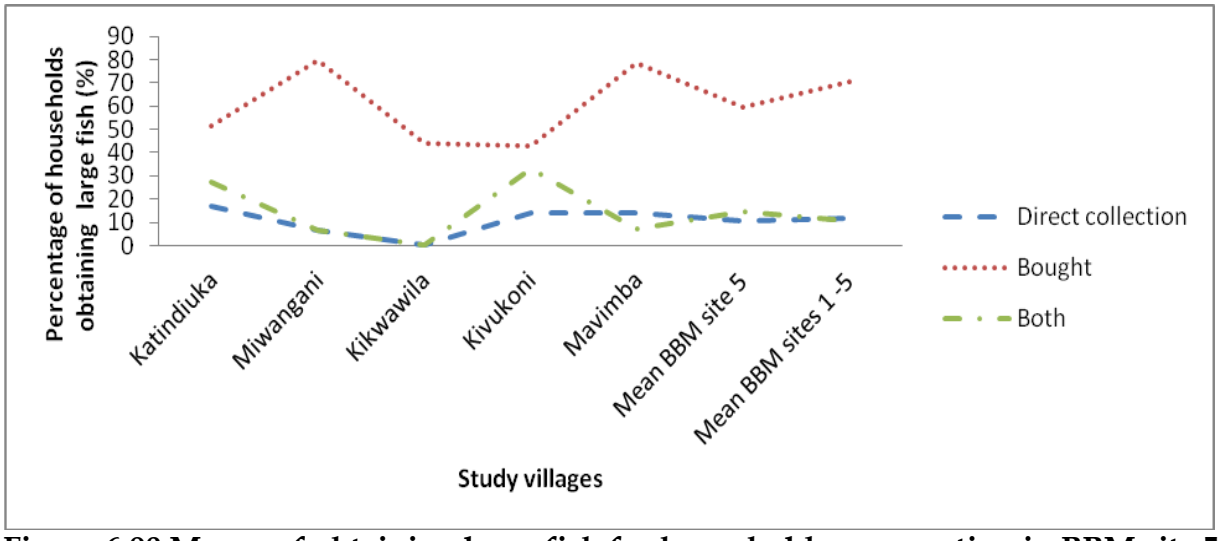

Figure 6.90 Means of obtaining large fish for household consumption in BBM site 5

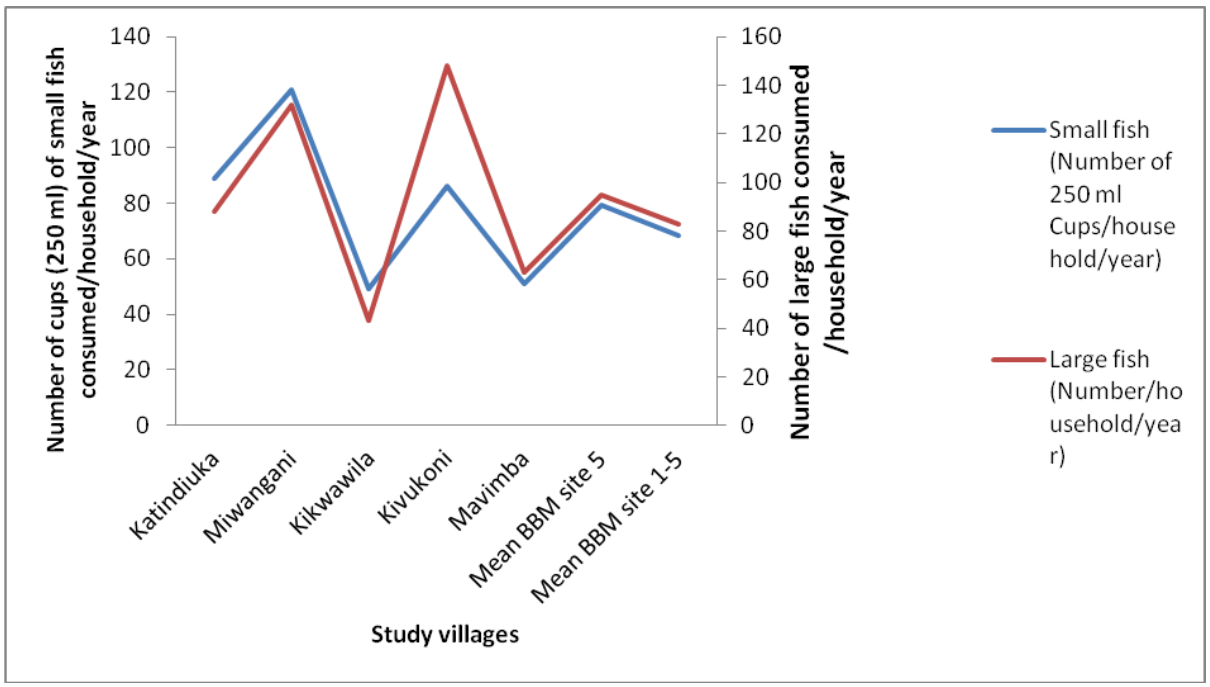

Figure 6.91 Amount of small fish and large fish consumed by a household per year in BBM site 5

6.6.3.4 Animals, birds and insects

Besides fish, other aquatic animals such as Hippopotamus amphibius, Crocodylus niloticus, Lutra lutra, "kindasi", "python" and "lizard" exist in the rivers. Some of these are also consumed by locals

6.6.3.5 Natural and cultivated vegetables and fruits

On average 87% of households on natural and cultivated vegetables (95% depending on both leaf and fruit form vegetables, 93% depending on leaf form vegetable and 69% depending on fruit form vegetables) (Figure 6.92). Different types of natural vegetables and fruits are consumed by the local population (see annex 5). Approximately 87% of the households depend on natural vegetables and fruits mainly collected by themselves (81%) (Figure 6.93 and 6.94).

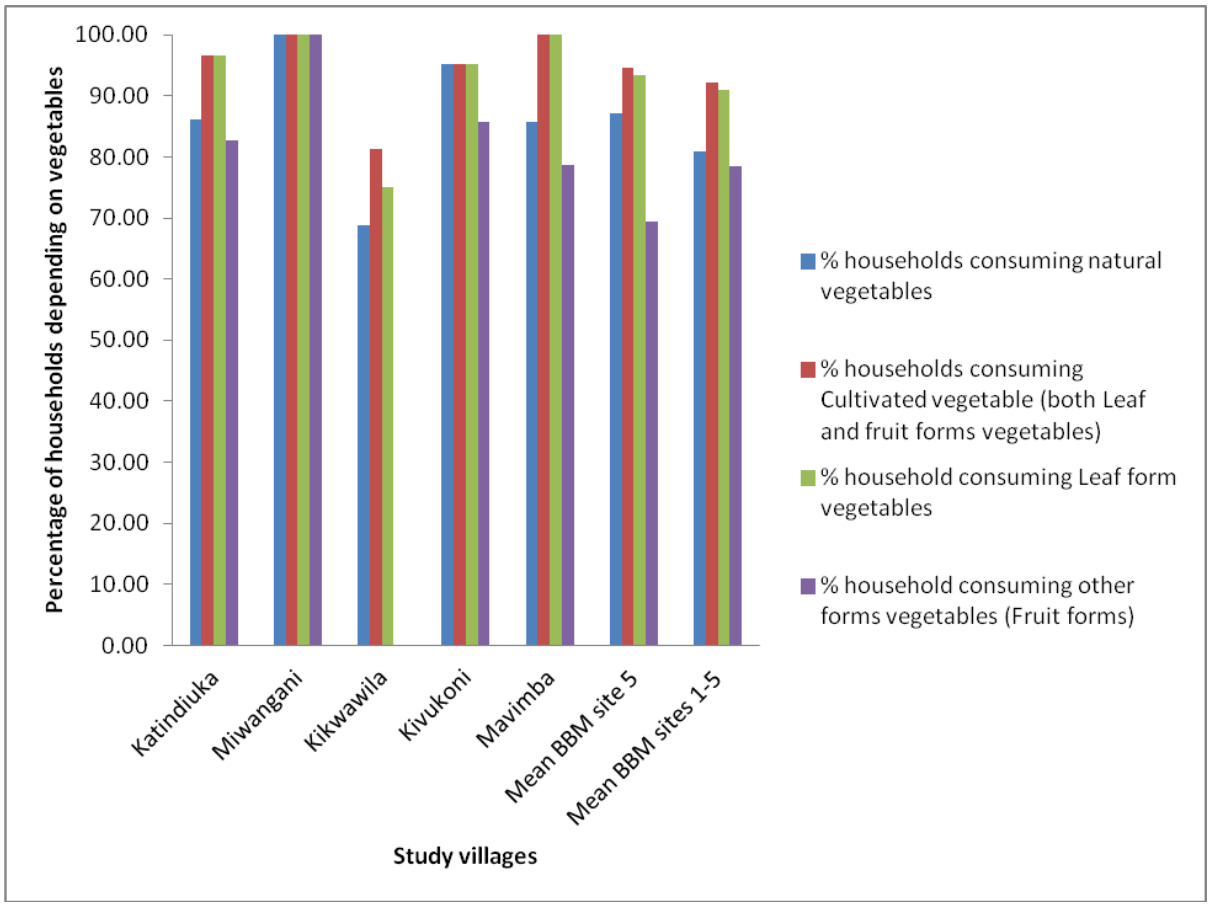

Figure 6.92 Households depending on natural and cultivated vegetables in BBM site 5

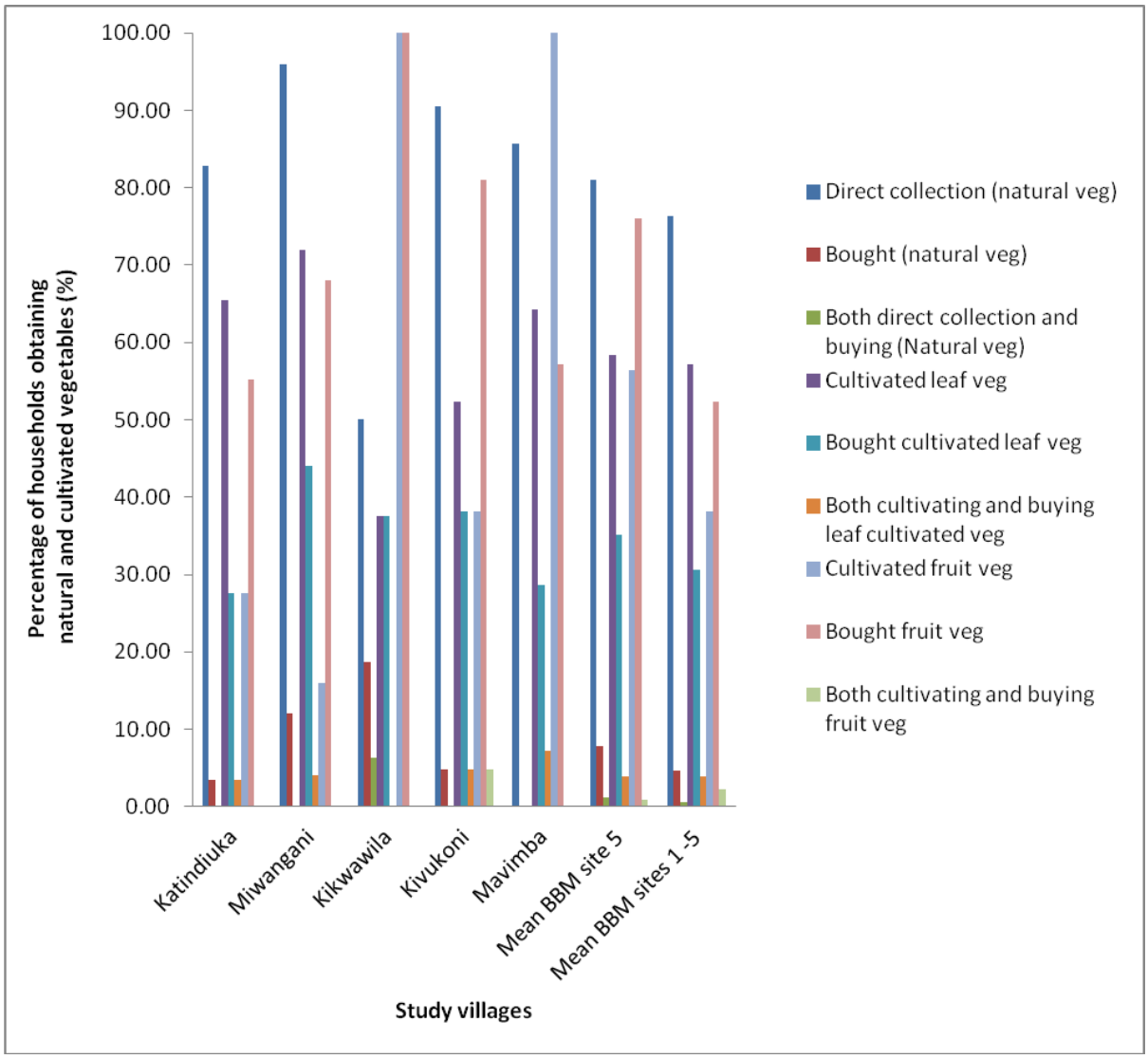

Figure 6.93 Household means of obtaining natural and cultivated vegetables in BBM site 5

Figure 6.94 Women collecting Mwidu in Miwangani village (photo Beatus Temu)

Aeschynomene uniflora and *Sesbania sesban* are common vegetables found in all villages of BBM 5 villages. *Sesbania sesban* are the most preferred natural vegetable followed by "Li-

dadangala" and "Lichulu". *Sesbania sesban* and *Aeschynomene uniflora* are obtained throughout the year in ponds where *Sesbania sesban* (Figure 6.95) is mostly found in areas with water while *Aeschynomene uniflora* is mostly found in muddy areas or moist soils. The natural vegetables are mainly for own consumption. Some households sell the natural vegetables, especially the mushroom at the local market (see Figure 6.97 and Annex 4). They are found at different places, by mainly in the valleys and in the maize lands during the rainy season and in the forest and around the ponds during the dry season. Most vegetables can be found during the rainy season.

Figure 6.95 Sesbania sesban, most preferred natural vegetable found in ponds in villages of BBM site 5 (photo Beatus Temu)

On average a household consume between 2.9 to 4 bunches of natural vegetables per day (Figure 6.96). Natural vegetables and fruits are not really collected for business but rather for household food. Household in BBM 5 also deped on cultivated vegetables leaf vegetables (58%) and fruit vegetables (56%). Culivation of fruit vegetable vary from one village to the other. Households also get vegetables through buying (Figure 6.77).

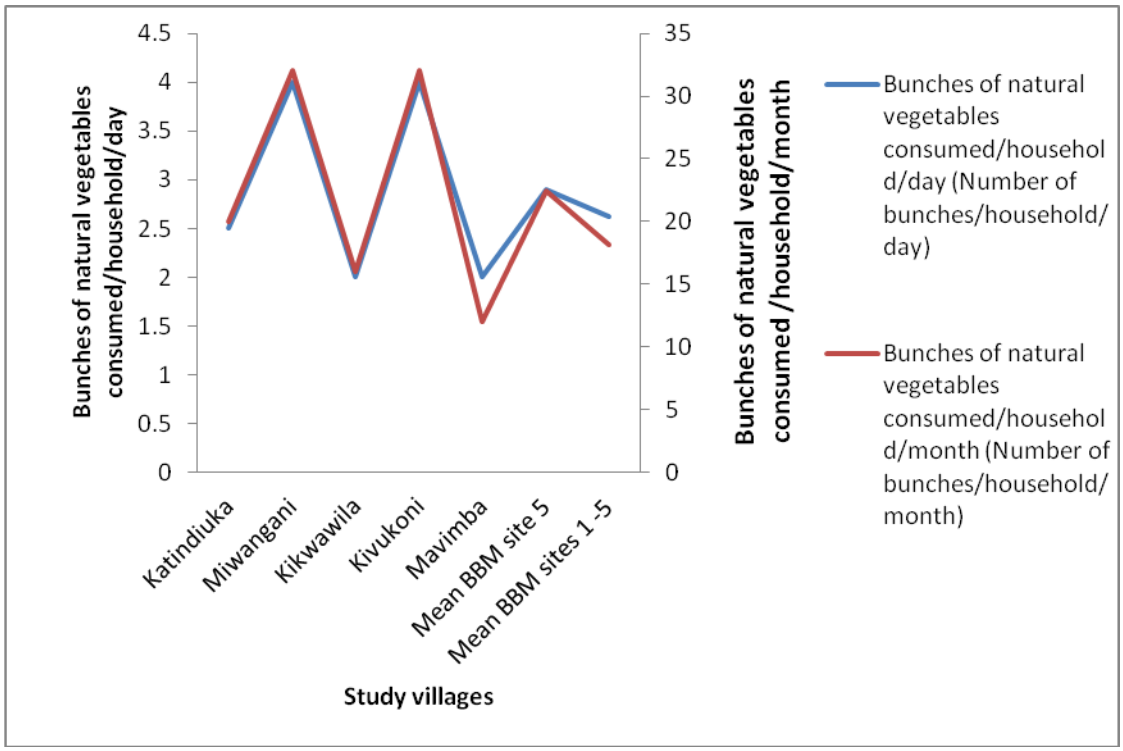

Figure 6.96Amount of natural vegetables consumed by a household in BBM site 5

Figure 6.97 Selling of mushroom in local markets (photo Beatus Temu)

Natural fruits commonly found in the villages are Mizambarau pori, Mafulu and Ukwaju. Valleys and forests are important places for growing of the natural fruits. Mafulu are most preferred fruits followed by Zambarau pori and Embe ng'ong'o. The details of location and seasonal availability can be found in Annex 5.

Weaving materials

Resources used for weaving materials include wild-date palm leaves or Ukindu (*Phoenix reclinata*) and Malala (*Hyphaene petersiana)*. About 76% of the households use Ukindu against 32% that use *Hyphaene petersiana* (Figure 6.98). Households obtain the materials through direct collection in the valleys and through buying. Many house holds (50%) get hold of Ukindu through buying (Figure 6.99). *Phoenix reclinata* and *Hyphaene petersiana* are used for making mats and carpets which when sold provide some revenue to

households. On average a household gets TZS 35,666.67 per household per year from selling mats and TZS 21,000/- per household per year from selling carpets. Nevetherless most of the mats and carpets are for household use.

