IRRIGATION LIVELIHOODS HETEROGENEITY AND WATER RESOURCE MANAGEMENT: A STUDY OF BUA WATERSHED IN NKHOTAKOTA, CENTRAL MALAWI

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Photo of Bua River by Jacque Liu, 2006

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Declaration

I, **Tawina Jane Joseph Kopa**, declare that this thesis is a result of my research investigations and findings. Sources of information other than my own have been acknowledged and a reference list has been appended. This work has not been previously submitted to any other university for award of any type of academic degree.

Signature………………………………..

Date…………………………………………

FOR MY PARENTS

Joseph Ackim Kopa and **Veronica Margaret Kopa**

AND

MY SIBLINGS

Allan Kopa, Chinsinsi Kopa, Pilirani Kopa, Abbas Kopa and **Agnes Chifundo Kopa**

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Irrigation livelihoods heterogeneity and water resource management: A study of Bua watershed in Nkhotakota, Malawi

ABSTRACT

Water resource depletion is increasingly threatening irrigation development in Malawi and elsewhere. Recognising that, Malawi's water and irrigation policies have embraced integrated water resource management (IWRM) principles with emphasis on irrigation development and stakeholder participation. This has seen the birth of farmer managed irrigation systems (FMIS) most of which have been mismanaged, resulting into underperformance. This study addresses irrigation and water management from a livelihoods perspective through assessing diverse livelihood activities and determining the economic importance of irrigation in relation to other activities. It also discusses the institutional framework for irrigation and water management. The study uses empirical data from the field research that was conducted among Bua watershed irrigators in Nkhotakota. The results indicate that 'irrigation livelihoods' are heterogeneous in that some are more irrigation based than others. This is reflected in varying benefits accrued from irrigation and how that determines household's dependence on other activities. Dichotomising the livelihood activities between water-dependency and non-water dependency provides a framework for analysing inter- and intra-household competing water uses. The analysis shows that irrigation, like most water-dependent livelihood activities, is less profitable to non-water dependent households contributing only 24 % to their livelihoods but more profitable to water-dependent households with 62 % contribution. In addition, water-dependent households have more diversified income sources and less income than non-water dependent households who are better off in terms of income by 29 %. The study reveals that as households make decisions around resource (assets and capabilities) allocation, rationally, more resources are allocated to more profiting activities such as trading. Further, it shows that irrigation plays a role in reducing income inequalities among water-dependent households but it has no significant effect among non-water dependent households. The study argues against the view that irrigation households have irrigation-based livelihoods as reflected in most literature and policy strategies. It shows that this view overshadows the water-dependency dichotomy of livelihood activities, which has implications for water management. The study concludes that integrated water resource management starts at household level as households efficiently allocate water to diverse uses. Therefore, placing irrigation and water management within the livelihood framework will not only promote the integrated approach but also ensure formulation of effective and result-oriented policies.

List of Acronyms and abbreviations

EPA	Extension Planning Area
FMIS	Farmer Managed Irrigation Systems
GOV	Gross Output Values
GWP	Global Water Partnership
IFAD	International Fund for Agricultural Development
IWRM	Integrated Water Resource Management
MK	Malawi Kwacha
NGO	Non-governmental Organisation
SFPDP	Smallholder Flood Plains Development Project
T/A	Traditional Authority
US	United States of America
USD	United States Dollar
WRB	Water Resources Board
WUA	Water User Association

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PART I. THE INTRODUCTION

1.0 Livelihoods heterogeneity and irrigation development: The study

Water resource depletion is of growing concern in irrigated agriculture as competition for water continues to increase among users and between uses (Mulwafu et al., 2003; Meinzen-Dick and Bakker, 2001; Bruns and Meinzen-Dick, 2000; GWP, 2000). Generally, in sub-Saharan Africa, unreliable and inadequate water supply in combination with declining soil fertility, has led to low agricultural productivity (Merrey et al., 2005; Malawi Government, 2002). This is one factor that has influenced the development and adoption of approaches that are thought to ensure equitable, efficient and sustainable allocation and utilization of water resource (Lankford, 2003; Meinzen-Dick and Bakker, 2001; Bruns and Meinzen-Dick, 2000). Integrated water resource management (IWRM) is one such approach (GWP, 2004). This study addresses water resource management in the Bua watershed in Malawi by adopting a livelihoods perspective.

1.1 Water resource management from a livelihoods perspective: The problem

Integrated water resource management (IWRM) is defined as 'a process that promotes the coordinated development and management of water, land, and related resources to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems' (GWP, 2000: 22). It has been observed in some quarters that IWRM has now become a dominant paradigm for water management (Merrey et al., 2005; Sokile et al., 2003; Biswas, Undated). Water and irrigation policies in Malawi have greatly embraced the concept of IWRM (Mulwafu and Msosa, 2005; Malawi Government, 2004a; Malawi Government, 2002) with particular emphasis on development of irrigation. This phenomenon is not unique to Malawi, as generally, in sub-Saharan Africa, irrigation is perceived to be an engine for both food security and rural development (Lankford, 2003).

In Malawi, irrigation has lately been recognised as a vital vehicle to increasing and stabilising agricultural productivity, and subsequently the country's agro-based economy (Mulwafu and Msosa, 2005; Malawi Government, 2002; Malawi Government, Undated). This is a shift away from long time continued reliance on rain-fed agriculture (Mulwafu et al., 2003), which is characterised by unreliable rainfall, floods and severe droughts (Malawi Government, Undated).

Along with this shift in agricultural policy has been a greater recognition of stakeholder participation in development of irrigation in Malawi (Malawi Government, 2002; Malawi Government, 1999). Thus, increased stakeholder participation with farmers on one hand and private sector on the other, has become a common feature in the country's current irrigation development sphere. This has seen establishment of water user associations (WUAs) and transfer of ownership and management of irrigation systems to the farmers -the so called Farmer Managed Irrigation Systems (FMIS)- with a view to devolve control and responsibility, and possibly maximise benefits from irrigation (McKay and Keremane, 2006; Malawi Government, 2002; Guijt and Thompson, 1994). In this new institutional setup, the policy has distanced government from implementation of irrigation programmes to a coordinating role, in a bid to create an enabling environment for stakeholder participation. This is different from Lankford's (2003: 817) analysis of irrigation development policy and strategies in Tanzania in which he positioned Tanzania government in a 'leading and interventionist' role in irrigation development.

All these twists and turns that irrigation development path has taken in Malawi, particularly in positioning farmers as partners and not passive stakeholders (Malawi Government, 2002), has not been without challenges. One of the challenges has been far-reaching consequences of overlooking the risks, costs and complexities of irrigation, and failure to fit irrigation into the farmers' broader livelihood arena where decisions on resource allocation -including water- are made (Lankford, 2003; Guijt and Thompson, 1994). Put differently, failure to place irrigation within the broader framework of rural livelihood systems has resulted in mismanagement of water and irrigation infrastructure, and consequently, underperformance of most farmer-managed irrigation systems. Approaching IWRM from a livelihoods perspective as already advocated for in some literature (Merrey et al., 2005; Lankford, 2003; GWP, 2003; GWP, 2000) has potential to address this seemingly overwhelming challenge.

1.2 Interface between irrigation, rural livelihoods and water management: The study objectives

This study addresses water resource management in the Bua watershed in Nkhotakota district of Malawi from a livelihoods perspective by venturing to understand the interface between irrigation, rural livelihoods and water resource management. This is achieved through undertaking the following:

(a) Analysing and describing Bua watershed irrigation households' livelihood activities and distribution of income between the activities, and among the households;

(b) Determining economic importance of irrigation in livelihood portfolios of Bua watershed households; and

(d) Discussing the institutional framework for irrigation and water management in Bua watershed and implications for water resource management.

1.3 Organisation of the thesis

This thesis uses empirical data from field research that was conducted among Bua watershed irrigation households in Nkhotakota, Malawi, between October and December 2006. The thesis is presented in two parts. The first part consists of an extended introduction which sets the tone for the thesis by providing a conceptual and theoretical overview of the study, its objectives and methodological approaches.

The Introduction has several sections: section 1.4 presents the approach of the study, followed by section 1.5 that gives a historical overview of irrigation development in the study area. Section 1.6 locates irrigation and water management in the broader context of livelihoods analysis. Section 2.0 of the Introduction starts with description of the study area, giving the geographical coordinates, and explaining the institutional and administrative structures, followed by some information which is of relevance to the study. It then moves on to outline the methodological approaches including analytical frameworks. The last section of the Introduction summarises the findings and provides insights for future research in the area of "irrigation livelihoods" and water resource management.

Part II is a Paper presenting the study with the detailed empirical findings. The Paper has followed 'Irrigation and Drainage Systems' journal format, with some modifications to conform to UMB Master Thesis standards. The Paper can also be read independently of Part I of the thesis.

1.4 Irrigation livelihoods heterogeneity and water management: The approach

Advancing the case for a more people-centred, livelihoods oriented platform in IWRM (Merrey et al., 2005), this thesis is concerned with understanding the interface between irrigation and rural livelihoods on one hand, and water resource management on the other. It uses a livelihoods approach to analyse trade-offs in water allocation that are made within, between and among households, as these have implications for water management. In this study, livelihood activities are dichotomously viewed as either water-dependent or non-water dependent based on how rural households derive them (see section 2.6*c*). The study conceptualises that there is heterogeneity in livelihood dependency on irrigation such that not all irrigation households have predominantly irrigation-based livelihoods, and that livelihood orientation does affect decision-making around water resource allocation and use. The orientation further informs individual's ability and willingness to invest in water management.

The approach taken in this study, complements Lankford's (2003:818) efforts to demonstrate that 'policy can target different stages of irrigation livelihoods and development (see section 1.6), and in doing so can be more focused and effective in financial, outcome and sustainability terms'. It however adds a dimension that at any one stage of irrigation development, the presumed 'irrigation livelihoods' will be heterogeneous in terms of irrigation contribution to the livelihood base. That is, while on face value they may be seen as irrigation livelihoods, in practice they may not be. The study also draws insights from Guijt and Thompson's (1994: 295) observation that regarding irrigation as 'an end in itself and not a means to an end' implies alienating irrigation from other livelihood endeavours. The authors condemn such reductionist view of irrigation.

1.5 Irrigation development in Bua watershed: A historical perspective

Irrigation development in Bua watershed in Nkhotakota district, Malawi, started in the early 1970's with the development of Bua river diversion gravity-fed irrigation system. The irrigation system was developed with funding from the Chinese government, whose technical experts managed the scheme until 1994 when it was handed over to Malawi government (SFPDP, Undated). The scheme was established to function as a settlement area and training ground for local farming communities who wanted to be trained in improved rice cultivation. Apart from rice, the scheme cultivated maize and vegetables on a smaller scale.

The first scheme management committee was established in 1977 and it comprised 10 members. The committee was mainly responsible for settling disputes related to land among its members. The succeeding committee was elected in 1982, and unlike the first committee which did not have female members, this one had 2 women, one serving as a secretary, the other as a committee member. The committees had 5-year terms. It should be noted that water resource management was not at the heart of the committees nor was it a policy issue, presumably because water demand was still low and irrigation was in the early stages of development.[1]

When the Chinese government pulled out in 1994, irrigated rice production came to a halt because farmers were not able to block Bua River to abstract water into the scheme as they lacked the technical expertise and financial resources. Between 1998 and 1999, the scheme got external aid through Smallholder Flood Plains Development Project (SFPDP) to assist in scheme rehabilitation. The rehabilitation included construction of permanent irrigation structures at the head works (such as weir, sand trap and pipeline) as well as reorganisation of farmers into what is called a water user association (WUA). The SFPDP project was funded with a loan from International Fund for Agricultural Development (IFAD). In fact, this assistance came in as a preparatory process for handing over the scheme to farmers, in line with the new government policy (see SFPDP, Undated).

While these strides in irrigation development were taking place in one part of Bua watershed, in another part an irrigation group was formed, albeit smaller than the Bua scheme. This group was called Chisambo, established in 2001. In addition, individual irrigation farmers have emerged over the years whose exact number is not known due to lack of documentation. To date, over 380 ha of land in the Bua watershed is under irrigation.[2]

1.6 Irrigation and water resource management in Bua watershed

As irrigation expanded in the Bua watershed, irrigated area is estimated to have increased from 240 ha in late 1970's to 380 ha as of 2006. The number of irrigators has also increased

[1] Discussion with key resource persons provided this information.
[2] The figure of 490 ha was verbally pointed out during interviews with the head of Linga agriculture office

and so has the water demand for irrigation and other needs. Coupled with this demand is population growth which is currently pegged at 2.8 % per annum (Nkhotakota District Assembly, 2005; Malawi Government, 2004b), and water demand for other water needs such as livestock, domestic, fishing, and micro-enterprises, for example, clay pot making and brick-making. These water demands were identified during the fieldwork.

Generally, irrigation development in the Bua watershed seems to have followed a sigmoid curve of irrigation growth. This theoretical curve suggests that irrigation uptake is slow in the initial stages of irrigation development[3] and with time, rate of uptake of irrigation increases due to a number of factors, which also sometimes act to hinder irrigation development. Such factors are "marketing, infrastructure, social background, labour availability, pricing policy, population density, land availability, and irrigation knowledge" (Kay, 2001: 36 quoted in Lankford, 2003: 819). In this study, it was observed that external aid also affects irrigation development. Intervention of the Smallholder Flood Plains Development Project (SFPDP) in Bua irrigation scheme, for instance, has led to dramatic increase in the number of farmers from less than 446 to over 600 between 2004 and 2006.[4] In fact, during data collection in one of the meetings with the irrigation farmers, some non-members showed up in anticipation that the meeting was about plot allocation. Evidently, they wanted to join the scheme. In Chisambo scheme, the same trend was observed where scheme membership had increased to 30 with the intervention of a Non Governmental Organisation (NGO) called Save the Children (US).

