PERCEPTIONS OF THE IMPACTS OF ARTIFICIAL FLOOD RELEASES ON THE GENERAL USE OF THE NATURAL RESOURCES OF THE PONGOLO RIVER FLOODPLAIN, SOUTH AFRICA.

BY

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PREFACE

The research described herein was undertaken at the Centre for Environment and Development, University of KwaZulu-Natal, Pietermaritzburg campus, under the supervision of Dr Joan Jaganyi.

I hereby declare that this is an authentic record of work and has not in its entirety, nor in part, previously formed for the award of any degree of this or any other University. Wherever use is made of others' work, it is duly acknowledged in the text.

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Signed **Date**

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Signed **Date**

Dr Joan Jaganyi

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ABSTRACT

A social survey of the communities living adjacent to the Pongolo river floodplain was carried out, in order to understand the perceptions of the impact of artificial flood releases on the general use of natural resources of Pongolo floodplain in terms of: general resource use, stream flow, water quality and subsistence agriculture. The results show that floodplain communities perceive that the present artificial flood releases which are intended to maintain the environmental requirements of the floodplain are not meeting their needs nor the needs of the environment. Key perceptions on environmental impacts identified are: (i) reduction in water required to maintain floodplain resources, (ii) deterioration in water quality and (iii) decrease in available floodplain land and natural resources.

LIST OF ACRONYMS

ARA	- Agricultural Resource Act
CCA	- Canonical Correspondence Analysis
CMA	- Catchment Management Agencies
DoA	- Department of Agriculture
DEA	- Department of Environmental Affairs
DLA	- Department of Land Affairs
DoA&EA	- Department of Agriculture and Environmental Affairs
DoH	- Department of Health
DWAF	- Department of Water Affairs and Forestry
ECA	- Environmental Conservation Act
EKZN	- Ezemvelo KwaZulu-Natal
ICDPs	- Integrated Conservation Development Plans
IUCN	- International Union for Conservation of Nature and Natural Resources
IWRM	- Integrated Water Resource Management
KZN	- KwaZulu-Natal
LWWP	- Lubombo Water Ways Programme
NEMA	- National Environmental Management Act
NGO	- Non-Government Organisation
NWA	- National Water Act
NWRP	- National Water Resource Planning
POWADETA	- Pongolo Water Association for the Development of Traditional Agriculture
SDI	- Spatial Development Initiative
WCD	- World Commission on Dams
WCED	- World Commission on Environmental and Development
WRC	- Water Research Commission

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CHAPTER 1: INTRODUCTION

1.1 Background

Heeg and Breen (1982) reported that the Pongolo River and floodplain ecosystem supports the livelihoods of a considerable local human population living on the Makhatini Flats, the area immediately adjacent to the floodplain. The study was later published in Heeg and Breen (1994) in an article entitled, 'Resolution of conflicting values on the Pongolo River and floodplain, South Africa', where it was indicated that people have depended on the floodplain's natural resources for centuries and that the floodplain still plays a key role in their subsistence economy (mainly agriculture, fishing, poles and grass for building houses and for making arts and crafts artefacts, wild vegetables, fruit and bush meat, e.g. waterfowl), which is bolstered by earnings from migrant labour and pensions. As a natural ecosystem, it is unique in South Africa and its biota, which includes tropical and other rare species, is adapted to the natural seasonal changes in the water levels of the floodplain (Heeg and Breen 1982). The study also demonstrated that the productivity of the whole system is dependent upon the annual summer floods. However, according to Heeg *et al.* (1980) the continued existence of this ecosystem is threatened by an altered stream flow regime, resulting from the development of the Pongolopoort Dam which was built in the 1970s with the original objective of increasing irrigated sugar production on the Makhatini flats. As a result, the reduction in flooding of the said ecosystem causes resource regeneration to decrease, leading to conflict among competing floodplain resource users (Bruwer *et al.* 1996). On this basis, it is imperative that an equitable, effective, affordable, sustainable and timely allocation of water from the dam be effected (NWA 1998; Dent 2000).

1.2 Conceptual Approach [1]

The Department of Agriculture has devised plans to expand the development of irrigation on the Makhatini flats as a means of reducing poverty and improving the social well-being of the population. It has been argued that the current water allocation for artificial flood releases to maintain the floodplain is 'wasting water' and that this water should be used for irrigation, which is perceived to be a more productive use when compared to subsistence agriculture and use of natural resources on the floodplain (DoA&EA 2002).

[1] This conceptual framework was informed by the objectives of the WRC Project (Jaganyi *et al*. K5/1299).

The interests of the people living in the immediate vicinity of the floodplain on the Makhatini flats are essential to consider, since cessation of flooding would not only destroy the floodplain ecosystem, but would, in effect, remove subsistence rights enjoyed for centuries (Heeg and Breen 1982). However, due to the altered stream flow regime coupled with increasing subsistence needs that may lead to floodplain degradation, there is a need to control the utilization of this floodplain. Understanding how local people perceive the use of resources, can contribute to finding solutions.

A conceptual framework indicating the institutional and socio-economic relationships influencing water allocation decisions is depicted in Figure 1.1. There are strong self-interests among stakeholders, with consequent tensions. Therefore promoting the equity, efficiency and sustainability of the local economy will require robust and resilient management systems (Senge *et al.*1999). The challenge is to put a plan in place that integrates all economic activity for the benefit of all. In order to contribute to providing information that shows the floodplain's importance relative to irrigation agriculture, it is necessary to start by identifying its goods and services (social, economic and ecological), which can then be used for a cost-benefit analysis in a resource economics study.

Although the floodplain produces goods with market values (crop, fish, pasture), many of the goods and services produced have non-market values, e.g. indirect non-consumptive values affecting ecosystem benefits shown in the chart below (Pearce and Turner 1990; Barbier 1993).

Habitat	Resistance	Religion
Water	Pollination	Education
Nutrients	Seed dispersal	Spirituality
Soils	Erosion	Amenity
Climate	Buffering	Intrinsic
Disease	Existence	Bequest
Option	Information	Resilience

The implication is that in order to arrive at an estimate of the total economic value, one would have to consider ecological, social and economic values (Pearce and Turner 1990; Barbier 1993) and employ an ecosystems approach to defining these values (Grumbine 1994).

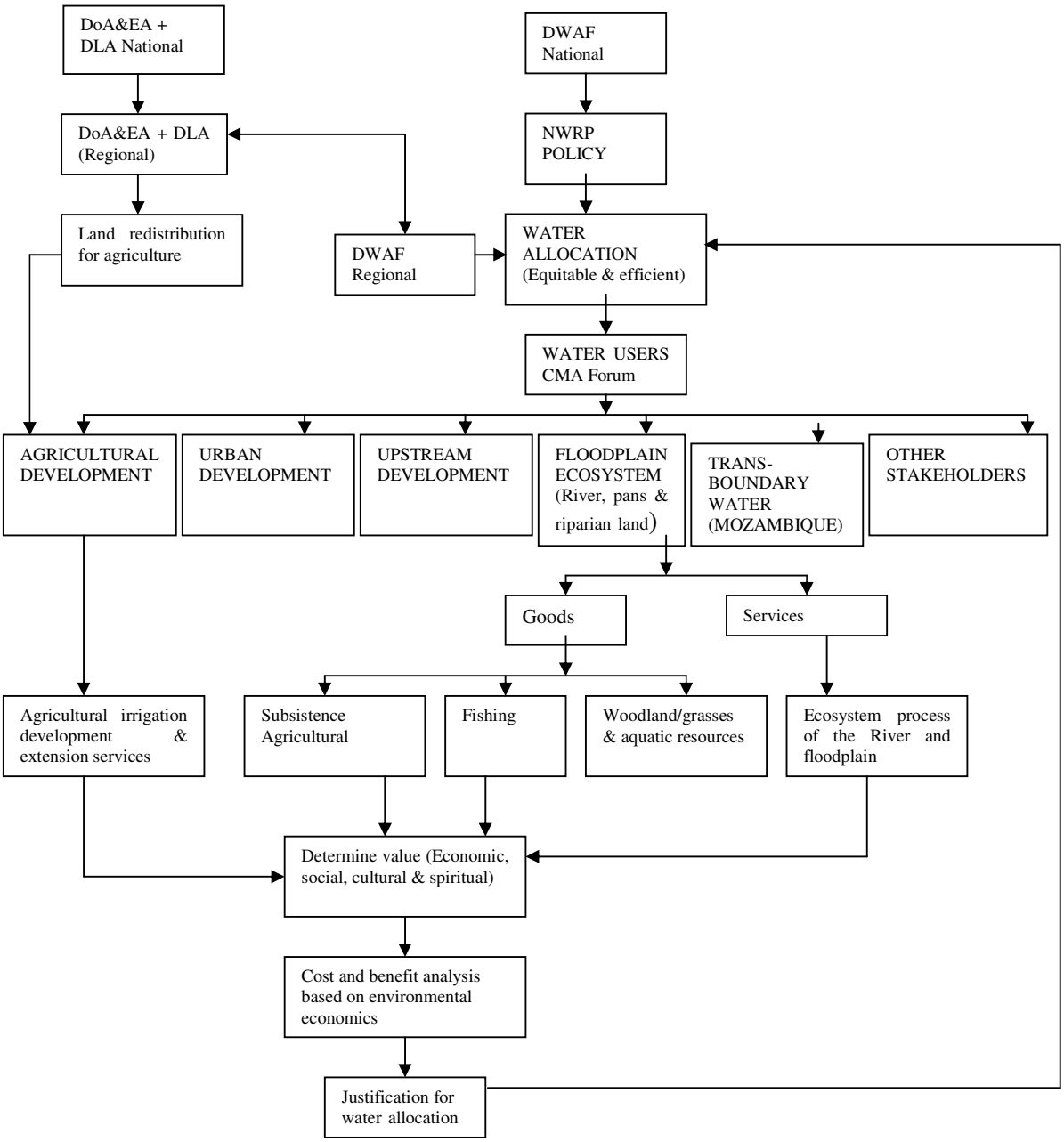

Figure 1: Institutional and socio-economic relationships influencing decision-making with respect to artificial flood releases from the dam.

Authors such as Keddy (2002) support the ecosystem management approach. For example, Keddy (2002) and Grumbine (1994) argue that for successful ecosystem management, an understanding of human interaction with the ecosystem is important. This must ensure that the management of ecosystems is prioritized (through protection, management and restoration) and monitoring to ensure that the management plans achieve their intended

goals. Keddy (2002) argues that the need to protect wetlands should be the first priority, owing to the fact that there is not much time left in which to protect relatively undisturbed wetlands. Principles that underpin the management and restoration of wetlands in order to maintain ecosystem functioning (Christensen *et al.* 1996; Haeuber and Franklin 1996; Grumbine 1997; Keddy 2002) include:

(i) The interconnectedness of the processes and functions of the ecosystems.
(ii) Maintaining the natural dynamic and character of the ecosystem.
(iii) Acting locally and thinking globally due to the fact that ecosystems are connected.
(iv) Involving humans as part of ecosystems in order to achieve the desired future state of the system.
(v) Proper monitoring of the goals and objectives set.

However, a major concern is that even though the principles of ecosystem management are known, human beings continue to destroy the environment. A serious problem according to Keddy (2002) is that wetland scientists are unable to relate and communicate scientific facts to the human community so as to facilitate change. Knowledge of the biophysical, social and economic sciences is necessary to enhance the ability of individuals to communicate and implement environmental problems (Goodland 1990; Goodland 1995; Ife 1999).

This understanding may form a basis for reconstructing human beliefs, norms and values that enable a change in attitudes, actions, practices and decision-making which in turn supports the natural maintenance of ecosystem processes, structure and functions (Senge *et al.* 1999 and Keddy 2002). The fact that humans are part of ecosystems means that the negative impact resulting from their activities which destroy wetlands and other natural habitats may cause the human race to become extinct, just like the many plants and species that are now extinct (Reid and Miller 1989; Raup 1992; Primack 1998).

Clearly, wetlands have always influenced humans. For example, early civilization started along the edges of rivers in the fertile soils of floodplains. However, humans are not only failing to live in harmony with their environment but also with each other (Ife 1999).

Ignorance, fear and greed, as indicated by Keddy (2002), Ife (1999) and Senge *et al.* (1999), are some of the factors influencing this behaviour.

These views are supported by management studies (Senge *et al.* 1999) which indicate that the point to start is to acquire learning skills which enhance overcoming such factors, thereby enabling a change in people's attitudes. However, the key problem is that people do not resist change but people resist being changed (Senge *et al.* 1999). Despite the presence of excellent technology and laws that protect the environment, a significant change in people's behaviour is not guaranteed and humanity has continued to destroy the environment.

To achieve profound change is to ensure that people's inner values, aspirations and behaviour change together with outer shifts in processes, strategies, practices and systems (Senge *et al.* 1999). This author also argues that it is not enough to alter laws, strategies, structures and systems, unless the thinking that produced them also changes. Implied here is a need to align people's perceptions, beliefs, norms and values with the environmental policies in place.

Due to the fact that effective conservation and management of wetlands begins in human brains, this study attempt to understand how the Pongolo floodplain communities perceive the impacts of artificial flood releases on the river and floodplain ecosystem and also how these effects (with respect to resource use, water quality and agriculture) have influenced attitudes (people's thinking, action and interactions). Based on this understanding, gaps are identified and probable options are recommended.

1.3 Aim

The aim of the study is to understand the general use of the floodplain resources, through the perceptions of the communities that depend on these resources, and to establish how flooding affects these resources. This is important since an understanding of local people's perceptions can be used to inform local development decision-making which may influence their standard of living. Therefore, perceptions relating to the knowledge of the Pongolo floodplain communities regarding socio-economic structures, stream flow, resource use, current utilization of the floodplain resources, management and development views will be covered in order to address the goal of the study.

1.4 Objectives

The objectives of the study are:

- To understand the patterns of resource use by communities in the study area.
- To assess the perceived impact of artificial flood releases on resource use, particularly in relation to the timing of flood releases being aligned to people's needs.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature related to floodplain issues. The concept of the floodplain and its importance are also described. Because the study area is located below the dam, the impacts of the dam on the floodplain are also reviewed.

2.2 Floodplains

2.2.1 Definition and importance of floodplains

According to Rogers (1995) and Junk (2000), floodplains are areas that are periodically inundated by the lateral overflow of river or lakes and/or by direct precipitation of groundwater. Breen and Begg (1989) and Keddy (2002) report that floodplains can also be considered as wetlands, a term which also includes marshes, swamps, bogs, vleis and pans, which are waterlogged for a particular period. Due to human-induced activities on the floodplain, as Adams (1993) showed, physical features such as river channels are modified, resulting in a variability of the topography and sediment characteristics that also leads to different flooding conditions. Adams (1993) also indicated that in many African floodplains, these physical features cause the time of flooding to differ, from a very short to a permanent period.

Adams (1993) furthermore found that in the upper reaches of a river, floodplains tend to be narrower, and a more peaked hydrograph is evident, whereas in lower reaches downstream, floodplains are large and exhibit a more complex form, so that floods tend to be slower to rise, to last longer, and end later than they do upstream.

Flooding deposits nutrients from water-borne sediments on the floodplain soils (Heeg and Breen 1982; Barbier and Thompson 1998). These alluvial deposits make such soils highly productive ecosystems (Barbier and Thompson 1998) and consequently vulnerable to human exploitation. Also, because alternating water fluctuations cause wetter and drier conditions on the floodplain, activities such as fishing, seasonal livestock grazing and agricultural production are possible (Heeg and Breen 1982; Barbier and Thompson 1998).

2.2.2 Floodplain uses and benefits

Lack of development in Africa, especially in rural areas where the use of natural resources is the major source of survival, has made the floodplain most important for hydrological, ecological, economical and social benefits (Barbier and Thompson 1998). From the study undertaken by Thompson and Polet (2000) in the Hadejia-Nguru wetlands of North-Eastern Nigeria, it is clear that alternating wet and dry seasons influence the availability of resources for use and for the practice of recession agriculture. In their study, for example, fishing and rice cultivation is possible when the land is flooded, while when the water recedes other crops are planted or the land is used for grazing.

Floods are very important to the environment and to those whose livelihoods depend on wetland resources. Barbier *et al.* (1997) indicate that floodplains are highly productive in ecological terms compared to the drylands that surround them, partly because floodplain soils retain adequate soil moisture to support plant growth for a longer period. According to Heeg and Breen (1982), Barbier *et al.* (1997) and Barbier *et al.* (1998), floodwaters stimulate fish migration and breeding and convey essential moisture and nutrients to the soil, providing fertile agricultural land. Water that soaks through the floodplain recharges the underground aquifers, which supply water to wells beyond the floodplain (Barbier *et al.* 1997). Soil moisture persists into the dry season and provides grazing for migrant herds (Buchan 1988; Barbier *et al.* 1997). The floodplains also yield valuable supplies of timber, firewood, medicines, and other products and offer habitats for wildlife, especially migratory birds (Bruwer *et al.* 1996; Barbier *et al.* 1997; Barbier *et al.* 1998). In many cases, a lack of floods has seriously diminished the living standards of rural populations, by causing increased disease in people and livestock and the loss of biodiversity (WCD 2002).

2.3 Impacts of damming on floodplains

Many studies have confirmed that dams reduce flooding downstream, which results in reduced wetlands areas leading to the expansion agricultural land into the wetlands area and changes in plant species from herbaceous to woody ones (Klimas 1988; Nilsson *et al.* 1991; Poiana and Johnson 1993; Rosenberg *et al.* 1995; Toner and Keddy 1997).

The amount of flooding on floodplains differs, but has decreased in recent years owing to drought and the construction of dams (Adams 1993; Barbier and Thompson 1998; Keddy

2002). Adams (1993) indicates that the construction of the Tiga Dam in Senegal reduced the flooded area of the plain from 2350 km^2 in 1970 to 1186 km^2 in 1986 and 700 km^2 in 1987. In addition, Llewellyn *et al.* (1996) established that as a result of the development of dam and irrigation agriculture, the size of the Mississippi River floodplain has been reduced from 85 – 95 million ha in 1990 to 2 million ha in 1996.

As a result of reductions in floodplain areas, encroachment of bush is often more widespread (Ehrlich and Ehrlich 1981; Noss and Cooperrider 1994; Barbier and Thompson 1998; Acreman 1999; Keddy 2002) and reflects a greater impact than that of agriculture (Keddy 2002).

2.4 Impacts of agricultural development on the floodplain

According to Junk (2000), the floodplain wetlands that have been largely disturbed by large-scale agricultural development are those of the Nile delta, the fringing floodplains along the Nile River, the Logone floodplain and the floodplain of the Benue River (Cameroon), the Hadejia-Nguru wetlands (northern Nigeria), the Pongolo floodplain (South Africa) and the Senegal delta (Senegal). This disturbance is the result of the changed extent, timing, shape and frequency of the floods below the dam reservoirs (Junk 2000). Up to this point it has indicated that the Pongolo (Heeg and Breen 1982; Bruwer *et al.* 1996) and Senegal valley (Horowitz and Salem-Murdock 1993) floodplains are the only ones where an artificial flood regime has been established to reduce the negative impacts of the upstream dams. However, very often various interests want floods released at different times of the year to suit personal interests. This often leads to increased conflict (Bruwer *et al.* 1996).

A cost-benefit analysis of the dam construction for irrigation schemes in the Hadejia Jamare River basin in northern Nigeria showed that the benefits of increased agricultural production from irrigation did not compensate for the losses of benefits from the natural floodplain system (Barbier and Thompson 1998). Though population density is lower in most African countries than in Asia, Barbier and Thompson (1998) indicates that most African countries exhibit high population growth rates and depend largely on agriculture as a result of the favourable availability of agricultural production resources.

Impoverished farmers who possess no resources to improve land productivity usually develop the practice of moving from one piece of land for grazing and cultivation (Barbier 2000). This is to some extent influenced by the fact that it is cheaper to bring additional land into productivity than to invest in maintaining the long-term productivity of existing land (Barbier 2000).

Large-scale agriculture results in reduced diversity of habitat and species (Meador and Goldstein 2003). These authors also indicated that increased chemical use in large-scale agriculture affects aquatic ecosystems (through eutrophication processes) owing to runoff from agricultural land. Meador and Goldstein (2003) reported that agricultural land use was correlated with instability of banks and decreased conditions of water quality in streams.

According to Lemly *et al.* (2000), developments of dams for irrigation agriculture cause reduced downstream flood discharges, which result in crop failures and declining fisheries. Acreman (1999) reported that as a result of damming, in some African countries, people whose livelihoods were dependent on agriculture were forced to stop their recession cultivation.

2.5 The value of the floodplain ecosystem compared to irrigation

Barbier *et al.* (1997) indicate that most planning and development decisions are made on economic grounds. However, making use of economic considerations alone to evaluate biodiversity and use of floodplain resources use does not include all of the potential benefits (e.g. spiritual), as they cannot be assigned a monetary value.

A combined economic and hydrological analysis was conducted in the Hadeija River, Nigeria, to simulate the impacts of upstream projects on the flood extent that determine the downstream floodplain area (Barbier and Thompson 1998). The economic gains of the upstream water projects were then compared to the resulting economic losses of downstream agricultural, fuel wood and fishing benefits. The results show that, given the high productivity of the floodplain, the losses in economic benefits stemming from changes in flood extent are large. These results confirmed that the additional value of production from large-scale irrigated schemes does not replace the lost production attributed to the wetlands downstream. A similar case is that of the Manantali Dam on

Mali's Bafing River, a tributary of the Senegal River (Horowitz and Salem-Murdock 1993). Constructed during the 1970s, the dam was supposed to be operated to expand irrigation, and generate power.

However, a study by Barbier and Thompson (1998), comparing the agricultural, fishing and fuel wood benefits lost through reduced flooding downstream against the gains from increased irrigation production upstream in the Hadejia-Jama'are River Basin in northern Nigeria, suggests that the benefits of irrigation can only partially replace the benefits lost from reduced floodplain inundation. In order to minimize further losses from increased irrigation, Barbier and Thompson (1998) indicate that the introduction of regulated flood releases is the best option. Further expansion of large-scale irrigation within the river basin should also be avoided.

Many studies have noted that floodplain farmers spread their livelihood options into different economic activities. Often, such farmers are also fish catchers, herders or dry land cultivators, and sometimes all of these. The economic value of floodplain agriculture can be significant, although there are few formal studies. Barbier *et al.* (1998) calculated that the net benefit from agriculture in the Hadejia-Jama'are floodplain in Nigeria was 239 Naira per ha per year (US$1 = 7.5 Naira).

The anticipated benefits of agricultural irrigation projects often do not compensate for environmental degradation, artificial water-shortages and the increased rates of poverty amongst local communities managing the wetlands by traditional methods, as was also shown for Mexican wetlands (Contreras-Balderas and Lozano-Vilano 1994).

2.6 Flooding and the ecosystem

Clearly, flooding plays a major role in the process and sustainability of the floodplain ecosystem. This is because most of the floodplain resources are water-dependent and if they are to be maintained, they will require sufficient flooding, either natural or artificial.

2.6.1 Importance of artificial flooding downstream

Flooding is the key to the availability of natural resources in a floodplain. Such availability is also a key to sustained livelihoods and survival. Hence, disturbance of flooding means disturbed livelihoods. This is the major issue of the present investigation. Horowitz and

Salem-Murdock (1993) reviewed previous studies and found that researchers had discovered that in Senegal, artificial flooding from the dam could be beneficial for both the development and the maintenance of the ecosystem downstream. They also showed that when the flood-based system's benefits were taken into account, including crop production, fisheries, and use of the floodplain by livestock, the system was more productive than the irrigation option (Horowitz and Salem-Murdock 1993).

2.6.2 Flooding as a means of maintaining floodplain ecosystems

The study undertaken by Slinger (1988) on the Pongolo floodplain has demonstrated that artificial flooding is important to maintain the ecosystem in a productive state. This study found that bi-annual flooding carried out in November and March is more beneficial to both farmers and fish stocks because it is similar to the natural flooding regime: that is with bi-annual flooding, number of fish increase while winter grazing and crop production also show growth.

2.6.3 The Pongolo floodplain

2.6.3.1 Flows

Owing to developments upstream that decrease stream flow, such as commercial forestry, construction of the Bivane Dam and the Pongolopoort Dam and sugarcane irrigation, the volume of water needed to maintain the natural flooding requirements, e.g. up to the high flood level, has decreased (Bruwer *et al.* 1996). The Pongolopoort Dam average annual inflows from 1983 until 2004, are illustrated in Figure 2.1.a. Inflows decreased from 1995 after Bivane Dam was developed. Outflows have stabilized when compared to natural patterns (1930 – 1969). The flood volumes started decreasing dramatically after 2000 (Figure 2.1.b).

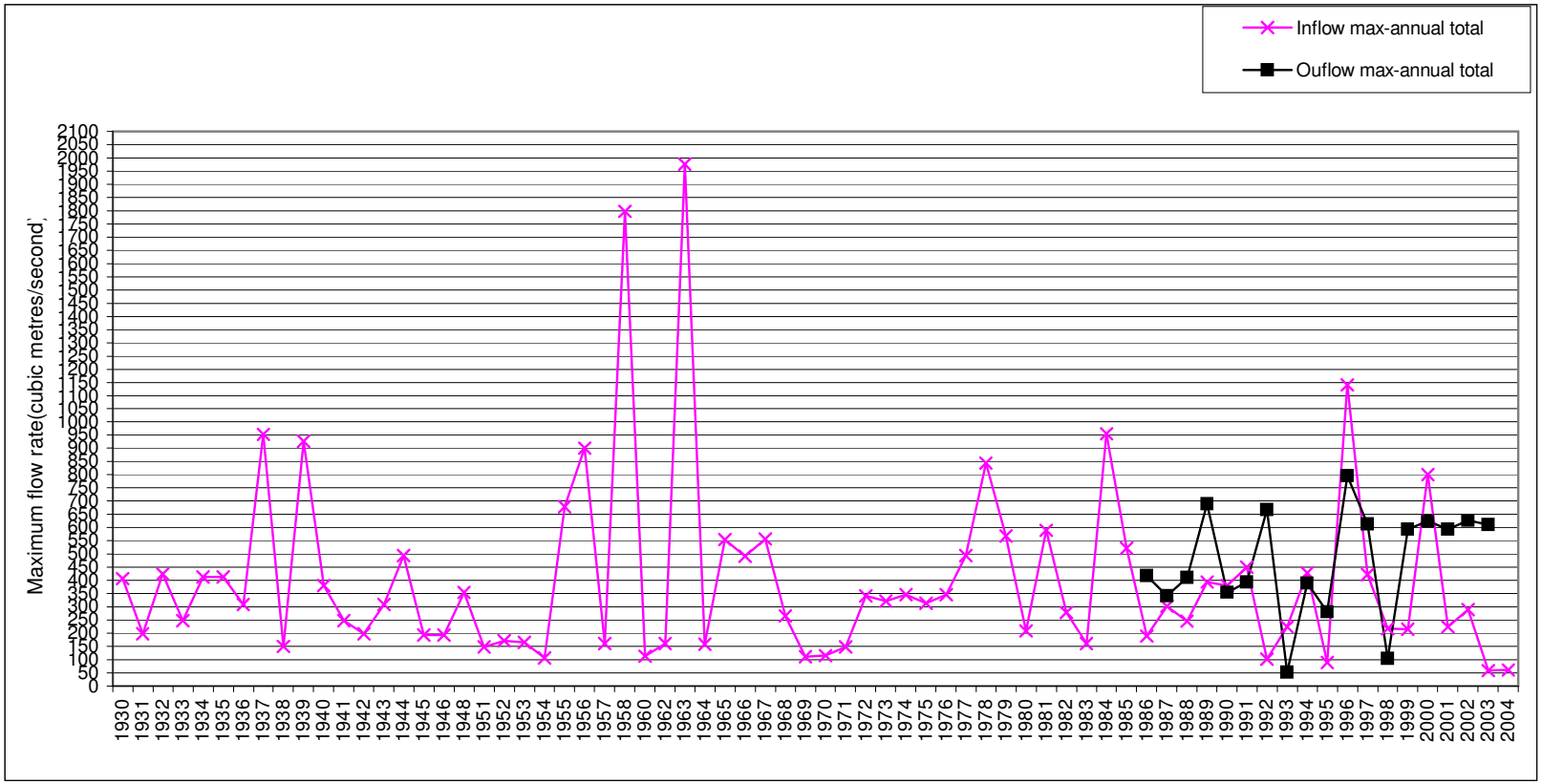

Figure 2.1.a: Inflow rate (cubic metres/second) (Maximum Annual Inflows) into Dam and Downstream Outflows from the Dam. Dam Inflows (1930 to 1968 Pongolo River at Intulembi W4H002 & 1969 to 2004 – Pongolo River at MhlathiW4H006). Data outflows (Pongolo River at Jozini 1986 – 2004 W4H013). Data missing 1947, 1949, 1950, 1958 (Inflows) Data missing 1973 –1985 (outflows). (Source: CCWR and DWAF Database)

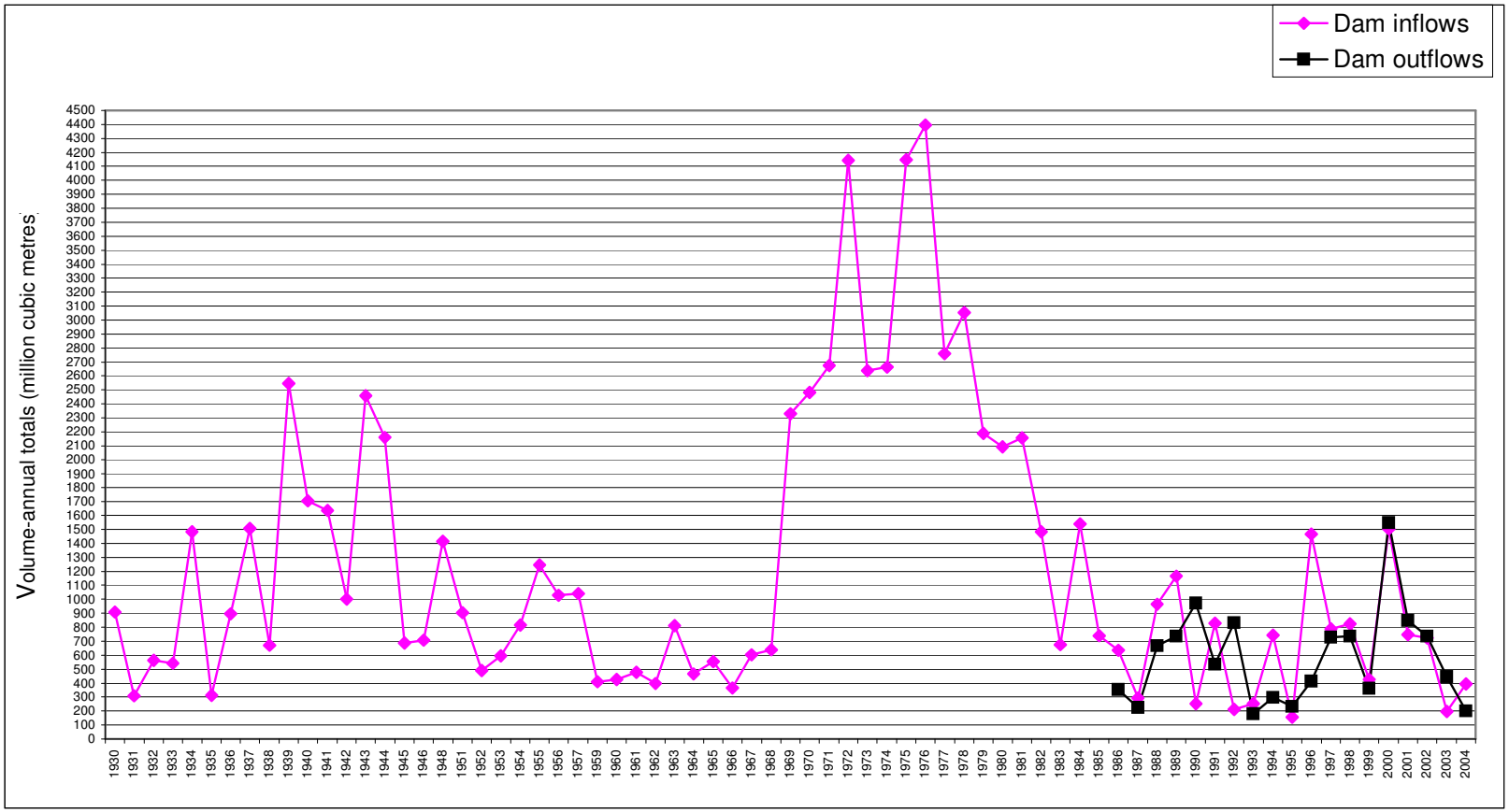

Figure 2.1.b: Inflow Volume (million cubic metres) (annual totals) into dam and downstream outflows from the data Dam inflows (1930 to 1968 Pongolo River at Intulembi W4H002 & 1969 to 2004 – Pongolo River at MhlathiW4H006). Data outflows (Pongolo River at Jozini 1986 – 2004 W4H013). Data missing 1947, 1949, 1950, 1958 (Inflows) Data missing 1973 –1985 (outflows). (Source: CCWR and DWAF Database)

Figure 2.2 depicts the average monthly river volume before and after the dam was built. Because the dam holds back run-off during normal summer flood periods, the duration, frequency and area of flooding are all reduced (Heeg and Breen 1982). For example, a comparison of natural flows (Figure 2.2) and those of the current situation shows clearly that the current management system has resulted in a significant shift of the natural flow, mainly the elimination of two annual summer flood peaks in February and December. In addition, shifted flood timing causes a lag in the release of water, so that flooding can be delayed by months. The delay may impact on the growing season of wetland plants and animals that normally would develop after flood peaks have passed (Heeg and Breen 1982).

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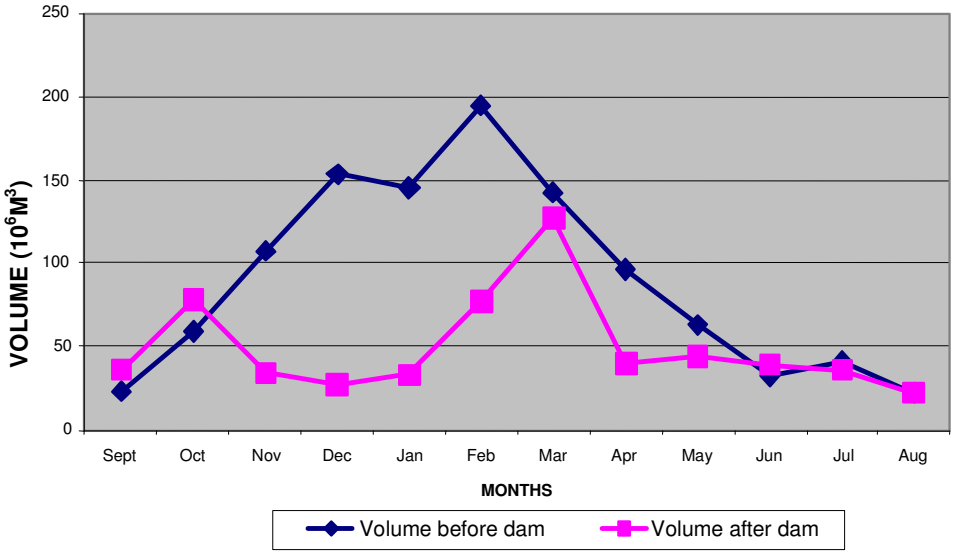


Figure 2.2: Total stream discharge volume for natural (before dam) and artificial (after dam) states. (Source: CCWR Database 1904 – 2000 and DWAF 1999 – 2004)

The duration of the inundation of the floodplain is dependent upon the number of days a pan is in contact with the river (Slinger 1988). Breen *et al.* (1978) conducted a preliminary bathymetric survey of some of the Pongolo floodplain pans. They analysed relationships between water depth and area relative to the maximum retention level of each pan. It was found that pans with extensive floodable margins due to the flatness of the surrounding marginal land were all flooded at a river flow of 85 x 10^3 $L.s^{-1}$ (85 cumecs) or less. They estimated that such pans could be inundated for five days or longer during three years in

every four, and in excess of 40 days once in every four years. A number of the more important pans (in terms of productivity, notably Mzinyeni, Tete, Tetomcani and Namanini) are normally flooded for much longer periods, allowing adequate time for the utilization of flooded terrestrial vegetation by aquatic fauna (Heeg and Breen 1982). The pans requiring a river flow in excess of 85 cumecs before receiving water all lie in more steep-sided depressions and are as a result flooded less frequently and for shorter durations.

