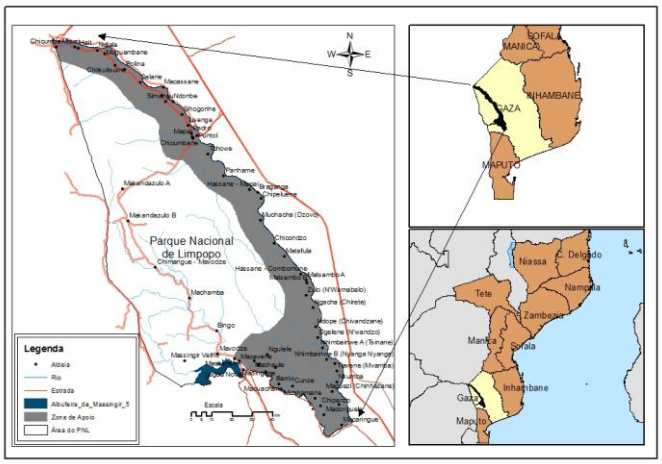
MINISTRY OF TOURISM
NATIONAL DIRECTORATE OF CONSERVATION AREAS

LIMPOPO NATIONAL PARK

STUDY ON THE LAND USE POTENTIAL AND CARRYING CAPACITY FOR THE POPULATION IN THE SUPPORT ZONE OF THE LIMPOPO NATIONAL PARK IN MOZAMBIQUE



1.1. Integrated Analysis Report of Carrying Capacity in the Support Zone of the Limpopo National Park and Baseline of Carrying Capacity - Final Report

RURAL CONSULT

Maputo, 21 December, 2012

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1. Introduction

1.1. Backgrounds

According to various international bodies such as the International Union for Conservation of Nature (IUCN), the World Wildlife Foundation (WWF), and other international, regional and national legislations, the primary purpose of a national park is conservation of natural resources and biodiversity in their areas of jurisdiction, which shall be subject to a technical-scientific management contributing towards resource valuing, taking into account that these territories, sooner or later, will be exposed to a pressure on the use of natural resources and biodiversity, which endanger maintaining of such status.

The biggest pressure is that resulting from the presence of Man and his social, cultural, economic activities translated in different types of land use, often without minimum requirements considered necessary in the context of sustainable use of natural resources resulting therefore in direct conflict between those types of land use and the purposes for which the conservation areas were established.

Such conflicts sooner or later contribute to a degradation of the natural resource basis, preventing sustainability of the types of land use practiced by a marked reduction in productivity of production systems practiced, i.e. agriculture, livestock, agro-forest, etc., which worsens the scenery of conflict between the national park and local residents or neighbours. This situation currently occurs in the territory under administration and management of the Limpopo National Park (PNL) either by internal pressure on the side of the resident population, or through pressure from people living in nearby villages.

It is in this regard that the management of Limpopo National Park, in coordination with neighbouring District Administrations, i.e. Massingir, Mabalane, and Chicualacuala, established as a priority, inventory and assessment of land resources with emphasis on the Support Zone of NLP in order to identify the types of alternative and sustainable use of land that can contribute to mitigate impacts currently verified as well as meet the current and future needs of resident communities and those in the short term will be resettled into the Support Zone.

For this undertaking, use of scientifically appropriate approaches and conventionally called Agro-Ecological Zoning are required, which will have the particularity, as a methodology, integrated analysis of Carrying capacity of the support zone.

The study was initially planned for a period of 12 months, which was largely overcome by integrating a set of steps that once performed, allowed access to its essential goals:

- Diagnosis / Baseline (data collection/selection of variables/definition of models),
- Analysis and processing of field data and other information sources for construction of different determinant scenarios/models of Carrying capacity,
- Development proposals for land use and handling plans in view of results of Carrying capacity assessment (results),

- Agro-Ecological Zoning
- Priority projects.

The Drafting of Diagnostic Support Zone was carried out iteratively with Data Analysis and Processing, both field, and from other sources, in two phases: in the first phase it was possible to gather a general understanding of the situation and the future prospects and simultaneously consider alternative solutions to its development. In the second phase, we proceeded to deepening the Diagnosis, already oriented to most considered relevant aspects, which enabled to consolidate the choice of Proposed Land Use and structure it in its core areas, i.e. agricultural production systems, livestock production systems, agro-forestry, ecotourism, conservation, amongst those considered appropriate to the region and according to prevailing social and cultural patterns.

Based on the priorities defined in the previous Phase, priority projects were drafted that, once integrated, constitute alternative development opportunities to current use of land, with the main goal of alleviating pressure on resources, introduce new sources of income for families, especially those that raise more added value through agro-processing.

In order to better systematize all information, knowledge and to better represent the physical space, we chose to define representative homogeneous and common zones in terms of ecological, social, cultural and economic criteria, with assumptions to do with maintenance of equilibrium between the needs of the people and conservation of the natural resource basis. This phase corresponds to Agro-Ecological Zoning.

Zoning means a process of division, whether a certain regular or irregular area conducive to definition of zones or unique spatial units with particular characteristics and a relatively high degree of internal consistency in all or certain essential attributes for specific purposes.

Characterizing zones allows assessment of their fitness for possible types of land use.

This study on the potential use of land and Carrying capacity of the Support Zone of the Limpopo National Park was conducted by Rural Consult, in partnership with NLP Management, with the District Administrations of Massingir, Mabalane and Chicualacuala, and with coordination and collaboration of local communities residing in the study field.

1.2. Goals

In order to fully address the challenges and needs that the NLP Management faces regarding managing and conservation of natural resources and biodiversity, and looking for the response to each of these challenges, translated by:

(i) the current Carrying capacity of the Support Zone is sufficient to accommodate and respond to needs in a sustainable way, to a current population and their present activities, as well as

(ii) any impacts resulting from additional pressure of 2-4 resettlement villages currently residing in LNP and intended to be transferred to the Support Zone, taking into account other development scenarios inherent in the socio-economic growth of the region itself, and

(iii) the extent to which current and future pressures exceed the Carrying capacity of land resources, mitigation and management measures will be recommended to the Support Zone to fulfil its mission as an adjacent area of the LNP where there are multiple uses and maintaining its sustainability without exerting any pressure on the LNP resources. Based on the assumptions above, we identified the following objectives of the study, according to the approved ToR:

(iv) assess the pressure on natural resources considering the current use of land and population regarding to productivity and Carrying capacity of the Support Zone,

(v) determine the Carrying capacity bearing human resettlement of more families in the area, with the assumption that production systems remain unchanged,

(vi) consider the impacts of potential and anticipated changes in land use in the study field, and access to natural resources as well as increased demand for natural resources,

(vii) proposed types of land use taking into account recommendations for new technologies to improve productivity of existing production systems and therefore increase human and animal Carrying capacity in the Zone Support,

(viii) draft a monitoring and evaluation system in defining indicators to objectively assess the sustainability and the relative degree of success of the proposed interventions, and

(ix) proposed starting points for technical assistance.

These objectives should actually address the main concerns and in a broader context, so that it can be assessed whether the Support Zone has the basic and enough socio-economic conditions to accommodate without sacrificing resource basis and the population currently residing, the population to resettle from LNP, and how to improve their sustainability.

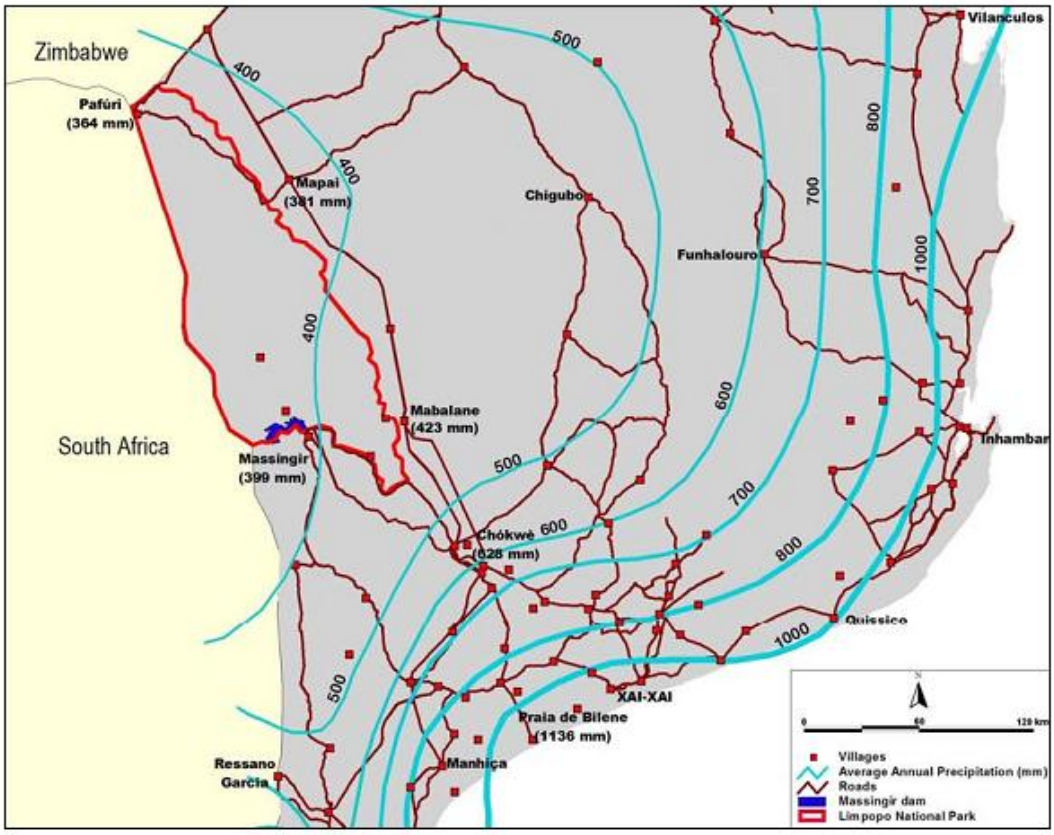
2. Field of Study

The Support Zone of the Limpopo National Park (LNP) is situated along the Limpopo River and inland toward the East limit of the LNP, extending from Pafuri to the confluence of the Limpopo and Elefantes Rivers, about 320 km long and 10 km wide, on the right bank of the Limpopo up to the LNP limit. This region corresponds to the most populated part of the LNP and as such, due to the potential Man – Animal conflict, there was need to review the boundaries in order to update them to the presence of villages. Coincidentally, and because of their location, the study field offers the greatest potential for agricultural development.

2.1. Climate

The agricultural fitness of a given location or unit of land is conditioned not only by its nature but other factors, including, predominantly, the climate origin. A brief climate description of the region was made from historical data on the climatic elements of weather seasons of Mapai, Pafuri and Massingir, units located in the same region, i.e. semi-arid to arid and has similar characteristics including the dominant types of natural vegetation. Mapai season is one that is closer and that can best characterize the climate of the study field. However, the registry period of meteorological data in this unit is relatively shorter than the recommended standard. In general, the region according to Torthwaite climate classification is ***Arid*** type, and ***Semi-Arid*** type for the sector Pafuri – Mapai and Pafuri – Massingir.

Regarding the classification of climatic zones and according to the moisture content, the region is classified as "***Semi-Arid Dry***" because it is characterized by occurrence of a dry period equal or more than 10 months during the year and average annual rainfall equal or less than 500mm (400-600mm) and moisture content not exceeding 75%. Picture 1 below (*BRL, 2006*) shows the map of isohyets to rainfall, depicting the low level of precipitation in the study field.



Picture 1. Isohyets of rainfall in Southern Mozambique (*Source: Feasibility Study Report-PNL, (BRL, 2006)*)**.**

However, the cumulative annual rainfall is only 357.0 and 366.0mm in the meteorological stations of Pafuri and Mapai, respectively. The curves of the reference evapotranspiration (ETO mm) and that corresponding to its half (½ ETO mm) - the latter defines the availability of water in the soil from the moment that the values of ½ ETO exceed the values of monthly rainfall – they show a permanent water deficit throughout the year, because in no time the ½ ETO can exceed the precipitation. This is a typical characteristic of arid regions where rainfed agriculture is extremely high risk.

Table 1. Average monthly number of rainy days - "North" refers to the section above of Mapai; "South" refers to the confluence of the Limpopo and Elephants *Rivers* *(Source: Report of the Feasibility Study - LNP (BRL, 2006))*

	Rainy days	
	North	South
January	9	9
February	8	8
March	7	7
April	3	4
May	2	2
June	2	2
July	1	2
August	1	1
September	2	2
October	3	4
November	7	7
December	9	9
Total	**57**	**54**

The thermal regime of the region is more influenced by its geographic location in the inland than the altitude of the place, because the two reference weather stations are at altitudes 109 and 215m in Mapai

and Pafuri, respectively. However, Massingir, due to its greater proximity to mountainous region (Libombos) has eventually lower temperatures.

The average annual air temperature is 24.8°C in Pafuri and 23.9°C in Mapai. The annual averages of the maximum values are 32.9°C and 30.9°C in Pafuri and Mapai, respectively. The minimum averages are 16.7°C in Pafuri and 17.0°C in Mapai.

The temperature range is 16.2°C and 13.8°C in Pafuri and Mapai, respectively. It is important to note that the maximum extreme events occur between December in a year to February the following year, the minimum extreme being between June and July.

The average annual relative humidity of air is 63% in Pafuri and 64% in Mapai, with the highest values in February and March (66% in Pafuri) and February with 71% in Mapai.

The lowest extreme values occur in September, being 55% and 58% in Mapai and Pafuri, respectively.

Associating these climatic elements, the risk of crop loss is very high, greater than 75%, causing rainfed farming to be an uncertainty as regards to the success of harvesting provided that the probability of loss of crops is too high.

This area, however, despite its aridity and drought characteristics, can have good agricultural potential, resorting to irrigation, and considering alluvial soils of the Limpopo valley, including supplementation and use of irrigation during the rainy season to mitigate the occurrence of water-stressed plants due to lack of moisture. Generally and out of the valleys, there are grasslands, although the main limiting issue is availability of animal drinking water.

2.2. Geomorphology

The study field is located in the Sedimentary Basin of Mozambique, characterized by an extensive plain of erosion, intercepted by the Limpopo River valley (Barradas, 1962).

To better understand the relationships between physiography, geomorphology and soils, it should be noted that the area is geologically characterized by thick deposits of Pleistocene marine sediments, called "Mananga", located in relatively high areas, and by Quaternary sandy deposits. Mananga sediments are often covered by recent colluvial and alluvial deposits (Beernaert, 1987), featuring a sandy-loam texture with a high proportion of coarse sand. Merging marine deposits, there are virtually flat extensive depressions (plains), filled with more recent colluvial material or lacunar deposits and featuring a clayey sand to clayey texture. One of the main forms of land and that stands in the landscape is the wide valley of the Limpopo River.

Along the Limpopo River, in the river curves and meanders, river sediments were deposited recently. Distribution of these river deposits is typical, with formation of higher natural dykes and sandy deposits closer to the river and marshy clayey sediments depressions furthest from the river. Most of the villages along the river are located on natural dykes and upper ancient terraces of the river.

In geomorphological terms, the study field is therefore considered to be part of the of the Limpopo Accumulation Plain, and three major geomorphological units may be distinguished, namely: (i) the Limpopo River floodplain, considering the complex of terraces, recent and ancient alluviums and small tailing ponds, (ii) ancient surface of erosion, which in turn can be differentiated on the hills and slopes of eroded pebbles, and colluviums at different altitude levels and (iii) inland plain (or flattened surface) of sandy dunes from Pleistocene period.

So this geomorphological configuration acts as modifier in the relationship between geology and soils, whose specifics are the result of pedogenetic processes that manifest on the source material (geology), in time and space.

This synthesis in terms of geology, geomorphology and physiography, transports us to another extremely important factor in classifying natural resources in the study field, i.e. soil resource, which will focus on the fitness classification and subsequent agro-ecological zoning, through its grouping in the main ground units, so determined, by geology, geomorphology, vegetation and land use in the region. Unfortunately spatial and temporal distribution of the main climatic features are not detailed enough to allow their differentiation, pending their integration in single characterizing differentiated units of land based on other land attributes.

2.3. Soils

If we go back to the previous geomorphological characterization and taking into account each of the three main units, there is then a strong correlation between geology, geomorphology, physiography and soils, whose description is presented below.

2.3.1. Floodplain Soils

Floodplain is the latest ground unit and occurs along the Limpopo River on its right bank (lowlands). Limpopo River is, like many others, active despite its flat topography and large bed, which enables to build today, actively terraces which, depending on their closeness may be:

- Natural dykes (top and middle slope) which are lighter, sandy coarse soils, increasing the clay content at the transition between the upper slope and depressions, presenting or indicating laminated texture (soil unit: ***Fs***), and that in terms of age are more recent. This subunit is topographically complex as marginal of the riverbed; it shows some variability of smooth to very wavy slopes, due to erosive action of river during floods. In the local system this would be *Cowene* land type; transition between this unit to the next is represented by *Banhine* land type, with relatively higher and lighter features, better drained.

- Old alluvium, in softer slope, more limited and narrower than the recent alluvium and that due to the removal of water course it forms tailing ponds or scattered beds, where there are heavier texture soils, corresponding to a dumping zone of finer sediments (unit of soils: ***Fa***), which is thought to correspond to *Gowene* land type. The lower parts, as tailing ponds, are dominated by presence of finer, heavier, more clay textures and can also be moderately or really sodic. These certainly are not considered in the analysis

of Carrying capacity because they have serious limitations for agricultural production, and any attempt to use them is economically not feasible.

In general this unit is characterized by presenting a moderate to good fitness for agricultural production, whose existing limitations can easily be corrected by using inputs like both organic and chemical fertilizers or through, in case of excess moisture, improved soil drainage.

2.3.2. Ancient Soil Surface of Erosion Hills and Eroded Slopes of Rolled Pebbles and Colluviums

It is mportant to note that this unit is associated with rolled pebbles and occurrence of colluviums; depending on the domain of each subunit four main groupings of soils can be distinguished, including the unit of shallow soils over non-limestone rock (soil unit: ***Wp***) and lithic unit shallow soils, over rolled pebbled (soil unit: ***Sl***). This unit is situated along the upper part of the study field, and at some points falls sloping towards the river. Geomorphologically, the unit is a complex mix of Tertiary and Quaternary deposits including very wavy gravel ridges, eroded hillsides and finer plain gravel and clay top levels. In the ridges the profile can be throughout occupied by gravel, stones and pebbles (all rolled). Typically the parent material is conglomerate, lying at different stages of erosion. This unit in turn can accommodate and correspond either to *Mananga* type or *Gangene* type lands.

Alternating with rolling and hilly landscape there are depressions and lows (***Cm***) are low soils to almost flat plains, with slopes generally less than 0.5% and at level of 2-1m below the level of marine terraces. These depressions are generally poorly to imperfectly drained and can be flooded for several weeks, perhaps months, during and after heavy rainfall due to their almost flat landscape and low permeability of clayey soils. Locally these soils are moderate to strongly saline and sodic in the subsoil, although occasionally also can be sodic in the surface.

These depressions of longitudinal orientation and small narrow valleys still occur along the foothills of hills, which depending on the mother rock, result in colluvial soils of sedimentary origin, rhyolites, showing a wide variation in texture, as in the case of soils ***Cs*** (foothills of rhyolites hills), ***Cw1*** to ***Cw3*** derived from sedimentary fine texture to coarse rocks, respectively, and ***Cc***, limestone colluviums.

Perhaps those with the highest expression in this land unit is the subunit representing occurrence of soils at smooth slopes of interfluves and hills, almost flat landscape, relatively deep, medium to fine in texture since they are or form the transition zone and contact with two large units of land, the alluvial zone and the sandy plain zone inland, occurring compact clayey soils in this subunit with poor drainage and predominantly sodic, from Tertiary, also known as Mananga soils or Mananga plain. A key feature of Mananga soils is the thickness of sandy coverage, varying from <25cm depth (***M1***), 25 to 50cm (***M2***) to more than 100cm depth (***M3***), although in this case such soils are considered as belonging to flattened land unit, further inland, where sandy soils predominate.

2.3.3. Flattened Soil Zones or Inland Sandy Plains

This zone occurs further inlad of the Support Zone, being the highest, flat, without rocky outcrops and stoniness. In this land unit there are red soils derived from Red Sandstone (***G***) with a very regular, homogeneous profile, elevated flat and excessively drained tops.

A small variant of these soils characterized by a sandy texture dominated by medium to coarse sandy soils are sandy, orange Aj soils, also excessively drained, and virtually no structure.

Joined to these soils are the Mananga ***M3*** ones, covered in sand greater than 100cm in thickness, and undifferentiated ***A*** sandy soils.

3. Context and Rationale

3.1. Limited Carrying Capacity by Availability and Quality of Resources

There are several studies and models showing strong relationship between the ability of human Carrying, for example, and population growth, although later new variables to support such findings have been introduced, such as food availability to better characterize the ability of human Carrying. Availability of food in turn is influenced by availability of land resource and its quality, in as much as the increase in human population is a function of increased availability of food.

This relationship between growth of population and food availability is typically used to further characterize and determine a system's Carrying capacity.

Thus, in absence of a limitation of resources, i.e. space and food, any population will meet an exponential growth. However, on the contrary, in the event of limited resources, the growth rate meets a considerably lower deceleration than the maximum size of the population that the environment can withstand. Environmental tolerance limits are eventually regulators between the balance and reduced growth rate of the population from a particular location.

We also know that, in the presence of other socio-economic variables, environmental factors affecting the Carrying capacity of a certain region may be changed through simultaneous occurrence of different processes. Specifically, and perhaps most notorious cases of those changes in technologies, and availability of resources, such as those that may significantly contribute to increased crop yields, and therefore food production, serving as an opportunity to increase availability of food at the level of a given population.

Talking about food production is establishing direct link between the type of land use as in the case of family farming, considering the current levels and production systems, and the innovations and improvements in these production systems with a view to their higher productivity. The same with the other systems present in the Support Zone, as extensive livestock production based on natural grasslands, agro-forestry, eco-tourism, and equally important, the potential conflicts between different land uses, especially one that actually dominates and is the reason for the study, determined by the presence of LNP

as an area of wildlife conservation, and consequently, the impacts resulting from the presence of wildlife species in agriculture, animal husbandry, eco-tourism and vegetation.

Their study and characterization will enable to find the functionality of existing production systems, the circumstances in which each type of land use is developed and its limitations, and opportunities for improvement.