It should be appreciated that the Chinese government has since started supporting the scheme again. At the time of research a Chinese technical expert was on site to help farmers in agronomic aspects of irrigated agriculture. This may also have contributed to increase in number of scheme members and prospective members.

The final stage of development on the sigmoid curve is characterised by conflicts and conflict resolution within limits of water use. The Bua watershed irrigation development identified well with this characterization of the stage of irrigation growth whereby water management has now become an important issue due to increased demand and conflicts and conflict

[3] Lankford (2003) talks of three stages of irrigation development along the sigmoid curve. The first stage, proto-irrigation stage, is where irrigation uptake is slow. In stage B, irrigation livelihoods momentum grows, and the benefits are well known. The final stage, stage C, irrigation settles at dynamic equilibrium level. Conflict resolution within sustainable limits of water use becomes common feature.
[4] These figures were obtained from the scheme management committee of Bua irrigation scheme

resolution is a common phenomenon. Marketing infrastructure and services however have remained poorly developed despite the scheme being in the advanced stage of irrigation development. On the same note, no river basin management plans have been developed yet for the basin.

Water resource in the watershed is managed under the dichotomy of open-access/common property regime. Within the Bua irrigation arena, individuals have bundles of rights defined by whether they are members or not. In fact, Bua irrigation scheme farmers pay for water rights while irrigation farmers in the upstream of Bua River do not pay. Individual irrigators[5] on the other hand abstract water from anywhere provided it is not within an irrigation system like along conveyance canal. This fragmented approach to water allocation and hence water resource management, coupled with aforementioned factors, has aggravated water scarcity problem in the basin. The following section gives a detailed overview of the research methods and methodology that were employed in the study, their limitations and how they were addressed. It also serves to give the researcher's position in the study in relation to the research approach used and the research findings.

[5] These are irrigation farmers who do not belong to any irrigation scheme or are not part of irrigation scheme. They do individual irrigation. Some farmers are both individual irrigators as well as group irrigators.

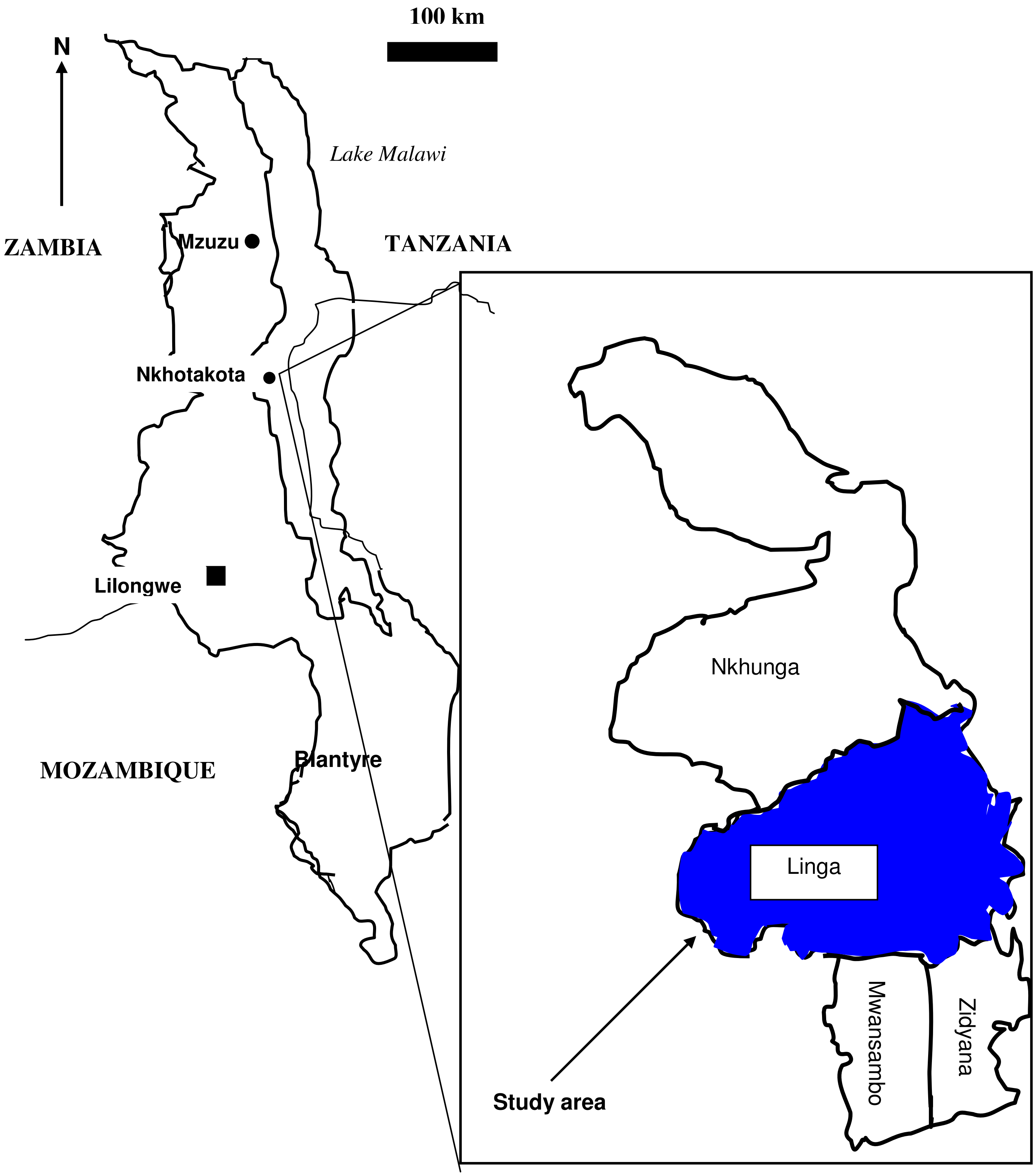


Figure 2.1: Map of Malawi showing Nkhotakota district and the study area

2.0 Research methods and methodology

2.1 Description of the study area

a) Location, demography and topography

The study was conducted in the watershed of Bua River Basin in Traditional Authority (T/A) Mphonde in Nkhotakota. Nkhotakota is a lakeshore district located 200 km north of the capital Lilongwe in the central region of Malawi (See Figure 2.1).

The Bua Basin has an estimated area of 10, 700 km^2 and a catchment area of 10, 654 km^2 (Esser et al., 2005; Kidd, 1983) stretching from Mchinji through Kasungu and Ntchisi districts to the West and South-West of Nkhotakota, respectively, to Nkhotakota district. It lies at latitude 12 degrees (South) and longitude 34 degrees (East), and at an altitude of about 500m above sea level (Malawi Government, 2004b).

Nkhotakota district is generally flat and sparsely populated with an elevation ranging from 493m to 1,638m above sea level (Malawi Government, 2004b; SFPDP, Undated) with a land area of 4,259 sq. km holding 230, 361 inhabitants (Malawi Government, 2004b). The district has thus a population density of 54 persons per sq. km, making it the least dense in the region.

b) Local institutional structures and administration

Nkhotakota district has 421 villages governed by 82 Group Village Headmen (GVH) existing under jurisdiction of six Traditional Authorities (T/A), namely, Kanyenda, Kafuzira, Malengachanzi, Mwadzama, Mwansambo and Mphonde. Traditional Authority Mphonde has 38 villages with a population of 18, 611 and population density of 131 persons per sq. km. This population size represents 8.1 % of the total population of Nkhotakota district and 1.6 % of the Malawi population. Of the 18, 611 inhabitants of the T/A Mphonde area, less than half are above 18years of age (47 %) and 51 % are women (Malawi Government, 2004b).

The district has an Assembly established under Local Government Act 1998 (Malawi Government, 2004b). The Assembly (also called District Council) is composed of elected members, T/As or Chiefs, Members of Parliament and co-opted members. It is the highest authority as regards development and political issues at district level. Under the assembly or council are Area Development Committees (ADCs), which are a cluster of villages under one T/A. The next lowest level is Village Development Committee (VDC) which is headed by a GVH or Village Head. These local structures coordinate development activities at various levels and are also responsible for mobilizing community resources and determining development interventions (Malawi Government, 2004b).

c) Agricultural development institutional structures

Like most districts in Malawi, Nkhotakota is agriculturally active with 71, 088 farming families and an average land holding size of between 0.8 and 1.8 ha (Nkhotakota District Assembly, 2005; Malawi Government, 2004b). Main crops grown are maize and cassava for food, and rice, cotton, tobacco (barley) and sugarcane for cash income. Minor crops include ground nuts, paprika, vegetables, beans, soya, chilly, millets, cowpeas and sweet potatoes (Malawi Government, 2004b; SFPDP, Undated).

The district agricultural activities are coordinated under Salima Agriculture Development Division (SLADD), one of the regional agricultural development coordinating units with sub offices in Nkhotakota and Salima districts. These sub offices are further demarcated into smaller coordinating units called Extension Planning Areas (EPA). Nkhotakota district agricultural development office has 4 EPAs, namely, Linga, Nkhunga, Mwansambo and Zidyana. Bua watershed falls within the Linga EPA. At the time of research, the EPA reported that the area under irrigated agriculture was in excess of 490.8 ha, with over 1002 farmers, 30 % of which were female. Main irrigation water lifting devices included treadle pump, motorized pumps, and river impounding. Water conveyance and field distributions were principally by gravity through open channels, and/or flooding.

The Bua watershed constituted about 63 % of the reported irrigated area in the EPA. The total irrigate area was divided among two irrigation schemes, namely, Bua and Chisambo, and a number of individual irrigation farmers. Bua irrigation scheme is the largest scheme in the area as well as the district. It has a gross area of 360 ha and net area of 300 ha (IFAD, 2002), benefiting 511 farmers, 187 of which are women. On the other hand, Linga EPA office reported that

Chisambo irrigation scheme had a net area in excess of 8 ha benefiting 22 men and 8 women. The EPA further reported that the scheme got assistance from a Non-governmental organization called Save the Children (US). The organisation provided assistance mainly in form of agricultural inputs and technical expertise. This information was confirmed by the irrigation farmers during data collection in focus group discussions and household interviews.

d) Water resource and irrigation development

The lower Bua Basin in Nkhotakota district has one big river called Bua, and a number of perennial and seasonal tributaries and streams. Some of these streams are Kasangadzi, Chisambo, Chankhombe and Kalongo. Most irrigation activity in T/A Mphonde area takes place along Bua River. For instance, Bua irrigation scheme abstracts water from the Bua River.

Bua River realises an average monthly flow of 68.25 cubic metres per second, a maximum flow of 136 cubic metres per second (in January) and a minimum flow of 0.5 cubic metres per second in October (SFPDP, Undated). However, during the study from October to December 2006, there was literally no water flow in the river. SFPDP (Undated) further reported that the area receives an annual rainfall of about 685.3mm with an average of 57.11mm per month.

Chisambo and Kasangadzi streams are also important for irrigation in the area. Chisambo irrigation scheme is fed by Chisambo stream which in turn gets some of its water as spill over from Bua scheme collector drain. Before Bua scheme development, the stream used to get water from Bua River as spill over. It was learnt that this change had affected water quality and quantity in the stream such that aquatic life which previously flourished in the stream, has disappeared. Also, the water is no longer safe for drinking and domestic use.

The inhabitants of the area also practice irrigation using residual moisture, but to a lesser extent. This is mainly done along Kalongo stream and other low lying areas which get flooded during rainy season and maintain a higher water table way into the winter season.

2.2 Field work and data collection

The field work was carried out over a period of three months from October through December 2006 by a researcher as part of her studies for the Master's degree in Natural Resources Management and Sustainable Agriculture at the Norwegian University of Life Sciences (UMB). The researcher was also employed as an Irrigation Agronomist in the Malawi Ministry of Water and Irrigation Development, in the Department of Irrigation Services. Her choice of Bua watershed for this study was encouraged by her previous encounter with the irrigation community in the area where she became aware of some of the challenges the farmers were facing in the area of water resource management.

This previous association with the farmers enabled the researcher to gain access to the study area. Initial contacts were made through the Department of Irrigation Services district office in Nkhotakota district. The irrigation officials together with the researcher then met with the local authorities and scheme leadership in preparation for the reconnaissance survey and subsequent data collection. During the same period, the researcher identified some enumerators; two were local and two from Lilongwe. She trained them in questionnaire administration and code of conduct when carrying out research. The enumerators were suitably qualified with a minimum qualification of a diploma. They took part in household questionnaire pretesting, which formed part of hands-on training prior to conducting the actual interviews. This thorough training led to successful collection of data.

a) Survey methods

A reconnaissance survey was conducted to select villages for the study. Villages, which had households that were practicing irrigation either at group level (e.g Bua and Chisambo) or at individual level, were identified. There were 31 villages involved in irrigation out of 38[6] villages existing in TA Mphonde area. These villages were selected for further screening.

From the selected villages, one village, Pendwe, was purposively identified for household questionnaire pretesting exercise. Five households from this village were conveniently but

[6] The figure of 38 was the documented one. However, this figure was different from the one the Traditional Authority Mphonde office had provided of 280. The number has increased because more villages have mushroomed due to splitting of some villages into 2 or more.

randomly selected for the exercise. The exercise allowed for necessary adjustments that ensured quality data collection during the actual survey.

b) Data collection methods

Both qualitative and quantitative methods were complementarily used in order to collect as much detailed and constructive information as possible to inform the study. Qualitative methods of data collection included focus group discussions, key resource persons interviews, group meetings and field observations. These methods were employed to get a broader picture of livelihood systems and irrigation activity in the area. A stakeholder questionnaire was also administered to understand the scope of stakeholder involvement.