2.6.3.2 Vegetation

According to Tinley (1976), Furness and Breen (1980) and Heeg and Breen (1982), vegetation in the immediate vicinity of the Pongolo floodplain can be divided into five principal types: the Sand forest, Woodlands, Acacia tree and Bush vegetation, riparian forest and Aquatic and marginal pan vegetation. The distribution of aquatic and marginal pan vegetation, the component influenced by flooding, is illustrated in Figure 2.3. The forest and floodplain vegetation are the only local sources of material for building huts, firewood and a variety of foodstuffs (Heeg and Breen 1994). These researchers also found that a flood of significant magnitude causes the river to overflow out of the main channel and to flood adjacent areas up to high flood level, and then recede slowly back to its maximum pan retention level.

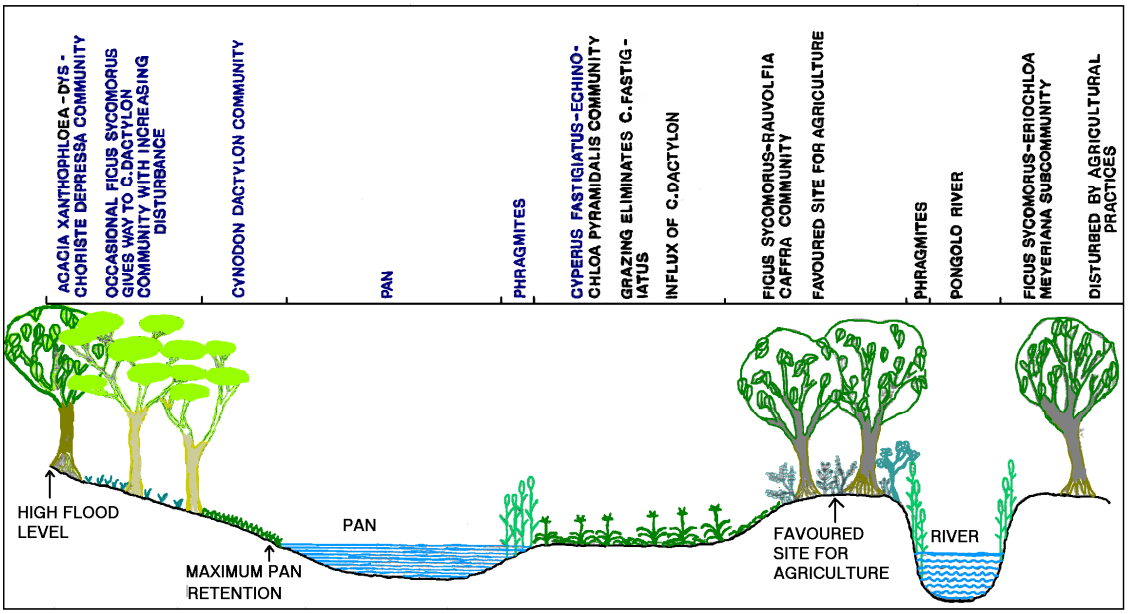


Figure 2.3: Cross section of the floodplain showing the distribution of typical plant communities (from Heeg and Breen 1982).

2.7 Conflicts and floodplain resource use

In the Senegal valley, existing production systems are threatened by the construction of the Manantali Dam upstream and associated irrigation developments have led to conflict between farmers and herders (Adams 1999). Similarly, conflicts over shrinking floodplain resources have also emerged in the floodplain of the Hadejia and Jama'are rivers in northeastern Nigeria (Barbier and Thompson, 1998). Land once available for cattle grazing in the dry season is now being cultivated, and there is a serious conflict between pastoralists and crop farmers. This case is similar to that of the Pongolo floodplain where different stakeholders want the timing of flood releases to favour their needs (Bruwer *et al.* 1996).

2.8 Conclusion

The high productivity of the floodplain land attracts people to use its resources. In addition the alternating wetter and drier conditions of the floodplain afford people the opportunity to perform different activities for the purpose of survival, such as fishing, cultivation, livestock grazing and harvesting other resources such as wild vegetables. However, population growth and economic development, e.g. dam construction, poses a threat to the floodplain wetland ecosystem and consequently to those who are dependent on the natural floodplain resources for a subsistence livelihood.

There is therefore a need to assess the value of the wetlands as judged by those who rely on them for their livelihood. Chapter 3 of this report briefly discusses the location of the study site while chapter 4 briefly describes the methodology used to obtain data: that is social and biophysical surveys. The results of the study are presented in chapter 5, followed by a discussion and the conclusion in chapters 6 and 7 respectively.

CHAPTER 3: THE STUDY AREA

3.1 Introduction

This chapter describes the location of the study area, the climate and settlement along the Pongolo River.

3.2 Location of the study area

The Pongolo floodplain is situated in the northern part of the KwaZulu-Natal province of South Africa. It is within the jurisdiction of the Umkhanyakude District Municipality. The floodplain lies on both sides of the river (east and west). It starts just below the Pongolopoort Dam (27°26' S, 32°04' E) up to the point where the river meets with the Usuthu River from Swaziland in the Ndumu Game reserve (27°56' S, 32°06' E) and then enters into Mozambique. Figure 3.1 shows the location of the Pongolo River and Pongolopoort Dam and some of the agricultural irrigation developments. As the river meanders towards the sea, it forms pans. Floodwaters break out of the main channel and fill the pans. According to Heeg and Breen (1982) there are 90 pans, of varying size, within the 13 000 ha area which comprises the Pongolo floodplain (Figure 3.2).

3.3 Climate

Schulze (1965) describes the Maputaland plain, which includes the Pongolo floodplain, as having a warm to hot, humid, sub-tropical climate, with winters being drier than summers. High temperatures are experienced between December and March and low temperatures between June and July. Heeg and Breen (1982) indicated that the plain is frost-free. The rainfall ranges between 500 and 700 mm. The average monthly rainfall from 1962 until 2004, as recorded by DWAF, is indicated in Figure 3.3. Owing to high temperatures and high runoff wind, the rate of evaporation is high (Heeg and Breen, 1982).

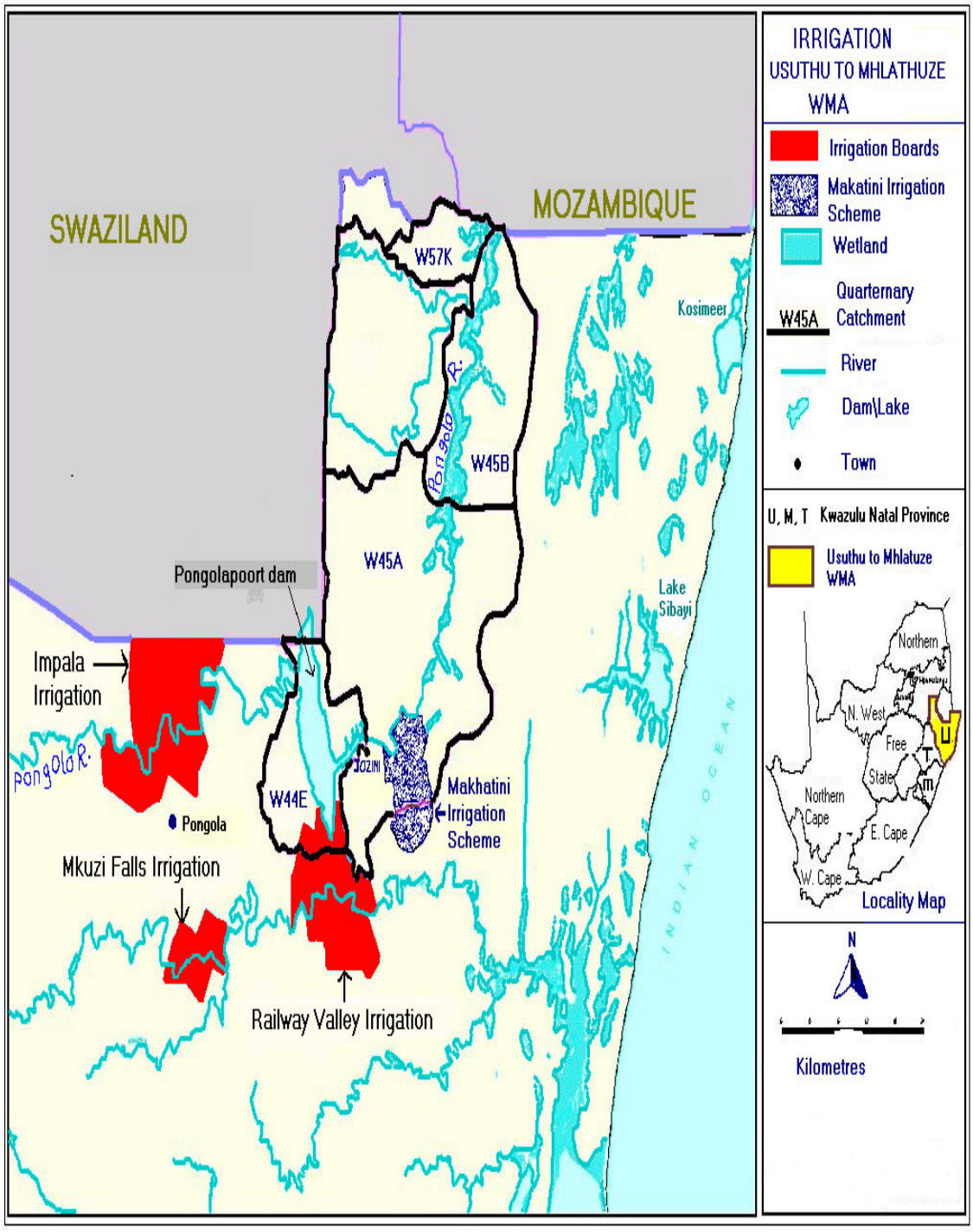


FIGURE 3.1: Location of the Pongolo River and Pongolopoort Dam (source: DWAF GIS Database, Durban, 2003).

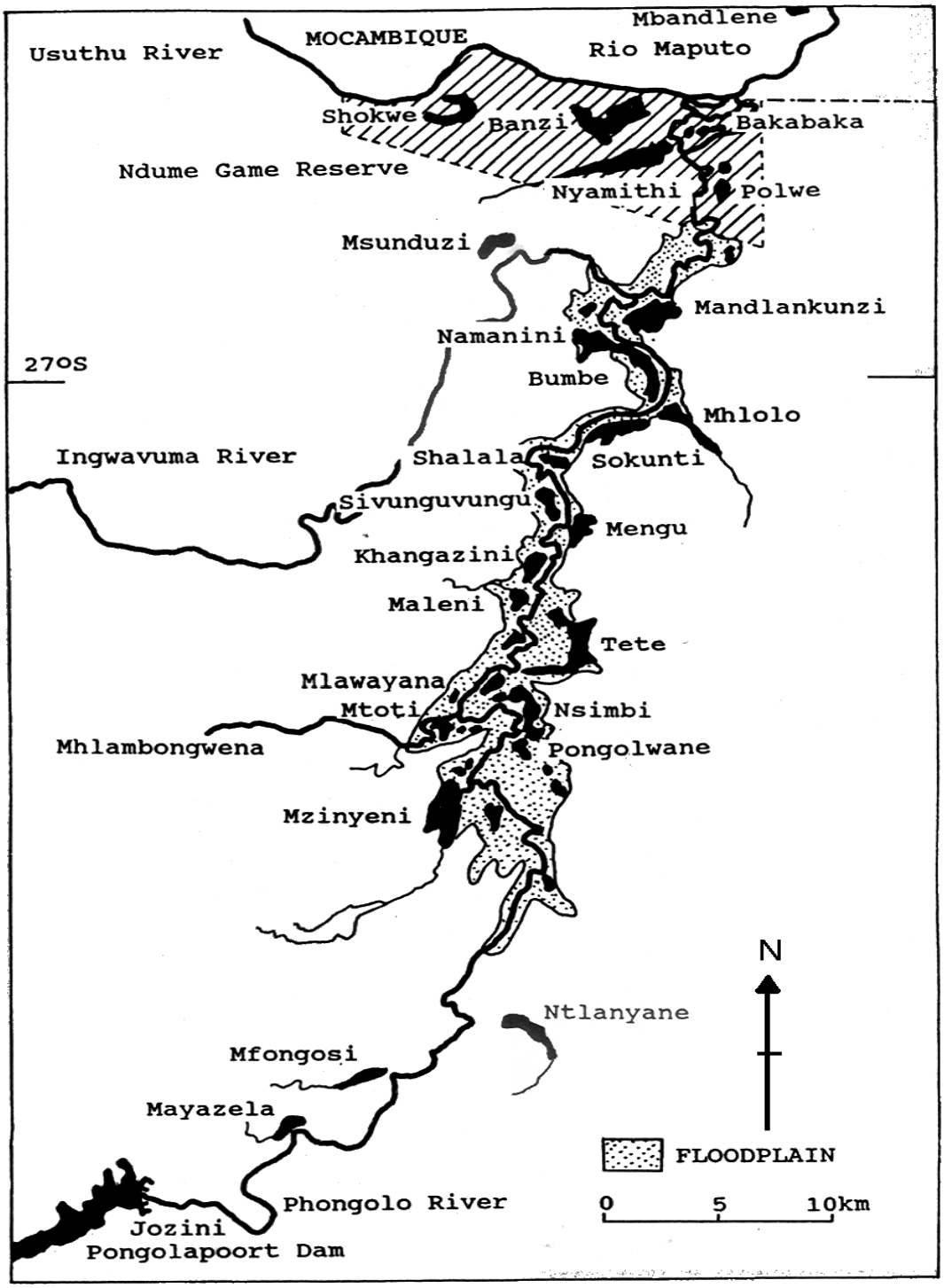


Figure 3.2: The Pongolo floodplain showing the major pans and the flooded area (from James 1992).

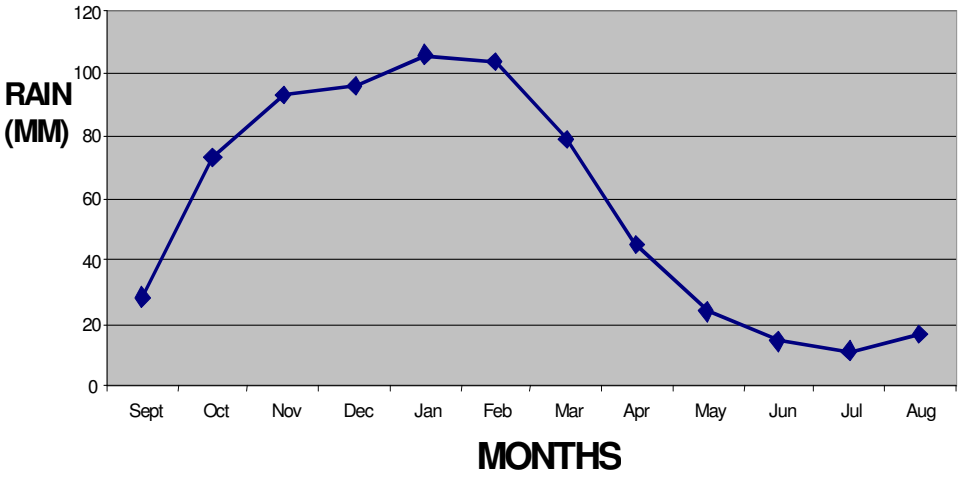


Figure 3.3: Average monthly rainfall between 1962 and 2004 (source: CCWR Database 1904 – 2000 and DWAF 1999 – 2004).

3.4 Settlement

The resident human population which currently uses the floodplain lives beyond the normal reach of the floodwaters, and their homesteads are therefore located on the Makhatini flats. Figure 3.4 below depicts this settlement. Note that settlement is mainly concentrated along the river. This indicates direct dependency on the river's resources.

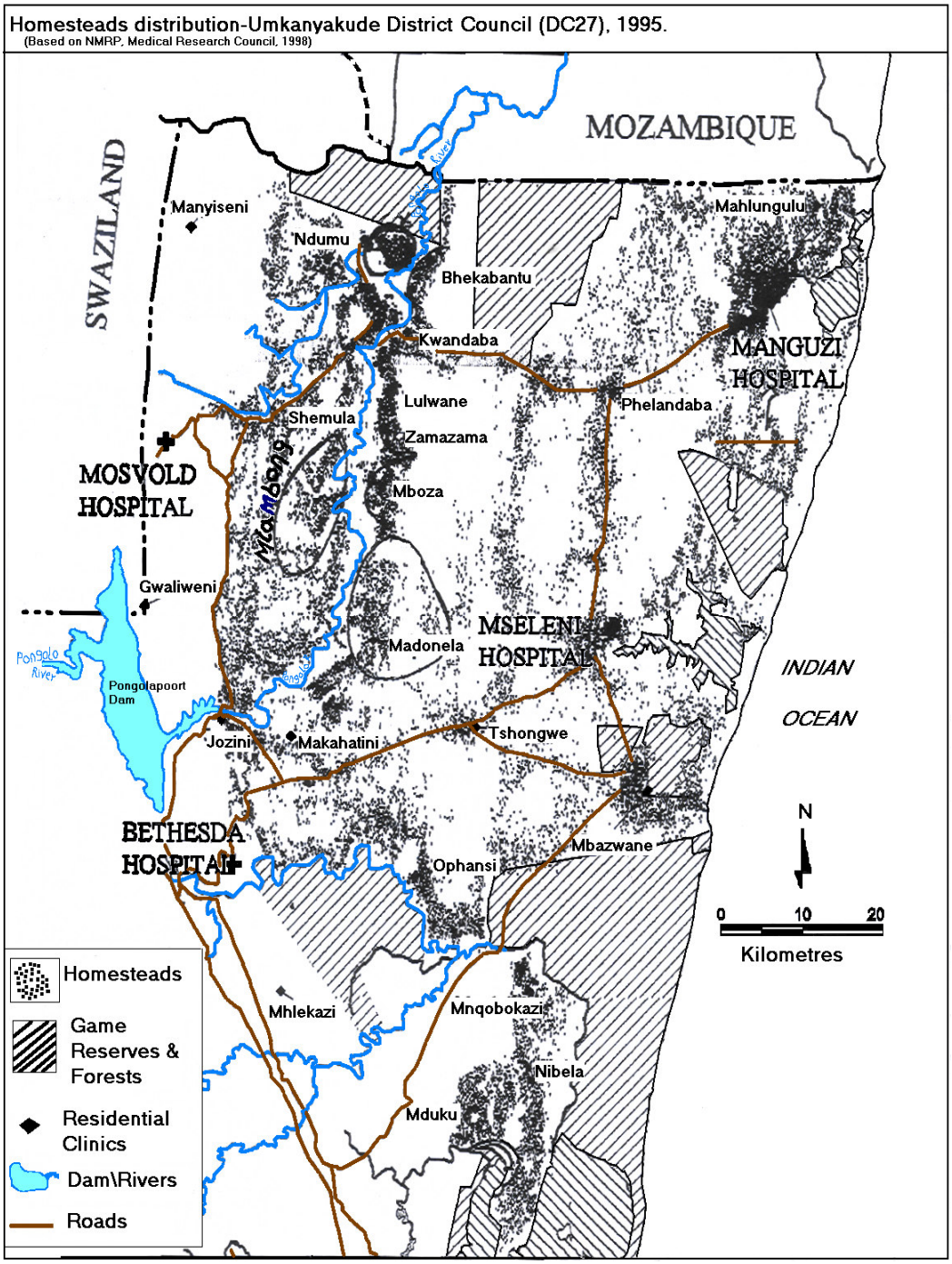


Figure 3.4: Spatial distribution of homesteads in the Umkanyakude District Council (DC27), formerly known as the Ubombo and Ingwavuma districts of KwaZulu-Natal Province. (Source: Medical Research Council 1998).

CHAPTER 4: METHODS

4.1 Introduction

This chapter describes the methods followed to obtain the data, explains why such methods were chosen and discusses the limitations encountered. Social and biophysical surveys were mainly used for data collection.

4.2 Social survey

4.2.1 Research approach and methods

An exploratory approach using both qualitative and quantitative research methodology was adopted (Neuman 1997). An exploratory study is often undertaken as an initial step before the actual decision about a project, and determines the practical possibilities for carrying out any project (Bless and Higson 1995), and was appropriate here. Neuman (1997:20) listed the goals of exploratory research as:

- to familiarize oneself with the basic facts, people, and concerns involved,
- to develop a well-grounded mental picture of what is occurring,
- to generate many ideas and develop tentative theories,
- to determine the feasibility of doing additional research,
- to formulate questions and refine issues for more systematic inquiry, and
- to develop techniques and a sense of direction for future research.

4.2.2. Data collection

The tools used to collect data were: a literature review, site visits, structured and unstructured interviews and check sheet observations. A questionnaire containing close-ended (structured) and open-ended (unstructured) questions was employed. Close-ended questions are also referred to as fixed-response questions (Neuman 1997). In this study the structured questions included ranking types of questions, in order to assess the level of importance of some issues according to the respondents' views. Open-ended questions are also referred to as free-response questions (Neuman 1997). These types of questions were used to allow the respondents to express their views freely without any restrictions. These questions are effective for gathering qualitative data, which is frequently used for exploratory research. Qualitative data tends to be open to using a range of evidence and discovering new issues (Neuman 1997). From the interviews, information about people's perceptions of their floodplain agriculture resource use was gathered using a questionnaire (Appendix A) based on the following information categories:

- Communities and their socio-economic structure;
- Perceptions of stream flow;
- Perceptions of resource use;
- Current utilization of agricultural resources on the floodplain, and
- Management and development.

The questionnaire was designed using the criteria indicated in Table 4.1. It was observed that stakeholders were not willing to talk freely during DWAF annual flood release meetings, due to the high tension arising from diverse interests with respect to artificial flood timing needs. Therefore personal interviews were preferred. The status of biophysical characteristics was assessed at 43 different points along the floodplain using a check sheet shown in Appendix B.

Table 4.1: Questionnaire design criteria

Main section of the questionnaire	**Specific areas that required questions to be asked**
Biographic data	Age and gender Location of settlement in relation to water resources Employment and income Land tenure
Household activities	Collection of resources from the floodplain Looking after the household Household decision-making
Use of floodplain resources	Use of the river and the pans Use of the land on the floodplain Perception of floodplain stream flow in relation to resource use.
Water quality	Impact of changing seasons on the water quality and impact on daily activities. Agricultural practices' impact on water quality. Impact of water quality on human health.
Subsistence agriculture survey	Crop growing activities Crop growing decisions Cultivation of land on the floodplain Crops grown on the floodplain Crop quantity harvested Selling of crops produced Quality of crops produced Buying of crops produced
Management and development	Perceptions about development of subsistence agriculture on the floodplain. Issues related to conflicts of interest in the community in terms of flooding and resource use on the floodplain.
Local institutions and groups	Local institutions and groups present in the community and their roles e.g. Government, NGOs, local associations and traditional groups.

4.2.3. Sampling procedure

Stratified random samples of households in six communities, adjacent to the floodplain, were used as units of analysis. The sample was done based on the distance from the river. For example, we interviewed both those who were close and those far from the river in same proportion within a particular area. The total number of households sampled comprised 10% of the total number of households per individual section of a ward. Section numbers are assigned according to the local Malaria Control Programme labels of the Department of Health. Table 4.2 indicates how the number of sampled individuals was defined.

Table 4.2: Area sampled and its population

Tribal Authority	Area\Ward	Sections	Population	No of households	10% of households
Mashabane (east side)	Mboza	3	1114	244	24
		4	996	162	16
		5	617	247	24
Nyawo (west side)	Mlambongwenya	7	1721	295	30
		9	1275	132	13
		10	654	118	12
Thembi (east side)	Zama-Zama\ Tete pan	5	812	112	11
		6	1380	316	32
	Lulwane	3	976	112	11
	Bhekabantu\ Makanis	5	1082	228	23
		6	134	32	3
Mathenjwa (west side)	Ekukhanyeni\ Ndumu	2	2795	448	45
Totals	**6**	**12**	**13556**	**2446**	**244**

The reason for this sampling was to obtain representative views from the communities along the floodplain on each side of the river (west and east side), those close to the dam (e.g. Mlambongwenya and Mboza), those in the middle (Lulwane and Zama-Zama) and those far from the dam (Ndumu and Bhekabantu).

4.3 Biophysical survey

4.3.1 Interpretation of aerial photographs

The objective was to learn aerial photo methodologies for interpreting the land cover and land use. A base map stemming from 2001 aerial photographs was developed and the distribution and extent of different land use types on the floodplain (e.g. forests, grassland, crops grown and extent of cultivation) was defined in relation to the 1979 aerial photograph. The total area of the floodplain and area under cultivation was estimated using the scale 1:32 000 shown on the original 1979 aerial photograph. The area (e.g. *Y* ha) was estimated using 1cm^2 (*X* squares).

1 cm = 32 000 cm

1 cm^2 = 320 m x 320 m

=102400 m^2

Y = (*X* squares x 102400 m^2)/10 000 m^2

= *Y* Ha

4.3.2 Land use check sheet

For the biophysical survey a check sheet was developed (Appendix B) as a ground truthing tool of the aerial map. This sheet was designed to collect information on land-use practices, their impacts and the state of the floodplain. As mentioned, information was obtained from 43 different points along the floodplain. The frequency of occurrence of various land uses and impacts was tabled. This information supplemented the knowledge obtained from the social survey.

4.4 Data analysis

A multivariate statistical technique known as principal components analysis (Ter Braak 1986; Ter Braak 1988) was used in some of the analyses to discriminate between respondents' perceptions within and among communities.

The nature of the complexity of data collected was such that:

- The study area covered was large (the whole floodplain extent was 112 km),
- Key sample sites numbered 12,
- 244 households were interviewed, hence leading to many perceived variables (see Appendix A).

Therefore, the multivariate statistical technique was helpful in organizing such a complex data set, making it possible to see patterns, trends, similarities and differences. For example, in the results chapter, the multivariate analyses diagram made it possible to see easily how people perceive their environment relative to various variables such as perceptions of the 'distance between their households and the river or pans' relative to 'gender' and 'age'.

Other tools of analysis used were those of ranking in order of importance and comparing. This in some cases was done using percentages (see Chapter 5).

4.5 Limitation of the study

Because of the large number of respondents that had to be interviewed and the large questionnaire that had to be completed, assistants were hired to help with interviews. They were first advised about the nature of the study, and the intended objectives. This was important so that the right information was captured. However, depending on the translation of questions from English to Zulu and of answers from Zulu to English, since the questionnaire was in English, it is possible that the information might be distorted. This is due to the fact that in translation from one language to another, message tends to loose their actual meaning (Thomas 1979).

Another limitation was that the questionnaire was too long. By the time people reached the last questions they were too tired to respond adequately. As a result of respondents are very low with respect to economic questions. To correct this limitation would have required returning to the field to ask those particular questions only. However, resources to explore the economic aspects further were not available.

It should be noted that not all respondents are involved in similar activities on the floodplain and some were not sure about the answers to a particular question, hence the number of respondents differs for some results. For example, not all respondents are farmers; hence for the farming section only those involved responded.

CHAPTER 5: RESULTS

5.1 Introduction

Interviews comprised a total of 247 respondents, three more than the 10% of households (244) indicated in Table 4.2. However, not all respondents answered the questionnaire fully. Hence number of respondents differs in some questions. For the results, the following representation was used:

- S1 – Mboza section 3
- S2 – Mboza section 4
- S3 – Mboza section 5
- S4 – Mlambongwenya section 7
- S5 – Mlambongwenya section 9
- S6 – Mlambongwenya section 10
- S7 – Zama-Zama section 5
- S8 – Zama-Zama section 6
- S9 – Lulwane section 3
- S10 - Bhekabantu section 5
- S11 – Bhekabantu section 6
- S12 – Ndumu section 2.

A multivariate plot of the communities sampled, and respondents, revealed a clustering of communities along the river flow gradient (upstream-downstream).

5.2 Biographic status of communities

Understanding the biographic status (gender, age classes, period of residence in the study area, distance of households to the river and pan, family size, land allocation and income) of the communities sampled was necessary for interpreting the findings of the study with respect to people's relationship with the river and the floodplain ecosystem. Details of actual results are shown in Appendix C.1. The following is a summary of findings.

5.2.1 Age and gender

Because the focus of the study falls on perceptions and values, and these changes with age, various age group categories were used to understand the perceptions of and values assigned to the use of floodplain resources. In developmental studies it is important that results are interpreted in a way that not only reflects gender numbers but, also, gender

thinking. The age and gender structure of the communities sampled was consequently analyzed using multivariate analysis illustrated in the ordination diagrams in Figure 5.1. Interpretation of the diagrams is illustrated in Table 5.1 where various gradients of variation are shown. Out of 247 respondents 151 were women and 96 were males. Respondent age classes decreased in the order of 56–65, 46-56, 26-35, 36-45, 15-25 and above 66 years. For example, the numbers of male and female respondents were highest in S8 and S3 respectively and the greatest number of respondents over the age of 65 was found in S10.

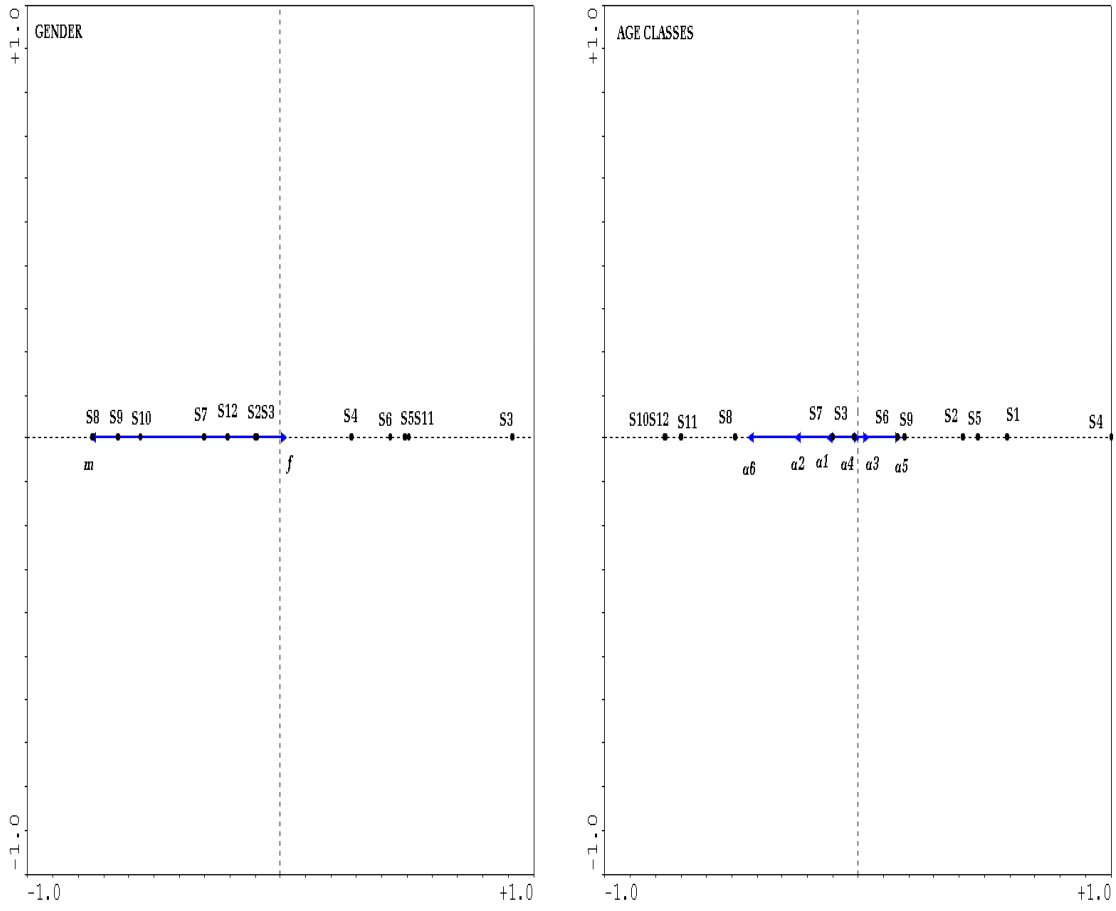


Figure 5.1: Age and gender structure of the communities sampled shown in ordination diagrams created using CCA. Key: Community samples (S1-S12), Males (*m*), Females (*f*). Age classes are: *a1* (15-25), *a2* (26-35), *a3* (36-45), *a4* (46-55), *a5* (56-65), *a6* (>65).

Table 5.1: Community sample groups, arranged in order of increasing number of respondents from left to right. For example in the male row, S1 and S2 have similar numbers of respondents; S12 contains fewer respondents than S7; S8 contains the highest number of respondents.

Variables		**Percentage (%)**	**Sample groups**
Gender (n=247)	Male (96)	39	S1S2, S12, S7, S10, S9, S8
	Female (151)	61	S4, S6, S5, S11, S3
Age Class (n=241)	15 – 25 (24)	10	S7, S8, S12, S10
	26 – 35 (43)	17.8	S8, S11, S12, S10
	36 – 45 (35)	14.5	S6, S2, S5, S1, S4
	46 – 55 (47)	19.5	S3, S9, S2, S5, S1, S4
	56 – 65 (73)	30.3	S6, S9, S2, S5, S1, S4
	> 65 (19)	7.9	S12, S10
For age class, only 241 out of 247 responded. The remaining 6 either did not know or did not respond.			

5.2.2 Period of residence in the study area

The length of stay in the study area can offer an indication of rates of migration or emigration. The overall majority of respondents (158/247) = (64%) have lived in the study area for more than thirty years. Table 5.2 shows that the majority of people who have lived in the area for less than 5 years are situated in S4 (Mlambongwenya section 7).

Table 5.2: Period of residence in the study area (based on interpretation of ordination diagram)

Variables (n=219)	**Percentage (%)**	**Sample groups**
< 5 years (9)	4.1	S7S1, S4
6-10 years (7)	3.2	S8, S11, S10
11-20 years (20)	9.1	S2S12, S9, S6, S8, S10
21 – 30 (25) and >31 years (158)	83.6	S3, S5, S7S1, S4
Out of 247 only 219 responded. The remaining 28 either did not respond or did not know.		

5.2.3 Distance between individual homes and the river and pan

The distance between individual homes and the river and pan can influence the use of resources. For example, those close to these water resources might be more dependent (for cultivation, fishing and other resource harvesting) than those that are further away. Results show that the majority of the respondents live closer to the pans than the river (Table 5.3). During periods when the pans are dry or too salty, some must walk long distances to reach the river for fresh water (e.g. the majority in S3, Mboza section 3).

Table 5.3: Distance between individual homes and river and pan (based on interpretation of ordination diagrams). Close = less than 100 m; Far = between 100 and 1 km; Very far = more than 1 km.

Variables		**Percentage (%)**	**Sample groups**
Distance from house to the river (n=219)	Close (71)	32.4	S5, S11, S4, S6, S12, S10
	Far (70)	32	S5, S11, S4, S6, S12, S10
	Very far (78)	35.6	S8, S7, S9, S2, S1, S3
Only 219 out of 247 responded. The other 28 either did not respond or did not know.			
Distance from house to the pan (n=210)	Close (93)	44.3	S9, S12, S10, S5, S7, S8
	Far (60)	28.6	S9, S12, S10, S5, S7, S8
	Very far (57)	27.1	S4, S6, S11, S3, S1, S2
Only 210 out 247responded. The other 37 either did not respond or did not know.			

Gender analysis revealed that, on average, more female respondents perceived the river and pans to be very far away while men perceived it to be in the close-far range (Figure 5.2). This can be attributed to the fact that women utilize these resources more often than men. It was observed during visits that women spent many labour hours per day collecting drinking water, washing clothes, bathing (swimming), and cultivating food crops on the floodplain.

