

Article

Household Vulnerability and Transformability in Limpopo National Park

Michel Notelid and Anneli Ekblom *

Department of Archaeology and Ancient History, Uppsala University, Box 626, SE-751 26 Uppsala, Sweden; michel9496@gmail.com

* Correspondence: anneli.ekblom@arkeologi.uu.se

Abstract: In this paper, household vulnerability in Limpopo National Park (LNP) is discussed in relation to interannual climate variability and the effects of the park itself. Climate variability is high and projected to increase with climate change. Meanwhile, the establishment of the national park in 2002 has added both challenges and possibilities. We present the results of livelihood surveys carried out 2013 and discuss changes taking place in and around the park until present day. Constraints and possibilities for endurability of households are discussed. In conclusion, the vulnerability of the LNP households to climate change is high, but there are a number of strategies in place to ensure endurability. Migrant labour is vital for household economy, and cattle production is important for endurability. The hunting ban in the park and losses of crops and livestock due to wildlife present serious challenges. Income from the illegal wildlife trade, which exploded from 2011, has had little impact on household economy or in mitigating household vulnerability but has had devastating effects on the social fabric of households. We discuss possible avenues for transformability, where access to markets and transport remain a challenge for farmers. Individual cattle owners' view of constraints and possibilities for expanding cattle herding are discussed and assessed in terms of transformability.

Keywords: livelihood; vulnerability; resilience; endurability; self-sufficiency; climate change; Limpopo National Park; Mozambique

Citation: Notelid, M.; Ekblom, A. Household Vulnerability and Transformability, Limpopo National Park. *Sustainability* **2021**, *13*, 2597. <https://doi.org/10.3390/su13052597>

Academic Editor: Alejandro Rescia

Received: 7 January 2021

Accepted: 22 February 2021

Published: 1 March 2021

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).

1. Introduction

Resilience thinking and vulnerability studies have long been combined to understand the effects of climate change on the household and community level [1–9]. In this paper, we will discuss constraints and possibilities for the endurability and transformability of households in Limpopo National Park (LNP), which was proclaimed in 2002. Most southern Mozambique households live below the poverty line and experience challenges to food security on an annual basis [10–16]. Interannual climate variability and climate disasters have a decisively negative impact on household poverty in Mozambique [16–20]. Thus, most households are structurally vulnerable due to poverty and climate variability but may still be able to avoid prolonged hunger or increased poverty during shocks. Endurability (preferred here over the term “resilience”) is built through the diversification of resources, labour migration, use of social networks, or sale or barter of transferrable assets such as livestock. A household can employ several of these strategies to absorb or adapt to shocks or to prolonged negative challenges [6,9]. However, endurability is restricted by issues of access and rights to land, resources, assets, and labour movements. Meanwhile, opportunities and possible strategies to counter vulnerability over the long term are referred to here as transformability [6]. The study is the result of livelihood surveys carried out by the authors with households in the core area of the park in 2013,

during resettlement negotiations taking place between (the government) and (local communities inhabiting the park). These surveys will be discussed in relation to livelihood studies commissioned by the park and also other similar studies made in the area. While we carried out the surveys, the impact of wildlife on crops and livestock was increasingly affecting households. New economic opportunities had arisen with new roads and better communication. In addition, we saw the effects of the exploding market for illegal wildlife trade. Benefit sharing and development projects linked to the park brought new funding schemes for local agriculture, and generally there were expectations of increasing revenues from tourism. Herein, we attempt to discuss these changes over time in terms of constraints and opportunities for endurance and transformability.

Extreme dry and wet events have increased over recent decades in southern Africa [21–23]. On average, cyclones hit Mozambique once or twice a year [20]. Within the last two decades, the region has been afflicted by unprecedented floods (in 2000 and in January 2013) [24,25] and very severe droughts, the latest occurring in 2016–2017 [26]. With global warming, IPCC global circulation models predict that temperature increases in sub-Saharan Africa will be around 1.5–2 °C higher than global averages, which will increase evaporation. Southern Africa is also predicted to receive less rainfall overall [27,28]. In addition, regional climate models forecast a higher incidence of concentrated and extreme rainfall events [29,30]. All these predictions are dire for households that are already vulnerable.