A structured questionnaire was used to collect quantitative data on households that were engaged in irrigated farming. Households from Chisambo and Bua irrigation schemes and some individual farmers were interviewed. Some households were affiliates of both schemes as well as holders of individual irrigation farms. Data collected using the questionnaire included quantitative component of the livelihood portfolio such as assets, activities, incomes and vulnerability factors (see Ellis and Freeman, 2004; Ellis, 2000). On the same note, information on residual moisture cultivation was captured. This was possible because most farmers who used moisture cultivation for winter cropping were also members of the irrigation groups.

c) Sampling of households

Households for the study were selected from the villages that had been identified as practicing irrigation (refer section 2.2a). The villages were stratified into three strata according to their degree of proximity to Bua River. From each of the stratum, 3 villages were randomly picked and their households grouped to form a household stratum. In total, 3 household strata were formed. Polygamous families were treated as separate households. It should be noted that Chikunichoola village was purposively selected to ensure that Chisambo irrigation farmers who mostly hailed from the village, formed part of the sample. In total 10 households were selected as shown in Table 2.1.

Table 2.1: Study villages with corresponding number of participating households, by degree of proximity to Bua River

Distance from Bua River	Name of village	Number of households
≤ 3km	Kambuzi	69
	Makoka	17
	Vulachitambo	41
3 – 4km	Chitambo	29
	Khutu	7
	Mphonde	20
> 4km	Mvula	27
	Mthawanji	1
	Mndota	2
	Chikunichoola	30
Total		**243**

Source: Field survey (2006)

The stratified households were then subjected to simple random sampling from which 92 households were selected. About 43 % of the sample households came from the first stratum which was composed of households located within a radius of 3 km (nearest) from Bua River. Some 25 % of the sample households were from the second stratum, located between 3 km and 4 km away from the river. From the last stratum comprising households located further than 4km (furthest) away from the river, 60 % of the households were randomly selected representing 32 % of the sample households (see Table 2.2).

Table 2.2: Proportion of households sampled with varying degree of proximity to Bua River

Stratum (proximity)	Number of households by stratum*	Number of households selected	Percentage of households in the stratum	Percentage of total number of sample households
1 (≤ 3km)	127	40	16	43
2 (3 – 4km)	56	23	10	25
3 (> 4km)	60	29	12	32
Total	**243**	**92**	**38**	**100**

Source: Field survey (2006)

* This is the total number of households participating in irrigation from three villages that formed a stratum

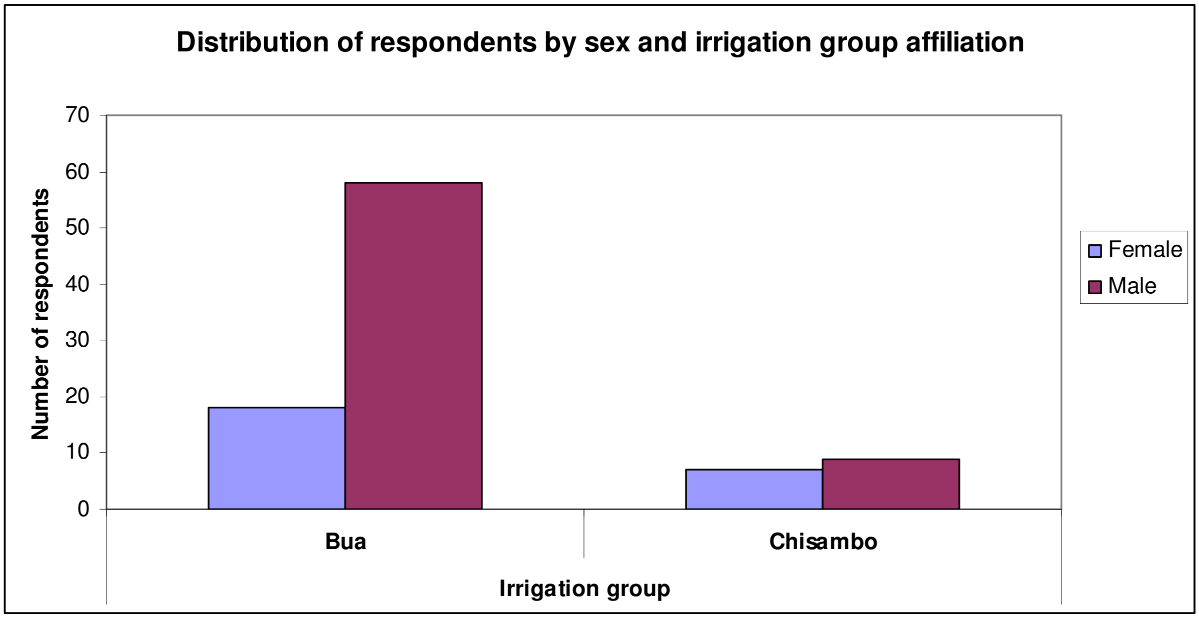
d) Household characteristics

Household was the analytical unit that was used in the study. It has been defined as a 'group of individuals living together and eating from the same pot' (Lwesya, 2004: 25). Other literature has looked at it as a unit of production and consumption (Overholt et al., 1985). The authors define household (agricultural) as a 'kinship-based group engaged in both production and consumption with corporate ownership of some resources and a degree of joint decision making among members' (p 21). This study, drawing upon some insights from household economic model[7], subscribes to the latter definition which embraces polygamous and extended families notion, which was a common feature in the study area. Polygamous families were treated as separate households (see section 2.2c).

The households exhibited characteristics which were attributed to socio-cultural and economic contexts of the Bua watershed community they were part of. It is worth mentioning that 67 % of the respondents were not natives of the land. They had come from various parts of the country such that in total over 16 tribes were identified among the respondents. It was however, beyond the scope of this study to consider implications on livelihood strategies and water management of such tribal diversity.

[7] For more elaboration of household economic model, see Lwesya (2004) and Vedeld (1990)

About 27 % of the respondents were female aged between 23 and 70 years. Male respondents were aged between 22 and 70 years. As earlier alluded to, the respondents were from two irrigation groups existing in the watershed. About 10 % of the respondents were members of both groups and 5 % engaged in individual irrigation farming using either residual moisture or simple irrigation technologies such as treadle pumps. Figure 2.1 below shows distribution of respondents by sex and irrigation group.



Source: Field survey (2006)

Figure 2.2: Distribution of respondents by sex and irrigation group affiliation

More information about general characteristics of the households categorised into water-dependent and non-water dependent households (see Section 2.6*c*) is shown in Table 2.3 below.

Table 2.3: Household characteristics (Mean) by level of livelihood dependency on water

Household characteristic	Water-dependent households (n = 63)	Non-water dependent households (n = 29)	Total (n = 92)
Household size (no.)	7.8	7.4	7.6
Household existence (yrs)	18.2	16.8	17.7
Area farmed (ha)	1.4	1.9	1.5

Source: Field survey (2006)

e) Interviews and focus group discussions

Key resource persons interviews were conducted among 7 key resource persons that were selected for their knowledge and experience in various key issues relevant to the study but also their position (significance) in the irrigation community. For instance, two longest serving scheme members were interviewed to obtain information on historical background of irrigation in the watershed, institutional changes that had taken place since 1976 when irrigation development was first introduced in the area. Local authorities, scheme leadership, leaders of water user groups (both men and women), and government officials were also interviewed.

Focus group discussions with Bua and Chisambo irrigation farmers were conducted to gather information on main livelihood activities and general perception about irrigation as a livelihood strategy. Deliberate effort was made to include both men and women in the discussions. The discussions were also done to identify key resource persons that were later interviewed individually.

f) Field observations

Field observations were done by the researcher to obtain data on physical structures in the schemes and these included data on irrigation and drainage system in the schemes as well as individual irrigation farms, and soil and water conservation interventions such as storm water drains and flood protection bund. This aided in having a general appreciation of the physical condition of the schemes and its implications for water management.

2.3 Data validity and reliability

Data validity and reliability measure the accuracy and consistence of the research. Reliability assesses whether the research has random errors. It determines the consistency of the measurements. High reliability represents high correlation between dependent and independent variables. Reliability can relate to the researcher or the respondents.

Validity on the other hand, is a measure determining the extent of system errors in the data material (Bryman, 2004). If relevant variables are excluded, the statistical models are biased. Data validity is to a great extent dependent on the researcher.

This study checked for both reliability and validity in a number of areas. For instance, it was noted that reliability problems could have been due to two reasons. Firstly, some respondents were so old that they had problems remembering some figures especially on crop production (crop inputs and sales) and livestock production (livestock management costs). To correct this problem, more information was collected from their spouses and children.

Secondly, some respondents seemed not so clear about the purpose of the study and were deliberately underestimating their production and income levels. This problem was corrected by explaining the study purpose prior to and throughout the interview session.

Validity problems could have arisen from asking unclear questions and/or leading questions. This problem was checked by training the enumerators thoroughly and involving them in the pretesting exercise.

2.4 Ethical issues

Diverse codes of ethics have emerged over time and these are mainly concerned with how to treat research subjects and what activities to engage in or not in relation with the subjects. These codes reveal a great deal of variation in understanding of what is ethically acceptable or not. Bryman (2004) asserted that writers tend to differ widely on issues of ethical concern. However, there are some basic ethical principles which researchers should not afford to disregard. A researcher should be aware of ethical concerns such as invasion of privacy, confidentiality, harm to participants, informed consent and deception (see Bryman 2004:509). Ethical behaviour has been noted to impact both social and physical environment, and to have the potential to increase -or decrease[8]- the sum of good in the world' (Israel and Hay, 2006:2).

In this study, some considerations were made on ethical issues especially those that were likely to arise in the course of data collection. For instance, research participants were informed of the purpose of the study prior to their participation. This enabled them make informed decisions on whether they could take part in the study or not. On the same note, participants were assured of confidentiality of information they provided. Furthermore, administration of questionnaires was scheduled in a way that it caused minimal inconvenience to participating members. The researcher can assure that this study was conducted within ethically acceptable premises in as far as it was reasonably practical.

2.5 Frameworks used for data collection and analysis

a) Rural Livelihood Analytical Framework (RLAF)

A livelihood is defined as the 'means of gaining a living, including livelihood capabilities, tangible assets, such as stores and resources, and intangible assets, such as claims and access (Chambers and Conway, 1992 in de Haan and Zoomers, 2005). Ellis (2000) defines livelihood as 'comprising the assets (natural, physical, human, financial and social capital), the activities, and the access to these (mediated by institutions and social relations) that together determine the living gained by the individual or household'. A livelihood system on the other hand, 'comprises capabilities, assets (including both material and social resources) and activities required for a means of living (de Haan and Zoomers, 2005).

This study subscribes to both livelihood definitions but is greatly concerned with measurable outcome of livelihood process, which is both cash income and in-kind contributions, and to a lesser extent, institutions that inform individual's livelihood base. Rather than looking at a livelihood system of an individual or individual household, this study dwells much on the livelihoods system of the community in the study area. The livelihoods system is understood as

[8] I have taken it upon myself to include 'or decrease' considering that ethical behaviour can good or bad and hence can have negative or positive impacts depending

system of interaction of livelihoods of diverse rural households, which together characterise a livelihood of a community, for example, where it can be asserted that a community is poor or better off. Issues of income inequality and livelihood diversification, for instance, are brought to the fore in attempting to explain the livelihoods system of a community.

A rural livelihood analytical framework (RLAF) (Figure2.2) has been devised to aid in analyzing rural livelihoods. In this study, the RLAF was used to analyse the livelihoods system in the study area. The components of the framework were identified such as households' capabilities, assets, and activities they engaged in for a living. In other words, the five capital assets, namely, physical, financial, social, human and natural capital assets, were identified as well as the structures and processes.

Data was collected on livelihood activities such as farm, non-farm and off-farm activities, which included irrigation, rain-fed crop and livestock production, micro-enterprises and so on. Information was also sought on institutions and organizations in order to assess the importance of the same in the livelihood portfolio of the households. In the framework, these were considered household capabilities. Major institutional structures identified in the area included the district's Agriculture and Environmental Affairs Department offices, Save the Children (US), Bua Water User Association (WUA), National Smallholder Farmers Association of Malawi (NASFAM), Fisheries and Wildlife departments and local and political structures (see section 2.1a).