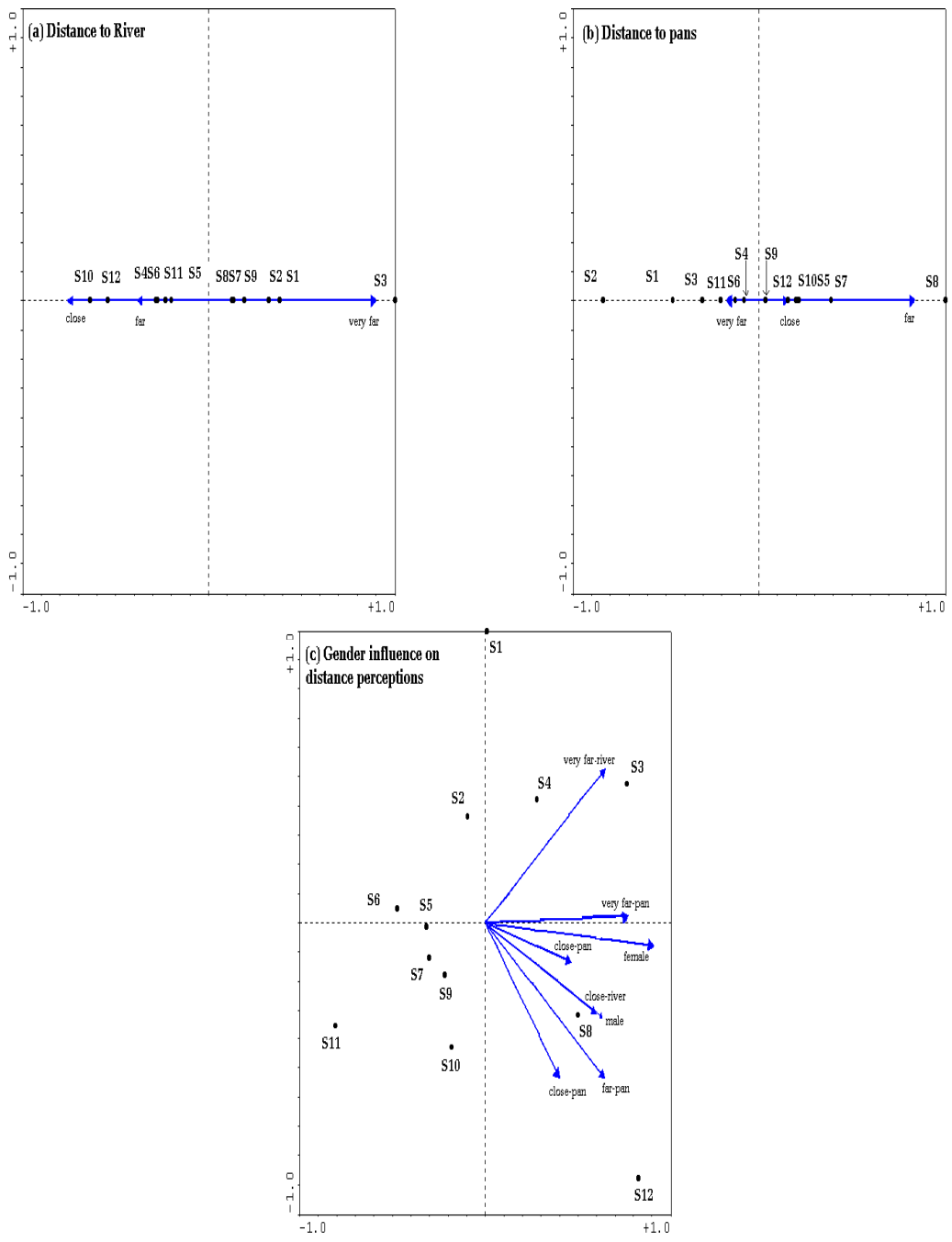


Figure 5.2: Perceptions of distance between homes and the (a) river; (b) pans; (c) the influence of gender on perceptions of distance.

5.2.4 Family size

Table 5.4 indicates how family size is distributed across the sample groups. Large families (> 16) reached maximum numbers in S12 (Ndumu), which is far downstream and less

developed, while the numbers of small families (<3) were highest in S2 (Mboza section 2), which is closer to the dam where urban and agricultural irrigation developments are based.

Table 5.4: Family size (based on interpretation of ordination diagram)

Variables (n= 247)	Percentage (%)	Sample groups
< 3 (13)	5.3	S8, S4, S5, S3, S2
4-5 (57)	23.1	S6, S7, S11, S10, S12
6-10 (105)	42.5	S8, S4, S5, S3. S2, S1
11-15 (42)	17	S6, S7, S11, S10, S9
> 16 (30)	12.12	S10, S9, S12

5.2.5 Land allocation

Indunas (sub-tribal chiefs) allocated the majority of land, followed by fathers, then the Inkosi (tribal chief) (Table 5.5). The majority of people allocated land by their fathers is in S3 (Mboza section 3). In some cases, respondents (26/247) indicated that they had allocated themselves land to cultivate without prior authorization by anyone. Government has not allocated land to anyone because the area is under a tribal authority.

Table 5.5: Land allocation

Variables (n= 194)	Percentage (%)	Sample groups
Inkosi (51)	26.3	S4, S5, S2, S1
Induna (74)	38.1	S10, S11, S8, S7, S9, S12
Father (69)	35.6	S4, S5, S6, S2, S1, S3
Government (0)	0	0
Out of 247 only 194 responded; however some indicated that they allocated themselves land without prior authorization.		

5.2.6 Occupation and source of income

This includes income from both the formal and the informal sectors. The formal sector comprises a formal job or an allowance from government such as a pension, a government grant for children or support grants from relatives. The informal sector includes temporary jobs such as farm labour and hawking - mainly crop produce and fish. The majority of respondents (99) are subsistence farmers, followed by those who are unemployed (38), labourers (32) and scholars (30) (see Table 5.6 below for details). For more information on the specific communities sampled, see Appendix C.2.

Earnings from the informal sector depend on the season when crop produce is available, which means that in some months there is no income. Most (58) respondents' monthly income is between R501 and R1000, followed by those who earn less than R500 (34), then from R1001 – R2000 (21) and lastly those who earn R2001 – R4000 (9). Most respondents

within the communities sampled (see Table 5.7) earn between R501 and R1001 per household. With respect to external sources of income, 46 respondents are pensioners, 35 receive grants from the government and state welfare and 7 depend on relatives who are working.

Table 5.6: Formal and informal occupation (@ means each)

	Formal					**Informal**			
Occupation	Respondents	Males	Females	**Total**	Occupation	Respondents	Males	Females	**Total**
Labourer	0	28	4	**32**	Subsistence farmers	15	32	52	**99**
No job	34	1	3	**38**	No jobs	5	0	0	**5**
Health workers	1	1	6	**8**	Hawkers	4	4	3	**11**
Contract workers	1	8	0	**9**	Shepherd	7	4	0	**11**
Schooling	0	16	14	**30**	Builders	0	4	1	**5**
Game ranger	0	5	0	**5**	Cleaners (house and yard)	0	4	7	**11**
Mine worker	0	6	0	**6**	Fishermen	1	3	0	**4**
Security	0	6	0	**6**	Shopkeepers	0	1	3	**4**
Drivers	0	4	0	**4**	Temporary jobs	2	4	0	**6**
Commercial farmer	0	2	1	**3**	-	-	-	-	**-**
Teachers	0	2	0	**2**	-	-	-	-	**-**
Temporary jobs	0	2	1	**3**	-	-	-	-	**-**
Sugar cane farmer	0	3	0	**3**	-	-	-	-	**-**
Male others: 1 @ (Taxi owner; Steel firm worker; Pastor; Researcher; Policeman; Forest worker; Plumber; Pensioner; Wiring)					Male others: 1 @ (Selling fish; Sugar cane grower; Traditional healer; Shoe maker; Carpenter)				
Female others; 1 @ (Sales woman; Maid; Weeder)					Female others: 1 @ (Sell cotton; Collect water; Trader; Community worker; Cooking)				

Table 5.7: Income from different sources

	Income formal/month						**Income informal/month**						**Other source of income**		
	< R500	**R501-R1000**	**R1001-R2000**	**R2001-R4000**	**R4001-R6000**	**> R6001**	**< R500**	**R501-R1000**	**R1001-R2000**	**R2001-R4000**	**R4001-R6000**	**> R6001**	**Pension**	**grant from Relative**	**Government grant**
MBOZA TOTALS	**5**	**7**	**3**	**2**	**0**	**0**	**1**	**7**	**3**	**0**	**0**	**0**	**9**	**3**	**7**
MLAMBO TOTALS	**7**	**13**	**3**	**1**	**1**	**0**	**2**	**2**	**2**	**0**	**0**	**0**	**8**	**1**	**6**
ZAMA-ZAMA TOTALS	**1**	**6**	**5**	**3**	**0**	**0**	**9**	**3**	**1**	**0**	**0**	**0**	**7**	**1**	**3**
LULWANE	**1**	**0**	**1**	**0**	**0**	**0**	**1**	**3**	**1**	**0**	**0**	**0**	**1**	**0**	**0**
BHEKABANTU TOTALS	**4**	**8**	**2**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**12**	**0**	**13**
NDUMU	**3**	**8**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**9**	**2**	**6**
TOTALS	**21**	**42**	**14**	**8**	**1**	**0**	**13**	**16**	**7**	**1**	**0**	**0**	**46**	**7**	**35**

When participants were asked whether they have jobs, only a few (99) said they were farmers. But when asked if they grow crops, respondents indicated that most (210/247) do so, out of which 55 and 54 respectively buy and sell what they produce (Table 5.8).

Therefore, these results support the fact that the floodplain community is mainly dependent on a subsistence farming economy. A smaller proportion of respondents also indicated dependence on a cash economy.

Table 5.8: Communities were asked whether they grow, buy or sell crops.

	Grow crop	**Don't grow crops**	**Sell crops**	**Buy crops**
Mboza (65)	52	13	19	11
Mlambongwenya (55)	53	2	14	10
Zama- Zama (43)	35	8	7	12
Lulwane (12)	11	1	7	4
Bhekabantu (26)	24	2	3	12
Ndumu (45)	35	10	5	5
TOTAL	**210 (85%)**	**36 (14.6%)**	**55 (22.3%)**	**54 (22%)**

5.2.7 Household roles

A gender analysis of roles and responsibilities shows that various household activities such as collecting and gathering, looking after the house, crop-growing activities and crop-growing decisions were undertaken mainly by women. Household decision-making, related to money, is taken mainly by men (see Table 5.9 and Appendix C.4)

Table 5.9: Household crop decisions

	Which crops to grow					**Where to grow crops**					**When to plant & harvest**					**Marketing crop produce**				
	Everyone	**Men**	**Boys**	**Women**	**Girls**	**Everyone**	**Men**	**Boys**	**Women**	**Girls**	**Everyone**	**Men**	**Boys**	**Women**	**Girls**	**Everyone**	**Men**	**Boys**	**Women**	**Girls**
Mboza	5	28	1	42	0	6	25	0	42	0	5	23	0	41	0	3	9	7	19	8
Mlambongwenya	3	25	0	32	0	2	24	0	31	0	2	21	0	32	0	2	20	0	23	0
Zama- Zama	4	9	0	27	2	4	9	0	28	3	4	7	0	28	2	3	4	0	23	2
Lulwane	2	4	0	9	1	2	3	0	8	1	2	3	0	8	1	1	3	0	6	1
Bhekabantu	5	6	0	18	0	4	6	0	19	0	5	6	0	18	0	2	3	0	9	0
Ndumu	2	10	1	41	3	3	8	0	41	3	2	8	0	39	3	3	6	0	38	3
TOTAL	**20**	**82**	**2**	**169**	**6**	**21**	**75**	**0**	**169**	**7**	**20**	**68**	**0**	**166**	**6**	**14**	**45**	**7**	**118**	**14**

It should be noted that some of the decisions taken concern joint ventures among family members. As a result the number of respondents will total more than 247.

5.2.8 Summary of community structures

From the above results it can be concluded that:

(i) More women (than men) were interviewed.

(ii) Large numbers of respondents were between the ages of 56 – 65.

(iii) Many people have lived in the area for more than 30 years, although there is an indication of recent (<5 years) immigrants.

(iv) Households are closer to pans than the river.

(v) On average many households have a large family size (6 – 10 individuals). Communities closer to developments upstream (e.g. urbanization and irrigation) report smaller family sizes compared to those further away from developments downstream.

(vi) Indunas (sub-chiefs) allocate land more frequently than Inkosi (chiefs). Once land has been allocated to an individual, he can sub-divide it further amongst his children. Many people did not seem to be aware of the fact that some land on the east and west side of the river was state-owned.

(vii) Many respondents are subsistence farmers; however, there are a few commercial farmers (sugarcane & cotton) and some are working in the formal sector. Many respondents earn between R500 – R1000 per month. External support grants come in largely as pensions.

(viii) Women mainly carry out household and crop-growing activities while men make decisions about how money is to be spent.

5.3 Resource use

Three areas of the floodplain (the river, pans and land) provide resources. The overall importance of various uses is illustrated in Table 5.10. The results show that the river is very important for resource use, followed by the pans and lastly the land (e.g. drilling a borehole on land to provide water). This is based on the largest number of respondents for each resource use. Gradients of variation in the levels of use in various communities sampled are shown in Table 5.11. For example, the majority of respondents who perceive the river to be very important come from S12 (Ndumu). Appendix C.3 shows details of the actual responses. Overall importance, in decreasing order, was accorded to drinking, bathing/swimming, livestock watering/grazing, crop cultivation/irrigation, plant and animal resources respectively, and cultural practices. Least important uses were those of water abstraction and purification for domestic use (e.g. collecting water from the river and boiling it before use to kill bacteria), waste disposal, effluents and sand mining. Although a question on fishing was omitted from the questionnaire, many respondents indicated that this was important.

Table 5.10: Quantification of floodplain resource use based on perceptions.

	River				Pan				Land			
	Don't know/ No response	Not important	Important	Very important	Don't know/ No response	Not important	Important	Very important	Don't know/ No response	Not important	Important	Very important
Drinking	39	25	35	148	166	17	22	42	224	7	4	12
Bathing	43	10	39	155	155	12	40	40	229	13	2	3
Swimming	68	11	34	134	167	12	29	39	232	11	2	2
Livestock watering	48	10	41	148	160	9	34	44	228	12	2	5
Livestock grazing	100	14	33	100	177	10	24	36	215	6	5	21
Cultivated crops	97	9	29	112	182	9	17	39	188	10	8	41
Water tubers	110	9	30	98	165	9	26	47	214	9	7	17
Grasses & reeds harvesting	122	11	23	91	173	10	24	40	210	8	8	21
Woodland	129	12	26	80	190	12	16	29	185	7	10	45
Bush meat	131	15	24	77	193	18	13	23	219	10	5	13
Cultural practices	115	14	25	93	183	12	21	31	223	15	6	3
Irrigation of crops	116	8	18	105	176	12	23	36	231	10	3	3
Abstracting & purifying water for domestic use	124	10	17	96	187	14	21	25	225	12	4	6
Domestic waste disposal	164	19	11	53	200	16	12	19	195	11	11	30
Industrial effluent	167	18	9	53	200	16	14	17	217	11	4	15
Sand mining	161	22	14	50	204	18	11	14	219	10	3	15

Table 5.11: Gradients of variation in levels of floodplain resource use in the various floodplain communities sampled

Variable		Sample Groups						
		Drinking	**Bathing & Swimming**	**Livestock Watering**	**Livestock Grazing**	**Cultivated Crops**	**Water Tubers**	**Reeds & Grasses**
River	**Don't know**	S7	S1, S7	S1	S3, S6	S1	S5, S3, S2	S12, S3
	Not important	S3	S5, S2, S3, S4	S2, S9, S5	S3, S7, S6	S12, S3	S5, S2	S9, S7, S6
	Important	S3, S8	S12, S10, S8, S9, S7	S10, S4, S3	S9, S10, S8	S5, S8, S4	S5, S3, S2	S4, S8
	Very important	S6, S9, S5, S1, S10, S4, S12	S11, S12, S10, S8, S9, S7	S10, S4, S3	S3, S2, S1, S12	S2, S5, S4, S3, S12	S12	S10, S12
Pan	**Don't know**	S7	S1, S7	S7, S1	S3, S6, S4	S1, S5, S8	S5, S3, S4	S4
	Not important	S10, S4	S12, S11, S6	S12, S6	S9, S5, S4	S10, S7, S5	S3, S2	S6, S2
	Important	S9, S5, S10, S4	S5, S3, S2, S4, S6	S10, S4, S3	S9, S5, S4	S2, S5, S8, S4	S5, S3, S2	S1, S10, S3
	Very important	S6, S5, S1, S12	S3, S2, S4, S6	S12, S6	S3, S2, S1, S12, S8	S10, S7, S1, S8, S4	S4, S6, S3, S2, S1	S4, S8
Land	**Don't know**	S10, S4,	S5, S3, S4	S4, S3	S3, S4	S4	S5, S3	S12, S3
	Not important	S3, S6	S5, S3, S2, S4, S6	S4	S6	S2, S4	S5, S3	S5
	Important	S3	S11	S4, S3	S6, S4	S5, S4	S4, S3, S2	S4
	Very important	S3	S1	S10, S3	S9, S5, S4	S10, S1, S5, S8, S4	S10, S4	S4, S8, S10

Variable		Sample Groups							
		Woodlands	**Bush meat**	**Cultural Practices**	**Irrigation of Crops**	**Abstract & Purify Water for Domestic Use**	**Domestic Waste Disposal**	**Industrial Effluent**	**Sand Mining**
River	**Don't know**	S9, S3	S1, S4	S3	S2, S4	S1	S6, S3, S2	S2, S3	S3
	Not important	S9, S3, S2	S10, S3	S7, S12	S5, S3	S3, S5	S3, S2	S2, S3	S9, S3
	Important	S3	S10, S3	S4, S8	S2, S3, S4	S8, S4	S4	S8, S3	S12, S6, S4
	Very important	S9, S3	S12, S8	S8, S10, S1, S12	S2, S4	S7, S8, S1, S4, S9, S12	S7, S12	S12, S8, S2, S5, S3	S1, S12, S6, S4
Pan	**Don't know**	S4, S10	S4	S5, S2, S3	S5, S3	S3, S5	S5, S4	S3, S5	S5, S3
	Not important	S9, S3	S3, S10	S4	S4	S2, S10, S6	S5, S4	S2, S3	S3
	Important	S3, S2	S12, S8, S2	S4	S5, S3	S3, S4, S5	S8	S2, S3	S10, S2
	Very important	S4, S7, S10	S12, S8, S2	S8, S10	S7, S9, S1, S8, S12	S7, S1, S4, S8	S6, S3, S2, S8	S12, S8	S7, S2
Land	**Don't know**	S3	S3	S4	S5, S3	S3, S5	S5, S4	S4	S5, S9, S3
	Not important	S5, S6, S4	S10, S3	S4	S5, S3, S4	S3, S5	S6, S3, S2	S3	S5, S3
	Important	S9, S3	S10	S10, S8	S3	S8	S9, S8	S10	S10
	Very important	S5, S6, S4, S10	S4	S12	S4	S12, S4	S10, S7, S12	S4, S9, S6	S12, S6, S4

Results of actual field observations of resource use (Table 5.12) are generally similar to the importance rating of such use based on perceptions.

Table 5.12: Quantification of floodplain resource use based on observation

	Frequency of activities observed at 43 different points along the floodplain in summer (December 2002)	**% of observations**
Livestock grazing	30	70
Water collection	11	26
Fishing	10	23
Washing around the river/pan	10	23
Swimming	7	16
People cultivating	6	14
Wild fruit collection	5	12
Wood collection	4	9
Sand collection	2	5

5.4 Stream flow perceptions

5.4.1 Flood timing perceptions

It was important to discover how the said communities perceive hydrological changes because resource productivity depends upon annual flooding of the floodplain system. The natural flooding patterns (timing, duration, and volume) were altered after the dam was built. Understanding changes in peoples' perceptions and their subsequent actions or attitudes should enable corrective measures to be put in place. In order to track changes in hydrological perceptions, communities were initially asked to state during which months of the year they received rainfall (see appendix C9). Responses for the various communities sampled in Figure 5.3 showed similar patterns regarding the measured rainfall to those established by Heeg and Breen (1982) where 80% falls between October and March. The total N value for rainfall perception is above 247, since some respondents indicated two months to be the period during which they receive rain. Communities were then asked about the timing of natural floods and the majority of responses showed that perceptions had mainly shifted from the natural patterns (i.e. a major flood in February followed by a relatively smaller flood in December) (Figure 5.4). However, there were few respondents who still remembered the natural flooding patterns.

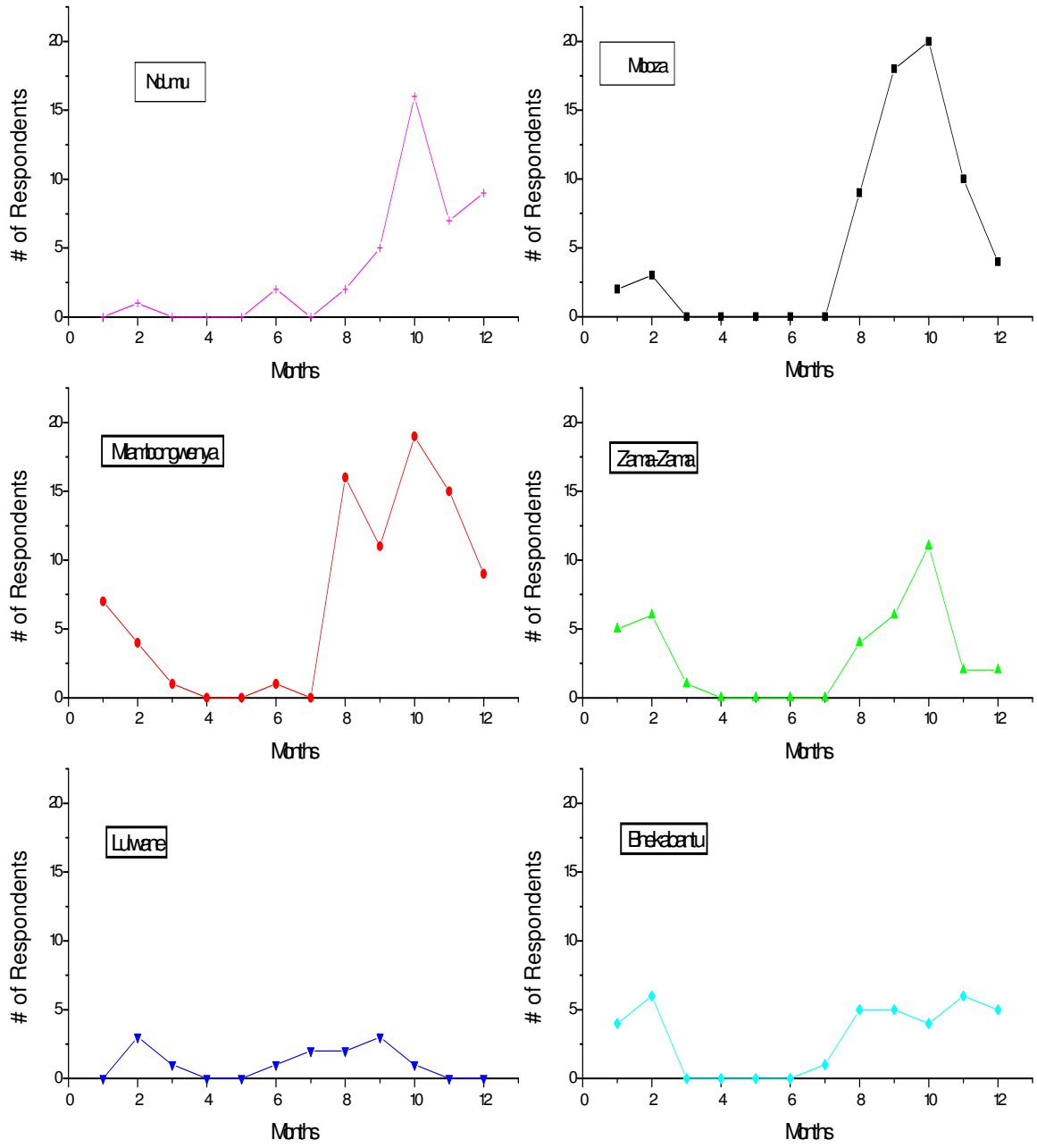


Figure 5.3: Rainfall perception (n value: Mboza = 66; Mlambongwenya = 83; Zama-Zama = 37; Lulwane = 13; Bhekabantu = 36; Ndumu = 42) Total N value = 271 (NB 1 – 12 on the X – axis represent months January - December). See Appendix C9 for data.

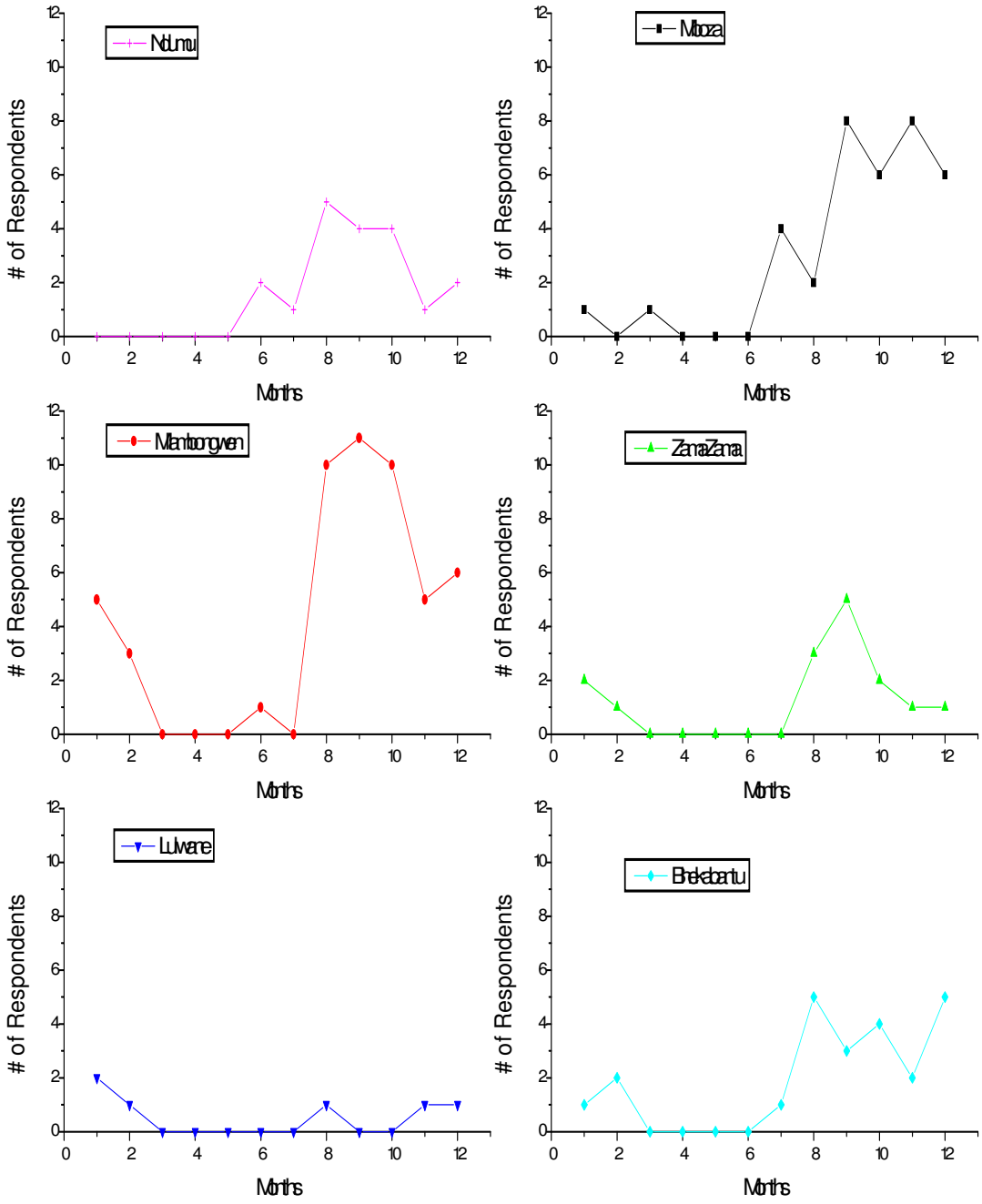


Figure 5.4: Natural flooding perceptions (n value: Mboza = 36; Mlambongwenya 51; Zama-Zama = 15; Lulwane = 6; Bhekabantu = 23; Ndumu = 19) Total N value=150 (NB 1 – 12 on the X – axis represent months January - December). See Appendix C9 for data.

Likewise, perceptions of artificial flooding revealed patterns similar to real values (Figure 5.5.a), i.e. variations in months (e.g., 2000 – no floods; 2001 – July; 2002 – September).

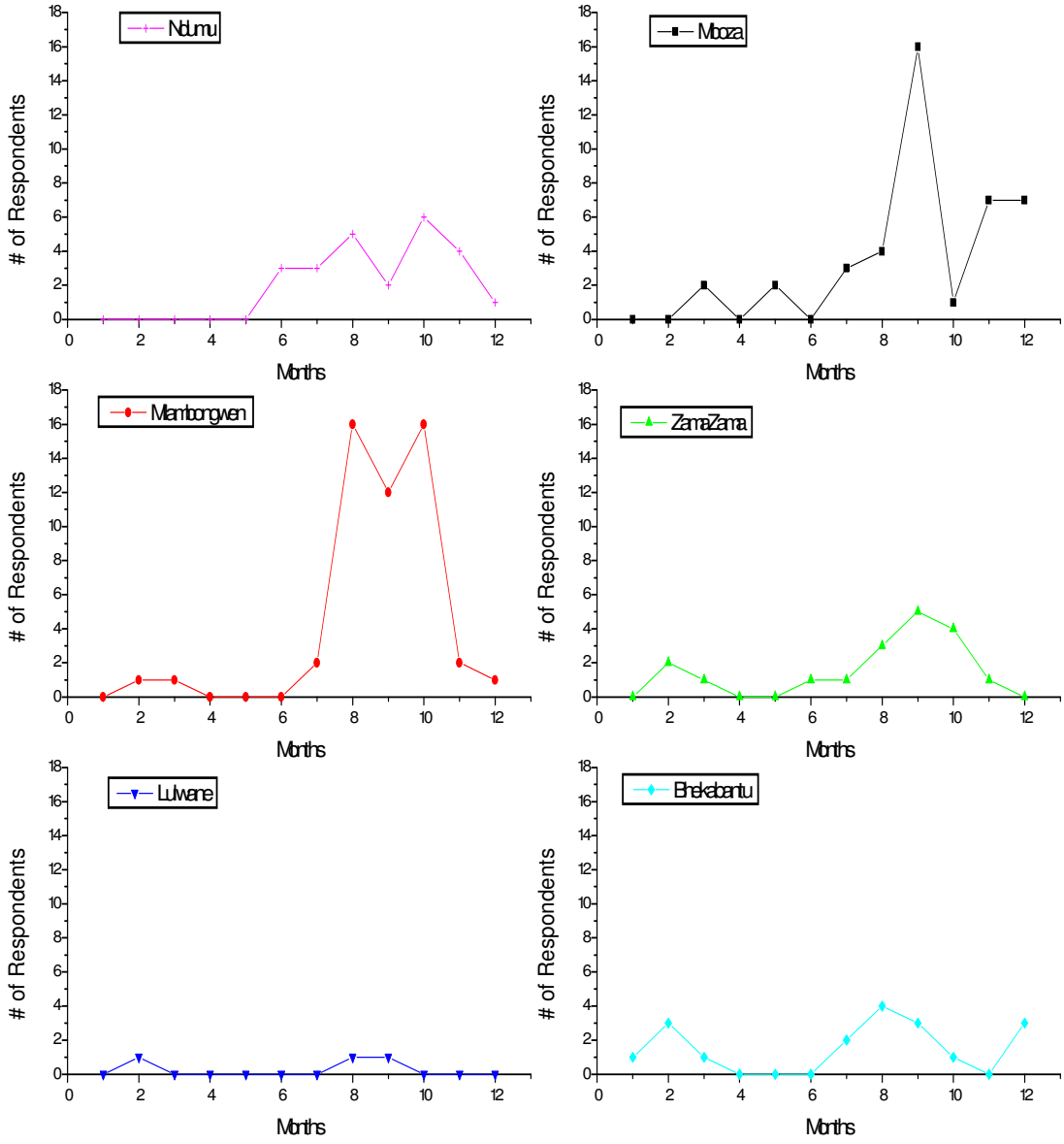


Figure 5.5 a: Artificial flooding perceptions (n value: Mboza = 42; Mlambongwenya = 51; Zama-Zama = 18; Lulwane = 3; Bhekabantu = 18; Ndumu = 24). Total N value = 156 (NB: 1 – 12 on the X – axis represent the months of January - December). See Appendix C9 for data.

Figure 5.5 b shows the perceptions of flood release after the dam was developed.

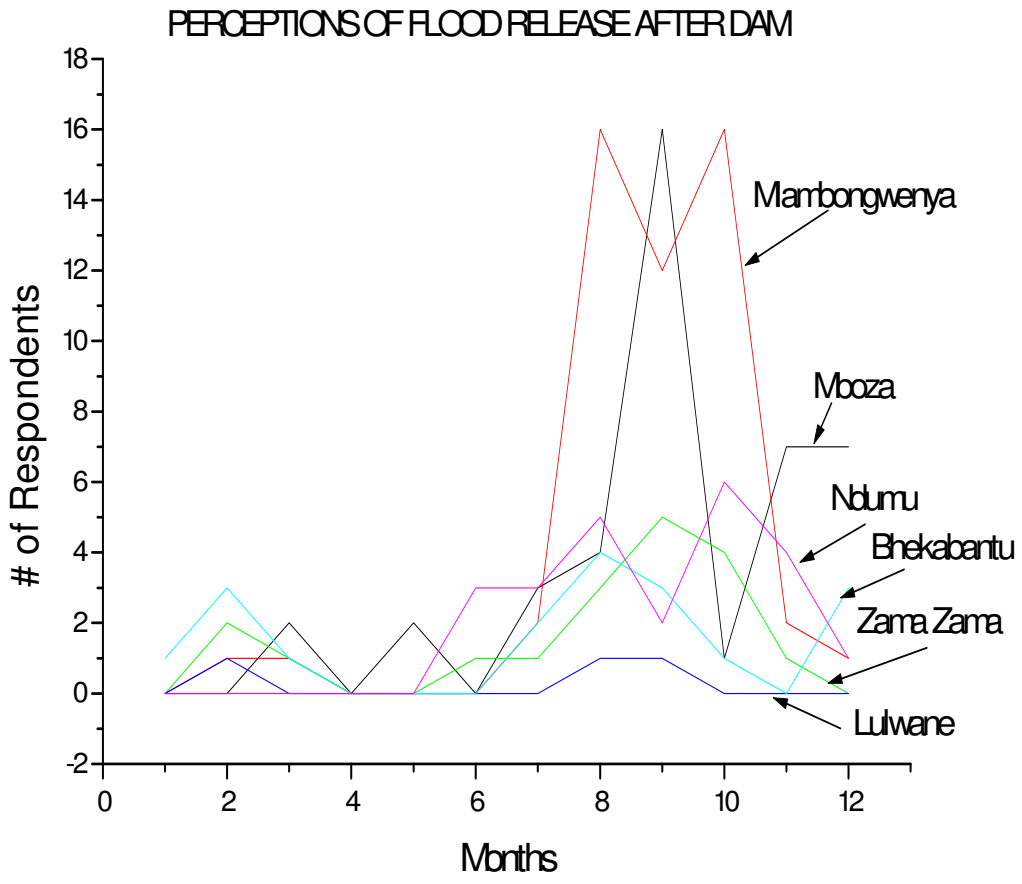


Figure 5.5 b: Artificial flooding perceptions (Combination of diagrams in Figure 5.5 a).

