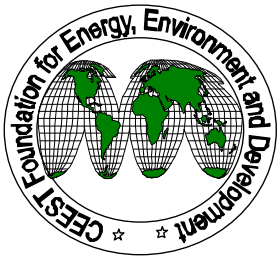

THE CENTRE FOR ENERGY, ENVIRONMENT, SCIENCE AND TECHNOLOGY (CEEST FOUNDATION)

NETHERLANDS CLIMATE CHANGE ASSISTANCE PROGRAMME (NCAP)

DRAFT FINAL REPORT

Climate Change Impacts on Livelihoods in Tanzania and Adaptation Options: Experience of floods and drought in Rufiji

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1.0 Introduction

The study was conducted by CEEST-Foundation under the leadership of Hubert E. Meena, as NCAP National Coordinator in collaboration with the Vice President's Office (Division of Environment), Envirocare institution, The Tanzania Traditional Energy Development and Environment Organisation (TaTEDO) and African Links.

This report documents the findings of a study consisting of a household questionnaire carried out in January 2005 and a Participatory Rural Appraisal (PRA) carried out in March 2006. The study investigates technical and policy options for adaptation to the consequences of climate change in Rufiji, Tanzania, looking at improvements at community level in which will enable adoption of a range of low cost, technically uncomplicated and easily accessible adaptation strategies.

1.1 Climate Change

It is now widely accepted by scientists and the Intergovernmental Panel on Climate Change (IPCC) that despite any future reductions in greenhouse gas emissions, climate change is already underway (IUCN et al, 2003,). Devastating effects on communities (loss of life, human suffering and destruction of infrastructure and natural resources which people's livelihoods depend) brought by the rising total of existing climate variability and extreme events foreshadows the likely adverse future impacts of climate change. It has been accepted that adaptation has some role to play in responding to climate change as seen in recent policy focuses through the United Nations Framework Convention on Climate Change (UNFCCC) (IUCN et al, 2004; Eriksen et al, 2005).

High levels of vulnerability in the developing worlds are linked to a range of factors including a high reliance on natural resources. Whatever the effects of climate change will be (sea level rise, increased floods, drought, disease), the most vulnerable groups will be the poor who depend whose ability to withstand environmental shocks and stresses to their livelihoods are low (Adger, 2003; IUCN et al, 2004 & Thomas et al, 2005).

1.2 Tanzania's Initial National Communications to the UNFCCC

Tanzania's Initial National Communication to the United Nations Convention on Climate Change (UNFCCC) documented the following:

- Ø Anthropogenic greenhouse gas sources and removals and technological and policy options for GHG mitigation
- Ø Assessment of vulnerability to climate change impacts and adaptation strategies
- Ø National economic and development strategies
- Ø Systematic observation and strategies
- Ø Implementation strategies

Vulnerability to climate change impacts was analysed in the context of biophysical impacts over a range of sectors (forestry, agriculture, rangeland/livestock, coastal resources, biodiversity and health).

1.2.1 Impacts, Vulnerabilities & Adaptation

General Circulation Models (GCM) used to develop scenarios predicts that in Tanzania, as whole, mean daily temperatures will increase by 3.5°C. This increase will have differing effects over seasons and in different regions. Rainfall is predicted to decrease in some regions by 5 – 15% while increasing between 5 – 45% in others.

The resulting climate and ecological zone shifts will have drastic effects on the sectors listed above. In agriculture, coffee and cotton growing zones will change (becoming either more or less productive) while maize yields will decrease by an average of 33% for the whole of Tanzania.

Some rivers may experience more runoff, thereby increasing risk of damage caused by floods, while reduced river flow in others will have serious effects for power generation and water management. Decreased precipitation will increase water demand in some regions, reducing its availability for agriculture, while increased precipitation in others will increase nutrient leeching.

Increased temperature and moisture will increase the burden of disease (particularly Malaria) in Tanzania, as more areas will provide ideal conditions for disease vectors (Mosquitoes).

Suggested adaptation measures include use of drought resistant varieties, practices to reduce mineral leeching and improve water retention (minimal tilling, mulching etc), pest/disease control, groundwater development, rainwater harvesting, water saving and conservation technologies and practices and in dealing with health issues a multi-sectoral approach combining prevention measures, medicine availability, vector control etc is needed (UNFCCC, 2003).

Although discussing key issues such as poverty and development, the limitations of the initial national communications are that they focus mainly on biophysical and technical aspects, do not provide a clear framework for adaptation assessment of vulnerable group uptake. Additionally current knowledge of adaptive capacity is insufficient for a rigorous evaluation of planned adaptive measures. (Mwandosya et al, 1998; Ikeme, 2003).

1.3 Relevance of the NAPA and MKUKUTA Processes

1.3.1 The NAPA

The second key steps of NAPA, were the entry point for the NCAP study. The aim here was to complement the top-down NAPA approach with the bottom up approach of NCAP. Trying to show how people at local community level are vulnerable to climate

change impact and how they adapt themselves to problem. Also indicated the adaptive capacity at community level, gaps, and assistance required for adaptation.

The main findings of the NAPA, include, among others, the following:

- Climate change is already impacting Tanzania key sectors of the economy.
- There is evidence of decreased rainfall over time and increased temperatures overtime for the areas where studies have been conducted
- Analysis of total annual rainfall for 21 meteorological stations in selected regions of Tanzania indicated that there is a decreasing trend for over 13 stations (61.9%) whereas an increasing rainfall trend was observed over 7 stations (33.33%) and 1 station had almost a constant pattern. However, one common feature of the rainfall pattern was a greater variability in cycles.

Important information on food security, rural water supply and health, was obtained and analysed in order to study their relevance with the vulnerability and adaptation to climate change impacts, of the local community in Rufiji District.

The bottom-up approach used here was able to directly link the NAPA findings especially the climate change impacts and vulnerability with the communities at household level especially the agriculture (food security), rural water supply and health aspects. These were done with integration of the poverty and gender issues at the grassroots in relation to how individual households were impacted and their response mechanisms which was not the case in the NAPA findings hence bottom-up approach was the strength of the NCAP part, which complimented the top-down approach of NAPA.

1.3.2 The MKUKUTA process

Tanzania in the implementation of the NCAP involved members who also are working group that supports the PRSP process with studies and analysis later on NSGRP. These members of the PRSP assisted on the elaboration of PRSP process and its integration to other developmental issues including environment. The PRSP process is a vigorous and effective which characterized by a high degree of country ownership, transparent and participatory one that involves all sectors in Tanzania.

The Team member of the PRSP was also responsible for the Participatory Poverty Assessment (PPA). Thus communication and effective integration of the results of the proposed NCAP studies into the process of continuous improvement of the PRSP process in Tanzania, however, this was not much achieved because some of these member were not active in participating in NCAP activities due to being very busy, with the preparation of MKUKUTA / NSGRP.

The Participatory Poverty Assessment utilized the concept of “vulnerability” – a powerful concept for understanding the resilience of household livelihood systems in the face of a wide variety of uncertainties and external stresses. However, vulnerability is

only one side of a coin. The other side is "capacity". The NCAP studies enriched the prior PPA by investigating the present capacity of rural women and local communities in Rufiji area to cope with extreme climate change through PRA and survey.

During the first cycle of PRSP review the judgment was that poverty reduction efforts in Tanzania did not have sufficient emphasis on health, agriculture, environment, gender, and rural water supply. These areas were still not – in the second review cycle – being addressed and strengthened. The PRSP was also silent on climate change. These missing aspects of poverty reduction were the precise focuses of the NCAP studies for Tanzania. Although the NCAP in Tanzania did not adequately influenced the PRSP process on these issues. We think this can be also taken further during the NCAP Phase II in Tanzania, to make sure that the PRSP working groups understand fully issues of climate change at community level and its integration with poverty reduction effort.

Tanzania has not reduced food poverty significantly since its independence. Tanzania's policies remain somewhat contradictory to the extent that they emphasize the large scale commercial agricultural sector and traditional export crops while also expressing a commitment to rural development in a country where the majority of the people survive by rain-fed, semi-subsistence agriculture (4 million households in 8,000 villages). There has also been a bias in favour of urban water supply so far in the National Water Strategy. The public and policy debate around the focuses of the NCAP studies was to help to clarify and resolve these apparent contradictions. Since Tanzania's PRS process is an open and transparent one, and since the NCAP studies was structured to feed directly into the Vice President's Office, such debate somehow was positive, constructive, and fruitful, although more time is required to make total influence, probably NCAP Phase II will have an answer to that.

1.4 Integrated Approach

Vulnerability, in the context of climate change is the degree of susceptibility or inability of a system to cope with the adverse effects of climate change, including climate variability and extremes. Adaptive capacity is conversely; the ability to adjust, moderate potential damages, take advantage of opportunities, and cope with consequences of climate change, variability and extreme events.
The above definitions offer a useful but broad perspective on matters of vulnerability and adaptation. Past research has illustrated vulnerability in the context of heterogeneity within places, whereby differing access and entitlement to resources occurs upon many lines (e.g. age, gender, wealth status and education) resulting in one single event producing differing effects over different groups (Eriksen et al, 2005). Adaptation is defined as adjustment in behaviour and or economic structures to reduce society's vulnerability to climate change (URT, 2003). Eriksen et al (2005) illustrate that coping mechanisms (resilience) refer to actions and activities taking place within existing structures while adaptation involves changing the broad frameworks.

Adaptive capacity and thus, adaptation are innately linked with issues such as vulnerability and resilience of people's livelihoods, therefore any adaptation strategy should reflect the livelihoods of such people (IUCN et al, 2004).

As adaptation is linked to vulnerability and resilience of people's livelihoods, adaptation strategies should reflect livelihoods of people, paying attention to factors that determine the vulnerability of different groups as well as existing coping strategies that may already be in place (IUCN et al, 2004).

1.4.1 Livelihoods Framework

The Sustainable Livelihoods Framework developed by DFID (1997) (Figure 1.) provides an entry point for assessing current levels of vulnerability and resilience of the poor. It helps assess livelihood construction using assets and the ways they are affected by vulnerability to shocks, trends and seasonality. It also relates livelihoods to government and private structures as well as processes, which affect people's lives (laws, culture etc) and finally to outcomes people expect to achieve from engaging in certain activities.