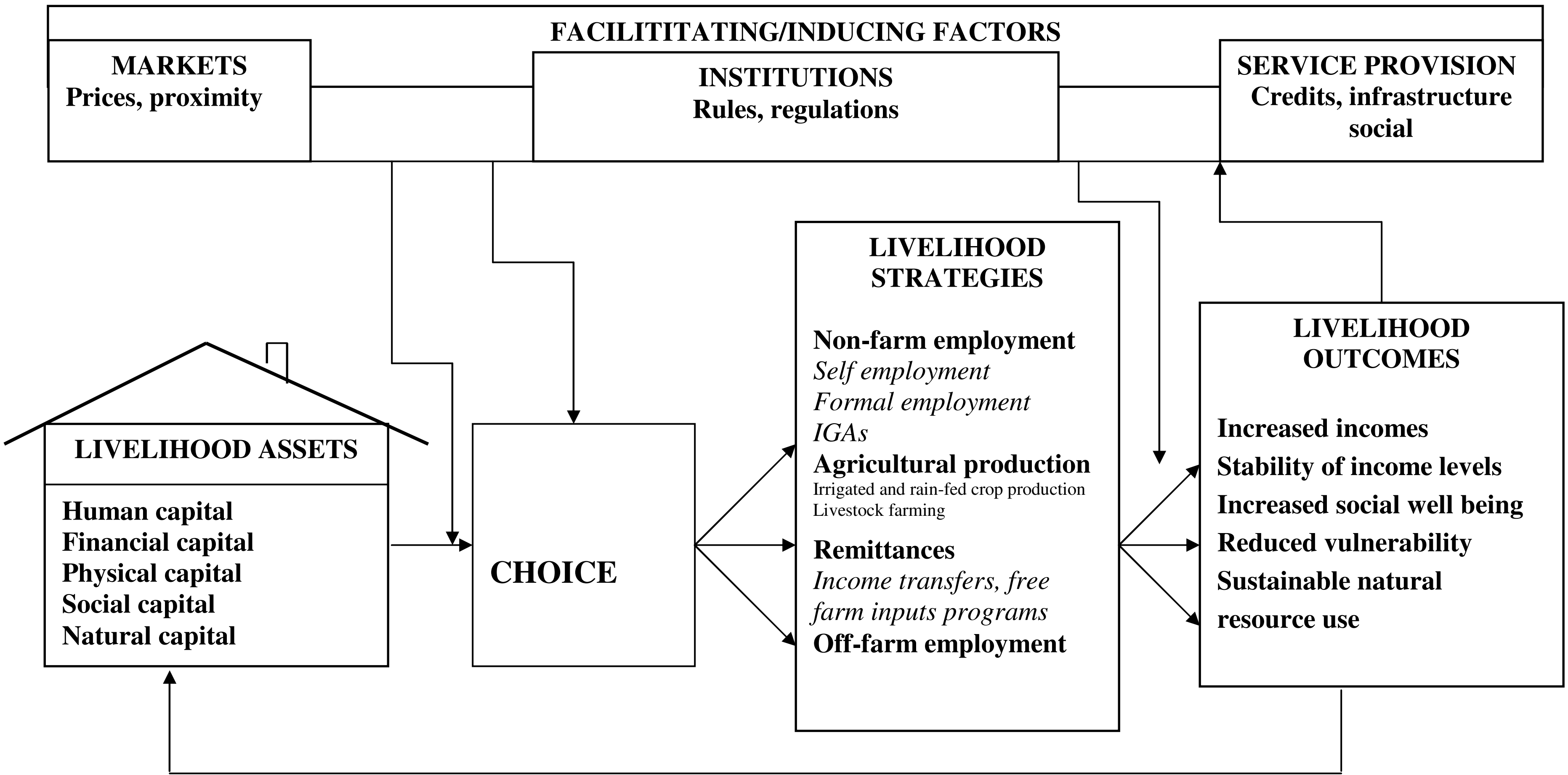


Figure 2.2: Rural livelihood analytical framework (Adapted from Scoones, 1998)

Other data was collected on assets which ranged from individual ownership of the assets/resources to control and/or use rights. Thus information was sought on water allocation and use in the irrigation systems, land rights, users and uses of water, and institutional networks in the watershed.

The RLAF however had some limitations in its application as analytical tool in the study. One limitation was its failure to explain complex interactions in the livelihoods despite recognizing such interactions. For instance, it recognized the assets and the fact that they were drivers of the livelihoods, but it failed to explain the combinations of assets that would translate into sustainable livelihoods.

Another notable limitation of the RLAF was its failure to reflect that not all five capital assets were equally important to all households and also how the inequality affected their livelihood status. Finally, as also noted by Carney (1998), the framework did not aid in analyzing the trade-offs and sustainability between assets.

b) The dichotomy of livelihood activities: Water-dependency versus non-water dependency

In this study, livelihood activities were defined in terms of whether they were derived from direct utilization of water or not, such that two groups of livelihood activities emerged, namely, water-dependent livelihood activities and non-water dependent livelihood activities. Water-dependent livelihood activities were defined as those activities which households derive from direct utilization of water. Examples of such livelihood activities are irrigation, fishing, beer brewing, vegetable growing and selling and livestock production. Non-water dependent livelihood activities (defined as activities which households derive without water or from indirect utilization of water) are activities such as managing a grocery/hawker, weaving, remittances, rents, carting and ploughing, and wages.

It is worth noting that some activities were not easy to determine whether they were water dependent or not because of their nature. Such activities included selling fish, selling beans, rain-fed crop production, and selling vegetables. To address this ambiguity, the extent of activity's water-dependency was considered as described below.

Vegetable selling, as an activity, depended on water to some extent in that even if one was not a producer but a seller (middleman), they would rely on producer's access to water for vegetable production. On the other hand, if water availability affected vegetable production of one grower, the middleman would rationally opt to buy from another grower who might have more access to water and hence some considerable level of vegetable production. In other words, as a seller and not producer, the middleman was able to maneuver. This applied to fish selling as well. In this study therefore, these variables were considered non-water dependent activities.

Rain-fed crop production was also treated as non-water dependent activity due to its mode of engagement. This was based on the reasoning that decisions about rain-fed cultivation in the area- and Malawi at large- do not depend much on water availability but more as a matter of tradition. Thus cultivation process (e.g. land preparation) starts before any assurance of water availability (adequate and well distributed rainfall) and water only becomes a concern when the growing season has prolonged dry spells or too much rainfall and so on. These generalizations and characteristics of rain-fed production led to the activity's categorization as a non-water dependent livelihood activity in this study.

i) Water versus non-water dependent livelihoods

Based on categorization of the livelihood activities, the households with more than half of their gross output values (GOV) (see section 2.6c) deriving from water-dependent livelihood activities are labeled water-dependent households or households with water-dependent livelihoods. Households with less than half of their GOV deriving from irrigation are termed non-water dependent households or households with non-water dependent livelihoods.

This study has introduced a livelihood water-dependency ratio that has been used to split the data into two groups, water-dependent and non-water dependent. The ratio was estimated by:

$$\textit{Livelihood water-dependency ratio} = \frac{\textit{Water dependent household incomes}}{\textit{Total household income}} \quad \textbf{........2.5.1}$$

Water-dependent household incomes are sum of all household incomes from water dependent livelihood activities, and Total household incomes are the sum of all household incomes (from both water and non-water dependent livelihood activities) within the household, that is the total gross output values. The ratio values ranged between 0 and 1. The greater the value (closer to 1), the more water dependent the household livelihood base would be, and the closer to 0 the value is, the more non-water dependent the household livelihood base would be. Using this ratio presentation, 63 households have been grouped as water-dependent and the rest (29) as non-water dependent households.

2.6 Statistical Analysis

Data from household questionnaires was analysed using Microsoft Excel, JMP and Minitab statistical packages. Tests were run at 95 % level of confidence. The following statistical analyses were done:

a) Descriptive statistics

These statistics included means, standard deviations and percentages of variables such as crop incomes, crop input costs, livestock incomes, household incomes, and gross output values. All these and others helped in explaining livelihoods system in the study area by looking at livelihood adaptations of the households.

b) Logistic regression

This was used to establish the relationship between dependent and independent variables. It was run for example, to explain the relationship between livelihood water-dependency (as a dependent variable) and some independent quantitative variables such as self-employment incomes, water dependent incomes, household irrigated area, respondent level of education, household size, and independent categorical variables such as reliance on input credits (yes/no), perception about water institutions. These were considered factors affecting the probability of having a water-dependent livelihood. For the purposes of running the statistical analysis, having a water-dependent livelihood was a success while having non-water dependent livelihood was a failure. The model was estimated by the following general equation (Agresti, 2002);

$$Log(\pi_1) = \beta_0 + \beta_1 X + \beta_2{}^y \quad \ldots\ldots \mathbf{2.5.2}$$

where, π_1 **=** the probability of having water dependent livelihood

β_0 **=** constant

$\beta_1 X$ = quantitative variables

β_2^y = qualitative variables

Logistic regression was preferred to simple linear regression because the dependent variable in question was categorical and not quantitative, rendering it impossible to run a simple linear regression on it. Some independent variables were dropped as they proved to have no effect on the livelihood water dependency status.

Thus some new contextual terms/concepts were introduced in the data set to be able to run the logistic regression but also to explain some hypotheses. For example, the more water dependent a household livelihood base is, the more willing the household is to invest in water resource (that is enter into water conflicts negotiations, engage in efficient use of water, and so on). This hypothesis of course holds other things constant, for example, land ownership, which motivates an individual to invest in land. The following section explains some of these concepts.

c) Gross output values (GOV)

This was used as a proxy for estimating livelihood status of households. Estimations were made on the value of entitlements that households could save, consume, invest or exchange into other goods. A higher GOV signifies a better or an improved livelihood (see Lwesya, 2004).

GOV was calculated as sum of values in terms of Malawi Kwacha (MK)[9] from different entitlements that households own. These included irrigated crop production given as the market value of total irrigation produce; rain-fed crop production given as the market value of total rain-fed produce; livestock production calculated from market value of the stock; off-farm and non-

[9] 1 US Dollar = MK 137; this was the rate at the time of data collection

farm activities valued as gross wages; self-employment calculated as gross earnings; remittances and rental incomes valued as such; and other incomes valued accordingly (e.g. casual labour)

d) Assessment of income distribution levels

Two methods were complementarily used to assess income distribution levels and also contribution of various income activities to total household incomes. The assessment was done by using the following:

i) Diversity index for incomes

An index of diversity was used to measure diversification of incomes among the households. Different methods of calculating diversity indices are available that attempt to describe diversity in terms of the number of income activities and the distribution of total income between the activities (Ellis, 2000; Chang, 1997; Kamanga, 2005). This paper calculated diversity index as follows:

$$\mathbf{DITI} = \sum_{i=1}^{n} (I_i/TI)^2, \ \ldots\ldots\ldots\ldots \mathbf{2.5.3}$$

where, DITI = Diversity index for total income

I_i = Total income from source i

TI = Total household income.

Value of 0 represents no diversification (one income source), and value of 1 represents maximum diversification (an infinite number of sources of income of equal size.

Diversity indices were calculated for the whole sample (n = 92) as well as water-dependent and non-water dependent categories (see section 2.5b). This was done to track any changes in income distribution that might have registered with change in level of livelihood water-dependency among the households. Diversity indices were also calculated for water-dependent and non-water dependent households with and without irrigation.

ii) The Gini Coefficient

The Gini coefficient was used to assess income distribution levels across the sample (n = 92) and water-dependent and non-water dependent household categories (see Kamanga, 2005). It was estimated by:

$$G = \frac{n+1}{n-1} - \frac{2}{n(n-1)\mu}\sum_{i=1}^{n} \sigma_i y_i \text{ , } \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \mathbf{2.5.4}$$

where, G = Gini coefficient

σ_i = total household income for household i

y_i = rank for household total income, where 1 represents the household with the highest total household income.

μ = mean total household income.

The value ranges between 0 and 1. A measure of 1 means high-income inequalities in a population and a measure of 0 means equality of incomes.

e) Calculation of incomes

Sources of incomes were grouped into irrigated crop income, rain-fed crop income, livestock income, off-farm and non-farm incomes, remittances, rentals, and self-employment income. In some instance, in some instances, the incomes were further grouped purposively into water-dependent and non-water dependent incomes sources.

Gross incomes or GOVs were calculated by summing up incomes from all sources (see Section 2.6c). Net incomes were found by deducting production costs from gross incomes. Such costs included livestock production costs and agricultural input costs, among others. Only the cost of hired labour was accounted for in the calculations of net incomes. Household own labour proved difficult to deduce because of variations of labour prices in Malawi. Exclusion of own labour cost was also done to avoid duplications in labour costing. These observations have also been made elsewhere (Kamanga, 2005; Campbell and Luckert, 2002).

Irrigated and rain-fed crop incomes (Total crop income) were calculated as follows:

$$Y_c = \sum_{i=1}^{n} [(C_i P_i) - (K_i)] \text{ ....} \mathbf{2.5.5}$$

where Y_c = Total crop income (irrigated and or rain-fed crop incomes)

Ci = Yield of crop *i*

Pi = Market price of crop *i*

Ki = Production costs of crop *i*

Irrigated crop for 2007 winter season was still in the field (had not yet been harvested). Such being the case, respondents gave estimated figures on yield and/ or incomes and their derivatives. The researcher cannot rule out the possibility of this affecting total income figures.

Livestock income, which included all domestic animals, was calculated as follows;

$$Y_l = \sum_{i=1}^{n} \left((NiPi) - (Ki) \right) \text{ ....} \mathbf{2.5.6}$$

Where Y_l = Total livestock income

Ni = Number of livestock in category *i*

Pi = Price of each livestock in category *i*

Ki = Cash costs of keeping livestock *i,* i.e. management costs like feeding, vaccination and drugs.

Most respondents reported that they had sold off their poultry especially chickens to escape the effects of New Castle disease '*chitopa*' outbreak. Yet others reported that they had lost their chickens to the disease. In the latter case, the respondents were requested to estimate the value of lost chickens using market price. It is however probable that this affected the total income values.

2.7 Researcher's notes

Information on figures on crop yields, input costs, livestock sales and all other money related transactions is based on households' livelihood activities for the previous six months prior to (before) the research. The six month period was chosen on premises that the respondents would not have to struggle to remember any money and money related transactions that they and their household members had carried out. It was also felt that six month period was long enough to make statistical sense. However, the researcher would discourage extrapolation of this information to make annual estimations on incomes because it was apparent that not all activities households engage in are carried out through out the year. Thus, livelihood activities may change with season and available opportunities and constraints, for example, irrigation.