Finally, communities were asked to state what time of the year they desired (wanted) to receive artificial floods (Figure 5.6.a). Overall results show that: every month of the year was mentioned. Even within sections of a community, there were variations in desired months for floods. When sections within a community sample are grouped, results show that the majority of respondents in the Mlambongwenya, Zama-Zama, Bhekabantu and Ndumu communities want artificial floods in August (winter), whereas the Mboza, and Lulwane communities want artificial floods in September (spring).

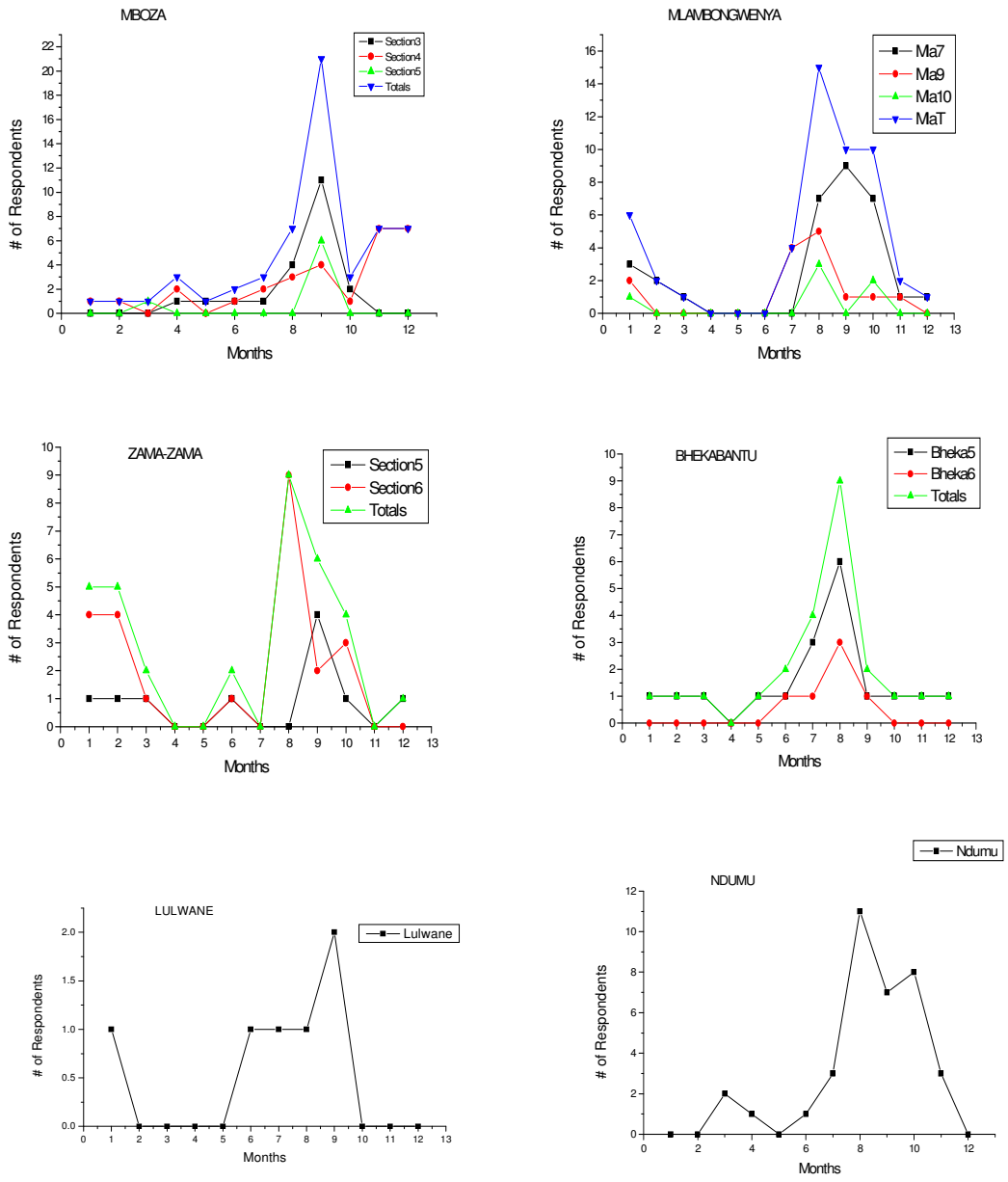


Figure 5.6.a: Artificial flooding 'wants' (n value: Mboza = 57; Mlambongwenya = 51; Zama-Zama = 34; Lulwane = 6; Bhekabantu = 24; Ndumu = 36). Total N value=208 (NB: 1 – 12 on the X – axis represent the months of January - December). See Appendix C9 for data.

When respondents' artificial flooding 'wants' are grouped according to the seasons (Table 5.13), spring is highest followed by winter, summer and lastly autumn. Within the seasons, flooding 'wants' decrease from September (highest), then August and October. For example, all community sections want flooding in September except Mlambongwenya (section 10).

Table 5.13: When would you really like to have artificial floods released by DWAF? (√= want flood release; X= no flood release)

	Spring			Summer			Autumn			Winter		
	Sept	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**
Mboza 3	√	√	X	X	X	X	X	√	√	√	√	√
Mboza 4	√	√	√	√	√	√	X	√	√	√	√	√
Mboza 5	√	X	X	X	X	X	√	X	X	X	X	X
Mlambongwenya 7	√	√	√	√	√	√	√	X	X	X	X	√
Mlambongwenya 9	√	√	√	X	√	X	X	X	X	X	√	√
Mlambongwenya 10	X	√	X	X	√	X	X	X	X	X	X	√
Zama – Zama 5	√	√	X	√	√	√	√	X	X	X	X	X
Zama – Zama 6	√	√	X	X	√	√	√	X	X	√	X	√
Lulwane	√	X	X	X	√	X	X	X	X	√	√	√
Bhekabantu 5	√	√	√	√	√	√	√	X	√	√	√	√
Bhekabantu 6	√	X	X	X	X	X	X	X	X	√	√	√
Ndumu	√	√	√	X	X	X	√	√	X	√	√	√
Months Total √	**11**	**9**	**5**	**4**	**8**	**5**	**6**	**3**	**3**	**7**	**7**	**10**
Seasons Total √	**25**			**17**			**12**			**24**		
MonthsTotal X	**1**	**3**	**7**	**8**	**4**	**7**	**6**	**9**	**9**	**5**	**5**	**2**
Seasons Total X	**11**			**19**			**24**			**12**		

When artificial flood timing 'wants' are compared with natural seasonal flood timing, there is a distinct shift in attitude from natural summer floods to spring and winter floods (Figure 5.6. b). This fact is central to the current conflicts within floodplain communities over flood releases.

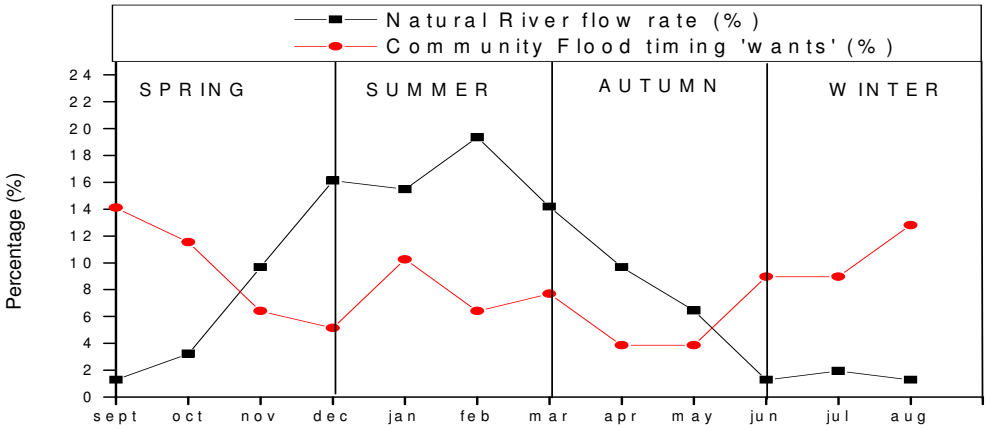


Figure 5.6.b: Artificial flood timing 'wants' grouped according to seasons and compared with natural flooding times based on river flow rates.

5.4.2 Flood timing 'wants' based on user groups

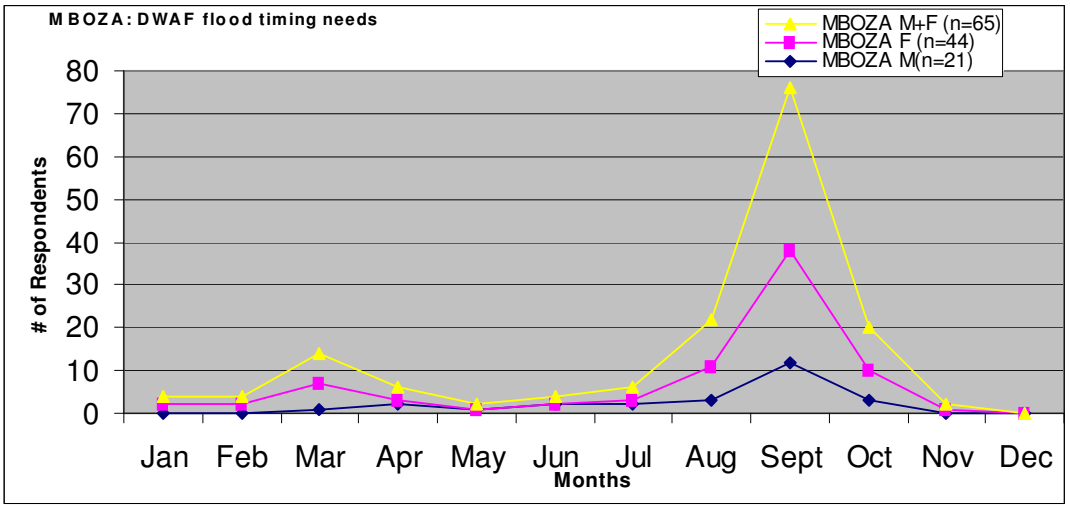
When respondents, artificial flood timing 'wants' are grouped according to various user groups namely:

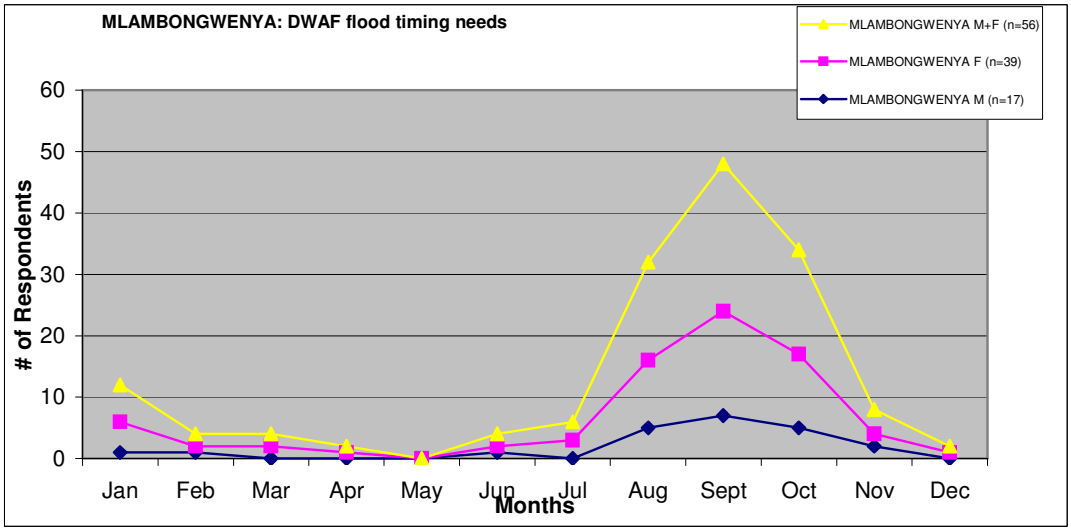
- Gender
- Crop cultivators
- Livestock owners
- Fishing
- Household activities (e.g., collecting water),

gender analysis showed that flood timing 'wants' expressed by men and women are the same for all the communities sampled (see Figure 5.7). For flood timing 'wants', based on activities (user groups), Figure 5.8 shows that the majority of respondents are involved in more than one activity – mainly crop cultivation and any other activity. Crop cultivation is the major activity that determines the flooding period. For other specific activities on the floodplain, the majority of respondents indicate that they prefer floods to be released around late winter (August) and early spring (September). A few respondents also indicate that they would like flooding around summer (December, January and February) and early autumn (March). These flood-timing wants do not resemble the natural flooding system.

5.4.3 Summary of Stream flow perception

The rainfall and natural flooding patterns perceived by communities generally mimic those of nature where 80% of rain falls between October and March, and natural flood timing exhibits two peaks – a small peak around October/November (i.e. towards the end of spring) and a slightly bigger peak around January/February (i.e. in summer). However, the desired flood timing patterns (wants) reported by the majority of respondents indicate significant shifts away from the natural flood timing patterns. For example, at the community level, the majority (4 out of 6) communities want floods in August (late winter) and the rest (2 out of 6) in September (early spring). At the individual level, the majority want floods in September (spring) followed by August (winter). This pattern does not change within the various user groups (gender, farmers, livestock owners, fishing and household activities). It must be noted that few individuals desire the natural summer flooding pattern.





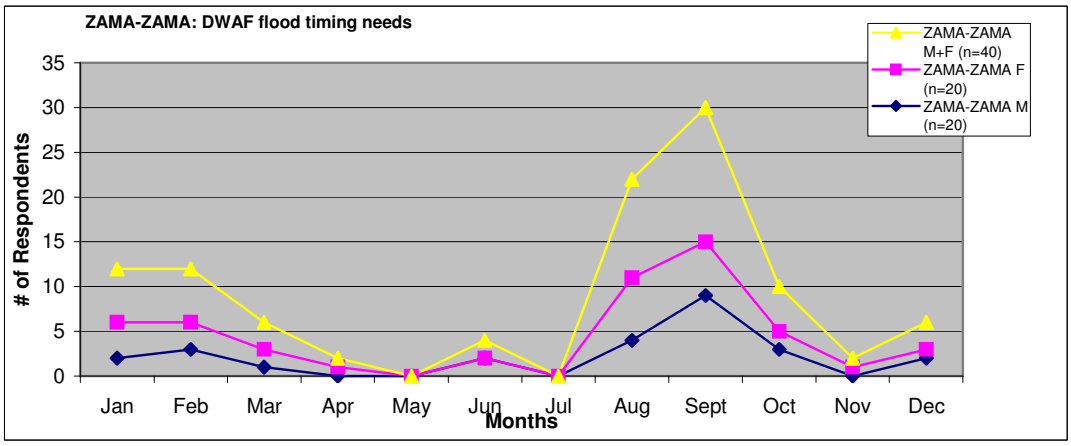
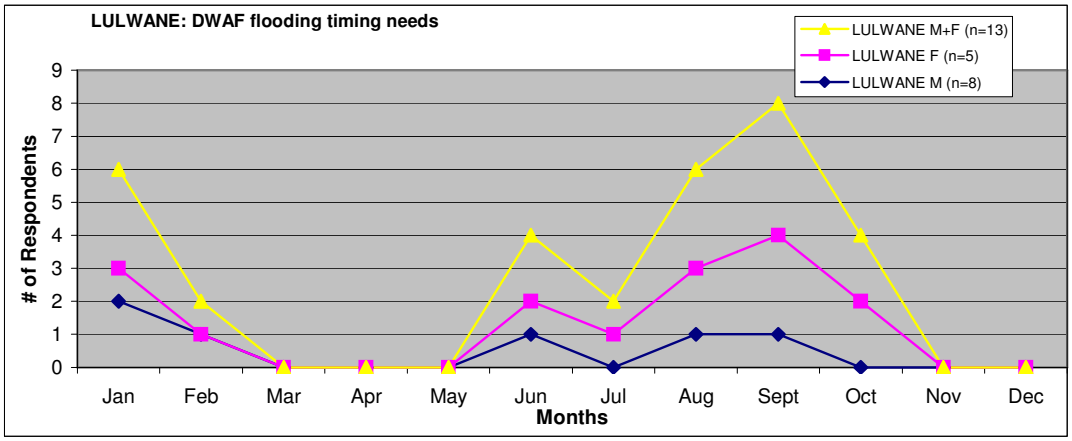
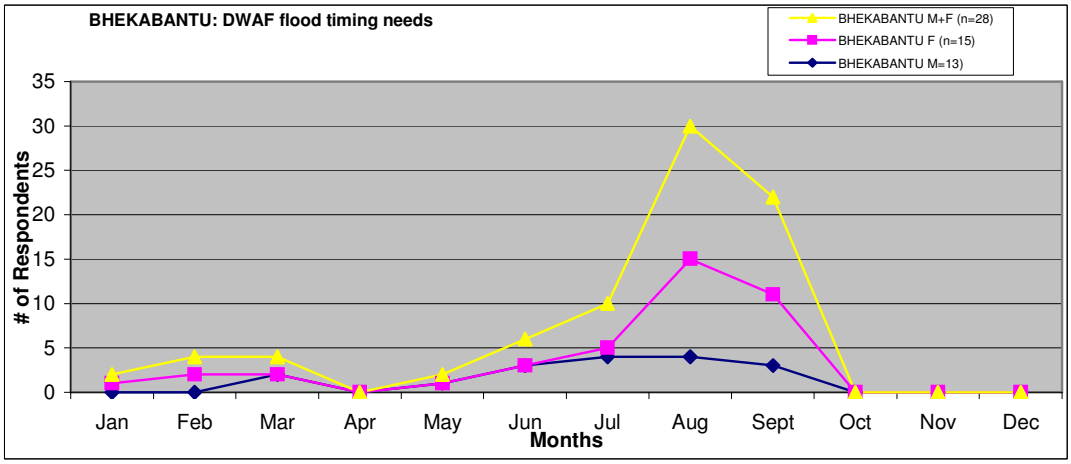


Figure 5.7: Flood timing wants based on gender (NB: n is the number of respondents, and in some cases they mentioned two or more months).





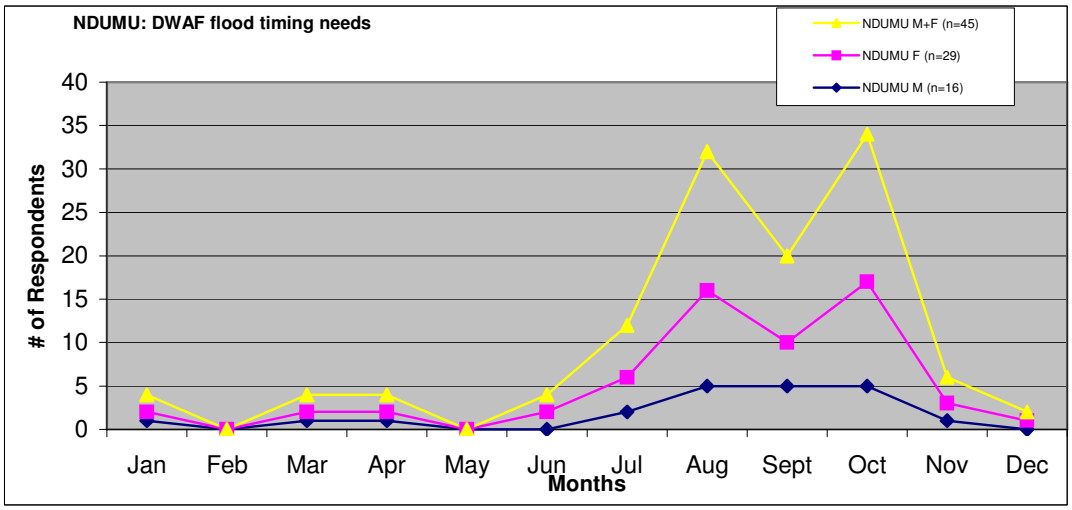
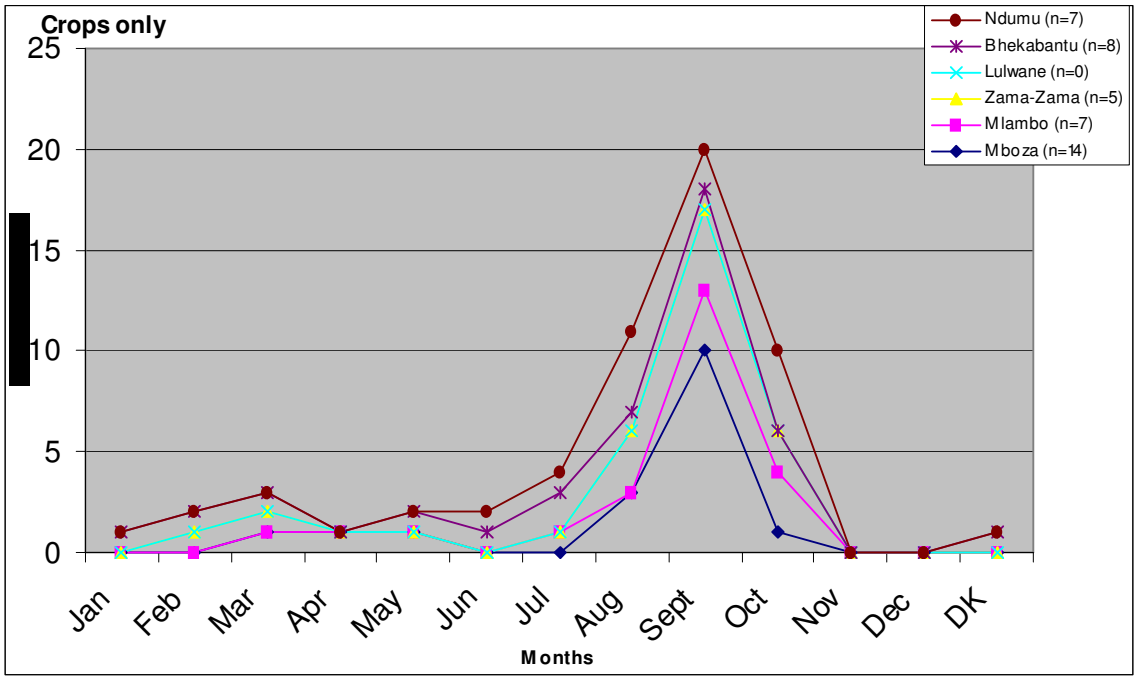


Figure 5.7 (continued): Flood timing wants based on gender. (NB: n is the number of respondents, and in some cases they mentioned two or more months).



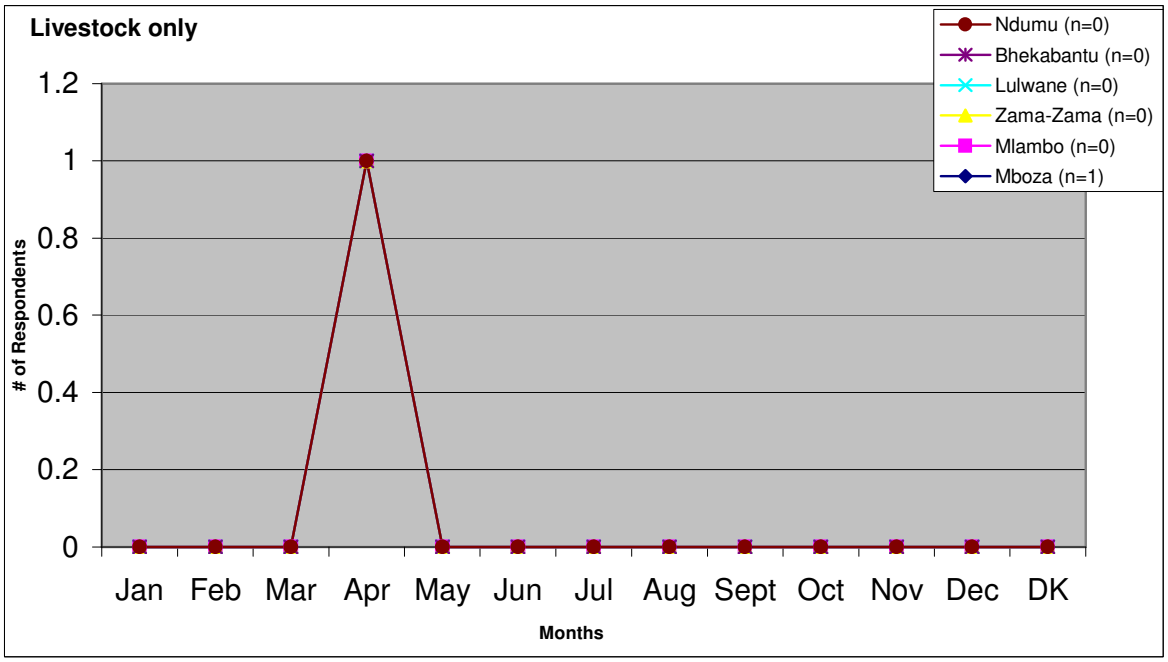
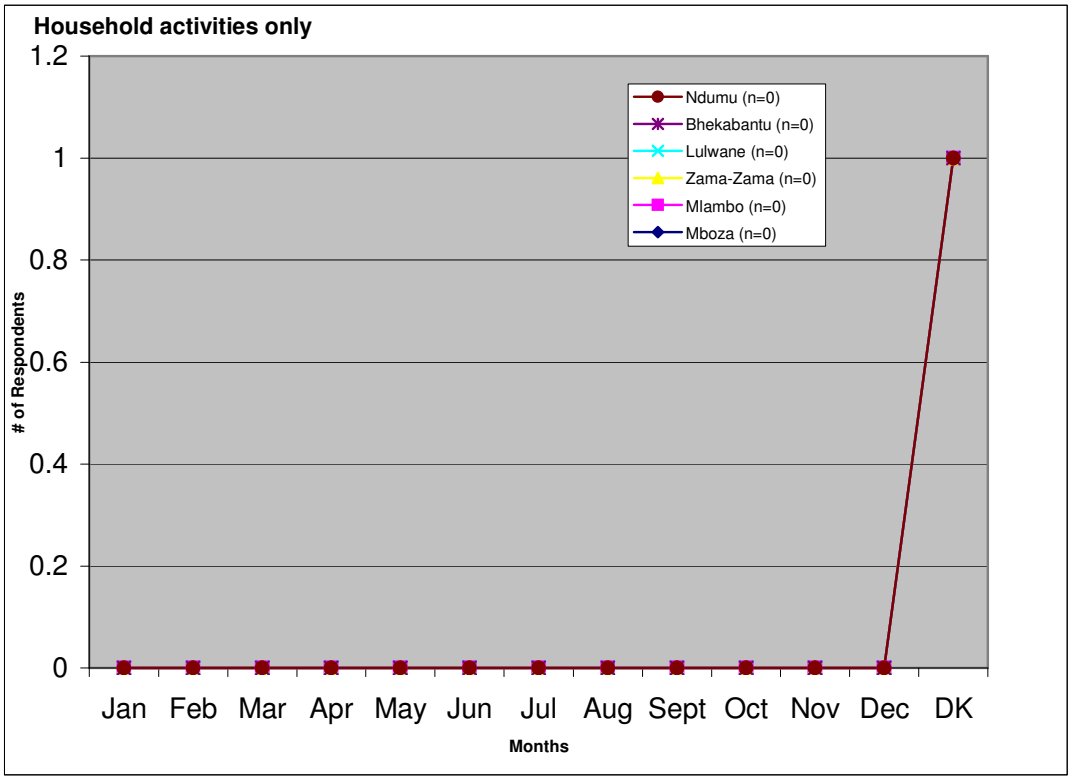


Figure 5.8: Flood timing wants based on user groups. (NB: n is the number of respondents, and in some cases they mentioned two or more months. DK means don't know).



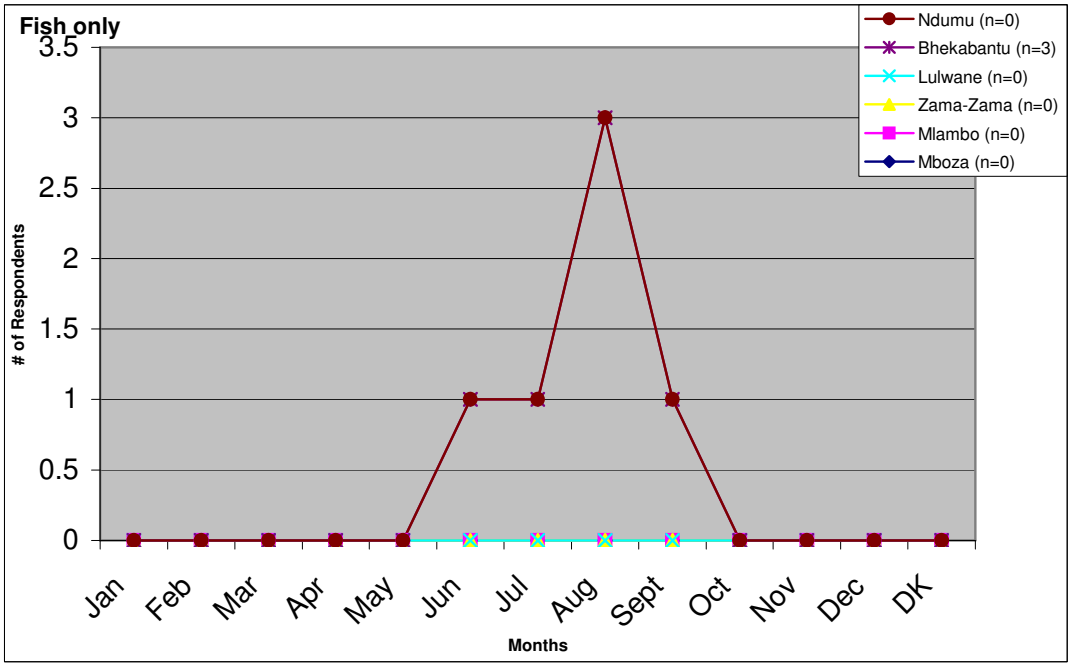
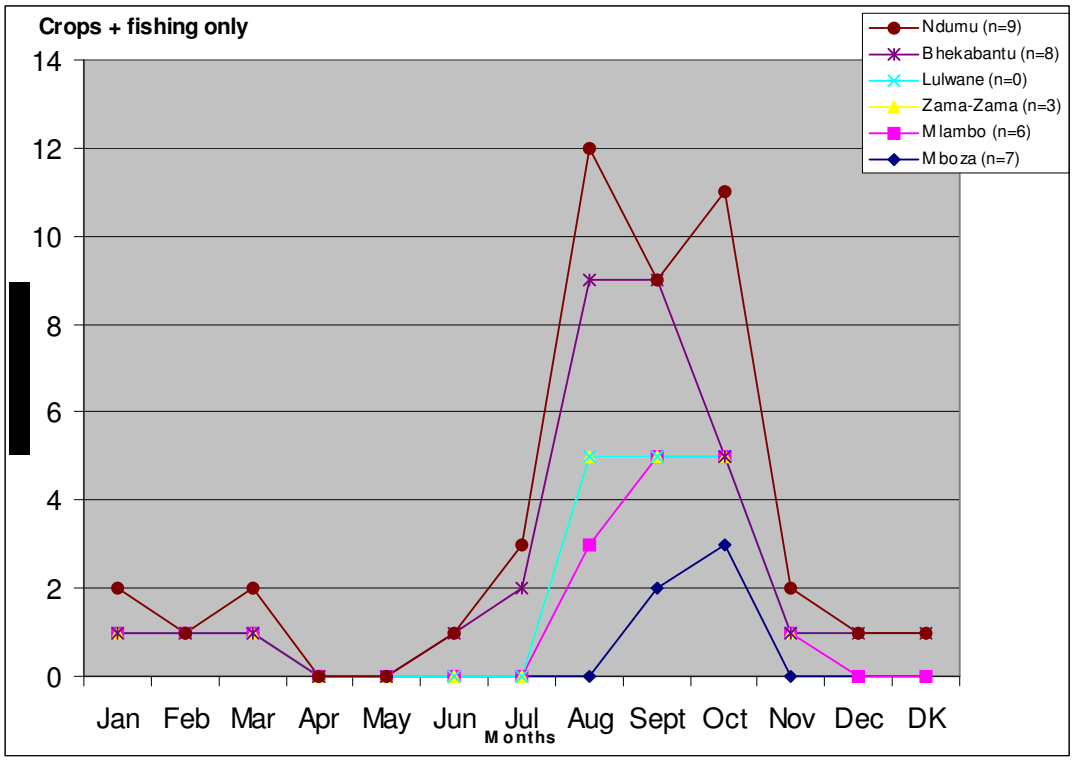


Figure 5.8 (continued): Flood timing wants based on user groups. (NB: n is the number of respondents, and in some cases they mentioned two or more months. DK means don't know).



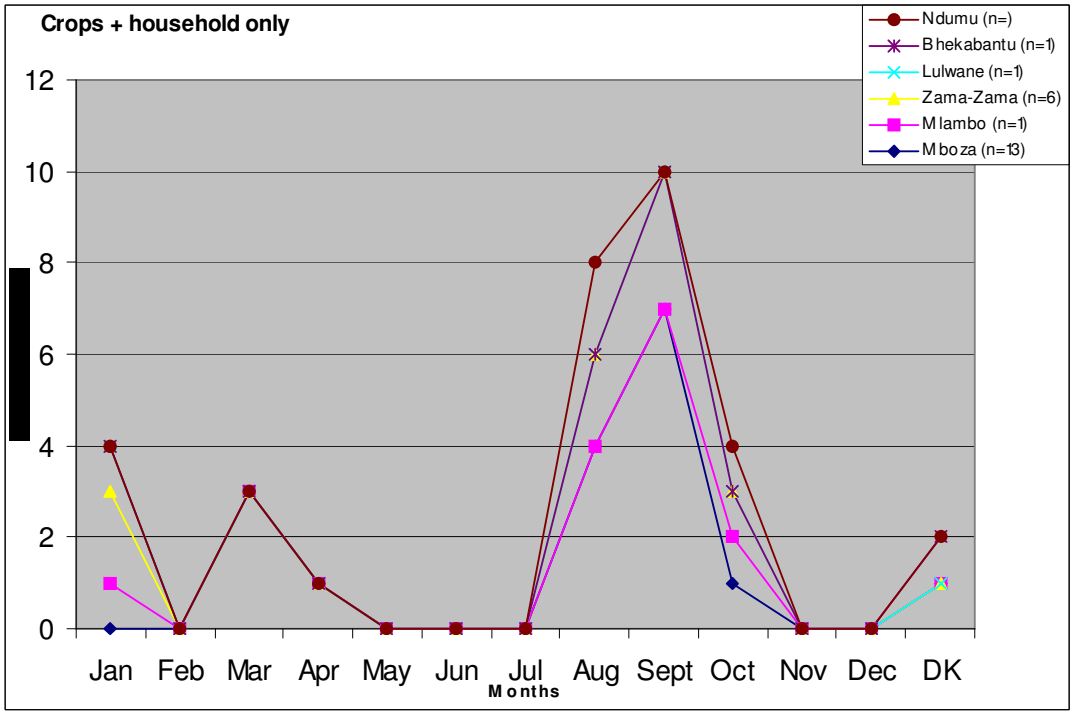
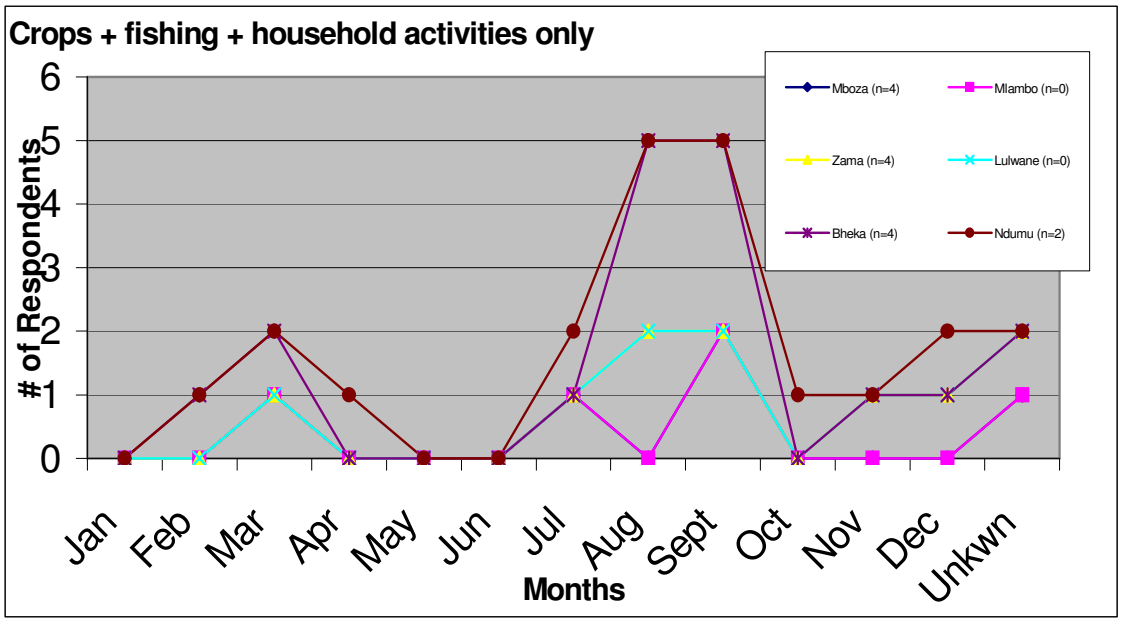


Figure 5.8 (continued): Flood timing wants based on user groups. (NB: n is the number of respondents, and in some cases they mentioned two or more months. DK means don't know).



