Farming Systems within Protected Areas and dealing with drought and elephant invasion: Climate change challenges in Limpopo National Park, Mozambique

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Abstract

Drought and elephants are interconnected factors that determine food security in the Limpopo National Park (LNP) Multiple Use Zone (MUZ) communities. About 30.000 people inhabit the so called MUZ relying on rain fed agriculture for their livelihoods. The low and unpredictable rainfall pattern (320 to 450 mm year^{-1}) under semi arid conditions, coupled with low input technology shape the main farming systems. Cropping in different locations, seeding at every rainfall event regardless of the season, mixed crops to ensure crop diversity and reduce crop failure risk are some of the adaptive strategies of MUZ communities to cope with recurrent drought events. The effectiveness of all the adopted strategies is further challenged by elephant invasion in the park setting, with consequent crop damage. This paper assesses how MUZ communities respond to drought and elephant pressure to overcome food insecurity. Participant observation, in-depth and semi-structured interviews, participatory mapping and a survey with 106 households were used to gather qualitative and quantitative data on socio-economic and seasonal livelihoods variations, between February 2008 and July 2009. Results show a positive relationship between droughts and crop damaged by elephants. The number of elephant raids increases with intensity and severity of drought, up to five or more invasions per cropped area. As a consequence, 48.1% of households reduced the cropped area while 52% also decreased crop diversification, and therefore amplified their exposure to food insecurity due to the limited livelihood opportunities. The limited opportunities for diversifying MUZ livelihood and overcoming food insecurity call for urgent intervention to seek alternative Park management strategies. A systemic and action-oriented approach is proposed to work towards harmonizing people-wildlife coexistence.

1. Introduction

Small scale or subsistence farming systems are a prominent feature of agriculture in Mozambique. About 99.6% of the registered farms are classified as small scale farming, often characterized by 0.1 to 0.5 ha size cropping plots under rain fed conditions, using low input technologies and consequently low productivity (INE, 2011). For instance, the average yield of maize (the most important staple crop) is estimated at 1.4 ton/ha compared to its potential of 5-6.5 ton/ha (Cunguara, 2011). In the semi-arid areas the average yield is even lower, ranging from 0.5 to 0.9 ton/ha (Goodbody, *et al*, 2010).

The Limpopo National Park (LNP) in Mozambique was established in 2001 as part of the Great Limpopo Transfrontier Park (GLTP) initiative which integrates two other parks, namely, Kruger National Park in South Africa and Gonarezhou National Park in Zimbabwe. LNP differs from the traditional protected areas due to the presence of a buffer zone within the park boundary. LNP is located in the semi-arid area of Northwest Gaza Province, in south Mozambique, covering an area of 1.123.316 ha of which 20.9% is allocated to the buffer zone or also called the Multiple Use Zone (MUZ). The MUZ hosts about 30.000

people distributed in 44 villages along Limpopo and Elephants Rivers (Ministry of Tourism, 2003). The MUZ policy for LNP tolerates natural resource exploitation for subsistence purposes, except hunting which is prohibited under any circumstances (Ministry of Tourism, 2003). Subsistence farming under dry conditions shapes the main livelihood of LNP communities in the MUZ. The rainy season lasts from October to March with an annual rainfall varying between 320 to 450 mm and the maximum average temperature oscillates between 29-35^{o}C (Brito, et al. 2009). However, due to the climate change phenomena, evidences suggest a Southern African region even drier with an increase of variability and intensity of extremes (Silva *et al*., 2010; McCluskey and Qaddumi, 2011) tendency also observed for Mozambique. Rainfall patterns are changing in South Mozambique. According to INGC climate change report (2009) the expectations for the region are, a decrease in the rainy season length with a later start of rains and an increase in evaporation which will result in reduced soil moisture before the main cropping season starts. The erratic and scarce rainfall makes the area drought prone and vulnerable to food insecurity. This situation is worsened by the presence of elephants that impact on the farmers' already limited coping strategies, leaving the community without options and unable to explore the limited natural resources opportunities to overcome drought related vulnerability. This paper describes how elephants affect the seasonal and spatial farming strategies adopted by the farming communities inhabiting the LNP's MUZ in their efforts to overcome drought related crop failure, taking the case of Macaringue village. The first three sections of the paper elaborate on the farming systems in the context of semi-arid and protected areas emphasizing the main relationship aspects highlighted in the paper, including the livelihood development opportunities and the conservation dilemmas. Following a summary of the methodology used for data collection, the results are presented starting with a description of the existent farming system in the Macaringue LNP village, a discussion of the effect of drought and elephants on the system as well as the coping strategies implemented by the community to overcome food unavailability. The paper concludes by reflecting on the crucial aspects and exploring research alternatives to address such a complex situation.