3.0 A summary of findings and policy implications

The study is based on research that was conducted around Bua watershed in Malawi to address water resource management from a livelihoods perspective. It looks at the interaction between irrigation and rural livelihoods on one hand, and water resource management on the other hand, by locating integrated water resource management within the livelihoods framework. This is achieved through assessing different livelihood activities of households and determining the economic importance of irrigation in relation to other activities. The study also discusses the institutional framework for irrigation and water management in the area.

The study has found that Bua watershed households have diverse portfolios of livelihood activities that include rain-fed and irrigated crop production, formal employment such as teaching, micro-enterprises such as beer brewing, brick-making, pot making and petty trading. Only 30 % of the households are highly specialised in irrigation, accruing over 75 % of their income from the activity. It is evident that livelihoods are heterogeneous in the levels of income contributed to households by irrigation activities. This entails that within an irrigation system, households can be envisaged as being at different stages of irrigation livelihoods and therefore as having different interests and needs. This dimension should reflect in the formulation of policies that aim at improving irrigation development and livelihoods.

Apart from variability in levels of income accrued from irrigation, the study has also found varying dependence of households on other water-dependent livelihood activities. This is another dimension of heterogeneity among irrigation livelihoods. The extent to which a household relies on irrigation income determines its level of dependency on other water-dependent livelihood sources. The more irrigation-based a livelihood is the more dependent on other water-dependent livelihood activities the household tends to be. In addition, mean household incomes from water-dependent livelihood activities (such as irrigation and livestock) are greater for households with water-dependent livelihoods than for those with non-water dependent livelihoods. On the other hand, mean household incomes for non-water dependent livelihood activities are greater for non-water dependent livelihoods than for water dependent livelihoods. This demonstrates that it is worthwhile defining livelihood activities under the dichotomy of water-dependency/non-water dependency, as helps in unveiling competing economic uses of water between households and within a household.

The results further show that irrigation activities contribute only 24 % to the livelihoods of non-water dependent households and over 60 % to the livelihoods of water-dependent households. Households with non-water dependent livelihoods are better off in terms of income by 29 % than water-dependent households. It can therefore be inferred that irrigation activity, like other water-dependent livelihood activities, is less profitable and therefore unattractive to non-water dependent households. This has important policy implications for water management, as it would affect non-water dependent households' willingness and interest to invest in water resource management by reducing time and effort they spend on irrigation activities.

The study has also found that households with water-dependent livelihoods are more diversified with lower mean total household income than non-water dependent households. The lower mean total household income for water-dependent households shows that in trying to allocate assets in pursuit of a more satisfying livelihood, households develop a wider income base. The larger mean total household income for non-water dependent households indicates that they are better off. Furthermore, the non-water dependent households are less diversified as they have smaller mean income diversity index, indicating some level of specialisation in income sources.

The study also shows that generally, irrigation income reduces income inequality across households. However, comparing water-dependent and non-water dependent households, the effect is greater for the former than the latter. Irrigation plays a role in reducing income inequality among water-dependent households but has no significant effect on income distribution across non-water dependent households.

As regards institutional arrangements for irrigation and water resource management in the Bua watershed, the study discusses that irrigation organizational structures and institutions are loosely connected rendering it difficult for irrigators to claim their rights, for example, on negotiations or bargain for produce prices. The study concludes by adopting the alternative definition of IWRM, which seems to promote a people-centred and rural livelihood oriented approach to water resource management, making it more applicable to Malawi and sub-Saharan Africa. It demonstrates that irrigation should not be seen as an end in itself but a process, influencing and influenced by other activities within a livelihood system. At every stage of irrigation development, policy should be cautious that irrigation livelihoods would be heterogeneous with varying benefits accrued from irrigation and other livelihood activities. Dichotomising livelihood activities between water-dependency and non-water dependency provides a framework for analysing inter-household and intra-household competing uses of water.

3.1 Policy implications for irrigation and water resource management

The study findings have some important policy implications for irrigation development and water resource management. Variation in benefits accruing from irrigation, for instance, implies that households with predominantly irrigation-based livelihoods are more likely to adopt water management interventions than those households with non-irrigation based livelihoods. This reasoning is based on economic theory of rationality that households/individuals tend to allocate resources to activities that are likely to be of benefit to them. While irrigation-based livelihoods are generally water-dependent, not all irrigation households have water-dependent livelihoods, as this depends on the type of other livelihood activities households engage in. Thus, decisions around water allocation and use start at household level as households seek to allocate water between competing uses. This is important to realize as it has implications for adoption of water management options in irrigation systems.

The fact that non-water dependent households are better off would imply that non-water dependent livelihood activities are more profitable, all things being equal. As such, households would rather allocate their assets or resources to non-water dependent livelihood activities where they will be utilized efficiently than to water-dependent livelihood activities. This has a policy dimension since it will affect households' willingness and interest to invest in irrigation, which is a water-dependent livelihood activity, as well as water resource management, as these are determined by livelihood processes they follow according to their assets. This should guide policy on how much of water management can and should be left in the hands of irrigation households based on stages of irrigation development as well as heterogeneity of the livelihoods.

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PART II. THE PAPER

Irrigation livelihoods heterogeneity and water management in Bua watershed, Central Malawi: Policy implications for irrigation development

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Abstract

A study was conducted in Nkhotakota, Malawi, among Bua watershed irrigation households to determine the economic importance of irrigation in relation to other livelihood activities, and examine institutional arrangements for irrigation and water management. A livelihoods approach was adopted for the study. The results indicate that 'irrigation livelihoods' are heterogeneous in that some are more irrigation based than others, as reflected in varying benefits accrued from irrigation. Dichotomising livelihood activities between water-dependency and non-water dependency provides a framework for analysing inter- and intra-household competing water uses. It reveals that irrigation, like most water-dependent activities, is less profitable to non-water dependent households contributing only 24 % to their livelihoods than it is to water-dependent households with 62 % contribution. The study suggests that as households make decisions around resource allocation, rationally more resources are allocated to more profiting activities. It further shows that water-dependent households have more diversified income sources and less income than non-water dependent households who are better off by 29 %. Also, irrigation seems to play a role in reducing income inequalities among the water-dependent households but it has no significant effect among non-water dependent households. The results argue against the common view that irrigation households have irrigation-based livelihoods. It shows that this view overshadows the water-dependency dichotomy of livelihood activities which has implications for water management. The study concludes that integrated water resource management starts at household level as households efficiently allocate water to diverse uses. Therefore, placing irrigation within the livelihood framework will promote the integrated approach as well as ensure effective and result-oriented policies.

Key words: livelihoods approach; irrigation; integrated water resource management; institutional arrangements; Bua watershed

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1. Introduction

Water resource depletion is of growing concern in irrigated agriculture as competition for water continues to increase among users and between uses (Mulwafu et al., 2003; Meinzen-Dick and Bakker, 2001; Bruns and Meinzen-Dick, 2000; GWP, 2000). Generally, in Sub-Saharan Africa, unreliable and inadequate water supply in combination with declining soil fertility, has led to low agricultural productivity (Merrey et al., 2005; Malawi Government, 2002). This is one factor that has influenced the development and adoption of approaches that are thought to ensure equitable, efficient and sustainable allocation and utilization of water resources (Lankford, 2003; Meinzen-Dick and Bakker, 2001; Bruns and Meinzen-Dick, 2000). Integrated water resource management (IWRM) is one such approach (GWP, 2004). It has been observed in some quarters that IWRM is currently a dominant paradigm for water management (Merrey et al., 2005; Biswas, Undated). This study addresses irrigation and water management in the Bua watershed in Malawi by adopting a livelihood perspective.

Water and irrigation policies in Malawi have greatly embraced the concept of IWRM (Mulwafu and Msosa, 2005; Malawi Government, 2004a; Malawi Government, 2002) with particular emphasis on irrigation development and stakeholder participation (Malawi Government, 1999). There has thus been emergence of farmer managed irrigation systems (FMIS)[10] and increased private sector involvement in irrigation development arena. One of the challenges of these twists and turns in irrigation development has been far-reaching consequences of overlooking the costs, risks and complexities of irrigation, and failure to fit irrigation into the farmers' broader livelihood arena where decisions on resource allocation -including water- are made (Lankford, 2003; Guijt and Thompson, 1994). Put differently, failure to place irrigation within the broader framework of rural livelihood systems has resulted in mismanagement of water and irrigation infrastructure, and consequently, under performance of most farmer-managed irrigation systems. Approaching IWRM from a livelihoods perspective as already advocated for in some literature (see Merrey et al., 2005; Lankford, 2003; GWP, 2003; GWP, 2000) has potential to address this seemingly overwhelming challenge.

[10] FMIS is a common feature in current irrigation development realm where ownership and management responsibility of irrigation systems rests on farmers. It can be partial of full transfer of control and responsibility (see Mckay and Keremane, 2006)

This paper therefore locates irrigation within the livelihood framework in seeking to understand the interface between irrigation and rural livelihoods on one hand, and water resource management on the other. It uses empirical data from field research that was conducted among irrigation farmers around Bua watershed of Nkhotakota district in Malawi. To achieve this, the paper assesses livelihood activities and distribution of income between them; determines the economic importance of irrigation vis-à-vis other livelihood activities and; to a lesser extent, investigates the institutional framework (arrangements) for irrigation and water resource management in the Bua watershed. Furthermore, the paper dichotomises livelihood activities between water-dependency and non-water dependency in an effort to unpack trade-offs in water allocation and use that are made within, between and among households. This dichotomy also helps to broaden the concept of multiplicity of water users and uses which is mostly narrowly viewed in 'one user-one use' context (Meinzen-Dick and Bakker, 2001; Mulwafu, 2000).

The paper complements previous efforts to demonstrate how policy can target stages[11] of irrigation livelihoods and development, and it adds a dimension that at any stage, 'irrigation livelihoods' will be heterogeneous in terms of irrigation contribution to livelihoods. It is asserted that this approach would make policy 'more focused and effective in financial, outcome and sustainability terms' (Lankford, 2003: 818). The paper also draws insights from Guijt and Thompson's (1994) observation that regarding irrigation as an end in itself and not a means to an end implies alienating irrigation from other livelihood endeavours. The authors condemn such reductionist view of irrigation. These two viewpoints are the foundations of this paper. The paper has five sections: section two provides an overview of irrigation development in Bua watershed followed by a description of the study area and methodology in section three. The results of the study are presented and discussed in section four, which includes an analysis of the livelihoods system of the community studied, their livelihood adaptation, and to a less extent, institutional framework/arrangements as regards irrigation, and implications for water resource management. The last section draws together the conclusions from the study and provides some policy recommendations.

[11] Three stages of irrigation development have been identified using a theoretical sigmoid curve (see Lankford, 2003 for details)

2. Overview of irrigation development in Bua watershed

Irrigation development in Bua watershed area in Nkhotakota district, Malawi started in the early 1970's with the development of Bua river diversion gravity-fed irrigation system. The irrigation system was developed with funding from the Chinese government, whose technical experts managed the system until it was handed over to Malawi government in 1994 (SFPDP, Undated). The first scheme management committee was established in 1977 and it comprised of 10 members. The committee was mainly responsible for settling disputes related to land and water among its members. Water resource management was not at the heart of the committee nor was it a policy issue, presumably because water demand was still low and irrigation was in the early stages of development.[12] Committees with five-year tenure ran the scheme until when a water user association (WUA) was established and registered in 2003 (SFPDP, Undated).

Between 1994 and 2004 area under rice production in the scheme reduced drastically due to farmers' failure to divert/abstract water into the scheme as they lacked expertise and financial muscle. It was during this period that the scheme got external aid through Smallholder Flood Plains Development Project (SFPDP) to assist in scheme rehabilitation. The rehabilitation included construction of permanent irrigation structures at the head works (such as weir, sand trap and pipeline) as well as reorganisation of farmers into an association. The SFPDP project was funded with a loan from International Fund for Agriculture Development (IFAD). This assistance came in as a preparatory process for handing over the scheme to farmers, in line with the new government policy[13].

While these strides in irrigation development were taking place in one part of Bua watershed, in another part, an irrigation group was also formed, albeit smaller than the Bua scheme. This group is called Chisambo and was established in 2001. In addition, individual irrigation farmers have emerged over the years whose exact number is not known due to lack of documentation. To date, about 380 ha of land in the Bua watershed is under irrigation[14] with about 31 participating villages and over 600 farmers. Increase in number of irrigators, coupled with population growth which is currently pegged at 2.8 % per annum (Nkhotakota District Assembly, 2005; Malawi

[12] Discussion with key resource persons provided this information.

[13] The current Malawi government irrigation policy mandates to transfer scheme control and management responsibility to farmers. This is also in line with decentralization policy

[14] The figure of 380 ha was verbally pointed out during interviews with the head of Linga agriculture office

Government, 2004b), and water demand for other needs such as livestock, domestic uses, fishing, and micro-enterprises (for example, clay pot making and brick-making), have increased pressure on water resource. These trends were reported elsewhere as well (MaKay and Keremane, 2006)

Irrigation development in Bua watershed, like in most irrigation areas, seems to have followed a theoretical sigmoid curve of irrigation growth which describes irrigation development in three stages; proto-irrigation, irrigation-momentum and river basin management (see Lankford, 2003). The study observed that irrigation development in the area identifies well with the third stage of irrigation growth whereby water management has now become an important issue due to increased demand, and conflicts and conflict resolution are a common phenomenon. Marketing infrastructure and services have however remained poorly developed despite the area being in this advanced stage of irrigation development. On the same note, no river basin management plans have been developed yet for the basin or specifically the watershed area in Nkhotakota.