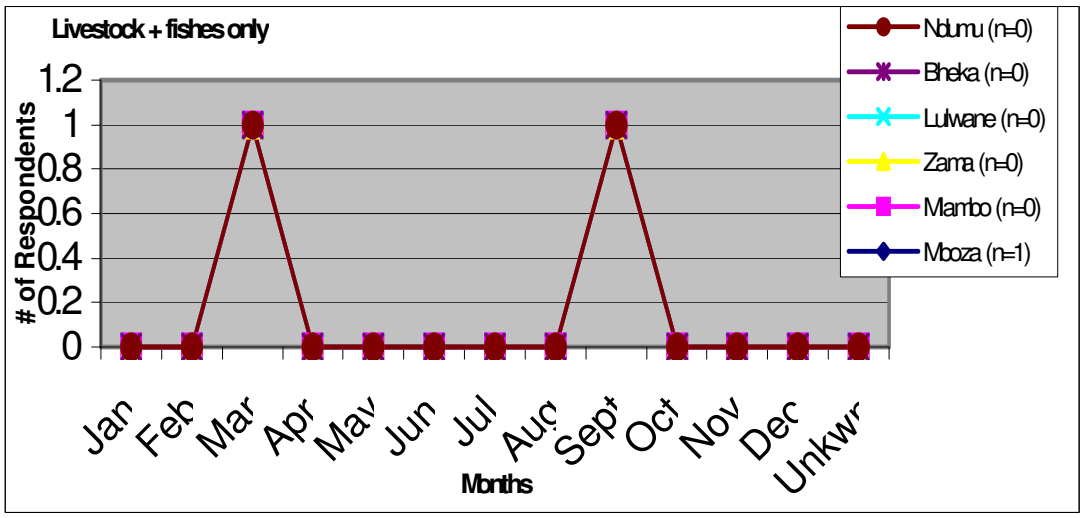
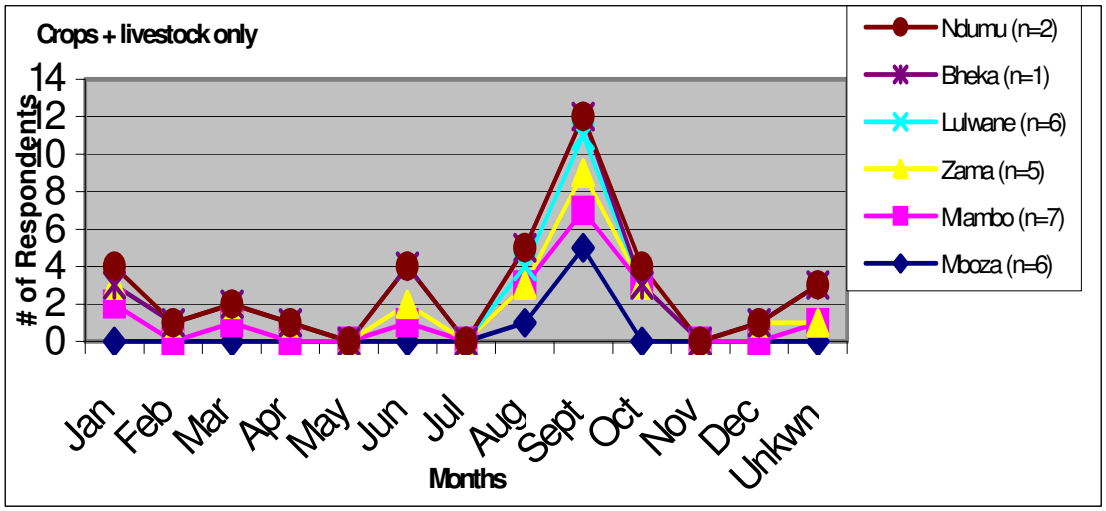


Figure 5.8 (continued): Flood timing wants based on user group. (NB: n is the number of respondents, and in some cases they mentioned two or more months).



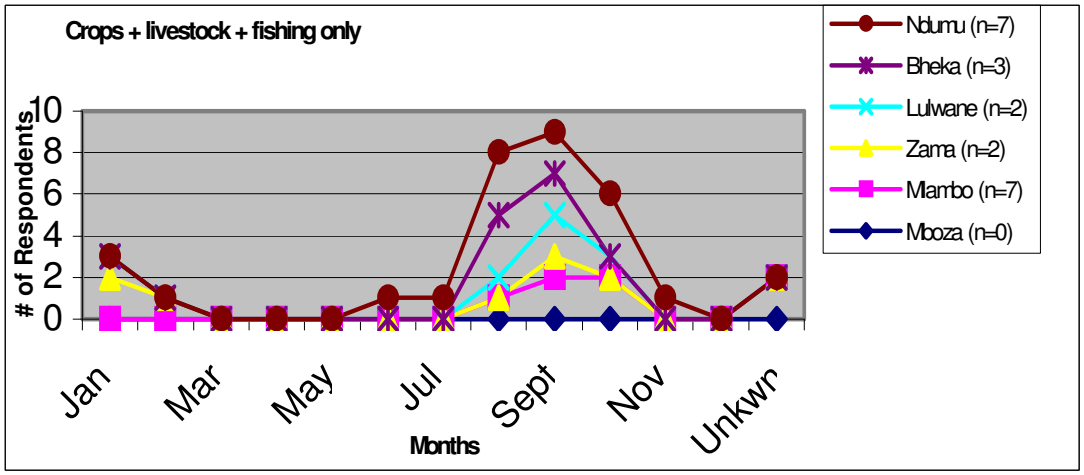
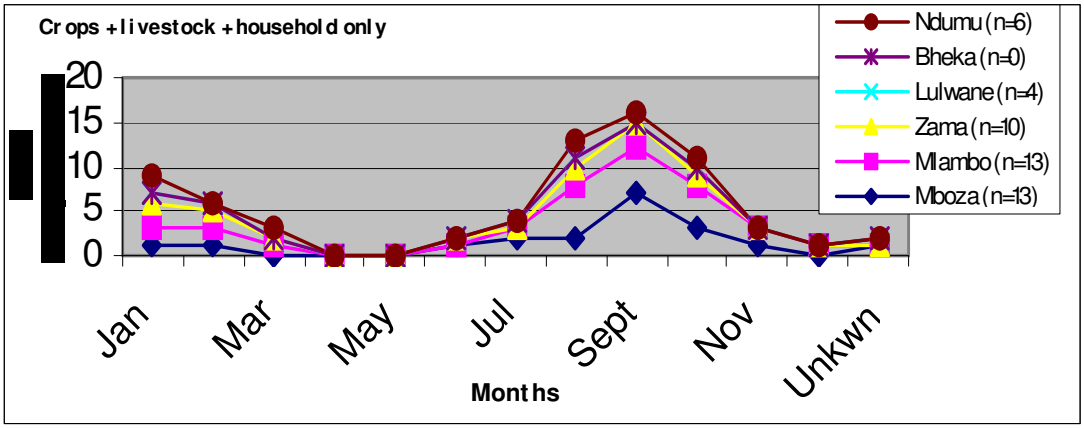


Figure 5.8 (continued): Flood timing wants based on user group. (NB: n is the number of respondents, and in some cases they mentioned two or more months).



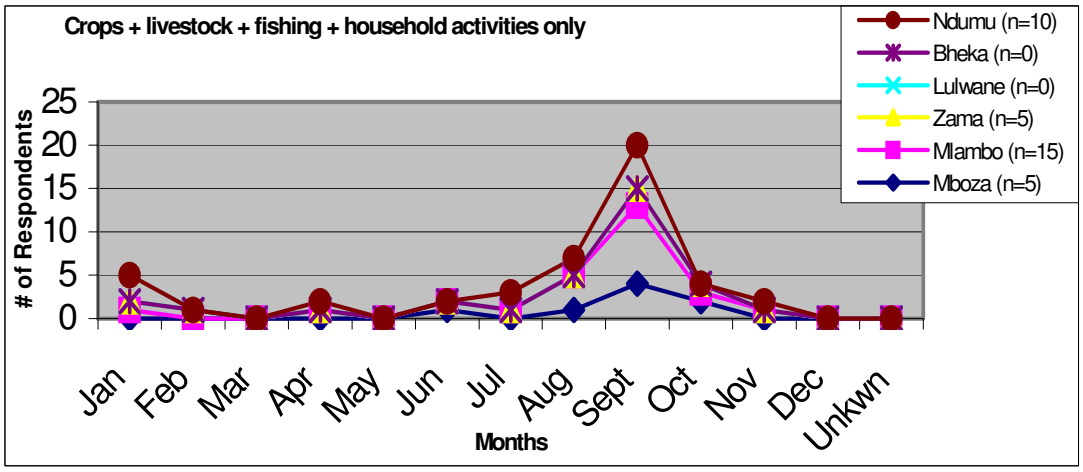


Figure 5.8 (continued): Flood timing wants based on user group. (NB: n is the number of respondents, and in some cases they mentioned two or more months.)

5.4.4 Impact of flooding on pans, cultivated and grazing areas

When asked whether it is important for floods to fill up pans, cultivated areas and grazing fields, a large number of respondents (pans - 192; cultivated areas – 184 and grazing fields – 156) in each of the sampled areas indicated that this is very important (Table 5.14).

Table 5.14: Impact of flooding on uses within pans, cultivated areas and grazing fields

	Pans				Cultivated area				Grazing fields			
	Don't know/ No response	Not important	Important	Very important	Don't know/ No response	Not important	Important	Very important	Don't know/ No response	Not important	Important	Very important
Mboza	9	**3**	**8**	**44**	**4**	**4**	**12**	**44**	**11**	**5**	**11**	**37**
Mlambongwenya	6	**2**	**4**	**43**	**1**	**0**	**3**	**51**	**8**	**2**	**4**	**41**
Zama-Zama	5	**1**	**5**	**32**	**5**	**0**	**6**	**32**	**10**	**0**	**4**	**29**
Lulwane	1	**0**	**1**	**11**	**1**	**1**	**0**	**11**	**1**	**0**	**0**	**12**
Bhekabantu	0	**3**	**2**	**21**	**2**	**2**	**11**	**11**	**11**	**8**	**3**	**4**
Ndumu	1	**1**	**2**	**41**	**1**	**2**	**7**	**35**	**3**	**1**	**8**	**33**
TOTALS	22	**10**	**22**	**192**	**14**	**9**	**39**	**184**	**44**	**16**	**30**	**156**

However, the majority of respondents (pans – 90; cultivated areas – 84; grazing fields – 80) indicated that DWAF flood releases only fill up these areas rarely (Table 5.15).

Table 5.15: DWAF flooding perceptions

	Pan				Cultivated area				Grazing fields			
	No idea	Rarely	Sometimes	**Always**	No idea	Rarely	Sometimes	Always	No idea	Rarely	Sometimes	Always
Mboza	13	24	16	11	15	20	16	13	27	19	14	4
Mlambongwenya	4	14	17	20	2	11	21	21	7	14	15	19
Zama-Zama	10	11	14	8	10	13	11	8	14	11	12	6
Lulwane	1	5	4	2	1	5	4	2	1	6	3	2
Bhekabantu	2	17	5	2	4	14	7	1	17	7	1	1
Ndumu	6	19	14	6	7	21	10	7	7	23	9	6
TOTALS	**36**	**90**	**70**	**49**	**39**	**84**	**69**	**52**	**73**	**80**	**54**	**38**

The following represent some of the verbatim reasons why respondents said that it is important for these areas to be flooded.

- Pans: are close to homesteads and water is collected for household use. We get fresh water for drinking and household use activities. Fish harvesting increases. Pans are important for livestock watering and grazing, for the irrigation of crops cultivated closely and for additional harvesting of natural resources such as water lily tubers (Nymphaea) and water chestnuts (Trapa), known locally as *Madumbe* and *Mazibu* for food, reeds (Phragmites species) and grass for crafts making. If

the pan dries up or the water becomes salty, we have to walk for three hours (about 5 Km) to and from the river in order to get fresh water. Also sicknesses such as cholera and diarrhoea increase.

- Cultivated area: flooding soaks the land so that cultivation becomes easy. Soil fertility is replenished. With good flooding we are assured of good crop production.
- The grazing fields: receding floods stimulate the growth of meadow grasses (e.g. cynodon dactylon), which are loved by cattle.

5.4.5 Impacts of dam hydraulics on the system

The majority of respondents, both at the community section level and at the overall floodplain community level, agree that a significant change have been observed before and after the dam was built. Overall impacts appear to be qualitatively significant (Table 5.16. a&b). For example, pans filling up with soil (140); productivity of cultivated land decreasing (168); productivity of grazing areas decreasing (158); the main river channel becoming narrow (143); the river edge becoming very steep (142); and the river bed becoming deeper (123).

Table 5.16.a: Significant changes on flooding observed before and after the dam

	Pan filling up with soil				**Pans drying up quickly**				**Productivity of cultivated land decreasing**				**Productivity of grazing areas decreasing**			
	No idea/ No response	**Disagree**	**Agree slightly**	**Agree**	**No idea/ No response**	**Disagree**	**Agree slightly**	**Agree**	**No idea/ No response**	**Disagree**	**Agree slightly**	**Agree**	**No idea/ No response**	**Disagree**	**Agree slightly**	**Agree**
Mboza	21	3	8	32	24	3	4	33	10	9	1	44	20	7	3	34
Mlambongwenya	8	9	0	38	2	7	3	43	2	7	7	39	4	3	8	40
Zama-Zama	4	12	7	20	5	4	4	30	7	5	1	30	6	4	1	32
Lulwan	1	3	2	6	0	0	1	11	1	0	1	10	1	0	0	11
Bhekab	10	1	2	13	4	5	6	11	12	5	3	6	22	2	1	1
Ndumu	0	13	1	31	0	5	1	39	2	2	2	39	0	3	2	40
TOTAL	**44**	**41**	**20**	**140**	**35**	**24**	**19**	**167**	**34**	**28**	**15**	**168**	**53**	**19**	**15**	**158**

Table 5.16.b: Significant changes in terms of flooding observed before and after the dam

	Main river channel becoming narrow				River edge becoming very steep				River bed becoming deeper			
	No idea/ No response	Disagree	Agree slightly	Agree	No idea/ No response	Disagree	Agree slightly	Agree	No idea/ No response	Disagree	Agree slightly	Agree
Mboza	28	8	2	26	22	7	11	24	31	8	6	19
Mlambo	8	4	4	39	13	3	4	35	13	8	2	32
Zama-Zama	12	3	2	26	8	3	3	29	9	4	4	26
Lulwane	1	2	1	9	1	2	1	8	3	3	1	6
Bhekabant	11	7	1	7	12	6	1	7	12	5	5	4
Ndumu	5	4	0	36	1	3	4	39	4	2	3	36
TOTALS	**65**	**28**	**10**	**143**	**57**	**24**	**24**	**142**	**72**	**30**	**21**	**123**

When asked how long the pans, cultivated and grazing areas should remain flooded or be in contact with the river in a year (Table 5.17), the majority did not respond, as they did not know. However, of those who responded, a large number (18), (10) and (10) for pans, cultivated areas and grazing areas respectively, indicate that in the past these areas had been in contact with the river for between 2 and 4 weeks a year. Most people do not know about the past situation and as a result they did not respond. At present, most respondents (16) indicated that for between 2 and 4 weeks in a year, the pans are in contact with the river. For cultivated areas and grazing areas, most respondents (13) and (11) respectively, indicate that during between 1 and 2 weeks these areas are in contact with the river in a year. For the future, most respondents indicate that they do not know how long these areas should remain flooded. However, among those who responded, most indicate that it should be less than 2 weeks, for pans (4); cultivated areas (8) and grazing areas (5).

Table 5.17: How long should the pans, cultivated areas and grazing fields remain flooded or be in contact with the river in a year?

PANS															
	Past					**Present**					**Future**				
	1–2 weeks	2-4 weeks	3 months	6 months	Most	1-2 weeks	2-4 weeks	3 months	6 months	Most	1-2 weeks	2-4 weeks	3 months	6 months	Most
Mboza	-	2	0	1	4	3	5	2	2	2	0	0	-	0	0
Mlambongwnya	-	12	0	0	0	9	7	0	0	0	3	0	-	0	0
Zama	-	2	0	0	0	0	2	0	0	0	0	2	-	0	0
Lulwane	-	1	0	0	0	1	0	0	0	0	1	0	-	0	0
Bhekabantu	-	0	1	2	0	0	0	1	1	0	0	0	-	1	1
Ndumu	-	1	0	1	3	1	2	0	1	1	0	0	-	0	0
TOTAL	**-**	**18**	**1**	**4**	**7**	**14**	**16**	**3**	**4**	**3**	**4**	**2**	**-**	**1**	**1**

Table 5.17 (continued): How long should the pans, cultivated areas and grazing fields remain flooded or be in contact with the river in a year?

CULTIVATED AREAS															
	Past					**Present**					**Future**				
	1-2 weeks	**2-4 weeks**	**3 months**	**6 months**	**Most**	**1-2 weeks**	**2-4 weeks**	**3 months**	**6 months**	**Most**	**1-2 weeks**	**2-4 weeks**	**3 months**	**6 months**	**Most**
Mboza	0	0	-	-	4	7	3	-	-	3	0	0	-	-	-
Mlambongwnya	0	8	-	-	0	8	5	-	-	0	5	0	-	-	-
Zama	1	1	-	-	0	2	0	-	-	0	1	1	-	-	-
Lulwane	1	0	-	-	0	1	0	-	-	0	1	0	-	-	-
Bhekababantu	1	1	-	-	0	2	0	-	-	0	1	1	-	-	-
Ndumu	0	0	-	-	0	0	0	-	-	1	0	0	-	-	-
TOTAL	**3**	**10**	**-**	**-**	**4**	**20**	**8**	**-**	**-**	**4**	**8**	**2**	**-**	**-**	**-**
GRAZING AREAS															
	Past					**Present**					**Future**				
	1-2 weeks	**2-4 weeks**	**3 months**	**6 months**	**Most**	**1-2 weeks**	**2-4 weeks**	**3 months**	**6 months**	**Most**	**1-2 weeks**	**2-4 weeks**	**3 months**	**6 months**	**Most**
Mboza	0	0	-	-	1	6	3	-	-	-	0	-	-	-	-
Mlambongwnya	0	8	-	-	0	11	0	-	-	-	4	-	-	-	-
Zama	0	1	-	-	0	2	0	-	-	-	1	-	-	-	-
Lulwane	0	1	-	-	0	1	0	-	-	-	0	-	-	-	-
Bhekabantu	1	0	-	-	0	1	0	-	-	-	0	-	-	-	-
Ndumu	0	0	-	-	0	0	0	-	-	-	0	-	-	-	-
TOTAL	**1**	**10**	**-**	**-**	**1**	**21**	**3**	**-**	**-**	**-**	**5**	**-**	**-**	**-**	**-**

5.5 Water quality perceptions

5.5.1 Water quality dissolved solids

Communities were asked to rate the level of water saltiness on a scale of salty or fresh as a perceived measure of dissolved solids in water in the pans. On the overall floodplain community scale, most respondents agreed that the months where the water was fresh are October (21) and June (19) while the months with the most salty water were January (14) and February (13). Variations in the individual community scales are also shown (Figure 5.9). Communities in Ndumu and Mlambongwenya perceive the water to be mainly fresh, although they pointed out that often there is a change in smell and colour. Generally many people commented that there were some pans that were more salty than others and that these became fresh for a few months after DWAF flood releases. The majority agreed that the utilization of pans as a resource for various activities was greatly reduced when the water became too salty. There was a perception that very salty water caused diarrhoea in people and livestock.

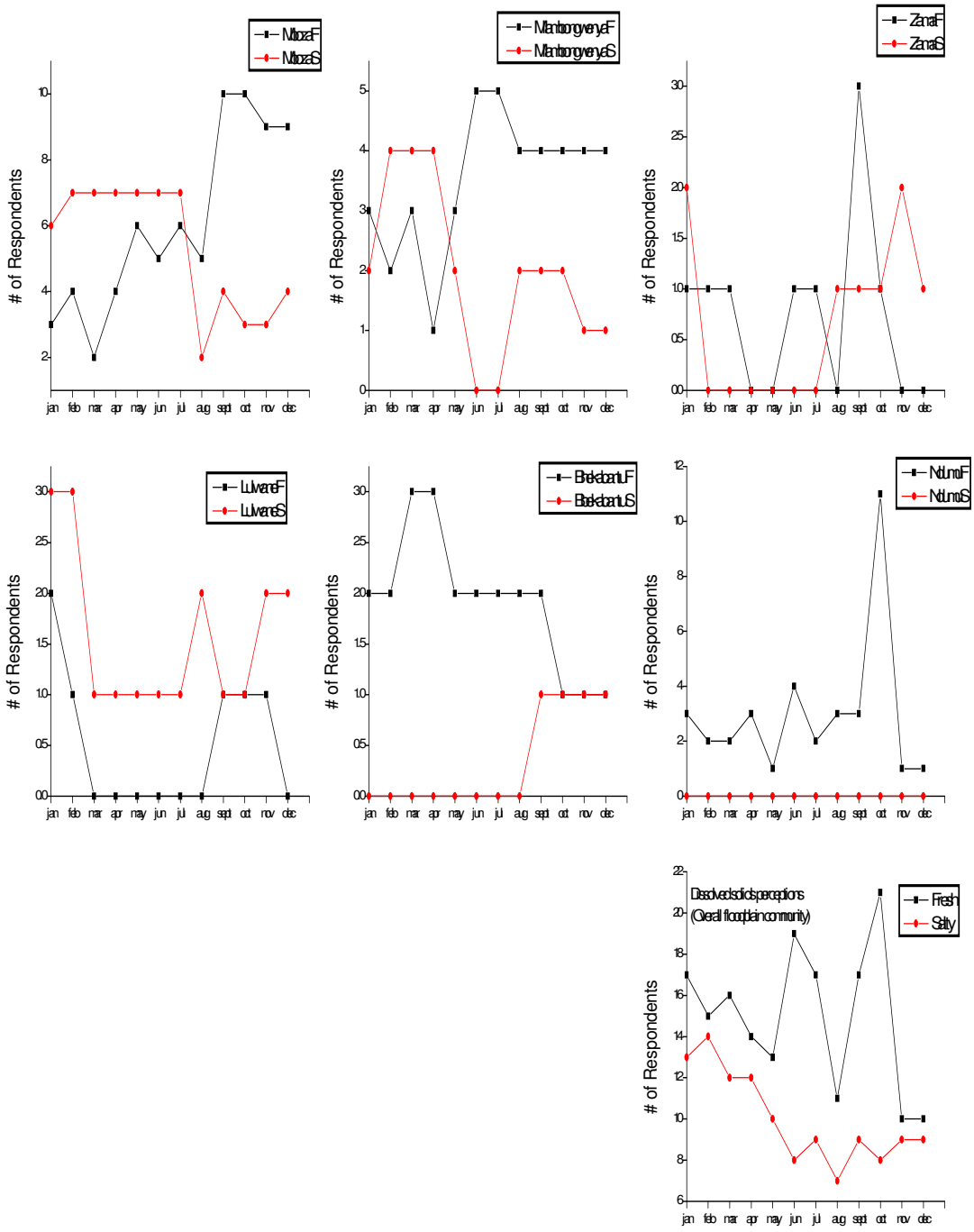


Figure 5.9: Community perceptions of dissolved solids in water measured on a scale of Fresh (F) or Salty (S) on the individual community scale and the overall floodplain community scale.

Qualitative physical observations on the floodplain itself were also performed at 43 points and the following Table (5.18) represents these observations of water quality, especially in the pans (at other points observed there were no water sources i.e., open land or cultivation, hence observations add up to 27 not 43):

Table 5.18: Physical observation of water quality in the pans

Observation	Frequency of observations at 43 different points along the floodplain in summer (December)	%
Dry	7	16
Muddy	7	16
Clear	3	7
Hypotrophic (aquatic vegetation)	10	23

5.5.2 Water quality chemicals from agricultural practices

Table 5.19 shows the response to queries whether pesticides are used on crops cultivated both on and off the floodplain. Crop spraying is carried out in September, October, November and December (spring & summer). Pesticides and fertilizers, in addition to chemicals used in cattle dips situated off the floodplain, constitute sources of water pollution. Some respondents did not respond as to whether they use pesticides.

Table 5.19: Do you use chemicals on crops to increase productivity?

Community sample	Pesticide use on the floodplain		Pesticide use off the floodplain	
	yes	no	yes	No
Mboza	27	16	7	7
Mlambongwenya	27	9	22	25
Zama Zama	7	20	11	2
Lulwane	1	10	9	2
Bhekabantu	5	2	1	7
Ndumu	8	-	-	1

5.5.3 Water quality diseases

The majority of communities were aware that cholera, malaria, bilharzia and diarrhoea are water-borne diseases. Their perceptions of during which months such diseases were more prevalent are depicted at the overall floodplain community scale (Figure 5.10.a) and the individual community scale (Figure 5.10.b). Clearly diseases are more prevalent in summer.

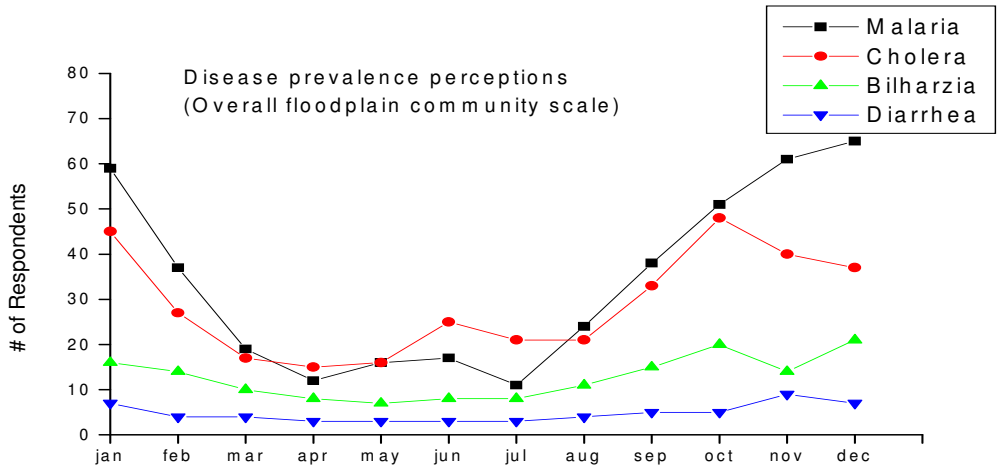


Figure 5.10.a: Perceptions of how water-borne disease levels change with seasons floodplain community scale.

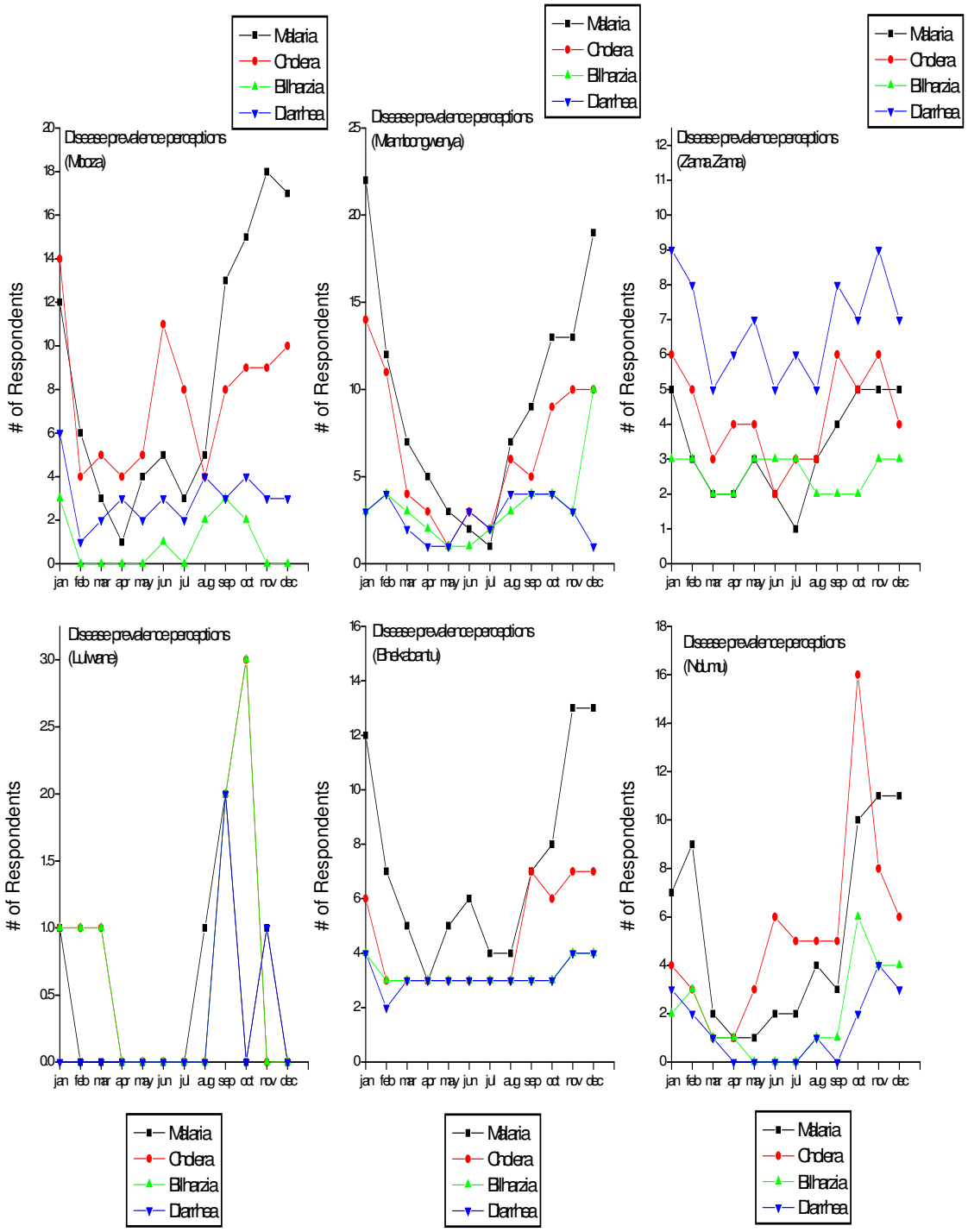


Figure 5.10.b: Perceptions of how water-borne disease levels change with seasons - individual community scale

The chemicals used to control disease vectors are mainly applied in spring and summer with a peak in January. Spraying is carried out more frequently in houses than in rivers, pans and irrigation canals (Figure 5.11).

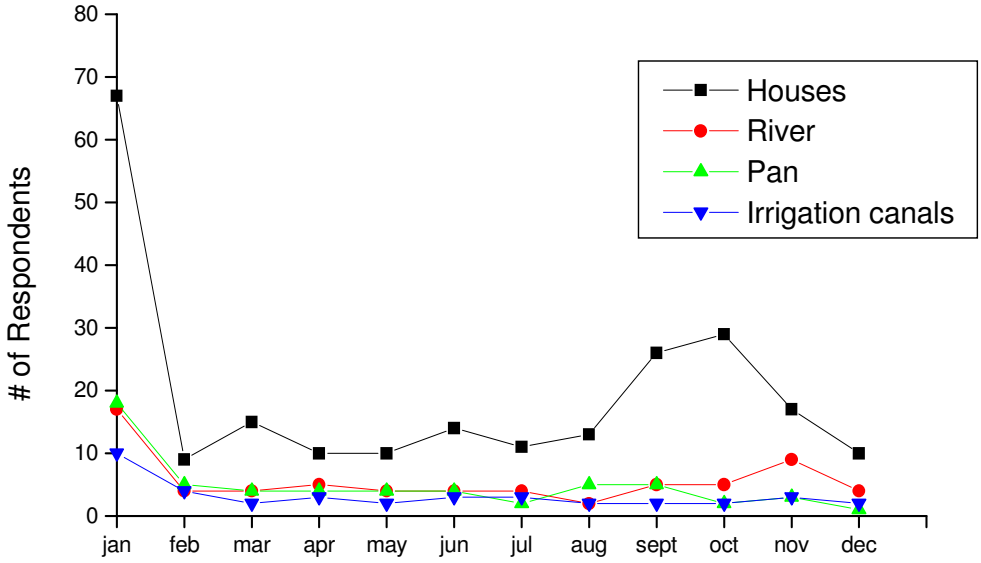


Figure 5.11: When and where chemicals are sprayed to control disease vectors in the environment.

5.6 Current utilization: agriculture

5.6.1 Cultivation

The cultivation of crops on the floodplain is in conflict with interest regarding the conservation of ecosystems. As a consequence there are perceived tensions between the communities and conservation regulation authorities (EKZN – Wildlife) arising from divergent needs for the appropriate timing of artificial flood releases from the dam (Jaganyi *et al.,* 2002). Conservation agencies require more natural summer floods while communities require spring and winter floods. Furthermore, conservation agencies perceive the need to remove cultivation from the floodplain. The floodplain communities are totally opposed to this opinion (Jaganyi *et al.,* 2002). A first approach was consequently to understand patterns of crop cultivation on the floodplain.

The communities were asked to state where crops are cultivated. The results show that most people (144 respondents of 228 of those who do cultivate) cultivate both on and off the floodplain, followed by 66/228 who cultivate only on the floodplain and lastly 18/228

who cultivate only off the floodplain (Table 5.20). A 35 of the overall 247 individuals interviewed are not cultivating at all.

Table 5.20: Cultivation on and off the floodplain

	On the floodplain	Off the floodplain	Both on and off the floodplain	Not cultivating
MBOZA	14	3	34	13
MLAMBONGWENYA	19	3	31	2
ZAMA-ZAMA	13	5	17	8
LULWANE	6	0	7	0
BHEKABANTU	0	5	19	2
NDUMU	10	3	22	10
TOTAL	**66**	**18**	**144**	**35**

The communities were then asked how much land they cultivated. Respondents indicated that more land (357 Ha) is cultivated on the floodplain than off it (277.4 Ha) (Table 5.21).

Table 5.21: How much land do you cultivate?

	No. of respondents	Land on the floodplain (Ha)	No. of respondents	Land off the floodplain (Ha)
Mboza	48	116	37	90.5
Mlambongwenya	48	140	33	91
Zama-Zama	30	47	22	26.4
Lulwane	9	6.1	5	2
Bhekabantu	19	63.5	23	63.5
Ndumu	32	7	20	4
TOTALS	**186**	**357**	**140**	**277.4**

In addition, many respondents have cultivated the land for a long period of time (Table 5.22).