Description of space factor will be done, inferring mapping and describing different land attributes, mainly soils and geomorphology to determine the biophysical units that meet the requirements necessary to for the main types of land use, and its ranking in terms of fitness, and therefore its ability to produce food and other resources necessary for the welfare of the resident population.

This comparative exercise is the balance between the environment and human or animal population that through environmental, socio-economic, and cultural limitations will be possible to develop alternative scenarios for mitigating any action which may result in environmental degradation of base land resources in the study field.

It is therefore clear that the agro-forestry and livestock sector should remain, though with renewed and/or expanded goals and responsibilities, the main user and guardian of countryside conservation in the Support Zone. The profound transformations that today confront agriculture and rural areas, associated with the growing conflict around different possibilities of land use, result of rapid changes in social, political and economic context, there is need to rethink about the spatial functionality and arrangement of the territory under management of the Support Zone, bearing in mind the existence of the Limpopo National Park, and its limitations while using the natural resources.

These transformations, possible quarrelsomeness, consequence of rapid changes, are actually the main reasoning for initiating Agro-Ecological Zoning of the Support Zone at LNP, with the assumption being the integrated analysis of different environmental, social, economic, cultural and political variables while safeguarding the sustainable use of land resources as the best way to protect any impact at LNP.

Rural development requires sustainable use of land resources in a given region, in this case the Support Zone, through development of land use proposals that meet not only the biophysical potential of a given geographical unit, as well as social, economic and cultural expectations of a particular user or farmer. On demand, taking into account basic features and qualities of biophysical or agro-ecological attributes, better allocation of human factor per unit area, is an attempt to draft and fit, and in the geographic space, the socio-economic, cultural and environmental policies of a given society.

The process itself is also known as land assessment and classification in terms of suitability for the potential development of a given activity, and in this case the extensive use of agricultural lands, animal husbandry and eco-tourism, and conservation of nature.

At initial resource diagnosis covering the study field the main Types of Land Use (TLU) were identified and assessed according to community sensibilities and family farmers and considering the priorities for action

by various institutions and government agencies in several management and decision-making levels, highlighting district administrations and the Limpopo National Park.

Land assessment has to do with identifying the main limitations of land resources for agricultural development in a particular area or region, while maintaining the sustainability of the resource base of agricultural land and consequent conservation of resources in the long term, and making recommendations of best practices to land and water management as relating to selected TLU. The TLU considered in this assessment exercise include:

Natural grasslands without introducing forage species and without recourse to any improvements in the soil natural fertility. Access to watering points for animals was taken into account, however, and within the major limitations of TLU, will be considered in the context of proposed management and development strategy, the priority ''inputs'' needed to improve management of community rangelands;

Traditional rainfed agriculture through animal traction refers to agriculture practiced with use of animal traction in the context of family sector, with or without fertilizers;

Traditional rainfed agriculture assesses the current status of production systems in family sector without any kind of input.

Conservation of Nature considers the present status of free areas from any type of use of the above mentioned land, where disturbance and impact by virtue of humans and domestic animals action is considered to be low or nonexistent, and are therefore in conservation terminology, those systems classified as fragile and sensitive, justifying the protection regime.

Reforestation/use of native forest is repopulation of areas that had vegetation removed by nature forces (fire, for instance) or human actions (fire, logging, expansion of agricultural areas, forest fires). This green area recovery is made with native species, improving degraded ecosystems. Reforestation also serves to improve performance of watersheds.

The outcomes of assessment and classification exercise of fitness ratings are systematized through the methodology and techniques of agro-ecological zoning, enabling to assess the productive capacity of land resources.

3.2. Land Use and Distribution of Population

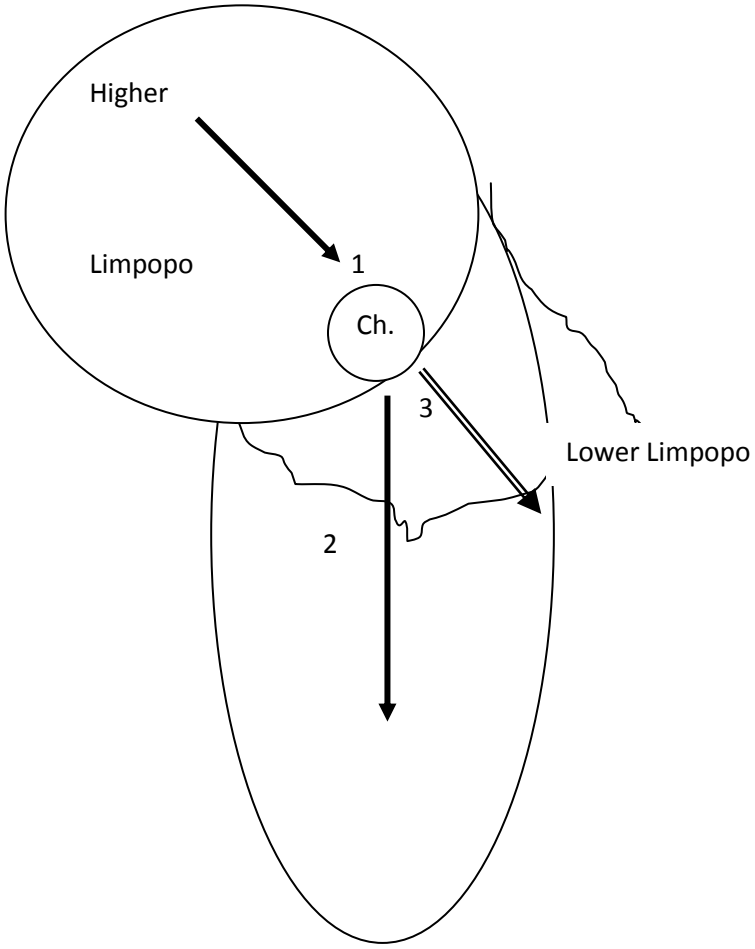
The Support Zone, according to the report of the feasibility study conducted in 2006 (BRL 2006), accommodates about 20.225 inhabitants, corresponding to about 5.530 families or households. These families are spread over about 44 villages, with certainly preference to their location along the two main rivers that drain the region, Limpopo and Shingwedzi, where they develop much of their agricultural production activity, and fundamentally, access to water for human consumption and domestic use. Being a rural area, take it that virtually the entire population has agriculture as the principal activity, mainly

subsistence. Beyond or in addition to agricultural production, as well as relief activity, most households are engaged in livestock extensive production, resorting to natural grasslands.

Due to extreme aridity and occurrence of almost permanent droughts, the rural population is forced to develop livestock production, the most important socio-economic activity of the SZ since rainfed agricultural production results in low levels of food security due to systematic loss of crops.

The use of other natural resources is limited to collecting firewood, their main source of energy, an activity which can also develop within the boundaries of the LNP. From the different surveys conducted by previous studies they show that this population does not use charcoal in their domestic activities. Only charcoal is produced commercially as a source of household income, production of which has just been licensed by district authorities. Nearly 80% or more of charcoal production is marketed in major southern urban centres, including Chókwè, Manhiça, Xai-Xai, Maputo and Matola.

Picture 2 shows mainly the following charcoal flow as starting from Higher Limpopo, corresponding to the location of the study field.



Picture 2. Relationship between scales applied in the study field (*Competir, 2003*)**.**

1. Interaction between Chókwè and the area of Medium and Higher Limpopo

2. Flow of charcoal

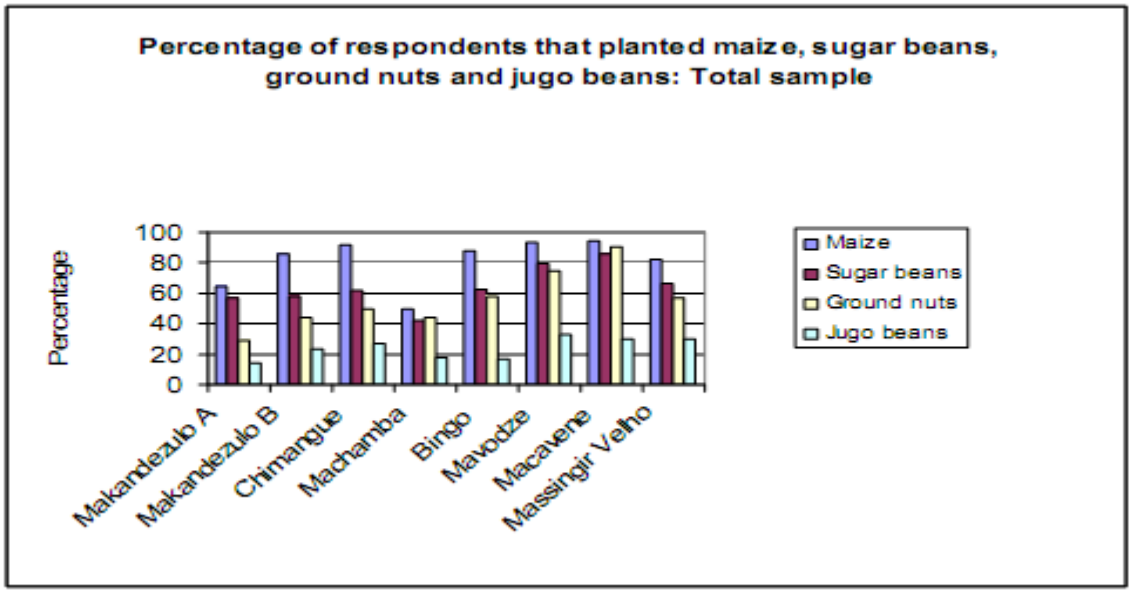
3. Environmental impacts along the river and down stream.

Ch: Chókwè

3.2.1. System of Food Crop Production

Farmers use household production of rainfed crops, and their cultivation systems are characterized by low productivity, without using inputs, with hand labor in the household, not using fertilizers, exploring relatively small areas in rotation with fallow graund of variable duration. According to Maria (2006) and Leonardo (2007), still associated with the characteristics of production systems, the rural family is the main source of labour for agricultural activities, being in average households comprising 4 people, and may still reach 8 people in the case of extended families. In fact the number of household members varies depending on the proximity of the village to major socio-economic infrastructures, and even its location in terms of region, with aggregates with more family members in the South of the Support Zone, which can reach up to 8.9. Families in Northern and Central SZ are lower, reaching 3.6.

Rainfed agricultural production is moderate to high risk, most pronounced in the inland regions towards the limits of the LNP and to the north, towards Mapai. They are traditionally 1st season crops. The graph of picture 3 illustrates the percentage distribution by village crops produced with maize always being the first crop. The corns clearly show that standard cultivation is centred in those more tolerant to droughts.



Picture 3. Percentage of respondents who grew maize, sugar beans, ground nuts and jugo beans (*Source: BER, 2006, quoting the SUNI socioeconomic base study, 2002*).

Yet according to the authors, the ratio between active and passive consumers is nearly 1.5 units, which means that in average two people should produce enough food to meet the needs of three people. In terms of productivity and efficiency of such systems there are severe limitations if one considers that, according to TIA data and interviews to the farmers, they indicate that families grow less than 2.5 Ha in average.

However, the size of the production area is in many cases proportional to the size of households, and also in terms of soil quality/fertility, those with poorer soils justifying production areas that can reach 8 Ha.

Areas less than 2 ha are relatively small to meet food needs of a family with an aggregate average of 5 people throughout the year. This is compounded by absence of using agricultural inputs and varieties with high potential. They practise subsistence agriculture. In many instances the families resort to using animal traction to prepare the soil.

Because they live along the banks of the Limpopo River, the population has grown some vegetables such as tomatoes, onions, lettuce, cabbage, chilli, as 2nd season or fresh period crops, or even under a small irrigation system (See Picture 4).

Picture 4. Map Locating Support Zone Villages. Label: village – river – road – Massingir dam – buffer zone – LNP area

The *origin of fertility* is essentially from *natural vegetation remnants*. It's still usual practice of fires preceding cultivation and fallow ground for a period determined by the speed of regeneration of soil fertility, provided that land availability for agricultural production is not yet an issue of serious concern.

Yields for different crops are generally low due to low rainfall and soil fertility, associated with poor soil and water management practices, and low level of using agricultural inputs. According DINA (2003), groundnuts crops are generally at around 260 kg (peeled) per Ha. The average yield of maize lies in the standard of the south, in average less than 500 kg per Ha, ranging between 400 and 1000 kg/Ha, while in the case of beans, the average incomes are 250 kg per Ha. The average yield of cassava is 5 t/Ha, but due to eating habits its production is not common.

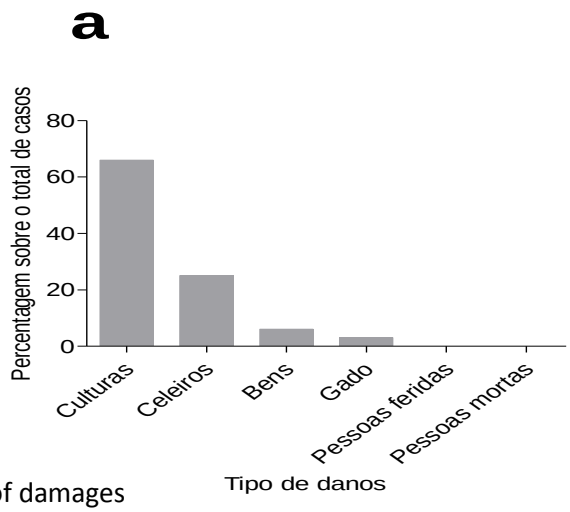
In addition to the physical problems of soil, related to shallow, micro topography and stoniness, and compactness, associated with low fertility, drought is usually cited as the main problem affecting production systems in all villages.

The standard crop is defined in most cases by the contents of precipitation / evaporation recorded at the beginning of the rainy season/time of growing crops, distribution of precipitation in, i.e. a half of the rainy season or closer to its end, alternating with occurrence of more or less longer periods, limiting the length of the growing period, and also the spatial distribution of precipitation between uplands and lowlands.

It is therefore common in the case of late onset of rains, few farmers growing groundnuts and sweet potatoes, risking otherwise maize x pumpkin intercropping.

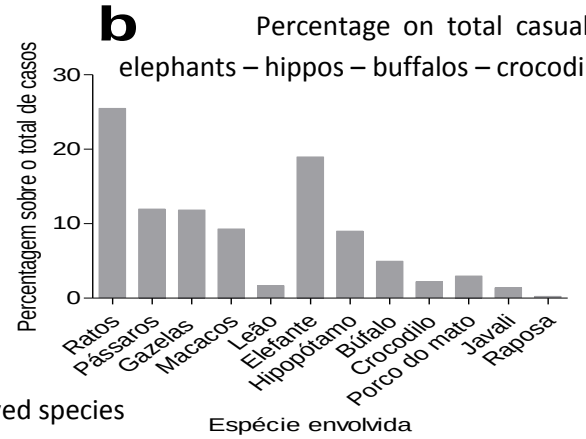
Presence of insects (weevils), rats and presence of other animal species, small mammals, which constantly invade farmers' fields, are the second and third biggest constraint on agricultural production, respectively. The attack to farms by other animal species, either by bush chickens, partridges and other birds, either by bush pigs, monkeys, elephants and other small and medium species are also a problem (Picture 5).

Percentage on total casualties: food crops – barns – goods – cattle – wounded people – dead people

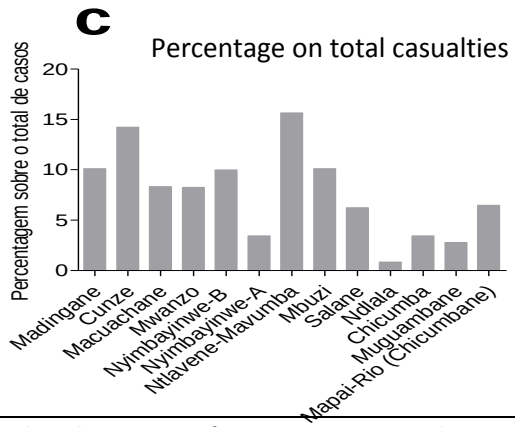


Type of damages

Percentage on total casualties: rats – birds – gazelles – monkeys – lions – elephants – hippos – buffalos – crocodiles – bush pigs – boars - foxes



Involved species



Percentage on total casualties

Picture 5. **Occurrence of pests and type of pest damage in case of rats (a), birds (b) and by animal species (c).**

Previous studies at province level show that about 89% of farmers reported that pests are a major limiting agricultural production (crop losses before and after harvest).

Photo 1. Farm fenced for protection against animals.

The manner of storage of agricultural products varies with the type of culture and agricultural product. Maize is stored in the form of spike while about half of beans and groundnuts are stored in shell and the other half in the form of grain.

The storage system varies depending on the crop characteristics, material availability and time of year. Dried maize is usually stored in barns with or without a roof, depending on the household. This is subsequently bagged. Cassava is usually not stored but stored in the fields, and harvested when the household needs both for feeding and for sale.

On-farm conservation in the case of cassava has proven to be highly susceptible to attack by various pests, especially wildlife species. Crops harvested are stored in the farm for about 2-4 months. After this stage, they are mostly used for consumption and as seed for the following season. Just as an example, and for maize, about 80% of production is usually consumed by the household, the remaining 20% retained as seed for the following year and sold as surplus.

Production systems also feature as an important factor and that reduces hand labour at the household level, especially in activities related to soil preparation and weeding, which is animal traction, as well as transportation of the harvest to their places of residence.

Manure is not used in agriculture, and only in a very limited way it is applied in plant production, representing an opportunity for biogas production, fertilization of agricultural fields and cultivation of fruit trees.

3.2.2. System of Livestock Production

The region's arid climate makes farming a feasible and low risk activity and that is why it serves as reserve bank for transfer of the accumulated value in other activities. In the buffer zone of the LNP, cattle are undoubtedly the most important at the community level, although goats, sheep, pigs, chickens and ducks are common.

Cattle breeding in a traditional extensive activity is the most important common practice of livestock in the study field, as shown in Table 2. Income out of livestock 80% is the result of cattle and only 1% of chickens. All livestock on rangeland grows without supplementation, only "in situ" use of some annual food crop stubble after harvest (Photo 2). At no time using system enclosures was identified for grazing cattle.

The breed of cattle is Landim, a native animal, adapted to extreme weather conditions, showing great ability to survive at low grazing levels, particularly in drier years and during dry season each year.

Table 2. Households, the Buffer Zone of the Limpopo National Park, raising animals and source of annual money income from sale of animals (%).

Animal species	Breeder aggregates	Source of household annual income
Cattle	74,1	41
Goats	67,7	3
Sheep	15,7	3
Pigs	16,2	3
Chickens	72,5	1
Ducks	19,2	0
Turkeys	0,2	0

Source: GTZ Baseline Study, Report 2009

Observation: Other income sources (%): Cereals (1); Fish (1); Services (7); Remittances (14) and Employment (2).

The Landim was described as the largest native breed in the country, with poor milk production (572 litres/lactation), high birth rates (86% to 93%) and low calf mortality (4%). The general docility of the breed allows them to be trained as suitable working animals, so people use animals for plowing and

pulling carts, in addition to existing donkeys. Donkeys and oxen are of great value in transporting people and goods by wagon between usually distant local agricultural production sites, by the rivers, and places of sale.

Photo 2. Maize fields already harvested and stubbles can only be seen after harvest. Farm in uplands, also fenced to prevent invasion by cattle. This is only permitted to graze the stubble after harvest as in this case.

According to the BER study (2006), 90.4% (Massingir), 89.5% (Mabalane) and 75.4% (Chicualacuala) of households use the plow as agricultural implement.

The extensive breeding system practiced and seasonal rains do not favour the grasslands throughout the year. Therefore, cattle lose weight in the dry season and put up weight in the rainy season.

The livestock production system is totally dependent on natural grasslands and watering in natural water sources such as rivers, lakes, dams, whirpools or lowlands and ponds which occur in circular depressions. For exploitation of these resources, land or areas are common, but cattle are private, i.e. they belong to various creators.

Irregular rainfall and prevailing economic activity (livestock) provide the water a fundamental importance for the lives of the buffer zone. Water supply to the population and livestock is therefore, in the environmental conditions of the region, the major constraint for the population, which revolves around the triangle grassland-animal-water. However, around the water stations there are almost always overCarryings of humans and animals. This suggests that the water problem must be seen in its complexity rather than reduce grassland problems to the water issue. In this context, the solution of the water problem, if not viewed with caution, it may be the starting point for new and more complex problems.

Low productivity of grasslands, the far distances that animals have to travel for food and the location of watering points are possibly the main limiting factors of current production systems. The veterinary care is poor; there is absence of any kind of improved livestock management. There are only a few notions of improved animal production, the only special technique is training of animals for animal traction, but ideas revolving food handling are not patent and supplementary feeding to animals is not practiced. The pride of the families is raising animals, and it should be noted that in conversations the breeders claim that they know how to raise animals.

On the health aspect, the region has recorded diseases difficult to control, often being referred to by producers on the occurrence of diseases transmitted by ticks. Due to lack of operational bathing tanks in the region, applying acaricides to animals, manual sprayers are used or the "pour-on" method which consists in applying acaricide only on the back or sides of the animals. Vaccinations against hematic and symptomatic carbuncles and aphthous fever are ongoing and follow a programme and timetable drawn up by the Provincial Livestock Services. It was not possible to collect information about vaccinations against hematic and symptomatic carbuncles, aphthous fever or tuberculizations.

Grazing livestock production is the result of interaction between growth stages (grassland production), using (from crop produced grassland) and conversion (which is transforming consumed grassland into animal product). Rangelands at buffer zone of the LNP represent a rather huge natural resource. A large portion of this land is very dry and very poor to support a reasonable crop production, yet it is sufficiently suitable for extensive grasslands.

Domestic animals presented (in April, when a visit took place at Buffer Zone) a reasonable nutritional and constitutional status contrasting with a few means of production (infrastructure, food) that breeders possess.

It is naturally productivity of spontaneous resources, conditioned by the rains that fall, and by the amount of available forage mass, which is the main determinant of the forms of exploitation of grazing areas and the greater or lesser degree of settlement of cattle.