2. Farming Systems in the Protected Areas Context

According to IUCN (2007) Protected Areas (PA) is "*a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values*". The Limpopo National Park (LNP) is a wildlife protected area which has to deal with issues at the people-wildlife interface. The debate about whether protected areas remain protected with or without human inhabitants is not settled. Hawken and Granoff (2010) have recently argued for the need to move beyond the people-parks debate and re-imagine the concept of parks itself, drawing on Foucault's analysis of society and space. Foucault (1986) referred to two kinds of spaces, 'utopia' as the one we imagined but with no actual place, and 'heterotopia' as the one that is imagined and yet also had a real place. Hawken and Granoff (2010) draw on this concept of heterotopia as a useful way to articulate the complexity of parks and protected areas as both imagined places premised on the idea of pristine and untouched nature separate from humans, and as physical places often influenced and inhabited by humans. The farming systems concept is adopted here in a holistic perspective taking the whole Macaringue community as a system of interest by exploring the farming practices, strategies, interconnections and relationships applied by the households to overcome the effect of climate change phenomena. Additionally, being the community located inside a National Park, its interaction with wildlife (in this case elephants) adds to the multifaceted and complex situation.

3. Semi-arid Farming systems and climate change challenges

Climate change has been acknowledged as a set of challenging phenomena in the efforts to ensure food security in Africa, some even designating Saharan Africa as the food crisis epicenter of the World (Scholes and Biggs, 2004). Its impact is expected to deteriorate the already vulnerable condition of the poor. Studies on climate changes projections reported 5-8% increment of arid and semi-arid areas in Africa by 2080, and water scarcity affecting 75 to 250 million people by 2020 (IPCC, 2007). Other studies (Jones and Thornton, 2003; Thornton *et al.* 2008; and Thornton *et al*. 2009) alerted that the warming and drying effects of climate change may decline 10-20% of crop yield by 2050 in sub-Saharan Africa affecting especially poor croppers and livestock keepers. Such conditions influence all farming and livelihood systems, impacting especially people whose farming and livelihood are rain dependent. More than 90% of the staple food in Mozambique is being provided by rain-fed farming systems (INE, 2011), a situation which is being challenged by the climate change circumstances. Based on INGC climate change report (2009), the drought worse scenario for Mozambique is expected to be in the South, where most of semi-arid areas are concentrated. Rain is expected to reduce in amount and length of rainy season, leading to a later start of the rainfall season. In addition, the evaporation is predicted to significantly increase in the Limpopo valley which will result in decreasing in soil moisture before the main cropping season starts. These changes have already been perceived by local communities and reflected in their farming practices. The present research has tracked the changes in and responses to climate variability adaptation of the Macaringue farming systems.