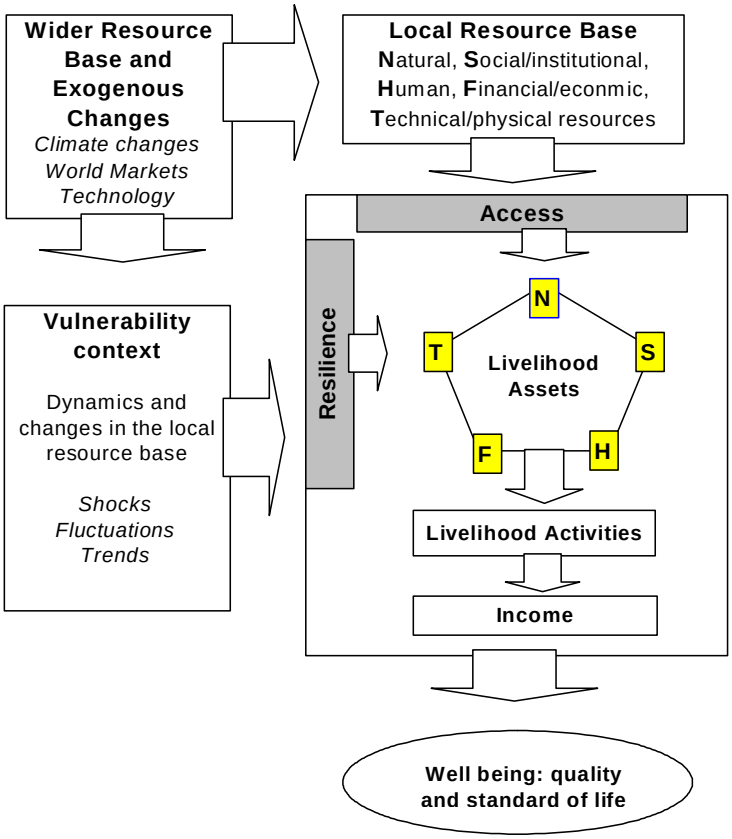

Figure 1. Sustainable Livelihoods Framework (DFID, 1997)

People require a range of livelihood assets in order to achieve livelihood outcomes. No one single asset can function independently of others in order to generate livelihood outcomes. Measuring such assets is essential as this enables analysis of the ways people construct their livelihoods and substitute one capital to replace others in order to cope during periods of shock and stress. Livelihoods are measured in terms of the following: (DFID, 1997).

- Ø Human Capital (Labour potential, health status, education and skills)
- Ø Social Capital (Entertainment, sports, community/group functions)
- Ø Natural Capital (Natural resource stocks and flows)
- Ø Physical Capital (Infrastructure such as transport, housing, water and sanitation)
- Ø Financial Capital (Earned income, savings, credit facilities etc)

1.5 Aims and Objectives of the study

The main objective of the study is to analyse impact of climate change on livelihoods in the Rufiji Basin in terms of impacts of flood and drought on agriculture, water and sanitation and health. In looking at existing responses of people to such events, examine the shortfalls in responses and assess what can be done in order to strengthen future responses to climate change impacts.

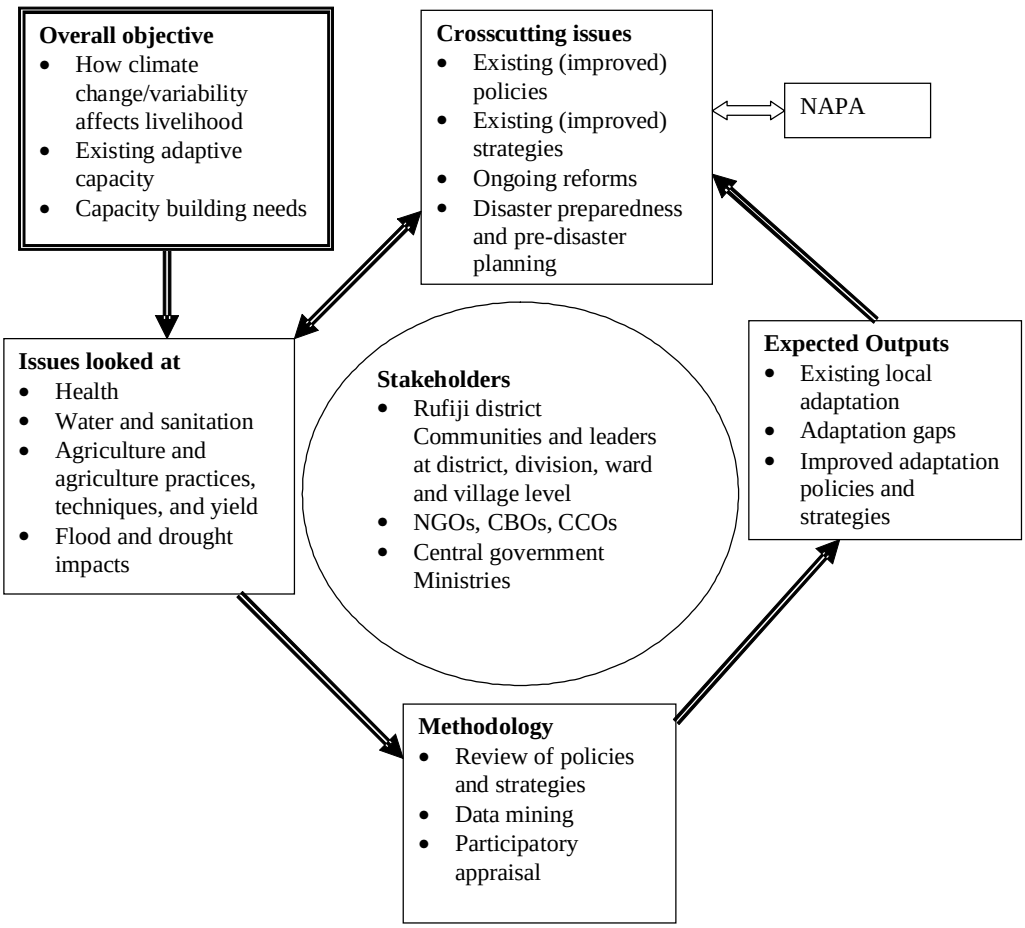

Figure 2. Study overview

This study also coincides with the aims of NCAP, which include, among others, the following:

- Ø To verify the extent to which rural women have already adapted themselves to climate extremes
- Ø To determine the obstacles which have hindered the adoption of some available low cost, technically uncomplicated technologies
- Ø To identify qualitatively and understanding variables and processes that are involved in adaptation and coping mechanism at village level and
- Ø To analyze coping mechanisms which are known and practiced by women and men in the face of variability and climate extremes (floods and drought). Specific focus would be on examining change on the livelihood systems of poor communities

2.0 The Study Area

Located 178 km south of Dar es Salaam and rising to 100 m above seal level, Rufiji, the largest of six coastal districts covers 13,339 km^2 and is comprised of 6 divisions, 19 wards and 91 villages. The Rufiji River divides the district into roughly equal halves.

Climate in Rufiji consists of two rainy seasons: short rains (October – December) and long rains (February - May). Average annual precipitation is 800-1000 mm.

The population of Rufiji in 2002 was 202,001 (97,735 males and 104,266 females). Population density was 15.14 people per km^2. Average household size in rural regions was 4.26. Education in the region is generally poor with high proportions never having attended or simply dropping out of school. Figures are considerably worse for girls. Only small percentages of the population attend secondary school and drop out rates are even greater than primary education.

2.1 Water

The main sources of water in Rufiji include rivers, boreholes (deep wells), shallow wells, natural dams, piped water and rainwater harvesting however these resources are generally poorly developed (especially boreholes and rainwater harvesting) leading to pressure on existing sources and demand for new ones. Water quality varies significantly with many boreholes and shallow wells containing saline water. Of the 33 wells and 32 hand pumps installed by the government in 1996 only 9 wells and 15 pumps still functioned a year later. Such projects have often failed and installation of irrigation infrastructure in the 1970's has been abandoned. There are concerns over water-borne disease in the region where only 41.6% of the population have toilets, the majority of which are unimproved pit latrines (NBS, 1997).

The effects of such pressures on water resources already cause reduced flows and drying of some rivers as well as increased effects of drought in the region.

Small seasonal floods control many activities in the floodplains, bringing in fertile silts, though many in the rein do not perceive these as floods. Larger scale flooding occurs on average every four years while disastrous floods occur every ten years on average. Such floods have significant impacts on livelihoods by destroying harvests, property, infrastructure and causing loss of life. People adapt and organise their activities according to the seasons. Small seasonal floodwaters are used to cultivate rice, maize, vegetables and fruits and people living on the floodplains either migrate between houses or use suspended temporary homes called 'Dungus' (see Figure 3) (Lilende, 2004 Personal Communication and Mwageni et al. 2005). Forced resettlement projects of households from the floodplains into upper regions by the government in the 1970's is largely responsible for such migrations as people were not provided with sufficient assets to adequately construct livelihoods. The projects failed to situate people away from the floodplains (Ngusaru, 2000; Sandberg, 2004).

Figure 3. Dungu structure in Rufiji floodplain.

2.2 Food Security

The region is highly dependant upon agriculture with 78% of residents engaged in agricultural activities over only 18% of available land (NBS, 2004). Food security is a concern due to geographical, environmental and socio-economic situations in the region. (Mascarenhas, 2000). Average daily calorific intake for the region is below international minimum standards and malnutrition accounts for 80% of maternal death.

Land is underutilised in Rufiji and is mainly used for small-scale subsistence purposes. Small hand tools (hoes, bush knives) are mainly used and agriculture is rain-fed as machinery and irrigation are largely absent. The introduction of modern market economics (crop, capital, labour and property markets) in the region during the late 20th century increased livelihood risks due to low labour returns of agricultural production. Additionally, the drive towards an export based agricultural system with larger agricultural plots failed to improve livelihoods.

Ownership of cattle in Rufiji is very low with only 1,004 heads of cattle (0.9% of cattle in the coastal region (116,752)) in 1996. No regional figures were available for goats and poultry but coastal region figures for 1996 were 25,574 and 1,065,000 respectively.

2.3 Health

Despite the efforts of Health Education Programmes (HEPs), disease incidence in Rufiji is still above acceptable levels (MoH, 2003). Sanitary diseases are prevalent in the area as is malaria. The poorest households are most at risk of morbidity and mortality as shown by Mwageni et al (2005) who found that infant mortality was highest in the lowest income households.

2.4 Climate Change Impacts

As discussed in the Initial Communication, areas with bimodal precipitation such as the coastal zone will experience an increase in precipitation (5 – 45%) because of climate change. Situated near the coast, Rufiji is expected to receive mean daily temperature increases between 2.7°C and 3.1°C.

Although precipitation will increase, rainfall patterns will become less reliable and less predictable. Such change is likely to result in delays in onsets as well as shortening of rainy seasons. Such changes would likely result in shifts in seasons which people organise their activities around as well as increased incidence and severity of drought (Mwandosya et al, 1998).

Yields of maize, a staple crop in Rufiji will decrease due to increased temperature and unpredictable rainfall. Although no figures are available as of yet for Rufiji there will be significant decreases in average yields of crops such as maize.

The River Rufiji is predicted to receive an increase in flow rate, which will likely increase the frequency and severity of floods, which occur in Rufiji.

Increased precipitation and temperatures are expected to increase the burden of disease in Rufiji as more favourable conditions are created for malaria vectors to breed and survive. (UNFCCC initial communication, 2003)

The impacts brought by climate change will work to reinforce the cycle of poverty in the region, creating severe social and economic costs, which will affect human capital and general economic development. Thus, climate change will have severe adverse impacts

on the livelihoods of people who are currently struggling to overcome the burdens of poverty, poor water supply and quality, food insecurity and disease. Therefore the need to adapt is apparent, however prevailing vulnerability and adaptive capacity in the region need to be assessed before such measures can be undertaken effectively (Ikeme, 2003).