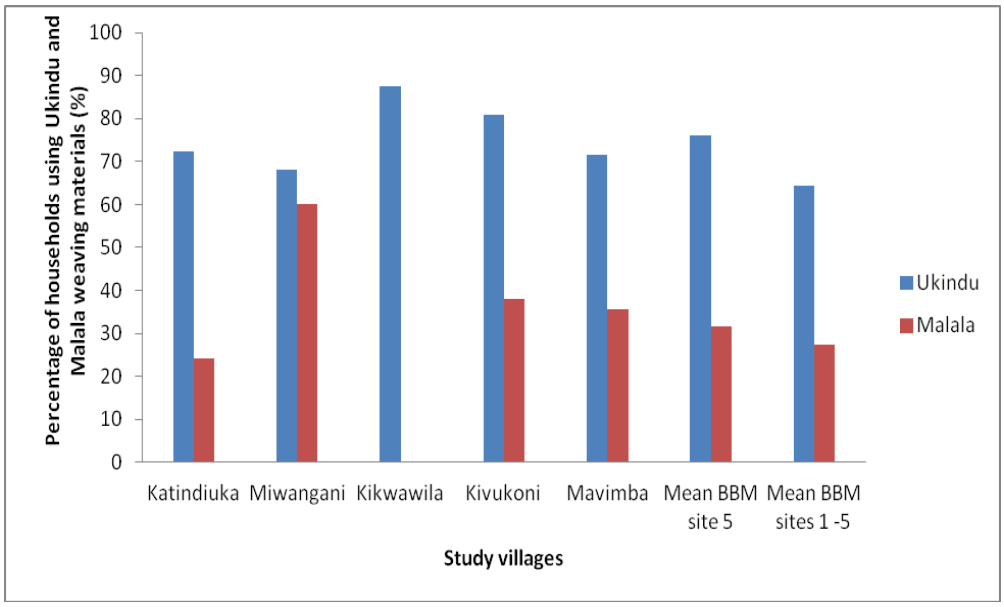

Figure 6.98 Percentage of households using weaving materials in BBM site 5

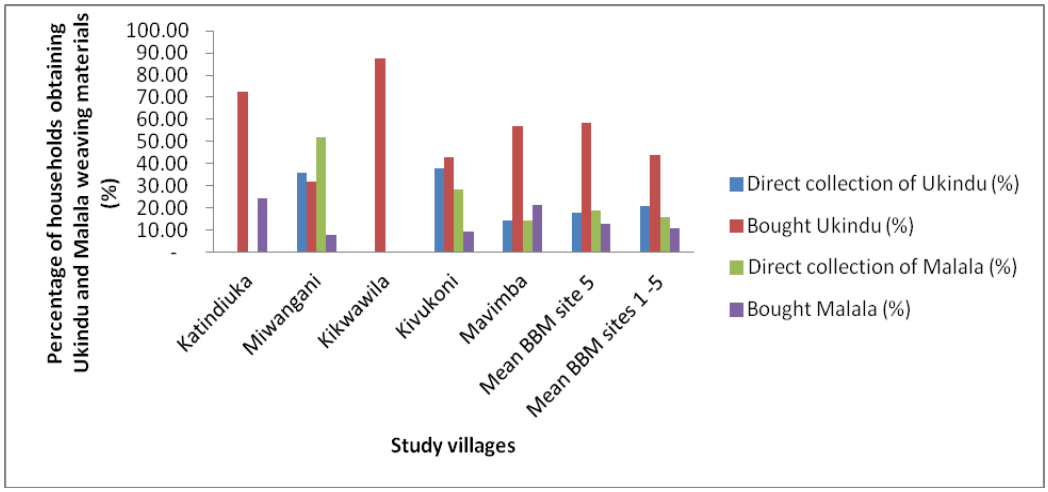

Figure 6.99 Means of obtaining weaving materials BBM site 5

Construction materials

Matete and bamboo were used as a thatch and poles for construction of houses respectively. Households may also use Milenga Maji for construction. Some of these trees such as Milemba Maji, Mishasha are normally not destroyed with belief that it conserves water and therefore environment.

Fuel

Mishasha may also be used by the villagers for firewood.

6.5.4 Contribution of income generating activities to annual household income in BBM site 5

In BBM site 5 villages households obtain 80% of their incomes from fishing than any other income generating activities. Large fish contribute 71% to annual household income while small fish contributed 9% of household income. Crop farming contribute 14 % of annual household income, out of which 13% is derived from rice farming . Livestock keeping, weaving and vegetable cultivation contribute 4%, 0.2% and 0.2% respectively. It can be argued that households can lose 71 % of its annual in case large fish disappear and 9% of its annual income in case small fish (dagaa) disappear. Moreover, in case water to support vegetables cultivation becomes insufficient to allow vegetables cultivation, a household in BBM site 5 are likely to lose 0.2% of its annual household income.

6.5.5 Water depth and velocity during wet and dry seasons

Water levels and inundation levels during wet and dry seasons

Water depth in inundated areas with water from main rivers during wet season in BBM site 5 was revealed to be above breast level by 47% of households in BBM site 5. An average of 43% of households for BBM site 1 to 5 had similar response. However, 44% of households in BBM site 5 prefer that water in inundated areas be at knee level (Figure 6.100). Water depth in inundated areas with water from small/seasonal rivers during wet season in BBM site 5 was revealed to be at waist level by 64% of households. An average of 42% of households for BBM site 1 to 5 had similar response. However, 64% of prefer that water in inundated areas be at knee level (Figure 6.101). Water depth during dry season in main rivers in BBM site 5 was revealed to be above breast level by 47% of households. An aerage of 44% of households with had response for BBM site 1 to 5. However 29% of households prefer water level in rivers during dry season to be remain above breast level (Figure 6.102). Inundation level in distance from main rivers for water coming from the main rivers during wet season in BBM site 5. 35% of households in BBM site 5 show that inundation level was above 15 km from main rivers. An average of 27% of households for BBM site 1 to 5 had similar response. However, 19% of households in BBM site 5 preferred that inundation level be between 1 to 3 km from main rivers, and another 19% preferred that inundation level be between 0 to 1 km from main rivers (Figure 6.103). Inundation level in distance from small/seasonal rivers for water coming from the small/seasonal rivers during wet season in BBM site 5. 55 % of households in BBM site 5 show that inundation level is between 1 to 3 km from small/seasonal rivers. An average of 29% of households for BBM site 1 to 5 had similar response. However, 55% of households in BBM site 5 prefer that inundation level be between 0 to 1 km from small/seasonal rivers (Figure 6.104).

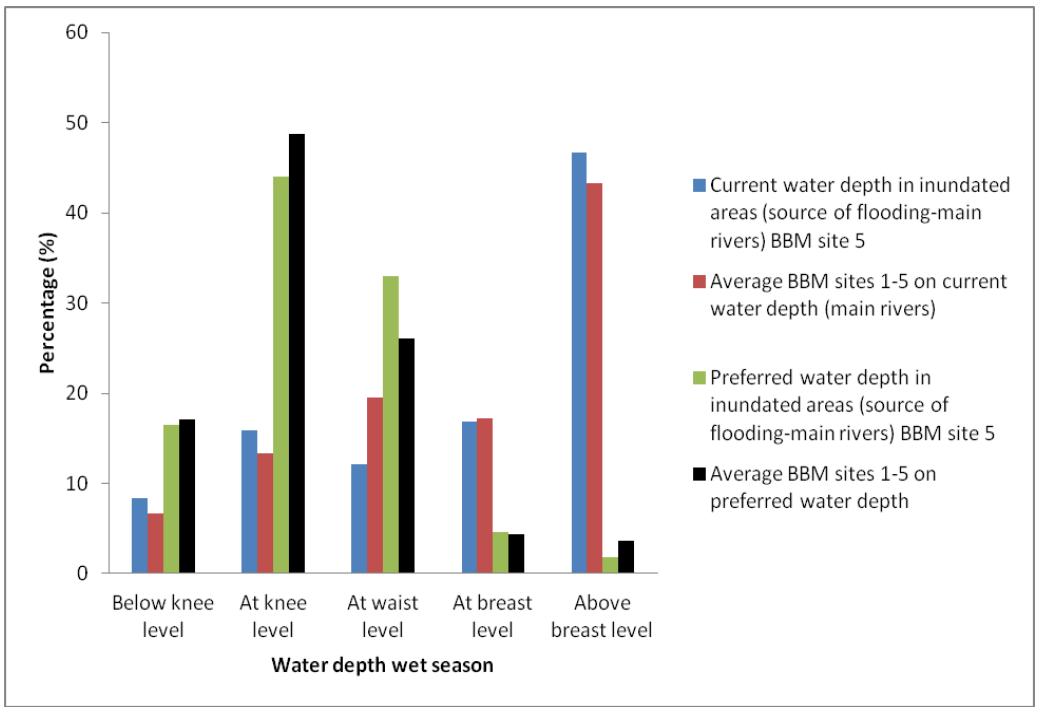

Figure 6.100 Water depth in inundated area for water from main river during wet season

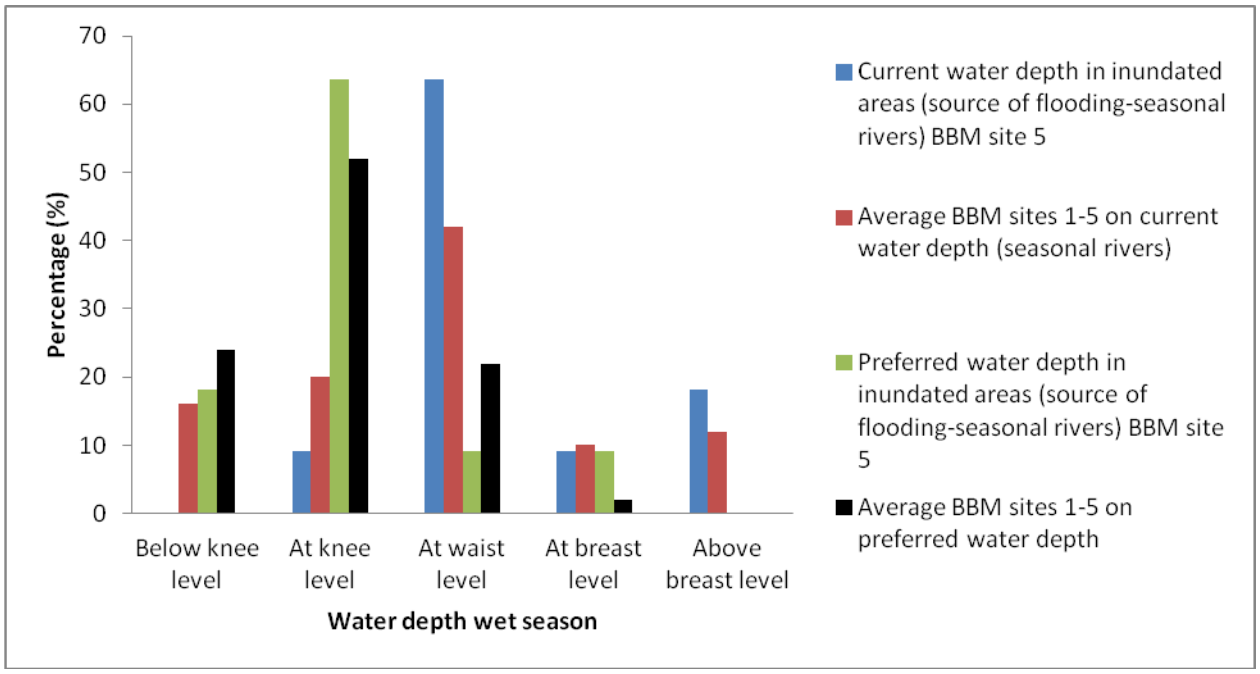

Figure 6.101 Water depth in inundated area for water from seasonal river during wet season

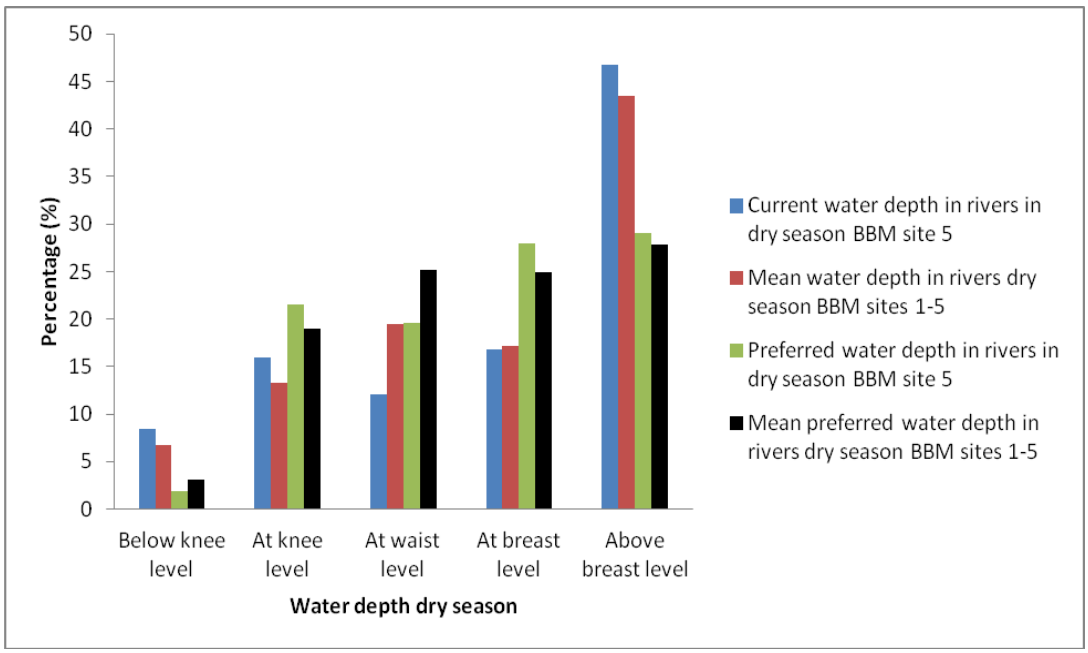

Figure 6.102 Water depth in main rivers during dry season

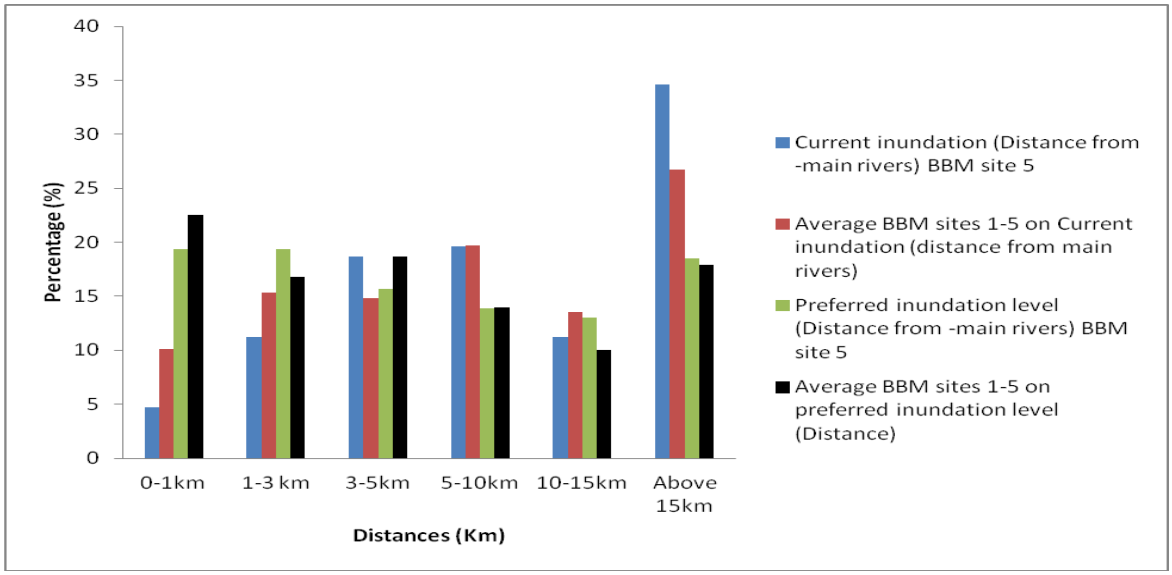

Figure 6.103 Inundation level distances from main rivers

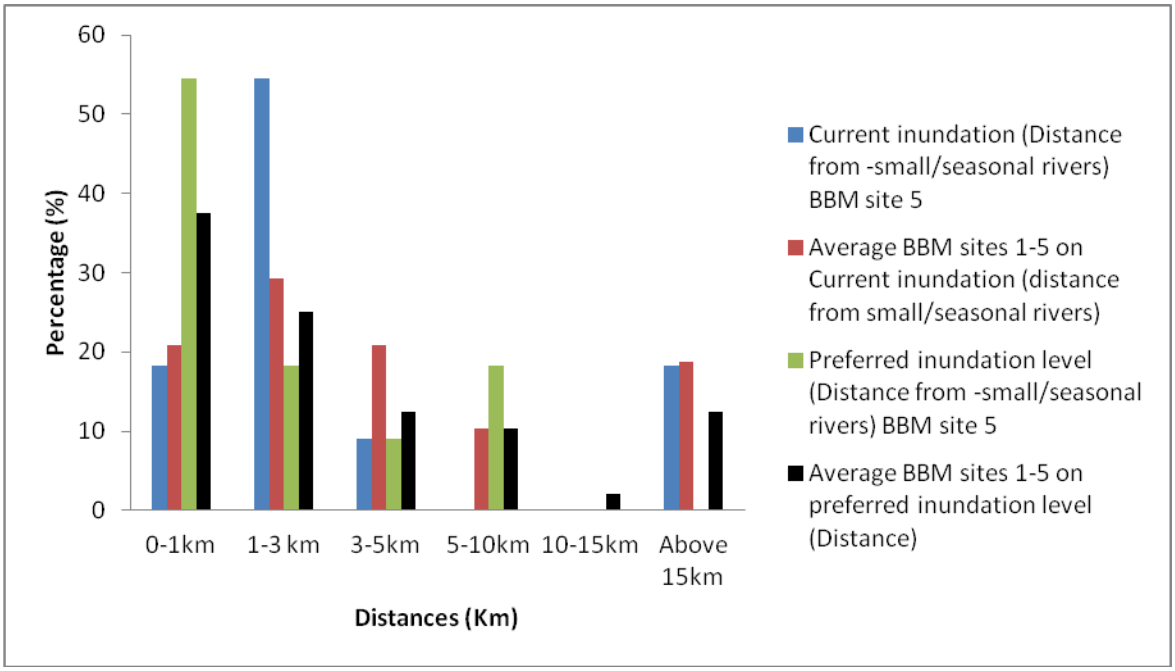

Figure 6.104 Inundation level in distances from small/seasonal rivers

Water velocity during wet and dry seasons

Water velocity for main rivers during wet season was revealed to be high in BBM site 5 by 62% of households. An average of 49% of households for BBM site 1 to 5 had similar response. However, 53% of households in BBM site 5 prefer medium water velocity, 42% preferred low water velocity and 5% preferred high water velocity (Figure 6.105). Water velocity for small/seasonal rivers during wet season was revealed to be high in BBM site by 5. 55% of households. An average of 28% of households for BBM site 1 to 5 had similar response. However, 55% of households in BBM site 5 preferred medium water velocity, 36% preferred low water velocity and 9% preferred high water velocity (Figure 6.106). Water velocity for main rivers during dry season was revealed to be medium in BBM site 5. by 61% of households. An average of 61% of households for BBM site 1 to 5 had similar response. However, 69% of households in BBM site 5 preferred medium water velocity, 18% preferred high water velocity and 13% preferred low water velocity (Figure 6.107).