4. People-Park interaction towards livelihood and food security

By rethinking human-wildlife conflict raised by the strict protected area regimes and the associated social and ecological costs that eventually threaten the long term viability of the protected area itself (Pimbert & Pretty, 1995; King, 2007) and also lead to animal extinction (Woodroffe, *et al* 2005); management ideas behind protected areas have been shifting from a strict protection and preservation approach to the multiple uses and sustained production (IUCN, 1994) where for example people and wildlife are allowed to coexist. However, debates whether conservation policies should prioritize biodiversity, landscape and wildlife protection or poverty alleviation or livelihood improvement persist. Despite the benefits such as harvesting forest products and animal species for food and other uses, people-wildlife interaction has been contested due to negative impacts that over ride the positive ones. Wildlife including threatened species can cause significant loss of human lives and livelihood (Thirgood*, et al* 2005). Currently the debate is centered in assessing the last 20 years trials of different approaches (e.g. such as integrated Conservation and Development, Community based Natural Resources Management, Ecosystem Services and few others) in its attempt to accommodate conservation and improvement of people's livelihoods (Sayer and Campebell, 2004; McShane, *et al.* 2011). From a conservation perspective, integrated projects that rely on extraction and use of natural resources are being seen as ecologically unsound. Similarly, on the human well-being side, the effort to link economic benefits to conservation and development initiatives are being claimed as unable to provide the necessary income-generating, labour intensive activities that satisfy the livelihood needs of local people (Sayer and Campbell, 2004). In addition, McShane *et al.* (2011) also argue that win-win solutions to promote both conservation and human well-being can hardly be attained, as it does not reflect the multiple dynamics and complexity of the majority of conservation and development scenarios and it imposes hard choices. According to them, choices are hard because they involve trade-offs between different interests and priorities, between long versus short term time horizons and between benefits at one spatial scale and costs at another. Following the same arguments within LNP scenario and despite the 20% sharing of park revenues with the communities, farmers do not perceive the park as a benefit. On the one hand, this is, because elephants have added a threat to the farming system which also weakens the farmers' drought coping strategies. On the other hand, the park´s natural resource use policy has limited the livelihood options, since part of activities such as hunting and charcoal production adopted by the farmers to overcome drought related food unavailability are no longer permitted in the MUZ of the LNP.

5. Methodology

A participatory research approach was used in this study and the combination of data collection methods used were transect walk, in-depth interviews with key informants, and focus group discussion. Participatory mapping was used in order to understand the natural resources distribution, uses and its variability over seasons. A systematic semi-structured interview method was also used to gather qualitative information for describing the farming system and respective seasonal variability among households including different coping strategies, ownership of assets and main sources of income. To collect quantitative information on selected indicators about household socio-economic characteristics, cropping land, food production and availability, frequency of elephant invasion and crops damaged, 106 households were surveyed following a proportional (25% of each settlement population) and random sampling. The data presented and analyzed in this paper constitutes a 2-year old baseline study which now becomes the start of longer term research and in so doing helps sharpen the problem context.

6. Results and Discussion

6.1 Farming systems in practice at Macaringue LNP

Cropping and animal husbandry are the two main livelihood means in the Macaringue community. Cropping has an important role in food supply while cattle are the safety net of the household, and also an important determinant of the cropping system. The size of cropping area and the household's capacity for resilience depend partially on cattle possession and size of the herd. Smaller species of farm animals such as goats, sheep and chicken play the saving and trade coin role, especially for immediate needs such as seeds, schools materials and other domestic needs. From the survey data (n=106), livestock numbers show positive trend from year 2000 to 2009. Most livestock was lost during the 2000 flood event with 51% households reporting to have lost their cattle, compared to 23% of the respondents who indicated not owning cattle in 2009. In total 77.4% of households own cattle, of whom 44% own more than 5 heads of cattle. On the other hand, although fewer households referred to not owning goats in 2009 compared to the 2000 period, the majority (34.9%) of households own 5 - 10 goats.

Regarding cropping, three main land and water system characteristics spatially shape the cropping system in Macaringue MUZ.