Debates around the effects of climate change effects on households and the reduction of poverty in Mozambique revolve around local agriculture [31]. An estimated 70–80% of the labour force in Mozambique is dedicated to small-hold farming (on average 0.5–1.5 ha) [11,32]. In Mozambique, the area of cultivated land has increased in tandem with population increase, yet, agricultural production per capita seems to be stagnant [31,32]. Most small-scale farmers in Mozambique do not use fertilizers, pesticides, or hybrid seeds, and irrigation is rare. Current agricultural policy in Mozambique is a continuation of the green revolution, promoting new technologies and an expansion of agriculture for markets [33–35]. As in neighbouring countries, while the promises of “sustainable intensification” are poorly defined, they are usually not conducive to small-scale agriculture [36]. The agricultural output of crops in Mozambique varies widely between years, with climate variability remaining the strongest driver regulating output [11,32,37–39].

Local production remains deeply embedded in labour mobility and markets [31,40,41]. In Mozambique, increased vulnerability due to climate crises are typically conflated with price instability [13,17,42]. Thus, though the impacts of climate change are certainly felt and recognised at the household level, climate change may not directly influence decisions. In terms of GDP, Mozambique’s economy has been growing fast, but household poverty has still increased [31,43,44]. Elevated poverty levels are strongly linked to increased food and fuel prices, most markedly in the price “shocks” of 2008 [31,32,34,45]. LNP households in general have exceptionally low access to public services, no access to electricity, and generally bad communication in terms of roads and cellular phone networks. Since 2007, a national framework for adaptation in response to climate change has been in place, and now also a disaster management framework, but the Mozambique state, provinces, and districts still have a limited capacity to mitigate and alleviate the impacts of climate disasters, especially in remote rural areas [24,39].

2. Materials and Methods

2.1. Description of the Research Area

LNP is situated in the low rainfall savanna lowlands (on average rainfall 399 mm/year), sharing a border with Kruger National Park (KNP), and it is also confined by the Limpopo River to the east and the Elephant River to the south. Climate variability is a long-term feature of this landscape, but the large-scale floods experienced in the last century are probably unprecedented [25]. Variability in rainfall between years is remarkably

high: annual rainfall in Massingir, the town closest to LNP, ranged from 200–900 mm/year between 1986–2005 [42]. Though most households in LNP would profess to be farmers, labour migration to South Africa is common and has been so since the end of the 19th century, at that time mostly directed to the mines and today mainly for farm labour [46–48].

LNP forms part of the Great Limpopo Transfrontier Park, combining Kruger National Park in South Africa and Gonarezhou National Park and the Sengwe corridor in Zimbabwe [49–52]. LNP is zoned as a core area (c. 8787 km²) and a buffer zone (c. 2326 km²) (Figure 1). An estimated 20,225 people live inside the borders of LNP [53], and several villages are located within its buffer zone [54]. During the Mozambique civil war, 1977–1992, many of the residents fled to South Africa, Zimbabwe, or urban areas of Mozambique [48,55]. The formulation of plans for the park took place at the same time as residents moved back to the area [56,57]. The area between the Shingwedzi River and the Kruger National border has the highest concentration of wildlife. Provincial and district governments and park management made an offer of resettlement to the residents of the seven villages residing in this core area of the park, totalling some 6500 individuals. Though resettlement was planned as a voluntary process, increasing wildlife numbers and hunting bans have diminished prospects of staying in the area [52,57–64].