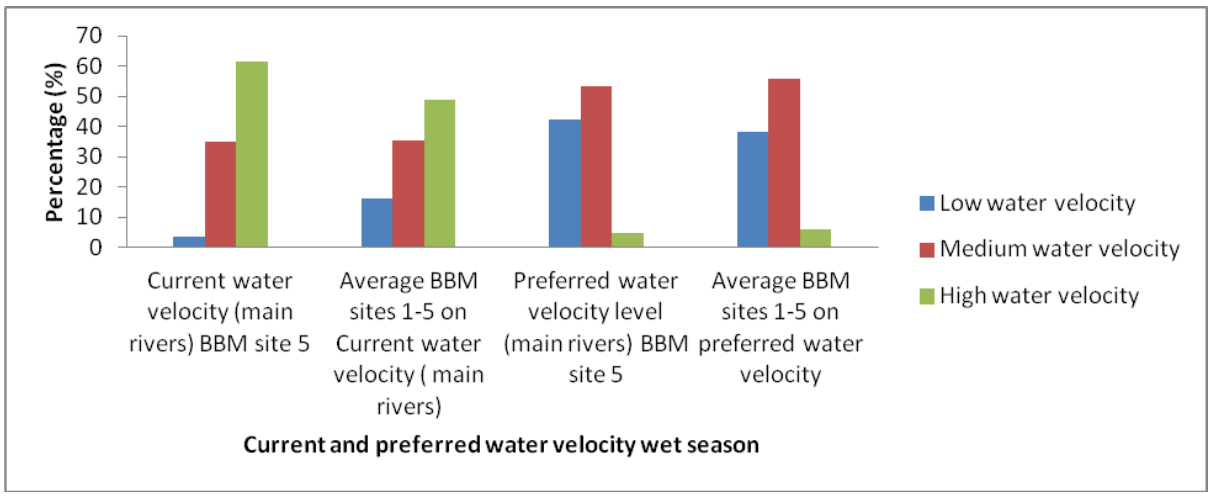

Figure 6.105 Current and preferred water velocity for main rivers during wet season

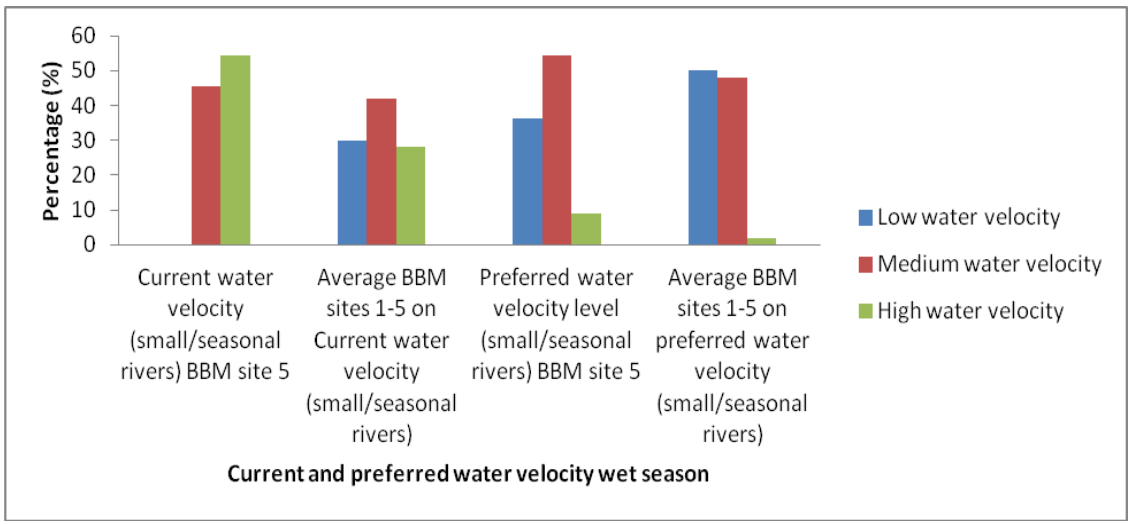

Figure 6.106 Current and preferred water velocity for small/seasonal rivers during wet season

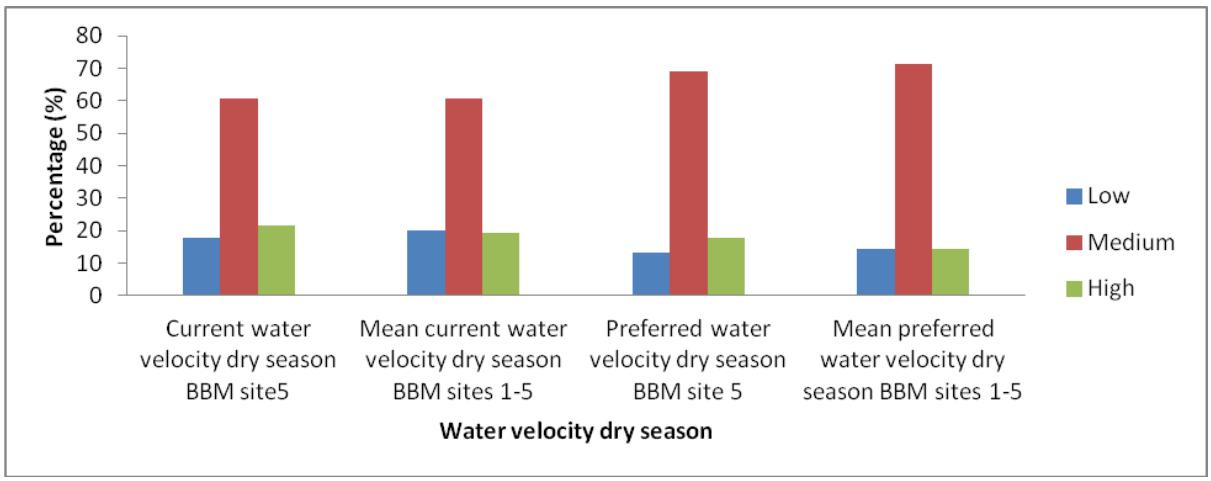

Figure 6.107 Current and preferred water velocity for main rivers during dry season

6.6.6 Determination of the preferences of the locals on selected environmental flows

The services are categorised into Production, Regulation and Information ecosystem services. Generally, preference ranking (Table 6.29) shows that, production ecosystem services were more preferred, followed by regulation and Information ecosystem services. This implies that communities relatively high importance to production ecosystem services than other categories of ecosystem services. Out of the eleven (11) productions ecosystem services tested, 4 services were most preferred by more than 50% of the respondents. High preference was attached to moist and fertile soils for flood recession agriculture as reported by all (100%) of the respondents. This implies that moist and fertile soils for flood recession agriculture is the most more important economic activities for their livelihood. Equally 79%, 65% and 58% of the respondents attach relatively most preference to Water for domestic uses, cultivated vegetables & fruits and fish & fishing grounds respectively. Natural vegetables and fruits were are preferred by 65% of the respondents Out of four (4) regulation ecosystem services tested only Malaria, bilharzias and UTI control are most preferred by a majority of 65% respondents. This suggests that, water related diseases such as Malaria, bilharzias and UTI are major problems to the area and therefore control measures are of high importance. Accordingly, physical water quality control was preferred by just 46% of the respondents. Sedimentation and erosion control and flood mitigation was less preferred by 42% and 38% respondents respectively. Information ecosystems services are relatively less and/or not preferred as reported by more than 50% of the respondents. This is justified by 62% of respondents who did not prefer recreation & tourism, and 49% of the respondents who did not prefer sites for cultural and ritual activities. Accordingly, less preference was reported by 62% on biodiversity conservation.

Table 6.29 Respondents preferences on ecological services in BBM site 5

Category	Ecosystem service	Mean BBM site 5 (%) Preferences in Percentages				Preference ranking	Ranking according to E. category
		Not preferred	Less Preferred	Preferred	Most preferred		
Production	Fertile valley plains for grazing	54.1	24.8	15.6	5.5	15	9
	Moist and fertile soils for flood recession agriculture	0	0	0	100	1	1
	Water for domestic uses	11.9	5.5	3.7	78.9	2	2
	Fish and fishing grounds	1.8	7.3	33.0	57.8	5	4
	Aquatic animals such as hippopotamus, Crocodylus niloticuss and snails	69.7	12.8	17.4	0	17	10
	Cultivated vegetables and fruits	0	4.6	30.3	65.1	3	3
	Natural vegetables and fruits	6.4	14.7	65.1	13.8	8	6
	Fuel woods, weaving mats and poles/timber	5.5	17.4	42.2	34.9	6	5
	Soils for brick making	20.2	29.4	36.7	13.8	10	7
	Water for navigation	46.8	36.7	9.2	7.3	12	8
Regulation	Flood mitigation	16.5	37.6	31.2	14.7	7	2
	Sedimentation	29.4	42.2	22.0	6.4	14	4

	and erosion control						
	Physical water quality control	12.8	27.5	45.9	13.8	9	3
	Malaria, bilharzias and UTI control	0.9	8.3	25.7	65.1	4	1
	Biodiversity conservation	11.0	61.5	21.1	6.4	13	2
Information	Recreation and tourism	62.4	27.5	6.4	3.7	16	3
	Sites for cultural and ritual activities	48.6	36.7	6.4	8.3	11	1

Determination of the maintenance level on the selected Ecosystem services

Out of nine (9) Ecosystems services tested, four (4) services were preferred to be increased as reported by more than 50% respondents. Table 6.30 shows that, increase in current services was a prefered by majority of 93%) for control of Malaria, bilharzias and UTI, followed by 77% for Moist and fertile soils for flood recession agriculture. This finding supports the preference attached to Malaria, bilharzias and UTI control, implying that, water related diseases are a major problem to this area and therefore efforts to control them is vital for the community's livelihoods. Likewise services must be increased to moist and fertile soils for flood recession agriculture which is the main activity on which people depend. Other services preferred to be increased by majority of respondents are sedimentation and erosion control (58%) and flood mitigation in inundation areas (51%).

Table 6.30 Respondents' preferences on ecological service maintenance levels in BBM site 5

Ecosystem service	Mean BBM site 5 (%) Preferences on maintenance level in percentages (%)		
	Maintain the current service	Decrease the current service	Increase the current service
Fertile valley plains for grazing	32	53.	15
Moist and fertile soils for flood recession agriculture	22	1	77
Crocodylus niloticuss, hippopotamus, snails and their riverine habitats	45	52	3
Physical water features such as ponds, natural springs, oxbow lakes	61	6	34
Game controlled areas	53	37	10
Control of malaria, bilharzias and UTI	5	3	93
Flood mitigation in inundation areas	22	28	51
Sites for cultural and ritual activities	62	17	21
Sedimentation and erosion control	34	8	58

Moreover, 62%, 60% and 53% of respondents prefer the maintenance of the current services offered by sites for cultural and ritual, physical water features such as ponds, natural springs, oxbow lakes and game controlled areas respectively. On the other hand, 53%, and 52% prefers decrease in the current services on fertile valley plains for grazing and Crocodylus niloticuss, hippopotamus and snails respectively. These findings implies that, these services are either less important to them, harmful or they may facilitate negative effects to the communities livelihoods. Crocodylus niloticuss and hippos are reported to be problematic animals to the people's property and their general livelihoods.

8. ENVIRONMENTAL FLOW REQUIREMENTS

In this chapter a flow setting recommendation is described in details. The locals mentioned their prefferences on ecosystem goods and services and the flow levels that would sustain their main economic activities which include crop farming, fishing and livestock keeping. They also considered the flow that would support the ecosystems goods and services they most rely on. The information set a benchmark which was used to recommend flows.

8.1 BBM site 1 - Lwipa

Present Ecological State Category

C - 96% of the communities depend on recession agriculture which are practiced within a range of 0-2km distance from the river bank. Clear felling of the forests was noted especially on the side of Mbingu village, to the buffer zone of Udizungwa National Park. From group discussions, historical perspectives of the rivers reveal that water flows have decreased drastically over the past decade. Accordingly, over fishing was also reported by the key informants.

Objective category

B- Improvement is needed on land use practices, biodiversity conservation including vegetation in catchment area and controlled over fishing, management of water physical bodies i.e. rivers, ponds and streams banks to mitigate flooding, controlled free range grazing.

General flow objective

Maintenance of moderate range of flows presently in the river

Objectives	Motivation
Maintain moderate flows in dry season	To enhance fishing and recession agriculture in dry periods
Maintain medium flows during rainy seasons	To maintain the flows that will enhance moisture retention and fertility for recession agriculture, vegetables, fruits and replenishment of water physical bodies such as ponds, swamps and oxbow lakes which are necessary for fish breeding
Maintain moderate flood during the rainy season	High flooding negatively affects the recession agriculture and transport infrastructure
Control flooding down-stream by improving land use practices upstream	There is improper land use practices i.e. overgrazing, crop farming at upstream river banks

Objectives for livelihoods
Maintain a river condition that will enhance the community's livelihoods who depends on the river Luipa for crop farming (96%), fishing (51%) and fish consumption (on average a household consumes 116 large fish per year and 920 cups (250 ml) of small fish per household per year), cultivated and natural vegetables consumption (96% and 84% respectively) and grazing of livestock (17 %).

Objectives for target species
The following species should be abundant enough to suffice the livelihood needs of the population residing along Luipa River:

1. Fish species: Perege, kitoga, kambale, Sulusulu and Ngogo (Most preferred)
2. Reads for weaving mats: Ukindu and Malala (*Hyphaene petersiana*) used by 72% and 34% of the communities respectively (Most preferred)
3. Natural vegetables: liwowo, Linyala, Lidadangala and Mwidu (Most preferred)
4. Thatching grasses: Mbasa and Mikangaga species (Most preferred)
5. Other aquatic animals: Hippos and Crocodylus niloticuss which will enhance the physical maintenance of the river for breeding sites of the important fish specie

8.2 BBM site 2 - Udagaji

Present Ecological State Category:
D - 93 % of the communities depends on recession agriculture (Mainly rice and Maize) which are practiced in valleys located within a mean distance of 0.4 km from the river bank. Compared to other BBM, fishing is practised by 49 % of households. Accordingly, relatively few (8) fish species were reported in river udagaji, partly due to relatively less water flow reported in the river udagaji during dry season. From group discussion, historical perspectives of the rivers reveal that water flows has decreased more drastically compared to other BBM sites over the past decade.

Objective category
B- Major improvement in the whole biophysical condition of the rivers to mitigate floods down the stream and also restore the degraded biodiversity including decreased fish varieties and enhance crop farming especially the lower parts of the rivers

General flow objective
Regulate a full range of flows presently in the river

Objectives	Motivation
Maintain high flows in dry seasons	To Improve the moisture and fertility and supply of water for domestic uses
Maintain high flows	To maintain the flows that will enhance moisture retention

during rainy seasons	and fertility for recession agriculture, vegetables, fruits; replenish water physical bodies such as ponds, swamps and oxbow lakes
Maintain the current flooding level	Current flooding level would be enough to support the existing recession agriculture

Objectives for livelihoods:
Maintain a river condition that will enhance the community's livelihoods who depends on the river Mgugwe and Udagaji for crop farming by 93%, fish consumption over 89%, cultivated and natural vegetables consumption (98% and 86% respectively), cultivated and natural fruits consumption (98% and 86% respectively) and grazing of livestock (10%).

Objectives for target species:
The following species should be abundant enough to suffice the livelihood needs of the population residing along Mgugwe and Udagaji Rivers:

1. Fish species: Kambale, Perege, Kitoga and Njuju (Most preferred)
2. Reads for weaving mats: Ukindu and Malala used by 51% and 21% of the communities respectively (Most preferred)
3. Natural vegetables: Liwowo, Lidadangala, Kamdegela, Mchicha pori and Mwidu (Most preferred)
4. Cultivated vegetables: Kalubwagila, Chainisi, Mchicha, Majani ya Kunde, Bamia and Nyanya chungu (Most preferred) or Nyaya chungu, okra, green paper, figiri/chines spinac (from flow setting workshop)
5. Natural Fruits: Mikusu, Mafuru, Mapingipingi, Matopeta and Bwegela (Most preferred)
6. Other aquatic animals: In this river big animals were not reported during dry season but Chelonia spp and Brachyura spps were available, normally big animals i.e Crocodylus niloticuss come during wet seasons up to the bridge in drought years less of these are expected to come

8.3 BBM site 3 - Mpanga

Present Ecological State Category
B - (91% of the communities depends on recession agriculture (Mainly rice, maize and sesame) which are practiced within a range distance of 1-14 km from the river bank. Compared to other BBM sites, this block has relatively many livestock keepers (44%) ranged in free grazing system within a mean distance of less than 1 km from Ponds and

River. Some of the fish species like Mgundu has turned to be rare fish species partly due to bad fishing practices.

Objective category

B- To maintain the current status so as to enhance the ecosystem services provided by the river Mpanga to the local communities.

General flow objective

Maintenance of moderate range of flows presently in the river

Objectives	Motivation
Maintain current flows in dry seasons	To enhance fishing and recession agriculture in dry season
Maintain medium flows during rainy seasons	To maintain the flows that will enhance moisture retention and fertility for recession agriculture, vegetables, fruits; replenish water physical bodies such as ponds, swamps and oxbow lakes which are also necessary for fish breeding
Maintain moderate flood during the rainy season	High flooding negatively affects the recession agriculture and transport infrastructure
Control flooding downstream by improving land use practices upstream	There is improper land use practices i.e. overgrazing, crop farming at upstream river banks

Objectives for livelihoods

Maintain a river condition that will enhance the community's livelihoods that depends on river Mpanga for crop farming by 91%, fishing (33%) and fish consumption (of about 56 large fish per year and 45 cups (250 ml) of small fish per year), cultivated and natural vegetables consumption (83% and 71% respectively), cultivated and natural fruits consumption (88% and 42% respectively) and grazing of livestock (20 %).

Objectives for target species

The following species should be abundant enough to suffice the livelihood needs of the population residing along Mpanga River

1. Fish species: Kambale, Perege, Ngogo, Njege and Sulusulu (Most preferred)
2. Reads for weaving mats: Ukindu and Malala used by 54% and 29% of the communities respectively (Most preferred)
3. Natural vegetables: Liwowo, Lidadangala, Likongela, Matembele pori and Libobombo (Most preferred)

4. Natural Fruits: Mafulu. Zambarau pori, EmbeNg'ong'o and Unanga (Most preferred)

5. Thatching grasses: Mbasa, Michelele and Lusano species (Most preferred)

6. Other aquatic animals: Hippos and Crocodylus niloticuss which will enhance the physical maintenance of the river for breeding sites of the important fish species

8.4 BBM site 4 - Ifwema

Present Ecological State Category

B - 100% of the communities have as main economic activity crop recession agriculture (Mainly rice, maize and sesame) which are practiced within a range distance of 1-5 km from the river bank. 30% of the communities are livestock keepers of who 13 % keep cattle and ranged their livestock in free grazing system within a mean distance of less than 1km from ponds and rivers. Some of the fish species like Mgundu has turned to be rare fish species partly due to bad fishing practices.

Objective category

B- To Maintain the current status to enhance the ecosystem services provided by the Kilombero river to local communities

General flow objective

Maintenance of moderate range of flows presently in the river

Objectives	Motivation
Maintain current flows in dry seasons	To enhance fishing, navigation and recession agriculture in dry season
Maintain medium flows during rainy seasons	To maintain the flows that will enhance moisture retention and fertility for recession agriculture, vegetables, fruits; replenish water physical bodies such as ponds, swamps and oxbow lakes and sedimentation transfer
Maintain moderate flood during the rainy season	High flooding negatively affects the recession agriculture and transport infrastructure
Control flooding downstream by improving land use practices upstream	There is improper land use practices i.e. overgrazing, crop farming at upstream river banks

Objectives for livelihoods

Maintain a river condition that will enhance the community's livelihoods who depends on the river Kilombero for crop farming by 100%, fishing (42 %) and fish consumption (of about 67 large fish per year and 56 cups (250 ml) of small fish per year), cultivated

and natural vegetables consumption (90% and 78% respectively), and grazing of livestock e.g. Cattle) (13 %).