3.0 METHODOLOGY

3.1 Questionnaire

The questionnaire was conducted between 13/1/2005 and 19/1/2005 by 20 people (8 women and 12 men) recruited as enumerators. The questionnaire consisted of 161 questions designed to quantify livelihood assets in the region such as household information, water, sanitation, housing conditions, household assets and expenditure. Agriculture, floods, drought, health and climate change were also explored.

3.1.1 Sample Design & Strategy

The study area was divided into two strata (Upland and Lowland). To capture the conditions of the strata, Kibiti (upland), Ikwiriri (both upland & floodplain) and Muhoro (floodplain) divisions were selected. 1/10 of the wards contained in all 3 divisions were randomly selected to gather information Steel & Torrie, 1980).

500 households were to be sampled in each stratum. Project members aimed to interview 400 households in Kibiti, 400 households in Ikwiriri (200 households each for Upland and Lowland respectively) and 200 households in Muhoro. In total however, only 976 households wee interviewed.

3.2 Participatory Rural Appraisal (PRA)

Participatory Rural Appraisal (PRA) studies were carried out between 25th and 26th March 2006 in Rubada, Ikwiriri. The main objective of the study was to collect qualitative data. The event included local leaders, and community participants from Ikwiriri, Muhoro and Kibiti.

A checklist of issues to be looked into was prepared and used to lead the participants in discussing the issues related to

- Major historical events of the area
- Various assets and their dates of being installed
- Community and household calendars
- Participation in household activities in gender perspective
- Major catastrophic events like floods and droughts
- Poverty indicators in terms of food intake and access to schooling facilities for children
- Off farm activities and incomes

- Social activities and their timing

A ranking exercise was carried out first by identifying problems faced. A secret ballot was conducted whereby women used beans and men used maize to indicate their ranking of the significance of each problem.

4.0 Results

4.1 General Characteristics

Households were predominantly male-headed with an average age of 46.7 years. Households headed by those 65+ and >20 years of age formed the highest and lowest proportions of heads in the study area respectively. Most male and only a few female household heads were married. More female headed households were classified as divorced/separated or widowed (Annex Tables 1-3)

Table 1: Age Group by Marital Status

	MARITAL STATUS				TOTAL
	Never	Married	Separated/Divorced	Widow/Widower	
Less than 20	10(1.1)[1]	5(0.6)	2(0.2)	-(-)	17(1.9)
20 – 24	23(2.6)	54(6.2)	7(0.8)	-(-)	84(9.6)
25 – 29	24(2.7)	75(8.6)	16(1.8)	-(-)	115(13.1)
30 – 34	16(1.6)	95(10.8)	13(1.5)	3(0.3)	127(14.5)
35 – 39	11(1.3)	88(10.0)	10(1.1)	1(0.1)	110(12.6)
45 – 49	- (-)	45(5.1)	7(0.8)	3(0.3)	55(6.3)
50 – 54	1(0.1)	41(4.7)	1(0.1)	2(0.2)	45(5.1)
60 – 64	1(0.1)	45(5.1)	4(0.5)	5 (0.6)	55(6.3)
65+	1(0.1)	137(15.6)	28(3.2)	21(2.4)	187(21.3)
Total	88(10.0)	659(75.2)	93 (10.6)	36(4.1)	876(100.0)

Numbers in the brackets are percentages

The majority of respondents are educated to primary level, followed by high numbers of uneducated people. Beyond primary, those who attained higher education decreased dramatically. The same occurs for literacy status (Annex Table 4)

Table 2: Education Attainment by Marital Status ($P \leq 0.05$)

EDUCATIONAL ATTAINMENT	MARITAL STATUS				TOTAL
	Never	Married	Separated/Divorced	Widow/Widower	
Never schooled	36(3.8)[1]	254(27.0)	52(5.5)	26(2.8)	368(39.1)
Primary Educ	47(5.0)	363(38.6)	43(4.6)	11(1.2)	464(49.4)
Form VI	9(1.0)	44(4.7)	1(0.1)	1(0.1)	55(5.9)

form VI+or more	2(0.2)	17(1.8)	1(0.1)	- (-)	20(2.1)
Adult Educ	1(0. 1)	26(2.8)	- (-)	1(0.1)	28(3.0)
Student	2(0.2)	2(0.2)	- (-)	1(0.1)	5(0.5)
Total	97(10.3)	706(75.1)	97(10.3)	40(4.3)	940(100.0)

On average, most households consisted of less than eight persons. Increases beyond 8.0 resulted in decreased frequencies of households.

Table 3: Household size distribution in the study area (P ≤ 0.05)

	STRATUM		DIVISIONS			WARDS			
	Upland	Flooded	Ikwiriri	Kibiti	Muhoro	Umwe	Mbwala	Ikwiriri	Kibiti
<3.9	248(25)	152(15)	140(14)	150(15)	110(11)	47(5)	110(11)	94(10)	149(15)
4.0-7.9	297(31)	171(18)	162(17)	190(20)	116(12)	47(7)	116(12)	94(10)	149(19)
8-11.9	65(7)	37(4)	35(4)	42(4)	25(3)	14(1)	25(3)	21(2)	42(4)
12.0+	3(0.3)	47(7)	116(12)	94(10)	149(19)	47(7)	116(12)	94(10)	149(19)
Total	613(63)	362(37)	337(35)	385(40)	253(26)	131(13)	253(26)	208(21)	383(39)

Only radio and bicycles related to household size. Most ownership occurred in households with less than eight people.

Table 4: Association of household size and household assets (P ≤ 0.05)

Attributes	RADIO			BICYCLE		
	Yes	No	Total	Yes	No	Total
<3.9	555(26.4)	140(14.5)	395(40.9)	194(14.0)	197(20.5)	391(40.7)
4.0-7.9	276(28.6)	189(19.6)	465(48.1)	212(22.1)	251()26.1	363(48.2)
8.0-11.9	53(5.5)	48(5.0)	101(10.5)	49(5.1)	52(5.4)	1(10.8)
12.0+	2(0.2)	3(0.3)	5(0.5)	1(0.1)	4(0.4)	5(0.5)
Total	586(60.7)	380(39.3)	966(100.0)	456(47.5)	504(52.5)	960(100.0)

Ownership of radio and bicycles is associated with literacy whereby literate households were roughly 2 – 3 times more likely to own such assets compared to illiterate households (Annex Table 5).

Education at primary level increased the ownership of household assets such as sewing machines, electric fans, bicycles, motorcycles, radios & T.V. sets) compared to those who did not attend school (Annex Tables 6-12).

Less than half of household members diversified their income. ‘Other activities’ (art, charcoal making, fishing etc), unskilled labour and small business ventures accounted for the highest proportions of diversification. More men participated in diversification

compared to women. Those below 30 account for most employment activities as well as relatively large numbers of elderly people (Annex Table 13).

Table 5: Type of work and Sex (P ≤ 0.05)

	SEX		TOTAL
	Male	Female	
Unskilled labourer	262(13.5)	204(10.5)	466(24.1)
Skilled labourer	86(4.4)	23(1.2)	109(5.6)
Office	53(2.7)	20(1.0)	73(3.8)
Small business	224(11.6)	150(7.8)	374(19.3)
An expert	20(1.0)	8(0.4)	28(1.4)
Others	495(25.6)	389(20.1)	884(45.7)
Total	1140(58.9)	794(41.1)	1934(100.0)

4.2 Houses and Housing Conditions

Most households owned the houses they inhabited (Annex Table 14). Rented accommodation was more common in the Uplands than the Floodplain. Most households paid Tsh 1000 – 3000. Higher variation in rent paid occurred in the Upland stratum.

Table 6: Payment of rent per month (P ≤ 0.05)

	STRATUM		DIVISIONS			WARDS			
	Upland	Flooded	Ikwiriri	Kibiti	Muhoro	Umwe	Mbwala	Ikwiriri	Kibiti
A	12(7.0)	-(-)	-(-)	2(1.1)	-(-)	1(0.6)	-(-)	1(0.6)	10(5.8)
B	33(19.3)	8(4.7)	7(4.0)	24(13.6)	10(5.7)	4(2.3)	9(5.3)	3(1.8)	25(14.6)
C	31(18.1)	12(7.0)	9(5.1)	21(11.9)	10(5.7)	-(-)	12(7.0)	10(5.8)	21(12.3)
D	17(9.9)	3(1.8)	13(7.4)	5(2.8)	3(1.7)	5(2.9)	4(2.3)	7(4.1)	4(2.3)
E	25(14.6)	1(0.6)	17(9.7)	11(6.3)	2(1.1)	6(3.5)	1(0.6)	12(7.0)	7(4.1)
F	18(10.5)	-(-)	14(8.0)	2(1.1)	-(-)	6(1.4)	-(-)	10(5.8)	2(1.2)
G	10(5.8)	1(0.6)	126.8)	11(6.3)	3(1.7)	10.6)	1(0.6)	3(1.8)	6(3.5)
Total	145(85.4)	25(14.6)	72(40.9)	76(43.2)	28(15.9)	23(13.5)	27(15.8)	46(26.9)	75(43.9)

A= <-1000; B=1000-1999; C=2000-2999; D=3000-3999; E=4000-4999; F=5000-5999; G=6000.0+

Ownership of assets (motorbike, radio, TV and bicycle) is related to type of roofing material. TV and motorcycle ownership strongly correlated with corrugated iron sheets while radio and bicycle ownership correlated with households under corrugated iron sheets and coconut leaves. Households under grass and tin roofs owned few assets (Table 7 & Annex Tables 15-17.

Table 7: Bicycle by Thatching or Roofing Materials for the House (P ≤ 0.05)

BICYCLE	THATCHING MATERIALSFOR THE HOUSE				TOTAL
	Corrugated iron Sheets	Grasses	Coconut Leaves	Tins	
Yes	234(24.6)	30(3.2)	185(19.5)	-(-)	449(47.3)
No	189(19.9)	60(6.3)	249(26.2)	3(0.3)	501(52.7)
Total	423(44.5)	90(9.5)	434(45.7)	3(0.3)	950(100.0)

4.3 Water and Sanitation

91.1% of households with corrugated iron sheet roofing material harvested water for domestic use. The highest proportion of households obtained water from wells (**see fig.4**) Harvested water was generally clean; most households stored 6+ buckets per day in mainly steel containers (Table 8).

Table 8: Water sources

Water sources	Frequency	Percent	Valid Percent	Cumulative Percent
Pipe Water	1	0.1	0.1	0.1
Neighbour's Water pipe	91	0.3	9.4	9.5
Public Water pipe	176	18.1	18.2	27.7
Well(s)	567	58.2	58.5	86.2
Water Dam	27	2.8	2.8	89.0
River(s)	96	9.8	9.9	98.9
Purchase	11	1.1	1.1	100.0
Total	969	99.4	100.0	

High proportions of households collected water from neighbours within 15 minutes. As this time increased, proportions of households engaged decreased (Annex Table 18).