The river terraces locally named "*banhine*" characterized by alluvial and grey clay soils are the main cropping locations, with holdings extending from 1 to 5 or more hectares, and maize as the main crop. However, the size of cropped area varies seasonally depending on the rainfall patterns (amount, distribution and the length). A second type of cropped area, locally called "*mananga*" (the upland) and located inside the forest, is formed by red sandy soils and only cropped if the rainy season is regular and lasting longer. These are fenced[1] plots ranging in size from 1/8 to ¼ ha and groundnuts, *bambara* nuts, watermelon are exclusively grown in this area. The wetlands and river flooded plots (*mitanguene)* as locally called is the third system which remain as the last type being cropped in a regular rainy season and first and strategic type to be explored in a "bad" or dry season. It is characterized by dark and heavy soils, normally very fertile due to residues deposition during flooding. Vegetables (pumpkin, cabbage, onions and tomato) are essentially grown in this section of the landscape in good rainy season while, in bad or dry season, it plays a contingency role and a combination of at least six different crops can be found being grown here. Plot location determines the type and combination of crops; for instance, maize, pumpkins and sweet potatoes are cropped by the majority of the households in the river terraces in normal year (sufficient rain), and also in other well watered locations such as flooded area and wetlands. The upland (*mananga*)

[1] Fencing in this case is to keep cattle out as the overlaps with the grazing area. Fencing is done with tree branches.

is dominated by leguminous crops (groundnuts, *bambara* nuts and cowpea) and watermelon, while wetland and flooded plain areas are likely to have a mixture of all possible crops in the same plot.

Grazing areas are also interchangeable according to the season and rainfall pattern within and between seasons. The herds are moved from areas around the households and close to river terraces in a good rainy season to more distant areas towards the forest or are maintained by feeding them with crop residues in the field. In critical years with almost no rain, some households moved the herds to other villages with which they have social relationships.

Rainfall variability between and within seasons has an effect on crop productivity as discussed by Cooper *et al.* (2008) but also influences crop diversity. The adoption of high crop diversity in wetlands and flooded plains in irregular rainfall years is seen by the households as a risk management strategy. According to them, planting crops varying in their levels of water demands increases their chances of harvesting some of the crops. This is a common practice among smallholder farmers in regions where water is a limiting factor, although from a crop management perspective it can be argued that increasing planting density increases intra and inter specific competition, especially in water stressed environments (Molla and Sharaiha, 2010).

6.2 Drought and Elephant Effects to the LNP MUZ Farming System

Precipitation patterns (quantity, distribution and length of the rainy season) determine the size of the cropping plot, the number of cropped fields, type of crops and location of the fields as seen above. Rainfall is perceived by the community as becoming irregular and insufficient for their needs from 2002 onwards. 82% of the 106 survey respondents characterized the length of rainy season as decreasing and 92.4% described rainfall as being concentrated and intense. These figures are supported by climate change studies by INGC (2009) where projections indicate an increment of temperature, increase of evaporation and therefore dryness amplification for Gaza province. The Macaringue community responded to these changes by reducing the cropped area in 48% of the cases with the remaining 52% saying that they reduced both cropped area and crop diversity under these conditions leading to seasonal food deficit. About 78.3% claimed to have suffered a worsening of the food situation with months of food unavailability going up from 3 to 5 or more months. Selling off animals (goats and cattle) is the most important coping alternative adopted to overcome the crisis (Table 1). Likewise, livestock is also negatively affected by the reduced cropped area, as it decreases the availability of crop residues to overcome drought related lack of pasture.

Table 1: Periods of food shortage and different coping strategies.

Response to shortage of food	Period of Food shortage			Total
	4 months	5 months	6 months and more	
Animal Selling	11,3%	14,2%	12,3%	**37,7%**
Wetland crops	2,8%	4,7%	11,3%	**18,9%**
Labour selling	2,8%	5,7%	5,7%	**14,2%**
Remittances	,9%	3,8%	3,8%	8,5%
Animal selling and Remittances	,9%	3,8%	1,9%	6,6%
Other	2,8%	3,8%	4,7%	11,3%
Miss Value		,9%	1,9%	2,8%
Total	21,7%	36,8%	41,5%	100,0%