Exploitation of pasturage resources is itinerant grazing, as it includes semi-nomadic and sedentary aspects in open areas near the village. The classification of these types is based on mobility or larger or smaller restriction of the movement of species in the grassland. Specifically because of the fields in the rainy season the animals are grazed by shepherds in areas where there is no agricultural activity. In the dry season the animals graze freely in the lowlands where there is some grass and waste from agricultural

crops, mainly maize. The animals gather to corrals near the homes of owners to stay overnight without it being a practice of supplementation. The time of grazing varies according to availability of the shepherd being common to find animals in corrals between 13.00 - 14.00 hours, because the shepherd is at school in the morning. This fact is further limiting access to grassland when grassland availability itself is not the limiting factor.

Semi-nomadic or transhumant grazing consists of seasonal movement of herd from at its basis to other areas where there is water availability and grasslands, then returned to the basis. The movement of the herd can be partial.

Sedentary or fixed grazing-type or under corral regime is dominant in the region. In this system the grazing is carried out throughout all the year from the breeder's place of residence to the corral. Cattle, goat and ram species are bred under these conditions and, sometimes, even pigs. Animals are monitored during the day and go back to corral at night. The animals kept on corral, with reduced grazing periods, reflect on their development and productivity, nutrient deficiencies, especially in dry season they are subjected to. There are reports that during longer dry periods, it may happen that animals are left in grassland areas even at night and only conferred by the owners at watering points. This uncommon practice today results from fear of herding cattle to long distances from villages due to theft of livestock.

The corral system has some advantages including: i) less chances of theft. ii) increased possibilities of defense against wild beasts. But there are also factors that may affect productivity, including: i) insufficient grazing periods (late departures and early return to the corral when the grass starts missing and have to move to points well away from places of gathering), ii) disorderly exploitation of grazing areas, with reduced food capacity (excess pressure in some areas, especially when the local watering are abated, as the rivers dry up after the rains).

Corrals are usually built in adjacent areas to residences which implies constant movement of animals having as consequence the need to invest in fenceing farms and resulting erosion of cattle paths or corridors (grazing area, watering point and corral for overnight).

The expoitation is best done with animals that live permanently in large enclosures, where it has at its disposal sufficient grassland, water and shade. It is the ideal method for breeding in extensive systems; animals provide a yield of 25% obtained under the usual enclosure conditions during overnight. The greatest burden of fences, troughs, is compensated with this increase. However, one has to consider that the household sector have their production guided by market principles, and the second question is related to their own grasslands that are owned by the community that does not allow the individual breeder to invest in improving them.

The grazing areas, around water troughs and animal concentration sites in corral regime, featuring – for the results of the various pressures they face. 1) In the first zone, around the watering points, eventually grasslands disappear, leaving the ground bare or with weeds and bushes. 2) In the second zone, and also grazed on weeds, can comprise grassland grasses, but especially during the rainy season. 3) In a third zone, involving the previous one, grasslands consist of annual species. The best species are the fourth zone,

even in dry season. Externally to this latter area, sometimes, 8 – 20 kms of the watering point, grazing is already reduced in the event of faults.

Watering is conditioned by the shepherd moving the animals to the respective locations, and may be carried out only once a day, or be so rushed that the cattle does not have sufficient time to properly watering.

The improvement of the system would entail keeping animals in closed areas with the following advantages. i) Grazing and watering not conditioned by the shepherd, ii) greater possibilities for management and protection of grasslands. Typically, the animal goes grazing also at night, and there may be periods of 65% of grazing hours during the day and 35% at night (in South Africa, it was found that steers in pens, after weaning; reached 226 kg liveweight eight months earlier than those kept in the corral).

Besides investments in facilities that will have to be made, compared to corral system and that can also affect productivity, the following drawbacks are mentioned: i) increased possibilities of theft, ii) fewer possibilities for control against diseases.

People rely on livestock as a source of income, keeping small to medium size cattle herds. The animals are sold to buy food or pay for household expenses. Eating animals at the household level is less frequent. The area is still undercrowded in cattle, and there is potential to greatly increase the number of animals, provided that attention to availability of grassland and development and management of water sources is paid. Limitations are not so much in terms of land availability and adequate infrastructure, but rather technical, financial and economic capacity. The change in the production system by farmers can be advantageous, especially in dry season, while keeping the growth and fattening of animals constant and achieving greater productivity of the herd. This will allow for a quick return on capital employed, with results in terms of increased productivity areas, greater weight gain in a short time span and better health monitoring.

3.2.3. Livestock Herds

The total number of cattle in the villages at Support Zone of the LNP is presented in Table 3.

Table 3. Cattle herds in the Buffer Zone villages of the Limpopo National Park (2012)

District	Administrative village	Village	Cattle
Chicualacuala	Pafuri	Chicumba	-
		Malhanglene	-
		Mbuzi	1400
		Ndlala	-
		Munguambane	600
		Chitsuitsuine	350

		Salane	1000
		Chicoro	-
		Mbeti	-
		Matsilele	1200
		Sihogonhe	-
		Makandazulo A	550
		Makandazulo B	-
	Sub total Pafuri		**5100**
	Mapai	Lisenga	1200
		Chicumbane	650
		Tchowe	300
		PanHame	350
		Nwamavique	250
		Hassane	600
		Chipeluene	200
	Sub total Mapai		**3550**
Total Chicualacuala			**8650**
Mabalane	Combomune	Muchacha (Dzovo)	580
		Chicondzo	670
		Matafula	850
		Mvudla	-
		Hassane	680
		Macuva	-
		Matsambo	1000
		Zulo	750
	Sub total Combomune		**4530**
	Tlavene	Ngacha	-
		Ndope (Chivandzane)	900
		Dgelene (N'wandzo)	-
		Chintlavanine	300
		Nhimbainwe A (Tsinane)	550
		Nhimbainwe B (Nyanga Nyanga)	600
		Chimangue	520
		Tlavene (Mvamba)	-

		Nkumba	690
		Maguezi (Chinhezane)	650
		Mahanuque (Psitima)	750
	Sub total Tlavene		**4960**
Total Mabalane			**9490**
Massingir	Zulo	Macaringue	1926
		Guswe	-
		Chibombe	-
		Maconguele	1667
		Chipanzo	210
		Munhamane	808
		Cunze	1315
		Macuachane	1163
	Sub total Zulo		**7089**
	Mavodze	Madingane	951
		Chibotane	1674
		Mahlaule	544
		Macavene	982
		Mavodze	2203
		Bingo	1189
		Machamba	1163
		Chimangue	888
	Subtotal Mavodze		**9594**
Total Massingir			**16683**
GRAND TOTAL		LNP-Buffer	**34823**

Source: Adapted from National Park and Limpopo Provincial Livestock Services, 2012.

3.2.4. Other Aspects of Handling Animals

3.2.4.1. Possession of cattle in communal conditions

Possession of cattle in communal conditions leads to increased number of heads, because there is no effective limit to the breeder intending to possess them, besides, the number of animals is a defense to

the reduction that occurs in herds in the event of droughts. This gives rise to what is termed as cattle cycle with several phases. Initially, or in the first stage, there is a small number of animals and lots of grassland, even in the dry season, where fertility and survival are good. Later, a second stage, there is an increase in the number of animals, the grazing decreases, particularly in the dry season, and the animals still reproduce, but the levels are low. A dry year comes and leads into the final stage, where the grassland is already inadequate, even during the rainy season, there is shortage of water, and the herds have high mortality. Reducing the number of animals in the region around the livestock cycle to the beginning, there is lots of grassland and very little cattle. In summary the productivity is low in these conditions. Among cattle one calf can be obtained every two years and mortality rate in calves can also reach high numbers, about 50% of calves in some cases.

Animals are the catalyst factor that allows breeders to gain greater security and open up new opportunities in livelihood terms. The first step is acquisition of animals. For them to increase the number, they need to be alive, so access to animal health services and appropriate disease control relevant to this group must be ensured. Once survival achieved, the number of animals will increase and it will be worth investing in productivity, particularly in food, shelter or breeding.

As this cycle develops, people have more animals to sell and more money to invest in more animals on their farm by buying inputs, in small business, in health and education expenses, and other elements that integrate a viable livelihood.

This process also leads to an increase of animals available for sale, lending or purchase, increasing the possibility of households without livestock, believed to have a greater degree of poverty, to acquire animals. Once they have them, and that can keep them alive, they begin to follow the same route described above for family poor breeders.

3.2.4.2. Goats and pigs

Household livestock scheme is "free range" extensive farming. Pigs and goats are raised in the loose or partially confined in makeshift and rudimentary facilities with little or no health care and owners spend a few hours in animal husbandry and it is quite difficult to carry out some investments. In some villages the communities decided to hunt loose pigs to avoid problems of hygiene pigs cause when scratching in the kitchens of neighbours.

There are conflicts arising from the fact of socio - spatial unity of Housing for rural families being the site where active production, collection, and grazing take place. Our model suggests building corrals outside the Housing area for amongst other technical and environmental advantages to enable establishment of fruit or shade trees in the Housing area.

3.2.4.3. Small species

Production systems of small species, especially those practised by peasants, have been developed based on knowledge of the peasants themselves. Birds are the species raised by preference because they have

the ability to survive under conditions of extensive management, they are resistant to diseases, they are able to fly and easily escape from predators.

Chicken production is characterized by small clusters ranging from 7-15 chickens per litter, being birds of all ages and is often associated with raising other birds like ducks, geese, bush chickens, pigeons, and their raising involves low investment in general handling.

Most breeders have barns and these are kind of placed in higher sites in most cases, some breeders have roosts lying on the ground and still others without barns and chickens remain overnight in trees, ground barns, higher barns and stay indoors.

Water is supplied to the birds in containers like old tires cut from cars, clay pots, old zinc pans, and this water is clean depending on the care that each breeder has and even on availability of fresh water.

Chickens are raised loose, scratching the soil (scavenge system) and eating insects and waste resulting from daily preparation of food and vegetation. Chickens seek their own food around the house, feeding on locally available resources.

The big problem in raising chickens has to do with Newcastle disease, in which breeders complain of mortality suffered by chickens. Lack of availability of vaccines is a barrier to combating this disease. In 2009 a project to support production of chickens among several activities that included vaccination of these animals was implemented by Kyeema foundation.

3.2.4.4. Fires as grassland handling technique (good servant but bad master)

The fact that most of the population live below the poverty line, which means they do not have access to appropriate technology (materials and tools) to practise agriculture, hence shifting cultivation is widespread in the country and it is one of the causes that contribute to fires, deforestation and forest degradation. At community level fire is widely used in preparing fields, eliminating natural vegetation or agricultural residues. In many cases burning is done without proper isolation of combustible material which facilitates its spread into the forest. The same is true for grassland renewal, hunting and rejuvenation of wild palm from which a local drink is extracted. Most (90%) of fires occur during dry season, especially from June to September, when the herbaceous vegetation and deciduous tree and shrub components of the forest release leaves, thus providing potential fuel to be burned. Fires during the wet period are limited and localized. This situation often worsens lack of grazing for the animals.

Fires in management of grasslands appear as an alternative practice widely used, because of their low cost and easy adoption. Their main goal is removal of unpalatable, killed material, and rejected by cattle, providing a new regrowth in periods of food shortage. This regrowth, being more tender, flavourful and better quality, can lead to better results in terms of animal production. Other purposes of using fire in grassland stand up control of woody vegetation, destruction of parasites, particularly ticks. However, in order to achieve burning objectives without prejudice to grasslands, over time, some aspects should be observed, such as frequency and time of year of its occurance as well as its subsequent handling.

The use of grazing after burning is one of major causes of degradation. Often, the animal is placed immediately after the start of the grassland regrowth and thereby weakening the plants because the reserves are used for regrowth after fire and no time to recover energy needed for new regrowth after grazing. The high use of grazing after burning is a practice that exacerbates erosion, because it delays the soil cover and closing the grassland. In arid regions fires aggravate water stress in the plant, damaging more than encouraging, with plants better adapted to dry conditions more favoured with burning.

In the buffer zone of the LNP, episodes of fires decreased significantly probably due to: i) awareness of the population about the impacts of fire on the environment, ii) demarcation of the buffer zone, iii) limited land resources, iv) significant grazing activity; v) efficient organization of the local farmers and producers in the management of the common good. However, we could see one of the villages burning by-products in the fields instead of keeping them for animal supplementation and this may be the release of an uncontrolled fire.

3.2.4.5. Infrastructures and regulation of Animal Health

Tick tanks, treatment corridors, vaccinations, marking (identification) and weighing of cattle are a very important infrastructure for periodic and allowed concentration of animals to various management actions, epidemiological surveillance and control of animal diseases, inspection and enrollment of the cattle. Absence of such infrastructure in most villages in the buffer zone may partly explain lack of statistical data or difficulty of obtaining them. According to the Regulation of Animal Health (2009) all herds of cattle and other animals in the holdings should be registered by the Veterinary Authority and to this end have their passbook record authenticated. There is no evidence that buffer zone breeders have the registry books according to the regulation.

Lack of fences on land grazing means in accordance with regulation, permanent surveillance (shepherds) because cattle without shepherds are considered abandoned, and if not claimed within 30 days are declared in favour of the State. Compliance with health regulation might hinder theft of cattle as well as their movement.

3.2.4.6. Trading

The meager household income also suffers for its disadvantageous fit within the trading scheme. Household farmers have no bargaining power and are the last step in a chain that appear at least 2 intermediate dealers before their product is sold to the local final consumer or exporter.

Trading is also an issue that will be considered as part of the global effort to stimulate rural economy. Through these actions, this group of breeders gradually get more security, which in turn will allow them to become increasingly commercial in their orientation. This will mark the beginning of change of attitude of household breeders with regard to payment for services rendered. This will lead to an increase in the quantity and quality of animals and livestock products placed on the market, since these breeders will seek to achieve higher yields, and being supported by adequate policies, services and infrastructures.

3.2.5. Vegetation/Grasslands

The LNP is inserted into the Sudan-Zambezian vegetation and corresponds to Mopane bush. Mopane is important as a food source for ruminants and valuable as timber and energy source. Additionally, the tree hosts the most important seasonal larvae - Mopane larvae (*Gonimbrasia belina*) - an important source of protein and for the local economy. Agricultural activity coupled with existence of large animal population encouraged the establishment of extensive conservation areas in the eco-region.

Mopane, according to Photo 3 is characterized by dominance of *Colophospermum mopane* tree species, and may also be associated with tree and shrub species as *Kirkia acuminata, Dalbergia melanoxylon, Adansonia digitata, Combretum apiculatum, C. imberbe, Acacia nigrescensis, Cissus cornifolia* and *Commiphora spp*., showing considerable variations in height (3 to 25 metres).

Other tree featuring species include *Acacia spp., Albizia spp., Mespiliformes Diospyros, Ficus sycomorus, Kigelia africana, Lonchocarpus capassa, Trichilia emetic, Xanthocercis zambesiaca, Xeroderris stuhlmannii, C. collinum, Dichrostachys cinerea, Kirkia acuminata, Peltophorum africanum, Piliostigma thonningii, Sclerocarya birrea, Terminalia sericea* and *Strychnos sp*.

Photo 3. The picture shows a herd being conducted by a shepherd to graze in Mopane.

The herbaceous component of Mopane communities differs according to the soil and vegetation conditions: dense grass in the openings of Mopane uplands in favourable soil, while herbs are almost absent in heavy, waterproof and alkali soils.

Main herbaceous species include *Aristida spp., Eragrotis spp., Digitaria eriantHa, Brachiaria deflexa, Echinochloa colona, Cenchrus ciliaris, Enneapogon cenchroides, Pogonarthria squarrosa, Schmidtia pappophoroides, Stipagrostis uniplumis* and *Urochloa spp.*

Large areas of rangeland in Mozambique, particularly in the south of the Save River, according to Timberlake (1985) and Myre (1971), are a very precious and available resource without much investment for extensive cattle breeding.

Biomass production in the Buffer Zone occurs only in hot and rainy season. The herbal extract recruits, grows and reaches its biological maturation over a period not exceeding three months (November to March) and dry once water conditions have a deficit. Along with natural drainage lines and depressions where residual moisture continues for longer to tree/shrub species or grass remain green for longer periods. Along the lines of natural drainage and depressions, with domain of herbaceous vegetation, species such as *Echinochloa, Panicum, Eragrostis* and *Urochloa*, there is a belt of scattered acacia trees and in higher parts there are Colophospermum mopane communities (chanate) associated with *Sclerocarya birrea* (amarula), *Terminalia sericea* (conolas), *Brachystegia spiciformis* (missassa) and other species.

The region rangelands fall under the classification of "sweet grass", with a predominance of species like *Panicum, Setaria, Cenchrus, Urochloa* and *Digitária* in various soil units. The grasslands coverage ranges from weak to very weak, with exception of more moisture depression zones in the soil.

The grazing areas of the Support Zone have basically a similar botanical composition with slightly specific variations in the prevalence of species. The botanical composition refers to existing species and their relative abundance. In the study field, there is a great diversity of species of natural grass such as *Themeda triandra, Heterogon contortus Hyperthelia dissolute, Urochloa mossambicensis, Digitaria eriantHa* and *Panicum maximum*, being the most important areas to grazing: *Themeda triandra, Panicum maximum* and *Hyparrhenia sp*.

Themeda triandra, considered be a mixed or semi-sweet species, is one of the most important for grazing cattle; it develops best in heavy textured soils with good fertility and becomes a natural grassland greatly appreciated when developing in an environment where *Acacia nigrescens* predominates. *Panicum maximum*, considered to be a sweet species, develops best around trees in shaded conditions, yielding in favourable conditions, large amounts of green palatable material. *Hyparrhenia sp.* occurs associated with *Hyperthelia dissoluta*; these two species are often found in sandy soils associated with various types of miombo. These species are very productive and palatable only during a few months (only in vegetative and flowering stages).

3.2.6. Forest Resources and Usage

The LNP vegetation is an extension of Habitats that occur in Kruger National Park. The area consists mainly of forests dominated by Mopane, as mentioned above, particularly on soils with high clay content, to the north of Shingwedzi. The margins are characterized by large dominant trees such as *Diospyros mespiliformis, Xanthoceris zambesiaca, African Cordyla* and *Acacia albida*.

There are in the zone a total of fifteen plant communities: Community 1: *Androstachys johnsonii - Guibourtia conjugata*, low forest; Community 2: *Baphia massaiensis - Guibourtia conjugata*, low thicket; Community 3: *Terminalia sericea - Eragrostis pallens*, low woods; Community 4: *Combretum apiculatum - Pogonarthria squarrosa*, low woods; Community 5: *Combretum apiculatum - Andropogon gayanus*, low

woods; Community 6: *Colophospermum mopane - Panicum maximum*, short woods; Community 7: *Colophospermum mopane - Combretum imberbe*, tall shrub forest; Community 8: *Kirkia acuminata - Combretum apiculatum*, tall forests; Community 9: *Terminalia prunioides - Grewia bicolor*, thicket; Community 10: *Acacia tortilis - Salvadora persica*, short woods; Community 11: *Acacia xanthophloeia - Phragmites sp.*, woods. Community 12: *Acacia xanthophloeia - Faidherbia albida*, high forest; Community 13: *Plugia Dioscurus - Setaria incrassata*, creeping grass meadows; Community 14: *Sporobolus consimilis - Setaria incrassata*, tall grass meadows; Community 15: *Stenotaphrum secundatum - Cynodon dactylon*, creeping grass meadows (Stalmans et al. 2004).

At the LNP we can find sandy plains, the Mananga platform with *Colophospermum mopane* shrub savannah, basaltic plains or colluviums with mopane forest or savannah shrubs, riolitic mountains and boulders with *C. apiculatum* and *C. mopane* - wooden savannah plains, and floodplains with *Faidherbia albida* or *Salvadora angustifolia* - tree savannah (Stalmans *et al.*, 2004).

Based on the composition of their plant communities, one can expect the sandy Nwambia landscape, *Andansonia digitata* landscape/*Colophospermum mopane* and North Lebombos landscapes are relatively richer than the others. Important species for conservation include *Stadtmannia oppositifolia* and *Pterocarpus lucens* (Stalmans *et al.*, 2004).

Abandonment of land and fallow cycle results in a number of regeneration states to be found along the LNP. The most distinct ones are regeneration of mopane community 6 (*Colophospermum mopane - Panicum maximum*, low forest) and open forest with *Sclerocarya birrea*, *Berchemia discolor*, *Cassia abbreviata*, *Acacia tortilis*, mopane trees and creeping vegetation of *Urochloa mossambicensis* and *Panicum maximum* that are the sites of abandoned settlements. *Dichrostachys cinerea* and *Dalbergia melanoxylon* in association with Mopane can also represent regeneration in previously grown areas (Farrell, 1968).

Overthrow of vegetation for agricultural purposes still continues to take place now, even in sensitive areas and rich in species, such as riparian forest of community 12 (high forest of *Acacia xanthophloeia - Faidherbia albida*) and sandy area from community 4 (low tree Savannah of *Combretum apiculatum - Pogonarthria squarrosa*). The annual rate of deforestation in Gaza is 0.33% (MINAG-DNTF, 2007).

In the region the following exotic invasive species can still be found: *Nicotiana glauca* (in Massingir dam banks), *Parkinsonia aculeata* (in marshy plain of Limpopo near Pafuri), *Ricinus communis* (along Limpopo River near Mapai), *Agave sp.* (high Shingwedzi), and *Xanthium strumarium* (riparian areas).

The Limpopo River, near Pafuri, is infested by the following aquatic weeds: *Pistia stratiotes, Salvinia molesta* and *Azolla filiculoides* (Stalmans *et al.*, 2004).

The Inhabitants of the park gather roots and tubers, honey and berries of plants and trees. The trees provide fruit for food and manufacturing of traditional beverages (Cashew-tree - *Anacardium occidentale*, amarula tree - *Sclerocarya byrrea*), medicine, firewood for cooking, building materials (they primarily use mopane), and is used for making charcoal for sale. With creation of the park, charcoal production was banned in the buffer zone but still exists on a small scale.

Hunting for local consumption has traditionally been performed by the population and is an important source of protein. Fishing is also an important activity for the communities living near rivers, lakes and Massingir dam (Dimande and Salas, 2010). In the area there is a small amount of chanfuta (*Afzelia quanzensis*), however, and there is a collection point for manufacturing furniture (MITUR-DNAC, 2010).

The majority of the population is located in the southern part of the LNP, as the number increases, the pressure on natural resources will also increase (MITUR-DNAC, 2010).