Table 5.22: For how long have you cultivated these lands? (Short period = less than 5 years; not a very long time = between 6 years and 10 years; long time = between 11 and 20 years; Very long time = more than 21 years)

	On the floodplain				Off the floodplain			
	Very long time	Long time	Not a very long time	Short period	Very long time	Long time	Not a very long time	Short period
Mboza	41	5	0	2	27	5	4	1
Mlambo	23	20	5	0	10	13	10	0
Zama- Zama	15	13	2	0	8	10	2	3
Lulwane	6	1	1	0	4	1	0	0
Bheka	7	7	4	1	9	9	4	0
Ndumu	20	10	2	1	8	9	2	1
TOTAL	**112**	**56**	**14**	**4**	**66**	**47**	**22**	**5**

Many respondents are cultivating land that is ‘close–very close’ to the river and pan margins (Table 5.23) and their households are mainly ‘far–very far’ away from the fields.

However, in some cases households cultivate more than one field, one close and the other far away; as a result the responses indicated on the tables below total more than 228 (the number of cultivators)

Table 5.23: Distance of crop fields from water source and house (Very close = less than 50 m; close = between 50 and 100 m; Far = between 100 m and 1 km; Very far = more than 1 km)

	ON the floodplain											
	Distance from river bank				**Distance from pan margin**				**Distance from the field to the house**			
	Very Far	Far	Close	Very Close	Very Far	Far	Close	Very Close	Very Far	Far	Close	Very Close
Mboza	18	6	23	10	16	6	22	8	37	7	5	5
Mlambo	2	9	33	10	11	10	19	7	4	18	20	9
Zama-Zama	5	15	13	3	4	11	16	4	10	15	5	5
Lulwane	4	1	5	1	2	1	5	3	2	1	4	1
Bheka	2	1	12	11	2	6	6	11	4	11	8	4
Ndumu	3	10	16	19	4	17	14	11	5	14	17	8
TOTAL	**34**	**42**	**102**	**54**	**39**	**51**	**82**	**44**	**62**	**66**	**59**	**32**
	OFF the floodplain											
	Distance from river bank				**Distance from pan margin**				**Distance from the field to the house**			
	Very Far	Far	Close	Very Close	Very Far	Far	Close	Very Close	Very Far	Far	Close	Very Close
Mboza	31	7	2	5	25	5	2	2	6	12	18	4
Mlambo	13	14	11	1	15	9	11	1	4	6	15	12
Zama-Zama	8	7	8	5	7	9	9	2	1	3	15	7
Lulwane	1	2	1	4	1	4	1	1	0	1	3	1
Bheka	7	7	7	5	10	4	5	6	1	5	7	13
Ndumu	6	12	12	5	12	7	13	5	3	3	12	13
TOTAL	**63**	**44**	**40**	**24**	**63**	**37**	**39**	**16**	**15**	**28**	**67**	**46**

Physical observation on the floodplain was also carried out at 43 points and the following (Table 5.24) were the distances of cultivated crops from a water source.

Table 5.24.: Physical observation of distance of cultivated crops from a water source

Distance	**Frequency of activities observed at 43 different points along the floodplain in summer (December)**	**%**
<10 meters	19	44
10 – 100 meters	10	23
> 100 meters	10	23

Land cultivation takes place mainly by shifting cultivation (cultivating on a particular piece of land for a short period, then moving to another piece of land) off the floodplain (84), followed by tilling only (63) and lastly by planting directly (30). On the floodplain most respondents (99) till only, followed by shifting cultivation (76) and lastly by planting

directly (43). Some use more than one type of land preparation. Community section level responses vary (Table 5.25).

Table 5.25: How land is prepared for cultivation

	ON the floodplain						OFF the floodplain					
	Land preparation on the floodplain			Means used to prepare land on the floodplain			Land preparation off the floodplain			Means used to prepare land on the floodplain		
	Shifting cultivation	Till only	Plant directly	Tractor	Animals	Human	Shifting cultivation	Till only	Plant directly	Tractor	Animals	Human
Mboza	16	19	16	15	49	22	29	5	5	5	33	12
Mlambo	22	25	2	16	37	25	15	22	1	12	28	12
Zama- Zam	14	17	7	15	13	20	11	13	6	8	11	17
Lulwane	1	5	2	7	4	2	1	4	1	3	3	4
Bheka	14	7	2	5	2	23	21	2	0	1	3	20
Ndumu	9	26	14	5	32	36	7	17	17	6	24	25
TOTAL	**76**	**99**	**43**	**63**	**137**	**128**	**84**	**63**	**30**	**35**	**102**	**90**

Communities were asked their opinion on the extent of cultivation of land. Respondents indicate that cultivation on and off the floodplain (past, present and future) on the section level, and for the whole of the floodplain, is very extensive (Table 5.26).

Table 5.26: Opinions on the extent of cultivation of land

	On the floodplain														
	Past					Present					Future				
	Don't know	Very low	Low	High	Very high	Don't know	Very low	Low	High	Very high	Don't know	Very low	Low	High	Very high
Mboza	5	0	4	6	36	0	3	4	13	31	34	2	1	2	12
Mlambo	7	0	5	6	35	6	0	14	14	19	28	7	5	0	13
Zama- Zama	4	0	4	3	24	0	4	12	7	12	19	3	0	0	13
Lulwane	5	0	0	1	6	4	0	0	1	7	7	0	0	0	5
Bheka	12	0	1	1	10	2	0	5	5	12	10	2	1	1	11
Ndumu	1	0	4	1	32	1	4	16	14	2	17	5	2	4	7
TOTAL	**34**	**0**	**18**	**18**	**143**	**13**	**11**	**51**	**54**	**83**	**115**	**19**	**9**	**7**	**61**
	Off the floodplain														
	Past					**Present**					**Future**				
	Don't know	Very low	Low	High	Very high	Don't know	Very low	Low	High	Very high	Don't know	Very low	Low	High	Very high
Mboza	15	0	7	5	24	13	1	5	12	20	40	1	0	5	5
Mlambo	23	1	5	10	14	20	0	11	8	14	38	5	3	1	6
Zama- Zam	11	0	3	3	18	5	5	11	6	8	23	1	0	0	11
Lulwane	5	0	1	0	6	5	0	2	0	5	6	0	1	0	4
Bheka	9	0	4	3	8	3	1	7	4	9	13	0	3	1	7
Ndumu	1	0	5	3	26	1	1	14	13	6	17	3	2	5	8
TOTAL	**64**	**1**	**25**	**24**	**96**	**44**	**8**	**40**	**43**	**62**	**137**	**10**	**9**	**12**	**41**

The communities were also asked their opinion regarding the number of people cultivating crops on the floodplain in their community. Large numbers of respondents (see Table 5.27) agree with the opinion that every household or most households do cultivate both on and off the floodplain.

Table 5.27: Opinion on number of people cultivating

	On the floodplain											
	Every household cultivates on the floodplain				**Most households cultivate on the floodplain**				**Few households cultivate on the floodplain**			
	Don't know	**Not sure**	**Disagree**	**Agree**	**Don't know**	**Not sure**	**Disagree**	**Agree**	**Don't know**	**Not sure**	**Disagree**	**Agree**
Mboza	2	5	8	36	0	0	5	46	5	0	33	13
Mlambo	16	1	6	30	16	1	7	29	33	2	17	1
Zama- Zam	5	0	3	27	11	1	5	18	16	2	15	2
Lulwane	3	0	1	8	3	0	1	8	4	0	6	2
Bheka	3	3	2	16	8	1	0	15	7	1	13	3
Ndumu	1	0	1	33	8	1	12	14	13	5	14	3
TOTAL	**24**	**9**	**21**	**150**	**46**	**4**	**30**	**130**	**78**	**10**	**98**	**24**
	Off the floodplain											
	Every household cultivates off the floodplain				**Most households cultivate off the floodplain**				**Few households cultivate off the floodplain**			
	Don't know	**Not sure**	**Disagree**	**Agree**	**Don't know**	**Not sure**	**Disagree**	**Agree**	**Don't know**	**Not sure**	**Disagree**	**Agree**
Mboza	12	1	9	29	18	0	2	31	21	0	21	9
Mlambo	32	1	7	13	25	2	3	23	34	1	9	9
Zama-Zama	13	1	2	19	21	0	3	11	21	0	12	2
Lulwane	5	0	1	6	6	0	0	6	5	0	5	2
Bheka	2	7	2	13	7	1	2	14	9	2	10	3
Ndumu	2	0	6	27	13	1	5	16	15	6	14	0
TOTAL	**66**	**10**	**27**	**107**	**90**	**4**	**15**	**101**	**105**	**9**	**71**	**25**

They were then asked to give reasons why the cultivation of land on the floodplain was increasing. Most respondents (98) agreed on this point. Of these respondents:

- 49 indicate that the increase is due to suitable conditions for crop production (good soil moisture, fertile soil, water close by and access to land).
- 32 indicate that population growth is rapid and there is high unemployment; hence cultivation is increasing.
- 12 indicate that the cultivation of cotton and good returns from its production have prompted people to increase cultivation on the floodplain. However, most people indicated that they prefer stable food crops as they can eat them and some of the excess is sold.
- 5 indicate that they live close to the floodplain, which is why they are cultivating on the floodplain. On the other hand, a very few respondents (5) indicated that

cultivation is decreasing because young people are no longer interested in farming, the drought is severe, animals are destroying crops in the fields and the floodplain is no longer productive as it used to be in the past.

Table 5.28 indicates an estimation of the extent of cultivation based on an interpretation of the 2001 aerial photographs of the floodplain land cover. The area cultivated without trees is 1163 Ha, while that cultivated with sparsely distributed trees is 1462 Ha, so that the total area under cultivation (with and without trees) is 2625 Ha. Cultivated areas are also used for grazing livestock, especially on the floodplain after harvesting.

Table 5.28: Estimation of extent of cultivation based on interpretation of 2001 aerial photographs of the floodplain land cover.

Location	**Mzinyeni to Pongolwani area**	**Ntunte, Nsimbi and Mthikeni area**	**Lusundu, Tete, Maleni and Khangazini area**	**Mengu to Sivunguvungu area**	**Shalala to Bumbe area**	**Ngodo to Madlankunzi area**	**From Madlankuzi to Ndumu game reserve fence**	**Totals**
Cultivated area without trees (Ha)	411	185	103	42	93	329	0	**1163**
Cultivated area with trees (Ha)	380	185	165	125	165	380	62	**1462**
Totals	791	370	268	166	258	709	62	**2625**

Buchan (1988) points out that previously, the most reliable records of the Pongolo floodplain area under cultivation were those taken from 1970 aerial photographs where 1 344 Ha was visibly disturbed by cultivation. In 1985 the area was remapped separately by Furness (1988) and Buchan (1988), when 2 650 Ha and 2 885 Ha of disturbed area were recorded respectively. This indicates that over the period 1970 to 1985 the area under cultivation had approximately doubled. The 1985 values indicated that 41 to 45% of the usable floodplain was being, or had recently been, cultivated. For dry land areas within one kilometre of the floodplain, where an estimated 80% of other cultivation occurs, Furness (1988) recorded 3 903 Ha of disturbed land in 1970 and 4 251 Ha in 1985, indicating that little change had taken place, which is unlike the situation on the floodplain. In total the land cultivated in 1970 was 5 247 Ha, and 7 136 Ha in 1985. Furness (1981) indicates that the ratio of the area cultivated on the floodplain to off the floodplain increased from 0,3:1 to 0,6:1 between 1970 and 1985 respectively. The study here estimates that 2 625 Ha (just for the area between Mzinyeni and the Ndumu game reserve fence, whereas Furness's studies included the Ndumu game reserve) are under cultivation on the floodplain, which is

about the same as the values obtained in 1985. The reason that the area measured is nearly the same might be due to the following factors:

- The floodplain area has reduced. Since the development of the dam (1970s), flooding has been altered and reduced. As a result, the width of the floodplain area has reduced over time, as also observed in other floodplains by Barbier and Thompson (1998) and Keddy (2002). Heeg and Breen (1982) estimated the total floodplain area to be 13 000 Ha. At maximum retention level, i.e. immediately after the waters of a flood sufficient to inundate the full extent of the floodplain have receded, the various pans of varying size have an estimated collective area of 2600 Ha. The study here estimates a floodplain area of 8010 Ha (excluding Ndumu game reserve). Therefore the overall floodplain area may have reduced by approximately 2000 Ha.
- This study measured the area between Mzinyeni pan and the area before the Ndumo Game reserve. In the past the people living in the Mbangweni corridor used to cultivate in this game reserve before it was fenced off.
- In the past (the 1979 aerial photographs) there was no fluvial deposit on the floodplain, but this is now noticeable. These fluvial deposits have accumulated in some of the areas that used to be cultivated, reducing the area suitable for cultivation on the floodplain.

Based on this analysis it is highly likely that the area under cultivation on the floodplain has increased over the years, but it may be that the increase has been limited by a decreasing inundation of the floodplain.

The features in the interpretation of the aerial photograph were ground-truthed by physical observations along the Pongolo floodplain (Table 5.29).

Table 5.29: Physical observation of land cover

Observation		**Frequency of activities observed at 43 different points along the floodplain in summer (December)**	**%**
Signs of recent land cover	Increased cultivation	25	58
	Fallow land	11	26
	Bush encroachment	4	9
State of trees	Cut down	26	60
	Fallen	4	9
Signs of soil erosion		19	44
% of grass cover	<50%	15	35
	>50%	24	56
Invasive alien species		25	58
Burning of forest		8	19
Fluvial deposit (Sand deposit from the river)		5	12

5.6.2 Threats to the floodplain environment

During the check sheet observation, certain possible future threats to the floodplain ecosystem were noticed:

- The area between the Pongolo River and some of the pans on the floodplain is highly cultivated, which will lead to the collapse of river bank due to destabilization, if there are no controls.
- As a result of destabilized riverbanks and increased fluvial deposition at the outlet feeding Tete pan, sand from the river is filling up the pans. This will in future stop water flow from the river into Tete pan. There is also increased fluvial deposition at Ngodo pan and a pan opposite Madlankunzi on the other side of the river.
- Erosion due to extensive cultivation, shifting cultivation and removal of riparian vegetation was observed, which will lead to the pans silting up and the collapse of the riverbanks.
- Artificial water diversion channels and engine pumps for crop irrigation, for example as observed at Ngodo pan, will lead to pans drying up fast.

5.6.3 Irrigation (source of water and type)

Large numbers of respondents (Table 5.30) indicate that they depend on the river, followed by DWAF flood releases and finally some depend on the pans. However, their dependence on the various sources of water for irrigation varies within the sections of the community. For example, most respondents from Bhekabantu indicate that they use pans as a source of irrigation for all crops grown on the floodplain, as compared to other areas (see also Appendix C.5).

Table 5.30: Floodplain irrigation (source of water and type)

		Maize	Cotton	Cowpeas	Beans	Pumpkin	Mangoes	Sweet potatoes	Groundnuts	Sugarcane	Cabbage	Spinach	Cassava	Tomatoes	Bananas	Onions	Madumbes
Source of irrigation	**DWAF flood release**	71	11	4	29	26	11	35	23	13	17	16	8	17	18	18	7
	River	97	13	7	34	51	24	51	27	16	32	24	15	18	21	20	15
	Pans	27	7	0	13	13	6	14	10	5	15	13	3	9	7	10	6
Irrigation type	**Flood irrigation**	27	4	4	8	11	3	11	5	3	4	4	2	2	4	3	3
	Sprinkler	7	0	1	4	9	4	11	3	3	4	3	6	4	5	4	1
	Bucket	38	6	2	13	16	8	18	8	5	22	14	9	14	9	13	7
	Furrow	5	1	0	1	1	1	1	0	1	0	1	1	0	0	0	0

Buckets and artificial floods are the major irrigation types as regards crops grown on the floodplain.

Physical observation on the floodplain was also done at 43 points; the following irrigation types are shown in Table 5.31.

Table 5.31: Irrigation types observed

Type	**Frequency of activities observed at 43 different points along the floodplain in summer (December)**	**% (n=43)**
Totally rain dependent	31	72
Petrol pump	7	16
Bucket	2	5
No cultivation	3	6.9

5.6.4 Crop calendar

The crop calendar refers to the process of obtaining the seed, land preparation, planting, applying fertilizers and pesticides, harvesting, and marketing of crops. From the responses (Appendix C.6) it is evident that crops are planted and harvested throughout the year. The crops most frequently cultivated on the floodplain are maize, cotton, beans and pumpkins. Figure 5.12 illustrate that these crops are mainly planted in winter and spring and harvested in summer. These activities have been aligned to artificial flood timing (winter and spring), which is not natural.

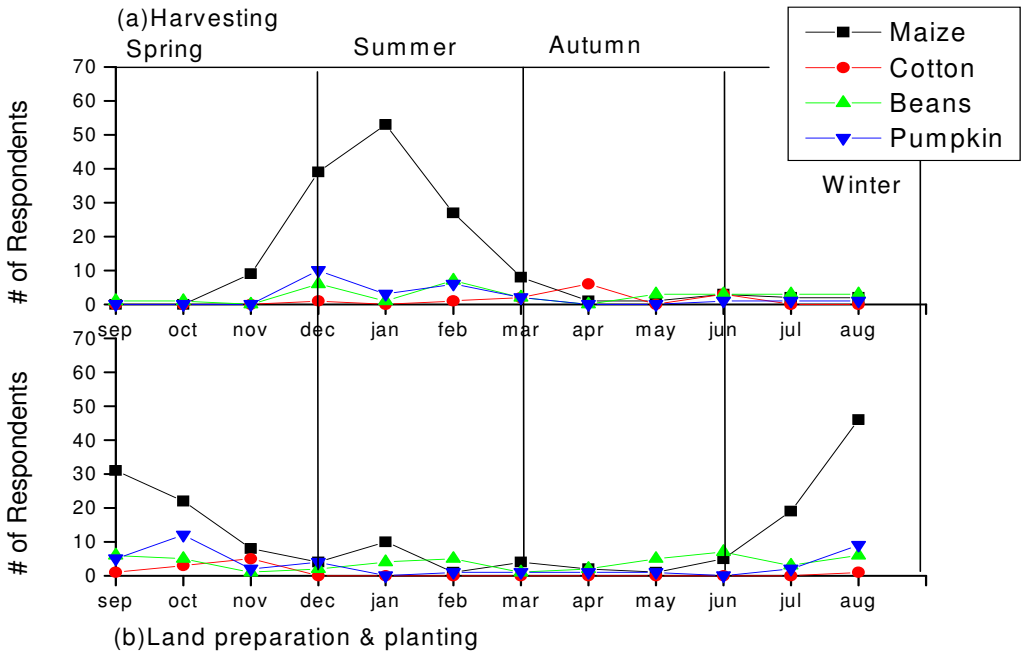


Figure 5.12: Crop calendar showing periods of (a) crop harvesting and (b) land preparation and planting for the crops most frequently cultivated on the floodplain.

5.6.5 Quality of produce

When asked about the quality of crop produce, for those who responded, most (105/247) indicate that in the past this quality was very good all the time, while at present 75/247 respondents indicate that it is good sometimes but for the future, most respondents (146/247) indicate that they do not know. Many also expressed the fact that many insect pests were increasing. For more information see Table 5.32.

Table 5.32: Quality of crop produce

	Past					**Present**					**Future**				
	Don't Know/ No response	**Bad all the time**	**Bad sometimes**	**Good sometimes**	**Very good all the time**	**Don't know/ No response**	**Bad all the time**	**Bad sometimes**	**Good sometimes**	**Very good all the time**	**Don't know/ No response**	**Bad all the time**	**Bad sometimes**	**Good sometimes**	**Very good all the time**
Mboza	19	1	1	7	23	28	2	10	9	2	29	7	7	2	6
Mlambongwenya	30	0	1	6	16	29	0	4	19	1	51	1	1	0	0
Zama-Zama	12	0	0	3	20	11	0	8	9	7	23	2	5	0	5
Lulwane	7	0	0	1	4	7	0	2	2	1	10	0	0	1	1
Bhekabantu	12	1	0	0	11	2	3	1	14	4	16	1	0	2	5
Ndumu	1	0	1	2	31	1	2	5	22	5	17	4	5	7	2
TOTALS	**81**	**2**	**3**	**19**	**105**	**78**	**7**	**30**	**75**	**20**	**146**	**15**	**18**	**12**	**19**

Most respondents (30 and 27) indicated that January and December respectively are the best crop production months, while the worst crop production months according to most

respondents (19 and 10) are June, May and July respectively (see Table 5.33). For more information on the section level, see Appendix C.7.

Table 5.33: Changes in crop quality with the season

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Best crop	**30**	**15**	**4**	**1**	**6**	**12**	**11**	**4**	**7**	**10**	**17**	**27**
Not so good	**6**	**7**	**12**	**14**	**10**	**9**	**5**	**4**	**6**	**4**	**3**	**3**
Bad crop	**4**	**-**	**4**	**3**	**10**	**19**	**10**	**4**	**1**	**2**	**1**	**1**

5.6.6 Crop quantities and values

Regarding the amount harvested, some respondents indicate that maize is produced in large quantities (e.g. 9 respondents indicate that they harvest more than 1000 Kg). The majority of people harvest less than 500 Kg. The amount harvested for various crops cultivated on the floodplain is shown in Table 5.34.

Table 5.34: Crop quantities harvested and values.

	0 – 250 Kg	251 – 500 Kg	501 – 750 Kg	751 – 1000 Kg	> 1000 Kg	Others	Price/quantity (R/Kg)
Maize	13	10	2	3	9		R100-R150\50Kg; R1-R2\cob
Cotton	2	1	-	-	-	1@ -(3, 5, 15 Bales); 2@ -(4, 8 Bales); 5@ -10 Bales	R500-R800\Bale
Sugar cane	4	2	-	1	-	-	R1\stick
Cabbage	10	-	-	1	-	-	R25\25Kg
Beans	7	-	-	2	1	-	R200\50Kg
Pumpkin	1	-	-	1	-	3- (10 –20); 3-(20 - 50)	From R2.50 – R10
Sweet potatoes	1@ -(20, 25, 50Kg)	-	-	-	1	1@ -(50-70, 25 Bags); 2@ -7 Bags	R3 – R5\Kg
Groundnut	3	-	-	-	1	3@ -10 Bags	R150 – R300\50Kg
Bananas	1@ -(20, 50Kg); 2@ -80Kg	-	-	-	-	-	R30\50Kg; 50c each
Mangoes	2@ - 50 Kg	-	-	-	-	1@> 3Bags; 5Bags; 30 Cases	R35\50 Litre
Tomatoes & onions	3	-	-	-	-	1@ -(4 Bags Tomatoes) (3 Bags onions)	Tomatoes – R40\crate; Onions – R2.50\Kg

Physical observations of cultivated crops are recorded in Table 5.35.

Table 5.35: Physical observations of cultivated crops

	Frequency of activities observed at 43 different points along the floodplain in summer (December)	**%**
Maize	36	84
Cotton	14	33
Sugar cane	5	12
Beans	7	16
Pumpkin	8	19
Bananas	22	51
Paw-Paw	2	5
Sweet Potatoes	2	5
Cabbage	2	5
Onions	3	10
Spinach	1	2
Beetroot	1	2
Cassava	1	2
Groundnut	2	5
Tomatoes	2	5

5.6.7 Crops bought and sold

The following statements are true if the "don't know" response is ignored. Most respondents consume all the produce that they grow. Some also sell and buy crop produce. Crop produce purchased comes both from within the floodplain and from outside it (Table 5.36).

Table 5.36: Where does crop produce bought come from?

	All from the floodplain			Some from the floodplain; other crops outside the floodplain			All come from outside the floodplain		
	Don't know	Disagree	Agree	Don't know	Disagree	Agree	Don't know	Disagree	Agree
Mboza	8	24	19	2	6	43	28	16	7
Mlambongwenya	43	9	1	36	1	16	47	4	2
Zama-Zama	19	8	8	21	6	8	27	5	3
Lulwane	8	1	3	7	0	4	7	2	3
Bhekabantu	10	3	11	12	6	6	13	6	5
Ndumu	3	12	20	13	5	17	18	10	7
TOTAL	91	57	62	91	24	94	140	43	27

The crop produce stemming from outside the floodplain is obtained from Jozini (13 respondents), home gardens (10 respondents) that are not on the floodplain, the Makhathini irrigation scheme and the Mjindi farms (8 respondents), as well as Ngwavuma, Ngwanase, Swaziland and Mozambique (especially maize) and Manguzi (2 respondents each).

5.7 Management

5.7.1 Perceptions of development

Owing to the high agricultural potential of the Makhatini flats (land adjacent to the floodplain), the DoA is planning expanded agricultural development off the floodplain (e.g. of the Makhathini Irrigation scheme for the purpose of cotton growing among other crops such as sugarcane). Some developments have been completed and others are underway (in state owned lands on the west side of the river). Hence it was necessary to

establish whether the floodplain community members were aware of the planned developments

5.7.2 Community opinions about the level of subsistence agriculture relative to commercial agriculture

The following statements are true if the "don't know" response is ignored. A majority of respondents felt that subsistence agriculture had been increasing in the past but that it appears to be decreasing at present. On the other hand while commercial agriculture was felt to have been increasing in the past, a majority perceived no change in the present (Table 5.37)

Table 5.37: Opinions about the level of subsistence agriculture relative to commercial agriculture.

SUBSISTENCE												
	Past				**Present**				**Future**			
	Don't know	**Increasing**	**No change**	**Decreasing**	**Don't know**	**Increasing**	**No change**	**Decreasing**	**Don't know**	**Increasing**	**No change**	**Decreasing**
Mboza	21	16	7	7	6	21	14	10	30	6	6	9
Mlambongwenya	33	18	2	0	32	5	7	9	40	3	3	7
Zama-Zama	14	19	10	0	10	5	17	11	26	2	11	4
Lulwane	7	4	1	0	6	2	1	3	8	0	4	0
Bhekabantu	14	9	0	1	2	6	9	7	15	8	1	0
Ndumu		25	5	1	4	4	10	17	19	1	7	8
TOTALS	**89**	**91**	**16**	**9**	**60**	**25**	**31**	**30**	**138**	**20**	**32**	**28**
COMMERCIAL												
	Past				**Present**				**Future**			
	Don't know	**Increasing**	**No change**	**Decreasing**	**Don't know**	**Increasing**	**No change**	**Decreasing**	**Don't know**	**Increasing**	**No change**	**Decreasing**
Mboza	37	3	7	4	28	7	11	5	41	2	5	3
Mlambongwenya	36	13	4	0	33	9	6	5	39	4	4	6
Zama-Zama	23	9	8	3	21	3	16		29	1	11	2
Lulwane	7	3	2	0	6	2	2	2	8	0	4	0
Bhekabantu	15	9	0	0	6	5	7	6	14	6	1	3
Ndumu	15	15	5	0	12	2	13	8	24	0	8	3
TOTALS	**133**	**52**	**26**	**7**	**106**	**28**	**55**	**29**	**155**	**13**	**33**	**17**

Many respondents were not aware of the following planned developments - irrigation, the cotton industry, a sugar mill, fish farming and tourism (Table 5.38). Development of irrigation and the cotton industry were the most well-known, with 72 and 64 respondents respectively.

Table 5.38: Are you aware of the following developments in the area?

	Irrigation Development		Cotton industry		Sugar mill		Fish farming		Tourism	
	Yes	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
Mboza	29	35	22	42	4	60	12	52	3	61
Mlambongwenya	20	35	20	35	11	46	2	53	3	52
Zama-Zama	6	37	4	39	7	36	6	37	5	38
Lulwane	3	10	6	8	5	7	4	8	4	8
Bhekabantu	3	23	3	23	2	24	2	24	2	24
Ndumu	11	34	9	36	9	36	9	36	9	36
TOTALS	**72**	**171**	**64**	**183**	**38**	**209**	**35**	**210**	**26**	**219**

When the communities were asked whether such developments would improve people's livelihoods, most respondents perceived that job opportunities would increase; farmers could produce more with better irrigation; the cotton industry would make more profit with less intensive farm work; and a sugar mill nearby would reduce the cost of traveling far to sell sugar cane. However, the communities living far away from the Makhathini irrigation (Mjindi) schemes felt that only those who are close to such developments would benefit.

5.7.3 Access and controls

When asked about access to and control of land and resource use on the floodplain, most respondents (36) indicated that there were no controls, apart from land allocation controls, for which the Inkosi and the Induna are responsible. Also, one of the respondents indicated that during a certain period of the year, the Induna and the Inkosi prohibit the hunting of certain creatures e.g. fish.

5.7.4 Opinion leaders

Communities were asked to name those who they felt were opinion leaders in their communities. Most respondents indicated Indunas (sub-tribal chiefs) and Inkosi (tribal chiefs) (Table 5.39). Some leaders do negotiate regarding water release, while others do advise community members on agricultural activities (e.g. Mr Jobe), or help with community projects (e.g. Clive Poultney, who is known as Mr Gumede, and Mr Nyathi; some are community elders.

Table 5.39: Opinion leaders

	Opinion leader
Mboza	Mr Jobe (11) – Induna; Mr Gumede (6) – Inkosi; Mr Nyathi Z (4) – Community member; Mr Khumalo (2) & Mrs Nhleko (1) – Both councillors; Mr Shenge (1) – Community member
Mlambongwenya	Mr Mpontshana (12) – Inkosi; Mr Nyawo M (10) – Induna; Mr Mabika (6) – Induna; Mr Baqhoshile (5) & Mr Mabika Nkawana (2) – Elected councillor; Mr Mtembu Tipson (2) – Farmer; Mr Jobe (1) - Induna Mr Mbabane (2) – Community member
Zama-Zama	Mr Mazweni (7) – Induna; Mr Mhlongo Gulu (6) – Induna; Ms Nhleko Lindiwe (4) – Councilor; Mr Shongwe (4) – Ordinary men in forum committee; Mr Tembe (2) – Induna; Mr Kakudi (1) – Induna, Mr Kakatho (1), Mr Masinga (1) Mr Dlamini (1) – Ordinary elder
Lulwane	Ms Nhleko Lindiwe (8) – Councillor; Mr Mhlongo Gulu (7)– Induna; Mr Mabhutu (2) – Inkosi
Bhekabantu	Mr Gumede (12) – Induna; Mr Ndembha (1); Mr Mobutu (1) – Inkosi; Ms Nomusa (1) – councillor
Ndumu	Mr Tembe Nkosinati (9) – Induna; Mr Khumalo (3) – Ordinary elder; Mr Mashi Ndlezi (3); Mr Msane (3) – Ordinary elder

5.7.5 Conflicts

Regarding conflicts in the community, respondents indicated that the nature of these is due to the following:

- Some Indunas are being excluded from water committee and development initiatives.
- The demand for land on the floodplain, where crop cultivation conflicts with grazing of livestock.
- Disagreements over flooding period between various interest groups, conservation agencies, upstream communities (summer floods) and floodplain communities (some want winter floods, others spring floods).
- The flood release structure is not inclusive of all parties concerned.

The actions taken to resolve these conflicts to date are:

- Discussions with the Indunas and Inkosi for land on the floodplain to be shared equally, so that all communities do benefit from its resources and services.
- It has been agreed that those whose cultivated fields have been grazed by livestock should receive compensation.
- Water committees have been set up to negotiate flood releases.

Communities were then asked their opinion regarding what needed to be done to resolve such conflicts. It was felt that:

- Rules need to be laid down, and everyone should follow them so that the floodplain ecosystem is maintained sustainably.
- Cultivated crops on the floodplain need to be fenced, and some free space should be set aside for livestock grazing.

- Cotton should be grown off the floodplain as cotton farmers disagree with everyone else regarding times of flooding.
- Government must support the floodplain economy by assisting farmers with farming equipment, such as tractors and other farming inputs.
- The farmers and the floodplain community must be educated concerning how to manage and use floodplain resources sustainably.
- Controls should be introduced and maintained for the best use of the floodplain resources.
- All stakeholders involved in the use of the floodplain must agree to cooperate in order to solve the floodplain issues.
- Respondents indicated that in most cases not all stakeholders attend the meeting which deals with issues pertaining to floodplain management and use of floodplain resources. They indicate that the individuals affected and who are mostly present at the meetings are actually the cotton farmers.

5.7.6 Local institutions and groups

When asked about local institutions and groups that are available and helpful to the community, respondents indicated the following institutions in order of importance:

- Inkosi (Tribal chiefs) (132)
- Cultural groups (church and traditional healers (isangoma)) (130)
- Induna (Sub-tribal chiefs) (128)
- Elected councillors (108)
- DoH (106)
- DWAF (85)
- Municipality (76)
- Associations, committees and co-operatives (e.g. water committees, and the farmers' association) (75)
- KZN Wildlife (58)
- DOA (48)
- DEA (47)
- Groups (e.g., NGO's) (9)

For more information on the community section level see Appendix C.8.

CHAPTER 6: DISCUSSION

6.1 Introduction

The purpose of this chapter is to show that people's perceptions are influenced by a number of factors. In this chapter matters such as the location of settlements in relation to water resources, flooding in relation to resource use, and impact of flooding on the floodplain ecosystem, management and development will be discussed in terms of the way they influence people's attitudes towards a flooding regime.

6.2 Evaluation of people's perceptions

The different perceptions are influenced by varying dependence on the floodplain's natural resources. Though it is clear that respondents want an annual flooding, the major problem is that everyone would like flooding to take place at the time most suitable for his or her specific needs. Indeed, what is a disadvantage to one person may be an advantage to another. Women, for example, benefit from the pans filling with water as they can collect good quality water for domestic use close by their households; on the other hand, cotton farmers do not want flood releases at the time when the pans really need to be flushed or filled up, because the cotton is not yet ready for harvesting.

The results show that people's attitudes towards artificial flooding are influenced by past experience and systems of livelihood. Most of them (81%) have lived along the floodplain area for more than 20 years and they are used to the natural flooding system, which was beneficial to them in terms of resource replenishment and provision of resources. In addition, the distance between their individual homes and the river and or pan affects their awareness of the impact that flooding may have on their houses. The main floodplain area is between the river and the pans; hence it is not surprising why the majority of residents live far or very far (32% and 35.6% respectively) from the river, but close (44.3%) to the pan. Also, the area between the river and the pan is used for cultivation, so that the field crops are close by these water sources (Table 5.23). Those who live close to the river are mainly located on the floodplain area that is very narrow, in such areas as Lulwane (between Tetomcane and Mengu pan), Bekabantu (the area between Madlankunzi and Hlanjana pan) and Mlambongwenya Section 9 and 10 (areas between Mzinyeni and Ntunte pan). Communities perceive that the DWAF's artificial annual floods rarely fill up pans, cultivated areas and grazing areas (Table 5.15). Yet it is crucial that these areas are filled (Table 5.14 – 5.16) to ensure good productivity on the floodplain. Hence, the flooding

pattern (time, duration and volume) is crucial for these communities to continue enjoying these resources.

6.3 Perceptions of resource use

During the present study, it was discovered that people's perceptions of the flooding regime were influenced, among other factors, by their perception of the benefits they gain, as mainly captured in the section dealing with agricultural issues. Information from Bembridge (1993) and stakeholder workshop (Jaganyi *et al* 2002) indicates that some families had been allocated plots on the Makhatini irrigation scheme. However, due to the costs of travelling to this scheme, more especially for those living far away, and the costs of production such as fertilizers and payments for irrigation, most people abandoned the scheme and returned to the floodplain for the purpose of cultivation, as there are no costs for irrigation and fertilization. Hence, once again the flooding pattern (time, duration and volume) is crucial for the said communities to continue enjoying these resources.

The relation between flood timing wants (Figure 5.6a and Figure 5.7) and resource use (Figure 5.8) clearly indicates that flooding should be based on periods when resource production can be maximized. A major flooding around August, September or October is crucial. A minor flooding around February as indicated in Figure 5.5.b and Figure 5.6.b is also necessary (i.e. in the Mboza, Lulwane, Mlambongwenya and Zama-Zama areas where people use water for domestic purposes from the pans; during the beginning of the year the water is salty (Figure 5.9) and a flood release is necessary to flush the salt away).