On the other hand, the pressure of elephant invasion and crop raiding is positively related to intensity of drought. Elephant movements towards the river increased with the intensity of drought and the pressure of crop raiding also increased yearly with the rapid rise in elephant population created through free crossing between Kruger National Park and LNP. For instance, during the four year period of 2002-2006, the elephant population has been reported to have grown from 600 to 1000 animals (Milgroom & Spierenburg, 2008) and probably exceeding 2000 in number in 2009. In the dry season, elephants moved from wildlife LNP core area to the MUZ toward the Limpopo and Elephant Rivers to fetch water and in doing so they crossed the main cropping fields causing massive damage through consuming the crops and directly affecting the crop land through trampling. The double impact of the crop raiding in this period on the households should be noted here: the direct destruction of crops at one level and the reduced capacity of the household to respond to droughts, in other words, the destruction of their drought coping strategy at a second level. The number of elephant invasions and the extent of the damage are also seasonally variable, both becoming more severe with the increasing intensity of the drought (Figure 1). From the survey, 84.9% shared the view that elephant invasion and consequent crop raiding happened more often in the dry season and that the frequency of invasion ranged between 3 and 5 times in anyone cropped area.

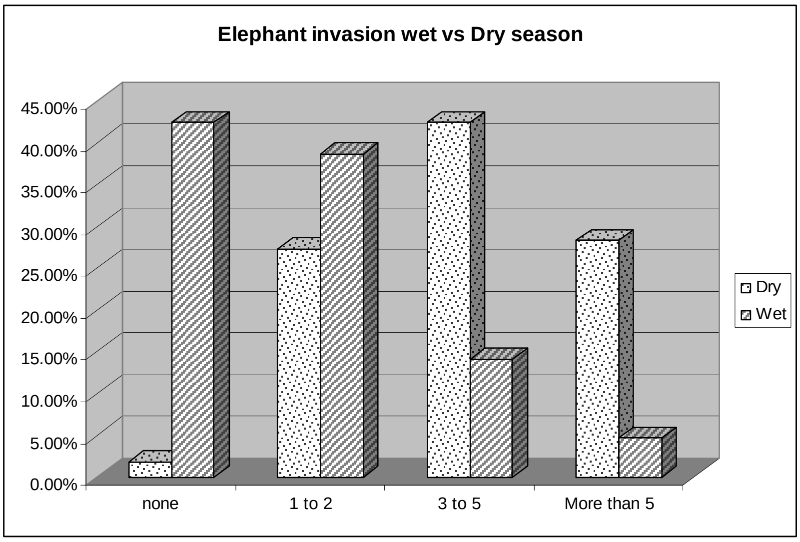

Figure 1: Frequency of elephant invasions in wet and dry seasons.

The exposure to elephants has influenced the cropping system in recent times. For instance, cropping locations such as upland areas where staple leguminous crops were produced have been abandoned partly because of the lack of rain (23.96%) but mainly due to elephants (40.6%) or a combination of both (18.75%). When exploring the alternative locations for growing these crops, about 56% of the respondents argued that the soil characteristics in other available locations were not appropriate, while 41% stated that they have tried to grow crops in river terraces and flood plain areas without any success. The lack of rain in combination with the presence of elephants has threatened the main livelihood source for the community, limiting their potential for exploiting the soil and water system to overcome drought related food shortages. Climate variability was already pointed as an additional risk element by Limpopo River Basin farmers, as it leads to coping strategies that are not well suited for a commercial farming (Silva *et al.*, 2010). The same authors argued that farming techniques such as seeding many small plots are well adapted to manage environmental variability but play against the transition from subsistence farming system to more commercial agriculture which was needed to overcome economic stressors posed by the economic globalization. By being surrounded by a national park, these smallholder farmers not only have to deal with the constraint of adapting farming techniques that respond to environmental variability and not compatible with the challenges posed by economic stressors , but have also to manage the pressure of wildlife (elephants in this case) which adds more complexity to their farming systems at hand.