Threats to plant diversity within the Park should be taken into account, including: unsustainable collection of wood for domestic use, sale or production of charcoal, unsustainable collection of plants for medicinal use, homogenous spatial impact of herbivores, a time scale sufficiently long to change (positively or negatively) recruitment or growth of individual plant species and communities. Impacts of tourism activities, i.e. 4x4 vehicle rails, off-road driving, and frequent high intensity fires. Standards of spatio-temporal homogeneous fires that change the structure of plant community. Alien plant invasion and theft of rare species (MITUR-DNAC, 2003).

Production of charcoal and undoubtedly the main source of income of the community once a lucrative business, resorting to cutting mopane trees for its production, with the main markets being Chókwè and Maputo.

Besides weather vulnerability, the region in general and the Support Zone in particular faces another serious environmental problem: deforestation caused by human activity, and increased soil erosion, which can significantly affect the productivity of land resources, reducing Carrying capacity and feed, which in turn will have serious consequences to the LNP, since the pressure and demand for these resources can easily raise situations of invasion of the LNP territory, and therefore change the dynamics of natural resource management of that region.

However, this phenomenon is not particular to the Support Zone, because during the field/ground diagnosis it was found that there was intense and progressive deforestation at adjacent areas, e.g. Massingir, Mabalane, and Chókwè, in the latter and Massingir being more serious. Moreover, there is an imbalance between demand and supply of timber, both for consumption, building material, as for firewood and charcoal. More than 95% of domestic energy source in this region derives from biomass. Studies recommend that there should be control over deforestation by taking measures to reduce consumption and increase "affordable" supply for people, especially at the level of major urban centres, such as Massingir and Chókwè. High demand for forest products is characterized as a "threat" to the region's development rather than as an opportunity to increase production and wealth of local communities. This is mainly due to the perception people have that products such as firewood and charcoal are common property ownership and free access to forests in whatever regime they are in, i.e. conservation, community, State reserve, etc.

Population growth and disorganized urbanization lead to deforestation not only to satisfy growing consumption of firewood and charcoal, and to provide wood for construction with a view to setting people already in Housing crisis due to various natural disasters and political and social conflicts occurred

in inhabited regions. There is absence of intervention which can promote rational consumption of energy and development of efficient buildings. For example, the resettlement programme of households at LNP and transfer to the Support Zone is certainly a reason to increase pressure on the forest since the construction materials, in part, are cut on site. This is because local prices of woody material are relatively low due to the notion of free resource beyond availability factor.

Despite imbalances of the current situation there is a perception that the native forest area formed by the territorial districts of Chókwè, Mabalane and Massingir is likely to ensure basic needs of the population in terms of fuel supply and also a monetary surplus resulting from additional sale of firewood or charcoal. For this it is necessary to perform an initial afforestation or improvement programme of villages, and implement efficient solutions for private management of forest areas by involving the communities. Simultaneously, we must act in the rationalization of energy consumption by promoting use of more efficient equipment and eventually alternative energy.

Today without intending to replace natural forests by planting fast-growing exotic species, it is important to find the balance between those species with greater economic interest that may add value to any of the dominant production systems, and improve the quality of rural family life. An excellent example is undoubtedly the establishment of lots of bush/tree called *Moringa*, which has high nutritional value for livestock, and also in terms of human nutrition and water purification improving its drinkability for human consumption.

3.2.7. Wildlife

Wildlife is a major attraction potential at LNP. Elephants, rhinos, giraffes and lions are some of the most famous species.

Forty-nine species of fish are known in the area. Three species deserve special conservation status, due to their rarity and limited distribution, these being the two small seasonal Inhabitants of ponds, the *Nothobranchius orthonotus* and *Nothobranchius rachovii* as well as the fish with lungs, *Protopterus annectens* (MITUR-DNAC, 2003).

Thirty-four species of frogs inhabit the area. The Pyxie from sandy soils, *Tomopterna krugerensis*, was discovered inside Kruger Park and has the main area of distribution in the Transfrontier Park area, although it was also found in KwaZulu - Natal in South Africa.

At least 116 species of reptiles are known from the area of the Transfrontier Park. Among them there are two almost endemic species: *Nucras caesicaudata* (sand lizard with blue tail) and *Monopeltis decosteri* (lizard De Coster trowel-nosed).

A total of 505 bird species are known from the Kruger National Park (KNP), but a small number of additional species is likely to be present at LNP. None of the species from the KNP is endemic.

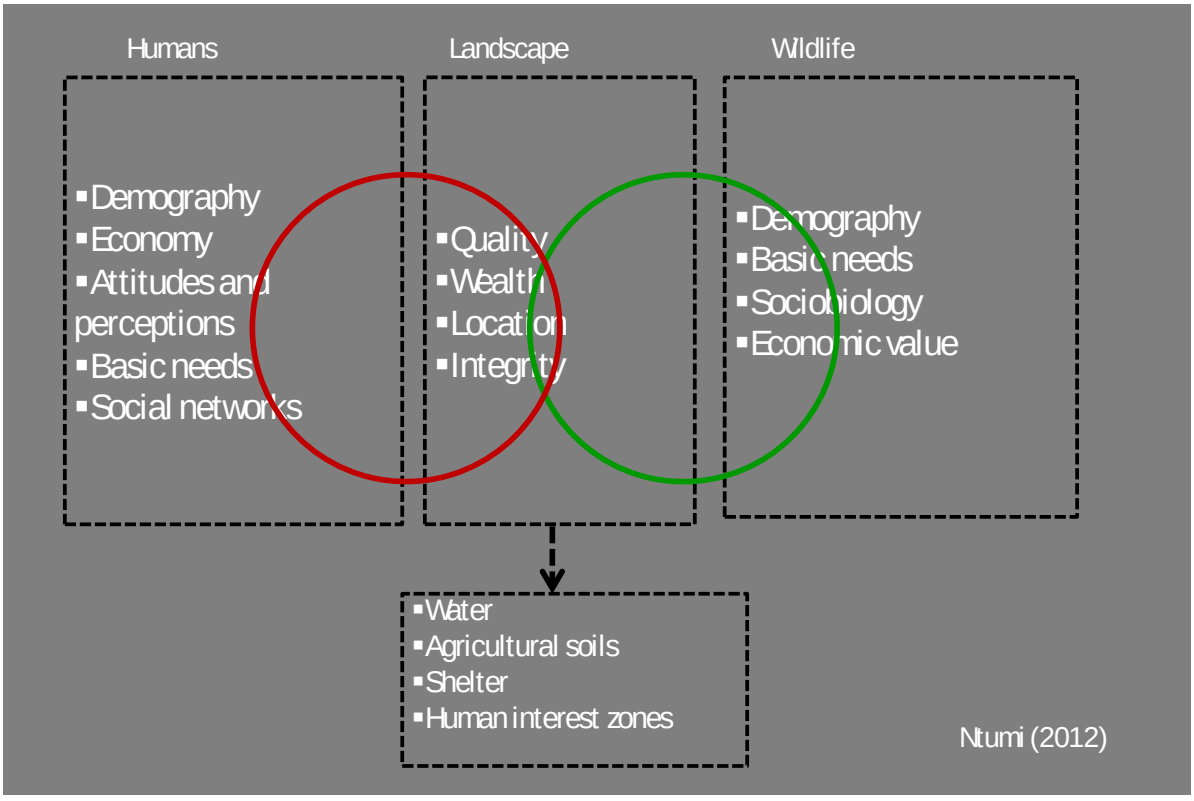
A total of 147 species of mammals, of which none is endemic. However, besides a population located around Pretoria in South Africa, the golden mole of Juliana, *Amblysomus julianae* is known only from a few

specimens collected in Pretoriuskop area of the KNP. Currently, the KNP is also one of the last areas of the world that has viable populations of wild dog, *Lycaon pictus*, with close to 300 individuals in total. The 3000 population of white rhinos, the *Ceratotherium simum* at KNP is present in the greatest of the entire world, while the 300 black rhinoceros, *Diceros bicornis* is the second largest. Both species are increasing significantly and increase of the distribution area into Mozambique and Zimbabwe will improve the conservation of these endangered animals, such as the endangered wild dogs. A new species of bats, *Eptesicus* undescribed is known from the KNP. A number of rare species of antelope representing unique gene groups are also largely located within TFCA, such as matagaica, *Hippotragus equinus*, the pala - pala, *Hippotragus niger* and damalisco, *Damaliscus lunatus* (MITUR-DNAC, 2003).

With integration of transboundary parks with more survaillance and awareness raising efforts in communities, the reintroduction of wildlife to LNP is becoming a reality. While there is not still a fence that separates the buffer zone of the park's central areas, occurrence of conflicts between people and animals is a major concern today.

3.2.8. Risk of Conflict between Humans and Wildlife

Conflict between humans and wildlife refers to negative interactions between people and wildlife. Negative interactions between humans and wildlife can be linked to ecological, social, economic and political factors. Such interactions may result in injury or death to persons and/or livestock, loss of infrastructures or destruction of food crops (Picture 6).



Picture 6. Conceptual approach of conflict between humans and wildlife. Human and wildlife species interact within the landscape full of resources for both, which can lead to overlapping interests.

The main assumption for conflict to happen is co-occurrence that takes place in space and time, between troublesome species and humans in a landscape full of resources (Naughton *et al.*, 1998). The use of landscape and resources that exist on the two competing species is governed by a set of socio biological and socioeconomic factors (Swanson, 1994). Moreover, each type of conflict does not use random landscape, it tends to maximize its fitness through obedience to behaviour, but also in relation to habitat.

There are intrinsic and extrinsic factors that predispose occurrence of conflicts in a certain place. Both these can be rooted directly or indirectly. For instance, both humans and wildlife species inhabit rather dependent on existence of resources. But the use of these resources is governed by each population demographics, economic and social traits. External changes to each (e.g., biophysical variables, climate change in general and policies adopted) may favour or dispel the driving forces of conflict between humans and wildlife.

Individuals, families, villagers and communities have different perceptions about the value, preference, interests and management of resources. These perceptions change in space and time according to economic growth and the inertia of the community, thereby dictating constant adjustments in the household behaviour in using resources dispersed in the environment that are also used by their exclusive competitors.

Socio-economic changes in households allow building predictions of cause and effect in the rates of meetings between humans and wildlife as well as building the condition for a conflict to take place, based on the assumption that the parent basis for a conflict is the encounter between species or overlapping interests.

Thus, the variables that dictate the use of space by species in interaction are extremely important in predicting and mitigating of conflicts between humans and wildlife. Therefore, the risk of these conflicts can be correlated with spatial variables that dictate human activity on the landscape, such as human density, transformation of the landscape, farming practices, density of roads and others (Hoare & Du Toit, 1999; Parker & Osborn, 2001; Sitati *et al.* 2003). These considerations allow building criteria to assess conflicts, based on the nature of troublesome animals and the typology of conflict because troublesome animals differ in their natural history, diet and behaviour.

Predictive variables and response previously selected based on literature review in other fields of Africa in general, in Mozambique and in particular the LNP included human density, transformation of landscape, farming practices, density of roads (Ntumi, 2012) and others (see Table 4 for details).

As mentioned above, the main premise for conflict to happen is co-occurrence in space and time between troublesome species and humans in a landscape full of resources (Naughton *et al.*, 1998). The risk of conflict with the most troublesome species was estimated based on the rates of conflict with each of the A, B, C and D groups. The conflict rates for each case was estimated based on the number of cases referred to that species came into conflict with humans. The conflict indicators considered were: (i) the

number of deaths of people in each classified settlement, (ii) the number of deaths of cattle in each classified settlement, (iii) the number of deaths of wild animals in each classified settlement; (iv) the number of injuries to people in every human classified settlement, (v) the area destroyed by wild animals in every human classified settlement expressed in Ha and (vi) the number of infrastructures destroyed by wild animals in each human settlement.

Occurrence of each species is also a function of occurrence of certain landscape features, dictated by vegetation units or by the type of predominant land use. Therefore, distribution models of farmland, forest and open forest were also designed.

The cultivated areas are a main predictor for occurrence of crop damages; the forest and open forest are predictors of distribution of some species, such as carnivores and small animals.

Table 4. Biology of some troublesome species common in the support zone of the LNP

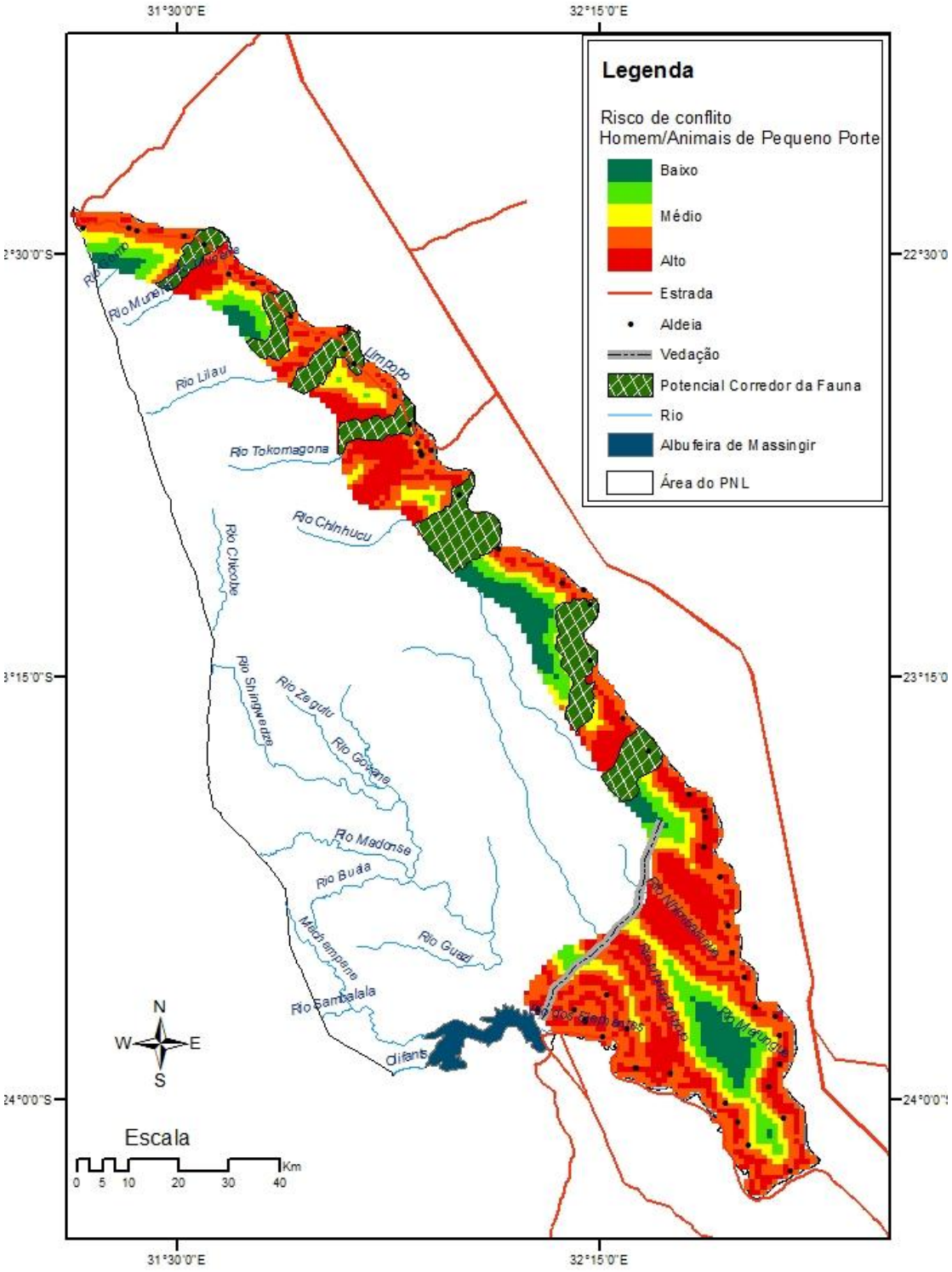
Scientific name	Common name (English)	Habitat	Eating habits	Reproduction season	Forest*	Riparian vegetation	Water
Papiu ursinus orientalis	Grey-monkey-dog	Mountains, rock zones, woody vegetation	Omnivore	Undifferentiated	+	-	+
Panthera leo	Lion	Bush, riparian vegetation and stony zores	Carnivore	Undifferentiated	+	-	-
Cercopithecus aethiops	Grey monkey	Savannah, mountains, riparian vegetation	Omnivore	Undifferentiated	+	+	+
Crocodylus niloticus	Nile-crocodile	Rivers, lakes	Carnivore	Nov - Dec	-	-	+
Thryonomys swinderianus	Cane-big mouse	Prairie, near permanent water sources	Herbs	Aug - Dec	-	+	+
Loxodonta africana	**Elephant**	**Forest, bush, prairie**	**Mixture**		**+**	**+**	**+**

The results obtained (see Pictures 7, 8, 9 and 10) show that humans tend to choose to live in areas close to rivers and roads. Indeed, the human distribution was negatively correlated with the distance to rivers and roads. However, occurrence of fauna in general was positively related to the presence of natural water and the presence of forest areas.

The distribution of cattle was dependent on the presence of water and linked to the presence of humans, i.e. in settlements areas, and agricultural areas, near highways. In turn, the agricultural areas are strongly associated with human settlements. Zones associated with presence of rivers, but away from roads are generally occupied by forest and/or grassland.

Picture 7. Predictive model of the potential conflict between humans and wildlife in the Support Zone of the Limpopo National Park

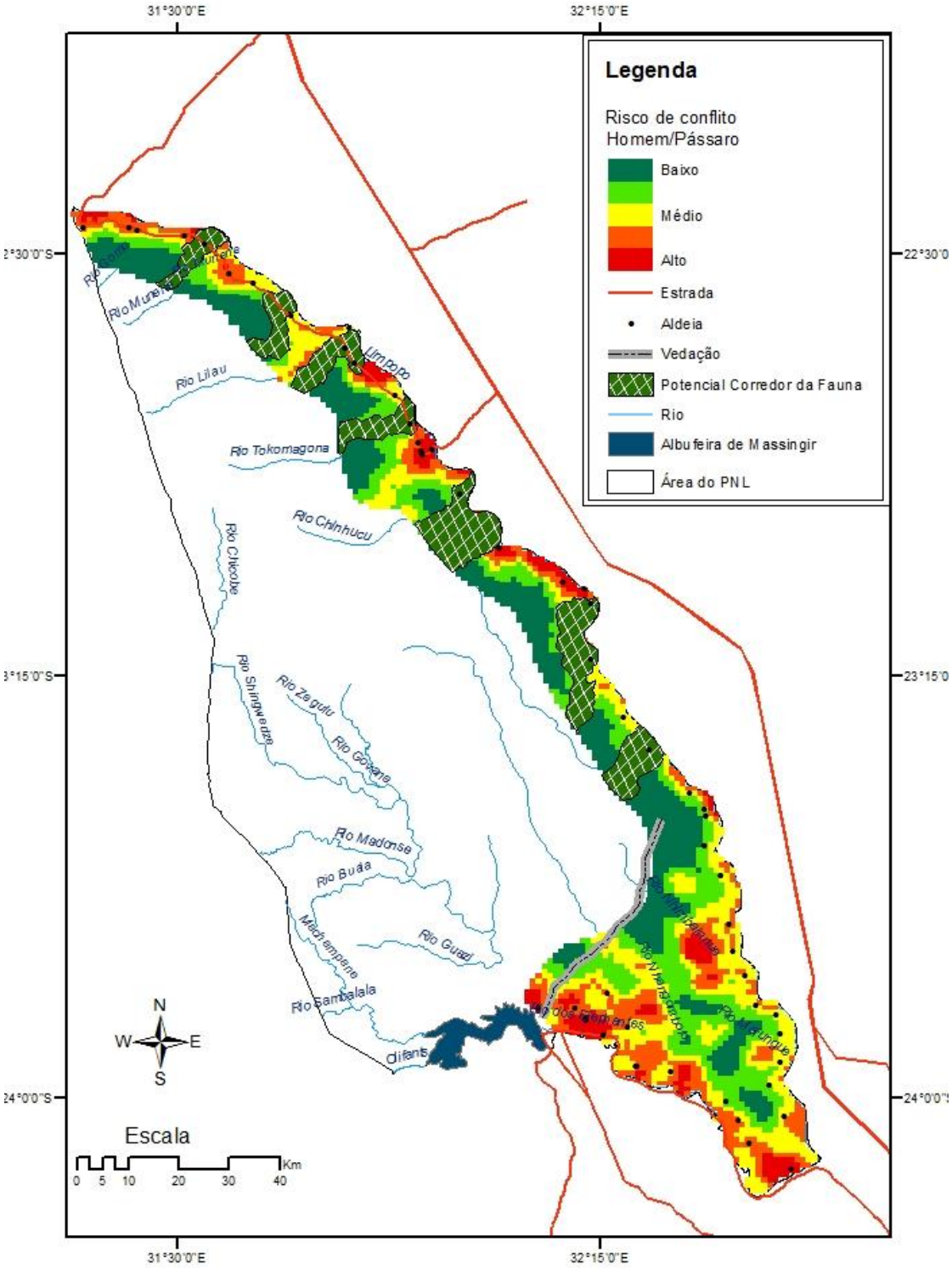
Although the fence has been designed to prevent wildlife species from crossing the zone of interests to humans, this may be especially effective for elephants and lions. Species such as monkeys, wild pigs and others of riparian system will continue to be conflicting in the southern part of the fence. As a consequence, pressure of cumulative risk of conflict at Hassane area and surroungdings may increase, since animals may be forced to explore this area for watering.