6.4 Perceptions of the stream flow regime

For perceptions regarding rainfall and natural flooding, the results depicted in Figure 5.3 and Figure 5.4 are slightly different to those of Heeg and Breen's (1982) findings. The majority of respondents indicate that the peak occurs around September, October and November, when compared to the peak of natural patterns (Heeg and Breen 1982): December, January and February. This could be the reason why people perceive a need for a small flood release around February and March, because the system is very dry during this period owing to irrigation demands. As mentioned, the February and March flooding is beneficial as it would flush away salty water which is indicated to be high during the first few months of the year (Figure 5.9). As indicated in Figure 5.6 and Figure 5.8 it is clear that the majority of respondents want a flood release between July and October because land preparation and planting is undertaken during the same period (Figure 5.12). The

relation between flood timing wants (Figure 5.7) and user groups (Figure 5.8) clearly indicates that flooding is based on needs for resources and should therefore be aligned with people's practices. It is interesting to note that there is no significant difference in flood timing wants among various user groups. This is because most households are involved in all activities (crop cultivation, pasture and fishing) in order to sustain themselves. It is also interesting to know that even though men and women in some cases are involved in different activities, the majority desire flooding to be done at the same periods (Figure 5.7).

6.5 Perceptions regarding subsistence agricultural production perceptions

Apart from state-owned lands located on the west side of the river and floodplain, communities perceive the floodplain as constituting the only resource with good soil for agriculture, to which they have full access. Heeg and Breen (1982) and Bruwer *et al.* (1996) indicate that for centuries, the Pongolo River floodplain has played a critical role in supporting local livelihoods through agricultural and floodplain resources. However, respondents perceive that the present extent of cultivation, as compared to past years, seems to be declining due to smaller artificial floods, leading to a reduced floodplain area and productivity. This is an indication that some sectors upstream such as irrigation, forestry and use of the dam for recreation and tourism are benefiting at the expense of floodplain users. These various interests would need to be balanced in stakeholder dialogue workshops.

6.6 Perceptions concerning management

An unequal distribution of resources affects perceptions of resource use. Lack of commitment and of proper planning by the local authorities and Departments responsible, leads to the consequences of mismanagement such as shifting tillage, which destroys vegetation. Poor planning, such as not involving communities, is a serious problem because they think they are being undermined. One respondent at the Mboza area indicated that recently the Indunas and Inkosi, had not been restricting communities from using land as they would like to, because they feared that their land would be taken from them by the Land Redistribution and Restitution policies. This fear has led communities to utilize the land fully for their own benefit before it is taken away. Such perceptions are a serious threat to the floodplain ecosystem. From Table 5.38, it can be clearly seen that respondents are not well informed about the planned developments. Possibly the local institutions and or groups are not communicating well with the communities, as can be seen in Section 5.7.6 where the respondents indicate that most local institution, and groups are not

available and helpful to them. Therefore a strategic management plan will need to be developed, through Water Users Association processes, to begin balancing various interests.

The results of this study demonstrate how the altered stream flow on the ecosystem is reflected in perceptions of resource use (Figure 5.8) and water quality (salinity, eutrophication and disease). It is evident that users have aligned their activities and attitudes (e.g. cultivation on the floodplain) to altered flood timing. Apart from conservation agencies and a few respondents within the floodplain communities who desire natural summer floods, many prefer spring floods, followed by winter, then summer, then autumn.

Therefore the management of the flow regime is the determining factor. If we were to shift back to natural annual summer floods, users activities and attitudes would most probably shift as well. However, the question of managing the dam for the purpose of flood control would still have to be answered. Engineers will need to design systems that will meet these two objectives (flood control and summer floods). Therefore 'the ball is in the DWAF officials' court'!

Increasing irrigation upstream, thereby decreasing dam inflows, could solve the problem of managing the dam for flood control. However, this approach should be avoided because it will decrease their options regarding development for the downstream population and this may contradict the moral ethics of equitable allocation of resources, which increases negative social impacts (see discussion in section 6.8 below). Alternatively, some floodplain communities could be allocated farming land upstream.

For long-term solutions to the problem, DWAF officials must not only design systems that imitate nature as much as possible but also work closely with ecologists and sociologists. This study therefore supports the recommendations of Heeg and Breen (1982): that there is a need to install a system of adjustable weirs where maximum and minimum releases are carried out in order to maintain natural water level fluctuations (high pan margin levels, low pan margin levels and contact with the river).

6.7 Ecological impacts

6.7.1 Sedimentation

Cultivation of the floodplain has not only decreased the land available for grazing (Figure 6.1) but has also increased soil erosion, resulting in high sediment loads in run-off water and enhanced fluvial deposition in the river and pans (Figure 6.2), increased eutrophication in pans, and increased nutrient loading in the river and pans where green algal blooms were observed. In addition, the stored sediment in the dam from the catchments is deposited on the floodplain during a flood release. The effects of soil erosion and the subsequent accelerated sedimentation (fluvial deposition) are increased further by an altered stream flow which has led to the cultivation of floodplain lands in spring and summer when the maximum rain falls.

Figure 6.1: Subsistence agriculture around Tete Pan, excluding livestock from the best pasture (October 2002).

Figure 6.2: Scouring of the riverbank resulting in fluvial deposit (December 2002).

These impacts may increase as a result of irrigation expansion in lands adjacent to the floodplain (Makhatini flats) downstream of the dam leading to rapid changes in the floodplain's habitat, structure and function and a decrease in species diversity. Adverse effects are those of pans drying up and filling up with sand too fast, with a resulting loss of goods and services to humans and livestock (drinking, grazing, fishing, wild fruit, medicine, vegetables and bush meat).

Proposed expansion of irrigation and associated road construction on lands adjacent to the floodplain would accelerate sedimentation further. Because the floodplain is a fragile ecosystem, the most appropriate option is to limit agricultural expansion but enhance wilderness activities (tourist development). However, the needs of communities in terms of subsistence agriculture will need to be kept central in all discussions because they form a majority of the population

In aquatic situations, increased fertility causes eutrophication, resulting in diebacks of macrophytes and consequent anoxic conditions that kill fish. This results in a major impact on fish production in the great lakes (Christie 1974; Vallentyne 1974). Keddy *et al.* (1994) have also reported that the competitive displacement of subordinate species by the dominant species is higher in flooded and fertilized conditions.

6.7.2 Water quality

The results of this study indicate that the negative impacts of salinity and water-borne diseases increase in summer when the pans are characterized by a low pan level (see Figure 6.3). The absence of artificial floods to flush out the system and refresh the pans increases the local population's vulnerability to disease. For example, many respondents complained of increased diarrhoea in both people and livestock. People are obliged to walk long distances to the main river channel to obtain fresh water. Due to very low pan water levels, animals may be stuck in the mud. Also, respondents perceived that the river channel is becoming deeper and the riverbanks steeper, so that it is difficult for their animals to drink directly from the riverbanks. As a result they must walk long distances along the river to find suitable sites where animals and people can drink the water. The point that the river channels are becoming deeper also indicates that large amounts of flood releases are needed to effect flooding.

Figure 6.3: Water use for basic human needs at Nsimbi pan (October 2002).

6.8 Socio-economic impacts and options

6.8.1 The people

Using the 1973 population census data of South Africa, Heeg and Breen 1982 estimated that approximately 36% of the total population of Maputaland, i.e. 40 000 people, were resident in the area immediately around the floodplain and had close links with it. Using the value of 36% from the 1996 and 2001 census data it is estimated that 120,000 people (in 1996) and 145,000 people (in 2001) are resident in the immediate vicinity of the floodplain. The results of this study, in addition to the outcomes of a workshop held with the communities (Jaganyi *et al.* 2002) indicate clearly that such a population increase has led to increased exploitation of natural resources and increasing conflicts over resource allocation and use, conservation and other developments and the lack of regulation and management.

The pans are an important source of fish and are linked to aspects of social life. Before the Jozini Dam was built, the local population used the productive areas which were subject to intermittent inundation both for cultivation and for grazing during the dry winter months. However, this study demonstrates that altered patterns of stream flow after the dam was built have led to a significant shift in the local people's attitudes (flood timing wanted in winter), leading to the utilization of the floodplain for cultivation and grazing in spring and summer, e.g. by many of the respondents in Mboza and Mlambongwenya who mainly cultivate cash crops, such as sugarcane and cotton. It must be noted that some respondents still value the natural system (winter use) and advocate flood releases that mimic natural

summer floods, for instance some residents in Lulwane, Zama Zama, Bhekabantu and Ndumu.

6.8.2 Regulation by traditional authorities

The Tembe-Thonga people have a strong clan structure. Clan chiefs (Inkosi) usually appoint family members as sub-district/ward headmen (iziNduna). This structure of authority plays an important role in the lives of the people under their jurisdictions. In addition to being the most important judicial institution at the local level, they control access to natural resources such as land. In addition, the respondents did not seem to be aware of the fact that some land on the east and west side of the river was state-owned because they believe that they own the land, based on Traditional Authority (TA) regulations, and because their households are situated on these lands. This conflict of authority over land resources is a result of colonial rule, where colonial authority was imposed on traditional structures. Such problems typically persist into post-colonial eras. Today many African governments face the challenge to develop appropriate or best-practice strategies (e.g. land restitution and land reform) to address these problems - evolving new land rights, policy and tenure (Toulmin and Quan 2000).

State-owned lands on the west side of the Pongolo River contain good soil with the potential for productive agricultural development. The land reform strategy of the DOA aims to achieve this agricultural potential by promoting agricultural development and expansion, with the aim of alleviating poverty. However land tenure problems are limiting progress since local residents' households are situated on these lands. Certaintly, developments that can alleviate poverty are necessary: employment opportunities are minimal. Many people depend on subsistence farming and live below the poverty line, and there are very few emerging commercial farmers (sugarcane and cotton). The DOA&EA has committed itself to address issues that have in the past hindered agricultural development on the Makhatini irrigation scheme and the wider Makhatini flats area. The plan, among other things, involves looking for partnerships for the sake of development, and disposing of state land as development occurs (DOA&EA 2002). What is missing in these agricultural development plans is an explicit plan which ensures that local people benefit in the long term and that the floodplain ecosystem is conserved as irrigation and development expand.

6.8.3 The need to apply environmental economics in decision-making

As irrigation expands, the floodplain ecosystem, which provides goods and services for the benefit of a sizeable local human population, is likely to compete with irrigation for limited water from the dam. Thus the floodplain ecosystem faces serious threats, i.e. a decrease in area and a change in function, with negative impacts on the human population which depends on it. This study shows clearly (Table 5.34) that subsistence agriculture on the floodplain is still a vital part of the economy, 25 years after Heeg and Breen's comprehensive study in 1982.

Bembridge (1993) pointed out that a considerable number of irrigation plots were allocated to people from outside the floodplain. In addition many floodplain communities, who are allocated irrigation plots, have over the years leased them out to external people from outside the floodplain. This implies that many floodplain communities are largely dependent on the floodplain for their subsistence needs. The results also point to the presence of recent immigrants (Table 5.2) into the area adjacent to the floodplain, which indicates the importance of the floodplain.

Studies of irrigation projects and dam developments worldwide (Barbier 1993; WCD 2002) show that it is unlikely that big commercial irrigation alone will alleviate poverty and conserve the floodplain ecosystems without an explicit plan being put in place. Therefore, there is a need to ensure equitable water allocation among the various users (fisheries, subsistence agriculture on the floodplain and eco-tourism). Clearly, the floodplain communities need to be empowered to manage farming while conserving natural ecosystems.

Although it is highly likely that not all of the people living on the Makhatini flats will benefit either directly or indirectly from employment in the proposed agricultural developments, the results of this study demonstrate clearly that the food-producing potential of the floodplain cannot be lightly dismissed, hence supporting the findings of Heeg and Breen (1982). As indicated by Heeg and Breen (1982), if available land that is used for livestock grazing is then used mainly for crop production as proposed for developments, this will restrict subsistence agriculture to crop growing, and the population will, of necessity, have to revert to fish as its main protein source. As Heeg and Breen (1982) indicated, it must also be taken into consideration that the proposed agricultural

crops (sugar cane, cotton, citrus) are seen as generating cash flow, and are not intended for local consumption. However, 'if the increased money in circulation has to go towards the purchase of foodstuffs brought in from elsewhere to replace that which was freely available from the floodplain ecosystem before development took place, this can hardly be considered a gain for the local population' (Heeg and Breen, 1982.

The question to be asked here is: to what extent do the river and floodplain resources contribute to the subsistence economy of the population adjacent to the floodplain? Can agricultural development alone adequately support the basic needs of the floodplain population, while conserving ecosystem processes and functions? Are there other means of diversifying the economy? Given the daunting socio-economic problems facing Africa, and the impacts of globalization, Africa continues to find itself caught in a trap that confines it to a vicious cycle of underdevelopment, poverty, conflict and suffering (Roberts and Hite 2000; Rupert 2000). Which conditions are required to achieve a balance between agricultural development and the conservation of ecosystems, hence their sustainability?

According to the perceptions, indicated in the results of this study, the changed flooding regime has reduced the floodplain's productivity (Table 5.16) and a larger population has increased the exploitation of floodplain resources and led to greater conflicts over use and regulation. Hence, the findings of Heeg and Breen (1982) are strongly supported that "the cessation of flooding would be far more serious; it would not only result in a removal of subsistence rights enjoyed for centuries" but it will also drive many people deeper into poverty and could stimulate the mass migration of local people to major cities in order to look for better livelihoods, thereby shifting the problem to the metropolitan areas and may increase crime and informal settlements there.

Therefore, agricultural development in conjunction with a policy of floodplain preservation is therefore likely to prove to be the only means whereby the continued existence of the floodplain as a viable ecosystem can be assured (Heeg and Breen, 1982).

Consequently, "it is imperative that an equitable partitioning of the water stored in the Pongolopoort Dam" be maintained both for developments and for environmental flows in order to enable the floodplain to serve as an additional source of agricultural produce, while conserving ecological processes (Heeg and Breen, 1982). Heeg and Breen (1982)

argued that, the supply of water exceeds the demand and there is no conflict of interest between the two ecosystems. However, when water demand will exceed supply as agricultural expansion continues greater conflicts of interest will emerge. Indeed, more recently some government agricultural planners are already questioning the value of maintaining the floodplain ecosystem with artificial floods. They perceive flooding as 'wasting water'- instead of directing the water to more productive uses such as irrigation (DoA&E, 2002). The conservation value of the floodplain ecosystem is coming into question.

CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS

7.1 Introductions

This chapter is divided into two sections: conclusions based on the results of the study and recommendations about what actions could be undertaken to sustain the diversity of resource use on the floodplain.

7.2 Conclusions

An understanding of patterns of resource use was developed quantitatively using people's perceptions. It has been shown how residents perceive the ecological and socio-economic values of the floodplain and the impacts of artificial flooding on these values: that the present artificial flood releases intended to meet their water requirements are not actually meeting their needs or the needs of the environment. For example, water levels of pans decrease quickly and remain very saline most of the year. Also, the flooded area has decreased, hence increasing conflict among the communities over grazing and cultivation areas.

The fact that the communities live adjacent to the river and pans, indicates a high dependency on the river resources. Should annual artificial floods decrease or be completely eliminated, without providing alternatives, the impacts on the livelihoods of these communities will probably be adverse.

The desired timing of floods (late winter, August, and early spring, September) reported by the majority of respondents indicates a shift away from the natural summer flood timing patterns. This has provided an opportunity for summer crops to be grown (e.g. cotton) at the expense of grazing, fishing and other wildlife resources. This is supported by the fact that the river volume, and the river flow rate, have largely reduced since the development of the dam, indicating that flood timing may have been aligned with some people's needs (e.g. to grow cotton), ignoring other needs such as growing food crops and fishing. The diversity of various conflicting needs is indicated by the fact that respondents want flooding in almost every month of the year.

Increasing irrigation upstream, thereby decreasing dam inflows, could solve the problem of managing the dam for the purpose of flood control and releasing floods in summer. However, an approach which increases irrigation upstream at the expense of users

downstream should be avoided because it will decrease the development options for a huge downstream population. It also opposes the moral ethics of an equitable allocation of resources, which is likely to increase negative social impacts downstream, given the large population.

Economic growth in terms of irrigation development is dependent directly on the limited water stored in the dam. The economy is complex because it must balance economic and subsistence needs. There are strong self-interests and consequent tensions. Therefore, promoting the equity, efficiency and sustainability of the economy according to the National Water Act will require robust and resilient management systems. Governance must enjoy legitimacy. The challenge is to put a plan in place that integrates all economic activity for the benefit of all. A first priority would be to initiate a co-operative management process and to instill a culture of continuous learning so as to underpin co-operative governance and strategic adaptive management, which will provide a means that enables the integration of the floodplain agriculture into a diverse economy. Implied here is a need to ensure that stakeholders receive access to scientific information or to a knowledge base that enables them to develop a shared understanding of the current state of the elements of their socio-economy and how they work. This understanding will enable stakeholders to be aware of the opportunities that are available but are not being realized and of how they can be integrated into a diverse economy, in line with the National Water Act.

Because the floodplain is a fragile ecosystem, the most appropriate option with respect to protecting this system is to implement natural summer flood releases and limit agricultural expansion, but enhance wilderness protection activities (e.g. tourism and recreation development).

7.3 Recommendations for enhancing maintenance of the floodplain

1) Set up a community-based local catchment management structure (in accordance with the National Water Act) with a local office and a coordinator to drive the process of calling meetings, keeping minutes and records of community complaints and developing new initiatives. The Mboza Village Trust carried out these functions from 1988-1999 with external donor support. They should be supported to take up their leadership role again

since they have already put in place a local community-based structure, which should be promoted.

2) The members of the committee of this local structure should comprise representatives of national, local and regional government, conservation agencies, local communities, NGOs and researchers with which co-operative management of the floodplain can be planned and implemented. Within this co-operative structure some of the goals that need to be set must have an overall purpose, which could be: 'The need to protect and maintain or restore ecological processes and functions so that they continue to provide goods and services for the benefit of humans'. Within this purpose, some of the goals that need to be set in order of priority are to: (i) protect representative ecosystems, (ii) maintain ecological functions, (iii) restore damaged wetlands, (iv) monitor management plans and (v) discuss economic and subsistence development.

3) Develop training programmes to educate communities and to empower the envisaged co-operative structure, in order to enable them to think holistically (ecologically, socially and economically) and to understand the short- and long-term consequences of various actions so that decisions to protect the ecosystem can be reinforced.

4) More studies on the floodplain ecosystem need to be carried out so that proper decisions are taken regarding future developments. The studies might include the following issues:

- The impact of flooding in Mozambique, to make sure that trans-boundary water requirements are met and to establish if the present flood timing is suitable.
- Detailed in-depth economic valuations of downstream and upstream dam-dependent resources. For the Pongolo River system, upstream developments (around the dam itself such as irrigation and tourism) and down-stream developments were never compared and valued to see which developments could be supported. This evaluation will help policy- and decision-makers to make well-informed decisions.

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APPENDICES

A. Survey questionnaire

1. Biographic Data

Gender	
Age	
How long have you lived in the area?	
Who allocated you the land for building your house?	
How long have you lived in the village?	
How far is your house to the river\pan?	
How many are you in your family	
What job do you do?	
What about your other household members, what job do they do?	
How much money do you earn per month from all your activities?	

2. Household activities

	Everyone	**Men**	**Boys**	**Women**	**Girls**
Collecting and gathering					
Water					
Fuel wood					
Fodder for cattle					
Wild plants					
Looking after household					
Cooking					
Washing					
Looking after children					
Cleaning the house					
Tending the garden					
Buying household goods					
Building & maintaining house					
Making household decisions					
Credit					
Education					
Budgets					

3. Use of the floodplain resources

Do you use the floodplain area; river, pans and land? And what are you using it for? And which areas are important for the various activities?

What do you use these areas for?	Which areas are important for the various activities? Rating of importance: Don't know-0; Not important-1; Important-2; Very important-3			
	River	Pan	Land	

4. Stream flow Perceptions

a) Rainfall and flooding perceptions

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Most Rainfall												
Rain Before the dam												
Rain after the dam												
When would you like to have floods released by DWAF												

b) Is it important for floodwater to reach or fill up areas on the floodplain that you use?

	Very important	Important	Not important	I don't know
Pans				
Cultivated areas				
Grazing fields				

C) Give reason why it is important for flood water to fill up these areas?

	Reasons
Pans	
Cultivated areas	
Grazing fields	

d) How often do DWAF floods reach or fill up these areas?

	Always	Sometimes	Rarely	Not at all
Pans				
Cultivated areas				
Grazing fields				

e) How long should these areas remain flooded or be in contact with the river in a year?

	Past (No. of days\months	Present (No. of days\months	Future (No. of days\months
Pans			
Cultivated areas			
Grazing fields			

f) Have you observed any significant changes (before & after the dam) on the floodplain with respect to the following things?

	Agree	Agree slightly	Disagree	Don't know
Pans appear to be filling up with soil				
Pans are drying up very quickly after flood				
Productivity or fertility of cultivated areas is decreasing				
Productivity or fertility of grazing areas is decreasing				
The main river channel is becoming narrow				
The river edge is becoming very steep				
The riverbed is becoming deeper				

5. Water Quality

a) How does water quality change with season?

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fresh												
Salty												

b) How does water quality (saltiness) affect floodplain activities and resource use?

What do you use these areas for? (e.g, drinking)	Rating of impact: Not at all-0; Not so much-1; Much-2; Very much-3		
	River	Pan	Land

c) Do you use pesticides on crops? (Yes\no)

……

d) Which diseases related to water are prevalent in this area? E.g: Cholera, diarrhea, malaria, Bilharzia and others.

……

e) Which months have high diseases level?

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Malaria												
Cholera												
Diarrhea												
Bilharzia												
Others												

f) When and where are chemicals sprayed to control disease vectors in the environment?

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Houses												
Rivers												
Pans												
Irrigation canals												
Others												

6. Subsistence Agriculture Survey

a) Which of these crop activities do you do?

Grow crops	Sell crop produce	Buy crop produce

b) Who does the following crop growing activities in your household?

	Everyone	Men	Boys	Women	Girls
Land preparation					
Planting					
Harvesting					
Marketing					
Crop decisions					

c) Where do you cultivate your crops?

On the floodplain	Off the floodplain	Both On and Off the floodplain

d) What is the size of the area cultivated, Distance from water source and how long have you been cultivating the land? (Both on and off the floodplain)

Size (Ha)	Distance from the river banks				Distance from pan margins				Distance from household				How long have you been cultivating the land		
	Very far	Far	Close	Very close	Very far	Far	Close	Very close	Very far	Far	Close	Very close	Very long time	Long time	Short time

e) How do you go about getting more land to cultivate on and off the floodplain?

……

f) How do you prepare the land on and off the floodplain?

Shifting cultivation (clear and burn bush and trees)	Till only	Plant directly	Other

g) What means do you use to prepare land for on and off the floodplain?

Tractor	
Animals (e.g., Cattle)	
Human labour	
Other means	

h) Are the pieces of land near each other or are they far apart in various places?

……

i) What is your opinion about the extent of cultivation of land on and off the floodplain?

	Past	Present	Future
Very high			
High			
Low			
Very low			
I don't know			

j) Why is cultivation of land on the floodplain increasing?

……

k) What is your opinion about the number of people cultivating on and off the floodplain?

	Agree	Disagree	I am not sure	Don't know
Every household cultivate on the floodplain				
Most household cultivate on the floodplain				
Few household cultivate on the floodplain				
I don't know				
Any other opinion (Describe)				

7. Crops grown on the floodplain

a) What are the crops grown on the floodplain? Do you irrigate your crops? Where do you get water for irrigating the crops? What type of irrigation do you practice?

Crops	Source of irrigation water				Irrigation type			
	DWAF flood release	River	Pans	Others	Flood irrigation from the dam	Furrow	Bucket	Others

8. Crop calendar:

a) Which crops do you grow? Are they traditional or modern crops? When do you prepare land, plant, harvest and market crops?

Crop	Traditional or modern crop	Land preparation	Planting	Harvesting	Marketing

b) Crop quantity harvested:

Crop	Quantity of crop harvested	
	No of units	Kg/unit

c) Selling Crop produce
Do you sell crop produce? (Yes\No)
……

d) Where do you get the crop produce that you sell?
……

e) What do you do with the crop produce that you farm?

Crop	Eat all	Sell all	Eat some & sell some	Other use

f) To whom do you sell crop produce?

Crop	Name of buyer

g) What is the price of the crop produce you sell?

Crop	Last year price (Rands\Unit)	Current price (Rands\Unit)

h) Which months do you sell crop produce most, least and not at all?

Crop	Most sells (Months)	Least sells (Months)	No sells (Months)

i) Why do you have to sell crop produce?

……

9. Quality of crop produce sold

a) What is your opinion about the crop quality that you sell? 4-(very good all the time); 3-(good sometimes); 2-(Bad sometimes); 1-(Bad all the time); 0-(Don't know)

Crop	Past	Present	Future

b) How does crop produce quality change with seasons? Which months do you sell good quality crop produce? 4-(best crop produce); 3-(Not so good crop produce); 2-(Bad crop produce); 1-(Don't know)

Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec

c) Why do you think that crop produce quality is changing?

……

10. Buying Crop produce

a) Do you buy crop produce? (Yes\no)

……

b) What do you do with the crop produce you buy?

Crop	Eat all	Re-sell all	Eat some & Re-sell some	Other use

c) Where do you buy your crop produce?

Crop produce	Where do you buy it?

d) Does the crop produce you buy come from the floodplain or outside the floodplain?

……

e) Where does the crop produce from outside the floodplain come from?

……

11. Development

a) What is your opinion about the level of subsistence agriculture taking place on the floodplain for subsistence needs and for commercial benefit (buying & selling)?

	Subsistence agriculture (basic needs)			Commercial benefit (buying & selling)		
	Past	Present	Future	Past	Present	Future
Increasing						
No change						
Decreasing						

b) Why is subsistence agriculture changing or not changing?

……

c) What development should take place to minimize over harvesting?

Agricultural development	Type of development
On the floodplain	
Off the floodplain	

d) What new developments are taking place in the area?

……

e) Are you aware of the following developments in the area? Yes\No

	Yes\no
Irrigation development on the Makhatini flats	
Cotton industry	
Sugar mill	
Fish farming	
Tourism	

f) Do you think that these developments will improve people's livelihoods or well being? Give reasons
……

12. Access and control

a) What controls exist with respect to subsistence agriculture?

Controls	Who sets them	How they work

b) What is the best way to manage sustainable agriculture on the floodplain?
……

13. Opinion leaders

a) Who are the leaders in the community that you go to for advice and information relating to agriculture? Who are the leaders that are respected in the community? Leaders whose opinion is valued by the community?

Name of opinion leaders	Male or female	What they do e.g., Induna, ordinary men or women.

14. Conflicts of interest in the community

a) What fears do you have that may be limiting or hindering your access to subsistence agriculture on the floodplain?
……

b) Which people or groups are you not agreeing with, when it comes to issues of access and use of subsistence agriculture on the floodplain?
……

c) What is the nature of this conflict or disagreements?
……

d) What actions have been taken to try to resolve these conflicts?
……

e) What is your opinion about what needs to be done to resolve these conflicts?
……

f) Which individuals or groups affected were or are present at focus discussions?
……

15. Local institutions and groups

a) What local institutions and groups are present in your community and what role are they playing?

Local institutions & groups	Very important	Important	Not so important	Not at all	Don't know

b) What other information about subsistence agriculture on the floodplain would you like to add?
……

B. Checklist used during field survey

1. Date surveyed	
2. Location details (based on Table 4.2)	
3. Signs of recent land use change (e.g., pasture, cultivated fields or natural forest)	
4. Signs of recent agriculture intensification (e.g., extension of cultivated fields)	
5. Distance of the crop fields from water course (river and pans)	
6. Signs of deforestation	
7. Signs of soil erosion	
8. Type of animals around and the their numbers	
9. Herbaceous vegetation covers e.g., no effective plant cover or effective plant cover (based on grass cover and uncultivated areas).	
10. Degraded/disturbed vegetation present and reason (trampling, overgrazing)	
11. Crops cultivated	
12. Condition of the water (water quality), especially in the pan (e.g., clear, muddy, polluted or signs of eutrophication)	
13. Activities around (e.g., grazing of animals, fishing, washing and others)	
14. Irrigation type (e.g., bucket, pumps) and source (river or pan)	
15. Threats for future or possible impacts relating to location	
16. Natural vegetation communities present (e.g., trees or shrubs)	
17. Land management practices	
18. Invasive alien plants	
19. Impact of the recent human activity on environmental factors that affect ecosystem functioning (e.g., cutting of trees and collection of soil for building)	
20. State of river banks	
21. Overall comments	

C. Results data

C.1. Biographical details

	Gender		Age							Period of residence						Family size				
	Male	**Female**	**No Idea**	**15-25**	**26-35**	**36-45**	**46-55**	**56-65**	**>66**	**No Idea**	**<5 years**	**6–10 years**	**11-20 years**	**21-30 years**	**>30 years**	**No Idea**	**<5**	**6-10**	**11-15**	**>16**
Mboza 3	9	13	1	3	4	4	3	8	1	2	1	0	2	3	16	1	10	12	1	0
Mboza 4	8	10	0	0	2	2	6	6	0	0	0	0	1	2	13	0	6	6	3	1
Mboza 5	5	20	4	0	0	4	6	6	4	0	2	0	0	1	21	0	4	17	3	0
Mlambongwenya 7	9	22	0	3	6	5	6	9	1	0	3	1	2	6	18	0	8	12	9	1
Mlambongwenya 9	4	9	1	0	2	3	4	3	0	0	0	0	0	4	9	0	5	6	2	0
Mlambongwenya 10	4	8	0	2	3	3	1	3	0	2	0	0	3	0	7	1	3	6	2	0
Zama-Zama 5	6	4	4	2	0	2	2	2	0	3	2	0	2	0	5	2	1	8	1	0
Zama-Zama 6	14	16	1	3	10	0	2	15	1	11	1	1	2	0	17	2	6	17	6	1
Lulwane	9	4	0	1	0	0	2	10	0	1	0	0	1	1	10	3	1	5	4	0
Bhekabantu 5	11	11	2	3	7	3	3	3	2	0	0	4	4	4	11	0	2	12	8	1
Bhekabantu 6	2	3	0	0	1	0	1	1	0	0	0	1	0	0	2	0	0	2	1	0
Ndumu	15	31	0	3	7	9	11	5	10	14	0	0	2	3	26	0	25	7	5	8
Totals	**96**	**151**	13	**20**	**42**	**35**	**46**	**72**	**19**	33	**9**	**7**	**19**	**24**	**155**	9	**72**	**109**	**45**	**12**

	Land allocation				**Distance house to river**				**Distance house to pan**			
	Inkosi	**Induna**	**Father**	**Other**	**Very far**	**Far**	**Close**	**Not sure**	**Very far**	**Far**	**Close**	**Not Sure**
Mboza 3	8	1	12	3	11	4	2	7	1	2	12	9
Mboza 4	5	4	7	0	10	3	2	1	8	0	5	3
Mboza 5	4	4	16	0	21	3	0	0	16	5	2	1
Mlambongwenya 7	3	11	9	7	5	11	12	2	4	6	15	5
Mlambongwenya 9	4	1	4	4	3	4	6	0	1	5	7	0
Mlambongwenya 10	0	3	6	3	1	6	5	0	2	3	6	1
Zama-Zama 5	1	6	1	4	6	2	1	3	1	5	2	4
Zama-Zama 6	9	15	5	3	8	14	5	5	6	12	9	4
Lulwane	2	7	1	3	7	4	1	1	6	4	1	2
Bhekabantu 5	3	12	7	1	0	7	14	2	1	7	15	0
Bhekabantu 6	2	1	0	0	0	1	2	0	1	1	1	0
Ndumu	9	9	0	27	6	11	21	7	10	10	18	7
Totals	**50**	**74**	**68**	55	**78**	**70**	**71**	28	**57**	**60**	**93**	36

C.2. Income sources

	Respondents formal			Respondents informal			Men and Boys formal			Men and boys informal		
	Type of job	Inside village	Outside Village	Type of job	Inside village	Outside Village	Type of job	Inside village	Outside Village	Type of job	Inside village	Outside Village
Mboza	1 - Security	-	-	3 – Subsistence farmers	-	-	1 @ - Security; Forest worker; Sugar cane harvester; Teacher; Health worker; 3 - Contract worker; 5– Laborer; 2 – Game ranger; 8 – schooling;	8	3	7–cultivate crops; 4–cleaning the house & yard; 2-Temp jobs; 2-builder; 1 @ - fish & sell; produce crop & sell1- traditional healer; shoe maker; Shepard;	3	-
Mlambo	1 – health worker 1 – contract worker; 25 – no job	-	2	10 - subsistence farmers; 1 – temporary job;	11	-	5-Laborer; 2–Commercial farmers; 2–Schooling; 2–Contract worker; 1 @ - Steel firm worker; Mine worker; Truck driver; Unemployed; Temporary job;	4	6	8 – subsistence farmers 2 – cattle herder	-	-
Zama-Zama	6 – no job		-	2 – sell fruits and crops	3	-	5 – laborer; 5 – scholar; 3 security; 3 – work in mines; 1 – taxi owner; 1 – researcher; 1 - policeman	5	6	6 – cultivate crops; 1 – fish; 1 – sugar cane grower; 1 – sell crop 1 – Shepard	6	- -
Lulwane	3 – no jobs	-	-	1 – Subsistence farmer			1 – plumber; 1 pensioner; 1 – laborer; 1 temporary job	-	1	1 – carpenter	-	-
Bhekab		-	-				7 – laborer; 2 – mine workers; 3 – contract workers; 1 teacher; 1 – wiring; 1 – tractor driver; 1 – Cane harvester; 1 – taxi driver; 1 - schooling	3	11	1 - Fishing; 2 - sell fruits and crops; 2 – temporary jobs; 1 – laborer; 1 – farm worker	1	1
Ndumu	5 - schooling	3	-	7 – Shepard; 5 – no jobs; 2 – selling mangoes and sweets; 1 @ – Temp job; Grass material collector; Subsistence farmer; Fishing; Builder; General dealer	5	7	2 – security; 1 – pastor; 4 – working; 3 – Ndumo Game Rangers; 1 – driver; 1 – sugar mill	7	7	9 – Subsistence farmers; 2 – house builders;	12	3
TOTAL	34 – No jobs; 1 – Health worker; 1 – Contract worker	3	2	15 – Subsistence farmers; 7 Shepard; 5 – no jobs; 4 – hawkers; 2 – temporary job; 1 – fishing; 1 – builder; 1 – general dealer; 1 – grass material collector	10	7	28 – Laborers; 16 – Schooling; 8 – Contract workers; 5 – game rangers; 6 – Mine workers; 6 – securities; 4 – Drivers; 3 – Sugar cane workers; 2 @–Commercial farmers; Teachers; Temporary jobs; 1 @ Health worker; Unemployed; Taxi owner; Work in steal firm; Researcher; Policemen; forest worker; Plumber; Pensioner; Pastor; Wiring	27	34	32 - Subsistence farmer; 4 @ - Temporary jobs; Sell crops; House builders; Shepard; Cleaning the house; 3 – Fishing; 1 @ - Selling fish; Sugar cane grower; Traditional; Shoe maker; Carpenter	22	4

	Women and girls formal			**Women and girls informal**		
	Type of job	**Inside village**	**Outside Village**	**Type of job**	**Inside village**	**Outside Village**
Mboza	2 – Health worker; 6 – schooling;	1	1	10- cultivate; 2 – cleaning; 1 – sell cotton; 1 – collect water; 1 – trader; 5 – cleaning the house	1	-
Mlambongwenya	1@ - Health worker; sales woman; commercial farmer; plough & sell 1 – work as a maid; 2 – no job; 1 - weeder		2	8 – cultivate land; 2 sell fruits and crops	5	-
Zama-Zama	2 – health worker 1 - No job; 1 – student; 4 scholars; 1 – temp jobs	1	-	7 – subsistence farmer 1 –sell clothes and drinks	3	-
Lulwane	-	-	-	-	-	-
Bhekabantu	1 – Clinic cook; 3 schooling	1	-	3 – shopkeeper; 3 – laborer 3 – cultivating crops; 1 – community worker	4	-
Ndumu	1 – Laborer	1	3	23 – Subsistence farmers; 1 – cooking; 1 – building houses	19	
Total	**14 – Schooling; 6 – Health worker; 4 – Laborer; 3 – No jobs; 1 @ - Sales woman; Commercial worker; Maid; Weeder; Temporary job**	**4**	**6**	**52 – Subsistence farmers; 7 – cleaning; 3 – hawkers; 3 – Shopkeepers; 1 @ -Sell cotton; Collect water; Trader; Community worker; cooking; Building houses.**	**32**	**-**