High proportions of households accepted monthly water bills of only Tsh 500-999. Generally, as cost per month increased the proportion of households decrease who accepted such an increase declined (Annex Table 19)

The majority of households had toilets (ordinary pit latrines with no vents, doors, roofs though some had cement floors)

4.4 Agriculture

The majority of households owned farmland.

Table 9: Household Land for Cultivation

	STRATUM		DIVISIONS			WARDS			
	Upland	Flooded	Ikwiriri	Kibiti	Muhoro	Umwe	Mbwala	Ikwiriri	Kibiti
With	419(46)	333(37)	251(28)	266(29)	235(26)	99(11)	235(26)	154(17)	264(29)
Without	139(15)	13(1.4)	52(5.8)	90(10)	10(1.1)	22(2.4)	10(1.1)	30(3.3)	90(10.0)
Total	558(62)	346(38)	303(34)	356(39)	245(27)	121(13)	245(27)	184(2.4)	354(39)

Almost all land was allocated to households by village government as opposed to being purchased. Households own on average 1.52 parcels (average parcel size is 1.92 acres) located in different areas. However, combining owned and hired land, households have on average 3.66 acres (Annex Table 20).

Most households owned small tools such as hoes and bush knives (pangas). Very few households rented such implements or hired tractors (Annex Table 21).

High numbers of households cultivated maize, rice cowpeas cassava and ‘other crops’ on less than 1 acre of land. As land increased, numbers of households cultivating such crops dropped sharply beyond 3 acres. A similar pattern was observed over a 4-year average (Table 11).

Table 10: Acreages under the production of various crops

Acreages	PROPORTION OF HOUSEHOLDS GROWING CROPS				
	Maize	Rice	Cow peas	Cassava	Other crops
<0.9	37.4	35.3	82.4	77.7	90.6
1.0-1.9	19.4	31.5	3.8	12.0	2.5
2.0-2.9	8.6	14.8	8.2	4.7	1.0
3.0-3.9	3.6	3.7	2.9	2.1	0.5
4.0-4.9	2.4	1.7	1.0	1.3	0.7
5.0 +	42.4	13.0	1.7	2.2	4.7

Table 11: Proportion of households and acreages of food crops (Mean of 4-years)

ACREAGES	MAIZE	RICE	COWPEAS
<0.9	15.6	16.9	-
1.0-1.9	46.2	44.3	95.6
2.0-2.9	19.4	21.3	2.5
3.0-3.9	8.1	8.4	1.7
4.0-4.9	5.1	6.1	4.6
5.0 +	5.2	4.3	0.5

Over the four years, on the average, the majority of households obtained less than 5 sacks of maize and rice, 9 – 12 sacks of cowpeas and less than 3 sacks of cassava. As yield increased beyond these figures, the proportion of households receiving them declined progressively.

Table 12: Sacks produced (maize and rice) and proportion of households involved in the production of food crops in 2001-2004

SACKS	MAIZE					RICE				
	2001	2002	2003	2004	Mean	2001	2002	2003	2004	Mean
< 4.9	84.6	88.3	85.7	80.6	84.8	69.6	83.4	82.6	74.2	77.5
5.0-9.9	78	45	44	77	61	18.4	51	53	75	34.7
10.0-14.9	18	12	23	24	19	28	23	25	38	30
15.0-19.9	3	6	11	13	8	15	19	17	24	16
20.0-24.9	7	3	11	14	8	10	11	9	20	9
25.0+	22	26	29	41	30	42	37	39	76	55

Table 13: Sacks produced and proportion of households involved in the production of cowpeas and cassava in 2001-2004

SACKS	COWPEAS					CASSAVA				
	01	02	03	04	Mean	01	02	03	04	Mean
< 2.9	12	1	1	12	6.5	69.6	83.4	82.6	74.2	78.8
3.0-5.9	16	6	8	10	10.0	18.4	51	53	75	46.7
6.0-8.9	9	8	11	3	7.8	28	23	25	38	30.5
9.0-11.9	32	2	10	36	20.0	15	19	17	24	19.5
12.0-14.9	3	28	3	2	9.0	10	11	9	20	14.5
15+	13	5	5	14	9.3	12	5	8	18	12.0

Generally, as the number of households involved in production of food and cash crops increased, mean income also increased.

Table 14: Household income from crops

	N	Minimum	Maximum	Mean	S.D
Selling food crops in 2001	50	4	1400000	62,844.16	195127.91
Selling food crops in 2002	45	99	800000	54,339.98	118720.68
Selling food crops in 2003	50	1200	150000	37,094.00	35470.58
Selling food crops in 2004	84	3000	3000000	86,425.00	326639.33
Selling cash crops in 2001	32	1	1200000	94,390.66	236294.39
Selling cash crops in 2002	20	2000	600000	77,725.00	129909.23
Selling cash crops in 2003	34	20	480000	86,353.53	120906.97
Selling cash crops in 2004	52	1	3500000	155,329.23	499289.46

Food, clothing and implement hire, accounted for highest monthly expenditures.

Table 16: Expenses of households in the study area per month

Attributes	**N**	**Mean**	**Rank**
Rent per month	975	1,028.02	6
House rent per month	975	1,318.56	5
Clothing expenses per month	975	5,725.26	2
All food expenses per month	975	59,704.50	1
All school expenses per month	975	196.00	10
All cooking expenses per month	975	985.69	7
Expenses on water per month(Tsh)	974	831.29	8
Expenses on furniture per month(Tsh)	975	4,129.29	4
All expenses on drinks	975	213.30	9
Expenses on smoking/sniffing per month(Tsh)	975	142.92	11
agricultural implement hiring (Tsh)	975	2,616.24	3
Mean Total		76,991.07	-

Most households earned less than Tsh 50,000 per year from the sale of crops. As income increased, the number of households decreased (Annex Table 22).

In most households, women performed most agricultural activities. Women participated more than men and children in cultivation, weeding, planting, scaring birds, harvesting, threshing, marketing and ‘others’ (Annex Tables 23-25).

Table 17 Cultivation of land

ATTRIBUTES	N	PER CENT	Ranking
Labourers	156	16.0	3
Father	424	43.5	2
Mother	507	52.0	1
Children	57	5.8	5
All of them	140	14.4	4

Most households practiced mixed cropping as opposed to monocultures.

Table 18: Planting systems for food crops

	STRATUM		DIVISIONS			WARDS			
	Upland	Flooded	Ikwiriri	Kibiti	Muhoro	Umwe	Mbwala	Ikwiriri	Kibiti
Mixed	156(29)	189(35)	137(25)	92(17)	54(10)	10(1)	116(21)	83(15)	92(17)
Pure	84(16)	113(21)	45(8)	52(10)	26(5)	4(50)	100(19)	19(4)	52(10)

Very households in the study area used chemical fertilisers, as they were too not required, not available or too expensive.

Table 19: Use of chemical fertilizers

	STRATUM		DIVISIONS			WARDS			
	Upland	Flooded	Ikwiriri	Kibiti	Muhoro	Umwe	Mbwala	Ikwiriri	Kibiti
A	7(1.0)	8(1.2)	9(1.3)	3(0.4)	3(0.4)	5(0.7)	3(0.4)	4(0.6)	3(0.4)
B	363(54)	294(44)	220(33)	225(34)	212(32)	9 (13.5)	212(32)	131(20)	223(33)
C	370(55)	302(45)	229(34)	228(34)	215(32)	96(14)	215(32)	135(20)	226(34)

A=Use chemical fertilizers; B=Do not use chemical fertilizers; C=Others

Table 20: Reasons for not using fertilizers

	STRATUM		DIVISIONS			WARDS			
	Upland	Flooded	Ikwiriri	Kibiti	Muhoro	Umwe	Mbwala	Ikwiriri	Kibiti
A	75 (52)	68 (48)	74 (52)	54 (38)	15 (11)	34 (24)	15 (11)	40 (28)	54 (38)
B	221 (53)	197 (47)	74 (52)	129 (31)	178 (43)	32 (8)	176 (43)	81 (19)	127 (30)
C	74 (62)	45 (38)	47 (40)	46 (39)	26 (22)	28 (24)	26 (22)	19 (16)	46 (39)
D	7 (50)	7 (50)	7 (50)	6 (43)	1 (7)	4 (29)	1 (7)	3 (21)	6 (43)

A= Not required; B= Not available; C= Very expensive D= Others

Most households received planting seeds from village shops; however, a large proportion obtained seeds from relatives (Annex Table 26).

Only small numbers irrigated their crops, the majority of households waited for the onset of rains for planting (Appendix Tables 27-28). Irrigation sources mainly came from natural dams.

4.5 Floods and Droughts

Climate variation was identified as mainly reducing precipitation and the length of the rainy season. Rainfall became inadequtes due to variation in climate. People identified several indicators of weather conditions; however, weather was generally felt to be unpredictable in the region. Only small numbers indicate that there has been considerable change in weather patters over time (Annex Tables 29-32).

Most households reported a range of impacts such as cash flow decrease, crippling of business, failure of harvests, decreased food supplies etc. Households reported that regular diet changes during bad periods. Use of hard porridge still dominates however, the range of 'other' foodstuffs increases, replacing regular use of bananas, potatoes etc (Annex Tables 33-35).

Floods severly affected the livelihoods of most household's activities such as agriculture, fishing, employment and other activities

Malaria, Cholera and Diarrhoea frequently affect most households during floods. Malaria was identified as the most troublesome disease. Outbreaks of Malaria were considered to be most serious in 2001 (Annex Tables 40-42).

Measures following outbreaks in 2003 saw most people using mosquitoe nets while people pusued other measures in other years.

Table 21: Measures taken after diseases outbreak

	STRATUM							
	UPLAND AREA				FLOODED AREA			
	2001[1]	2002[1]	2003[1]	2004[1]	2001[1]	2002[1]	2003[1]	2004[1]
Boiling water	55(68)	30(60)	27(61)	21(68)	26(32)	20(40)	17(39)	10(32)
mosquito nets	86(80)	66(79)	132(64)	61(74)	21(20)	16(21)	79(36)	22(27)
Others[1]	155(60)	148(64)	63(58.9)	146(63)	103(40)	83(36)	44(41)	88(37)

[1] –Went to the hospital; cleaned the surrounding s of my household; constructed a raft for drying household utensils; wash hands with soap on leaving the toilet; eat hot meals; taking advices given by health officers; general cleanliness; digging and building a toilet and use it effectively etc

Most households sought treatment from district rather than private dispensaries

Table 22: Medical treatment

	STRATUM		DIVISIONS			WARDS			
	Upland	Flooded	Ikwiriri	Kibiti	Muhoro	Umwe	Mbwala	Ikwiriri	Kibiti
District	532 (62.1)	324 (37.9)	296 (34.6)	325 (37.7)	237 (27.7)	119 (13.9)	237 (27.7)	179 (20.9)	321 (37.7)
Private	80 (69.0)	36 (31.0)	41 (35.3)	57 (49.1)	18 (15.5)	14 (12.1)	18 (15.5)	27 (23.3)	57 (49.1)
Others[1]	16 (72.7)	6 (27.3)	5 (22.7)	14 (63.6)	3 (13.6)	1 (4.5)	3 (13.6)	4 (18.2)	14 (63.6)

[1] -Use indigenous medicine-consult medicine man for prescriptions

The majority of households indicated that very sunny conditions were indicators of coming droughts (Annex Table 43).