Label: Risk of Conflict between humans and small animal species; low, medium, high; road, village, fence; fauna potential corridor, river, Massingir dam, LNP area

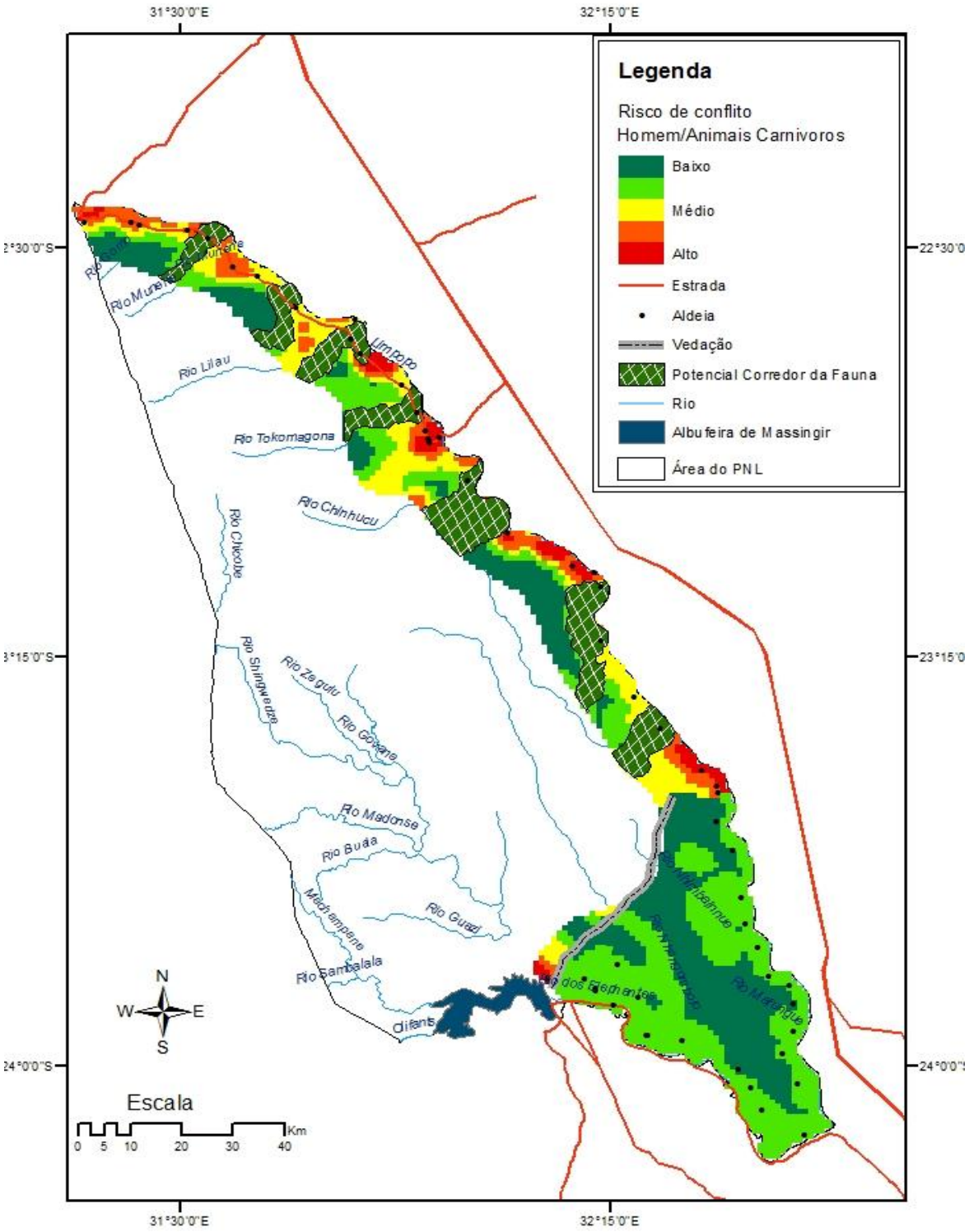
Picture 8. Predictive model of risk of conflict between humans and small animals (mice and insects) in the Buffer Zone of the Limpopo National Park

This conflict mainly refers to destruction of barns. Small animals (mice and insects) are eternal enemies of Man. Building a fence will not reduce potential occurrence of this conflict.



Label: Risk of conflict between Man/Bird

Picture 9. Predictive model of risk of conflict between humans and birds (mainly destruction of crops) in the Buffer Zone of the Limpopo National Park



Label: Risk of Conflict between Man/Carnivore animals

Picture 10. Predictive model of risk of conflict between humans and carnivores (lions, leopards, hyenas) in the Buffer Zone of the Limpopo National Park

This conflict mainly refers to injury and death of cattle. The potential occurrence of conflict in the south of the fence continues to be considered in this model, assuming that some birds, snakes and other species of local occurrence in this region may injure or kill livestock or people.

The probability of distribution of the human population suggests that it tends to occupy and use areas that lie along rivers and roads. This result is not surprising because, across the planet the use of space by humans responds to the ease access to natural resources and services, minimizing costs (Smith, 1983). At Limpopo National Park in general and particularly in the Support Zone, water is a scarce resource. Except the southern section of the park, where the confluence of the Chingwedzi river with Elefantes river and this with the Limpopo River, the northern and central sections (especially this one) are arid and water resources restricted to some areas. Soils and vegetation follow a similar pattern, with alluvial ones at lower topographic classes. Only those areas (so near rivers) agriculture is intensively developed.

The Limpopo National Park dates back to 2002 through the conversion of the former Park 16. No wonder that the road network is poor and because of that, the population settlements are encouraged by existence of few important roads and trails both for selling their productions such as small businesses that support the subsistence economy.

The fauna in general and especially large animals like elephants tend to be negatively affected by high human densities, which induce changes in the landscape (Newmark *et al.*, 1994). In contrast, insects and mice rarely dissociate human presence, their abundance responds to changes to forested landscape areas to grasslands, usually caused by human action. However, although these predictions have found support in relation to small animals, conflict with the mega fauna was often reported in areas of high human density. This suggests that farming is developed around bodies of water where humans and wildlife species overlap, i.e., water is a scarce but common resource.

Finally, carnivores may or not follow the gradient of space occupation by humans. In areas of abundant wildlife, lions, leopards and hyenas tend to be away from humans, happy by abundance of prey in their natural environment. In areas such as the Limpopo National Park, where abundance of prey is still small, often such species may prey on domestic animals. Frequent occurrence of conflict with carnivores in Mbuzi is an alert indicating that the LNP does not yet offer levels of dependency of carnivores to their environment.

This characterization alerts to the potential that these predictive models represent to practical scenarios. Although the criterion of proximity of a village to wildlife refuges has not been assessed, recently Ntumi & van Aarde (in prep.) found sufficient evidence for this relationship in almost all protected areas of Mozambique. This scenario draws attention to the need for planning the right to land use at the Buffer Zone of the LNP as to consider the need to demarcate the wildlife corridors and integrate them into this zoning process. Such demarcation must be preceded by proper analysis of ecological indicators of biological flows so as the solution of a problem today may not raise another problem tomorrow. For instance, although the location of the electric fence will help preventing occurrence of conflict with

elephants especially in the southern part, it is potential for directing the conflict to Matafula, Hassane and Vundla, as suggested in Picture 7. If corrections are made to the layout of this fence as suggested in the report on corridors will significantly improve the levels of conflict.

Conflict between humans and wildlife in Africa in general and in particular in Mozambique has allowed for crystallizing proactive rather than reactive solutions. Understanding existing today has about them is that even the more evident conflict (opposing humans and mega fauna) is eliminated altogether, local communities continue to bear a huge burden of conflict with small animals (mice and insects). These species tend to be most troublesome in high human density (Newmark *et al.* 1994). Mice and insects are troublesome in all stages of crops, but particularly in post-harvest losses. This explains why these species are associated with negative impacts to human interests, causing them enormous economic damages. In rural Africa, post-harvest losses are a major threat to food security, as described earlier. Programmes that improve post-harvest conservation should be adopted.

Many of the complaints related to wildlife resulting from intolerance of households due to high costs incurred by them without any tangible economic return. Community programmes focusing on the use of wildlife, such as game farms can be encouraged in the East margin of the Limpopo River. This exercise may improve tolerance of local communities regarding presence of fauna.

Proactive programmes to prevent occurrence of conflicts through micro-planning process of land use in the buffer zone are identified as "thresholds" that allow discouraging people who live and grow in areas prone to conflict. Agriculture is refocused on specific areas where there is great potential for with minimal risks of conflicts.

Despite proactive activities for mitigating conflicts between humans and wildlife mentioned earlier, there are common features that can not be circumvented. Water is indeed scarce in the North-Central region of the LNP. The zone of its abundance, the South will be excluded from access by animals through the fence. Thus, the common area of the Limpopo River will serve both for wildlife, livestock and people. Here, conflicts are inevitable. The reactive package to mitigating conflicts, consisting of various techniques should be implemented. Fortunately, the buffer zone of the LNP is very advanced in training and implementation of these techniques. There is no single technique that works, generally applying a menu of them has been advantageous (for details of mitigation measures that could be adopted, see Technical Sheet 4 in Section 5 of this document).

4. Integrated Analysis of Carrying Capacity

The main socio-economic aspects associated with land use in the Support Zone are listed in Chapter 2, which aims to characterize the ecological and economic point of view on dynamics of life of their communities.

It is noteworthy that, overall production and especially productivity in agriculture is extremely low, which is to say, to elect a priority, which would certainly contribute to household food security through greater

effort in improvement and development of some management practices, through adoption of relevant technologies adapted to social, cultural, environmental issues, and resulting in greater stability of the rural population.

And these production levels and low productivity are determined also by some biophysical factors that severely limit the performance of agricultural production systems, either in food or in animal production, especially the climate and soils.

Lack of income-generating activities for households at Support Zone, other than strictly agricultural activity, lack of resources to improve production and productivity especially, disabled marketing channels and quality of production, make the farmer to remain dependent on cultivating small or minimum areas per family member, we've seen in some villages to be much higher than recommended, which brings about a constant and increasingly intense pressure on natural resources such as forests, in order to expand the agricultural frontier.

Because rainfed farming is a risk, the more accessible area now and with the greatest potential is the Limpopo valley, along which about 44 villages are located and that are part of the SZ. Consequently, the pressure on the resource mainly in the South and Centre, is now a reality due to competition between types of land use, i.e. agricultural production, livestock production and forest conservation, specifically the riparian forest has been experiencing the greatest pressure in terms of opening new agricultural areas.

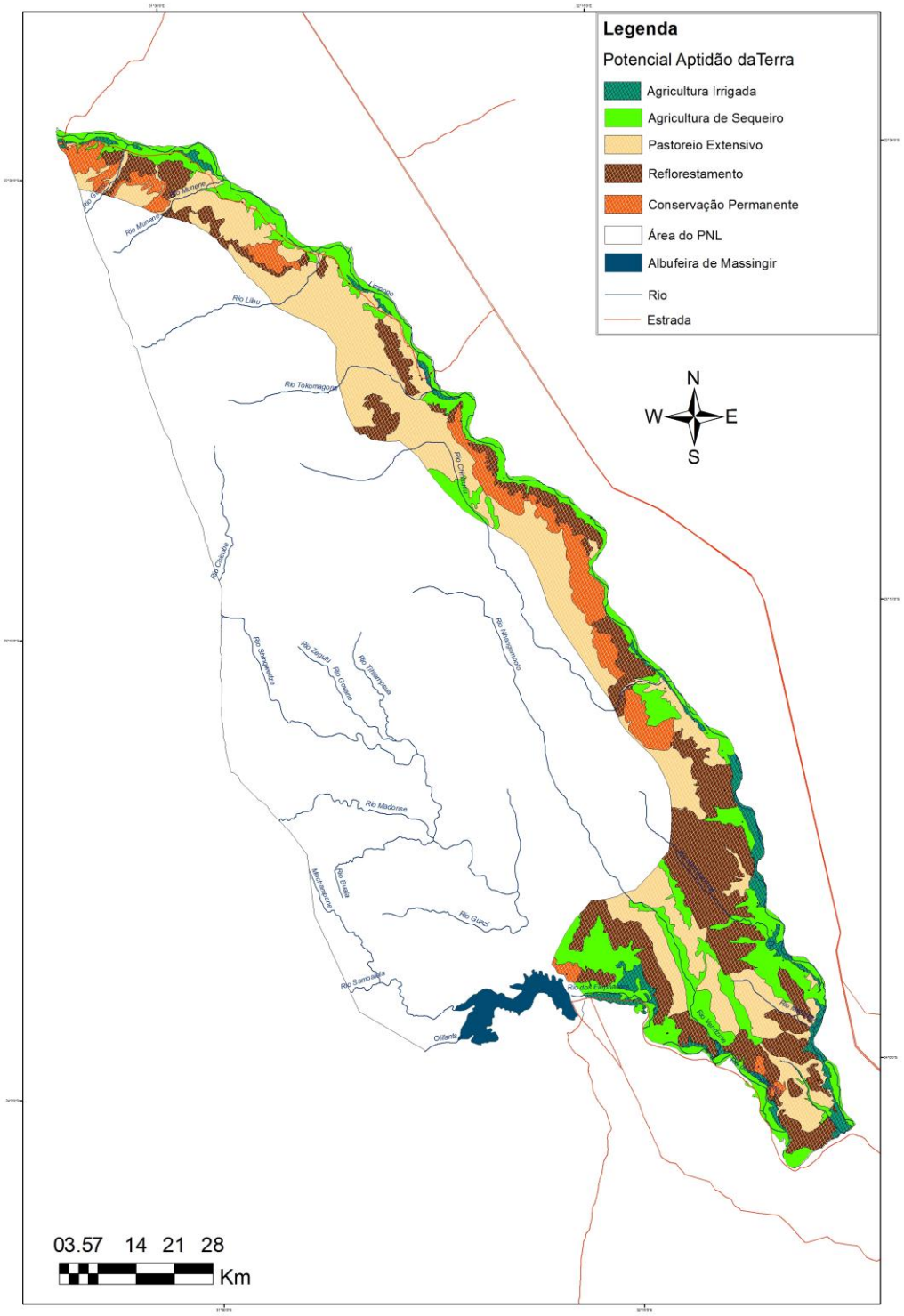
A better selection of areas and improvement of production systems can alleviate this pressure and the competition between types of land use, especially among livestock and agriculture, which will also result in higher productivity per unit area. For the sake of success, it is essential to adopt technology management and conservation of water in the soil as a way to improve availability of water for crops and animals, relieving pressure on land resources and extending the boundaries of units of land suitable for their production.

The Support Zone meets some of these characteristics, but without many options, due to marginal characteristics for agrarian production imposed by the climate and physiography, however, it was possible on the basis of integration of different submodels considering the key attributes for each type of existing land use in the study field. The discussion will be made on that basis, and followed by the main management units, from perspective of respect to expertise, based on agro-ecological potential.

Put simply, agro-ecological units were defined by overlap of the soil map, geomorphological and physiographic units, coverage and use of land and forests, special wildlife corridors, man-animal conflict, and yet the distribution of villages in the Support Zone. Overlaying all this information allowed the delineation of agro-ecological units.

On one level, the analysis followed a basic principle of combining the main land units considering its production potential, using classes II to VII, as it not only in the region or in the Support Zone where areas with productive potential were identified, high fitness for farming, soil limitations, in combination with the main vegetation types obtained from the forest map developed by the LNP, and inventory of land use and coverage (Cenacarta, 1998).

The main combination criteria followed certain principles, such as i) conservation of biodiversity and natural resources, since the Support Zone constitutes a buffer zone and extension of the LNP limits, ii) taking into account extension of sparse forest formations, some of the major forest formations should remain without reduction, therefore not accepting change of use except for protection purposes, iii) existence of biological corridors for wildlife and therefore these areas should be excluded in order not to allow cohabitation of uses provided the severity of existing Man-Animal conflicts, iv) in regard to erosion, with high ecological impact and therefore limiting the activities of intensive use of land as well as flood areas, or areas of shallow soils, very stony and coarse fragments, and consequently marginal areas in a normal situation for agriculture and livestock, but suitable for conservation or reforestation, agricultural or livestock farming activities developed in greater depth soils, and no major physical limitations. The Fitness Map (Picture 11) shows the agro-ecological units discussed below.



Label: Land Fitness Potential; irrigated agriculture; rainfed agriculture; extensive grassland; reforestation; permanent conservation; LNP area; Massingir dam; river; road

Picture 11. Map of Fitness Potential.

However, after a visit to some of these types of land use, particularly bearing in mind the current types, the present use of land in both agriculture potential rainfed zones and forest areas, there were underwood areas, mainly medium and high underwood units, allowing the possibility of alternative use of these types of vegetation for extensive livestock, since the area only in the presence of bovine current is close to capacity limits of stocking, as being necessary and pragmatically accept specialization of the potentially high area in terms of livestock production.

4.1. Natural Forest – Reforestation

In this unit those areas with forest cover type and low dense forest, riverine forest, open and low forest type and miombo were considered and necessarily would be reserved from the point of view of limited use for extraction of sub-products and forest products in a situation of sustainable use by local communities or the population as been done hitherto. Because of its already limited representativeness and the need for establishment of biological corridors, these spots are to preserve as sanctuaries that accommodate wildlife species on their migratory marches between the LNP area and how those areas outside the Banhine National Park and others. Eventually the mopane woodlands, simbirre, and other kinds of species of industrial value will certainly deserve further attention once there have been forest inventories conducted to enable producing management plans. **In this category we are in the presence of about 90.000 Ha or about 25% of the the support zone area.**

We believe that this unit will certainly experience the most dynamics by virtue of livestock impacts, as systematically forests are part of open borders for natural grassland of herds, and also for the activity of rainfed agriculture, following the cycle of opening new fields, alternating with fallow grounds.

4.2. Wildlife Biological Corridors

These, as described and recommended in 3.2.8, associated with occurrence of conflicts between humans and wildlife, appear or arise by virtue of the need to mitigate the occurrence of wildlife species or their movement due to the presence of humans and domestic animals, vegetation basically specifies water once again revisiting the assumptions and variables used in the characterization of the conflict.

While acknowledging the importance of more specialized areas or units related to conservation of natural resources, or very low-impact forestry production, targeted primarily to the use of forest products for local use such as stakes and reeds in construction, poles, fences, and forest products other than wood, as may be leaves, fruits, seeds, roots, and other parts for use in traditional medicine, often these patches of vegetation are used as a refuge for wildlife without necessarily establishing their territories, approaching other units less suitable for conservation, and for areas such as agriculture and livestock.

The proposed corridors are thus overlapping with other forms of land use without being considered exclusive but for multiple use, and LNP managers and leadership of local communities have to establish safe limits to beware of any conflict, while ensuring wildlife species to access to water for drinking. Mitigation measures therefore need to be integrated, where in many of the cases can be solved by

existence of fences, for animals, and compliance with other management practices with recourse to improved technologies. Thus, analysis is recommended to some corridors considered as priority or relevant, according to the following table (Table 5).

Table 5. Proposed corridors associated with Support Zone villages.

Name of Corridor	Relevance	Recommended corridor
Munguambane Corridor	Relevant	✓
Matsilele Corridor	Irrelevant	×
Sihogonhe Corridor	Irrelevant	×
Tchowe Corridor	Relevant	✓
Chipeluene Corridor	Highly relevant	✓
Matafula Corridor	Relevant	×

These are located mostly in the Northern and Central regions of the Support Zone, and along the banks of the Limpopo River. The following map (see Picture 12) represents the points of proposed corridors, corresponding mostly to specialized forest units and conservation, always within the limits of units potentially suitable for rainfed and irrigated agricultural production.

Picture 12. Map of Wildlife Biologic Corridors.

Taking into account that these corridors will be proposed and that this conservation unit comprises about **35,000 Ha**, accounting for about **10% of the total area of the Support Zone**, but recognizing overlaps in particular agriculture and grasslands, this number can only be small.

Like other proposals, in the case of communities and villages, the sooner the water supply for domestic use and for agriculture and livestock is solved, we will certainly help to reduce conflicts, since different studies undertaken are unanimous in selecting dispute to water resource as the main cause. Moreover, regarding large species, elephants and lions seem to be the main enemies thus being necessary greater awareness and disseminating measures of scaring these species as a way to reduce conflict and maximize access and use of corridor space.

Given three variables (human population, cattle population and wild population), as soon as possible introduction of control and registration numbers by population growth or village is justified, by both livestoock species and their handling as well as movement. What matters now is that the proposed mechanisms may be feasible and easy to implement, and in the absence of specialized technical services to the community through Management Committees of Natural Resources that will certainly have to be trained to cope with absence of any support being provided by the LNP.

Conflict seasonality of the graphs observed shows that there is a direct relationship between species and the conflict target product or the cause. In the case of agricultural production in the months of January to March increased incidence of pests and damage to crops is observed on farms, influencing harvesting and raising an established cause and effect relationship. The same is true in the post harvest in the barns, especially during dry months, where the elephant is the major pest (the same applying to any kind of species causing conflict). Therefore establishment, by the LNP of alert and early warning programmes that can guard communities and households to move these species before disaster errupts is justified.

The instruments are available, both in terms of areas and their spatial corridors, as well as other measures for what will be the short and medium term to meet the results and impacts. Any change of use in those areas considered for conservation and protection requires prior knowledge of the different management or administration authorities of the LNP and beneficiary Districts, representing villages or communities.

4.1. Productivity in Natural Grasslands

This unit is considered for livestock intervention, recognizing that the current production system is characterized by the use of rangelands, especially grasslands associated with top and middle underwood, to the prairies, and even with low open forest with low density of trees.

If there is overlap, those areas also geared towards rainfed agricultural production, their conversion into grassland areas would be under assumption that their productivity potential would be marginal for agriculture. Livestock production with extensive use of natural grasslands is the activity that should dominate this unit.

Grassland productivity is the quantity (weight) of dry matter (DM) produced by Ha per year that can be used by livestock. It is obvious that it has to do with production of grass, although green biomass production of certain species of shrubs is also important, particularly in very dry season, especially for small ruminants.

Grassland productivity is conditioned by four main factors namely: (i) duration of growth that is determined by availability of water, (ii) soil fertility, (iii) density of tree and shrub coverage, and (iv) composition of species.

Grass growth in the study field occurs in the period between November and March, with more moisture accumulated in the soil. Vegetative growth of grasses is, in general, weak and low productivity due to low rainfall, making these areas highly vulnerable to animal overCarrying and to degradation.

In the buffer zone 9 vegetation units were identified according to Table 6. Based on the number of Ha of vegetation units predestined for biological corridors, forest reserves and intensive farming with irrigation were subtracted and so we obtained fitness and available areas for grazing.

Table 6. Vegetation Units at Buffer Zone of the LNP.

	Vegetation unit	Ha	%
1	Dense Low Forest	19328,64	5,13
2	High Brushwood	92840,22	24,63
3	Water Bodies	2,05	0,00
4	Wooden Prairie	0,64	0,00
5	Medium Brushwood	189975,73	50,40
6	Prairie	14169,22	3,76
7	Low Brushwood	394,79	0,10
8	Low Open Forest	574,94	0,15
9	Agriculture	59661,99	15,83
	Total	376948,23	100,00

Based on vegetation units available and accessible for grazing by reviwing existing literature, the potential Carrying capacity and productivity of grazing animals was calculated as illustrated in Table 7. Carrying capacity is the number of Ha necessary in the long term, to keep animal unit on maximum production, under normal weather conditions. Assessment of Carrying capacity will consider tropical animal unit defined as "Tropical Cattle Unit" which is a 250kg-animal, commonly used in grassland studies in the region.