Water resource in the watershed is managed under the dichotomy of open-access/common property regime. Within the Bua irrigation arena, individuals have bundles of rights defined by whether they are members or not. These rights include ownership, control, and use rights, among others (see Meinzen-Dick and Bakker, 2001). In addition, the Bua scheme leased its area in 2003. While the scheme has ownership of the land, standing as an entity on its own, its members have only use rights. Bua irrigation scheme farmers pay a fee to use water in the scheme, and the scheme in turn pays for water abstraction rights in volumetric terms (SFPDP, Undated), while irrigation farmers in the upstream of Bua scheme and Chisambo irrigation farmers do not pay for water. Individual irrigators,[15] on the other hand, abstract water from anywhere provided it is not within the irrigation systems, for example, along the conveyance canal. The argument on payment for water abstraction rights has been that only schemes that abstract above a certain amount[16] of water per year should pay. This has not considered aggregated volume of water abstracted collectively by small-scale irrigation schemes or individual irrigators. This fragmented approach to water allocation and hence water resource management, combined with factors mentioned above, has aggravated water scarcity problem in the basin and is increasingly

[15] These are irrigation farmers who do not belong to any irrigation scheme or are not part of irrigation scheme. They do individual irrigation. Some farmers are both individual irrigators as well as group irrigators.
[16] The actual amount (volume) was not mentioned in the documents that were source (e.g Malawi National Irrigation Policy)

threatening development of irrigation in the Nkhotakota Bua watershed. The following section gives a description of the study area and the methodology adapted to the study.

3. Materials and methods

3.1 Description of the study area

The study was conducted in the watershed of Bua River Basin in Traditional Authority (T/A) Mphonde in Nkhotakota, located about 220 km north of the capital Lilongwe in the central region of Malawi. The Bua Basin has an estimated area of 10, 700 km^2 and a catchment area of 10, 654 km^2 (Esser et al., 2005; Kidd, 1983) stretching from Mchinji through Kasungu and Ntchisi districts to the West and South-West of Nkhotakota, respectively, to Nkhotakota district. It lies at latitude 12 degrees (South) and longitude 34 degrees (East), and at an altitude of about 500m above sea level (Malawi Government, 2004b).

Bua watershed in Nkhotakota (hereafter called Bua watershed) has one big river, known as Bua, and a number of perennial and seasonal streams, such as Kasangadzi, Chisambo, Chankhombe and Kalongo. Bua River realises an average monthly flow of 68.25 cubic metres per second, a maximum flow of 136 cubic metres per second (in January) and a minimum flow of 0.5 cubic metres per second in October (SFPDP, Undated). SFPDP (Undated) further reported that the area receives an annual rainfall of about 685.3mm with an average of 57.11mm per month.

T/A Mphonde area has a population of 18,611 (Malawi Government, 2004b) representing 8.1 % of the total population of Nkhotakota district and 1.6 % of the Malawi population. Population growth in the district is currently pegged at 2.8 % per annum. The district is reported to have an average landholding size of between 0.8 ha and 1.8 ha (Nkhotakota District Assembly, 2005; Malawi Government, 2004b). Main crops grown are maize and cassava for food and, rice, cotton, tobacco (barley) and sugarcane for cash income. Minor crops include ground nuts, paprika, vegetables, beans, soya, chilly, millets, cowpeas and sweet potatoes (Malawi Government, 2004b; SFPDP, Undated). Crops are grown under both rain-fed and irrigated conditions.

Bua watershed has two known irrigation systems; Bua and Chisambo (see Table 1). Bua irrigation system is the largest smallholder irrigation scheme in Nkhotakota district and among the largest smallholder irrigation schemes in Malawi as a whole. Rice, *mpunga*, is the main crop grown in the Bua scheme cassava, maize, watermelons and other secondary crops, while Chisambo scheme mainly grows maize, *chimanga*. Chisambo was at the time of study supported by Save the Children (US) in form of farm inputs such as seed, fertilizer and treadle pumps, and technical expertise, while Bua has a long history of getting external assistance dating as back as 1975/76 when the scheme was developed. The Chinese government has started to assist the scheme again after withdrawing in 1994.

Table 1: Features of irrigation schemes in Bua watershed, Nkhotakota

Feature/Scheme	Bua	Chisambo
Water user association formed and registered	yes	no
Irrigation system	River diversion gravity-fed system	Treadle irrigation pump
Number of members	511	30
Gross area (ha)	360	Not known
Net irrigated area (ha)	300	8
External support/aid	Malawi government, Chinese government, SFPDP-IFAD* project	Malawi government, Save the Children (US)

Source: Field survey (2006)
* SFPDP-IFAD: Smallholder Flood Plains Development Project-International Fund for Agricultural Development

3.2 Methodology

Fieldwork was conducted in 2006. Household survey questionnaire, focus group discussions and key resource persons interviews were the main sources of information. Direct field observations were also made. Key resource persons included officials from agriculture, environmental affairs and irrigation departments at district level, as well as long-serving members of the schemes and scheme committee members. Information was sought about historical background of irrigation and institutional changes (reforms) that had taken place in the area. A structured questionnaire, which was designed following thorough literature search and consultation with irrigation department, was used to collect quantitative data from households engaged in irrigated farming. The data included quantitative components of livelihood portfolio such as assets, activities and incomes from various sources including irrigated and rain-fed crop production, livestock production, remittances and formal employment. Focus group discussions provided information on main livelihood activities and general perception about irrigation development. Four enumerators were employed to administer the household questionnaire. Respondents came from

10 randomly selected villages out of the 31 villages that were participating in irrigation, and were selected based on proximity to Bua River as shown in Table 2 below:

Table 2: Proportion of households sampled with varying degree of proximity to Bua River

Stratum (proximity)	Villages	Number of households by stratum*	Number of households selected	Percentage of households in the stratum	Percentage of total number of sample households
1 (≤ 3km)	Kambuzi Makoka Vulachitambo	127	40	16	43
2 (3 – 4km)	Chitambo Khutu Mphonde	56	23	10	25
3 (> 4km)	Mvula Mthawanji Mndota Chikunichoola	60	29	12	32
Total		**243**	**92**	**38**	**100**

Source: Field survey (2006)
* This is total number of households participating in irrigation from three villages that formed a stratum

Bua River was purposively picked as a benchmark for village selection to ensure that the sample was as representative as reasonably possible. A total of 92 households, representing 38 % of the households from the sample villages were randomly selected.

3.3 Data analysis

Data from household questionnaires was statistically analysed using Microsoft Excel, JMP and Minitab statistical packages. Descriptive statistics including means, standard deviations and percentages were run on variables such as crop, livestock, micro-enterprises and other household incomes, and costs of production. A logistic regression analysis was used to establish relationships between dependent and independent variables. It was for example run to explain possible significant relationship between livelihood water-dependency (see section 3.3 a) and independent variables such as respondent level of education, household size, household irrigated area and so on. Tests were run at 95 % level of confidence.

a) The dichotomy of livelihood activities

During data analysis, livelihood activities were defined in terms of whether they were derived from direct utilization of water or not, such that the study came up with two categories of livelihood activities, namely, water-dependent and non-water dependent livelihood activities. Water-dependent livelihood activities were defined as those livelihood activities which households derive from direct utilization of water by the households. Examples of such livelihood activities were irrigated crop production, fishing, beer brewing, vegetable growing (and selling), and livestock production. Non-water dependent livelihood activities (defined as activities not derived from direct utilization of water) were activities such as managing a grocery shop/hawker, weaving, remittances, rents, carting and ploughing, and formal employment (e.g. teaching). It is worth noting that it was not easy to determine to which category some activities belonged because of the very nature of those activities. Such activities included selling fish, selling beans, rain-fed crop production, and selling vegetables. To address this ambiguity, the extent to which an activity was water-dependent was assessed. For instance, rain-fed crop production was considered a non-water dependent livelihood activity because its process is not determined by water availability –cultivation process (that is land preparation) starts before rains or any assurance of water availability and water only becomes a concern when there are prolonged dry spells.

Following this dichotomy of livelihood activities, households with more than half of their gross output values (refer below) deriving from water-dependent activities were labeled water-dependent households or households with water-dependent livelihoods. And households with less than half of their gross output values deriving from water-dependent activities were termed non-water dependent households or households with non-water dependent livelihoods. This categorisation was possible with introduction of what the study calls a livelihood water-dependency ratio calculated as follows:

$$\textit{Livelihood water-dependency ratio} = \frac{\textit{Water dependent household incomes}}{\textit{Total household income}}$$

Water-dependent household incomes were the sum of all household incomes from water dependent livelihood activities, and Total household incomes were the sum of all household incomes (from both water and non-water dependent livelihood activities) within a household, that is the total gross output values. The ratio values ranged between 0 and 1. The greater the value (closer to 1), the more water dependent the household livelihood base would be, and the closer to 0 the value is, the less water-dependent the household livelihood base would be. Using this ratio presentation, 63 households were categorised as water-dependent while the rest (29) were found to be non-water dependent.

b) Assessing income levels and distribution

Gross output values (GOV) were used as a proxy for estimating livelihood status of households. Estimations were made on the value of entitlements that households could save, consume, invest or exchange into other goods. A higher GOV signified a better or an improved livelihood (Lwesya, 2004). GOV was calculated as the sum of values in terms of Malawi Kwacha (MK)[17] from different entitlements that households owned, and these included irrigated crop production given as the market value of total irrigation produce; rain-fed crop production given as the market value of total rain-fed produce; livestock production calculated from market value of the stock; off-farm and non-farm activities valued as gross wages; self-employment calculated as gross earnings; remittances and rental incomes valued as such; and other incomes valued accordingly (e.g. casual labour). Income distribution levels and contribution of various incomes to total household incomes were assessed using the diversity index for incomes (see Kamanga, 2005; Ellis, 2000; Chang, 1997) and the Gini coefficient (Kamanga, 2005).The following section presents the discussion of the study findings.

[17] 1 US Dollar = MK 137; this was the rate at the time of data collection

4. Results and discussion

4.1 Defining heterogeneity in irrigation livelihoods

a) Livelihood diversification among irrigation households

Livelihood portfolios of most rural households comprise a number of livelihood strategies with some being more predominant than others (Ellis, 2000; Lankford, 2003). Some households may have primarily irrigation-based livelihoods (see Lankford, 2003) whereby more than half of their livelihood base rests on irrigation, while other households may access more than half of their income from a range of livelihood activities. The former scenario can be termed as 'specialisation within diversification'. Specialisation within diversification phenomenon dominated the previous livelihood policy thinking, which was tendered on the assumption that rural people always chose a particular livelihood strategy among available livelihood options and choices (see Ellis, 2000; DFID, 1998). Ellis (2000) noted that:

> '…official statistics and social scientific analyses prefer to identify people's place in the economy according to their main occupation and profession…'(p 3).

However, there has been growing recognition of livelihood diversification as an option in itself (Ellis, 2000) and not always a process of screening for a better option or an response to crisis (Davies, 1996). Thus, households sometimes enter into diversification as a matter of choice (for example, as a coping strategy for rural poor and means of accumulating wealth for rural rich) and not always out of necessity (Ellis, 2000; Ellis and Freeman, 2004). Various approaches have been devised which aid in explaining activity profiles -and hence livelihood strategies- for rural households. One commonly used approach is the income portfolios approach, which captures activity profiles by analysing income portfolios across households (Ellis and Mdoe, 2003). This paper observed that the extent to which a community's livelihoods system is dependent on a certain livelihood activity is reflected in the level of income derived from that activity, and the impact of its absence in some livelihoods within the system. In support of this observation Ellis (2000) asserted that livelihood and income are related and individual or household income is the most direct and measurable outcome of the livelihood process.

Like rural Tanzania and elsewhere (Lwesya, 2004; Ellis and Mdoe, 2003), households within Bua watershed irrigation community had livelihoods with varying degrees of diversification as well as specialisation in irrigation as regards income accrued. In other words, the households were found to depend on diverse portfolio of activities and income sources, among which were trading (e.g. running a grocery shop), livestock production, and rain fed and irrigated crop production. About 43 % of the households revealed a considerably high degree of diversification in their livelihood base while 30 % were highly specialised in irrigated agriculture (see Table 3).

Table 3: Proportion of households by typology of specialisation in irrigation (n = 92)
(Adapted from Ellis, 2000)

Specialisation category	**Proportion total sample (%)**	**Livelihood strategy**
75 – 100 % of total household GOV* from irrigation	30	Highly specialised
51 – 74 % of total household GOV from irrigation	27	Relatively specialised
≤ 50 % of total household GOV from irrigation	43	Not specialised
Total	**100**	

Source: Field survey (2006)
*GOV = Gross Output Value (see section 3.3b)

The table shows that there is heterogeneity in livelihood strategy as regards economic importance of irrigation activity among rural households. That is, the extent to which irrigation contributes to income portfolios of households varies greatly. The results therefore suggest that it is wrong to assume that irrigation households have irrigation based livelihoods as most policy and literature reflect, notably, Lankford, 2003 (see Guijt and Thompson, 1994). Variation in benefits accruing from irrigation defines to what extent a household's livelihood is irrigation based. This has implications for water management since irrigation consumes water and generates externalities. Households with irrigation-based livelihoods are more likely to adopt water management interventions than those with non-irrigation based livelihoods. This is based on economic theory of rationality (Vedeld, 2005) which contends that individuals tend to allocate resources where they are likely to be gainers and not losers.