Food and water expenses were the biggest problem faced by households during drought

Table 23: Biggest Problem faced during drought

Attributes	STRATUM		DIVISIONS			WARDS			
	Upland	Flooded	Ikwiriri	Kibiti	Muhoro	Umwe	Mbwala	Ikwiriri	Kibiti
A	463(60)	308(40)	274(36)	279(36)	218(28)	111(14)	218(28)	165(21)	277(36)
B	44(47)	50(53)	33(35)	25(31)	32(34)	18(19)	32(34)	15(16)	29(31)
C	43(54)	35(44)	32(41)	29(37)	17(22)	16(20)	17(22)	16(20)	29(37)
D	43(59)	30(41)	21(29)	25(34)	27(37)	12(16)	27(37)	9(12)	25(34)
E	44(79)	12(21)	5(9)	35(59)	18(32)	3(5)	18(32)	2(4)	33(59)

P > 0.05 for Shelter and NSC for other attributes
A=Food or water, B=Transport, C=Shelter, D= Children educ., E=Other expenses

Most households in the Upland regions remembered the effects of flooding 1989 – 1998 while most in the Floodplains recall more recent flood events (1999 – 2003).

Table 24: Occurrence of floods in the study area

Attributes	STRATUM		DIVISIONS			WARDS			
	Upland	Flooded	Ikwiriri	Kibiti	Muhoro	Umwe	Mbwala	Ikwiriri	Kibiti
<1978	3(0.9)	2(0.6)	1(0.3)	2(0.6)	2(0.6)	1(0.3)	2(0.6)	-(-)	2(0.6)
1984 – 1988	-(-)	3(0.9)	2(0.6)	-(-)	1(0.3)	1(0.30)	1(0.3)	1(0.3)	-(-)
1989 – 1998	40(12.7)	59(18.7)	47(14.9)	13(4)	39(12.3)	18(5.7)	35(12.3)	29(9.2)	13(4.1)
1999 – 2003	34(10.8)	158(50)	107(34)	6(1.9)	79(25.0)	41(13.0)	79(25.0)	67(21.2)	5(1.6)
2004	3(0.9)	14(4.4)	7(2.2)	-(-)	10(3.2)	1(0.3)	10(3.2)	6(1.9)	-(-)
	P< 0.05		P < 0.05			P < 0.5			

The majority of households indicated that during flood and drought food supplies were scarce

Table 25: Food situation in the household

Attributes	STRATUM		DIVISIONS			WARDS			
	Upland	Flooded	Ikwiriri	Kibiti	Muhoro	Umwe	Mbwala	Ikwiriri	Kibiti
Abundant	49(6)	11(1)	20(3)	34(4)	6(0.7)	11(1)	6(0.7)	9(1)	34(4)
Very scarce	449(55)	305(38)	258(32)	281(35)	215(26)	102(13)	215(26)	158(19)	279(34)
	P< 0.05		P< 0.05			P < 0.05			

Most households in Lowlands did not require any kind of assistance during flood events. Of those households who did require assistance, transport and food required most in the lowlands during floods. Most relied upon relatives for help. Assistance was generally considered inadequate however, such figures were only slightly higher than those who were satisfied (Annex tables 44-47).

Only small numbers dispersed members of the ousehold during flood. Most dispersion of household members to safe places was to towns. Most Lowland households moved assets such as utensils, agricultural implements, livestock, food, bicycles, radios, beds etc (Annex Tables 48-50).

Although food assistance was the most common assistance during drought, most households resorted to selling assets to meet food demands in response to droughts

Table 26 Assistance given during drought

Attributes	STRATUM		DIVISIONS			WARDS			
	Upland	Flooded	Ikwiriri	Kibiti	Muhoro	Umwe	Mbwala	Ikwiriri	Kibiti
Food[1]	209(56)	167(44)	135(36)	105(28)	136(36)	62(17)	238(36)	75(20)	103(27)
Money	62(72)	24(28)	28(34)	43(50)	15(17)	13(15)	15(17)	16(19)	42(49)
Others[2]	39(50)	39(50)	30(39)	20(26)	28(36)	20(26)	26(36)	10(13)	20(26)

[1] –Food assistance given include
[2] –Clothes, accommodation, seeds for planting (given by the Government), used my own servings, worked as a casual labourer etc.

Table 27: Steps taken when household food reserves are bad

Attributes	STRATUM		DIVISIONS			WARDS			
	Upland	Flooded	Ikwiriri	Kibiti	Muhoro	Umwe	Mbwala	Ikwiriri	Kibiti
A	62 (62.0)	38 (38.0)	44 (44.0)	29 (29.0)	27 (27.0)	27 (27.0)	27 (27.0)	18 (18.0)	28 (28.0)
B	109 (61.9)	67 (38.1)	69 (39.2)	61 (34.7)	46 (26.1)	31 (17.6)	46 (26.1)	38 (21.6)	61 (34.7)
C	449 (55.2)	305 (37.5)	29 (27.9)	40 (40.8)	35 (33.7)	15 (14.4)	35 (33.7)	14 (13.5)	40 (38.5)
E	213 (56.5)	164 (43.6)	112 (29.7)	154 (40.8)	111 (29.4)	39 (10.3)	111 (29.4)	74 (19.6)	153 (40.6)

NB: NSC-No statistics computed
A= Food reserves, B= Food contribution, C= Sold household assets, E= Others

Relatives again, provided most assistance during drought (Annex Table 51)

Main coping mechanisms to drought included casual labour, fishing, making charcoal etc

Table 28: Mechanism of surviving drought

Attributes	STRATUM		DIVISIONS			WARDS			
	Upland	Flooded	Ikwiriri	Kibiti	Muhoro	Umwe	Mbwala	Ikwiriri	Kibiti
A	19(70.4)	6(29.6)	14(51.9)	7(25.9)	6(22.2)	8(29.6)	6(22.2)	6(22.2)	7(25.9)
B	1(100.0)	-(-)	1(32.6)	-(-)	-(-)	1(100.0)	-(-)	-(-)	-(-)
C	6(54.5)	5(45.5)	6(54.5)	5(45.5)	-(-)	3(27.3)	-(-)	3(27.3)	5(45.5)
D	3(75.0)	1(25.0)	3(75.0)	1(25.0)	-(-)	3(75.0)	1(25.0)	-(-)	-(-)
E	165(60)	110(40)	80(29.1)	128(47)	67(24.4)	35(12.7)	67(24.4)	45(16.4)	128(47)

A=Food; B=Transport; C=Shelter; D=Children Education; E=Others
[1] –Worked as a casual labourer; Went out fishing; charcoal making; worked as a log hauler; worked as water vender using my bicycle; sold cassava; used house rent paid to me etc.

During flood and drought periods, most households diversified their activities rather than intensifying agriculture. The same can be said for women who also diversified, however the range of startegies undertaken was far more limited compared to those for household heads (Annex Tables 52-54).

For coping mechanisms such as firewood collection, women were mainly responsible, however for tasks such as purchasing food in good or bad days, men dominated this task (Annex Tables 55-57).

4.6 Participatory Rural Appraisal

4.6.1 Recent History

A severe flood occurred in 1962 lasting 6 months and causing considerable loss of life and property. People received government and international assistance in the form of a rescue helicopter as well as food, clothing and shelter as many lost everything. Upon return, people constructed 'Dungus' (houses suspended on poles (see Figure 1) and immediately resumed farming activities to take advantage of fertile silt deposits.

A researcher in the area would rent out use of his tractor to local farmers who would cover the costs of the ploughing after harvesting. The resultant harvest in 1968 was too large for local people's labour capacity to completely harvest.

Another severe flood in 1968 resulted in government plans to relocate people from the Rufiji plains to Ikwiriri. This plan was finalised in 1974 after another severe flood caused further loss of life and property. This resettlement was undermined by the failure of water projects in 1971 to pump water from local dams as well as people being allocated plots, which were too small, compared to what they had previously cultivated. As a result, they simply moved back to the Rufiji plains.

A new water source was developed at Uba Dam and three water tanks were constructed for storage and distribution to the Ikwiriri inhabitants. Water was made available four hours from 4 to 8 o'clock in the evening. Shallow wells were constructed by Wipers to supplement water availability. Figure 2 shows the two water tanks at Ikwiriri.

Figure 2: Two water tanks at Ikwiriri

1976 saw the installation of a small 40KW electricity generator in Ikwiriri. Although initially free, mainly well-to-do people (government employees & businessmen) benefited from electricity. Larger generators (120KW & 900KW) were installed in the 1980's to accommodate the increasing number of shops, maize grinding plants and increased residents. Government plans to relocate the 900KW generator (installed by Sweden) were prevented by protests in Ikwiriri.

Initially three villages (Umwe, Ikwiriri and Mgomba) with a Folk Development College and post office, the number of villages was proposed to increase to nine in 1979 and by 1983 registered villages included; Umwe South, Umwe Central, Umwe North, Mgomba South, Mgomba Central, Mgomba North, Ikwiriri South, Ikwiriri Central and Ikwiriri North.

An Iranian supported irrigation scheme was established which provided agriculture machinery, domestic animals, fishing gear and sewing machines on loan basis. Rice productivity increased up to 30 bags per acre as a result. After the project finished, 75 Ikwiriri residents took over its assets (including 2 tractors, water pumps and a planter). Tsh. 85,000,000 was provided for rehabilitation of irrigation infrastructure.

In 1990 some religious institutions constructed some boreholes for water supply.

In 1991 construction of a tarmac road from Kibiti to Ikwiriri started.

In 1997 there was an outbreak of cholera.

El Nino resulted in a severe flood in 1998 causing considerable loss of life and property and use of government rescue helicopters. The Tanzania Essential Health Intervention Project (TEHIP) as did construction of a tarmac road from Ikwiriri to Mkapa Bridge which imporvied the economy of Ikwriri and saved lives and property, the bridge had severe consequences for businesses and livelihoods dependent on the old ferry service.

A severe flood in 2002 destroyed infrastructure and crops and cut off communications between Dar es Salaam and Southern Tanzanian Regions. However, some people living in the plains refused to leave.

By 2006 there were approximately 200 boreholes with a capacity of supplying 56,000 litres per hour, to meet the needs of Ikwiriri. Some wells were constructed with French financial assistance near Mkapa Bridge (Darajani area).