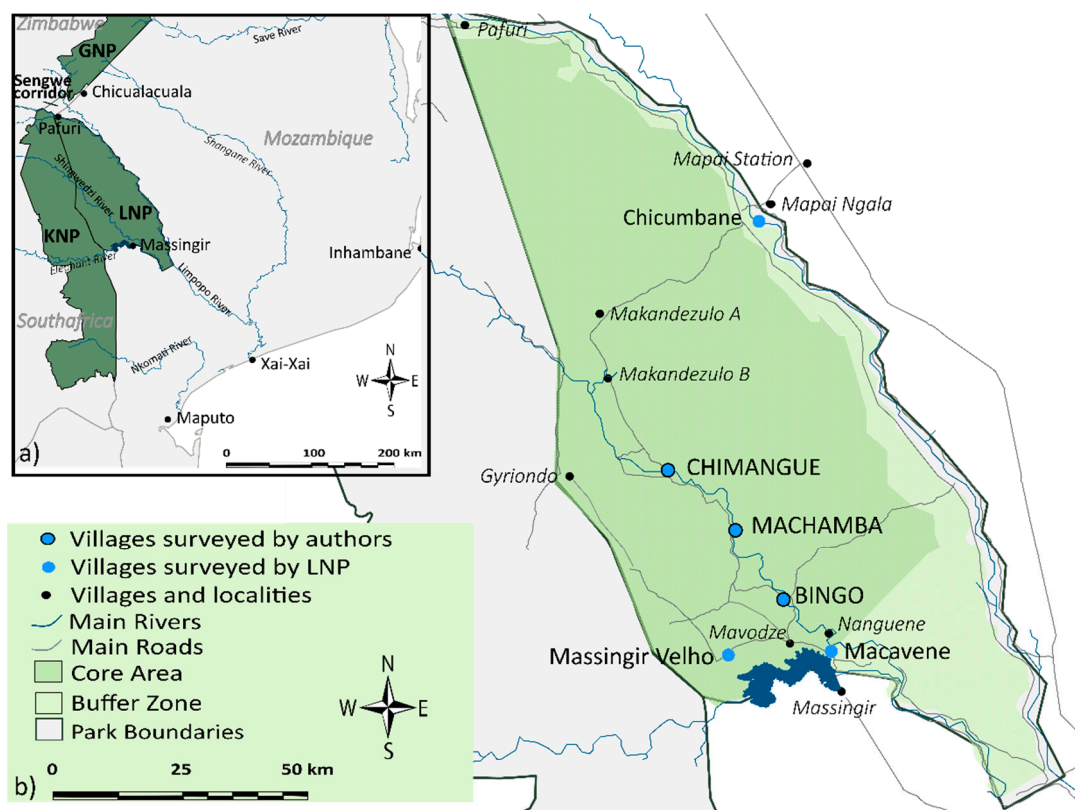


Figure 1. Area map: (a) Map of the Limpopo National Park (LNP), and neighbouring parks Kruger National Park (KNP) and Gonarezhou National Park (GNP), and (b) LNP villages and localities discussed in the text and the core area and buffer zone boundaries.

Of the villages where we have carried out surveys, Chimangue and Machamba are still negotiating resettlement, while Bingo is in the process of relocating to an area outside the park, south of Massingir. Using a 4 × 4 car, and if the road conditions are good, the most remote village of Chimangue is a 5–6 h distance from Massingir. In times of rain, roads become impassable, and villages are difficult or impossible to reach. In Macavene and Massingir Velho, livelihood surveys were carried out by the park in connection to the resettlement [65,66]. The villages of Macavene and Massingir Velho lie closer to the town

of Massingir, and job opportunities therefore are more numerous, as can be seen later. Between 2013 and 2014, the villages of Macavene and Massingir Velho resettled from within LNP to more populous areas around Massingir.

By 2011, a dramatic increase in the illegal wildlife trade of Rhino horn (and ivory and other wildlife products) added external pressure on LNP to speed up resettlement. The trade in illegal wildlife was in part channelled through LNP but was typically commissioned from outside [67–70]. As this very situation was unfolding, we carried out the livelihood assessments discussed here. Since then, donor funding has streamed into LNP and surrounding parks to militarise poaching prevention [68,70–72]. Even though official numbers are hard to come by, it has been estimated that as many as 300 to 400 men from the Massingir district have been killed in South Africa on suspicion of poaching [73], several from the villages in which we conducted our interviews.

2.2. Methodology

For this paper, we carried out a livelihood assessment in three villages: Bingo, Chimangue, and Machamba, situated along the Shingwedzi River, northwest of Massingir, (Figure 1). The largely informal contribution of rural incomes is difficult to measure [74,75]. A preferred method of ranking household wealth is therefore through consumption and expenditure [11,76,77], also factoring in household assets, networks, and capabilities [77–80]. The questionnaire was thus constructed using the asset and capabilities approach but also included questions about exposure to climate change and warning systems following Hahn et al. [14]. Though women have been shown to be disproportionately vulnerable to climate variability [81,82], we do not make a separation of the households based on gender or age here.