Within an irrigation system, farmers should be envisaged as being at different levels of irrigation livelihoods and therefore as having different interests and needs. For example, at Stage B (of irrigation development on a sigmoid curve) where irrigation livelihoods momentum grows (see Lankford, 2003), there will still be variability in attainment of output from irrigation among farmers. That is, 'irrigation livelihoods' are likely to be heterogeneous regardless of stage of irrigation development. It is therefore vital that policy interventions take livelihood characteristics of irrigation farmers into consideration at any stage of irrigation development. This will have implications for farmer participation in the interventions and consequently on outcomes and sustainability of the interventions.

b) Total household incomes and livelihood water-dependency

Apart from variability in irrigation income dependence, the households also varied in reliance on other water-dependent livelihood activities, which is another dimension of heterogeneity. About 68 % of the households were found to benefit more from water-dependent livelihood activities than others, so they had water-dependent livelihoods, while the rest of the households had non-water dependent livelihoods. Of the households with water-dependent livelihoods, only 19 % got less than half of their total income from irrigation, while for almost all non-water dependent households, irrigation income constituted less than half of their gross output values (see Table 4).

Table 4: Household irrigation income contribution by level of livelihood dependency on water (Adapted from Ellis, 2000)

Specialisation category	% of water-dependent households (n = 63)	% of non-water dependent households (n = 29)
> 50 % of total GOV* from irrigation	81	3
≤ 50 % of total GOV from irrigation	19	97
Total	**100**	**100**

Source: Field survey (2006)
*GOV= Gross Output Values

This finding suggests a relationship between household dependence on irrigation and its livelihood water-dependency status as the extent to which a household depended on irrigation determined its level of dependency on other water-dependent livelihood options such as livestock production. While irrigation-based livelihoods can generally be considered water-dependent livelihoods, not all irrigation households will have water-dependent livelihoods, as this will depend on the categories of other livelihood activities the households engage in. This revelation has implications for water management, as it is likely to affect the adoption of water management options among irrigation households.

Furthering the case for dichotomising livelihood activities between water-dependency and non-water dependency as a framework for analyzing characteristics of irrigation households, mean household incomes from various income sources were assessed. It was found that mean household incomes from water-dependent livelihood activities were greater for water-dependent livelihoods than for non-water dependent livelihoods. On the other hand, mean household incomes from non-water dependent livelihood activities were greater for non-water dependent livelihoods than for water dependent livelihoods (see Table 5).

Table 5: Mean household income portfolios, by level of livelihood water dependency

Source of income	**Water-dependent households (n = 63)***	**Non-water dependent households (n = 29)**	**All households (n = 92)**
	Mean (MK)**	**Mean (MK)**	**Mean (MK)**
Irrigation	87, 696 (62)	44, 167 (24)	73, 975 (49)
Rain-fed cultivation	22, 984 (16)	85, 324 (47)	42, 634 (27)
Livestock	18, 483 (13)	16, 139 (8)	17, 774 (11)
Self-employment	11, 615 (8)	36, 242 (20)	19, 378 (12)
Other***	1, 115 (1)	1, 207 (1)	1, 144 (1)
Total	**141, 893 (100)**	**183, 079 (100)**	**154, 875 (100)**

Source: Field survey (2006)
* In parentheses are percentages of mean total household income
**MK = Malawi Kwacha; 1 US Dollar = MK 137
*** Other includes income from non-farm, off-farm and remittances

It was also found that irrigation income contributed 62 % of the mean total household income for water-dependent livelihoods and 24 % of the mean total household income for non-water dependent livelihoods. This implies that irrigation was more important to the households with water-dependent livelihoods than it was to those with non-water dependent livelihoods. These results show that it is important to employ inter/intra-household (livelihood characteristics) approach when assessing 'irrigation livelihoods' for water resource management. They assert the significance of understanding the level of household livelihood water-dependency, and that this should go beyond looking at irrigation as the main water use (among other minor water uses) to other water-dependent livelihood activities that a household undertakes as well. That is, one should consider intra-household alongside inter-household competing uses of water. Irrigation as a livelihood activity exists within the realm of household livelihood system where decisions on resource allocation –including water- are made.

It is worth noting that there was a significant difference in mean total household income between water-dependent and non-water dependent livelihoods. Households with non-water dependent livelihoods were better off by 29 % than those with water-dependent livelihoods. The paper therefore contends that water-dependent livelihood activities were less profitable and therefore unattractive, and infers that given an opportunity, a household in Bua watershed community would rather engage in non-water dependent activities. For instance, one respondent, on being asked if he was attending irrigation meetings, said:

> "I do not attend irrigation meetings because I spend more time running my grocery shop."

This meant that he would rather allocate his time to trading (running a grocery shop) than attending irrigation meetings, reflecting how much he valued trading, and it could imply that he benefited more from trading than irrigation.

The study finds that irrigation-based livelihoods are poorer than non-irrigation based livelihoods. This contradicts what has been documented elsewhere that farmers who venture into irrigation activity often have sufficient assets from other sources (see Lankford, 2003). Rather than questioning this stance by Lankford (2003), this article calls for a critical review of his assertion and argues that a case-by-case study would lead to better understanding of 'irrigation livelihoods'. And, other livelihood activities alongside irrigation have to be taken into consideration as they all inform the livelihoods system (see Ellis, 2000).

c) Income distribution levels: diversity and inequality

There are varying schools of thoughts on the relationship between income diversity and rural livelihoods. One school of thought asserts that the more diversified household income sources are, the poorer the household would be. On the other hand, households with less diversified income sources would be better off (Vedeld et al., 2004). A second school of thought is that households may not be endowed with enough assets to diversify their income sources in which case they would be poorer. Richer households can have very diversified income sources where they have invested their productive assets efficiently. So it is the size of incomes from these sources that matters (Kamanga, 2005) and not necessarily the number of income activities. The paper used an index of diversity to describe the livelihood activities and the distribution of total income between the activities that Bua watershed irrigation households engaged. Results are shown in Table 6 below.

Table 6: Mean household incomes with corresponding diversification indices, by livelihood water dependency

	Water dependent livelihood (n = 63)	Non water dependent livelihood (n = 29)
Mean household income (MK)	141, 893	183, 079
Mean income diversification index	0.58	0.46

Source: Field survey (2006)

There is a significant difference in income diversity index between water-dependent and non-water dependent households. Water-dependent households are more diversified with less mean total household incomes than non-water dependent households. The smaller mean total household income for water-dependent households show that in trying to allocate assets in pursuit of a more satisfying livelihood, households develop a wider income base. On the other hand, non-water dependent households have a larger mean total household income indicating that they are better off. Furthermore, the smaller diversity index (0.46) indicates some specialisation in income sources for non-water dependent households.

Table 7: Mean household incomes with corresponding diversification indices, by livelihood water dependency

	Water dependent livelihood (n = 63)	Non water dependent livelihood (n = 29)
Mean household income (MK)	141, 893	183, 079
Mean income diversification index	0.58	0.46

Source: Field survey (2006)

It can be argued that water-dependent livelihood activities, irrigation inclusive, are not as significant in improving livelihood status (or in the livelihood portfolios) of Bua watershed irrigation communities as are non-water livelihood activities. Thus, a shift away from irrigation would be an indication of a household's livelihood improvement. This has implications for water resource management, demanding some considerations on how much of water management should be left in the hands of irrigation farmers (Sokile et al., 2003), taking into account the stage of irrigation development and heterogeneity of the households within the irrigation system.

Irrigation income is noted to have some effect on income inequalities among the Bua watershed irrigation households. Using the Gini coefficient to examine whether irrigation income leads to reduction in income inequalities across the households produced results as shown in Table 7.

Table 8: Gini coefficients with and without irrigation income, by household livelihood water dependency

	n	Gini coefficient with irrigation income	Gini coefficient without irrigation income	Change (units)
Water-dependent livelihoods	63	0.34	0.62	(0.28)
Non-water dependent livelihoods	29	0.40	0.42	(0.02)
Total	**92**	**0.38**	**0.52**	**(0.14)**

Source: Field survey (2006)

The table shows that there is a change of 0.14 units on income inequality among the households when irrigation income is deducted from the total household income. In other words, without irrigation, income inequality among the households is greater by 0.14 indicating that irrigation income reduces income inequality. The effect of irrigation on income inequality is significantly different across the households.

The effect is greater for households with water-dependent livelihoods unlike those with non-water dependent livelihoods. The Gini coefficient for water-dependent livelihoods with irrigation income (0.34) is significantly different from the Gini coefficient for the same group without irrigation income (0.62). This shows that irrigation plays a role in reducing income inequalities among the water-dependent households. The situation is however different for non-water dependent households as the Gini coefficient for non-water dependent livelihoods with irrigation income (0.40) is not significantly different from the Gini coefficient for the group without irrigation income (0.42). That is, irrigation does not play a role in reducing income inequality among the non-water dependent households.

This finding supports the idea of defining livelihood activities under the dichotomy of water-dependency and non-water dependency when studying irrigation, to better investigate inter and intra-household livelihood characteristics as they affect water resource management. The paper argues that households with water-dependent livelihoods are likely to take up interventions aimed at better management of water, as they will be more adversely affected by any negative changes in the water resource than their counterparts. However, the challenge is to make irrigation activity a mainstay and not a transition or pastime activity as the results seem to suggest for Bua watershed irrigation farmers, for this affects household decision-making. Making irrigation a mainstay would be significant for maximising returns from irrigation, and other water-dependent livelihood activities as well. Improvements (through system efficiency) in water use in irrigation systems are likely to release water for other livelihood activities thereby affecting the entire household livelihood base. Thus, disaggregated assessment of the economic importance of irrigation to households provides an opportunity for promotion of integrated water resource management approach from a livelihoods angle, whose success depends to a large extent on stakeholder (farmer) participation (see Merry, et. al, 2005 and Sokile, et. al, 2003).

4.2 Bua watershed livelihood adaptation and irrigation institutions

Choice of livelihood strategies is dependent upon a number of factors including capabilities one has such as social networks, skills and physical assets (Ellis, 2000). In his analysis of stages of irrigation development, Lankford (2003) identified factors that affect access to irrigation-based livelihoods, based on livelihood framework. He argued that natural and physical factors such as water, land and labour, and economic and financial factors such as market prices, inputs and credits, human and social factors such as social cohesion and conflict resolution, other livelihood strategies (diversified livelihoods), and skills and experience in irrigation and negotiation, all play a role in determining and developing household's livelihood strategy.

Similar observations were made from a regression analysis which examined factors that affect choice of livelihood strategies in the context of water dependent livelihood activities vis-à-vis non-water dependent livelihood activities among Bua watershed irrigation households. Self-employment opportunities (skills), availability of and access to water-dependent income sources, reliance on agricultural input credits and size of irrigated area (natural asset) are factors that were found influential. The probability of a household having a less water-dependent livelihood increases with reduction in irrigated land, increase in self-employment opportunities, reduction in water-dependent income sources, and less reliance on farm input credits.

The study has also noted some social, political and institutional factors that influenced households' adaptation of various livelihood strategies. Almost all households were affiliated to some social networks for input access, power relations, and so on. Networks identified in the area included kinship networks (which reflected in exchange of gifts such agricultural inputs and produce), water user associations, marketing associations, forestry clubs, and borehole water committees, among others. These networks had their own rules and regulations both informal and formal. It became apparent during interviews and discussions with the farmers that rarely would their households subscribe to all rules and regulations of networks or organizations they were affiliated to.

For instance, on marketing associations, most farmers were members of the sole association in the area, National Smallholder Farmers' Association of Malawi (Nasfam). To be affiliated to the organization, farmers paid a membership fee of MK1, 000 on agreement that Nasfam would in return buy rice from them. In the previous year, Nasfam had bought mostly *star* rice variety grown in the area. The following year, farmers grew more *star* rice in anticipation of a market. However, Nasfam for its own reasons changed its preference to a different rice variety called *kilombero*. This was a blow to the farmers as it affected the price of *star* rice variety, which dropped drastically. Due to lack of negotiating power, farmers did nothing more than crying foul.

It was noted that Nasfam bought produce in the area from individual farmers whereby, they (farmers) did not have a collective voice to bargain their produce deal, let alone contractual production with potential buyer. This is why Nasfam was able to buy a different rice variety without fear of any legal consequence. This is a classic case of the fact that institutions are as strong as organizations that back them up (Meinzen-Dick and Bakker, 2001) such that some institutions are weaker than others. This is reflected in power relations that exist between organisations. Lack of institutional connectedness and basic coordination was also observed among water users in Rufiji Basin in Tanzania as well (Sokile et al., 2003). The authors further contended that water management institutions were often at the periphery of water management agenda. This study confirms this claim from the way households demonstrated their level of understanding of water management issues, which showed their limited capacity to contribute to water management debate.

The farmers varied in understanding of the rules and regulations in the WUA constitution. This was evident in the interpretation of the constitution and also in members' dissatisfaction with some financial obligations stipulated in the constitution such as payment of plot fees, land lease and water rights. In fact, some respondents (14 %) were not aware that they paid for water rights and only 47 % knew that Water Resources Board (WRB)[18] was responsible for administration of water rights. Bua watershed irrigation farmers (in particular Bua WUA) first paid for water rights in 2002 when they became a registered body.

Some respondents (7 %) disagreed with the conditions of WUA such as payment of membership fees as they considered them to be unreasonably high. Another area of contention was as regards

[18] Water Resources Board is an arm of Malawi government responsible for water allocation in the country.

allocation of plots. Group interviews revealed that this was done unfairly by the committee. Related to this was settling of disputes. Some partiality was registered in the way disputes were handled by the committee. Local authority sometimes played an influential role in settling some disputes to the disapproval of some WUA members.