Table 7. Estimation of Carrying capacity and current cattle Carrying in grazing in the Buffer Zone of the Limpopo National Park

	Vegetation Unit	Ha	Ha/UA-estimates	Carrying capacity (UA)	Current animal Carrying /Cattle
1	Dense Low Forest	19.329	20	966	
2	High Brushwood	92.840	15	619	
3	Medium Brushwood	189.976	12	15.831	
4	Prairie	14.169	7	2.024	
5	Agricultural Fallow	59.662	2	29.831	
6	Others	972	0		
	Total	**376.948**		49.272	34.823

UA= Tropical animal unit = 250 kg (for maintenance)

Table 8. Conversion table by animal unit

Species /Animal class	UA
Bull	1.6
Ox	1.6
Cow	1.6
Calves	1.6
Steers	0.25
Goats	0.15
Sheep	0.15
Pigs	0.3
Chickens	0.005
Donkeys	1

UA= Tropical animal unit = 250 kg (for maintenance)

The average animal unit annually requires about 4000 kg of dry matter equivalent to 20 tonnes of fresh grass, to keep in good condition of productivity.

The current grassland park at Buffer Zone is approximately **376,948 Ha** as shown in Table 7. It is distributed by different agroecological management units without respecting the hierarchy proposed in this study and as a result of integrated analysis of Carrying capacity for different types of land use.

The current cattle population (animal Carrying) is 34,823 corresponding to AU 40 020 according to Table 9.

Table 9. Calculation of current Animal Units at Buffer Zone of the Limpopo National Park (cattle)

Class	% of cattle[1]	Cattle	Equivalent to UA	UA / totals
Bull	9	3000	1.6	4799
Ox	8	2908	1.6	4653
Cow	33	11471	1.6	18353
Calves	14	5004	1	5004
Steers	16	5466	1	5466
Young bulls	10	3487	0.25	872
Young cows	10	3487	0.25	872
Total	100	34823[2]		40020

[1]adapted feasibility study of proposed area for community grasslands – Massingir District. Final report - Rural Consult, 2009.
[2] Limpopo National Park and Provincial Services of Livestock, 2012.

Taking into account the present scenario and livestock numbers, we would almost venture to say that the Carrying capacity of the Support Zone has been reached, or is close by, because it is not far from 50.000

heads, so it can accommodate more than 15.000 heads, which will critically depend on the management to be adopted.

4.1.1. Identification of Major Limitations taking into account Production Systems

A variety of limitations to higher livestock production and productivity were identified and can be addressed in three main groups: i) technical limitations, ii) policy and institutional limitations, and iii) limitations related to agro-ecological zone, Buffer Zone of the LNP, shortage of food and nutrient deficiencies are more serious in dry season. Increases in food availability at low cost will be the most significant factor to determine whether the required growth in animal production is achieved, namely:

i. Technical limitations

Availability of grassland / food / rations: In the region the amount of forage is often insufficient for the amount of livestock, and food availability is subject to pronounced seasonal patterns and fodder are often of poor quality, with low energy and protein content.

Food resources are used almost entirely. Because of relatively moderate grazing pressure and good production potential, there are opportunities in these two areas for moderate expansion of livestock populations.

Animal Health: Animal diseases continue to constrain livestock productivity and result in annual losses that may represent about a quarter of the total value of livestock production. The impact of animal diseases derives from direct losses due to mortality and indirect effects on slow growth and fertility production of work as a result of weakness. Diseases with significant impact of livestock are ecto-and endo- parasites, respiratory arrests, Newcastle disease, and diseases transmitted by ticks such as *rickettsiosis* and *theileriosis*.

ii. Policy and institutional limitations

The decentralization policy and horizontal command of veterinary services adopted seem not to have benefited development of livestock, aspect compounded by budgetary constraints. The result of these budgetary constraints can be seen from the way research services do not generate any sufficient technology to promote agricultural development, and linkages with extension services and the provision of extension services of cattle are extremely limited.

Public veterinary services show limitations in providing animal health services needed to develop cattle. This leads to poor implementation of disease surveillance programmes and provision of vaccines, and control measures of epidemic diseases are inadequate with uncoordinated control of major infectious diseases.

Privatization of veterinary services may be an option, but must be adapted to reality of each zone. Because the private sector is profit-oriented, it is clear that only selected services could be effectively privatized. Authorities remain responsible for "strictly public" activities as national

research and extension, legislation and policies, disease surveillance, public health, transboundary animal diseases, control of livestock movement and quality control of animal products.

iii. Trading

Most livestock production is constrained by access to safe and fair market, both for inputs and outputs, and is mainly restricted to local and informal markets. Access to major domestic, regional and international markets is limited because of poor infrastructures and major technical needs. Absence of functional marketing facilities and infrastructures for storage and processing is a serious constraint to development of livestock sector.

There is lack of accurate and detailed statistical information, and poor negotiating powers. Furthermore, although technological problems are relatively well understood (from creator perspectives), there is lack of institutional capacity to implement appropriate solutions because the links between artists, communities, extension services and veterinary services are extremely weak in many cases, result in formulation and provision of bad programmes.

iv. Limiting related to agro-ecological zone

Livelihoods in arid zone are increasingly threatened by droughts that occur periodically. The high risks in production due to low primary production of grassland and wildfires, inadequate or nonexistent drought fodder, water shortages, diseases, inadequate veterinary services, poor infrastructure for handling, transporting, processing and marketing, and poor input provision systems, lack of technology, especially to improve agro-pastoral systems which reduce livestock productivity and make livestock holders become increasingly vulnerable to crises. Low potential of land restricts intensification of livestock production. However, improved market access and improved use of rangeland resources could significantly increase production and ease many of the problems that the new restriction on the movement of livestock imposed by fencing the LNP.

4.1.2. Recommendations on Possible Scenarios of Mitigation and Management Plans taking into account Results of the Evaluation of Carrying Capacity

Cattle breeding in the Buffer Zone of the LNP can be considered as an activity capable of triggering a conflict with the LNP due to: i) value that people attach to cattle, ii) spread of animal diseases, iii) competition for grasslands and iv) scarce water resources.

The strategy to meet the challenge of growth based on sustainable development, and avoid conflict, should be directed to: i) organizing communities, ii) the role of livestock in the process of intensifying agriculture, and iii) promoting development of market-based-livestock.

Specifically, efforts should be directed to:

I. Facilitate creation of associations and raising partnerships for management, control or access to common ownership of goods;

II. Create or strengthen institutions for administration of common property resources, particularly improved administration of water and land, community grasslands, to control tick-borne diseases, parasitic diseases, and disease controls limit regional and international trade;

III. Facilitate access to inputs and services and develop feasible and economic systems for provision of animal health services, using wherever possible, private veterinarians and assistants;

IV. Facilitate alternative income strategies, particularly diversification of livestock production;

V. Supporting development of infrastructure, livestock markets, roads and access to water, and

VI. Local meat processing and treatment of hides and skins, and improving effectiveness of market chain facilitation of technology transfer, particularly for mechanization based on development of animal traction technology.

VII. Development of a fund for local initiatives geared towards preserving the environment.

The livestock system is a set of elements in dynamic interaction organized by man to appreciate domestic animal resources. Livestock activity is integrated and differentiated: breeding animals to accumulate, services, animals for sale and to feed the household, so Animal husbandry is an important component in diversification of farmer livelihoods, and an income source as well as an economic reserve for the household. Animals are a key catalyst that allows farmers to gain greater security and open up new opportunities in terms of livelihood.

Our model calls for technical training of the "owners" of animals, functional literacy as "nuclear options" to equip them with knowledge to keep animals alive, with health and reproductive capacity. Once survival achieved, the number of animals will increase and it will be worth it investing in productivity, particularly in housing, food, animal identification, breeding and try new productive purposes. As this cycle unfolds, families have more opportunities to sell goods and buy elements that integrate feasible livelihood. This process also leads to an increase of animals available for sale, loan or purchase, increasing the possibility of households without livestock, to acquire animals.

There are conflicts arising from the fact that the socio-spatial unit of Housing for rural families is the space where production, collection, and grazing activities take place. Our model suggests building corrals outside the Housing for amongst other technical and environmental advantages to enable establishment of fruit or shade trees in the Housing area.

The choice, reservation and demarcation of communal grazing area in the villages is an option that will ensure sustainability of the livestock sector especially for species of greatest social and economic value (cattle and goats), and that's where all livestock infrastructure should be (medium-long-term) installed.

Corrals, barns as management units, their construction must comply with technical criteria established by competent authorities (models) and that materials should be strong and durable.

4.2. Agricultural Yield

This unit is rated for intensive agricultural use, occurring in higher fitness soils in higher productivity areas, along the Limpopo River valley, although in some cases there are constraints, especially because of its vulnerability to flooding, and consequently, locally with poor drainage. Some of the sub-units and the soil basis may show limitations due to toxicity under influence of the presence of salts.

In most cases and due to climatic factors considered most limiting, agricultural production is only possible through irrigation, both during the rainy season as supplementary irrigation, and in the dry season, such as full time watering.

The unit closer to the river and alongside it covers nearly **18,000 Ha** and in adjacent areas on the border with the inland zone of the units described above, around **45,000 Ha**.

Management of natural fertility of soils and their improvement associated with conservation of water availability in soil and erosion control are some of the recommended mitigation measures in order to increase and improve their potential, while preserving the agrarian resource base of Support Zone. The agronomic practices of crop rotation, the best herb mixtures, the observation of fallow grounds with cover crops and legumes or grass and other shrubby species of high feeding value for animals, for using as supplement, are part of measures to be taken to increase productivity of production systems.

The current population, about 20.225 people, occupies or cultivates about 4.500 Ha, with a margin growth of considerable available area if not losing part of production potential area for livestock, since these two types of using land compete for the same potential area.

However, according to the characteristics of the area most particularly in terms of soil, alluvial soil unit is that presenting the greatest Carrying capacity due to higher levels of fertility, resulting in yields above average in the Support Zone. Just by way of comparison, the soil unit **Fa**, and considering that, like the description in 3.2.1, reference crops are maize, groundnuts and cassava, requirements in terms of minimum area to meet production in current conditions, with cassava, 0.45 Ha, maize 0.75 Ha, groundnuts 0.66 Ha, for a unit of better soil.

In the case of lower soil potential, such as sandy, red orange soils, the minimum area to satisfy the same crops increases, although in the case of maize it remains approximately 0.75 Ha, and in the case of cassava to 1.0 Ha, and groundnuts to 1.25 Ha.

Thus, in the alluvial valley unit, a household should have access to basic needs in terms of food, to a farm with about 2.0 Ha, while in the higher more marginal part, the area of farm increases to 3.0 Ha, as regards to minimum areas.

It is therefore worth to say that, if we consider that each household cultivates at least two farms, one at downland and another at upland, we would have about 11,000 Ha currently cultivated in the lower part, and about 16.500 Ha cultivated at upland.

Keeping the same rates, we face a scenario in which the unit along the river, we would just have 8.000 Ha available to cope with any increase in population, which maintaining the same average in terms of Ha, allows only to accommodate more 4.000 households, equivalent to 14.400 people using the same average number of people per household.

Regarding upland, where 3.0 Ha are needed per family, would be available about 28.500 Ha, which is to say, in terms of Carrying capacity, it would be possible to expand the villages in general in more 9000 families.

This would be so far the most optimistic scenario, if the same levels of productivity are to be maintained, and without conversion of these areas to any other type of land use. Once natural fertility of these soils is limited, there is every convenience to make use of other management practices in order not to only maintain soil fertility but also improve the situation of soil degradation.

5. Proposals to Land Use

The proposed land use contained in this report is a result of integrated analysis and agro-ecological zoning because it systematizes for each use the best (possible) agronomic, agricultural, livestock, forestry, environmental and socio-economic practices contributing to sustainability of production systems described throughout the report, highlighting their main limitations, conflicts and opportunities for development of land use.

We recognize, however, that the approach followed so far has not been sufficiently participatory, as the discussions and sessions with different partners and beneficiaries, final responsible for its adoption, implementation, and facilitation were limited and must therefore follow the validation process for ownership by several stakeholders.

To highlight in this process the meetings and discussions with local leaderships, key in the ownerhip of recommendations because they will depend on the level of adoption of technologies proposed, considering the analysis of problems, limitations, opportunities for development, proposals of recommended land use in order to be corrected if accepted, as well as other opportunities not eventually considered.

The proposals that follow therefore require acceptance by various stakeholders, partners and beneficiaries, currently and basically representing opinion of the team working for the institution hired to carry out the study.

5.1. Strategies Adopted

In drafting and developing proposals only the following principles were considered:

- Radical changes in current patterns of land use should be minimal. As for example, agro-forestry and agro-livestock practices predominant in the study field should be improved, not abandoned, that is, abandonment of dryland farming or extensive livestock production is not recommended, but adoption of technologies and improved handling practices to increase productivity of agroecosystems.

- Because the Support Zone has been systematically subject to change its boundaries in order to better meet the natural conservation objectives of the LNP in this context it is expected to consolidate the social, cultural, anthropological and economic framework at Support Zone as a distinct area and for specific purposes to raising social, economic, cultural and environmental welfare of resident population. This issue is extremely important to consolidate coexistence mechanisms of Human population and wildlife species, but without laying a system of mutual exclusiveness regime, but an inclusive one. To safeguard interests of the communities should be the main slogan taking into account that preservation of nature and biodiversity will be in the medium to long term, an asset to communities.

- In the same vein of the previous point the exercise of bordering community lands is fundamental, especially natural resources in common use, as the best way of management and also ensure the rights of use and exploitation of land. It will certainly allow raising partnerships, including the NLP itself. The current programme implemented by CLI (Community Land Initiative) in Gaza Province, and with activities in several districts including Massingir, could be a way for eligibility of communities in support of bordering the areas as well as in raising partnerships for development, moreover, taking into account various proposals in the field of livestock and agriculture.

- Following the previous strategy, considering lands of River valleys of Limpopo, Elefantes and other waterways, as well as lowlands and depressions, as exclusively reserved lands for development of farming and animal husbandry by household sector, since these are a scarce resource and huge potential to contribute to the Carrying capacity of the SZ.

- By reserving up the valley lands of the rivers for agricultural production development, by communities, we would help reducing the pressure on the land resource of fragile or vulnerable areas or of potential man/wildlife conflict, as the case of corridors, and those areas along the fence and LNP borders.

- Improving access to lands of river valleys, with emphasis on irrigated or irrigable land, will provide better opportunities for spatial and temporal reduction on crop production highly dependent on climatic factors such as rainfall, and will increase product diversification which are strategies adopted by farmers.

- Proposals for land use are made according to land fitness, i.e. major limiting factors safeguarded and therefore mitigation measures needed to reduce any impact on the principle of environmental sustainability, in this regard also considered Carrying capacity of a given unit of land selected for such purpose.

- A very strong institutional capacity-building is recognized and recommended given current weakness of public institutions responsible for administrative, technical, social and economic management in the study field, provided that the populations living there belong to territories under local administrative management, i.e. district and administrative counties.

5.2. Development of Land Use Proposals for Agricultural Yield

We try to accommodate and associate the proposed land use, best management practices from the point of view of plants/crops, soil and water, both knowledge and experience in the region, especially Massingir, Mabalane and Chókwè, in order to get the best strategy to mitigate environmental impacts.

The study field, as its climate characterization is predominantly dry semi-arid to arid, belonging to southern inland. Several recent studies conducted either within the region or nationally, show that the scenario in general and the impact of climate change can only be more severe considering the high risk of loss of crops and harvests in most years.

For instance, the recent study by INGC (2009), shows that for cassava, the worsening of drought results in considerable losses in output/income, although for maize the impact is not as great as the area is regarded as marginally suited for maize and any aggravation means loss of the entire harvest or crop without reaching harvest stage.

Concerning other cereals only millet has a relatively better performance in the presence of higher moisture content available for plant growth, in contrast to the behaviour of maize, which can not survive under such supposedly more favourable conditions, crops much less tolerant to droughts or occurance of extended periods during growth period of crops. Similar behaviour for maize is rather limited by incidence of more severe dry periods.

INGC study results (2009) show that the areas considered chronic on food insecurity will be those most affected by the impact of climate change. These areas deserve greater attention regarding facilitation and prioritization of access to improved technologies, with emphasis to a package including improved varieties with increased tolerance to droughts, and still eligible for insurance while harvest loss to cope with food deficits.

To say that climate change by reducing the frequency, regularity and amount of rainfall apart from severely limiting rainfed agricultural production and therefore increasing food insecurity, it also has direct impact to water levels in rivers, and they become limited, which also brings consequences for irrigated agricultural production. This scenario will certainly face limitations bearing in mind sizing of systems and typified areas, type of producer, type of crops, and type of irrigation systems.

To this end the accumulated experience in implementating small scale irrigation in the region is an asset on the recommendation of the proposed land use.

In parallel with the two proposed land use already mentioned, such as rainfed farming and irrigated agricultural production, other proposals for land use in immediate future will be more competitive and

perhaps sustainable considering capacity Carrying of the SZ, as in the case of extensive livestock production.

Livestock production systems at this time seem better adapted to agro-ecological, social, economic and cultural reality of the region, and possibly the use of land, with less investment done, will bring greater immediate benefits, alternatively and compared to agriculture.

The SZ in terms of agroecology responds perfectly to these challenges because it accommodates the valley area of the rivers for development of irrigated agriculture, the river terraces and relatively higher areas adjacent to the river valleys for agricultural production in rainfed inland lowlands to extensive production of cattle and goats, and even conservation areas predestined to wildlife corridors and conservation of natural forests, on the hills and more corrugated, stony and more vulnerable landscape to erosion.

5.2.1 Rainfed Agriculture in River Valleys

Narrow strip of land along the river valleys, associated with river terraces and natural levees of rivers that are currently occupied by densely residential area. In this unit are located almost 95% of the SZ villages, due to their natural characteristics, higher, well-drained, access to water, easy soils to work on, allowing cultivation of various food crops around or near homes. This unit also lends itself to planting fruit trees, for example, the amarula tree is common, as well as some other fruit trees. We think that fruit trees are an important supplement in food and nutrition and particularly native species or native fruit trees should be promoted. If possible we recommend introduction of orange and lemon tree varieties tolerant to droughts, and even mango trees. The Chókwè Agricultural Station and the Chókwè Polytechnic Institute are important production centres and technology transfer, potential partners to consider when implementing such initiatives.

This unit is most suitable for the residential area in the study field and also moderately suited to production of some food crops such as maize, cassava, butter beans and cowpeas.

After harvesting, crop residues/stubbles serve as cattle feed and areas are open to grazing.

5.2.2 Rainfed Agriculture in Ridges/Old River Terraces

In these areas we witnessed rainfed crop production, currently less productive, marginal areas for agricultural production due to their high seasonality, high aridity content, resulting in low or zero production due to loss of crops and harvesting.

To enable agricultural production in this unit, it is worth to adopt several mitigation measures and more sustainable handling practices for soil and water, which enhance productivity of production systems.

The crop standard must eventually be better sized as to identify and recommend the best consociation possible, allowing greater coverage of soil, resulting in increased efficiency as regards the use of available soil moisture and nutrients, planting density, intervals between lines, extremely important design in conservation of water and soil.

Such measures, coupled with leading technologies, must have a solid institutional support because we believe that these skills and knowledge are limited to the level of our public institutions responsible for monitoring and tracking the activities of production, extension, and other rendered important tasks.

To this end and so that these technologies can be effectively transferred, translated by levels (quantified) for adoption by the farming families, is to establish protocols and memorandums of understanding with research institutions and higher education, as well as with the National Institute of Disaster Management, which have been developing a technology transfer programme in recent years adapted to arid and semi-arid areas of the southern country, implemented through their Development Centres, called CERUMS.

Many of these technologies have proven to be of great success and impact, but unfortunately only at the level of neighboring country, such as Zimbabwe. Given its proximity to and participation in transfrontier conservation project, it would be desirable that this collaboration could be extended to other institutions, including rural extension, as a way of training and capacity-building to some community members and technicians or public extension officers rendering services in districts.

Some of the district services of economic activities, Mabalane and Massingir, had the opportunity to participate and monitor some experiment work with water and land conservation technologies that are intended once more widespread in the SZ once we think it is the best way to adapt to adverse conditions constrained by climate change and arid and semi-arid characteristics ot the region.

These technologies are available in IIAM-South-Centre Zone, in Chokwe Agricultural Station, having been tested in field trials in representative agroecological environments similar to those of the SZ's. The technologies are proposed in the following Table, namely: **(I)** *mulch*: this practice aims to reduce soil temperature, reducing evaporation from soil, increased soil moisture and adding organic matter to the soil surface layer, **(II)** *zero tillage*: this practice would reduce hand labour required to prepare the soil and ensure optimum sowing season, as well as help in reducing soil temperature, evapotranspiration, as well as contribute in adding organic matter in topsoil; **(III)** *watersheds and fertilizer micro-dosing*: which is the concentration of water and nutrients in the seeding area as a way to maximize the use of rain; **(IV)** *strangled grooves*: also for better use of water rain. These practices may be adopted in sub-humid, semi-arid and arid environments.

Preparation and incorporation of organic compounds is a practice which can contribute to cost reduction of inorganic fertilizers, improve soil fertility and structure, as well as improve retention capacity of water and nutrients.

The incorporation of green organic fertilizers can reduce the costs of inorganic fertilizers, reduce the spread of pathogens, pests and diseases, improving the soil structure and its physicochemical properties. This can occur in rainfed and irrigated system.

In rainfed, sub-humid, semi-arid and arid areas, specifically in grain crops tolerant to droughts, as pigeonpea, the likelihood of grain harvest in years/in extremely low rainfall environments would increase; as well as millet and sorghum crops in rainfed low environments in sub-humid, semi-arid and arid areas.

There is need to work on crops like cowpea, groundnuts and maize (Matuba, and Changalane Djandza) to increase likelihood of grain crop in years/in moderately low erratic rainfall environments.