The questionnaire was harmonised to be comparable with the livelihood surveys carried out by LNP as part of the resettlement scheme [65,66]. We also added questions about distances to grazing and farmland and questions relating to the importance of wildmeat in the past and damages incurred by wildlife in the most recent years. In total, the questionnaire consisted of 63 questions (with follow up questions in some instances); the full questionnaire is explained in Appendix A, Table A1. During the surveys, we also asked follow-up questions based on responses from participants using semi-structured interviews. The selection of participating households took place in the field, aiming to include both small and larger households. This designation was estimated based on compound size. The number of households interviewed in each village is relatively small (c. 25% of the total number of families/households in each village, 59 households) (Table 1). The results are to be regarded as reflective of the individual households interviewed and not as representative of village households in general. Surveys were carried out with the head of the family (which was usually male, unless the household head was a widow) or sometimes with a wife (who are de facto heads of households in the absence of husbands [82]), or a son. Usually, several more household members attended and participated in the interviews conducted in the local language, Shangaan, in November 2013.

Table 1. Summary of village communications and number of households interviewed.

	Mashamba	Chimangue	Bingo	Macavene	Massingir Velho
Number of surveyed households	23	16	20	35	245
Livelihood surveys by	Authors	Authors	Authors	LNP	LNP
	Household details				
Number of families/households	95	125	144	148	247
Number of Individuals	unknown	594	720	765	1181

Average individuals per household	14	11	7.2	5	5
Max size of household	80	22	19	22	22
Children/household below age of 13	6	5	4	2.4	2
Communication and infrastructure					
Condition of road	Very poor	Very poor	Poor	Good	Good
Possibilities for transport	Irregular	Irregular	Infrequent	Good	Good
Distance to closest town (Massingir)	57 km	83 km	30 km	10 km	36 km
Distance to closest clinic	local clinic	26 km	11 km	10 km	Local clinic

Though we have explained to respondents that our surveys were independent of that of the park, as researchers, we are still associated with the park, which thus introduced a level of bias to our study. We have followed the respondent's definition of "household", i.e., all people living and eating within the same compound and under the same family head. These include both large and small households with different economic orientations and also female headed households ranging from very large (80 individuals) to small (4–5 individuals) and single households, consisting of widows (Table 1).

In addition, we used the results from surveys carried out by consultants to LNP prior to the resettlement of the villages of Macavene and Massingir Velho in 2012 and 2013 respectively (used here with the permission of LNP), comprising in total 282 households [65,66] (Table 1). Though this data was not compiled during our own surveys, the results provide an important comparison to our study and are presented and discussed here, as they are not published elsewhere.

We have revisited the villages surveyed by us in the core area and Chicumbane village, located in the buffer zone, annually since 2011, documenting village histories and oral traditions. This continuity has allowed us to ask follow-up questions. We have also complemented our surveys with semi-structured interviews of 10 cattle owners in Chicumbane (located in the buffer zone of the park). These interviews were carried out by Hilario Maluleke in 2016, under our guidance. We ourselves carried out semi-structured interviews with business owners in Chicumbane and Massingir as well as with a bank-official in 2015–2016; the results of which are included here, together with information from park officials and village representatives obtained through semi-structured interviews.

In the discussion, we compare our results with the livelihood surveys carried out by Milgroom [60] between 2006 and 2010 in seven different villages in and around LNP, including Macavene and Massingir Velho and Witter's [61] studies in the Makandezulo villages. Silva [83] and Lopes carried out surveys in the buffer zone of LNP and southeast of its boundary [84]. Several other studies carried out in the buffer zones and areas surrounding LNP are of relevance here, including Dixon's 2013 survey of 140 households in Chicualacuala [85], Chirozva's 2010 [86] survey in the Sengwe Communal Area, southeastern Zimbabwe, and a study by Ribeiro and Chaúque in Mapai Ngala [82] (Figure 1).

3. Results

Before we discuss any possibilities and constraints for endurability and transformability, we here present the result from both our own surveys and those of LNP. We first discuss the results in terms of local economy and then examine household vulnerabilities.

3.1. Local Economy

We begin by discussing household economy in the villages of Bingo, Chimangue, and Machamba, where we carried out our own surveys and therefore have the most detailed information. All these villages are situated at some distance, from 1 to 6 hours by car, from the closest town of Massingir. Households in these villages are dependent on their own agricultural production for income. Employment is exceptionally low; of the 59 households we interviewed, only one family stated that a household member sometimes worked for other households in the village. Only 3 of the 59 households held bank accounts and with little money deposited.