Objectives for target species

The following species should be abundant enough to suffice the livelihood needs of the population residing along Kilombero River

1. Fish species: Kambale, Perege, Kitoga, Ngogo, Njege and Mgundu (Most preferred)
2. Reads for weaving mats: Ukindu and Malala used by 57% and 10% of the communities respectively (Most preferred)
3. Natural vegetables: Linyala, Mwidu, Liwowo, Lisekeseke, Namgange and Kisamvu Mpira (Most preferred)
4. Natural Fruits: Mafulu, Misada, Madongadonga, Ukwaju, Misaula and Mtopeta (Most preferred)
5. Thatching grasses: Mbasa, Lusano and Nyaganga species (Most preferred)
6. Other aquatic animals: Kindasi (type of Chelonia spp) and hippos are reported to be eaten by people, but other animals like Lutra lutra, python, lizards and Crocodylus niloticuss are also found. A specific characteristic of this site is the occurrence of snails. Snails are important for breeding site and protection of some of sensitive species of fish.

8.5 BBM site 5 - Ifakara Ferry

Present Ecological State Category

C - 98% of the communities depends on recession agriculture which are practiced within a range of 1-7 km distance from Kilombero river bank. 31 % of the communities are livestock keepers of who 19 % keep cattle and ranged their livestock in free grazing system within a mean distance of 1-8 km range from Ponds and River. Some of the fish species like Mwjonga has turned to be rare fish species partly due to overfishing and bad fishing practices.

Objective category

B - Major improvement in the whole biophysical condition of the river to mitigate floods and also restore the degraded biodiversity including decreased fish varieties. Class B can probably not be achieved by flows alone, management actions to control anthropogenic activities will also be needed.

General flow objective

Maintenance of moderate range of flows presently in the river.

Objectives	Motivation
Maintain current flows in dry seasons	To enhance fishing, navigation and recession agriculture in dry season
Maintain medium flows during rainy seasons	To maintain the flows that will enhance moisture retention and fertility for recession agriculture, vegetables, fruits; replenish water physical bodies such as ponds, swamps and oxbow lakes and sedimentation transfer
Maintain moderate flood during the rainy season	High flooding negatively affects the recession agriculture and transport infrastructure
Maintain physical conditions of the flood plain (ponds/swamps/oxbowlakes)	To maintain spawning grounds, mitigate floods and enhance provision of vegetables

Objectives for livelihoods

Maintain a river condition that will enhance the community's livelihoods who depends on the lower part of river Kilombero for crop farming by 98%, fishing (40 %) and fish consumption (15% and 97% respectively), cultivated and natural vegetables consumption (average of 95 large fish are consumed by a household per year and 79 cups (250 ml) of small fish are consumed by a hoehold per year), cultivated and natural fruits consumption (95% and 87 % respectively) and grazing of livestock e.g. cattle (19%).

Objectives for target species

The following species should be abundant enough to suffice the livelihood needs of the population residing along the lower part of Kilombero River

1. Fish species: Kambale, Perege, Kitoga, Ngogo and Bula (Most preferred)
2. Reads for weaving mats: Ukindu and Malala used by 76% and 32% of the communities respectively (Most preferred)
3. Natural vegetables: Liwowo, Kaluberege, Lidadangala, Lichulu and Likongela (Most preferred)
4. Natural Fruits: Mafulu, Zambarau pori, Embe Ngo'ngo and Unanga. (Most preferred)
5. Thatching grasses: Mbasa, Mbambata and Michelele species (Most preferred)
6. For construction materials Bamboo / Milenga Maji is used. No trees in riparian zone close to the main river, they are further away.

7. Other aquatic animals: Hippos and Crocodylus niloticuss which will enhance the physical maintenance of the river for breeding sites of the important fish species

Conclusions

The study revelaled that most households in Kilombero basin are engaged in agriculture as their main economic activity. It is established that this people rely more on velleys for their crop farming, fishing and livestock keeping. Water bodies including rivers, swamps and ponds were found to be important resources that support main economic activities that include, crop farming, fishing and livestock keeping. The activities are mainly for subsistence and cash income generation to cater for basic needs including payment for school fees, medication and fairs when they travel. It is therefore important to note that any alterarion of the flows shall have impacts in this people's livelihoods.Though the final volume of water available to maintain the specific livelihoods requirements can only be determined once the stakeholders have agreed on the EFA classification for the rivers, this socio-economic component report suggests that a flow that would maintain these basic needs of the people to be recommended. Although the details of different flows are worked out in the flow setting document, in summary these were the main recommendation of socio-economic study. Dry-medium flow is recommended in BBM site 1,3,4, and 5 and status quo shoud be maintained in BBM 2.

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ANNEXES
Annex 1 Questionnaire

Environmental Flow Assessment (EFA): Socio-economic part
Household Questionnaire

Questionnaire No. ☐

Date of interview.....
Name of enumerator.....
Name of person doing quality check.....

Hamlet:.....
Village:.....
Ward:.....
BBM site.....

CONTENTS

1. PURPOSE

The general purpose of this questionnaire is to supplement the information in a quantitative term on the qualitative data obtained during the PRA. Specifically, the question-

naire has been designed to collect wide range of Environmental Flows information and the following is the structural arrangement of the questionnaire.

(i) Part I: Socio economic characteristics of the respondent

(ii) Part II: Extent on use of environmental goods and services and the expected losses

(iii) Part III: Perceived preferences of the respondents on selected environmental goods and services

(iv) Part IV: Maintenance level on the selected Environmental goods and services

2. INTRODUCTORY INFORMATION TO THE RESPONDENTS

My Name is xxxxxxxxx. I am a researcher from Sokoine University of Agriculture, working with issues of Environmental Flow Assessment. I am here as consultant contracted by CDM smith under theIrrigation and Rural Roads Infrastructure Project (IRRIP) funded by USAID. I have come to your household to discuss with you some issues regarding the socio-economic aspects of EFA. I kindly request your time to make this discussion possible.

Part I: Socio economic characteristics of the respondent

1. Sex A) Male ( ) B) Female ( )
2. Age inyears.....

3. Marital status.
   A) Married ( ) B) Single ( ) C) Widowed ( ) D) Divorced ( ) E)Separated ( )

4. Size of household……..
5. Education level
   A) None ( ) B) Primary ( ) C) Secondary () D) College/university ( )
   D) Others (specify)

6. Main economic activity
   A) Crop farming ( ) B) Livestock keeping ( ) C) fishing D) Others (specify)……

7. Distance of the household in reference to specific river …….....

8. (Specify the river).....

9. What is your annual income in TZS? .....
A) Less than 50, 0000 ( ) B) 50,000- 199, 000 ( ) C) 200,000- 599,000 ( )
D) 600,000- 1,990,000 ( ) E) 2,000,000 and above ( )

Part II: Determination of the extent of use of environmental goods and services and the expected losses

1. List the quantities, uses and values of crops your household has harvested during the past 12 months.

Crop	Farm size in acreage	Unit of harvest [1]	Total harvest (a)	Uses		Type of market[2]	Price per unit (TZS) (b)	Total revenue (a*b)
				Own use	Sold (a)			
Maize								
Rice								
Sesame								
Sunflower								
Banana								

1Codes: 1= 20kg plastic bucket, 2= 100 kg bag, 3= bunch
2Codes: 1= internal within Kilombero district, 2= external outside Kilombero district, 3= both internal and external

2. What are the quantities and values of inputs did your household use in crop production over the past 12 months?

Input	Type	Source of input[1]	Season of use[2]	Freq. of use[3]	Unit of an input	Input Quantity (a)	Price per Unit (TZS)(b)	Total costs (a*b)
Manure								
Fertilizers								
Pesticides/ Herbicides								

1 Codes: 1= internal within Kilombero districts, 2= external outside Kilombero district3= both internal and external
2 Codes: 1= dry, 2= wet
3 Codes: 1= once per season, 2= twice per season, 3=more than twice per season

3. List the number of livestock your household has now, and those you have sold or slaughtered in the past 12 months.

Livestock	Total number in last 12 months	Sold (a)	Price per animal in TZS (b)	Slaughtered for own use	Present number	Drinking water source[1]	Distance from a household to a water source (km)	Total revenue (a*b)
Cattle								
Goats								
Sheep								
Pigs								
Donkey								
Chicken								
Others								

1Codes:1= river, 2= pond, 3= swamp 4= others

5. List the quantities, uses and values of cultivated vegetables and cultivated fruits your household has harvested/bought in the past 12 months

A. Cultivated vegetables

Forms of Cultivated Vegetables	Unit of measurement[1]	Source[2]	Freq of consumption per month	Total amount harvested per year **(only if cultivated)**	Total Amount consumed/ day	Total amount sold **(only if cultivated)**	Type of market[3]	Price per unit (TZS)	Total cost/Revenue	
									Costs **(only if bought)**	Revenue

Leaf Vege-tables										
Other form of vege-table (to-mato, egg plant, ladies finger etc)										

1Codes: 1=bunch, 2=Sadoline, 3=buckets of 20litres, 4= others specify.....
2Codes: 1= Direct collected 2= Bought 3=Both collected & Bought
3Codes: 1= Internal within Kilombero district, 2= External outside Kilombero district, 3= both internal and external

B. Cultivated fruits

Type of fruit /fruit tree owned	No. of fruit trees	Source[1]	Unit of meas-ure-ment[2]	Total amoun-tharvest-ed **(only if cultivat-ed)**	Freq of con-sump-tion/ year	Total Amount con-sumed /day	Total amount sold **(only if cul-tivat-ed)**	Type of market[3]	Price per unit (TZS)	Total cost/Revenue	
										Costs **(only if bought)**	Revenue

1 Codes: 1= Cultivated, 2= Bought, 3=Both collected & Bought
2 Codes: 1=Number of fruits, 2= Sadoline, 3= buckets of 20litres, 4=others Specify.....
3Codes: 1= internal within Kilombero district, 2= external outside Kilombero district, 3= both internal and external

6. List the quantities, uses and values of the following natural products your household has collected in the past 12 months.

A. Natural vegetables

Item	Unit of meas-ure-ment[1]	Sou rce[2]	Frequency of		Total amountcol-lected/day **(only for direct source)**	Total Amount con-sumed/ day	To-tal amo unt sold /da y	Pri ce pe r un it (T ZS)	Total cost/Reve nue	
			Col-lec-tion per mont h	Con-sump-tion per month					Cos ts **(on-ly if bou ght)**	Rev enu e
Nat-ural vege-ta-bles										

1Codes: 1=bunch, 2=Sadoline, 3=buckets of 20litres, 4= others specify.....
2Codes: 1= Direct collected, 2= Bought, 3=Both collected & Bought

B. Natural fruits

Unit of meas-urement[1]	Sour ce[2]	Frequency of		Total amount collect-ed/day **(only for direct source)**	Total Amount con-sumed/d ay	Total amou nt sold/ day	Pric e/ unit (TZ S)	Total cost/Revenu e	
		Collec lec-tion per month	Con-sump-tion per month					Cost s **(on-ly if boug ht)**	Rev-enue

1Codes: 1=bunch, 2=Sadoline, 3=buckets of 20litres, 4= others specify.....
2Codes: 1= Direct collected, 2=Bought, 3=Both collected & Bought

C1. Direct fish collection

Please indicate season of fishing in months: From .....to..... (eg December to July)
In case of more than one fishing season: .....

Fish category[1]	Unit of measurement[2]	Total fish collection per trip	Total number of fishing trips for the past 12 months	Total amount of fish sold per trip	Price Per Unit in (TZS)	Total Revenue per year

1codes: 1= large fish, 2 =small fish
2Codes: 1= number of fishes, 2= cup, 3= sadolin

C2. Fish consumption

Fish category[1]	Means of acquiring [2]	Unit of Measuremnt[3]	Price Per Unit (TZS)	Freq. of consumption/year	Total number of fish consumed/day	Total Costs/year

1 Codes: 1= large fish, 2 small fish
2 Codes: 1= direct collected, 2= bought, 3=both direct collected and bought
3Codes: 1= number of fishes, 2= cup, 3= sadoline

D. Weaving materials

Item	Material used[1]	Source of material		Total items produced (numbers)	Uses		Type of Market[3]	Price per unit (sold products) in (TZS) (b)	Total revenue (a*b)
		Direct collection	Bought[2]		Own use	Sold (a)			

1 Codes: 1=Malala, 2= Ukindu, 3=matete
2 Codes: 1= internal within the village 2= external outside the village
3Codes: 1= internal within Kilombero district, 2= external outside Kilombero district, 3= both internal and external

E. Building poles and thatching materials

Product	Source of product		Unit of measurement[2]	Total collection	Total collected		Freq. of consumption [3]	Type of market[4]	Price per unit in TZS (b)	Total Revenue (a*b)
	Direct collection	Bought[1]			Own use	Sold (a)				
Building poles										
Thatching materials										

1 Codes: 1= internal within the village, 2= external outside the village
2Codes: 1= number of poles, 2= bundles (kichanga/mzigo)
3 Codes: 1= at least once in a month, 2= at least once in a year
4 Codes: 1= internal within Kilombero district, 2= external outside Kilombero district, 3= both internal and external

7. How much did your household spend on navigation for the past 12 months?

River used	Season[1]	Transport facility	Freq. of travel[2]	Cost per one trip (a)	Total trips in the past 12 months (b)	Total costs (a*b)

1 Codes: 1= rainy season, 2= dry season, 3= both dry and rain seasons
2 Codes: 1= everyday, 2= once in a week, 3= once in a month, 4= not often

8. List the quantity, uses and value of water your household has used in the past 12 months

a) Cooking, washing/bathing and other domestic uses

Source of water[1]	Distance from your household (Km)	Time used to reach a water source	Collected by whom[2]	Freq. of collection in a day	Unit of measure	Total units collected per day (a)	Price per unit if bought (b)	Total amount used per day (a*b)	Total cost if bought

1Codes:1= rivers, 2= ponds, 3= natural springs, 4= bore holes, 5= tape water
2 Codes: 1= men, 2= women, 3= children, 4= both women and children, 5= men, women and children

b) Swimming and bathing

Uses	Source of water[1]	Distance from your household	Time spent to reach a water source	Who are involved[2]	Freq. of swimming/ bathing/month	Cost if you pay anything
Bathing						
Swimming						

1 Codes: 1= rivers, 2= natural springs, 3= ponds, 4= tape water
2 Codes: 1= children, 2= men, 3= women, 4= both men and children, 5= both women and children, 6= men, women and children

Part III:Determination of the preferences of the locals on selected environmental goods and services

8. Which of the following ecosystem services supported by environmental flows do you mostly rely on and would you prefer to be sustained for the future?

Instruction: Please tick the appropriate response in a respective row.

1= Not preferred, 2= less preferred. 3= preferred, 4= most preferred

S/No	Ecosystem services	A4 Likert scale			
		Not preferred	Less preferred	Preferred	Most preferred
1	Fertile valley plains for grazing				
2	Moist and Fertile land for flood recession crop cultivation				
3	Water for domestic uses				
4	Fish and fishing grounds				
5	Aquatic animals other than fish and their riverine habitats (such as crocodiles, hippopotamus and snails)				
6	Cultivated vegetables and fruits				
7	Natural vegetables and fruits				
8	Fuel wood and Weaving mats, poles/timber for construction				
9	Soils for brick making				
10	Water for transportation uses (navigation)				
11	Flood mitigation				
12	Sedimentation and erosion control				
13	Physical water quality control				
14	Malaria,Bilharzias and UTI control				

15	Biodiversity conservation				
16	Recreation and tourism				
17	Sites for cultural and ritual activities				

Part IV: Determination of the maintenance level on the selected ecosystem services

10. Given the following ecosystem services, which maintenance level you mostly prefer

SNo	**Ecosystem service**	**A3 Likert Scale**		
		Maintain the current service	Decrease the current service	Increase the current service
1	Fertile valley plains for grazing			
2	Moist and Fertile land for flood recession crop cultivation			
3	Crocodiles, hippopotamus, snails and their riverine habitats (stock size).			
4	Physical water features such as ponds, natural springs, oxbow lakes			
5	Game controlled areas			
6	Control of Malaria, Bilharzias and UTI			
7	Flood mitigation in inundation areas			
8	Sites for cultural and ritual activities			
9	Sedimentation and erosion con-			

	trol			

1= maintain the current service, 2= decrease the current service, 3= increase the current service

11. What is your preference on water for flooding with reference point to inundated/flooding areas?

River used (Source of flooding)	Water depth[1] (Refers to inundation areas)		Water velocity[2]		Current inundation level[3]	Preferred inundation level[3]
	Current	Preferred	Current	Preferred		
Main/Unseasonal						
1						
2						
3						
Seasonal						
1						
2						
3						

1 Codes: 1= below knee level, 2= at knee level, 3= at waist level, 4= at breasts level 5= above breasts level

2 Codes: 1= low, 2= medium, 3= high

3 Codes: 1= 0-1 Km, 2= 1-3 Km, 3= 3-5 Km, 4= 5-10km, 5= 10-15km, 6=more than 15km

12. What is your preference on water level in main /un-seasonal rivers during dry season?

Rivers	Water depth[1]		Water Velocity[2]	
Main/Unseasonal	Current depth	Preferred depth	Current velocity	Preferred velocity
1.				
2.				
3.				

1 Codes: 1= below knee level, 2= at knee level, 3= at waist level, 4= at breasts level 5= above breasts level

2 Codes: 1= low, 2= medium, 3= high

Annex 1 PRA Protocal

CHECKLIST FOR KILOMBERO PRA-SUB BASIN ENVIRONMENTAL FLOW ASSESSMENT

PART ONE- SOCIAL CULTURAL INFORMATION

1. What are your social cultural activities i.e. rituals, dancing, recreation etc
2. Who perform the activities
3. When in a year are these activities performed
4. Why are these activities performed specifically in a specified season in a year
5. Which resources supports your social activities during those times/seasons
6. Based on their importance and usefulness prioritise these resources
7. Where in your village are these activities performed
    1. Sketch a map that show all these information

PART TWO- ECONOMIC ACTIVITIES INFORMATION

1. What are your economic activities i.e. farming, fishing, livestock keeping, mining, tourism, hunting etc
2. Who perform the activities
3. When in a year are these activities performed
4. Why are these activities performed specifically in a specified season in a year
5. Which resources supports your specified economic activities during those times/seasons
6. Based on their importance and usefulness prioritise the resources that supports your mentioned economic activities
7. Where in your village are these activities performed
    1. Sketch a map that show the location of all these economic activities

PART THREE- NATURAL RESOURCE INFORMATION

1. What are the natural resources that are useful for your livelihood i.e. for food, building, crafting (In a mind concentrate on environmental flows resources or riverine resources)
2. When do you get the mentioned resources in a seasonal timeline of the year
3. When do you use them in a seasonal time line of the year and why
4. To what extent are these resources available in a seasonal time line and why
5. Where do you get the mentioned resources (Location)
6. To what extent are the resources dependent on
    1. inundation,

2. velocity of water flows and
3. depth

7. How do you get the mentioned resources
8. How can you rank the importance of the natural resources you have mentioned over the other
9. To what extent are you depend on the natural resources for your livelihoods

PART FOUR: WATER ISSUES THROUGHOUT A YEAR

1. What are your different uses of water i.e. domestic, recreation, transportation, (specify) etc

.....
.....
.....
.....
.....
.....
.....
.....