6.3 Adaptive strategies of MUZ communities of LNP towards Food Security

Cropping at different water holding locations such as wetlands, river basin, or other flooded areas, continuous crop trials by seeding at every rainfall event regardless of the season, and mixing crops to ensure crop diversity as a way of reducing crop failure risk were the main adaptive strategies practiced by the community to cope with recurrent drought events. However, due to elephant invasions, cropping close to water bodies has become a challenge, especially in the dry season when humans and elephants compete for the same source of water. Despite the efforts of the community to protect their crops against the elephants by staying overnight in the field and chasing the elephants using different strategies such as fire, use of whistles and drum noise, invasion and destruction of the crops has not gone down. Consequently, households have been concentrating their efforts (labour, fencing, and guarding) by growing crops in single small plots instead of in large or dispersed fields which they could not protect from elephant invasion. This strategy works against the option of crop diversification which has been described as an appropriate drought adaptation strategy (Cooper et al, 2008; Deressa et al, 2009; Hahn, et al, 2009). Additionally, it also goes in contradiction to what was reported by Silva, *et al.* (2010) as strategy used by farmers in the Limpopo Basin to respond to climate vulnerability by seeding several different small plots among high and low lying areas in order to be able to exploit different microclimates. Another important strategy that has been widely used in Macaringue village is the earlier harvesting of maize (while still wet) as soon as an alert of elephant invasion is received. However, this practice remained only as a temporary option and an immediate response to the elephant raiding threat, and not a long term solution; as the maize harvested this way could not therefore be stored for longer than 2 months. Irrigated vegetable growing with the use of a water pump has been another option for some community members, but this too had to be abandoned due to constant elephant threats as well as increasing fuel costs.

These results reveal the need to rethink subsistence farming systems as sources of people's livelihoods in rural semi-arid environments which are also affected by multiple factors such as climate change, wildlife presence and poor infrastructures. If the adopted strategies continue to fail, it might lead to greater degrees of unwillingness on the part of farmers to make new adaptation choices, as Patt & Schroter (2008) argued that people's decision to take an action is linked to both gains and losses that result from such action and when this is dominated by the potential losses they have a tendency to do nothing. On the other hand, Deressa, et al (2009), emphasize the importance of analyzing the factors affecting the choice of the adaptation methods since farmers' response to climate change is determined by a multitude of socio-economic and environmental factors.

6.4 Factors favoring adaptive strategies in LNP MUZ Communities

Nuclear versus Extended Households

In a majority of the interviewed households (64.2%), extended households with more than 2 families made up the household. More than 20 members share shelter, food and livelihood sources, but they provide additional labour force and/or the opportunity to diversify livelihoods. For instance, extended households held a higher chance of having more than one member in South Africa as immigrant workers, therefore with the assurance of receiving remittances to the families. Thus, extended households are seen as an advantage in this kind of situations, instead of the size being seen as an obstacle to attain better livelihood. This is implied in the evidence in Table 2 indicating that an extended household had a higher probability for living in an improved house covered by zinc roofing and also better probability of accumulating cattle.

Table 2: Household (HH) size and wealth relationship.

House Characteristics			Cattle Ownership					Total
			No cattle	Less than 5	5 to 10	10 to 20	More than 20	
Concrete	HH size	Extended	-	9,1%	18,2%	**45,5%**	9,1%	81,8%
		Nuclear	-	18,2%	-	-	-	18,2%
	Total		-	27,3%	18,2%	45,5%	9,1%	100,0%
Improved and zinc roof	HH size	Extended	8,2%	**26,5%**	**20,4%**	**14,3%**	2,0%	71,4%
		Nuclear	8,2%	6,1%	8,2%	6,1%	-	28,6%
	Total		16,3%	32,7%	28,6%	20,4%	2,0%	100,0%
Improved and grass roof	HH size	Extended	-	75,0%	-	**25,0%**	-	100,0%
	Total		-	75,0%	-	25,0%	-	100,0%
Mud, stake and grass roof	HH size	Extended	11,9%	14,3%	14,3%	7,1%	-	47,6%
		Nuclear	26,2%	16,7%	7,1%	2,4%	-	52,4%
	Total		38,1%	31,0%	21,4%	9,5%	-	100,0%

Alternative off-farm source of income

Off-farm activities, especially South Africa's migrant labour and other job sources in town contribute to accumulated assets such as cattle, animal traction, water pump, and also cash to revitalize farming in case of hazards. These assets and availability of labour were shown to be important determinants of livelihoods. For instance, households with animal traction can immediately restart ploughing of destroyed fields whereas those that do not have such assets need more time doing it manually; however households also share assets among them. In addition, households owning motor pump for irrigation can grow crops in the dry season (although fuel price remained as a constraint) in plots near the river as they can irrigate from the river. In the same way, households with large herds of cattle respond more quickly to the shortage of food through livestock sales.