Very few households felt comfortable or able to provide an estimate of income, and a wide range of numbers was given (confounded by the fact that some refer to Metical (MZT) currency in the old values of 100,000 and others to the devalued currency of 1000). Most informants also refer to Metical and South African Rand (ZAR) interchangeably; thus, self-reports of income are largely unreliable. Here, we refer to ZAR rather than Metical. Annual incomes based on information from interviews averaged 8261 for Bingo and 18,812 for Chimangue (but 14,759 ZAR discounting three outliers) (Table 2).

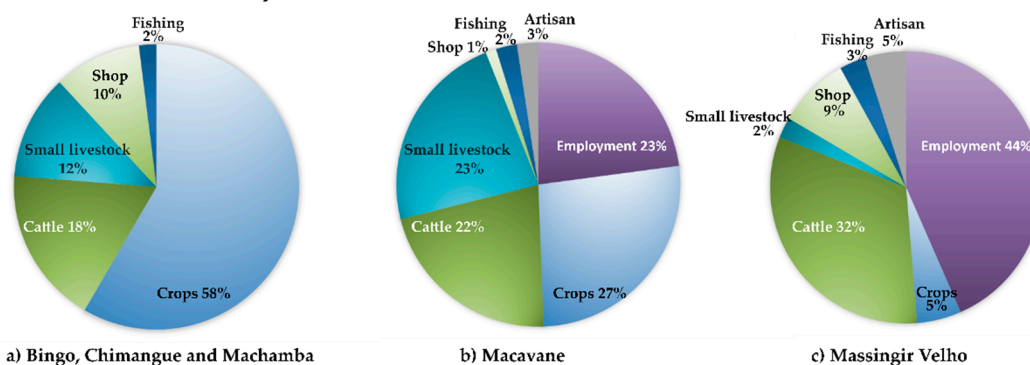
Table 2. Summary of household structure and assets with details also of household health.

	Mashamba	Chimangue	Bingo	Macavene	Massingir Velho
Level of schooling completed in the household					
Primary	1	0	0	12	157
Secondary (or higher)	3	3	0	4	0
Average household income ZAR					
Average with outliers (number of outliers)	15,282 (2)	18,812 (1)	8261 (0)	82,932 (3)	49,083 (8)
Average without outliers	6488	14750	8261	45,280	32,652
Household assets					
Car functioning/broken	3/6	1/1	1/1	1/1	12/1
Mopeds and motorbikes	-	-	-	5	9
Cattle per household	27	25	6	12	8
Goat, sheep, pig per household	44	44	10	3	4
Number of households with no livestock	2	0	4	6	73
Number of households with no cattle	1	1	8	8	99
Share of food					
Households with expenses on food	39%	38%	29%	30%	37%
Share of own production	c. 69%	c. 75%	c. 67%	-	-
Share of wild resources	c. 0,8%	c. 4%	c. 0.5%	-	-
Number of different crops	10	12	17	7	6
Household health					
Disease in the last year	14	7	10	31	142
Chronic disease	10	7	7	17	57
Number of children lost under age of 5	27	20	30	18	27
Women lost in childbirth	1	11	1	-	-
Wildlife damages					
Wildlife damages	20	7	17	-	-

When we asked households to estimate expenditure, we encountered similar problems as with income. Instead, we asked participants to estimate income and expenditure shares. Sale of livestock contributes to 30% of income generating activities (cattle 18%, followed by goat and chicken). Fishing contributed 2% of household income. Remittances from household members working in South Africa are not distinguished here as a separate income, but we estimate that it constitutes a large part of household income. Several households (10%) also own some sort of small quiosque (kiosk) where they sell necessities and also generate some income. In a few cases, some households had specialised in a particular trade, such as making bread, rearing of doves, selling seeds, providing traditional medicine, or fishing.

Expenses, in order of importance, were food (29–39%), transport (22%), clothes (14%) and other expenses (10%); the majority of the latter category was attributed to purchasing soap (Figure 2d). Though incomes were generally very low, a few households (five) had working cars. Building materials are mostly of local origins: there is no access to electricity or running water or wells/boreholes. Some of the quiosques have solar cells connected to car batteries, but none of the interviewed households had solar cells. Of the 59 households interviewed in these villages, only six (10%) did not own any livestock at all, and five owned only small livestock such as goat/sheep, ducks, or pigs (hens and chicken were owned by most, but numbers here are unreliable and not shown). Most households owned cattle: the biggest cattle owners counted 150–200 heads of cattle, but the average herd for a household was 20–25 heads (Table 2).