All these claims point to the assertion that committees are viewed apart from their members as separate entities disconnected from the members. Members feel powerless in the presence of committees, which they themselves elected. This stance has implications for collective power negotiations and conflict resolution within the schemes' institutional settings as well as the entire institutional framework (that includes water management institutions). In integrated water resource management, this has implications for stakeholder participation in water management and productivity (see Merry, et. al, 2005 and Sokile, et. al, 2003.

4.3 Policy implications for water and irrigation development

The study findings have some important policy implications for irrigation development and water resource management. Variation in benefits accruing from irrigation, for instance, implies that households with primarily irrigation-based livelihoods are more likely to actively participate in water management interventions than those with non-irrigation based livelihoods. Therefore, policy should be cautious of this level of heterogeneity which seems to cut across all stages of irrigation development. That is, within any stage of irrigation development, policy should envisage the households as being at varying levels of 'irrigation livelihood status' so that a livelihood assessment of an irrigation system can be considered to direct policy interventions.

While irrigation-based livelihoods are generally water-dependent, not all irrigation households will have water-dependent livelihoods, as this will depend on the type of other livelihood activities the households engage in. Thus, at household level, decisions are made to allocate water between different water-dependent livelihood activities, and priority is given to activities that the households find profitable. In that regard, irrigation may not always be a priority. This is important to realize as it has implications for irrigation water management and policies should be formulated to provide incentives for investment in water management where irrigation is not a priority, and this can be at any stage of irrigation development.

Defining livelihoods of irrigation households in terms of water-dependency, that is, the water/non-water dependency dichotomy provides a promising framework for analysing livelihood characteristics in an effort to advance integrated water resource management. The study has shown that this unravels intra-household relations regarding engagement in irrigation vis-à-vis other livelihood activities. Where changes in irrigation water use do not only affect irrigation output but also output from other activities within a household, the household will be more willing to invest in irrigation and water resource management. On the other hand a household with less output from water-dependent livelihood activities may not be willing to invest in irrigation and water management. This would explain why there is always variation in response to interventions in water management between irrigation systems and among households within an irrigation system. It is thus worthwhile to look into intra-household competing water uses alongside inter-household competing water uses when addressing water management. The policy dimension of this finding cannot be overemphasized.

The fact that non-water dependent households are better off would possibly imply that non-water dependent livelihood activities are more profitable. As such, households would rather allocate their assets or resources to non-water dependent livelihood activities where they will be utilized efficiently than to water-dependent livelihood activities. As earlier alluded to, irrigation may lose out in this respect and consequently, water resource management. Put differently, irrigation does not benefit all households equally and that says a lot of variation in interests on matters of irrigation development and water management. This should guide policy on how much of water management can and should be left in the hand of irrigation farmers based on stages of irrigation development as well as heterogeneity of their livelihoods. The results seem to suggest a strong relationship between irrigation, water resource management and livelihoods, and therefore a case for a livelihood analysis dimension in integrated water resource management.

5. Conclusions

The paper has revealed that irrigation livelihoods are just as heterogeneous as irrigation schemes. While heterogeneity in irrigation schemes lies in the 'non-uniformity of soils, weather, fields, cropping pattern and canal systems' (Smout and Gorantiwar, 2005) among other things, irrigation livelihoods are heterogeneous in that they accrue benefits from irrigation variably. Another level of heterogeneity stems from varying dependence on water as a source of livelihood. While some households have water-dependent livelihoods, others have non-water dependent livelihoods. The paper has inferred that households with water-dependent livelihoods are likely to take up water management interventions as the interventions inform their livelihoods. It is rational to do so.

The paper has argued against the wide view that irrigation households have predominantly irrigation-based livelihoods as is reflected in most literature and policy strategies. By dichotomising livelihood activities of irrigation households, the paper has shown that some irrigation households have non-irrigation based livelihoods, and majority of them are non-water dependent. In addition, water-dependent households, majority of which have irrigation-based livelihoods, are poorer in terms of income than non-water dependent households. Furthermore, water-dependent households benefit more from irrigation than non-water dependent households. This is a very important policy dimension because it informs households' ability to participate in irrigation and water management activities.

The study results have also shown that as households make decisions around resource allocation, rationally, more resources are allocated to more profiting activities. Where irrigation remains an unattractive and less paying livelihood activity as results for Bua watershed seem to suggest, investment efforts in water management are likely to be little and undesirable or even non existent. However, in cases where a household has a string of water-dependent livelihood activities, that may be an incentive for the household to invest in water. Finally, the paper concludes that the water-dependency/non-water dependency dichotomy of livelihood activities provides a promising analytical framework for assessing intra- as well as inter-household trade-offs in water allocation, and helps in understanding the interface between irrigation, water management and rural livelihoods. It thus adopts a people-centred, livelihood-oriented definition of IWRM which reads:

'*IWRM is the promotion of human welfare, especially the reduction of poverty and encouragement of better livelihoods and balanced economic growth, through effective, democratic development, and management of water and other natural resources at community and national levels, in a framework that is equitable, sustainable, transparent, and as far as possible conserves vital ecosystems*' (Merry et al., 2005:203).

6. Research needs

This paper looked at income portfolios to assess heterogeneity of irrigation livelihoods and argue for a livelihoods approach in integrated water resource management. Future research could broaden the scope taking into account other dimensions of livelihood analysis framework such as institutions (e.g, water rights, real markets).

Future research could also be done to institutionalise definition of livelihood activities based on the water-dependency/ non-water dependency dichotomy. While it was clear that livelihood activities such as livestock production, irrigation crop production and fishing were water dependent, it was difficult to place other activities (e.g. vegetable selling, rain-fed crop production and dry fish selling) in this categorization. Further exploration of this would allow for more and in-depth application of the livelihood approach in water resource management especially at watershed level.

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5.0 Appendices

Household Survey Questionnaire

Name of enumerator……………………… Date of interview……………………….

Start time…………………………………… Finish time………………………………

Name of village…………………………… **T/A**………………………………………

Household number.........………………..

Name of respondent…………………………………………………………………..

Relationship of respondent with household head………………………………………..
(father, mother, husband, wife, household head)

A. Household characteristics

1. Sex of respondent: a) Male b) Female

2. Age of respondent……………
3. Number of years the household has existed in the village/area…......................................
4. Were you born in this area or moved from somewhere else?
   a) Born here……………..
   b) Moved from somewhere else (*state where and when*)…………………………
   c) Why did you decide to come here?...
   ……………………………………………………………………………………………
   ……………………………………………………………………………………………
   ………………………………………………………………………...
   d) How long have you farmed in the scheme? ....
5. Tribe the household belongs to………...
6. Give details about occupation and education levels for household members

Note: Under occupation and education level specify for each household member, for school going children probe and if not applicable, indicate so.
Include and mark respondent with an asterisk

No.	Name of hh members	Sex	Age	Marital Status	Occupation	Education level	Relation to HHH
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							

Sex: male = 1, female = 2;
Marital status: single = 1, married = 2, widowed = 3, divorced = 4, separated = 5, never married = 6
Education level: none = 1, primary school = 2, Junior secondary = 3, Senior secondary = 4, Tertiary education = 5, Other (specify)
Occupation: Farming=1, Petty trading=2, Traditional healer=3, Mechanic=4, Other=5

7. Give details about Household agricultural production (*information based on 2005/2006 rainy season & 2006 irrigation season*)

Land cultivated		Land acquisition		Crop production										
Location	Area (acres/ha)	How	When	Crop	Variety	Reasons for cult.	Mode of cultivatio	Yield per cult.	Amount consumed &kept for consumptio	Amount sold (Kg)	Amount given out (Kg)	Input	Input Source	Input cost

Location: Dimba=1, Along stream/river bank=2, Bua scheme=3, Homestead garden=4, Upland farming=5, Other (specify) =6
Land acquisition (How): Inherited=1, Bought=2, Rent=3, Allocated to by chief/ Vhead/ Scheme committee=4, Gift=5, Other =6
Crop: Maize=1, Rice=2, Cassava=3, Sweet potato=4, Vegetables=5, Other (specify) =6
Reasons for cultivation: Income=1, Consumption=2, Used in reciprocity (exchanges)/gifts=3, Other (Specify) =4
Mode of cultivation: Rain-fed=1, Irrigated=2
Input name: Seed=1, Fertilizer=2, rent=3, manure=4, hired labour=5, transport=6
Input source: Loan=1, Bought=2, Gift=3, Own reserve=4,
Variety (Rice): Kilombero=1, IET=2, Lifuwu=3, Star=4, Superfaya=5, Other=6
(Maize): Local variety=1, Hybrid=2
Yield or amount in Kg or 50Kg bags

8. What type of livestock does the household keep?

Livestock type	**# Kept**	**Production**		**Utilization (*Indicate units e.g. Kg, Litres etc*)**				**Management**	
		Type	**Quantity (*indicate units e.g Litres, Kg etc*)**	**Qty consumed**	**Qty given out**	**Qty sold**	**Price (Mk)**	**Type**	**Cost (Mk)**
Goats									
Sheep									
Poultry									
Rabbits									
Pigs									
Cattle									

Production type: Milk=1, Meat=2, Manure=3, Live sales=4, Draught=5, Eggs=6, Hides (Zikopa)=7, Other (specify) =8
Management type: Feeding=1, Drugs=2, Vaccination=3, Labour=4, Other (specify) =5

9. What other livelihood sources/activities does the household have? (*Refer section **A** on occupation and education level*)

Source/ Activities	Income derived (past 6 months) in MK	Operational costs (MK) for 2005/2006
Fishing		
Remittances		
Micro enterprise (*Specify*)		
Wages		
Rents		
Gathering (e.g. Honey, mushroom)		
Off-farm (e.g labourer)		

10. List all the physical assets owned by the household.

No.	**Asset**	**Qty**	**How acquired** *(Bought, Received, Borrowed*, *Loan, etc)*	**When acquired**	**Condition**
1					
2.					
3.					
5.					
6.					
7.					
8.					
9.					
10.					

Asset: House=1, Bicycle=2, Radio=3, House furiniture=4, TV=5, Livestock=6, Farm implements (*list as below*) =7
Farm implements: Treadle pumps=*a*, Plough=*b*, Watering cans=*c*, Ridger=*d*, Ox-drawn cart=*e*, Other (specify) =*f* …………….e.g. 7*a,* 7*b, etc*
Condition: Good/working= 1, Fair=2, Poor/not working=3, Other (Specify) =4

11. Which organisations are you affiliated to?

No	Organization	Type of the organization	Conditions for joining/being affiliated	Household perception about conditions

Type of organization: Formal (registered)=1; Informal (not registered)=2
Conditions for joining: membership fee=1, village member=2, Owns land=3, Acceptance of by-laws=4, Other (specify) =5
Household perceptions: agree strongly=1, agree=2, somewhat agree=2, disagree=3, strongly disagree=4, not sure=5

12. Which other development organizations are working in the Basin?
    1. European Union
    2. Masaf
    3. Nasfam
    4. World Vision

13. What rules and regulations govern the management of water?
    1. Water abstraction requires payment of fees: **Yes/No**
    2. Access to water in the scheme demands membership to an Association: **Yes/No**
    3. Water Resources Board collects fees for water permits and water abstraction rights: **Yes/No**

14. Have you received any training in the following areas?

Training	Who offered the training?	Who participated in the training?	How many times has this training been offered?	When was the last training offered?	Where was the training offered?	How did you find the training?
Water management						
Agroforestry						
Management of trees						
Fisheries						
Water conservation						
Soil improvement						
Rainwater harvesting						
Irrigated crop management						
Gender						
Post-harvest handling						

Who offered the training? Government=1, Local NGO (*name*)=2, An association (*name*)= 3, Religious body (*name*)=4, Other (specify)=5
Who participated in the training? Irrigation farmers=1, Bua Irrigation Scheme members=2, Fishermen=3, Local communities (*name*) =4, Other (Specify) =5
How did you find the training? Very useful=1, Somewhat useful=2, Useful=3, Useless=4, Do not know=5

15. What type of training as regards irrigation would you like to receive in future?

General Comments:……
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Stakeholder Analysis Questionnaire

1. Name of organization……………………………………………………………….
2. How long has the organisation worked in the area?...
3. Brief description of the organisation (type and objectives)

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4. Describe the organization's areas of involvement in water resource management?

Area(s) of involvement	**Partner organizations**

5. What is the organisation's role in promoting water resource management in the Bua watershed?

Role	**How water resource management is promoted?**

6. What are the organisation's opportunities in dealing with water resource management?
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7. What are the organisation's constraints and/or challenges in dealing with water resource management?
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8. How does the organisation work with irrigation farmers in the Bua watershed?

   a) Not at all ....

   b)Directly

   (*explain*)…………………………………………………………………...
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   c)Indirectly

   (*explain*)……………………………………………………………….
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Interview Questions for Bua Irrigation Farmers

1. Explain the organizational structure of Bua Scheme Management?
2. When was Water User Association (WUA) formed? Who initiated its formation? Who are the members of WUA? How does one become a member of WUA?
3. How was the scheme managed before WUA establishment? What has changed since inception of WUA?
4. What are the functions (roles and responsibilities) of various arms of the Bua Scheme Management structure?
5. Which local rules (social norms) positively or negatively affect the running of WUA?
6. Which scheme functions seek to address water management issues in the Scheme?
7. Identify organizations working with the Bua Scheme to tackle water management issues? How do these organizations work or collaborate with the Scheme?
8. Explore the non-agricultural uses of irrigation water in the scheme? How do these uses affect the scheme performance (diverse water rights)?
9. What is the perception of the scheme management and members of the non-agricultural uses of the irrigation water?