4.6.2 Village Infrastructure/Assets

		Ikwiriri	Muhoro	Kibiti
Education				
	Primary Schools	5		>33
	Secondary schools	1		3
	Colleges	1*		0
	Kindergarten	8		>33
Health				
	Diseases	Malaria, Tuberculosis, Cholera, HIV AIDS	Malaria, elephantiasis, HIV AIDS, Cholera, Tuberculosis	Malaria, elephantiasis, HIV AIDS, Cholera, Tuberculosis
	Health Centres	1	1	1
	Dispensaries	2	1	10
	Hospitals	0	0	1
Water				
	River source	Used by people living on the Rufiji flood plains	Used by people living on the Rufiji flood plains	No river source
	Rain water	Used	used	Used
	Piped water	Not used	used	Not available
	Wells	>100	A few	2 + owned by individuals
Crops				
	Cash crops	Cashew nuts, sesame, sugar cane, cassava and fish	Sugar cane, mangoes	Cashew nuts, coconuts, sesame groundnuts, sisal, cotton and jack fruits
	Food crops	Maize, rice, bananas, cassava, fish and vegetables	bananas, maize, rice, beans and pigeon pea	Cassava, maize, lowland rice (irrigated) and upland rice, pigeon pea, beans, sweet potatoes and bananas
Entertainment				
	Dances	Traditional dances		
	Football	Two teams		
Business				
	Markets	1	1	1
	Wholesale shops	4	3	5
	Retail shops	many	many	Many
	Petrol stations	2	1	0
Institutions				
	Banks	0	0	1 NMB
	Police stations	1	1	1
	Courts	1	2	2
	Prisons	0	0	1
	Tanzania Revenue Authority	0	0	1
	Guest Houses	8	3	30
Energy				
	TANESCO Generators	Exist	Not there	Not there
	Private owned Generators	exists	exists	exists
	Charcoal	exists	exists	exists

	fuelwood	exists	exists	exists
	Kerosene	Used	used	used
Stoves				
	Three stones stoves	Used	used	used
	Saw dust stoves	Used	Not used	Not used
	Efficient stoves	Used by a few people		

4.6.3 Village Daily Calendar

Time	Women	Men
05.00am	Wake up boil bathing water for the family	• Some still asleep • Some wake up for prayers in the mosque
06.00am	• Cleaning up the area and prepare breakfast • Cook breakfast • Go to the field	• Take a bath, eat breakfast and go to the field • Some are still asleep • Some go to prepare their charcoal kilns
07.00am – 11.00am	• Some remain at home to prepare family lunch • Prepare school children ready to go to school • Go to the fields	• Working in the field • Some are sitting at some public places • Taking breakfast in the field
12.00pm – 03.00pm	• Working in the field • Fetching firewood and vegetables for supper	• Working in the fields • Some are returning home • Some still at public places • Some are looking for "vilingu"[1]
04.00pm – 07.00pm	• Returning home from the fields • Fetching water • Cleaning eating utensils • Preparing supper	• Some are still at public places • Some go to mosque for prayers • Some are looking for the market for their "kilingu" • Some are marketing charcoal
08.00pm – 10.00pm	• Some are still preparing supper for the family • Making sure that the young children have eaten supper • Preparing children to go to sleep • Eating supper • Cleaning eating utensils • Sleeping	• Some still at public places • Some go to mosque for evening prayers • Eat supper • Sleeping
11.00pm+	Sleeping	

4.6.4 Village Annual Calendar

Time	**Ikwiriri**	**Muhoro**	**Kibiti**
January	Weeding rice and cassava	Weeding rice and cassava	Weeding rice and cassava
	Final harvesting and selling cashew nuts	Final harvesting and selling cashew nuts	Final harvesting and selling cashew nuts

[1] "Kilingu" is a small piece of wood about one metre long and 15 centimetre thickness which is used to make furniture, including sofer sets, beds, etc.

	Harvesting “vuli” maize	Harvesting “vuli” maize	Harvesting “vuli” maize
	Preparation of sesame fields	Preparation of sesame fields	Preparation of sesame fields
	To send children to school	To send children to school	To send children to school
	Fishing	Fishing	Fishing
	Charcoal making	Charcoal making	Charcoal making
			Preparation of upland rice fields
February	To finish weeding and continue with other January activities	To finish weeding and continue with other January activities	Planting upland rice
			To complete weeding and continue with other January activities
March	Weeding continues	Weeding continues	Weeding continues
	To plant maize, beans and sweet potatoes	To plant maize, beans and sweet potatoes	To plant maize, beans and sweet potatoes
	Village Government meetings	Village Government meetings	Village Government meetings
	Fishing	Fishing	Fishing
	Rice transplanting	Rice transplanting	Rice transplanting
	Tree planting	Tree planting	Tree planting
April	Guarding the rice fields against pests	Guarding the rice fields against pests	Guarding the rice fields against pests
	To weed cashew trees, maize and pigeon pea	To weed cashew trees, maize and pigeon pea	To weed cashew trees, maize and pigeon pea
	Planting beans	Planting beans	Planting beans
	Students short break (Easter Holidays)	Students short break (Easter Holidays)	Students short break (Easter Holidays)
	People living on the plains start preparing for floods	People living on the plains start preparing for floods	People living on the plains start preparing for floods
	Charcoal making	Charcoal making	Charcoal making
	Tree planting	Tree planting	Tree planting
May	Continue protecting rice fields from pests	Continue protecting rice fields from pests	Continue protecting rice fields from pests
	crops begin to (ripe) be ready for harvest	crops begin to (ripe) be ready for harvest	crops begin to (ripe) be ready for harvest
	Harvesting of lowland rice	Harvesting of lowland rice	
	Insecticide spray to cashew trees	Insecticide spray to cashew trees	Insecticide spray to cashew trees
	Finishing cashew trees weeding	Finishing cashew trees weeding	Finishing cashew trees weeding
	Fishing and charcoal making continues	Fishing and charcoal making continues	Fishing and charcoal making continues
	End of masika rains	End of masika rains	End of masika rains
June	Rice and maize harvesting	Rice and maize harvesting	Rice and maize harvesting
	Insecticide spray to cashew trees	Insecticide spray to cashew trees	Insecticide spray to cashew trees
	Weeding of permanent crops	Weeding of permanent crops	Weeding of permanent crops
	Cassava harvesting	Cassava harvesting	Cassava harvesting
	Mid year break for students	Mid year break for students	Mid year break for students
	Potatoes harvesting	Potatoes harvesting	Potatoes harvesting

July	Selling of harvested crops	Selling of harvested crops	Selling of harvested crops
	Harvesting sesame	Harvesting sesame	Harvesting sesame
	Charcoal making	Charcoal making	Charcoal making
	Insecticide spray to cashew trees	Insecticide spray to cashew trees	Insecticide spray to cashew trees
	Village government meetings	Village government meetings	Village government meetings
	Potatoes harvesting continues	Potatoes harvesting continues	Potatoes harvesting continues
	Honey harvesting	Honey harvesting	Honey harvesting
	Ngoma entertainment	Ngoma entertainment	Ngoma entertainment
August	Cassava harvesting	Cassava harvesting	Cassava harvesting
	Insecticide spray to cashew trees	Insecticide spray to cashew trees	Insecticide spray to cashew trees
	Selling oranges	Selling oranges	Selling oranges
	Entertainment	Entertainment	Entertainment
	Potatoes harvesting	Potatoes harvesting	Potatoes harvesting
	Honey harvesting	Honey harvesting	Honey harvesting
			Preparation of upland farms
September	Preparation of rice and maize fields	Preparation of rice and maize fields	Preparation of rice and maize fields
	Insecticide spray to cashew trees	Insecticide spray to cashew trees	Insecticide spray to cashew trees
	Entertainments	Entertainments	Entertainments
	Fishing and charcoal making	Fishing and charcoal making	Fishing and charcoal making
	Honey harvesting	Honey harvesting	Honey harvesting
October	Harvest and sale of cashew nuts pineapples oranges and jack fruits	Harvest and sale of cashew nuts pineapples oranges and jack fruits	Harvest and sale of cashew nuts pineapples oranges and jack fruits
	Preparation of ‘vuli’ crop	Preparation of ‘vuli’ crop	Preparation of ‘vuli’ crop
November	Planting of maize, cashew trees, beans, lowland rice and pigeon pea	Planting of maize, cashew trees, beans, lowland rice and pigeon pea	Planting of maize, cashew trees, beans, lowland rice and pigeon pea
	Continues with harvesting and sale of cashew nuts, mangoes, pineapples, and oranges in bulk	Continues with harvesting and sale of cashew nuts, mangoes, pineapples, and oranges in bulk	Continues with harvesting and sale of cashew nuts, mangoes, pineapples, and oranges in bulk
December	Planting continues	Planting continues	Planting continues
	Weeding of crops starts	Weeding of crops starts	Weeding of crops starts
	Continues with harvesting and sale of fruits and cashew nuts	Continues with harvesting and sale of fruits and cashew nuts	Continues with harvesting and sale of fruits and cashew nuts
	Village government meetings	Village government meetings	Village government meetings
	Christmas holidays for students	Christmas holidays for students	Christmas holidays for students

4.6.5 Sources of Off-Farm Income

No	Source	Participants	Average Daily Income (in Tshs)
1	**Market vendor and hawkers**		
	Food vendor (female) (mamalishe)	100	500 -1500
	Food vendor (male) (babalishe)	10	500 – 1500
	Fried fish/chicken vendor	10	500 -1500
	Sale of bites (Vitumbua/maandazi/chapatti)	100	500 -1500
	Vegetables vendors	20	500 -1500
	Fruits vendors	20	500 -1500
	Fish vendors	20	500 -1500
	Coconut vendors	10	500 -1500
	Cassava vendors	10	500 -1500
	Charcoal vendors	50	500 -1500
	Water vendors	10	500 – 1500
2	**Vocational and Kiosk –semi permanent**		
	Sewing	200	3,000
	Carpentry	50	3,000
	Bicycle repair	40	3,000
	Phone technician	5	3,000
	Logging	100	3,000
	Shoe repair	5	3,000
	Barber shops	10	3,000
	Charcoal making and wholesale	100	2,000
3	**Middle income/permanent traders**		
	Vendor shops	80	10,000
	Guest houses	8	30,000
	Bars and restaurants	4	30,000
	Women hair dressing salons	10	15,000
4	**Rich/permanent traders**		
	Wholesale shops		750,000
	Petrol stations		750,000

4.6.5 Problem Ranking Exercise

Problem	Ranking		Total rank	Priority
	Women	**Men**		
Floods	6	11	17	10
Drought	32	71	103	4
Housing	12	39	51	7
Water	4	148	152	1
Education	13	109	122	2
Energy	0	9	9	11
Health	28	77	105	3
Sanitation	18	37	55	6
Poor agriculture	15	72	87	5
Misuse of food	4	36	40	8
Pests	0	19	19	9

4.6.6 Solutions to Problems

Problem	Solution	Responsible
Water	Construction of water wells in every village	• Responsible communities • The government • Donors
	Construction of dams	
	Rain water harvesting	
	Protection of water sources	
	Provision of environmental education to villagers	
Education	To increase the number of schools, classrooms and teachers	• Parents
	Stopping absenteeism to students	• Leaders at all levels
		• Teachers
Health	Health education to communities	• Responsible communities • Government • Donors
	Dispensaries to be constructed in villages	
	Increase the number of hospitals	
	Put in place ambulances	
	Increase the number of health workers	
	Make available relevant medicines	
	Cost sharing by communities	
Drought/floods	Environmental conservation	• Meteorology department • Relevant communities • Division of natural resources • Vice President's Office Division of Environment • Media • NGOs • All leaders
	Establish an early warning system	
	Tree planting	
	Provide environmental education	
	Use of environmental by laws effectively	
	To establish a local radio station	
Poor agriculture	Increase the number of extension service officers	• Relevant communities • The government • Donors • Ministry of agriculture and food security
	Increase availability of farm implements	
	Provide training on agriculture best practices to farmers	
	To undertake campaigns for improved agriculture through the media, publications and brochures etc.	
	Study tours	

4.6.7 Poverty Indicators

Information obtained during PRA concerning meals eaten per day and education attainment revealed that income affected number of meals eaten per day with the wealthiest still eating three meals while the poorest were not guaranteed of any food in one single day. Educated households and high income households generally always sent their children to school while poor families were not always able to allow their children to attend.