1. Attach the specified uses in a seasonal time line
2. Why are these uses specified in a particular seasonal time line
3. Where do you access such specific water for the identified use in a seasonal time line of the year and why
4. What are the water related problems i.e. diseases (use problem ranking)and how do you treat these

PART FIVE: BIOPHYSICAL ANALYSIS OF THE RIVERS AND WETLANDS

1. Mention (identify) rivers/tributaries that are present in your village

1. .....
2. .....
3. .....
4. .....
5. .....
6. .....
7. .....
8. .....

9. Give the history of the rivers/tributaries water volume from Nyerere's regimes to Kikwete's regime (Appendix 16)

10. Give us a history of the recurrence of the specified river flow (Low and High water flow) during Nyerere's, Mwinyi, Mkapa and Kikwete's regime(Appendix 17)
11. Give the history of time of occurrence, extent and duration of inundation for each river in a seasonal time line(Appendix 18)
12. Facilitate discussion on possible reasons for these changes and document
13. Give us a history of the resource use pattern during Nyerere's, Mwinyi, Mkapa and Kikwete's regime (Use historical transect charts) (Appendix 19)
14. Facilitate discussion on possible reasons for these changes and document (Focus will be on the significant resource change over time)

Annex 2 Fish species at BBM site 1 - 5
BBM site 1

S/No	Type of Fishes	Scientific Name	Season of availability												Favorable Habitat		Required water condition		
			Short rain raise			Short rain transition		Long rains raise		Long rains re-session		Early dry season		Late dry season	Rivers	Pond	Volume	Velocity	Depth
			OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEPT					
1	Bula	*Schilbe*													√	√			
2	Buta	Not identified														√			
3	Chibena Mdenga	Not identified														√			
4	Kambare	*Clarias* (Breathing catfish)													√	√			
5	Kapatwa	Not identified													√				
6	Kitoga	*Bagrus* (Bagrid cat-fish)													√				
7	Lwepi	Not identified														√			
8	Mbale	*Citharinus*													√				
9	Mgundu	*Alestes*													√				
10	Mjongwa	*Heterobranchus*													√				
11	Mjuju	*Brycinus*														√			
12	Mkunga	*Eel*													√				
13	Mlamu	Not identified														√			
14	Mtuku	*Labeo ulangensis*													√				
15	Ndipi	*Petrocephalus*														√			
16	Ndungu	*Distichodus*													√				
17	Ngaji	Not identified														√			
18	Ngakawi (Young	*Tilapia*														√			

	Perege)																		
19	Ngambala (Kamba)	*Shrimps*												√					
20	Ngodongodo (Young Kambale)	*Clarias*													√				
21	Ngogo	*Synodontis* (Squaker catfish)												√	√				
22	Ngolya	Not identified												√					
23	Ngulufi	*Labeo cylindricus*												√					
24	Njege	*Hydrocynus* (Tiger fish)												√					
25	Perege	*Tilapia*												√					
26	Sheta	Not identified													√				
27	Sulusulu	*Mormyrus*												√					

Key : Seasonal fish availability

- High Availability
- Medium Availability
- Availability is low

Key: Fish water condition

- High dependence
- Moderate dependence
- Low dependence

S/no	Fish Species	Scientific Name	Fish species revealed to be found in rivers and ponds in the villages		
			Villages		
			Mbingu	Kisegese	Mofu
1	Benasongwa	Not identified			
2	Bula/lwepe	*Schilbe*			
3	Bulukutu	Not identified			
4	Buta	Not identified			
5	Chibena Mdenga/Kibenamdenga	Not identified			
6	Dagaa	Not identified			
7	Gundu	Not identified			
8	Kamba/Ngambala	*Shrimps*			
9	Kambare	*Clarias* (Breathing catfish)			
10	Kapatwa/Ngapatwa	Not identified			
11	Kitoga	*Bagrus* (Bagrid catfish)			
12	Lwepi	Not identified			
13	Mbale/Mbala	*Citharinus*			
14	Mbwewe	Not identified			
15	Mdela	Not identified			
16	Mgundu	*Alestes*			
17	Mjongwa	*Heterobranchus*			
18	Mkunga	*Eel*			
19	Mlamu	Not identified			
20	Mnyela	Not identified			
21	Mtuku	*Labeo ulangensis*			
22	Ndipi	*Petrocephalus*			
23	Ndungu	*Distichodus*			
24	Ngaji	Not identified			
25	Ngakawi (Young Perege)	*Tilapia*			
26	Ngambala (Kamba)	*Shrimps*			
27	Ngodongodo (Young Kambale)	*Clarias*			
28	Ngogo/Ndulupa	*Synodontis* (Squaker catfish)			
29	Ngolya	Not identified			
30	Ngulufi	*Labeo cylindricus*			

S/no	Fish Species	Scientific Name	Fish species revealed to be found in rivers and ponds in the villages		
			Villages		
			Mbingu	Kisegese	Mofu
31	Ngulufi	*Labeo cylindricus*			
32	Ngunga	Not identified			
33	Ningu	Not identified			
34	Njege	*Hydrocynus* (Tiger fish)			
35	Njuju	*Brycinus*			
36	Nyongololo	Not identified			
37	Perege	*Tilapia*			
38	Sengerere	Not identified			
39	Sheta	Not identified			
40	Sulusulu	*Mormyrus*			

S/no	**Fish species**	**Scientific Name**	**Feeds**	**Breeding site**
1	Kambale	Clarias (Breathing catfish)	Feed on small fishes	Flood plain and ponds
2	Perege	Tilapia	Soil (mud) containing partially decomposed vegetation and small creatures. Also feed on grasses such as magugu, fufu, swagu (mbudu).	Ponds
3	Kitoga	Bagrus (Bagrid catfish)	Feed on small fishes	Along river banks where there is still water and in ponds
4	Sulusulu	Mormyrus	Soil (mud) containing partially decomposed vegetation and small creatures.	Ponds and in vegetation (e.g. Mafufu in water)
5	Ngogo	Synodontis (Squaker catfish)	Feed on small fishes and grasses such as	Along river banks where there is still

S/no	Fish species	Scientific Name	Feeds	Breeding site
			magugu, fufu, swagu (mbudu)	water and in ponds
6	Njege	Hydrocynus (Tiger fish)	Feed on small fishes	Ponds
7	Ndungu	Distichodus	Soil (mud) containing partially decomposed vegetation and small creatures. Also feed on grasses such as magugu, fufu, swagu (mbudu).	Along river banks where there is still water and in ponds
8	Mbale	*Citharinus*	Soil (mud) containing partially decomposed vegetation and small creatures. Also feed on feed on grasses such as magugu, fufu, swagu (mbudu).	Ponds
9	Mjongwa	*Heterobranchus*	Feed on small fishes	Along river banks where there is still water and in ponds
10	Mgundu	*Alestes*	Feed on small fishes	Ponds
11	Mtuku	*Labeo ulangensis*	Feed on grasses such as magugu, fufu, swagu (mbudu)	Ponds and in vegetation (e.g. Mafufu in water)
12	Ngulufi	*Labeo cylindricus*	Feed on Fruits, roots, decomposing matter in soil, and insects	Ponds and in vegetation (e.g. Mafufu in water)
13	Kapatwa	Not identified	Feed on small fishes	Ponds and in vegetation (e.g. Mafufu in water)
14	Mkunga	*Eel*	Feed on small fishes	Ponds and in vegetation (e.g. Mafufu in water)
15	Mjuju	*Brycinus*	Vegetation and insects	Ponds
16	Buta	Not identified	Vegetation and insects	Ponds
17	Sheta	Not identified	Feed on small fishes	Ponds
18	Ndipi	*Petrocephalus*	Vegetation and insects	Ponds
19	Ngakawi	*Tilapia*	Feed on small fishes	Ponds
20	Lwepi	Not identified	Vegetation and insects	Ponds
21	Ngaji	Not identified	Feed on small fishes	Ponds

S/no	Fish species	Scientific Name	Feeds	Breeding site
22	Mlamu	Not identified	Feed on small fishes	Ponds
23	Ngambale (Kamba)	*Shrimps*	Feed on small fishes	Ponds
24	Chibena mdenga	Not identified	Vegetation and insects	Ponds

BBM site 2

S/no	Type of Fishes	Scientific Name	Seasonal and Extent of availability												Favorable Habitat		Dependence level		
			Short rain raise			Short rain tran-sition		Long rains raise		Long rains re-cession		Early dry season		Late dry season	Rivers	Pond	Inundation	Velocity	Depth
			OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEPT					
1	Kambale	*Clarias* (Breathing catfish)													√	√			
2	Kitoga	*Bagrus* (Bagrid cat-fish)													√				
3	Perege	*Tilapia*													√	√			
4	Njuju	*Brycinus*													√	√			
5	Ndipi	*Petrocephalus*													√	√			
6	Ngogo	*Synodontis* (Squaker catfish)													√				
7	Sheka	Not identi-fied													√	√			
8	Dagaa	Not identi-fied													√	√			

Key

Highly available
Moderate available
Less available

Key

High dependence
Moderate Dependence
Less dependence

S/No.	Fish species	Scientific Name	Feeds	Breeding sites
1	Kambare	*Clarias* (Breathing catfish)	Insects, Small fishes, decomposed soil	In flood plains (farm areas)
2	Perege	*Tilapia*	Vegetation, decomposed soils	Ponds
3	Njege	*Hydrocynus* (Tiger fish)	Small fishes such as dagaa, small kambale, njuju, small perege and sometimes insects	Along the river bank, where water are still
4	Kitoga	*Bagrus* (Bagrid catfish)	Small fishes such as dagaa, small kambale, njuju, small perege, insects, and decomposed soils	Along the river bank, where water are still
5	Mjongwa	*Heterobranchus*	Insects, decomposed logs, small fishes	Along the river banks
6	Ndungu	*Distichodus*	Fruits1 from the trees along the rivers bank, Decomposed logs, insects and vegetation	In the still water along the river banks in the wallowing holes made by hippopotamus.
7	Ngulufi/Mtuku	*Labeo cylindricus*/ *Labeo ulangensis*	Vegetation, insects, and decomposed soils	Under the stones/caves found in the river bed
8	Njuju (small fishes)	*Brycinus*	Vegetation and insects	Along the river banks in flood plains where there is inundation
9	Mkunga	*Eel*	Insects and small fishes	Under caves/stones deep down the river
10	Dagaa	Not identified	Insects	Ponds
11	Sulusulu/Ndipi	*Mormyrus*/ *Petrocephalus*	Small insects and decomposed soils	Ponds and vegetation
12	Ngogo	*Synodontis* (Squaker catfish)	Decomposed soil and vegetation	Along the river bank, where water are still
13	Mgundu	*Alestes*	Tips of the soft vegetation/grasses	Ponds and vegetation
14	Bula	*Schilbe*	Feeds of other fishes	Along the river bank, where water are still

S/no	Fish Species	Scientific Name	Villages of BBM three
			Villages

1T18he fruits include, Mishasha, Mikuyu, Mivengi and Mbungulu

			Utengule	Chisano	Matema	Ngalimila	Mpanga
1	Benasongwa	Not identified					
2	Bula	*Schilbe*					
3	Bulukutu	Not identified					
4	Dagaa	Not identified					
5	Kamba/Ngambala	*Shrimps*					
6	Kambare	*Clarias* (Breathing catfish)					
7	Kibenamdegu	Not identified					
8	Kitoga	*Bagrus* (Bagrid catfish)					
9	Lwepe	*Citharinus*					
10	Mbala	*Citharinus*					
11	Mbewe	Not identified					
12	Mdela	Not identified					
13	Mgundu	*Alestes*					
14	Mgutu/macho manne	Not identified					
15	Mjongwa	*Heterobranchus*					
16	Mkunga	*Eel*					
17	Mlamu	Not identified					
19	Mnyela	Not identified					
20	Mtuku/Ngulufi	*Labeo ulangensis/ Labeo cylindricus*					
21	Ndipi	Not identified					
22	Ndulupa	*Petrocephalus*					
23	Ndungu	*Distichodus*					
24	Nduruka	Not identified					
25	Ngapatwa	Not identified					
26	Ngogo	*Synodontis* (Squaker catfish)					
27	Ngunga	Not identified					
28	Nguyu	Not identified					
29	Ningu	Not identified					
30	Njege	*Hydrocynus* (Tiger fish)					
31	Njuju	*Brycinus*					
32	Nyongololo	Not identified					
33	Perege	*Tilapia*					

S/no	Fish Species	Scientific Name	Villages of BBM three				
			Villages				
			Utengule	Chisano	Matema	Ngalimila	Mpanga
34	Perege Linkowo	Not identified					
35	Sengerere	Not identified					
36	Sheka	Not identified					
37	Sulusulu/Njogi	*Mormyrus*					

BBM site 3

	Type of Fish-es	Scientific Name	Seasonal and Extent of availability												Favorable Habitat		Dependence level		
			Short rain raise			Short rain transi-tion		Long rains raise		Long rains re-cession		Early dry season		Late dry season	Rivers	Pond	Inunda-tion	Ve-locity	Dep th
			OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JU-LY	AUG	SEPT					
1	Bula	*Schilbe*													√				
2	Dagaa	Not iden-tified													√	√			
3	Kamba/ Ngambala	*Shrimps*													√				
4	Kambare	*Clarias (Breathing catfish)*													√	√			
5	Ki-toga	*Bagrus (Bagrid catfish)*													√				
6	Lwepe	Not iden-tified																	
7	Mba-la	*Citharinus*													√				
8	Mgundu	*Alestes*																	

9	Mgutu/ macho manne	Not identified														√			
10	Mjongwa	*Heterobranchus*													√				
11	Mkunga	*Eel*													√				
12	Mtuka	Not identified													√				
13	Ndipi	Not identified													√	√			
14	Ndungu	*Distichodus*													√				
15	Nduruka	Not identified																	
16	Ngapatwa	Not identified													√				
17	Ngogo	*Synodontis* (Squaker catfish)													√				
18	Ningu	Not identified													√				
19	Njege	*Hydrocynus* (Tiger fish)													√				
2	Nju-	*Brycinus*													√	√			

0	ju																		
21	Nyongololo	Not identified												√	√				
22	Perege	*Tilapia*												√	√				
23	Perege Linkowo	Not identified																	
24	Sheka	Not identified												√	√				
25	Benesongwa	Not identified												√	√				
26	Sulusulu	*Mormyrus*												√					

Key:

Less available	Moderate available	Highly available

Key:

High dependence	Moderate Dependence	Less dependence

BBM site 4

S/No	Type of Fishes	Scientific Name	Seasonal and Extent of availability												Favorable Habitat		Dependence level		
			Short rain raise			Short rain transition		Long rains raise		Long rains recession		Early dry season		Late dry season	Rivers	Pond	Inun-dation	Ve-locity	Depth
			OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEPT					
1.	Benasongwa	Not identified													√	√			
2.	Bula	*Schilbe*													√				
3.	Bulukutu	Not identified													√				
4.	Dagaa	Not identified													√	√			
5.	Kamba/Ngambala	*Shrimps*													√				
6.	Kambare	*Clarias* (Breathing catfish)													√	√			
7.	Kibenamdegu	Not identified													√				
8.	Kitoga	*Bagrus (Bagrid catfish)*													√				
9.	Lwepe	Not identified																	

10	Mbala	*Citharinus*													√				
11	Mbewe	Not identified													√				
12	Mdela	Not identified													√				
13	Mgundu	*Alestes*																	
14	Mgutu/machomanne	Not identified														√			
15	Mjongwa	*Heterobranchus*													√				
16	Mkunga	*Eel*													√				
17	Mlamu	Not identified													√				
18	Mnyela	Not identified													√				
19	Mtuka	*Labeo ulangensis*													√				
20	Ndipi	*Petrocephalus*													√	√			
21	Ndulupa	Not identified													√				
22	Ndungu	*Distichodus*													√				
23	Nduruka	Not identified																	

24	Ngapatwa	Not identified													√				
25	Ngogo	*Synodontis* (Squaker catfish)													√				
26	Ngulufi	*Labeo cylindricus*													√				
27	Ngunga	Not identified													√				
28	Nguyu	Not identified													√				
29	Ningu	Not identified													√				
30	Njege	*Hydrocynus* (Tiger fish)													√				
31	Njuju	*Brycinus*													√	√			
32	Nyongololo	Not identified													√	√			
33	Perege	*Tilapia*													√	√			
34	Perege Linkowo	Not identified																	
35	Sengerere	Not identified													√				
36	Sheka	Not identified													√	√			
37	Sulusulu	*Mormyrus*													√				

38	Tuku	Not identified													√				

Key:

Less available	Moderate available	Highly available

Key:

High dependence	Moderate Dependence	Less dependence

S/no	Fish Species	Scientific Name	Villages of BBM four	
			Villages	
			Merera	Lukolongo
1	Benasongwa	Not identified		
2	Bula	*Schilbe*		
3	Bulukutu	Not identified		
4	Dagaa	Not identified		
5	Kamba/Ngambala	*Shrimps*		
6	Kambare	*Clarias (Breathing cat-fish)*		
7	Kibenamdegu	Not identified		
8	Kitoga	*Bagrus (Bagrid catfish)*		
9	Lwepe	Not identified		
10	Mbala	*Citharinus*		
11	Mbewe	Not identified		
12	Mdela	Not identified		
13	Mgundu	*Alestes*		
14	Mgutu/macho manne	Not identified		
15	Mjongwa	*Heterobranchus*		
16	Mkunga	*Eel*		
17	Mlamu	Not identified		
18	Mnyela	Not identified		
19	Mtuku	*Labeo ulangensis*		
20	Ndipi	*Petrocephalus*		
21	Ndulupa	Not identified		
22	Ndungu	*Distichodus*		
23	Nduruka	Not identified		
24	Ngapatwa	Not identified		
25	Ngogo	*Synodontis (Squaker catfish)*		
26	Ngulufi	*Labeo cylindricus*		
27	Ngunga	Not identified		
28	Nguyu	Not identified		
29	Ningu	Not identified		
30	Njege	*Hydrocynus (Tiger fish)*		
31	Njuju	*Brycinus*		
32	Nyongololo	Not identified		
33	Perege	*Tilapia*		
34	Perege Linkowo	Not identified		
35	Sengerere	Not identified		
36	Sheka	Not identified		
37	Sulusulu/Njogi	*Mormyrus*		

S/no	Fish Species	Scientific Name	Villages of BBM four	
			Villages	
			Merera	Lukolongo
38	Tuku	Not identified		