Share of Livelihood Activity



Share of Expenditure

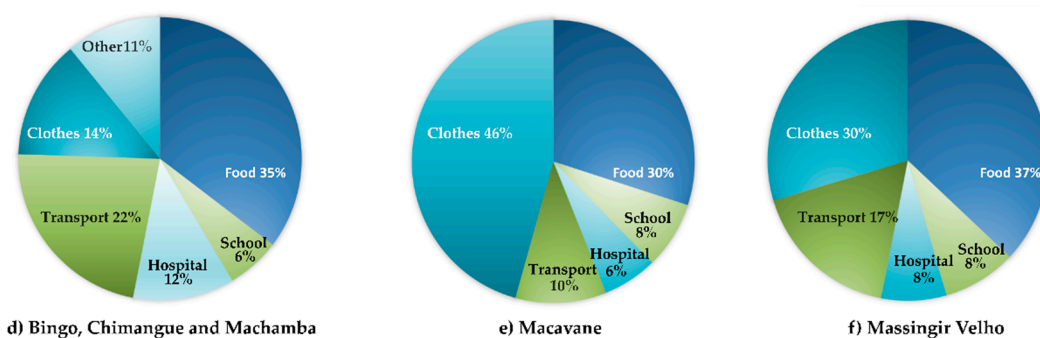


Figure 2. Circle diagrams of share of livelihood activities and expenditure in the villages discussed here. (a–c) Livelihood activities in terms of revenues from employment, sale of crops or livestock, revenues from owning a shop or from fishing, or artisanry work; (d–f) share of expenditure in terms of expenses for food, school, hospital, transport, and clothes. In Bingo, Chimangue, and Machamba, percentages are based on how often a resource is mentioned, while in Macavene and Massingir Velho, they are based on actual numbers.

Consultants to LNP carried out the assessments in the villages of Macavene and Massingir Velho, but some results are presented here as a means of comparison to the villages where we carried out our surveys. The number of cement-built houses and constructions are considerably higher in these villages, as are the local energy sources such as

solar cells. In Macavene, 23% of the households had a member with formal employment, while in Massingir Velho as many as 44% had formal employment (Figure 2b,c). In Massingir Velho, as many as 15% of the households had bank accounts with some accumulated savings (152,270 ZAR in total). The activity that most commonly generates income in Macavene is the sale of cattle and small stock, 45%, while in Massingir Velho livestock sale accounts for 35% of incomes, with cattle constituting the biggest share. Income from self-owned shops was reported in both villages (1 and 9% respectively).

In Macavene and Massingir Velho, both fishing and artisanry work are listed as income. The potential household income from possible remittances is unknown but here, income and expenditure can be better estimated). Incomes averaged 45,280 and 326,652 (without outliers, based on regression analyses) (Table 2). Discounting the outliers, average household spending is 3530 ZAR/year. The largest expenditure in Macavene was clothes (44%), and in Massingir Velho, food (45%) (Figure 2e,f). All of the households in the two villages together possessed, in total, two cars and five motorbikes. Seven of the 35 households in Macavene did not have any livestock at all, and three households only had small livestock. Most families owned cattle (from 1 to 91 heads, averaging 12 per household). In Massingir Velho, 53 households (22%) did not have any livestock at all, but 141 (58%) owned cattle, with the average herd size per household counting at eight heads [65,66] (Table 2).

3.2. Household Vulnerability

We asked households in the villages of Bingo, Chimangue, and Machamba if they could recall any drought or flood events occurring since 2000. All households reported there having been a different number of droughts (four on average), but most households generally agreed on two flooding events. During the 2000 event, no household could recall that they had received warnings over the radio, but in the latest flood (2012) many households received warnings via radio. None of the households had received any form of assistance during these floods.

There are no boreholes in these villages, and all households rely on water from the Shingwedzi River. When the Shingwedzi River is dry, it still holds underground water, which can be accessed by digging wells (Figure 3). None of the households had experienced or heard of conflicts over water, but replies would have possibly been different if respondents had been asked this question after the 2016–2017 droughts when the Shingwedzi River nearly dried out. We asked the households to estimate how much of their food comes from own production or is bought. Only two families reported being 100% self-sufficient in food, two households gave estimates as low as 25%, but on average households estimated that 70% of their food came from their own production. Maize is the most common crop (Figure 4), but there is also a high degree of variation in the composition of crops with millets, pumpkin, melons, peanuts, and beans being the most common. Wild vegetables and fruits are a common source of food, but in terms of their overall caloric contributions, informants ranked them low (0.5–4%) which is probably an underestimation of the importance of wild plant resources (see discussion below).