Community Social Networking

The community has shown cohesion in working collectively to overcome livelihood vulnerability threats. Little over 10% of the respondents declared that they did not own land in the wetlands and flooded areas, even though through social relationships between neighbors, relatives and friends they were able to share or borrow plots. The same applies also between settlements and even across villages. Once, when exploring the reason why community members shared plots despite the size and the critical state of the drought period, a community member said: "it is rather better to share land and allow your neighbor to produce food instead of sharing the little one can harvest…" Another important social norm used as a strategy to minimize labour intensive work is to share rotationally the labour by sharing cropping (ploughing, weeding, harvesting) and animal husbandry (herding) tasks among the households. Likewise, animal traction is also shared through a system of providing ploughing service to the owner. The community social networking plays an important role in reducing the impact of climate variability and elephant exposure of less wealthy households and it strengthens the adaptive capacity of the community.

This should also be seen as an opportunity to explore collaborative approach between park management and community leading to joint exploration of other yet unexplored alternatives, new forms of alternate employment and mutual learning and resilience built into the community.

6.5 Opportunities for Examining Possibilities of Coexistence

The Macaringue case illustrates the multifaceted and complex reality at the intersection of farming, conservation, and climate change and where research and management are being challenged. This emphasises once again the need for knowledge interface argued by Roux, *et al* (2006) in which through collaborative learning between experts, users and other citizens a conceptual space to meet, communicate, share knowledge and collectively create new knowledge is provided. Here we argue that the Farming Systems perspective might offer a possibility to explore and discover alternative futures where competing interests of human and wildlife survival can coexist and climate change communication be transformed into a proactive instead of reactive phenomenon. Approaches built on systemic frameworks and action-oriented learning (Checkland & Poulter, 2006; Packham and Sriskandarajah, 2005) offer opportunities for creating social learning platforms, spaces for facilitated dialogue and engagement of relevant sections of the community and for these to be institutionalized in appropriate ways(Hansen, 2008; Ison 2012). The planned research process within this approach would accommodate the diverse starting points and worldviews held by main groups and interests, particularly park management and the farming community, and has the potential to explore diverse range of dilemmas plaguing the relations between humans and nature, and a central problem for farming.

7. Conclusion

Based on the Limpopo National Park's (LNP) community living in the Multiple Use Zone (MUZ) we explored how their semi-arid farming systems in the Macaringue community responded to the double threats imposed on them via drought and elephants threat. The elephant invasion and consequent crop raiding amplifies the community's exposure to food insecurity. Examples of previous drought adaptation strategies used were recurrent seeding regardless of the season in several and different plot locations, diversifying the crops according to their water requirements and shifting them into the reduced cropped area available and therefore lower levels of crop diversification, and abandonment of risky cropping plots like upland. This shift on the other hand constituted the strategy of responding to elephant invasions and crop raiding, which is reinforced by night watching and chasing elephants using different techniques. At the same time, this strategy worked against the drought adaptation strategy, thereby limiting the alternatives for food production and eventually leading to higher exposure to food insecurity. Persistent failure of adopted strategies can induce farmers' unwillingness to explore new alternatives or adaptation choices (Patt and Schroter, 2008). Therefore, this paper argues for a systems approach with an Action Research orientation involving several research cycles of planning, action, revising and re-planning, as an alternative research approach that engages the relevant parts (communities, park management, government, donors, civil society, researchers, and others) to address livelihood and food security issues. In fact, this approach can not only open the space for seeking alternative farming or even livelihood strategies to cope with the double jeopardy of drought and elephants, through enabling co-production of knowledge through interfacing and sharing among the different protagonists (Roux et al 2006) but it can also help find ways around conservation and development dilemmas.

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