S/No.	Fish species	Scientific name	Feeds	Breeding sites
1	Kambare	*Clarias* (Breathing cat-fish)	Small fishes, decom-posed soil, snail, worms	Ponds
2	Perege	*Tilapia*	Vegetation, Small fish	Ponds
3	Njege	*Hydrocynus* (Tiger fish)	Small fishes such as dagaa, small kambale, njuju, small perege and sometimes insects	Along the river bank, where water are still
4	Kitoga	*Bagrus* (Bagrid catfish)	Small fishes such as Njuju, ndipi, dagaa and worms	Along the river bank, where water are still
5	Mjongwa	*Heterobranchus*	Insects, decomposed logs, small fishes	Along the river banks
6	Ndungu	*Distichodus*	Vegetables	Along the river bank, where water are still
7	Ngulufi/Mtuku	*Labeo cylindricus /Labeo ulangensis*	Vegetation, and de-composed soils	Under the stones/caves found in the river bed
8	Njuju (small fishes)	*Brycinus*	Vegetation and insects	Along the river banks in flood plains where there is inundation
9	Kunga	Not identified	Insects and small fish-es	Under caves/stones deep down the river
10	Dagaa	Not identified	Insects	Ponds
11	Sulusulu/Ndipi	*Mormyrus/ Petrocepha-lus*	Small insects and de-composed soils	Ponds and vegeta-tion
12	Bula	*Schilbe*	Vegetation and small fishes	Along the river bank, where water

S/No.	Fish species	Scientific name	Feeds	Breeding sites
				is still
13	Sulusulu	*Mormyrus*	Worms and mud	Along the river bank, where water is still
14	Ngogo	*Synodontis* (Squaker catfish)	Worms, Vegetation, Mud, Snail	Along the river bank, where water is still
15	Mbala	*Citharinus*	Grasses and Mud	Along the river bank, where water is still
16	Nyongololo	Not identified	Small fishes	Along the river bank, where water is still
17	Mgundu	*Alestes*	Feed on snails and small fishes	Breeds on the calves under the river bank

BBM site 5

S/No	Type of Fish-es	Scientific Name	Season of availability												Favorable Habitat		Required water condition		
			Short rain raise			Short rain transition		Long rains raise		Long rains re-cession		Early dry season		Late dry season	Rivers	POND	Volume	Velocity	Depth
			OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEPT					
1	Kambare	*Clarias* (Breathing catfish)													√	√			
2	Perege	*Tilapia*													√				
3	Kitoga	*Bagrus* (Bagrid cat-fish)														√			
4	Ngogo	*Synodontis* (Squaker cat-fish)													√				
5	Bula	*Schilbe*																	
6	Njege	*Hydrocynus* (Tiger fish)													√				
7	Ndungu	*Distichodus*													√				
8	Mbala	*Citharinus*													√	√			
9	Mgundu	*Alestes*													√				
10	Sulusulu	*Mormyrus*																	
11	Ngulufi	*Labeo cylindri-cus*													√				
12	Ndipi	*Petrocephalus*														√			

13	Njuju	*Brycinus*												√					
14	Ngambalo	*Shrimps*												√					
15	Jwalajiwala	Not identified												√					
16	Kibena mdenga	Not identified												√					
17	Mabangi	Not identified												√					
18	Nguyu	Not identified												√	√				
19	Mkunga	*Eel*												√	√				
20	Mjongwa (Kambale	*Heterobranchus*												√					
21	Benasongo	Not identified													√				
22	Dagaa	Not identified													√				

Key : Seasonal fish availability

- High Availability
- Medium Availability
- Availability is low

Key: Fish water condition

- High dependence
- Moderate dependence
- Low dependence

S/No	Fish Species	Scientific Name	Villages			
			Miwangani	Mahutanga	Katindiuka	Kikwawila
1	Kambale	*Clarias* (Breathing catfish)				
2	Perege	*Tilapia*				
3	Kitoga	*Bagrus* (Bagrid catfish)				
4	Ngogo	*Synodontis* (Squaker catfish)				
5	Bula	*Schilbe*				
6	Njege	*Hydrocynus* (Tiger fish)				
7	Ndungu	*Distichodus*				
8	Mbala	*Citharinus*				
9	Mgundu	*Alestes*				
10	Sulusulu	*Mormyrus*				
11	Ngulufi	*Labeo cylindricus*				
12	Ndipi	*Petrocephalus*				
13	Njuju/Njugu	*Brycinus*				
14	Ngambalo/Ngambala/Kamba	*Shrimps*				
15	Jwalajiwala	Not identified				
16	Kibena mdenga	Not identified				
17	Mabangi	Not identified				
18	Nguyu	Not identified				
19	Mkunga	*Eel*				
20	Mjongwa (Kambale Mkubwa)	*Heterobranchus*				
21	Benasongo	Not identified				
22	Dagaa	Not identified				

S/No	Fish Species	Scientific Name	Villages			
			Miwangani	Mahutanga	Katindiuka	Kikwawila
23	Ngunga	Not identified				
24	Gundu	Not identified				
25	Mtuka/Mtuku	*Labeo ulangensis*				
26	Mbewe	Not identified				
27	Mnyela	Not identified				
28	Nyongololo	Not identified				
29	Sengerere	Not identified				
30	Sheka/Sheta	Not identified				
31	Ningu	Not identified				
32	Bulukutu	Not identified				
33	Ngapatwa	Not identified				
34	Mlamo	Not identified				
35	Njuju	*Brycinus*				

S/No.	Fish species	Scientific Name	Feeds	Breeding sites
15.	Kambare	*Clarias* (Breathing catfish)	Feeds on small fishes, Dagaa, Snakes, Snails, Frogs, decaying matter and carcasses.	Ponds and small water streams in January and February.
16.	Perege	*Tilapia*	Water reeds, dagaa, Chamvi and decomposing organic matter in soil.	Ponds, areas with still water in March and April in particular in areas with water reeds known as

S/No.	Fish species	Scientific Name	Feeds	Breeding sites
				Mafufu and Makongo.
17.	Kitoga	*Bagrus* (Bagrid catfish)	Feeds on Dagaa, Ndipi, and other small fishes	Ponds, areas with still water in March and April in particular in areas with water reeds known as Mafufu and Makongo.
18.	Ngogo	*Synodontis* (Squaker catfish)	Feed on snails, decomposing organic matter.	Oxbow-lakes (maziwa) known as Lisienga/ponds
19.	Bula	*Schilbe*	Feed on dagaa. Do not feed on dirty or decaying matters.	Areas with water reeds (Mafufu and Makongo) and in Lisienga.
20.	Njege	*Hydrocynus* (Tiger fish)	Feeding on dagaa and all other fish.	Areas with water reeds (Mafufu and Makongo) and in Lisienga.
21.	Ndungu	*Distichodus*	Feed on small fish.	Ponds
22.	Mbala	*Citharinus*	Feed on decomposed organic matter in soil, grass and dagaa	Ponds
23.	Mgundu	*Alestes*	Feeding on dagaa and all other fish.	Areas with water reeds (Mafufu and Makongo) and in Lisienga.
24.	Sulusulu	*Mormyrus*	Feed on insects and dagaa.	Areas with water reeds (Mafufu and Makongo) and in Lisienga.
25.	Ngulufi	*Labeo cylindricus*	Feed on Fruits, roots, decomposing matter in soil, and insects.	Areas with water reeds (Mafufu and Makongo) and in Lisienga.
26.	Ndipi	*Petrocephalus*	Feeds like Sulusulu i.e. on insects.	Ponds
27.	Njuju	*Brycinus*	Feed on small insects	Ponds
28.	Ngambalo	*Shrimps*	Feed on reeds i.e. Makongo	Ponds

S/No.	Fish species	Scientific Name	Feeds	Breeding sites
29.	Kwalajiwala	Not identified	Feed on reeds i.e. Makongo	Ponds
30.	Kibena mdenga	Not identified	Feed on reeds i.e. Makongo	Ponds
31.	Mabangi	Not identified	Feed on reeds i.e. Makongo	Ponds
32.	Nguyu	Not identified	Feed on decomposed organic matter in soil, roots, reeds (Makongo), insects in rocks	Ponds
33.	Mkunga	*Eel*	Do not feed on grass. Feed on meat and dagaa.	Ponds
34.	Mjongwa (Kambale Mkubwa)	*Heterobranchus*	Feed on fish and carcasses.	Ponds
35.	Benasongo	Not identified	Feed on small insects	Ponds
36.	Dagaa	Not identified	Feed on small insects	Ponds

Annex 3 Crop cultivated, period of cultivation and location of cultivation at BBM sites 1 - 5

BBM site 1

S/No.		Cultivated Crop	Period of cultivation												Location/area cultivated
			Short rain raise		Short rain transition		Long rains raise		Long rains recession			Early dry season		Late dry season	
			OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEP	
		Crops													
1	*Oryza sativa*	Rice													Valleys (in the flood plain)
2	*Zea mays*	Maize													Uplands & Valleys
3	*Manihot glaziovii*	Cassava													Highland
4	*Solanum tuberosum*	Potatoes													Valleys & uplands
5	*Musa sp*	Banana													Valleys & uplands
6	*Dioscorea asteri-cus*	Yams													Valleys
7	*Phaseolus sp*	Beans													Valleys & uplands
8	*Pennisetum sp*	Millets													Valleys & uplands
9	Not identified	Cocoa													Uplands
10	*Vigna unguicu-lata*	Cow peas (ktambaa)													Valleys
11	*Vigna sp*	Cow peas (Ksimama)													Uplands & valleys
12	*Sesamum an-gustifolium*	Sesame													Uplands
13	*Saccharum of-ficinarum*	Sugar cane													Valleys
14	*Cajanus cajan*	Mbaazi (pi-													Uplands

S/No.		Cultivated Crop	Period of cultivation												Location/area cultivated
			Short rain raise		Short rain transition		Long rains raise		Long rains recession			Early dry season		Late dry season	
			OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEP	
		geon peas)													
		Vegetables													
1	*Lycopersicon esculentum*	Tomato													Valleys
2	*Allium cepa*	Onion													Valleys
3	*Brassica oleracea*	Cabbage													Valleys
4	*Apios tuberosa*	Groundnuts													Uplands & Valleys
5	*Amaranthus spinosus*	Amaranths													Valleys
6	*Amaranthus sp*	Chainisi													Valleys
7		Nyanya Chungu													Valleys
8	*Abelmoschus esculentus*	Okra													Valleys
9	*Solanum melongena*	Eggplants													Valleys
10	Not identified	Green-beans													Valleys
11	Not identified	Figiri													Valleys
12	*Manihota glaziovii*	Kasamvu-mpira													Uplands
13	Not identified	Choroko													Valleys
14	*Ipomoea aquatica*	Matembele													Valleys
15	*Cucurbita pepo*	Pumpkins													Valleys

S/No.		Cultivated Crop	Period of cultivation												Location/area cultivated
			Short rain raise		Short rain transition		Long rains raise		Long rains recession			Early dry season		Late dry season	
			OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEP	
		Fruits													
1	*Perica papaya*	Pawpaw													Uplands
2	*Mangifera indica*	Mangoes													Uplands
3	*Citrus sp*	Oranges													Uplands
4	*Citrus tangerina*	Tangerine													Uplands
5	*Citrus sp*	Lime													Uplands
6	*Citrus sp*	Lemon													Uplands
7	*Percea americana*	avacado													Uplands
8	*Psidium sp*	Guava													Uplands
9	*Passiflora edulis*	Passion fruits													Uplands/Valleys
10	*Citrulus lanatus*	Water Melon													Valleys
11	*Cucumis sativus*	Cucumber													Valleys
12	*Ananas comosus*	Pineapple													Valleys

Key:

One farming season per year

Two farming seasons per year

Three farming seasons per year

BBM site 2

S/NO.		Cultivated Crop	Period of cultivation												Location/area cultivated
			Short rain raise			Short rain transition		Long rains raise		Long rains recession		Early dry sea-son		Late dry season	
			OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEPT	
		Crop													
1	*Oryza sativa*	Rice													Valleys (in the flood plain)
2	*Zea mays*	Maize													Uplands and in Valleys
3	*Manihot glaziovii*	Cassava													Highland
4	*Solanum tuberosum*	Potatoes													Valleys and up-lands
5	*Apios tuberosa*	Groundnut													Uplands
6	*Sesamum angustifo-lium*	Sesame													Valleys and up-lands
7	*Musa sp*	Banana													Valleys & Up-lands
8	*Theobroma cacao*	Cocoa													Uplands
9	*Vigna unguiculata*	Cow peas (Kusmama)													Uplands and in valleys
10	*Saccharum officinar-um*	Sugar cane													Valleys
11	*Cocos nucifera*	Coconut trees													Uplands
		Vegetables													
1	*Lycopersicon escu-lentum*	Tomato													Valleys

S/NO.		Cultivated Crop	Period of cultivation												Location/area cultivated
			Short rain raise			Short rain transition		Long rains raise		Long rains recession		Early dry sea-son		Late dry season	
			OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEPT	
2	*Allium cepa*	Onion													Valleys
3	*Brassica oleracea*	Cabbage													Valleys
4	*Amaranthus spi-nosus*	Amaranths													Valleys
5	*Amaranthus sp*	Chainizi													Valleys
6		Nyanya Chungu													Valleys
7	*Abelmoschus escu-lentus*	Okra													Valleys / uplands
8	*Solanum melongena*	Eggplants													Valleys
9		Beans													
10	Not identified	Figiri													Valleys
11	Not identified	Mnafu													Uplands
12	Not identified	Green paper													Valleys
13	*Ipomoea aquatica*	Potato leaves (Mtembele)													Valleys/uplands
14	Not identified	Pumpkins													Valleys
		Fruits													
1	*Perica papaya*	Pawpaw													Uplands
2	*Mangifera indica*	Mangoes													Uplands
3	*Citrus sp*	Oranges													Uplands
4	Not identified	Madalansi													Uplands
5	*Citrullus tangerina*	Tangerine													Uplands
6	*Citrus sp*	Lime													Uplands

S/NO.		Cultivated Crop	Period of cultivation												Location/area cultivated
			Short rain raise			Short rain transition		Long rains raise		Long rains recession		Early dry sea-son		Late dry season	
			OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEPT	
7	*Citrus sp*	Lemon													Uplands
8	*Percea americana*	Ovacado													Uplands
9	*Psidium sp*	Guava													Uplands
10	Not identified	Jack-fruit													Uplands
11	Not identified	Soursop fruit													Uplands
12	Not identified	Pondson													Uplands
13	*Passiflora edulis*	Passion fruits													Uplands/Valleys
14	Citrulus lanatus	Water Melon													Valleys
15	*Cucumis sativus*	Cucumber													Valleys
16	*Ananas comosus*	Pineapple													Valleys

Key:

One season farming per year

Two seasons farming per year

Three seasons farming per year

BBM site 3

S/No.		Cultivated Crop	Period of cultivation												Location/area cultivated
			Short rain raise			Short rain transition		Long rains raise		Long rains recession		Early dry season		Late dry season	
			OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEPT	
		Crops													
1	*Oryza sativa*	Rice													Valleys (flood plain)
2	*Zea mays*	Maize													Upland &Valley
3	*Vigna unguiculata*	Cow peas (Kusimama)													Valleys
4	*Sesamum angusti-folium*	Sesame													Uplands &valleys
5	*Apios tuberosa*	Groundnuts													Upland &Valley
6	*Oxytenanthera ab-yssinica*	Mianzi													Valley
7		Minazi													Upland &Valley
8	*Manihot glaziovii*	Mihogo													Upland &Valley
9		Millets													Upland &Valley
10	*Musa sp*	Banana													Upland &Valley
11	Not identified	Ulezi													Upland
12	*Solanum tu-berosum*	Potatoes													Upland &Valley
13	*Helianthus annus*	Sun flower													Upland &Valley
14	Not identified	Njugu													Upland &Valley
15	Not identified	Choroko													Upland &Valley
		Vegetables													
1	*Lycopersicon escu-*	Tomato													Valleys

S/No.		Cultivated Crop	Period of cultivation												Location/area cultivated
			Short rain raise			Short rain transition		Long rains raise		Long rains recession		Early dry season		Late dry season	
			OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEPT	
	lentum														
2	*Allium cepa*	Onion													Valleys
3	*Brassica oleracea*	Cabbage													Valleys
4	*Musa sp*	Banana													Valleys & Uplands
5	*Amaranthus spi-nosus*	Amaranths													Valleys
6	*Amaranthus sp*	Chainisi													Valleys
7	*Raphanus sativus*	Nyanya Chungu (Radish plant)													Valleys
8		Pumpkin													Valleys
9	*Manihot sp*	Cassava													Uplands
10	Not identified	Bamia													Valleys
11	Not identified	Biringanya													Valleys
12	Not identified	Sigiri													Valleys
13	*Amaranthus sp*	Spinachi													Valleys
14		Cow peas leaves													Valleys
		Fruits													
1	*Perica papaya*	Pawpaw													Uplands
2	*Mangifera indica*	Mangoes													Uplands
3	*Citrullus lanatus*	Water Melon													Valleys
4	*Cucumus sp*	Cucumber													Valleys
5	*Ananas comosus*	Pineapple													Valleys
6	*Citrus sp*	Oranges													Valleys & Uplands

Key:

			One farming season per year
			Two farming season per year
			Three farming season per year

BBM site 4

S/No.		Cultivated Crop	Period of cultivation												Location/area cultivated
				Short rain raise		Short rain transition		Long rains raise		Long rains re-cession		Early dry season		Late dry season	
			OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEPT	
		Crops													
1	*Musa sp*	Banana													Upland &Valley
2	Not identified	Choroko													Upland &Valley
3	*Vigna unguiculata*	Cow peas													Valleys
4	*Apios tuberosa*	Groundnuts													Upland &Valley
5	*Zea mays*	Maize													Upland &Valley
6	*Oxytenanthera abys-sinica*	Mianzi													Valley
7	*Manihot esculenta*	Mihogo													Upland &Valley
8	*Panicum miliaceum*	Millets													Upland &Valley
9	Not identified	Minazi													Upland &Valley
10	Not identified	Njugu													Upland &Valley
11	*Solanum tuberosum*	Potatoes													Upland &Valley
12	*Oryza sativa*	Rice													Valleys (flood plain)
13	*Sesamum angustifoli-um*	Sesame													Uplands &valleys
14	*Helianthus annus*	Sun flower													Upland &Valley
15	Not identified	Ulezi													Upland
		Vegetables													
1	*Amaranthus spinosus*	Amaranths													Valleys
2	Not identified	Bamia													Valleys

S/No.		Cultivated Crop	Period of cultivation												Location/area cultivated
			Short rain raise			Short rain transition		Long rains raise		Long rains re-cession		Early dry season		Late dry season	
			OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEPT	
3	*Musa sp*	Banana	■	■	■	■	■	■	■	■	■	■	■	■	Valleys & Uplands
4	Not identified	Biringanya								■	■	■	■		Valleys
5	*Brassica oleracea*	Cabbage	■	■									■	■	Valleys
6	*Manihot esculenta*	Cassava	■	■	■	■	■	■	■	■	■	■	■	■	Uplands
7	*Amaranthus sp*	Chainisi								■	■	■	■		Valleys
8	*Vigna unguiculata*	Cow peas								■	■	■	■		Valleys
9	Not identified	Nyanya Chungu								■	■	■	■		Valleys
10	*Allium cepa*	Onion								■	■	■	■		Valleys
11	Not identified	Pumpkin								■	■	■	■		Valleys
12	Not identified	Sigiri								■	■	■	■		Valleys
13	Not identified	Spinachi								■	■	■	■		Valleys
14	*Lycopersicon esculen-tum*	Tomato								■	■	■	■		Valleys
15	*Peponium vogelii*	Kalubwagila								■	■	■	■		Valleys
		Fruits													
1	*Cucumis sativus*	Cucumber	■										■	■	Valleys
2	*Mangifera indica*	Mangoes	■										■	■	Uplands
3	*Citrus sp*	Oranges	■						■	■	■	■	■		Valleys & Uplands
4	*Carica papaya*	Pawpaw	■										■	■	Uplands
5	*Ananas comosus*	Pineapple	■										■	■	Valleys
6	*Citrulus lanatus*	Water Melon	■						■	■	■	■	■	■	Valleys