C.3. Individual areas resource use

	Drinking												Bathing											
	River				Pan				Land				River				Pan				Land			
	0	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**
Mboza 3	7	0	1	16	15	0	1	8	22	0	0	2	14	0	1	9	19	0	1	4	23	0	0	1
Mboza 4	1	3	0	12	6	1	4	5	15	0	1	0	4	0	0	12	6	1	4	5	15	1	0	0
Mboza 5	0	18	6	0	24	0	0	0	14	1	2	7	0	4	4	16	12	2	6	4	18	4	1	1
Mlambo 7	5	0	6	19	21	4	2	3	26	2	0	2	1	1	10	18	22	0	5	3	26	3	0	1
Mlambo 9	0	0	2	11	10	0	2	1	12	1	0	0	2	0	3	8	8	0	5	0	12	1	0	0
Mlambo 10	0	0	2	10	7	2	1	2	9	3	0	0	1	0	1	10	4	2	3	3	9	3	0	0
Zama 5	6	1	0	5	8	1	1	2	12	0	0	0	6	1	0	5	8	1	1	2	12	0	0	0
Zama 6	11	0	11	10	19	0	3	10	32	0	0	0	10	0	11	11	19	0	4	9	32	0	0	0
Lulwane	4	1	3	5	7	1	3	2	13	0	0	0	4	1	3	5	7	1	3	2	13	0	0	0
Bheka 5	7	1	2	13	14	5	2	2	22	0	0	1	4	1	3	15	16	2	4	1	22	1	0	0
Bheka 6	1	0	0	2	1	1	1	0	2	0	1	0	1	0	0	2	1	1	1	0	2	0	1	0
Ndumu	0	1	2	42	34	2	2	7	45	0	0	0	0	2	3	40	33	2	3	7	45	0	0	0
TOTAL	**42**	**25**	**35**	**145**	**166**	**17**	**22**	**42**	**224**	**7**	**4**	**12**	**47**	**10**	**39**	**151**	**5**	**12**	**40**	**40**	**229**	**13**	**2**	**3**
Note: 0- Don't know/No response; 1- Not important; 2- Important; 3- Very Important																								

	Swimming												Livestock watering											
	River				Pan				Land				River				Pan				Land			
	0	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**
Mboza 3	19	0	0	5	21	0	0	3	23	0	0	1	15	0	0	9	20	0	0	4	23	0	0	1
Mboza 4	4	1	1	10	6	1	3	6	15	1	0	0	5	1	1	9	7	0	3	6	15	1	0	0
Mboza 5	1	3	3	17	18	0	0	6	21	2	1	0	2	3	5	14	14	1	4	5	22	0	1	1
Mlambo7	4	2	7	17	16	2	5	3	25	4	0	1	7	0	10	13	21	0	6	3	25	4	1	0
Mlambo 9	2	1	1	9	8	0	4	1	12	1	0	0	4	2	3	4	10	1	3	0	10	2	0	1
Mlambo10	1	0	2	9	4	2	2	4	9	3	0	0	3	0	1	8	4	2	2	4	9	3	0	0
Zama 5	6	1	2	3	8	1	1	2	12	0	0	0	6	1	2	3	6	1	2	3	12	0	0	0
Zama 6	11	0	11	10	21	0	4	7	32	0	0	0	15	0	9	8	22	0	3	7	32	0	0	0
Lulwane	4	2	3	4	7	1	3	2	13	0	0	0	4	1	3	5	6	1	4	2	13	0	0	0
Bheka 5	10	0	3	10	16	1	4	2	22	0	1	0	15	0	5	5	14	2	4	3	20	2	0	1
Bheka 6	1	1	0	1	2	1	0	0	3	0	0	0	2	0	0	1	3	0	0	0	3	0	0	0
Ndumu	5	0	1	39	40	1	1	3	45	0	0	0	2	2	2	39	34	1	3	7	44	0	0	1
TOTAL	**68**	**11**	**34**	**134**	**167**	**12**	**29**	**39**	**231**	**11**	**2**	**2**	**82**	**10**	**41**	**108**	**153**	**9**	**34**	**44**	**228**	**12**	**2**	**5**
Note: 0- Don't know/No response; 1- Not important; 2- Important; 3- Very Important																								

	Livestock grazing												Cultivated crops											
	River				Pan				Land				River				Pan				Land			
	0	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**
Mboza 3	19	0	0	5	19	0	0	5	22	0	0	2	15	0	0	9	17	0	0	7	16	0	0	8
Mboza 4	5	2	1	8	8	0	3	6	16	0	0	0	6	1	0	9	8	0	4	4	13	3	0	0
Mboza 5	3	3	5	13	14	1	4	5	22	0	1	1	3	2	4	15	24	0	0	0	24	0	0	0
Mlambo 7	12	1	5	12	24	1	4	1	21	1	2	6	13	1	5	11	17	2	5	6	16	3	3	8
Mlambo 9	7	2	3	1	9	2	2	0	8	2	0	3	6	0	4	3	10	1	2	0	5	1	2	5
Mlambo 10	4	1	1	6	8	1	1	2	6	2	1	3	7	1	0	4	10	1	0	1	6	1	1	4
Zama 5	6	2	1	3	6	1	2	3	12	0	0	0	6	1	0	5	7	2	1	2	2	0	0	10
Zama 6	14	0	10	8	23	0	4	5	31	0	0	1	15	0	8	9	24	0	3	5	29	0	1	2
Lulwane	4	1	3	5	8	1	2	2	12	0	1	0	5	1	3	4	10	1	0	2	12	0	0	1
Bheka 5	14	2	4	3	16	2	2	3	20	0	0	3	13	1	4	5	13	1	2	7	19	0	0	4
Bheka 6	3	0	0	0	3	0	0	0	3	0	0	0	3	0	0	0	2	0	0	1	0	0	1	2
Ndumu	9	0	0	36	40	1	0	4	42	1	0	2	5	1	1	38	40	1	0	4	38	1	0	6
TOTAL	100	14	33	100	178	10	**24**	**36**	**215**	**6**	**5**	**21**	**97**	**9**	**29**	**112**	**182**	**9**	**17**	**39**	**180**	**9**	**8**	**41**
Note: 0- Don't know; 1- Not important; 2- Important; 3- Very important. Some people did not respond and they are not captured in this table																								

	Water tubers												Grasses and reeds for craft making and house thatching											
	River				Pan				Land				River				Pan				Land			
	0	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**
Mboza 3	18	1	0	5	14	0	0	10	23	0	0	1	18	0	0	6	20	0	1	3	24	0	0	0
Mboza 4	7	2	2	5	7	1	3	5	15	0	1	0	9	0	2	5	8	1	4	3	15	0	1	0
Mboza 5	2	0	9	13	14	1	7	2	19	2	3	0	1	2	7	12	15	2	6	1	21	1	2	0
Mlambo 7	16	0	5	9	23	2	3	2	21	2	1	6	17	1	2	10	20	2	3	5	22	2	2	4
Mlambo 9	7	1	1	4	11	0	2	0	10	1	0	2	8	1	1	3	9	0	2	2	9	2	0	2
Mlambo 10	7	0	0	5	9	1	1	1	8	3	0	1	7	1	0	4	8	2	0	2	8	2	0	2
Zama 5	8	1	0	3	7	1	1	3	12	0	0	0	9	1	0	2	7	1	1	3	11	0	0	1
Zama 6	16	0	8	8	22	0	3	7	30	0	1	1	17	0	7	8	22	0	3	7	29	0	1	2
Lulwane	6	1	1	5	10	1	0	2	13	0	0	0	7	2	1	3	10	1	0	2	12	0	0	1
Bheka 5	17	1	2	4	13	1	2	7	19	0	0	4	11	3	2	7	14	1	3	5	15	0	1	7
Bheka 6	3	0	0	0	1	0	1	1	1	0	1	1	2	0	1	0	0	0	1	2	0	1	1	1
Ndumu	4	2	2	37	34	1	3	7	43	1	0	1	14	0	0	31	40	0	0	5	44	0	0	1
TOTAL	**111**	**9**	**30**	**98**	**165**	**9**	**26**	**47**	**214**	**9**	**7**	**17**	**119**	**11**	**23**	**91**	**173**	**10**	**24**	**40**	**210**	**8**	**8**	**21**
Note: 0- Don't know; 1- Not important; 2- Important; 3- Very important. Some people did not respond and they are not captured in this table																								

	Woodland												Bush meat											
	River				Pan				Land				River				Pan				Land			
	0	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**
Mboza 3	17	0	0	7	17	0	1	6	23	0	0	1	18	0	0	6	21	0	1	2	24	0	0	0
Mboza 4	7	2	2	5	7	2	4	3	13	0	1	2	9	1	1	5	8	1	4	3	15	1	0	0
Mboza 5	2	3	7	12	15	5	3	1	19	0	2	3	3	3	7	11	17	3	2	2	21	3	0	0
Mlambo 7	15	2	4	9	25	2	2	1	20	3	1	6	20	2	0	8	25	3	1	1	21	2	2	5
Mlambo 9	9	1	2	1	12	0	1	0	4	1	2	6	10	2	0	1	11	1	1	0	10	1	0	2
Mlambo 10	8	1	0	3	10	1	0	1	5	1	1	5	9	2	1	0	10	2	0	0	10	0	0	2
Zama 5	8	1	0	3	9	1	0	2	12	0	0	0	9	1	0	2	10	1	0	1	12	0	0	0
Zama 6	18	0	7	7	23	0	3	6	27	0	2	3	18	0	6	8	25	0	2	5	32	0	0	0
Lulwane	9	1	0	3	10	1	0	2	11	0	1	1	6	1	3	3	10	1	0	2	12	0	0	1
Bheka 5	18	1	4	0	18	0	2	3	13	1	0	9	12	3	5	3	14	6	1	2	17	3	3	0
Bheka 6	3	0	0	0	3	0	0	0	2	0	0	1	3	0	0	0	3	0	0	0	3	0	0	0
Ndumu	15	0	0	30	41	0	0	4	36	1	0	8	14	0	1	30	39	0	1	5	42	0	0	3
TOTAL	**129**	**12**	**26**	**80**	**190**	**12**	**16**	**29**	**185**	**7**	**10**	**45**	**131**	**15**	**24**	**77**	**193**	**18**	**13**	**23**	**219**	**10**	**5**	**13**
Note: 0- Don't know; 1- Not important; 2- Important; 3- Very important. Some people did not respond and they are not captured in this table																								

	Cultural practices												Irrigation of crops											
	River				Pan				Land				River				Pan				Land			
	0	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**
Mboza 3	17	0	0	7	21	0	1	2	24	0	0	0	17	0	0	7	20	1	0	3	24	0	0	0
Mboza 4	9	0	2	5	8	0	5	3	15	1	0	0	7	1	1	7	7	0	5	4	6	1	0	9
Mboza 5	2	2	8	12	15	2	5	2	20	4	0	0	3	2	5	14	15	3	4	2	21	2	1	0
Mlambo 7	15	1	4	10	21	4	3	2	24	4	2	0	14	0	3	13	23	3	1	3	26	3	0	1
Mlambo 9	7	2	1	3	10	0	3	0	12	1	0	0	7	2	0	4	10	1	2	0	12	1	0	0
Mlambo 10	8	1	0	3	10	2	0	0	10	2	0	0	9	0	0	3	10	2	0	0	10	1	0	1
Zama 5	8	2	0	2	9	1	0	2	12	0	0	0	8	1	0	3	9	1	0	2	12	0	0	0
Zama 6	16	0	8	8	24	0	3	5	30	0	2	0	18	0	6	8	23	0	3	6	31	0	1	0
Lulwane	9	1	0	3	10	1	0	2	11	0	1	1	7	1	1	4	10	1	0	2	13	0	0	0
Bheka 5	11	3	1	8	13	2	1	7	9	3	1	0	13	1	2	7	11	0	5	7	20	1	1	1
Bheka 6	1	1	1	0	2	0	0	1	3	0	0	0	2	0	0	1	0	0	2	1	3	0	0	0
Ndumu	12	1	0	32	40	0	0	5	43	0	0	2	11	0	0	34	38	0	1	6	44	1	0	0
TOTAL	**115**	**14**	**25**	**93**	**183**	**12**	**21**	**31**	**213**	**15**	**6**	**3**	**116**	**8**	**18**	**105**	**176**	**12**	**23**	**36**	**222**	**10**	**3**	**3**
Note: 0- Don't know; 1- Not important; 2- Important; 3- Very important. Some people did not respond and they are not captured in this table																								

	Abstract and purify water for domestic use												Domestic waste disposal											
	River				Pan				Land				River				Pan				Land			
	0	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**
Mboza 3	19	0	0	5	20	0	0	4	24	0	0	0	21	0	0	3	23	0	0	1	21	0	0	3
Mboza 4	9	2	0	5	8	2	3	3	15	1	0	0	9	2	0	5	8	2	3	3	14	1	0	1
Mboza 5	3	3	6	12	15	2	5	2	20	3	1	0	3	9	3	9	15	6	1	2	18	5	0	1
Mlambo 7	16	0	3	11	21	3	4	2	25	3	0	2	20	2	3	5	24	4	1	1	24	1	1	4
Mlambo 9	6	2	1	4	10	1	2	0	12	1	0	0	8	3	0	2	10	1	1	1	10	3	0	0
Mlambo 10	10	0	0	2	10	2	0	0	10	2	0	0	11	0	0	1	11	1	0	0	10	1	0	1
Zama 5	8	1	0	3	9	1	0	2	12	0	0	0	9	1	0	2	9	1	0	2	10	0	0	2
Zama 6	20	0	4	8	24	0	3	5	30	0	2	0	25	0	2	5	26	0	1	5	26	0	5	1
Lulwane	7	2	1	3	10	1	0	2	13	0	0	0	10	1	0	2	10	1	0	2	7	0	3	3
Bheka 5	13	0	1	9	17	2	3	1	20	1	1	1	19	1	3	0	19	0	4	0	17	0	2	4
Bheka 6	1	0	0	2	2	0	1	0	3	0	0	0	3	0	0	0	3	0	0	0	2	0	0	1
Ndumu	12	0	1	32	41	0	0	4	41	1	0	3	26	0	0	19	42	0	1	2	36	0	0	9
TOTAL	**124**	**10**	**17**	**96**	**187**	**14**	**21**	**25**	**225**	**12**	**4**	**6**	**164**	**19**	**11**	**53**	**200**	**16**	**12**	**19**	**195**	**11**	**11**	**30**
Note: 0- Don't know; 1- Not important; 2- Important; 3- Very important. Some people did not respond and they are not captured in this table																								

	Industrial effluent												Sand mining in the river											
	River				Pan				Land				River				Pan				Land			
	0	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**
Mboza 3	22	0	0	2	23	0	0	1	23	0	0	1	22	0	0	2	24	0	0	0	24	0	0	0
Mboza 4	9	2	0	5	8	2	3	3	15	1	0	0	9	2	0	5	8	2	3	3	16	0	0	0
Mboza 5	2	8	4	10	15	6	2	1	17	7	0	0	5	12	3	4	16	7	1	0	18	6	0	0
Mlambo 7	21	3	1	5	24	3	2	1	25	1	0	4	20	1	3	6	23	4	0	3	24	0	0	6
Mlambo 9	10	1	0	2	11	1	1	0	10	2	0	1	8	1	0	4	11	1	1	0	10	2	0	1
Mlambo 10	11	0	0	1	11	1	0	0	11	0	0	1	9	1	1	1	11	1	0	0	11	0	0	1
Zama 5	9	1	0	2	9	1	0	2	12	0	0	0	8	1	0	3	8	1	0	3	12	0	0	0
Zama 6	25	0	2	5	26	0	1	5	31	0	1	0	24	0	2	6	28	0	1	3	32	0	0	0
Lulwane	10	1	0	2	10	1	0	2	12	0	0	1	10	1	0	2	11	1	0	1	11	0	1	1
Bheka 5	18	2	2	1	17	1	5	0	20	0	3	0	16	3	0	4	19	1	3	0	17	2	2	2
Bheka 6	3	0	0	0	3	0	0	0	3	0	0	0	3	0	0	0	3	0	0	0	3	0	0	0
Ndumu	27	0	0	18	43	0	0	2	38	0	0	7	27	0	5	13	42	0	2	1	41	0	0	4
TOTAL	**167**	**18**	**9**	**53**	**200**	**15**	**14**	**17**	**217**	**11**	**4**	**15**	**161**	**22**	**14**	**50**	**204**	**18**	**11**	**14**	**219**	**10**	**3**	**15**
Note: 0- Don't know; 1- Not important; 2- Important; 3- Very important. Some people did not respond and they are not captured in this table																								

C.4. Household and crop growing activities

		Everyone	Men	Boys	Women	Girls
House hold activities	**Water collection**	7	26	24	176	65
	Fuel wood	5	7	20	174	68
	Fodder	4	19	60	84	23
	Medicine	7	26	19	107	21
	Food	9	19	18	115	24
	Fruit	12	20	23	107	33
	Cooking	2	5	6	207	76
	Wash dishes	3	5	9	198	71
	Washing clothes	6	5	7	176	59
	Looking after children	6	4	4	204	47
	Cleaning the house	2	5	6	186	59
	Tending the garden	13	29	19	147	30
	Buying goods	5	55	6	133	22
	Building and maintaining house	8	86	16	94	14
	Decision on credit	6	114	3	73	0
	Repay loans	7	108	2	74	0
	Use of loans	8	103	2	72	0
	Amount to borrow	8	99	2	76	0
	Decision on which children are to go school	5	97	20	93	26
	Decision to stop child education	19	105	20	89	35
	Pay school fee	7	110	2	109	3
	Budget Responsibility					
	Save	11	91	17	85	3
	Repay loan	5	94	4	69	2
	Spend on ceremonies	5	93	3	78	1
	Spend on household needs	5	86	3	81	2

Crop growing activities		Everyone	Men	Boys	Women	Girls
	Planting	44	45	6	172	17
	Weeding	44	39	8	162	18
	Applying fertilizer	29	28	5	125	11
	Applying pesticides	30	29	6	128	10
	Bird Scaring	28	30	17	109	11
	Harvesting	39	38	10	144	15
	Transporting harvest from fields	33	44	7	145	18
	Processing crops	24	28	5	122	13
	Marketing	16	28	3	100	8
	Buying seeds and input	21	33	3	113	8
House hold crop decision	**Which crops to grow**	21	82	2	169	6
	Where to grow crops	21	75	0	169	7
	When to plant and harvest	20	68	0	166	6
	Marketing crop produce	14	45	7	118	14

C5: Source and type of irrigation for crops grown on the floodplain

	MAIZE							**COWPEAS**							**PUMPKIN**							**SWEET POTATOES**						
	Source of irrigation			**Irrigation type**				**Source of irrigation**			**Irrigation type**				**Source of irrigation**			**Irrigation type**				**Source of irrigation**			**Irrigation type**			
	DWAF flood release	**River**	**Pans**	**Flood irrigation**	**Sprinkler**	**Bucket**	**Furrow**	**DWAF flood release**	**River**	**Pans**	**Flood irrigation**	**Sprinkler**	**Bucket**	**Furrow**	**DWAF flood release**	**River**	**Pans**	**Flood irrigation**	**Sprinkler**	**Bucket**	**Furrow**	**DWAF flood**	**River**	**Pans**	**Flood irrigation**	**Sprinkler**	**Bucket**	**Furrow**
Mboza	7	33	10	5	0	1	4	2	3	0	1	0	0	0	4	19	6	6	6	2	0	5	14	3	0	0	3	0
Mlambo	29	21	1	9	0	2	1	0	1	0	2	0	0	0	10	11	2	1	0	0	1	17	16	1	6	1	0	1
Zama-Zama	17	11	3	7	0	10	0	0	0	0	0	0	0	0	6	7	1	3	0	5	0	5	4	1	3	0	4	0
Lulwane	1	3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Bhekabantu	1	6	11	0	0	11	0	0	0	0	0	0	2	0	0	1	3	0	0	3	0	2	1	8	1	4	4	0
Ndumu	16	23	2	6	7	13	0	2	3	0	1	1	0	0	6	13	1	1	3	6	0	6	14	1	1	6	7	0
TOTAL	71	97	27	27	7	38	5	4	7	0	4	1	2	0	26	51	13	11	9	16	1	35	51	14	11	11	18	1

	COTTON							BEANS							MANGOES							GROUNDNUTS						
	Source of irrigation			Irrigation type				Source of irrigation			Irrigation type				Source of irrigation			Irrigation type				Source of irrigation			Irrigation type			
	DWAF flood release	River	Pans	Flood irrigation	Sprinkler	Bucket	Furrow	DWAF flood release	River	Pans	Flood irrigation	Sprinkler	Bucket	Furrow	DWAF flood release	River	Pans	Flood irrigation	Sprinkler	Bucket	Furrow	DWAF flood	River	Pans	Flood irrigation	Sprinkler	Bucket	Furrow
Mboza	3	4	4	1	0	2	0	2	13	3	0	0	4	0	2	7	2	0	0	2	0	5	7	3	0	0	2	0
Mlambo	6	4	2	1	0	1	1	18	11	2	5	0	1	1	3	8	0	1	0	0	0	10	10	0	3	0	0	0
Zama-Zama	1	0	0	1	0	0	0	2	2	2	2	0	2	0	1	1	0	1	0	1	0	3	3	1	1	0	2	0
Lulwane	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Bhekabantu	0	0	1	0	0	0	0	1	1	5	0	1	5	0	1	2	3	0	2	3	1	1	1	4	0	2	3	0
Ndumu	1	5	0	1	0	3	0	6	5	1	1	3	1	0	4	6	1	1	2	2	0	4	5	2	1	1	1	0
TOTAL	11	13	7	4	0	6	1	29	34	13	8	4	13	1	11	24	6	3	4	8	1	23	27	10	5	3	8	0
	SUGARCANE							SPINACH							TOMATOES							ONIONS						
	Source of irrigation			Irrigation type				Source of irrigation			Irrigation type				Source of irrigation			Irrigation type				Source of irrigation			Irrigation type			
	DWAF flood release	River	Pans	Flood irrigatio	Sprinkle	Bucket	Furrow	DWAF flood release	River	Pans	Flood irrigatio	Sprinkle	Bucket	Furrow	DWAF flood release	River	Pans	Flood irrigatio	Sprinkle	Bucket	Furrow	DWAF flood	River	Pans	Flood irrigatio	Sprinkle	Bucket	Furrow
Mboza	2	2	2	0	0	1	0	3	8	3	1	0	1	0	2	5	3	0	0	2	0	2	5	2	0	0	2	0
Mlambo	6	8	0	1	0	1	0	3	4	2	1	0	1	1	5	6	0	0	0	5	0	7	7	0	1	0	5	0
Zama-Zama	1	0	0	1	0	0	0	3	3	1	1	0	3	0	5	2	1	1	0	3	0	3	2	1	1	0	2	0
Lulwane	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bhekabantu	0	1	3	0	1	1	0	1	1	6	0	1	5	0	1	2	5	0	2	3	0	1	1	6	0	2	3	0
Ndumu	3	5	0	1	2	1	1	6	8	1	1	2	4	0	4	3	0	1	2	1	0	5	5	1	1	2	1	0
TOTAL	13	16	5	3	3	5	1	16	24	13	4	3	14	1	17	18	9	2	4	14	0	18	20	10	3	4	13	0

	CABBAGE							CASSAVA							BANANAS							MADUMBES						
	Source of irrigation			Irrigation type				Source of irrigation			Irrigation type				Source of irrigation			Irrigation type				Source of irrigation			Irrigation type			
	DWAF flood release	River	Pans	Flood irrigation	Sprinkler	Bucket	Furrow	DWAF flood release	River	Pans	Flood irrigation	Sprinkler	Bucket	Furrow	DWAF flood release	River	Pans	Flood irrigation	Sprinkler	Bucket	Furrow	DWAF flood	River	Pans	Flood irrigation	Sprinkler	Bucket	Furrow
Mboza	3	12	5	1	0	5	0	0	2	0	0	0	0	0	2	5	3	0	0	2	0	2	5	2	0	0	2	0
Mlambo	6	7	0	1	0	5	0	1	1	1	1	0	0	1	9	4	1	2	0	0	0	1	0	0	1	0	0	0
Zama-Zama	3	3	1	1	0	2	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	1	1	1	1	0	1	0
Lulwane	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0
Bhekabantu	1	2	8	0	1	7	0	1	2	2	0	1	4	0	1	2	3	0	1	4	0	0	1	2	0	1	1	0
Ndumu	4	7	1	1	3	3	0	6	9	0	1	5	5	0	5	7	0	1	3	3	0	3	7	1	1	0	3	0
TOTAL	17	32	15	4	4	22	0	8	15	3	2	6	9	1	18	21	7	4	5	9	0	7	15	6	3	1	7	0

C6: Crop calendar

Crop	Land preparation	Planting	Application of fertilizers	Application of pesticide	Harvesting time	Quantity of crop harvested	Price for selling	Amount eaten and sold	Buyers
Maize	Aug, Sept & Oct	Sept, Oct & Nov	Oct & Nov	Oct & Nov	From Dec to March	Min- 3 * 50 Kg; Max- 3 Tons// 80* 50Kg	R100 – R150 per 50Kg; R1 – R2 per cob	More eaten than sold	Makhathini, Manguze, Jozini and local people
Cotton	Aug & Sept	Aug, Sept, Oct & Nov	Sept to Nov	Sept to Dec	Apr, May Jun	From 3 to 10 bails	R500 – R800/ Bail	100% sold	Mjindi
Sugar cane	June, July & Oct	Aug, Sept, Nov	No	No	Apr - June	1 Ton/Ha, 50Kg	R1/stick	More sold than eaten	Phongolo sugar milers, Truck people and community members
Beans	Jan, Feb, March, Aug, Oct, Dec	Jan, Feb, Aug – Nov	Feb, Sept, Nov	Feb, Sept, Nov	Feb - Sept	100 * 50 Kg; %0 Kg	R200/50 Kg	More eaten than sold	Mjindi and local people
Cabbage	Feb – May, Aug, Dec	Feb, Apr – Jun, Aug, Sept, Dec	Apr & Jun	No	Jan, March, Jun – Sept,	50 – 70 Heads; 3*25 Kg	R25/R25 Kg, From R2.50 each	More eaten than sold	Local people
Spinach	Anytime of the year		No	No	-	-	From R2.50 a bunch	More eaten than sold	Local people
Pumpkin	Aug – Nov	Aug – Dec	No	No	Dec, Jan, Feb	10 - 50	From R2.50 to R10	More sold than eaten	Local people
Cassava	-	-	-	-	-	-	-	More eaten than sold	

Mangoes		April, Aug	No	No	July, Dec	1 – 5 sacks	R35/50 Litre	More sold than eaten	Local and people from far
Tomatoes	Apr –May	May – Aug	-	-	Oct - Jan	50 Kg	R40/ crate	More eaten than sold	Local people
Bananas	Aug	Aug	Sept, Nov	Sept, Nov	Nov, Dec, Feb	50 Kg	R30/50Kg R4/8	More sold than eaten	Local people and people from far
Paw Paw	Aug	Aug	July	July	Dec		R4.50/6	All eaten (few cultivated)	
Sweet potatoes	Anytime of the year	Jan, Feb, Apr, Jun, Jul, Sept Oct Nov	No	No	Jan, Feb, Jun, Aug, Sept	1- 6 Kg	R3 - R5/Kg	More eaten than sold	Local people
Groundnuts	Aug, Sept, Oct	Aug, Sept, Oct	Nov	No	Dec & Jan	50*50 Kg/Ha	R150 – R300/50 Kg	More sold than eaten	Local people
Onions	Anytime of the year	-	-	-	-	Maximum 50 Kg	R10/bag; R2.50/ Kg	More eaten than sold	Local people
Madumbe	Not needed	Anytime	No	No		Depend	R12/5 L	More eaten than sold	Local people
Mazibu	Not needed	-	No	No	Mostly December	Depend		Mainly for consumption	-

C.7: Crop quality change with season

		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Mboza	Best crop	4	4	3	-	1	1	2	1	1	3	2	5
	Not so good	1	2	3	1	1	2	1	-	-	-	-	1
	Bad crop	1	-	1	-	1	3	2	1	-	-	-	1
Mlambongwenya	Best crop	9	1	-	-	1	2	1	-	1	-	5	6
	Not so good	1	3	3	3	-	-	-	-	1	-	-	-
	Bad crop	-	-	-	-	1	4	2	1	-	-	-	-
Zama-Zama	Best crop	2	2	-	-	-	-	-	-	1	2	3	3
	Not so good	1	-	-	-	-	1	2	1	1	-	-	
	Bad crop	-	-	1	-	2	2	-	-	1	-	-	-
Lulwane	Best crop	2	-	-	-	-	1	-	-	-	-	-	1
	Not so good	-	-	-	1	-	-	-	-	-	-	-	-
	Bad crop	-	-	-	-	1	1	-	-	-	-	-	-
Bhekabantu	Best crop	9	8	1	1	4	7	7	-	-	-	4	5
	Not so good	1	2	4	5	6	2	1	3	4	4	1	-
	Bad crop	-	-	-	1	2	3	3	1	-	2	1	-
	Best crop	4	-	-	-	-	1	1	3	4	5	5	7

Ndumu	Not so good	2	-	2	4	3	4	1	-	-	-	2	2
	Bad crop	3	-	2	2	3	6	3	1	-	-	-	-
TOTALS	**Best crop**	**30**	**15**	**4**	**1**	**6**	**12**	**11**	**4**	**7**	**10**	**17**	**27**
	Not so good	**6**	**7**	**12**	**14**	**10**	**9**	**5**	**4**	**6**	**4**	**3**	**3**
	Bad crop	**4**	**-**	**4**	**3**	**10**	**19**	**10**	**4**	**1**	**2**	**1**	**1**

C.8 Local institutions and groups

	DWAF					**DOA**					**DEA**				
	Don't know	**Not all**	**Not so important**	**Important**	**Very important**	**Don't know**	**Not all**	**Not so important**	**Important**	**Very important**	**Don't know**	**Not all**	**Not so important**	**Important**	**Very important**
Mboza	8	1	0	8	18	5	1	1	9	18	9	3	1	8	20
Mlambongwenya	2	1	4	17	23	6	9	8	10	12	5	10	7	8	8
Zama-Zama	2	2	2	3	14	2	1	1	2	5	1	1	1	2	7
Lulwane	0	1	0	1	7	0	0	1	0	1	0	1	0	0	0
Bhekabantu	2	1	0	6	11	3	3	2	6	2	3	3	1	8	2
Ndumu	0	0	2	0	12	0	0	1	0	10	0	0	0	2	10
TOTALS	**14**	**6**	**8**	**35**	**85**	**16**	**14**	**14**	**27**	**48**	**18**	**18**	**10**	**28**	**47**
Note: Some people did not respond and they are not captured in this table															

	DoH					**KZN Wildlife**					**Chief**				
	Don't know	**Not all**	**Not so important**	**Important**	**Very important**	**Don't know**	**Not all**	**Not so important**	**Important**	**Very important**	**Don't know**	**Not all**	**Not so important**	**Important**	**Very important**
Mboza	2	0	3	17	26	9	6	2	10	14	0	2	2	13	31
Mlambongwenya	3	0	1	14	24	3	6	9	4	6	3	4	7	9	24
Zama-Zama	0	0	0	4	16	1	2	0	2	9	1	2	4	5	22
Lulwane	0	0	0	1	2	0	0	0	0	0	0	1	1	1	2
Bhekabantu	0	0	0	1	18	3	5	3	2	4	2	3	2	6	10
Ndumu	0	0	0	2	20	0	0	0	4	25	0	0	0	0	43
TOTALS	**5**	**0**	**4**	**39**	**106**	**16**	**19**	**14**	**22**	**58**	**6**	**12**	**16**	**34**	**132**

	Isinduna					**Elected councilor**					**Municipality**				
	Don't know	**Not all**	**Not so important**	**Important**	**Very important**	**Don't know**	**Not all**	**Not so important**	**Important**	**Very important**	**Don't know**	**Not all**	**Not so important**	**Important**	**Very important**
Mboza	1	1	5	15	30	5	2	7	10	21	4	4	6	7	23
Mlambongwenya	1	3	7	12	25	3	3	5	12	22	2	6	4	7	4
Zama-Zama	0	2	7	4	20	2	1	5	2	19	2	1	0	1	10
Lulwane	0	1	1	1	2	0	1	1	0	2	0	0	0	0	0
Bhekabantu	0	0	4	5	14	1	7	1	5	6	2	1	1	4	12
Ndumu	0	3	1	0	37	0	1	0	2	38	0	0	0	0	27
TOTALS	**2**	**10**	**25**	**37**	**128**	**11**	**15**	**19**	**31**	**108**	**10**	**12**	**11**	**19**	**76**
Note: Some people did not respond and they are not captured in this table															

	Groups					**Association, Committees & Co - operatives**					**Cultural groups**				
	Don't know	**Not all**	**Not so important**	**Important**	**Very important**	**Don't know**	**Not all**	**Not so important**	**Important**	**Very important**	**Don't know**	**Not all**	**Not so important**	**Important**	**Very important**
Mboza	13	1	4	3	3	5	0	0	13	10	5	0	0	16	25
Mlambongwenya	6	0	3	0	1	0	7	0	0	11	1	2	1	8	25
Zama-Zama	1	0	0	0	0	0	1	0	0	15	1	1	2	1	20
Lulwane	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Bhekabantu	7	1	0	0	1	2	1	1	4	12	0	0	0	3	19
Ndumu	1	0	0	0	4	0	0	0	0	27	0	0	0	0	40
TOTALS	**28**	**2**	**7**	**3**	**9**	**7**	**9**	**1**	**17**	**75**	**7**	**3**	**3**	**28**	**130**
Note: Some people did not respond and they are not captured in this table															

C.9 Hydrology perceptions

Rainfall perception

Months	Mboza	Mlambongwenya	Zama-Zama	Lulwane	Bhekabantu	Ndumu
January	2	7	5	0	4	0
February	3	4	6	3	6	1
March	0	1	1	1	0	0
April	0	0	0	0	0	0
May	0	0	0	0	0	0
June	0	1	0	1	0	2
July	0	0	0	2	1	0
August	9	16	4	2	5	2
September	18	11	6	3	5	5
October	20	19	11	1	4	16
November	10	15	2	0	6	7
December	4	9	2	0	5	9

Artificial Flood perception

Months	Mboza	Mlambongwenya	Zama-Zama	Lulwane	Bhekabantu	Ndumu
January	0	0	0	0	1	0
February	0	1	2	1	3	0
March	2	1	1	0	1	0
April	0	0	0	0	0	0
May	2	0	0	0	0	0
June	0	0	1	0	0	3
July	3	2	1	0	2	3
August	4	16	3	1	4	5
September	16	12	5	1	3	2
October	1	16	4	0	1	6
November	7	2	1	0	0	4
December	7	1	0	0	3	1

Artificial flooding needs

Months	Mboza	Mlambongwenya	Zama-Zama	Lulwane	Bhekabantu	Ndumu
January	1	6	5	1	1	0
February	1	2	5	1	0	0
March	1	1	2	1	0	2
April	3	0	0	0	0	1
May	1	0	0	1	0	0
June	2	0	2	2	1	1
July	3	4	0	4	1	3
August	7	15	9	9	1	11
September	21	10	6	2	2	7
October	3	10	4	1	0	8
November	7	2	0	1	0	3
December	7	1	1	1	0	0