Figure 3. Fetching water from a natural spring fed by the Shingwedzi, Makandezulo B. (Photo taken November 17, 2011, by Michel Notelid).



Figure 4. The year 2014 was a good crop year. Maize storage at a household in a Chimangue granary (Photo taken July 28, 2014, by Michel Notelid).

When we asked the question “Why do you keep cattle?”, 46 households replied they did so in order to sell animals for cash or in exchange for food, with nine households adding that it was for security (as cattle is also used for bridewealth). Of the 46 cattle-holding households interviewed, only 14 reported that they kept cattle for consumption. Three of the 59 families we interviewed had successfully borrowed money from another household within the last year, although a total of 10 families had asked to borrow money from someone within the last year. Hospital and medicine costs are a big part of household spending, thus poor health is a serious source of household vulnerability: 24 (41%) households had a member with a chronic disease, most commonly relating to respiratory problems (17%), but also including rheumatism (10%) and stomach problems (8%). Seventeen (29%) households estimated that in the last month a household member had missed work or school because of sickness. Malaria was not listed as a disease, probably because it is seen as quite common and does not require hospital care. Eight households had also lost members in childbirth (even though most women gave birth in the local clinic

or in the Massingir hospital), and 32 (54%) families had sadly lost children under the age of five (Table 2).

A major concern for households living in the core area and the buffer zone is the increasing incidence of crop and livestock losses to wildlife. Of the households we interviewed, 72% had experienced wildlife-related loss of crops or livestock, most commonly having lost crops due to elephants but also lion attacks of livestock (Table 2). Respondents had not received any help or compensation for these losses.

Household wealth in Macavene and Massingir Velho, according to the study carried out by the LNP consultants, is higher than in Bingo and Chimangue, as is shown above. However, the question remains: are these wealthier villages thereby also less vulnerable to shocks? We do not have equivalent information on floods and droughts from these surveys. We also do not have information about where households got most of their food. In both cases, the purchasing of food accounted for large component of household spending. There is also less crop diversity in this area: in Macavene, village households almost solely grow maize, and in Massingir Velho, 76% planted their fields with maize. Within Macavene and Massingir Velho, a few households (6%) did not grow any crops at all, in stark contrast to the other villages in this study. In Macavene, two households had bank accounts with some accumulated savings. In addition, in Macavene 13 (60%) households had borrowed money from both family and friends within the last year, with 12 households still paying back their debts. In Massingir Velho, 62 households had borrowed money within the last year and were still repaying this debt. Again, hospital and medicine costs are a large source of expenditure. In Macavene, the most common health problems listed included diarrhoea, malaria/fever, and coughing or respiratory problems, and 12 of the households had lost children below the age of five. Massingir Velho has similar health problems, and 85 (35%) of the households had people suffering from a chronic disease. In addition, 22 households (9%) had lost a child below the age of five [65,66] (Table 2).

4. Discussion

In this section, we first summarise factors that make households vulnerable to shocks but also vulnerable on a more structural level, comparing our results with other investigations carried out in the region. We also discuss how new challenges emerging within the park lead to increased vulnerability. In the following sections, we then move on to discuss possibilities and constraints for endurability and transformability, as summarised in Figure 5.

4.1. Vulnerabilities and New Challenges

All households interviewed above have been affected by droughts and floods. Most respondents could remember at least four droughts since 2000, though numbers varied depending on individual definitions of drought. A UN-supported programme has sought to build early-warning systems in the region, mainly through public radio [39]. In 2013, residents in LNP did receive early warning of the floods. Contrary to areas closer to the national roads which received assistance during the 2013 floods [85], residents in LNP did not receive any outside help during these events, probably because the areas are located far away from the main towns and largely inaccessible during flood events.