Key:

			One farming season per year
			Two farming season per year
			Three farming season per year

BBM site 5

S/ No		Cultivated Crop	Period of cultivation												Location/area cultivated
			Short rain raise			Short rain transition		Long rains raise		Long rains recession		Early dry season		Late dry season	
			OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEPT	
		Crops													
1	*Oryza sativa*	Rice													Valleys (in the flood plain)
2	*Zea mays*	Maize													Highland &Valley
3	*Manihot esculenta*	Cassava													Highland
4	*Pennisetum sp*	Millet													Valleys
5	*Phaseolus sp*	Beans													
6	*Solanum tuberosum*	Potatoes													Valleys
7	Not identified	Cocoa													Highlands
8	*Vigna sp*	Cow peas (ktambaa)													Valleys
9	*Vigna sp*	Cow peas(Kusimama)													Valleys

S/No		Cultivated Crop	Period of cultivation												Location/area cultivated
			Short rain raise			Short rain transition		Long rains raise		Long rains recession		Early dry season		Late dry season	
			OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEPT	
10	*Sesamum angustifolium*	Sesame													Highlands
11	*Saccharum officinarum*	Sugar cane													Valleys
12	Not identified	Mbaazi													Highlands
		Vegetables													
1	*Lycopersicon esculentum*	Tomato													Valleys
2	*Allium cepa*	Onion													Valleys
3	*Brassica oleracea*	Cabbage													Valleys
4	*Musa sp*	Banana													Valleys & Uplands
5		Groundnuts													Highlands and Valleys
6	*Amaranthus spinosus*	Amaranths													Valleys
7	*Amaranthus sp*	Chainisi													Valleys

S/No		Cultivated Crop	Period of cultivation												Location/area cultivated
			Short rain raise			Short rain transition		Long rains raise		Long rains recession		Early dry season		Late dry season	
			OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEPT	
8	Not identified	Nyanya Chungu													Valleys
9	Not identified	Bamia													Valleys
10	Not identified	Biringanya													Valleys
11	Not identified	Maboga													Valleys
12	Not identified	Figiri													Valleys
13	*Manihot glaziovii*	Kasamumpira													Highlands
14	Not identified	Choroko													Valleys
15	Not identified	Matembele													Valleys
16	Not identified	Pumpkin													Valleys

S/ No		Cultivated Crop	Period of cultivation												Location/area cultivated
			Short rain raise			Short rain transition		Long rains raise		Long rains recession		Early dry season		Late dry season	
			OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEPT	
		Fruits													
1	*Perica papaya*	Paw-paw													Uplands
2	*Mangifera indica*	Mangoes													Uplands
3	*Citrulus lanatus*	Water Melon													Valleys
4	*Cucumis sativus*	Cucumber													Valleys
5	*Ananas comosus*	Pineapple													Valleys

Key:

			One farming season per year
			Two farming seasons per year

Annex 4 Natural vegetables and fruits at BBM sites 1 - 5

BBM site 1

S/No.		Natural Resources	Period of resources availability												Location found
			Short rain raise			Short rain transition		Long rains raise		Long rains re-cession		Early dry season		Late dry season	
			OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEPT	
		Vegetables													
1	*Sesbania sesban*	Liwowo													Ponds and areas with water throught the year
2 3	*Aeschynomene uni-flora*	Linyala													Ponds/valleys with moist soils throught the year
4	Not identified	Lidadangala													Ponds/valleys with moist soils throught the year throught the year
5	Not identified	Nakaberei													Farm areas in valleys which had moist soils
6	Not identified	Mhaka													Farm areas in valleys which had moist soils
7	Not identified	Namahangi													Farm areas in valleys which had moist soils
8	Not identified	Namiyundu													Farm areas in val-

S/No.		Natural Resources	Period of resources availability												Location found
			Short rain raise			Short rain transition		Long rains raise		Long rains re-cession		Early dry season		Late dry season	
			OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEPT	
															leys which had moist soils
9	Not identified	Kamdendeneka													Farm areas in valleys which had moist soils
10	Not identified	Lyulu													Uplands/forests
11	*Amaranthus spinosus*	Mchicha pori													Uplands/forests
12	*Amaranthus sp*	Mifigufugu													Uplands/forests
13	*Amaranthus sp*	Kifugufugu													Valleys/Ponds
14	*Ipomoea aquatica*	Libobombo													Valleys/Ponds
15	*Commiphora sp*	Litipitipi													Valleys/Ponds
16	*Barleria submollis*	Mwidu													Forest&Uplands
17	Not identified	Namgange													Valleys/Ponds
18	*Manihot glaziovii*	Kisamvu Mpira													Uplands
19	Not identified	Lilendi													Uplands
20	*Launaea cornuta*	Mchunga													Valleys
21	Not identified	Mlenda Pori													Valleys
		Fruits													
1	Not identified	Unanga													Found in ponds
2	Not identified	Mingulungulu													Found in ponds
3	*Vitex doniana*	Furu													Found in forests
4	*Syzygium owarience*	Zambarau													Found in forests

S/No.		Natural Resources	Period of resources availability												Location found
			Short rain raise			Short rain transition		Long rains raise		Long rains recession		Early dry season		Late dry season	
			OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEPT	
5	*Vangueria infausta*	Sada													Found in forests adjacent to rivers
6	Not identified	Mingolondwa													Found in forests
7	*Annona senegalensis*	Mitopetope													Found in forests
8	Not identified	Mingombi													Found in forests
9	*Tamarindus indica*	Ukwaju													Forest and Valleys
10	*Strychnos cocculoides*	Madongadonga													Valleys and farms
11	*Saba comorensis*	Mangombe													Forest
12	*Sorindeia madagascariensis*	Mapilipili													Valleys
13	Not identified	Bondamlomo													Forest & Valleys
14	Not identified	Masade													Upland & valleys
15	Not identified	Lukuibulu													Uplands
16	Not identified	Mapandepande													Uplands
		Animals													
1	*Hippopotamus amphibius*	Hipopotumus													Found in rivers and ponds
2	*Crocodylus niloticus*	Crocodile													Found in rivers and ponds
3	*Chelonia spp*	Turtle													Found in rivers and ponds
4	*Lutra lutra*	Otter													Found in rivers and

S/No.		Natural Resources	Period of resources availability												Location found
			Short rain raise			Short rain transition		Long rains raise		Long rains re-cession		Early dry season		Late dry season	
			OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEPT	
															ponds
6	*Varanus spp*	Monitor lizard													Found in rivers , ponds and valley
7	Not identified	Njapuli													Wilderness/ forests
8	*Thryonomys gregori-anus*	Lesser cane rat													Wilderness/ forests
9	*Kobus vardonii*	Puku													Wilderness/ forests
		Birds													
1	*Streptopelia capicola*	Ring necked Dove													Valley, ponds, rivers and uplands
2	Not identified	Twangu													Valley, ponds and rivers
3	Not identified	Ndalendale													Valley, ponds and rivers
4	Not identified	Filiwili													Valley, ponds and rivers
5	Not identified	Kimsambi													Valley, ponds and rivers
		Fuel													
1	*Antidesma venosum*	Muanga													Forests
2	Not identified	Miombo													Forests
3	Not identified	Mtogo													Forests
4	*Vitex doniana*	Mfulu													Forests

S/No.		Natural Resources	Period of resources availability												Location found
			Short rain raise			Short rain transition		Long rains raise		Long rains re-cession		Early dry season		Late dry season	
			OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEPT	
5	*Dalbergia melanoxylon*	Mpingu													Forests
6	*Annona senegalensis*	Mtopeta													Forests
7	*Senna sp*	Msonobari													Forests
8	Not identified	Bamboo													Valleys /Forests
9	Not identified	Migugu													Forests
10	Not identified	Mihimbilikiti													Forests
		Construction Materials													
1	Not identified	Bamboo													Valleys
2	*Antidesma venosumda*	Miwanga													Valleys
3	*Dalbergia melanoxylon*	Mpingu													Valleys
4	*Senna sp*	Msonobari													Valleys
5	*Cymbopogon nardus*	Mbasa grass													Valleys
6		Chekile grass													Valleys
7	Not identified	Mikangaga													Valleys
8	*Imperata cylindrica*	Misanu													Valleys
9	*Digitaria sp*	Misapi													Valleys
10	Not identified	Mbambata													Valley and uplands
		Weaving materials													
1	*Phoenix reclinata*	raffia / wild-date-palm leaves (Ukin-													Valleys

S/No.		Natural Resources	Period of resources availability												Location found
			Short rain raise			Short rain transition		Long rains raise		Long rains re-cession		Early dry season		Late dry season	
			OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEPT	
		du)													
2	Not identified	Miboro													Valleys
3	Not identified	Mifame													Valleys and ponds
4	*Hyphaene petersiana*	Malala													Forests
5		Makumbalale													Forests

S/No.		Natural Vegetables	Villages of BBM One		
			Mofu	Mbingu	Kisegese
1		Kamdendeneka			
2	*Amaranthus sp*	Kifugufugu			
3	*Manihot glaziovii*	Kisamvu Mpira			
4	*Ipomoea aquatica*	Libobombo			
5	Not identified	Lichulu			
6	Not identified	Lidadangala			
7	Not identified	Lilendi			
8	*Aeschynomene uniflo-ra*	Linyala			
9	Not identified	Lipopogolo			
10	*Commiphora sp*	Litipitipi			
11	*Sesbania sesban*	Liwowo			
12	Not identified	Lukangula			
13	Not identified	Lyulu			
14	Bidens pilosa	Mashona Nguo			
15	*Amaranthus spinosus*	Mchicha pori			
16	*Amaranthus spinosus*	Mchicha Pori			
17	*Launaea cornuta*	Mchunga			
18	Not identified	Mhaka			
19	Not identified	Mlenda Pori			
20	Not identified	Mushroom			
21	*Barleria submollis*	Mwidu			
22		Nakaberei			
23		Namahangi			
24		Namgange			
25		Namiyundu			
	TOTAL		11	13	14

S/No.		Natural Fruits	Villages of BBM One		
			Mofu	Mbingu	Kisekese
1	Not identified	Bondamlomo			
2	*Vitex doniana*	Furu			
3	Not identified	Lukuibulu			
4	*Strychnos innocua*	Madongadonga			
5	*Saba comorensis*	Mangombe			
6		Mapandepande			
7	*Sorindeia madagasca-riensis*	Mapilipili			

S/No.		Natural Fruits	Villages of BBM One		
			Mofu	Mbingu	Kisekese
8	*Vangueria infausta*	Masade			
9	Not identified	Mingolondwa			
10	Not identified	Mingombi			
11	Not identified	Mingulungulu			
12	*Annona senegalensis*	Mitopetope			
13	Not identified	Sada			
14	*Tamarindus indica*	Ukawaju			
15	Not identified	Unanga			
16	*Syzygium owariense*	Zambarau			
TOTAL			8	8	9

BBM site 2

S/No.		Natural Re-sources	Period of resources availability												Location found
			Short rain raise			Short rain transition		Long rains raise		Long rains recession		Early dry sea-son		Late dry season	
			OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEPT	
		Naural Vegetables													
1	*Sesbania sesban*	Liwowo													Valleys and Ponds/areas with water throught the year
2	*Kalanchoe sp. a sensu FTEA*	Kamdelega													Valley and Uplands
3	*Aeschynomene uniflo-ra*	Linyala													Ponds
4	Not identified	Kamdedeleka													Ponds
5	*Amaranthus spinosus*	Nafungo (Mchicha pori)													Upland areas
6	Not identified	Lukongela													Upland areas
7	Not identified	Livugua													Upland areas
8	*Barleria submollis*	Mwidu													Upland areas
9	*Ipomoea aquatica*	Libobombo													Ponds
10	Not identified	Lidadangala													Valleys and farm areas
11		Mushroom													Uplands
		Natural Fruits													
1	Not identified	Pingipingi													Upland areas
2	*Uapaca kirkiana*	Mikusu													Upland areas

S/No.		Natural Re-sources	Period of resources availability												Location found
			Short rain raise			Short rain transition		Long rains raise		Long rains recession		Early dry sea-son		Late dry season	
			OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEPT	
3	*Vitex doniana*	Mafulu													Valley and upland areas
4	Not identified	Mbwegele													Valley and upland areas
5	Not identified	Ndawatawa													Upland areas
6	*Parinari curatellifolia*	Misaula													Upland and Valley areas
7	*Vangueria infausta*	Misada													Valleys and upland areas
8	*Annona senegalensis*	Mandopeta													Valleys and upland areas
9	*Strychnos cocculoides*	Madongadonga													Valleys and upland areas
		Animals													
1	*Hippopotamus amphibius*	Hippopotamus													Found in rivers and ponds
2	*Thryonomys gregorianus*	Lesser cane rat													Valleys
3	*Kobus vardonii*	Puku													Valleys
4	*Sus scrofa*	Wildpig													Valley and Ponds
5	*Dendrohyrax arboreus*	Tree hyrax													Mountains (Udzungwa)
6	*Brachyura spp*	Crab													Rivers and valleys

S/No.		Natural Re-sources	Period of resources availability												Location found
			Short rain raise			Short rain transition		Long rains raise		Long rains recession		Early dry sea-son		Late dry season	
			OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEPT	
7	*Chelonoidis spp*	Turtle													Ponds
		Birds													
1	Not identified	Mamatele													Valleys
2	*Streptopelia capicola*	Ring necked dove													Valleys and forests
3	Not identified	Ngulaku													Valleys and mountains
4	Not identified	Kamyoyolo													Valleys
5	Not identified	Kongojole													Valleys
6	*Numida meleagris*	Guinefowl													Valleys
7	*Pternistis leucoscepus*	Yellow necked spurfowl													
8	Not identified	Kimsigili													Valley and mountains
		Insects													
1	Not identified	Maswa													
2	Not identified	Vijoholo													
3	*Gryllus spp*	Crickets													
4	*Cyptotermes spp*	flying termite													
5	Not identified	Pangopango													

BBM site 3

	Type of Vegetable/Fruits	Seasonal of availability												Location of Availability
		Short rain raise			Short rain transition		Long rains raise		Long rains recession		Early dry season		Late dry season	
		OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEPT	
	Natural vegetables													
Amaranthus sp	Amaranths													Upland &Valleys
Luffa cylindrica	Dodohi													Uplands & Valleys
Manihot glaziovii	Kisamvu Mpira													Uplands
Ipomoea aquatica	Libobombo													Valleys/Ponds
Not identified	Lidadangala													Valleys/Ponds
Aeschynomene uniflora	Linyala													Around the Ponds
Not identified	Lipombwe													Uplands
Laportea aestuans	Lipukapuka													Valleys
Corchorus triloc-ularis	Lisekeseke													Uplands and valleys
Not identified	Lisopwi													Valleys
Commiphora sp	Litipitipi													Valleys/Ponds
Not identified	Mhaka/Mnafu													Valleys/Ponds
Not identified	Mushroom													Uplands
Barleria submol-lis	Mwidu													Valleys &Uplands
Amaranthus sp	Kifugufugu													Valleys/Ponds
Sesbania sesban	Liwowo													Around the

														Ponds
Not identified	Namgange													Valleys/Ponds
Not identified	Likindawatu													Valleys
Not identified	Lukongera													Uplanda
Not identified	Mgangi													Uplands
Ipomoea aquatica	Tambere Pori													Valleys
Not identified	Unani													Uplands
Not identified	Lingetungwa													Valleys/ponds
Corchorus aestuans	Livata													Valleys/Ponds
Gynandropsis gynandra	Mgagani													Uplands
Not identified	Nyaladala													Valleys
Not identified	Mbochokela													Farmlands
Not identified	Msonga Mpini													Valleys/Ponds
Launaea cornuta	Sunga													Every where
	Natural Fruits													
Vitex doniana	Mafuru													Uplands and valleys
Tamarindus indica	Ukwaju													Uplands
Strychnos innocua	Madongandonga													Uplands
	Masade													Forest & valleys
Parinari curatellifolia	Misaula													Uplands and valley
Not identified	Minoi													Uplands, Along the rivers
Vitex payos	Miduli													Highlands
Not identified	Migapa													Along the river

														and heavy Forest
Not identified	Pingipingi													Uplands
Manilkara obovata	Usambisa													Along the river
Not identified	Migusu													Valleys, Along the rivers
Aframomum mala	Mitweve													Valleys
Uapaca kirkiana	Makusu													Uplands
Not identified	Mifudo													Uplands/Valleys
Not identified	Limbangatule													Uplands
Not identified	Msasati													Uplands
Annona senegalensis	Mitopete													Uplands
Not identified	Migapa													Uplands & Along the River
Not identified	Songwesongwe													Valleys
Not identified	Misaka													Valleys
Saba commorensis	Migolombi													Valleys
Not identified	Talali													Along the rivers
Cayratia gracilis	Fimungumungu													Valleys
Not identified	Mbakuso													Uplands
Not identified	Pingepinge													Uplands
Saba commorensis	Mangombe													Forest
Sorindeia madagascariensis	Mapilipili													Valleys
Not identified	Bonda Mlomo													
Not identified	Likuibulu													Uplands
Not identified	Mapandepande													Uplands

Not identified	Miwegele													Uplands
Not identified	Nanaunanga													Around the ponds
Not identified	Myaya													Valleys
Not identified	Mbakuso													Uplands
Not identified	Pingepinge													Uplands

S/ no		Natural Vegeta-bles	Villages of BBM three				
			Uten-gule	Chi-sano	Ma-tema	Ngalimi la	Mpan ga
1	*Amaranthus spinosus*	Ama-ranths					
2	*Luffa cylin-drica*	Dodohi					
3	*Amaranthus sp*	Kifugufu gu					
4	*Manihot gla-ziovii*	Kisamvu Mpira					
5	*Ipomoea aquatica*	Libobom bo					
6	Not identi-fied	Lidadan-dadan-gala					
7	*Sesamum an-gustifolium*	Likonge-la					
8	*Aeschy-nomene uni-flora*	Linyala					
9		Li-pombwe					
10	*Physalis an-gulata*	Lipukap uka					
11	*Corchorus trilocularis*	Lisekese ke					
12	Not identi-fied	Lisopwi					
13	*Commiphora sp*	Litipitipi					
14	*Corchorus aestuans*	Livata					
15	*Sesbania seban*	Liwowo					
16	Not identi-fied	Lukind-awatu					
17	Not identi-fied	Mbocho ke-la(Nyan ya pori)					
18	*Gynandrop-*	Mgagani					