5.0 Discussion of Findings

The questionnaire and PRA results are discussed below in the context of livelihood assets (although social capital is not easily measured). Qualitative findings of a small series of semi-structured interviews (based around this report) conducted for a separate study in July 2006 are include, offering further insight into livelihoods in the region.

5.1 Human Capital

A history of out-migration of young and able-bodied people from Rufiji is evident in the high proportions of elderly households. Government attempts to maintain a productive population by installing a range of social services and relocate people were unsuccessful. Rufiji also has a high separation/divorce rate.

Gendered divisions of labour are prevalent in the region as seen in the increased workload of women in the daily calendar and the large contribution of women to agricultural practices. Women perform household chores as well as their own cultivation (sometimes performing husband's activities as well) and the higher proportion of men in different types of work despite higher numbers of women.

Those aged 20-24 years old accounted for the highest proportion of employment. 'Other' categories were the most common occupation over unskilled, skilled labourers; office workers; small business or experts suggesting a wide variety of livelihood options in the region. Elderly people also accounted for a significant proportion of employment further illustrating past out-migration. Gender differences are also noticeable with lower numbers of females in employment.

Ranked the second most important problem in the region during PRA studies, education is poor in Rufiji. Many respondents only achieved primary level education while high numbers of respondents have never been educated. This may imply a lack of physical capital (lack of facilities etc) in the region as well as low labour productivity, preventing households from allowing children to attend school, as they are needed to provide valuable, low-cost labour elsewhere. PRA studies reveal that education is a function of income status with lowest attendance from poorest households. High-income households generally always sent their children to school despite the education status of the parents (Eriksen et al, 2005).

A high proportion of uneducated and illiterate people imply that a considerable proportion of the population are without necessary knowledge that could contribute to an improved livelihood.

The majority of households in the region had below four and between four and eight members. Although these figures suggest households are larger than census figures (NBS, 2004), a large household, despite the financial difficulties in raising a large family, could command high labour potential from its members, thus increasing its human capacity.

Ranked as the third biggest problem, human health is a serious issue in Rufiji. Malaria, Cholera and Diarrhoea frequently affect many households in the region (Malaria particularly in the upland strata). HIV/AIDS is a major concern especially for separated/divorced women who are more vulnerable to infection due to the increased traffic from Dar es Salaam following the construction of the bridge. Infection rates for women aged 15 – 49 are 8% (6% for men) (NBS, 2005). Nutrition and food security are also a cause for concern with an average daily calorific intake of 1950 calories (150 less than international minimum standard and 450 less than an adequate diet). Infant mortality rate is 99 per 1000 with malnutrition accounting for more than one third of this and up to 80% of maternal deaths. The PRA study revealed that the poorest were not guaranteed a meal every day when harvests were bad. High-income groups saw no reduction in the number of meals eaten (Eriksen et al, 2005).

Health status has significant impacts on labour potential. Discussions with locals in July 2006 revealed that small households (< 4 members) often were unable to carry out income generating activities when a member fell ill. Larger households coped by simply redistributing labour amongst other members.

As discussed by Ellis & Freeman (2004) Tanzanian villagers consider poverty in terms of exclusion from livelihood activities. Therefore, low labour potential of elderly households, those with few members, those with sick/disabled members, widowed etc will severely limit the ability of such households to generate a sustainable livelihood, thus making them vulnerable. Divorced and single female households will also face labour shortcomings but will be vulnerable due to socially constructed gender roles, which may exclude women from certain livelihood activities. Such households will be vulnerable to environmental shocks and trends.

5.2 Physical Capital

The high ownership of houses in the region illustrated the predominantly subsistence nature of the region. Numbers of rented houses in the region illustrates the penetration of free market modern economics into Rufiji. The high proportion of households paying Tsh 1000 - 1999 rent per month suggests the such houses were of low quality, likely to be located distant to public facilities and were an indication of low economic status of the area in general. Though most ownership was recorded in the highlands, specialised Dungus in the floodplains were not measured as they are often a second home for households.

Ownership of durable assets in the region such as radios, bicycles, fans, TV sets, sewing machines, motorcycles and cars is a good indicator of wealth status in Rufiji (Mbiha & Sinkondo, 2001). High ownership of such assets amongst educated and literate households suggests the economic advantages brought by education and that despite of prevailing economic problems; such households were determined to improve their livelihoods and lifestyles.

Radios and bicycles are important benchmark indicators as they were the most widely owned durable assets and they perform essential functions such as entertainment and news and transport for people and produce to market. Low priority, expensive assets such as motorcycles are indicative of higher income levels, which suggests a greater resilience in such households.

The low ownership of radios and bicycles in households with more than eight people suggests the economic disadvantages faced by such large households and limits their ability to acquire even low levels of physical capital.

Very few households in the region had access to electricity. The PRA study revealed that even though electricity was initially free when generators were first installed, only a small number of high-income households were able to take advantage of it as few could afford to wire their houses in order to connect.

In developing regions, houses built using a variety of materials (vegetation, solid materials etc) may reflect a combination of differing awareness, tradition, education and economic status. Thus, the correlation of low priority, expensive asset ownership in houses under corrugated iron roofs suggests such households were of higher income (followed by coconut leaves). Low ownership under grass thatch and tin roof houses indicates a lower level of physical capital and thus higher vulnerability.

91% of households with corrugated iron roofs harvested rainwater for domestic use. Much of this water was clean and stored in steel drums for later use. However, households with other roofing materials obtain water from other sources such as a neighbour's well. The majority of users took less than 15 minutes to fetch water from a neighbour (though figures did vary), this suggests that less time is being diverted from income generating activities. Fewer households have access to boreholes compared to NBS (2004) figures, and relied mainly on shallow wells. Only 41% of households have toilets, the majority of which are unimproved pit latrines. Shallow wells are vulnerable to contamination especially during the wet seasons and sanitary disease such as cholera and diarrhoea are common (Ako, 2001). Such low access to water and sanitation infrastructure are key indicators of vulnerability (Paavola, 2003).

Due to the lack of infrastructure in the lowlands, water vending is more expensive (considerable amounts of household income are spent on water) than the planned upland regions. Only small proportions of households were willing to pay more than Tsh 2000 per month for piped water reflecting the low economic status of households (Ako, 2001).

The near absence of irrigation in the region means that agriculture is predominantly rain-fed. Most irrigation that occurs utilises the natural dams that are present. Past irrigation projects failed because such dams were not utilised fully or maintained. The Iranian irrigation project, which also supplied the region with livestock and machinery, illustrates the potential boosts to production irrigation offers to livelihoods in the region.

5.3 Natural Capital

Indicators of risk to natural capital such as access to water, land and forests are evident in the findings (Quinn et al, 2003). As discussed previously, access to water for agricultural purposes is mainly through precipitation, which is especially vulnerable to changes due to climate change (Ikeme, 2003). High proportions of households owned agricultural land. Although allocation by village government prevailed over land purchase, the semi-structured interviews revealed that land was either inherited (mainly in the upland) or forest simply cleared to make way for farms (floodplains). Such acquisition supports the small-scale subsistence nature of agriculture in the region. Combining holdings of owned and rented land households on average 3.66 acres for cultivation. Small households may have difficulty in adequately cultivating such land while larger households may find themselves in a position to sell their labour to other farmers (Barrett et al, 2001). Despite the abundance of land, small numbers of households are without agricultural land (young families or migrants) making them extremely vulnerable due to the lack of such an important livelihood asset.

Agricultural activities (ploughing, weeding, sewing seeds, harvest etc) are organised according to season with all household members participating in agricultural activities (although women contribute most). Any change in climate patterns will seriously affect this pattern. The high participation by the household may reflect vulnerability of households in general during productive years (due to low technology and poor returns on investment) and as a coping mechanism during flood and/or drought. The importance of human capital (labour potential and good health) as an important livelihood asset is especially clear in Rufiji (DFID, 1997). Thus, the contribution of women to agricultural operations is an essential asset in livelihoods and coping mechanisms.

The poor state of agriculture in the region is a cause for concern. Most households practiced mixed cropping cultivating food crops (rice, maize, cassava, cowpeas & ‘other crops’) on small amounts of land (2-3 acres). Farming was practiced mainly using small hand tools such as hoes and bush knives. As land size increased, the proportion of households growing such crops decreased. This indicated the difficulty in cultivating large areas with such simple productive tools. High proportions obtaining below five sacks of maize and rice over the four-year period suggests a high degree of vulnerability, as yield potentials are currently unmet. The expected reduction in yields due to the impacts of climate change on temperature and precipitation will particularly affect crops such as maize, rice, sugar cane, millet sorghum etc. Projected decreases in maize yields could have catastrophic effects on smallholder rain fed agriculture in the absence of technological and breeding adaptations (Watson et al, 1997; Dixon et al, 2003 & Jones & Thornton, 2003).

Access of residents to the forest was restricted by the government several years ago in order to reduce deforestation, which is a major concern in the region (NBS, 1997). Interviews revealed that households relied upon the forest for fuelwood and charcoal as well as for the provision of other food sources and materials. Such restrictions can be

expected to have severe impacts for households who rely upon forest resources as part of their livelihood diversification strategy.

Traditional agricultural practices, knowledge and expertise, which have developed over time appear to have been eroded by modernisation under free market economics in the study area as illustrated by Ngeze (1991). The addition of low labour returns on farming under the free market adds to the already existing vulnerabilities to flood and drought, low yields etc.