There are other alternatives that should be explored, including promotion of fruit trees like pineapple, native fruits, citrus (lemon and orange) as well as mango trees. This should occur in order to increase probability of picking fruit yearly/in low rainfall environments in subhumid, arid and semi-arid areas.

Given that agrarian systems are a whole it would be important to stimulate creation of a fodder bank, from shrub species for the subsystem of livestock production.

Thus, it would become important to encourage shrub species (*Leucaena* and other legumes) to use as material rich in protein in forage and silage preparation in order to ensure feeding of cattle in dry weather; testing and development of cacti is recommended. Finally, proper use of maize, millet and sweet sorghum stalk would be an asset in promoting and ensuring food security of livestock in the communities.

Table 10. Some of the technologies tested and available in the region and that can add value to production systems and their adaptation to climate change

Technologies		Goal	Environment
Water and soil management	Mulch	Reducing soil temperature, reducing evaporation from soil, and adding organic matter to the soil surface layer.	**Sub-humid, semi-arid and arid**
	Zero/minimum tillage	Reducing hand labour required to prepare soil, timely sowing; reducing soil temperature, reducing evaporation from soil, and adding organic matter to the soil surface layer.	
	Fertilizer watersheds and micro-dosing	Concentration of water and nutrients in the planting site, e better use of rainwater	
	Strangled grooves	Concentration of water and nutrients in the planting site, e better use of rainwater	

	Preparing and incorporating organic compounds	Cost reducing in inorganic fertilizers, improved fertility and soil structure; improved retention capacity of water and nutrients	**All rainfed and irrigated environments**
	Cultivating and incorporating green organic fertilizers	Cost reducing in inorganic fertilizers, reducing pressure of weeds, improved fertility and soil structure; improved capacity for retaining water and nutrients	
Grain crops tolerant to droughts beans >Millet and sorghum>Peabeans and groundnuts>maize (Matuba, CHangalane and Djandza)]	Pigeonpea	Aumentar a probabilidade de colheita de grão em anos/ambientes de precipitação extremamente baixa	**Rainfed, in sub-humid, semi-arid and arid areas**
	Millet and sorghum	Increase likelihood of grain harvest in years/low rainfall environments	
	Feijão Nhemba e amendoim	Increase likelihood of grain harvest in years /moderately low erratic rain environments	**Rainfed: semi-arid and sub-humid areas**
	Milho (Matuba, CHangalane e Djandza)		
Fruit crops	Native fruit trees	Increase likelihood of fruit harvest in years/low rainfall environments	**Rainfall, in sub-humid, semi-arid and arid areas**
	Pineapple		
	Citrus (lemon and orange)		
	Mango trees		
Fodder	Shrub species	Use protein-rich material in	

crops/banks	(Leucaena and other legumes)	preparing fodder and silage to ensure feeding in dry weather	
	Cactus	Ensure availability of grassland for cattle in extremely dry environment	**Arid areas**
	Maize, sorghum and sweet millet stalk	Increase food security of cattle of agro-pastoral communities.	**Rainfed: semi-arid and sub-humid areas**
Crops adapted to low phosphorus	**Comon beans**	**Increase commom beans yield in poor soils**	**Poor soils in sub-humid areas**

The response of production systems to climate change can be described as adaptation strategy taking into account that such adjustments relate to changes made by producers in the short term in response to seasonal and climatic fluctuations from year to year. These changes are then followed conscientiously as those handling practices that can better take advantage of environmental risks, thus reinforcing the need for management practices of plants, soil and water recommended above, are those that have already been tested and adopted by farmers or producers from neighbouring regions.

5.2.3 Development of Irrigated Agricultural Yield – Irrigation

A major priority is to boost the existing irrigation schemes in order to fully operate, thus being necessary to update such areas by updating the inventory of irrigated lands, i.e. either those currently in production, or those with infrastructure but abandoned.

Updating this register of irrigated land and its tenure should include an analysis of the farmer, i.e. identification of the objectives of the peasant, existing resources, problems and interests. Farmers who do not show interest in the use of irrigation should be encouraged to focus their efforts on rainfed agricultural production through access to technologies previously proposed.

Any decision on irrigation schemes should weigh on the business opportunities and local or regional market, as this should still consider the economy in terms of production scale. That is, the strategy would be to support and encourage development of small, individual garden type irrigation schemes, specialized in the production of vegetables, with areas between 0.5 and 1 Ha, or small irrigation schemes up to 5 Ha operated by an association of irrigators/producers? If so what kind of production would be recommended in these irrigation schemes, since we would certainly face an exercise in cost/benefit of these infrastructures. Or proceed towards development of larger irrigated areas, between 100 and 500 Ha, where partnership would be negotiated, e.g., with major agro-industries in the region, where the Xinavane Sugar Company, with very rich experience in promoting 'outgrowers' of sugar-cane, under associations,

and also taking in mind the proximity of Procana in Massingir or MIA group in Chókwè, certainly all stakeholders in identifying potential power producers to boost their value chains.

We recommend that this analysis should be performed as urgent as possible to determine the typology of producers, irrigation systems and business agendas of communities or associations. Unfortunately the resource inventory conducted under this study does not allow the analysis of these parameters as crucial in decision-making.

However, the potential for irrigation is recognized, and support should be given to communities in development of irrigation infrastructure. Ideally producers benefit from credit to development and training on irrigation to producers, which would be amortized and obtained by a trading plan, taking into account assumptions as crops to produce and the potential contracts to establish with investors. Once again an example and experience from Xinavane could be a reference to consider if the option is the collective output of sugar-cane. The size or the area in general and the parcels in particular is important because of the issue on production scale, productivity and profitability, primarily water considering irrigation costs, and still bear in mind analysis of farmers for their selection and training. Some selection criteria for producers should be considered in terms of their ability to use irrigation, and their willingness to accept changes in attitude to embrace new challenges, which necessarily cater for greater discipline and use of new technologies.

A series of rules based on the standard of cultivation in irrigated areas will have to be adopted in order to harmonize the means of production, as crop selection in terms of productivity and market, tolerance levels regarding conservation, timing of different practices, irrigation schedules, etc. These operations are very demanding as regards transfer of technology which will require professional and responsible agricultural extension service in order to fulfill its social, financial, economic and environmental responsibility. The attached data sheets are a good support for planning of production under irrigation.

5.2.4 Proposals for Improving Agricultural Yield and Production Systems

5.2.4.1 Improved Soil Fertility

Knowing that livestock production is an important activity and the existence of a significant livestock, we propose that communities and farmers who are ranchers can use manure in their production areas, especially in their gardens or in the areas of irrigation.

In rainfed areas, associated with the previously recommended practices for mitigation of droughts, we recommend with regard to handling of the soil natural fertility, the introduction of fallows. Since this practice occurs but in a disorderly manner, it can be improved by introducing the planting of pigeonpea.

Regarding producers with more than one portion, we suggested that pigeonpeas should be grown at least during 2 to 3 years. Other legumes may also be used, such as cowpeas and groundnuts, depending on parcel size for subdivision and better management of the fallow grounds in crop rotation. The fallow with legumes has the advantage of restoring soil fertility in terms of nitrogen and also contributes to food

production. We found that these crops are here suggested for fallow to form part of the production systems of the SZ.

The following matrix (Technical Sheet 1) shows a summary of the main limitations of each of the production systems, opportunities, and systematic interventions as a means of local mitigation and responsibility.

Technical Sheet 1. Details of agricultural yield systems.

Problem	Main Limiting Factors	Mitigation/Improvement measures	Development initiatives/activities/potential projects	(Ecological/environmental) indicator	Term(short/immediate, medium and long terms)	(sout /nort
Current Production System: Low use of inputs	Technical skills	Training of farmers and District Services for Economic Activities	Strengthening Institutional Capacity-Building of SDAE; Community Empowerment through Local Initiative Fund	All SDAE technicians trained in principles of rural extension and crop science	Short term	In al espe th ag
Definition of technical itineraries	Lack of skilled technicians/extension workers	Training of extension workers and local innovative farmers	Short courses for technicians/extension workers and subsequently for early innovative farmers	- Existence of at least an association trained in each village; - Early innovative farmers identified in the villages and equipped with knowledge.	Short term	Vil ag
Shortage of relevant agrarian data	Weak linkage between local structure and SDAE	Strengthen local leadership in knowledge	Revitalization of existing Resource Management Committees	Local leaders trained in leadership and organization principles.	Short term	A
Weak associations	Dispersion of local initiatives for development of small irrigation systems	With properly trained extension workers they can leverage associations	Once again the need for training extension workers	Local committees established based on organization principles	Short term	A

Market weakness	Weak extension service	Proper use of extension services	Availability of extension services (information on agrarian markets)	Established information management mecanisms on agricultural markets	Short/Medium terms	Cent
Lack of credit	Weak economic capacity	Micro-credit	Introduction of a micro-credit system	Existence of formal and informal micro-credit as from intervention of rural extension services	Medium term	Cent
Low income	Weak technical capacity and weak financial capacity	Weak knowledge of crop science and lack of financial resources	Knowledge of technology sheets by extension workers and farmers	Improved farmer income per unit through good practices	Medium term	All v ag p

5.3 Livestock Production

5.3.1 Improvement of Animal Handling

The main feature available in the Buffer Zone for livestock production is large areas of grassland with little fitness for agricultural production. They have a low Carrying capacity as is typical of semi-arid areas.

However, taking full advantage of this resource involves improvements at the level of animal handling, basically taking into account the following areas:

- Suitable facilities and equipment;
- Balance of animal herds per sellection;
- Separation of herds by classes for specific care-providing;
- Extraction for “zootechnically” correct slaughter;
- Compliance with mandatory vaccination plans;
- Fighting parasitic diseases transmitted by ticks.

Indeed, for a good productive handling of livestock production there is need of basic facilities and equipment. As cattle is concerned, overnight corrals are needed, which should provide shade and equipped with stalls for placing food supplements. As referring to goats and poultry, stables and pens should be constructed.

In principle, herds and flocks should be structured (balanced) on a case-basis in order to achieve the ideal male/female proportions, the right header for grazing area and supplemental feeding ability of the breeder during the production cycles.

Breeders with large herds, occupying a considerable portion of the community grazing areas and watering points should achieve an annual minimum required extraction (10 to 15% of total herds) to monetize their use and contribute to their own income.

Failure to correct and regular extraction of animals for slaughter, not only can age the herds, but also underuses the local productive structure (grazing areas, watering points, facilities and equipment), in addition to hinder the breeder and their dependents to progress economically and socially through livestock.

The annual vaccination campaigns of beef cattle, due to costs, should be seen as acts of mutual technical and financial responsibility between the State, as an organizer and implementer, and breeders as livestock holders and beneficiaries of services.

Lack of tick tanks requires adoption of new strategies to combat tick-transmitted diseases, through controlling infestations with direct application (pour-on) or spraying, as well as strategic involvement of promoters in livestock, trained to handling of these new products and to perform basic deworming and other treatments.

5.3.2 Improvement of Animal Watering Conditions

In order to improve animal watering conditions the following alternatives are proposed:

- Construction of watering points along each borehole;
- Construction of drinking fountains;
- Construction of dams.

Improvement of watering conditions is extremely important for increasing animal productivity. Currently cattle, in effect, have to travel long distances from their grassland place and water sources, which, added to the low availability of water adversely affects the production performances.

5.3.3 Staff Training for Technical Assistance

To ensure good productive and health management, there is need to train new livestock promoters where they do not exist, as well as refresh the existing promoters and technicians.

In turn, trained or refreshed promoters should train producers in the following areas: facilities and equipment, production and basic sanitation management, and extraction.

5.3.4 Proposals for Improving Livestock Yields and Production Systems

5.3.4.1. Development and infrastructures

Infrastructures are an important component in development actions grassland areas to: (i) controlling, protection and circulation, (ii) watering, (iii) health management, (iv) trading, and (v) housing.

To this end, infrastructures may be deployed as shown in the following table.

Table 11. Table of infrastructures for grazing areas.

Type	Goal
Fences, parks and accesses	Correct technical management of grazing (rotational grazing; conservation; rest)
Distribution network of water ang troughs	The water distributed over the grassland area contributes to reduction of livestock walks in search of water, improving its production. It also helps to avoid degradation by concentration of animals in the areas surrounding the natural watering points.
Sanitation centre	Prevention and treatment of diseases affecting animals. Place of gathering of animals for veterinary collective interventions, including, vaccinations, internal and external deworming, registry, reproductive control, identification, sampling.
Cattle fair	For organized purchasing and selling of animals
Corrals	Controlling animals by breeders themselves and avoid long walks towards home corrals near the homesteads.

5.3.4.2 Development, management and improvement of grasslands

In areas where shrub encroachment is significant bleaching or shrub cutting must be done to enable development of grass. Assuming that grazing areas are communal, the ideal issue would actually be empowering each community and breeders to access specific grassland areas. This ensures accountability and facilitates administration and management of the grassland area. As discussed previously, organization of farmers in management committees of natural resources is fundamental to establish local standards for grassland management, considering different approaches from the property setting or definition of cattle moving corridors to and from grazing areas, from their corrals, grassland rotation, incorporating fallow rotation in grassland management system, and controlling of fires.

The following (Table 12) is a summary of key recommendations for the establishment of management committees and their training as a way to ensure sustainability of extensive livestock production systems.

Table 12. Recommendations for settling management committees.

Project	**Pilot to identify the best strategy for improving management of water and grassland to produce support tools and guidelines**
Title	To improve access to water and grassland for communities at Buffer de melhoria de acesso a aZone of the Limpopo National Park
General goal	Increase livestock productivity through improved access and water and grassland management as well as reinforce institutional capacity-building and local methodologies
Specific goals	• Establishment and training community organization on resource management • Participatory identification, construction/rehabilitation of water supply facilities for animals • Identify community grassland areas • Mapping of base grasslands for building collective fencing • Staff training on improvement of grasslands and use of Geographic Infrormation System • Studies and raising awareness
Project components	• Grasslands – access and management of improved grasslands • Water- access and management of improved facilities • Institutional support – Management Committees of natural resources at Buffer Zone strengthened
Implementation strategy	Participatory approach – breeders actively participate in the implementation process of the project, identifying problems until implementation of solutions set
Preliminary activity	Select a village by district and carry out the project

The need to introduce other services and technical assistance that could bring higher quality of livestock production and as such improve the productivity of recommended production systems cater for improving either governmental or non-governmental and private public services responsible for animal health.

The SZ of the LNP justifies the presence of such service or facilities to better manage livestock and thus contribute to maintenance of animal Carrying capacity of the study zone.

Table 13. Opportunities for livestock development

Projecto	
Title	Support programme to veterinary sector
General goal	Contribute in increasing livestock productivity through improved access to veterinary services
Specific goal	Improve animal health Improve epidemiological surveillance of livestock production systems of household sector
Project components	Reduction and control of Newcastle disease Support and strengthen veterinary services
Outcomes and components	• Control and reduction of death rates out of Newcastle disease component: the main objective is to control and reduce mortality of Newcastle disease. The project includes equipping a diagnostic laboratory, production and control of vaccines against Newcastle disease, training sessions, establishment of a system of vaccine distribution and application. • Support and strengthen veterinary services Component: aims to support SDAE/SPP/DNSV/PNL/management committee of the LNP? Through improvement and development of animal health framework, recruit a Veterinary Doctor, train and refresh technicians at Buffer Zone, implement the National Epidemiological Surveillance System, implementat the National Animal Identification System, procure and equip laboratory, train veterinary technicians or livestock care-providers, improve pharmacy operations, cold chains for storage of vaccines and other biological products, and recover and/or reactivate support facilities to livestock production.

The following matrix (Technical Sheet 2) shows a summary of the main limitations of each of the production systems, opportunities, and systematic interventions as a means of local mitigation and responsibility.

Technical Sheet 2. Details of livestock production systems

Current production system	Main limiting factors	Mitigation/improvement measures	Development initiatives/activities/potential projects	(Ecological/environmental) indicator	Term (short/immediate, medium and long terms)	Local (southern/central/northern zone or village)	Accountability
Raising cattle (extension)	Water sources. Lack of water for 4 – 6 months a year Seasonality of rainfalls	Boreholes; Building community watering Capture and storage of rainwater; Boreholes in riverbeds or lakes; Building drinking points near each borehole; Building dams.	Project: building handling facilities Microproject: Improved animal husbandry – Accommodation, Food, Animal Care	Distance between watering sources, not more than 5km. Need of 40L/day for adult cattle; goats and sheep 5L/day. Erosion resulting from cattle paths and corridors Soil degradation, increased loss of vegetation coverage, soil compaction Cattle lose weight in dry season and put it up during rainy season.	Immediate	All zones	LNP; management committee, SDAE

	Low productivity of grasslands; Total dependence on grasslands; Reduced grazing periods; Disordered use of grazing areas;	Increase production of dry matter/Ha/year (includes grass, trees and shrubs); Food reinforcement (hay); Reduce distances; Increase grazing time; Construction of firebreaks; Burn, rest and graze according to Carrying capacity; Keep constant growth and fattening;	Project: improvement of grassland Microproject: animal food reinforcement	Counting desirable and undesirable species as well as observation of soil cover and erosion; Decreased resource degradation – shrub invasion and erosion;	Medium	All zones	LNP; management committee, SDAE
	Lack of pens; Overnight corral	Construction of collective pens;	Microproject: Construction of corrals for Cattle	Decreased conflict between agricultural/livest	Medium	All zones	LNP; management committee, SDAE, local communities

	regime; Location of corrals; Distance that animals must travel to feed and water up; Lack of handling facilities	Construction of tick tanks, treatment corridors, vaccinations, marking (identification) and livestock weighing, access roads; Build slaughter houses	and Goats Microproject: feasibility study of the proposed area for Community grazing	ock yield (grasslands and farm fencing) Reduction of Erosion resulting from cattle paths or corridors			
	Poor general handling; Limited extension for disseminating technical standards of production and animal husbandry Lack of professional sherpherds; Inadequate health coverage for prevention and control of Diseases; Lack of compliance with health regulations;	Establish balance of herds by selection; Separation of herds by class for specific care-providing; Extraction for "zootechnically" correct slaughter; Compliance with mandatory vaccination plans; Fighting parasitic diseases and tick-transmitted diseases; Training of personnel for technical assistance; Breeder training, Advocate for	Project: Strengthening veterinary activity in the Buffer Zone of the LNP Microproject: Health Centre– Veterinary pharmacy and provision of Veterinary assistance	Availability of (public and private) veterinary and extension services	Immediate	All zones	LNP; management committee, SDAE, local communities; Provincial Services of Livestock

		introduction in primary and secondary education of issues related with good agricultural practices and animal production; Strengthen local radio broadcasting for introduction of agri-livestock programmes					
Raising goats	Death of young goats	Construction of corrals and their corridors of treatment and attachments; Breeder training; Use of non-conventional feed resources; Handling small fodder plantations for green mass production	Microproject: Health Centre– Veterinary pharmacy and provision of Veterinary assistance Microproject to build corrals for goats		Immediate	All zones	LNP; management committee, SDAE, local communities; Provincial Services of Livestock
Raising pigs	African swine fever; Lack of knowledge and information	Construction or improvement of facilities for swine, including covered park,	Microproject of rustic facilities for pigs Microproject:		Medium	All zones	LNP; management committee, SDAE, local communities; Provincial Services

	on nutrition, health and husbandry of pigs by breeders; Lack of slaughter facilities and meat inspection services	feeder, drinker, nitre-bed, food store and water reservoir Breeder training; Use of non-conventional feed resources; Handling small fodder plantations for green mass production; Disseminate and use information on swine production and diseases (Flyers, posters, technology packages	Health Centre– Veterinary pharmacy and provision of Veterinary assistance; Ensure protection of public health				of Livestock
Raising poultry	Newcastle Disease (ND)	Control of ND through ongoing vaccination of chickens; Disseminate information on vaccines; Promote distribution of vaccine up to end users	Project: Strengthening veterinary activity in the Buffer Zone of the LNP		Medium	All zones	LNP; management committee, SDAE, local communities; Provincial Services of Livestock
Current production system	**Main limiting factors**	**Mitigation/improvement measures**	**Development initiatives/activities/potential**	**(Ecological/environmental) indicator**	**Term (short/immediate, medium and**	**Local (southern/central/northern zone or**	**Accountability**

			projects		**long terms)**	**village)**	
Breeder organization/Community organization	Weak breeder organization	Facilitate raising associations and partnerships for management, control or access to common ownership of goods; Clarify rights, individual or collective incentives of possession and ownership of resources; Support (*Community-Based Natural Resources Management*, CBNRM) initiatives. Create or strengthen institutions for administration of common ownership resources; Development of a fund for local initiatives geared towards	Project: Training/Strengthening management committees of natural resources in the Buffer Zone of the LNP		Immediate	All zones	LNP; management committee, SDAE, local community

		preserving the environment					
Current production system	**Main limiting factors**	**Mitigation/improvement measures**	**Development initiatives/activities/potential projects**	**(Ecological/environmental) indicator**	**Term (short/immediate, medium and long terms)**	**Local (southern/central/northern zone or village)**	**Accountability**
Disabled livestock trading/production network directed to market/promote development of market-based livestock.	Weak technical and financial capacity of breeders; Long distances from breeding to market sites; Existence of intermediaries in trade network; Slaughters are carried out in the open, without health inspection for ticks and under deplorable hygienic conditions; Lack of commercial culture; Poor commercial network of livestock products	Facilitate access to financing and increased information on business opportunities and prices; Betting on livestock as the main source of income; Facilitate access to safe and fair market; Promote local processing of meat and treatment of hides and skins (leather industry) Create cold conditions in slaughter houses; Improve access	Microproject: Slaughter house, processing of hides and skins and cattle fair		Immediate	All zones	LNP; management committee, SDAE, local communities; Provincial Services of Livestock

		roads; Development of formal markets; Promotion of cattle fair; Shape community facilities, manpower and know-how, productive culture provided existing market conditions Induce proper resource management, allocated fair prices, demonstration of economic value of good management of resources Perform extraction (10 to 15% of total herds)					

5.4 Handling Existing Forest

About 90,000 Ha of the total area of the SZ which is in a state of permanent vegetative coverage should be considered as a handling system. This is due to the fragility of the landscape, aggravated by susceptibility to soil erosion. When considering the handling regime for this area, we would be working towards conservation of the natural resource, avoiding the possible maximum loss of natural forests in favour of opening up new areas for cultivation or clearing and cleaning for natural grassland.