S/no		Natural Vegetables	Villages of BBM three				
			Utengule	Chisano	Matema	Ngalimila	Mpanga
	sis gynandra						
19	Not identified	Mgangi					
20	Not identified	Mhaka/Mnafu					
21	Not identified	Msonga Mpini					
22		Mushroom					
23	*Barleria submollis*	Mwidu					
24	Not identified	Namgange					
25	Not identified	Nyakadela					
26	*Launaea cornuta*	Sunga					
27	Not identified	Unani					
		TOTAL	13	8	10	11	14

S/No.		Natural Fruits	Villages of BBM three				
			Utengule	Chisano	Matema	Ngalimila	Mpanga
1	Not identified	Bonpondlomo					
2	*Cayratia gracilis*	Fimungumungu					
3	Not identified	Limbangatule					
4	Not identified	Lukuibulu					
5	*Strychnos innocua*	Madongadonga					
6	*Vitex doniana*	Mafuru					
7	*Uapaca kirkiana*	Makusu					
8	*Saba comorensis*	Mangombe					
9	*Saba comorensis*	Manoi					
10	Not identified	Mapandepande					
11	*Sorindeia madagascariensis*	Mapilipili					
12	*Aframomum mala*	Matweve					
13	Not identified	Mbukuso					

S/No.		Natural Fruits	Villages of BBM three				
			Utengule	Chisano	Matema	Ngalimila	Mpanga
14	*Vitex payos*	Miduli					
15	Not identified	Migapa					
16	Not identified	Migolombi					
17	Not identified	Migusu					
18	Not identified	Mindopita					
19	*Vangueria infausta*	Misada					
20	*Parinari curatelli-folia*	Misaula					
21	Not identified	Miwegele					
22	*Syzygium owar-iense*	Mizambarau					
23	Not identified	Msasati					
24	Not identified	Myaya					
25	Not identified	Nanaunanga					
26	Not identified	Pingepinge					
27	Not identified	Pingipingi					
28	Not identified	Talali					
29	*Annona senega-lensis*	Topetope					
30	Not identified	Ufudu					
31	*Tamarindus indica*	Ukwaju					
32	*Manilkara obovata*	Usambisa					

BBM site 4

	Type of Vegetable	Seasonal of availability												Location of Availability
		Short rain raise			Short rain transition		Long rains raise		Long rains recession		Early dry season		Late dry season	
		OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEPT	
	Natural vegetables													
Aeschynomene uniflora	Linyala													Around the Ponds
Sesbania sesban	Liwowo													Around the Ponds
Barleria submollis	Mwidu													Forest &Uplands
Not identified	Lidadangala													Valleys/Ponds
Not identified	Namgange													Valleys/Ponds
Amaranthus sp	Kifugufugu													Valleys/Ponds
Commiphora sp	Litipitipi													Valleys/Ponds
Not identified	Mhaka/Mnafu													Valleys/Ponds
Ipomoea aquatica	Libobombo													Valleys/Ponds
Not identified	Mushroom													Uplands
Corchorus trilocularis	Lisekeseke													Uplands
Amaranthus sp	Amaranths													Upland &Valleys
Not identified	Lisopwi													Valleys
Vigna pubescens	Kunde pori													Valleys
Barleria submollis	Dyulu													Valleys
Manihot esculenta	Kisamvu													Valleys
Ipomoea sp	Matembele													Valleys
	Kalumwagila													Valleys
	Natural Fruits													
Vitex doniana	Mafuru													Along the rivers

Tamarindus indica	Ukwaju													Forest and Valleys
Strychnos coccu-loides	Madongandonga													Valleys and farms
Saba comorensis	Mangombe													Forest
Syzygium sp	Mazambarau Pori													Avery where
Not identified	Ngulungulu													Anywhere
Not identified	Mitopete													Upland & valleys
Not identified	Masade													valleys
Not identified	Likuibulu													Uplands
Not identified	Mapandepande													Uplands
Not identified	Miwegele													Uplands
Parinari *curatelli-folia*	Misaula													Uplands
Saba comorensis	Minoi													Uplands
Not identified	Migapa													Along the rivers
Not identified	Nanaunanga													Ponds
Hyphaene peter-siana	Malula													Uplands
Aframomum mala	Mitweve													Valleys
Not identified	Litopi													Forests
Not identified	Limbwelele													Uplands
Not identified	Mingulungulu													Uplands
Not identified	Vitapaluku													Uplands
Not identified	Mingolondwa													Valleys
Vitex payos	Miduli													Highlands
Not identified	Sabuni													Uplands

S/no		Natural Vegetables	Villages of BBM four	
			Merera	Lukolongo
1	*Amaranthus sp*	Amaranths		
2	Not identified	Dyulu		
3	Not identified	Kalumwagila		
4	*Amaranthus sp*	Kifugufugu		
5	*Manihot glaziovii*	Kisamvu Mpira		
6	*Vigna pubescens*	Kundepori		
7	*Ipomoea aquatica*	Libobombo		
8	Not identified	Lidadangala		
9	*Aeschynomene uniflora*	Linyala		
10	*Corchorus trilocularis*	Lisekeseke		
11	Not identified	Lisopwi		
12	*Comiphora sp*	Litipitipi		
13	*Sesbania sesban*	Liwowo		
14	*Ipomoea sp*	Matembele pori		
15	Not identified	Mhaka/Mnafu		
16	Not identified	Msonga Mpini		
17	Not identified	Mushroom		
18	*Barleria submollis*	Mwidu		
19	Not identified	Namgange		
	TOTAL		19	9
		Natural Fruits		
1	Not identified	Likuibulu		
2	Not identified	Limbwelele		
3	Not identified	Litopi		
4	Not identified	Madongandonga		
5	*Vitex doniana*	Mafuru		
6	Not identified	Malula		
7	*Saba comorensis*	Mangombe		
8	Not identified	Mapandepande		
9	*Not identified*	Masade		
10	*Syzygium sp*	Mazambarau Pori		
11	*Vitex payos*	Miduli		
12	Not identified	Migapa		
13	Not identified	Mingolondwa		
14	Not identified	Mingulungulu		
15	*Saba comorensis*	Minoi		
16	*Parinari curatellifolia*	Misaula		
17	Not identified	Mitopete		

S/no		Natural Vegetables	Villages of BBM four	
18	*Aframomum mala*	Mitweve		
19	Not identified	Miwegele		
20	Not identified	Nanaunanga		
21	Not identified	Ngulungulu		
22	Not identified	Sabuni		
23	*Tamarindus indica*	Ukwaju		
24	Not identified	Vitapaluku		
25	Not identified	Pingipingi		
26	Not identified	Mizaituni		
	TOTAL		24	5

BBM site 5

S/No.		Vegetable/Fruits	Seasonal of availability												Location
			Short rain raise			Short rain transition		Long rains raise		Long rains re-cession		Early dry season		Late dry season	
			OCT	NOV	DEC	JAN	FEB	MRC	APR	MAY	JUN	JULY	AUG	SEPT	
		Natural vegetables													
1	*Aeschynomene uni-flora*	Linyala													Ponds
2	*Sesbania sesban*	Liwowo													Ponds
3	*Barleria submollis*	Mwidu													Forest&Uplands
4	Not identified	Lidadangala													Valleys/Ponds
5	*Ipomoea aquatica*	Libobombo													Valleys/Ponds
6	Not identified	Lichulu													Around the Rivers and Ponds
7	Not identified	Mushroom													Uplands
8	Not identified	Kaluberege													Uplands
9	*Sesamum angusti-folium*	Likongela													Valleys
10	Not identified	Libakulambule													valleys
11	*Ipomoea aquatica*	Matembele pori													Valleys
12	*Amaranthus spi-nosus*	Mchicha pori													Upland/valleys
13	Not identified	Suga													Valleys
14	*Vigna pubescens*	Kunde pori													Upland/valleys
		Natural Fruits													
1	*Vitex doniana*	Mafulu													Forest and valleys

2	*Tamarindus indica*	Ukwaju													Forest and Valleys
3	Not identified	Madongandonga													Valleys and farms
4	Not identified	Unanga													Valleys & ponds
5	Not identified	Ndopeta													Uplands/valley
6	Not identified	Mandatawa													Upland & valleys
7	*Syzygium owar-iense*	Mizambarau pori													Uplands
8	*Dioscorea astericus*	Mapambika													Uplands
9	*Annona senega-lensis*	Topetope													Uplands
10	*Dioscorea hirtiflora*	Mayao													Uplands
11	*Sclerocarya birrea*	Mang'ongo													Uplands

BBM site 5

S/no		Natural Vegetables	Villages			
			Kikwawila	Miwangani	Katindiuka	Mahutanga
1	Not identified	Kaluberege				
2	*Vigna pubescens*	Kunde pori				
3	Not identified	Libakulambule				
4	*Ipomoea aquatica*	Libobombo				
5	Not identified	Lichulu				
6	Not identified	Lidadangala				
7	*Sesamum angustifolium*	Likongela				
8	*Aeschynomene uniflora*	Linyala				
9	*Sesbania sesban*	Liwowo				
10	*Ipomoea aquatica*	Matembele pori				
11	*Amaranthus spinosus*	Mchicha pori/Nafungo				
12	Not identified	Mushroom				
13	*Barleria submollis*	Mwidu				
14	*Launaea cornuta*	Sunga				
		Natural Fruits				
37.	Not identified	Madongadonga				
38.	*Vitex doniana*	Mafulu				
39.	Not identified	Mandawatawa				
40.	*Dioscorea astericus*	Mapambika				
41.	*Dioscorea hirtiflora*	Mayao				
42.	*Syzygium sp*	Mizambarau pori				
43.	*Sclerocarya*	Mng'ong'o				

S/no		Natural Vegetables	Villages			
			Kikwawila	Miwangani	Katindiuka	Mahutanga
	birrea					
44.	Not identi-fied	Nanaunanga/Unanga				
45.	*Annona sene-galensis*	Ndopeta				
46.	*Annona sene-galensis*	Topetope				
47.	*Tamarindus indica*	Ukwaju				

Annex 6. Coordinates of bio-physical features

Coordinate BBM site 1 (Distances to Lwipa river)	37 S UTM	**X_coordinate**	**Y_Coordinate**	**Distances**	**Description**
Mbingu Village		200828	9092224	1.868 Km	Settlement area in Mbingu village (coordinate at Vigaeni primary school)
		201853	9099407	0.492 Km	Coordinates taken at Chiwachiwa primary school
		205351	9096953		River Lwipa
Kisegese village		206338	9097241	4.884 Km	Settlement area in the village (point taken at Kisegese Primary school)
		206957	9096431	5.32 Km	Point of water level for years with high rainfall
		206285	9097535	4.794 Km	Point of water level for years with normal rainfall. Also it is a farm area for rice (during rainy season) and maize during dry season.
		206145	9097821	4.666 Km	Point of water level for years with low rainfall
		206158	9097780	4.674 Km	Rice farming area
		206016	9097853		Lwipa river
		207130	9095165	5.065 Km	Nambaya pond
		205881	9099221		Itende pond
Mofu village		206848	9083031	0.508 Km	Village settlement area-Point taken at village office
		205364	9084416	1.04 Km	Point of water level for years with high rainfall
		206272	9084248	0.136 Km (cross check)	Point of water level for years with normal rainfall
		207109	9083340	0.72 Km	Point of water level for years with little rainfall
		205819	9084310	0.589 Km	Point taken at Ngumbingumbi seasonal river. Also water fills seasonal rivers (including Ngumbingumbi river) first when it rains
		206964	9084064		Point taken at Lwipa River. Lwipa river overflows to inundate farm areas in Mofu village.

		204934	9087026	1.484 Km	Point taken in Namikolowa forest Mofu village
		208126	9085463	1.051 Km	Grazing land Mofu village
BBM site 2 Udagaji Village (distances to Udagaji and Kihansi rivers)	36 S UTM	818649	9048313	2.464 Km	Settlement Area in Udagaji village. Point taken at Udagaji village office
		816923	9046555		Udagaji river -point taken in the river bank
		817237	9046331	0.385 Km	Valley plain of Udagaji river, point taken in farm area of udagaji valley
		818006	9046211		Mnyoli pond in Udagaji valley. Point taken at railway crossing area.
		815592	9046229	1.370 Km	Udagaji valley, area with rice farms
		815574	9046188	1.398 Km	Kihansi River
		815450	9046215	1.12 Km	Meeting point of Kihansi River with water from Kihansi hydropower sta-tion
		816605	9046332	0.388 Km	Udagaji valley, area with rice and maize farms
		816580	9046775	0.407 Km	Udagaji valley, area with rice and maize farms
BBM Site 3 Ngalimila village(Distances to Mpanga river)		818862	9008989	3.812 km	End of inundation for years with relatively High rainfall
		819269	9008249	2.747 Km	End of inundation for years with relatively Normal rainfall
		821041	9007100	0.234 Km	End of inundation for years with relatively low rainfall
		818724	9009106	2.296 Km	End of inundation in the past 40 and 30 decades
		817573	9009035	1.674 Km	Ngalimila Settlement Area, Coordinate taken at Roman Catholic Church
		820371	9007260		Farm areas in Ngalimila
BBM site 3 Matema village		802208	9018106	3.866 Km	Lumumwe village settlement area
		804611	9021440	7.842 Km	Matema village settlement area (Point taken at the village market)

		803922	9017086	4.202 Km	Mpungulus valley where people have farms for maize, sesame and rice
		806014	9020048	8.945 Km	Sesame and Maize farms in upland areas in Matema
		805477	9023891	10.451 Km	Area with bamboo trees in Matema village
BBM site 3 Mpanga village		810813	9012508	1.248 Km	End of inundation for years with relatively Normal rainfall .
		810850	9012526	1.297 Km	End of inundation for years with relatively low rainfall
		809799	9011854	0.677 Km	Settlement area in the village (point taken at the village center)
		810671	9012348	1.078 Km	Farming area
BBM site 3 Utengule village		809868	9010978	0.245 Km	End of inundation for years with relatively High rainfall
		809854	9010983	0.200 Km (cross check)	End of inundation for years with relatively Normal rainfall .
		809868	9010978		End of inundation for years with relatively low rainfall
		812580	9009470	0.182 Km (184.2 metres)	Settlement area in the village (point taken at Utengule Primary school)
		808487	9007879	3.392 Km	Farming area
		816393	9001920	4.702 km	Ngapemba Fish Camp
BBM site 3 Chisano village		816897	9041088	14.341 Km	Tandalatab valleys (Livestock grazing areas)
		816540	9040547	14.394 Km	Chisano Farms
		819051	9041155	12.090 Km	Mkwekwea valleys- only rice cultivated
BBM site 4 Lukolongo village (Distance to Kilombero river)		183939	9079111		Settlement area in Lukolongo village-coordinate taken at village office Lukolongo
		183290	9077357		Meeting point of rivers Mchombo and

					Mngeta
BBM site 4 Merera village		173702	9047277	2.875 Km	Mrera Ranch
		174119	9051279	4.654 Km	Merera Farms
		172212	9054605	8.154 Km	Merera Residents
		830069	9054319		River Kihansi (Darajani)
BBM Site 5 Mahutanga Village (Distance to Kilombero river)	37 S UT M	241476	9099586	5.256 Km	Settlement area in the village (Coordinate taken at Mahutanga Primary School)
		240314	9099706	5.550 Km	Mahutanga mission forest plantation
		240497	9098166	4.09K m	Point of water level in years with floods
		240140	9097640	3.66 Km	Point of water level in years with drought
		240017	9097360	3.468 Km	Kilombero Game Controlled Area (KGCA) Bicon at Mahutanga, also point of water level regularly reached during normal rain season
		240451	9098174		Mahutanga grave yard
		239927	9097155	3.338 Km	Lukwandali oxbow lake (Ritual site)
		239829	9095882	2.383 Km	Kitandala Big pond/oxbow lake
		239419	9096158	2.872 Km	Point taken in area having small oxbow-lakes in Mahutanga
		247102	9101101	2.960 Km	Settlement area. Point taken at Katindiuka Primary School
BBM site 5 Katindiuka Village	37 S UT M	252210	9098233		Kilombero river
		251758	9098290	0.613 km	Luono Fishermen's camp found at the banks of Kilombero river.
		249526	9099844	1.745 Km	Point of water level (for water from Kilombero river) for years with high rainfall. Rice farms were found in the area.
		249884	9099178	1.137 Km	Point of water level (for water from Kilombero river) during normal/regualar rainfall. Rice farms were

					found in the area.
		250244	9099035	1.080 Km	Point of water level (for water from Kilombero river) for years with little rainfall. Rice farms were found in the area.
		251674	9098383	0.681 km	Grazing land during dry season. Grazing was done close to Kilombero river.
		249374	9098350	0.332 Km	Ngata pond. Water comes from Main Kilombero river forming Ngata pond and returns to Kilombero river.
		250439	9098956	1.080 Km	Mbaji seasonal river in Kilombero valley
		246205	9100100	3.933 Km	Katindika seasonal river. Brick making was mainly done along the seasonal river. Rice husks were used as fuel material for brick making in the area.
		246304	9100543	4.096 Km	Katindiuka pond. Brick making is also done around this area. Katindiuka seasonal river gets water to the pond.
		247586	9100225	2.994 Km	Maize farms area
		247552	9099980	4.054 Km	Chalu kwa Kitenga, a small hut (about 1m in height) made sticks and thatch grass was found with some earthened cooking pots inside it. Found at a place where Mbuyi Kitenga lived. There were trees including Mfulu tree, Coconut trees, Mango tree and Teak trees and surrounded by farms.
		247846	9099750	2.402 Km	Brick making area close to Chalu kwa Maanyika. Firewood and or rice husks were used as fuel material in the area
		247940	9099766	2.350 Km	Chalu kwa Maanyika. Mzee Maanyika lived in the area, and was burried there. It is close to and old womans' house. Trees including Mango trees, Senna siamea tree species and palm tree.
BBM site 5 Kikwawila village	37 S UT M	252351	9103394	5.162 Km	Point of water level for water from Kilombero river in years with heavy rains. Reference year 1998 (During el nino rains)
		247135	9104390	6.753 Km	Maize and Banana Farms in Kapolo valley Kikwawila
		247339	9104263	6.562 Km	Kapolo Pond in Kikwawila village. Children were found fishing, catfish was observed. Also natural vegetables i.e. Linyala, Liwowo and Lidadangala

					were found.
		247179	9104439	6.783 Km	Cultivated Vegetables were found in Kapolo valley including Okra, Eggplant and Amaranth
		247168	9104647	7.026 Km	Rice fields at Kapolo valley
		247429	9104598	6.849 Km	Kwamatunga seasonal river taking water to Kapolo pond. Point taken in Kapolo valley.
		247078	9105070	7.410 Km	Settlement area in Kikwawila village. Point taken at the collage of hospitality in the village.
		248950	9104953	7.789 Km	Kikwawila river
		250315	9105324	7.760 Km	Lihitu la Ndembo River
		251348	9105232	7.484 Km	Kikwawila valley. Rice and maize were cultivated in the valley.
		252727	9102630	4.891 Km	Point of water level during normal rains. Muhomakilo valley.
		251369	9105525		Kwakilawa River
		251904	9104888	7.030 Km	Muhomakilo valley maize farms
		251672	9106496	8.715 Km	Grazing land during rain season
		251909	9106858	9.078 Km	Matawale area, stone quarry. Men and women work at the stone quarry, but mostly women.
		251922	9106871		Isomba river. Point taken at the village boundery with Lungongole village. It is an area where livestock animals get water and pasture.