5.4 Financial Capital

External inputs to agriculture as an indicator of financial capital are low in Rufiji. Financial facilities such as banks and access to loan facilities are very poor in the region (absent in Muhoro & Ikwiriri). The majority of households did not apply agricultural fertilisers. A common answer was due to the cost of such inputs, however many more cited that they were simply unavailable. In the region demand for fertiliser is low and many households do not consider their use a priority. Very few farmers were able to rent tractors to assist in ploughing activities (interviews revealed tractor rental costs Tsh 20,000 per acre). This lack of financial capital adds to low labour potential and low technical capacity of agriculture, further restraining it from adjusting to the modern market.

The largest proportion of household income is spent on food and water. A high dependence on such expenditure indicates the general vulnerability of the region and raises concern for those households with unsustainable livelihoods (Brookes et al, 2004; Frankenberger & McCaston, YEAR).

The importance of off-farm income is important in the region, as income from farm produce (cash and food crops) was lower than figures calculated from monthly household expenditures. Diversification is the norm in rural livelihoods where only a minority draw from few assets. Diversification is the means through which people minimise risk and respond to diminishing returns. It is driven by limited resilience of livelihoods in the face of weak financial situations, forcing adoption of a variety of portfolios, which stabilise income flows and consumption constrained by limited labour or land production and climatic uncertainty (Barrett et al, 2001). Typologies of off-farm income unfortunately are not quantified in the survey data. However, the PRA study indicated such non-agriculture activities such as artisan, petty, medium-scale and large-scale businesses were methods through which households diversified their livelihoods and enabled them to meet expenditure figures.

Livestock play a vital role in the livelihoods of rural people (Kinsey et al, 1998). Herds of livestock such as cattle can provide households with draught power enabling tilling of soil. However, the sale of livestock plays an essential role in household coping mechanisms providing cash during difficult periods. In Rufiji, large livestock such as cattle are not found among arable farmers, but belong to nomadic pastoralists (Massai). Small livestock such as poultry and goats are owned by some middle and high-income

households however these trends cannot be quantified as ownership of livestock is not measured in the study.

5.5 Social Capital

Given the survey format, the nature of the data collected makes assessment of social capital difficult. Assessments of social assets such as contact networks, relationships of trust and reciprocity, membership to formal and informal groups and organisations cannot be quantified easily and many are beyond the scope of the survey results.

Quinn et al (2003) illustrates public services and assistance as good indicators of social capital.

Access to public services in the region is very low. Muhoro and Ikwiriri were home to very few schools, kindergartens, health centres and public medicine dispensaries. Upland Kibiti, a more established region with higher levels of infrastructure had many more of the previous services as well as a hospital. During disease outbreaks, few households reported going to public dispensaries for assistance, preferring traditional methods. Interview discussions often revealed that public dispensaries were poorly stocked with treatments, and few households were able to afford treatment form private dispensaries.

In response to flood and drought, high numbers of households who required assistance reported that government assistance was insufficient and so there is a heavy reliance on support from relatives. Support from relatives appears to be a key aspect of social capital not just during extreme events but may indicate that many households receive help such as remittances or though other methods (receiving planting seeds from relatives).

5.6 Flood and Drought

Flood and particularly drought (ranked fourth most important problem in PRA) are serious concerns in Rufiji. High numbers reported very serious consequences of flood and drought events for agriculture, employment and other livelihood activities. Crops either are destroyed by flood events or are significantly decreased over prolonged drought periods.

5.6.1 Effects of floods and drought

As discussed by Ikeme (2003) the impact of events such as floods and drought will work to reinforce existing deficiencies. The biggest problem caused by floods and droughts is malnutrition as household food becoming very scarce and food and water expenditures increase. In addition, household income from crop sales drastically decreased coinciding with the 2002 floods. The prevailing cycle of low labour productivity and its relation to low human, natural, physical and financial capital is made significantly worse by flood and drought. This is especially true for women and children whose existing burdens are compacted during such events (Makule, 1997).

5.6.2 Coping Mechanisms

For obvious reasons, lowland households' main requirements during floods were food, shelter and transport. Most households did not disperse in the floodplain nor did they require any assistance. Most who did relocate reported they moved to 'other places' rather than towns and villages. This suggests that such household in the floodplain used Dungus to cope with the floodwaters. Relatives provided most assistance for households.

Households generally change their diets from in response to food shortages. Staple diets eaten during good days are substituted with inferior diets of dry porridge, green bananas and increased reliance on other foodstuffs derived from a variety of other strategies (foraging vegetable and tree leaves, small fish, immature fruit and only eating small starter dishes). Despite government food assistance, the majority of households resorted to selling household assets in order to obtain food. PRA findings concerning meal uncertainty also reveals that households reduce consumption in order to enable food supplies to last longer. Such a coping mechanism highlights the

While the contribution of all household members in agriculture signifies a coping mechanism to low labour productivity in general, few households concentrated on agriculture and instead diversified their activities during flood and drought. The majority of households resorted to a vast array of diversion strategies such as petty business, food preservation, charcoal making, employment, foraging forest resources etc. Interviews revealed that government restrictions on the forest are ignored especially during floods and drought. As discussed by Barrett (2001) in theory, the poorest are most likely to diversify their strategies in managing during *(ex ante*) and coping after (*ex post*) extreme events as they simply do not have sufficient assets to convert into cash. Often isolated from financial and physical assets, the poorest are forced to adopt highly diversified portfolios with marginal returns, which are more opportunistic and not easily sustained for long periods. The relatively large numbers reporting low impacts on their livelihoods could signify relatively well-off households who are able to adapt by either exchanging assets or concentrating on high income generating activities such as carpentry and business ventures (Barrett, 1997; Reardon et al, 2000; Erikssen, 2005). Despite this, the sale of assets was more common than reduced food consumption, which, according to Eriksen et al (2005) supposedly enables households to minimise the exchange of assets for food.

Women in the region also focused mainly on diversification as a coping mechanism, specific activities undertaken by women included assisting others, seeking assistance, selling labour and abandoning affected plots. The limited range of women's coping mechanisms compared to the household's in general signifies that even during extreme events, gendered divisions of labour are still apparent and are likely to increase vulnerabilities of female-headed households. However, the high mean proportion of women involved in adaptation activities confirms women have built resilience over time.

Though the majority of households considered disease incidence normal for 2001-2004, severity seemed to be higher for 2001 & 2002. This could coincide with the flooding in

2002, as outbreaks of Malaria and Cholera have been known to be associated with increased vector breeding (Warsame et al, 1995) and contamination of water supplies and promotion of unhygienic practices due to water shortages caused by floods. Drops in severity in 2003 coincide with increased use of mosquito nets and various other measures such as cooking food, cleanliness and health advice. Resilience to disease outbreaks in Rufiji appears to be very low mainly due to the absence of adequate health infrastructure in many parts (Desanker & Magadaza, 2001).

5.6.3 Linking Climate Variability with Climate Change

Most associated climate variability with inadequate and changing precipitation while most felt that weather was largely unpredictable (despite a range of indicators of good and bad weather) most felt that there have not been large changes in weather over their lifetimes. This is to be expected in this region as the south of Africa currently recognises the importance of El Nino Southern Oscillation (ENSO) events. The impacts of climate variability can be seen in the often ill-fated government resettlement and irrigation programmes of the past decades. Discussion of floods in PRA exercises only focused on the very severe events that have occurred in recent decades. This is important as the increased frequency and severity of climate change related events could be as great as current ENSO events (Dixon et al, 2003).

People were not aware of climate change and in most cases could not relate the unpredictability of weather and recurrence of extreme events like floods and drought to with climate change.

The effects of climate change will have profound on the poorest within the population (women, children, those isolated geographically) who derive a substantial part of their livelihood from natural and communal resources are at most at risk of the effects of climate change (McMichael & Kovats, 2000). Poor households are likely to suffer as changes to varieties, which require less water may actually require increased inputs, which are unavailable (fertilisers) or increased efforts in cultivation if desired yields are to be met. This diversion of time and expense may have significant impacts on livelihoods, diverting time away from more currently productive diversification strategies.

6.0 Implications

The above discussion indicates that poor health status and vulnerability to the effects of flood and drought are the result of low access and entitlements to human, physical, natural, financial and social capital. The low status of such assets in livelihoods makes people vulnerable to both current climate variation and climate change impacts. Therefore, adaptation measures should aim to improve resilience of livelihoods. The histories of failed government policies to improve conditions in the region were typically imposed from the top and were unsuited to the needs of people in the region. What is required is a participatory approach, which seeks to improve existing capital for the benefit of stakeholders.

7.0 Recommendations

The government should increase access to financial capital by increasing loan availability in the region. Loan facilities specifically targeted at women may help households more as women are predominantly responsible for household operations and so could allocate financial capital according to the needs of the household. Such facilities will likely improve agricultural production by enabling households to apply fertilisers and hire tractors as well as enabling households to purchase livestock. Additionally, government employment projects in the region will create cash flows and help to make non-farm income for households more stable. Agro-processing activities may provide such opportunities in the region

Government intervention on marketing of crops is required in order to stabilise food prices during bad harvest periods. A return of the old cooperative schemes could also assist in this as cooperatives are run by local people and therefore benefits are returned.

Improvements to water and sanitary conditions should be a focus for government interventions, possibly with NGO assistance. Increasing the number of boreholes will help provide a clean supply of water in regions. In order to avoid the sinking of saline wells, adequate surveys are required to assess appropriate sites. Improvements in water infrastructure should be accompanied with improvements in sanitation. A pilot project consisting of the construction of Ventilated Improved Pit Latrines (VIPs) built using locally derived materials as well as an education programme utilising existing water and sanitation committees (watsan) that have already been established in the region to ensure the sustainable use of infrastructure.

Health education programmes are required and public dispensaries should be well stocked with medical supplies in order to ensure that people have access to knowledge and affordable medicines. Access to the hospital in Kibiti could be improved with the provision of an ambulance service to transport people who are referred from local health centres.

Technological innovation interventions such as wood fuel efficiency and greater electricity connections will help to reduce demand placed on forest resources for fuelwood and charcoal, helping prevent forest degradation.

There is great potential for a revival of irrigation in the region. Given the prevalence of infrastructure (natural dams), new projects could help to restart irrigation. Past projects failed as running costs exceeded available capital. Access to loan facilities and the improvements to incomes following such investments may help to make irrigation of medium to large-scale areas cost effective, producing higher returns on investment.

The establishment of a local radio station in the region would help raise awareness to general issues and concerns in the region and provide an early warning system. Education and advice to local residents could seriously improve some livelihoods.

8.0 Conclusion

Current socioeconomic conditions in Rufiji result in increased vulnerability to the effects of climate change especially amongst the poorest and the marginalised (women). The nature of past interventions and their failures expresses the importance of a participatory approach and analysis of the way people construct their livelihoods and how these can be improved to reduce vulnerability. The range of adaptation options put forward differs significantly from some of the top-down strategies (disease vector control, use of new crop varieties) suggested in the initial communication as they consider people's livelihoods and the constraints they currently face.

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