There is awareness for the growing need of wood as a source of domestic fuel, although it is recognized that this practice and needs should mostly result from the collection of old branches. Recent information confirms that the use of charcoal by local households is very limited, but its practice is more geared to supply other markets in the surrounding region, especially Massingir and Chókwè, and more for large urban centre, especially Maputo.

In order to preserve some of these forests, and if possible, consociate protection of these resources, with introduction of some woodland of native or exotic species of rapid growth that can be used either in the production of poles for construction and other purposes, or for production of firewood and charcoal, relieving possible pressure on native forest resources.

Failure to establish plantations located mainly around the villages in the medium term means that whatever needs to meet demand for domestic fuel will be made from exploitation of native forests and consequently their degradation.

At short and medium term restocking of reforestation is recommended in about 1,000 Ha, an area probably enough to supply the demand not only the SZ itself but also to the LNP while promoting tourism, considering that the increased immediate demand will be poles for building infrastructures.

Regarding native forests an intervention for a period of 10 years in an area of about 90,000 Ha, located in the districts of Mabalane, Massingir and Chicualacuala in existing forests, degraded or little degraded, with capacity for regeneration is proposed. The management of this project should be tripartite, based on community associations, in partnership with the district administrations and the LNP or other recommended partners. This model is encouraged by Forest Regulation in view to integrate communities.

The LNP is liable to provide technical assistance and supervision of the management and marketing support to other partners.

The area would be divided into a number of blocks and preferably determine the second location of the villages/communities, and also size (Ha) to determine, each block being delivered to each of the community associations to be established in the districts included.

Iintervention to native forests is essentially carried out by the associations already mentioned above, strong public support towards their empowerment is therefore expected, starting with legalization, support in the construction of small infrastructures, training leaders for marketing, training of field staff, particularly in sustainable handling techniques, monitoring and control of fires. We think that in this area the knowledge and skills of LNP supervisory body could be an asset.

The following matrix (Technical Sheet 3) shows a summary of the main limitations of each of the production systems, opportunities, and systematic interventions as a means of local mitigation, and responsibility.

Technical Sheet 3. Details of forest production systems

Current problems	Main limiting factors	Mitigation/improvement measures	Development initiatives/activities/potential projects	(Ecological/environmental) indicator	Term (short/immediate, medium and long terms)	Local (southern/central/northern zone or village)	Accountability
Deforestation	Felling of trees for agricultural purposes in sensitive and rich areas in species Charcoal and firewood production Manufacture of furniture Construction materials wildfires	Raise awareness to population on the importance of forests (trees provide fruit, medicine...) Alternative sources of income Rationalization of energy consumption by promoting the use of more efficient equipment, and alternative energy Building firebreaks	Early reforestation programme or improvement of villages Management project of private forest areas, involving communities Planting project of fast-growing exotic species Surveillance to forests Promotion of hives for honey production	Soil erosion affects land productivity, reducing human and animal Carrying capacity Area of degraded forest reduced or stable Number of Ha of plantations established Number of forest blocks and native forests under community management	Immediate	All zones	LNP; management committee, SDAE

5.5 Handling Wildlife

The fencing in the SZ, in southern and southeast areas, along the border of the LNP, and the proposed development of wildlife corridors are proposals for development in the short and medium term intending to contribute to mitigating conflicts between the human population inthe SZ, households covered by the resettlement programme of the LNP to the SZ, and resident wildlife in LNP.

Many wondered about the establishment either of physical barriers or corridors, until the causes of dispersal of species in their seasonal migrations between the KNP, LNP, SZ and other conservation areas beyond Limpopo, such as Banhine NP had not been diagnosed.

However, more recent research have resulted in some success at identifying such assumptions to better management of wildlife as a goal for conservation so that the community residing in the SZ can best benefit from those wildlife resources while they can best use the remaining resources of the SZ for their benefit, through zoning process.

Despite such measures aiming to mitigate any negative impacts of wildlife, we know the risks primarily to the growth of farming and livestock will be higher. This led to designing of an integrated matrix (Technical Sheet 4) which shows for each case/species, possible mitigation alternatives.

Technical Sheet 4. Summary of mitigation measures and relative efficacy that might be adopted against troublesome animals (Modified from: Hoare, 2001; Fernando *et al.*, 2004)

Methods	Application Scale	Efficacy	
TRADITIONAL		**Short**	**Long**
Guards			
(guards sleeping on platforms of agricultural fields)	m^2 a few km^2		**?**
(scarecrows)	m^2 a few km^2	**?**	
Noise in presence of troublesome animals			
(shouting and drumming)	m^2 a few km^2	✓	
(noise with metal cans or noisy objects)	m^2 a few km^2	✓	
Fire			
(fires lit on farmland outskirts)	m^2 a few km^2	✓	
(smoke from burning animal feces)	m^2 a few km^2	✓	
(burning material thrown to destroyer animals)	m^2 a few km^2	✓	
Missiles (e.g., stones, spears) thrown to animals	m^2 a few km^2	✓	
Simple home-made log barriers or among trees	m^2 a few km^2		**?**
(strings extracted from trees with cans/bells/cloth tied to them)	m^2 a few km^2		✓
CHASE			

Weapons fired near destroyer animals	A few km^2 to a hundred km^2	✓	
(rifles, war weapons)/chase brigades	A few km^2 to a hundred km	✓	
Torches thrown to troublesome animals	A few metres to a dozen	✓	
Flames near troublesome animals	A few metres to a dozen	✓	
Lights shone to destroyer animals	A few metres to a dozen	✓	
SLAUGHTER TO TROUBLESOME ANIMALS			
Slaughter to selected troublesome animals			
(slaughter by authorities responsible for wildlife)	An individual to groups	✓	
(slaughter by an authorized third party)	An individual to groups	✓	
(illegal slaughter)	An individual to groups	✓	
Marketing of commercial hunts for slaughtering troublesome animals			
(income for local communities)	A household to a hundred households		**?**
PHYSICAL BARRIERS AGAINST ANIMALS			
Conventional fencing methods (not electrified)	Metres less than 1 km		**?**
Electric fencing using electricity	Metres to a hundred km		✓
Electric fencing using solar panels and 12 volt batteries	Metres to a hundred km		✓
Fencing scheme			
Fencing around conservation areas of elephants or population setttlements	Metres less than 1 km		✓

Fencing opened and closed to repel animals from settlements	Metres less than 1 km	✓	
Fencing around protected areas/conservation areas of elephants	Metres less than 1 km		?
(property fencing equipment and under maintenance by authorities responsible for wildlife)	Metres less than 1 km		?
EXPERIMENTAL REPELLENTS AND DISSEMINATION OF ALARMS AGAINST ANIMALS			
Olfactory repellents (smell-based)			
Smoke of chilli seeds being burned	Metres less than 1 km	?	
Oil-based chilli applied to barriers	A few km^2 to hundreds		?
Auditory repellents (sound-based)	Metres less than 1 km		
(sound diffusion of people)	Metres less than 1 km	?	
CHANGES OF LAND USE THAT MAY REDUCE SPACE COMPETITION BETWEEN PEOPLE AND ANIMALS			
Reduce human settlements in animal areas	Hundreds to thousands of km^2		✓
Transfer agricultural activities out of animal areas	Hundreds to thousands of km^2		✓
Reduce the size of crop fields	Dozens to hundreds of km^2		✓
Change location of crop fields			
(Homes and nearby farmlands)/fields in blocks	Hundreds to thousands of km^2		✓
Change location of grazing areas	Hundreds to thousands of km^2		✓
Change the model/system adopted for cattle breeding	Hundreds to thousands of km^2		✓

Change cultivation system			
(diversify into more crop types)	Hundreds to thousands of km^2		**?**
(change timing of harvests)	Hundreds to thousands of km^2	**?**	
Create or secure routes /corridors for movement of animals	Hundreds to thousands of km^2		**?**
Ensure access for animals and humans to different water sources	Hundreds to thousands of km^2		✓
Reset the boundaries of the protected area	Hundreds to thousands of km^2		**?**
Designate new protected area	Hundreds to thousands of km^2		**?**
Signaling of risk sites	Metre to a kilometre		✓
Access to water for humans and wildlife	Dozens to hundreds of km^2		✓

6. Proposed Indicators

It is generally agreed, considering the various documents that were made available for completion of this study, that the **sustainable development of the Support Zone** (**SZ**), and consequently the LNP is an evolutionary process which involves combination of different strands of development from one region to the benefit of communities and existing and future population, i.e. **growth of economy** and **increase employment**, improve the quality of the **environment through rational and optimized use of natural resources and biodiversity**, and improve the **society**, **reduce poverty levels**.

To implement the concept of **sustainable development** it is fundamental to establishing **indicators**, depending on the **objectives** set in terms of development of the SZ and **results** which may arise along with the performance of the region in terms of sustainability.

Thus, the **indicators** are considered and selected parameters either singly or in combination, being especially useful to reflect on certain conditions of the systems under analysis.

Regarding the content, scope and nature of the system of sustainable development indicators proposed, four categories are considered:

> **Environmental indicators**

> **Economic indicators**

> **Social indicators**

>**Institutional indicators -** include classical institutions, non-governmental organizations (NGOs) and other partners.

These mostly geo-environmental indicators help addressing major basic issues raised by the LNP, including:

- ✓ What is happening in the environment due to the current practices of land use?
- ✓ (causas dos impactos mais frequentes, vínculo entre influências humanas e processos naturais) Why is this happening? (causes of most frequent impacts, the link between human influences and natural processes);
- ✓ Why are certain impacts significant? (ecologic, economic and social effects);
- ✓ What can be done to mitigate them? (Implications in hangling, planning, and Public Policy).

The previous chapters allow us to understand what is happening through description and characterization of the study field, the relationship between users of natural resources and the environment through the main uses of land, the impacts associated with each of these land uses and their mitigation through identification of proposed land use that are intended to be sustainable.

The table below lists the main indicators proposed to institutions responsible for the management and administration of the SZ and the LNP to adopt in order to monitor the level of implementation, development and undertaking of the various activities proposed.

Table 14. Suggested indicators for institutions

Indicator Class	Indicator	Measurement Unit	Assessment Benchmark
Institutional Capacity-building	LNP/District Administration SDAEs Associations Technical Assistance	Protocols and MoUs established Available financing/investment Number of extension workers available Number of Associations established and formalized Number of partners operating	Introduced reforms + % investment at community level + % extension workers assisting communities + % associations assisted + % partnerships raised
Agricultural Development	Available/adopted Technologies Increase of Productivity Reduce post-harvest losses Food security Agricultural surpluses	Diversity of food crops/income Income t/Ha Quality of products Availability of food throughout the year Access to trade/markets	+ de 35% river alluvial zone developed with irrigation + 50% production system in rainfed areas with mitigation measures
Livestock Development	Improved and adopted handling practices Access to animal health services Best quality of livestock Access to water sources	Livestock controlled Lower incidence of diseases Animals with better weight + % cattle marketed	Keep header according to animal capacity Carrying + % animals sold
Native Vegetation Coverage	Presence of forest in different stages of	% area covered with forest over the total	Keep more than 50% of the SZ covered in native

	growth/use Community handling blocks established	area % community blocks established	forest
Wildlife Conflict	Corridors established Operational fencing Absence or reduced conflicts	Mitigation methods and efficacy established	Greater tolerance with wild species Reducing conflicts and poaching Increased access to marketing and income from wildlife
Ecotourism	Infrastructure Increase of community income Partnerships raised	Camps built/operated Jobs created	High occupancy and visitor rates Increased demand for local crafts Increased demand for fresh local agricultural products
Physiography/Soil/Land Use	Adequate Carrying capacity Soil conservation	Reduced degradation Effective technologies adopted	Low rate of loss of vegetation in favour of other land uses Carrying capacity satisfying the needs of developing land use

7. Conclusions and Recommendations

The Support Zone of the Limpopo National Park (LNP) is situated along the Limpopo River and inland towards the East border of the LNP, extending from Pafuri to the confluence of the Limpopo and Elefantes Rivers, about 320 km long and 10 km wide, on the right bank of the Limpopo up to the LNP border.

In geological terms, the territory consists of Tertiary continental sediments, carved by recent alluvial deposits of the Limpopo River.

The climate is semi-arid to arid dry with a dry period in winter and has large variations in rainfall. The rainfalls that occur in the Limpopo basin bring frequent floods, some with disastrous consequences, like those seen in 2000.

Occurrence of floods alternating with droughts, gives the region a great weather vulnerability, which translates into the probability of occurrence of a flood or severe droughts every 5 years (12 floods and 9 severe droughts in the last 100 years). Currently there are droughts, which create survival problems, especially to people who depend on rainfed agriculture.

Besides weather vulnerability, the region faces two other serious environmental problems: deforestation caused by human activity and the process of migration or movement of some wildlife species associated with the localized over-grazing.

The latter is characterized by some seasonality given sporadic movement of wildlife, thus the recommendations for establishment of corridors as a means of limiting and preventing movement and occupation by the human population and cattle and goats herds near these areas.

The population has, in general, a weak organizational capacity at the level of socio-economic associations, which weakens the representation and advocacy, mainly small farmers and livestock producers, and satisfaction of common needs.

The studies developed assessed the agricultural production potential in the region of the SZ under rainfed conditions and, more specifically, irrigated lands, having been studied the major limitations of land use systems practiced by different productive sectors in the study field.

The field units more suited to irrigated agricultural production are those whose soils are developed in recent fluvial and alluvial sediments of the Limpopo River.
Regeneration of native forest and cattle breeding are potentially the two main factors boosting the development of tne SZ out the potential areas for irrigation, so they were particularly studied.

Despite imbalances of the current situation there is a perception that the native forest area formed by the territorial districts of Massingir, Chicualacuala and Mabalane is likely to ensure basic needs of the population regarding fuel supply and even an additional monetary surplus resulting from the sale of firewood or charcoal. For this there is need to perform an initial programme of afforestation (native

species) or improvement of the SZ villages, and implement efficient solutions for the management of forest areas, involving communities.

Livestock development is determined by the grassland potential resulting from the combination of climatic factors, topography, water relations, soil and vegetation in a given environment.

A variety of constraints to livestock production and higher productivity were identified and can be addressed in three main groups: i) technical constraints, ii) policy and institutional constraints, and iii) limiting related to agro-ecological zone, at Buffer Zone of the LNP, shortage of food and nutrient deficiencies are more serious in dry season. Increases in food availability at low cost will be the most significant factor that will determine whether the required growth in animal production is achieved or not.

The grassland area of the SZ includes the district of Massingir and neighbouring districts of Mabalane and Chicualacuala with identical usage capacity and possibly with better quality. The current grassland park in the SZ is approximately **376,948 Ha** distributed by different units of agro-ecological management, without respecting the hierarchy proposed in this study and as a result of integrated analysis of Carrying capacity for different types of land use.

The current cattle population (stocking) is 34,823 corresponding to 40,020 of AU. Taking into account the present scenario and livestock, we would venture to say that almost the stocking capacity of the Support Zone has been reached, or is close to happening, because it is not away from 50.000 heads, so it can accommodate more than 15.000 heads which will critically depend on the handling mode to be adopted.

Cattle are a good potential, but some assumptions must be met:

- a genetic option that maximizes intensification of extensive household production system, especially with regard to food regime;
- a food strategy based on the rational use of natural grasslands, added by supplemental agricultural by-products and forage;
- a productive and reproductive management seeking to achieve maximum indicators of cattle breed adopted;
- a sanitary management system adapted to local nosological conditions.

In most cases and due to climatic factors considered most limiting, the agricultural production is only possible through the use of irrigation, both during the rainy season as supplementary irrigation, and in the dry season, such as full time watering.

The unit closer to and along the river occupies approximately **18,000 Ha** and in adjacent areas on the border with the inland zone of the units described above, around **45,000 Ha**.

The current population, about 20.225 people, occupies or cultivates about 4,500 Ha, with a margin growth of the available and considerable area in case they do not lose part of potential production area in favour of other land uses.

The alluvial soil unit has greater Carrying capacity due to higher levels of natural fertility, resulting in above average yields in the Support Zone. In this unit, a household should have access to basic needs regarding food, with a production area of about 2.0 Ha, while in the highest part, more marginal, rainfed, the production area increases to 3,0 Ha, in terms of minimum areas.

It is therefore worth to say that, considering that each household cultivates at least two farms, one in the lowland and another in the upland would be about 11.000 Ha currently cultivated in the lower part, and about 16.500 Ha cultivated in the upland.

Keeping the same rates, we face a scenario in which the unit along the river, we would have just 8.000 Ha available to cope with any increase in population, which maintaining the same average in terms of Ha, allows only accommodating more 4.000 households, equivalent to 14.400 people using the same average number of people per household.

In the unit of alluvial soils due to their limited available area, the Carrying capacity is not by itself a limiting factor, since there is intention to adopt production systems of irrigated crops with the aim of introducing intensive farming. It therefore means assuming that the production areas will experience a permanent occupation unlike the rainfed areas, where the most limiting factor is availability of moisture for plants.

In a situation where the water resource is available to plants, we are facing a growing period of crops in the order of 300 days per year, also considering that part of the days, the soil moisture may eventually exceed the storage capacity of water. This implies in these conditions obeying the timing of watering intervals that will be recommended based on the crop production pattern in the irrigated areas.

The assumption of these irrigated areas before any corrected limitations, their productivity will be per unit of land area (Ha) or per volume unit of irrigation water (L), always above the basic needs of a household. It is therefore considered that these irrigated lands add value to the volume of agricultural production with higher yields by crop, creating surplus which will be commercialized, and will result in a return of increased revenue for households in the case of food crops such as maize, a basic cereal.

Maize technological sheets recommend adoption of varieties with yields up to 3 t/Ha, a condition of middle management, thus assuming use of either organic or chemical fertilizers or both in combination, use of water for irrigation, and pest and disease control, using short cycle varieties, i.e. between 120 to 150 days until harvest season.

These growth cycles before favourable climatic conditions, i.e. without water deficit, allow at least two crops per year, in terms of 1 cereal, and yet the possibility for an irrigated crop of legume grain or oilseed. In these cases, assuming that 1 maize harvest may be fresh, for marketing cob, and the second for grain marketing, allows the household to have a form of cash income while marketing the cob, and even preservation of part of grain production for grinding and consumption, in addition to the surplus entering the market.

As regards to upland, where 3.0 Ha are needed per household, would be available about 28.500 Ha, which is to say, in terms of Carrying capacity, it would be possible to expand the villages in general in 9000 more families.

This scenario allows for relocation in any one of the units of the households proposed to be withdrawn from the LNP to the SZ, i.e. 456 families, and a total of 2.447 people.

Adoption of improved agronomic, soil, water handling practices, in this agro-ecological unit reserved to rainfed agricultural production, also intends to establish a buffer condition that contributes to obtaining a crop successfully, by safeguarding the various limiting assumptions to agricultural production. Any measures to mitigate the impact of climate change on the risk of crop loss will result in increasing the Carrying capacity of the rainfed area. As a result we will always have a weighted average productivity while contributing towards maintenance of the averages of cultivation areas, without need to introduce an increase in the area of basic food needs for households.

Therefore it allows us to conclude that the areas actually resulting from the calculation of Carrying capacity are suitable both for human families residing in the SZ and for those covered by the resettlement.

With regard to the conflict of wildlife species, the proposed corridors are overlapping with other types of land use without however being considered of exclusive but multiple use, leaving the LNP managers and leaders of local communities to establish safe and use limits to protect themselves from any conflict, while ensuring access to drinking water for wildlife species.

Integrated mitigation measures are therefore necessary, where in many of the cases can be solved by existence of fences, for animals, and compliance with other handling practices which have recourse to the use of improved technologies.

The corridors are located mostly in the Northern and Central Regions of the Support Zone, and along the banks of the Limpopo River. Considering now that these corridors will be proposed and that this conservation area occupies about **35,000 Ha**, accounting for about **10% of the total area of the Support Zone**, but recognizing overlaps in particular agriculture and grasslands, this number can only be small. The potential reduction in the area of management of this unit due to elasticity factor of either rainfed agriculture use or extensive livestock production based on natural grasslands, since these are subject without implementating mitigation measures, to rotation cycles and fallow as practices of production systems that favour regeneration of natural fertility of soils, and vegetation with emphasis on grasse and low-size shrubs.

Like other proposals, in the case of villages and communities, the sooner the water supply for domestic use and for agricultural use and livestock are solved, we will certainly help to reduce conflicts, since the different studies undertaken are unanimous in selecting dispute to water resource as the main cause.

About **90,000 Ha** of the total area of the SZ which is in a state of permanent vegetative coverage and, due to fragility of the landscape, compounded by susceptibility of soils to erosion, should be considered

as a system of management in the context of natural resource conservation, avoiding the possible loss of natural forests or forests in favour of opening up new areas for cultivation or their clearing and cleaning to natural grassland.

Given institutional fragility and the various organizations, the priority is development of associations that can provide services to farmers, which will only be feasible if undertaken collectively. This applies to transfer of knowledge on production and marketing, access to credit, management of water use, purchase of inputs, commerce, etc.

Research and extension in order to provide the most efficient technological letter for different types of farmers and promote their dissemination are fundamental to the development of proposals for land use in the SZ.

Reduction of field and post-harvest losses through provision of appropriate technologies of drying and storage methods of some agricultural products.

For successful transfer of technology in terms of production of the SZ will require an integrated approach where public extension is strongly linked with the private sector for provision of services, including inputs and commerce.

Specifically aimed at reducing the gap between the potential of cultivated varieties and yields currently achieved in the fields, it is proposed that there should be a broad awareness raising campaign and training of farmers for using varieties with greater genetic potential.

A new standard for crop production for the SZ is proposed, on the basis of a programme of continuous cultivation, acting in particular as regards to sowing season, combination of crops and land use. For this there is need to intensify land use through introduction of 2nd season crops, benefiting from irrigation and even from a series of technologies to conserve soil moisture and natural fertility of the soil.

Raise partnerships/protocols necessary for forming the business environment conducive to competitiveness of their activity (district, provincial and central administration; IIAM; HICEP; NGOs; institute / agrarian school land Chówè; extension services of the State or others, in addition to extension workers from NGOs, agro-industry, livestock sector, producer associations, community leaders, service providers, financial institutions.

Implement a professional training plan for farmers and breeders as to achieve high levels of productivity and efficiency.

Recruit a team of extension agents who have or may have high credibility with farmers.

Finally there is need to develop a marketing plan for different components of development of the SZ.

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