From the results presented above, it can be concluded that households are very vulnerable to climate change. As most households also buy a large share of their food, they are also vulnerable to changes in global food prices (Figure 5 1a,b). Even in the more self-sufficient villages, an estimated 30% of food must be bought, and households are also dependent on monetary incomes to pay for health care, clothes, and other necessities. In the remote villages, the sale of agricultural products is therefore crucial, as there are few other opportunities for monetary income. The sale of agricultural produce accounts for the highest share of income generated by all of the livelihood activities people were engaged in. In good years, the security of these households is high, as they are self-sufficient

to a significant degree and less vulnerable to fluctuations in food prices. However, in times of droughts or floods, they are also more vulnerable to crop losses.

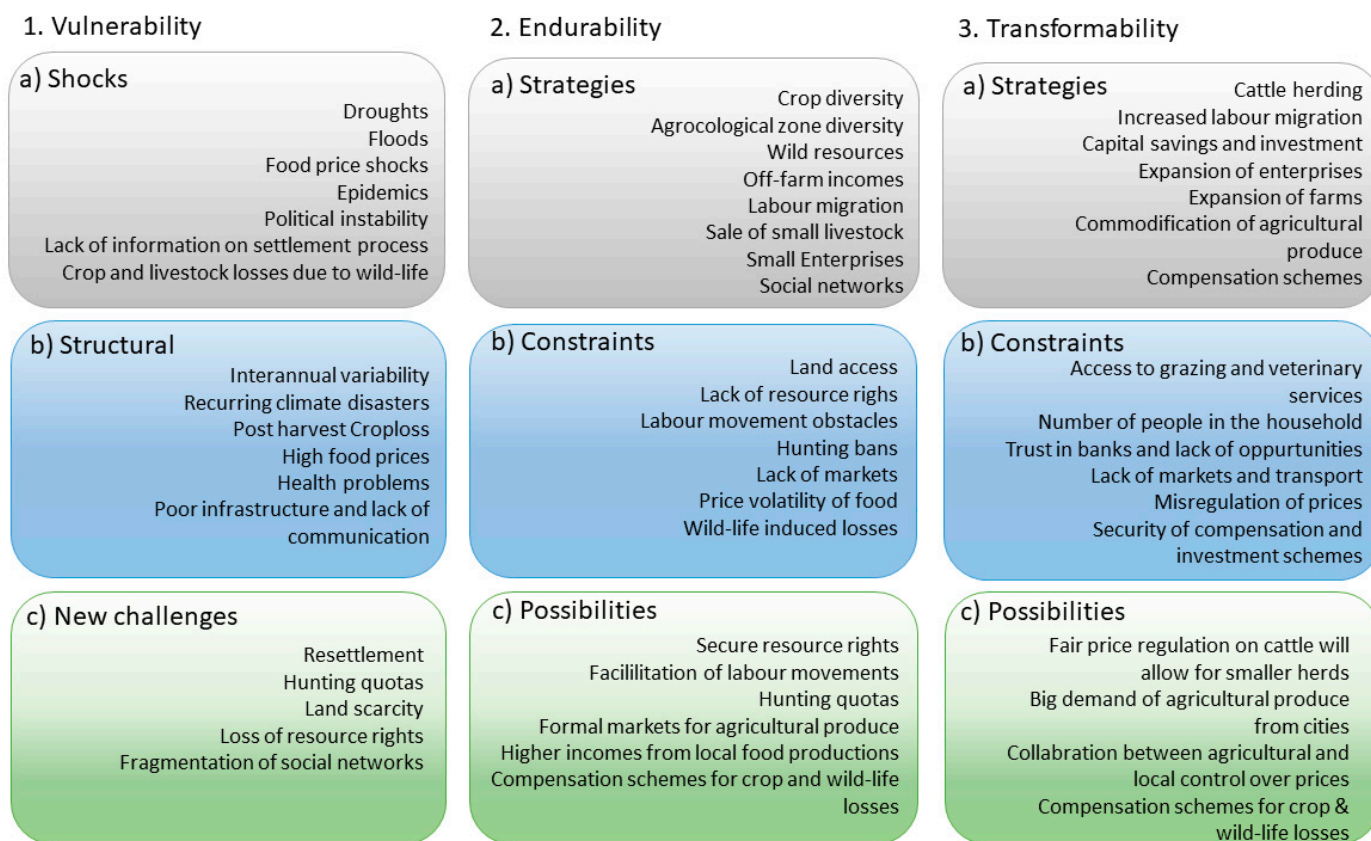


Figure 5. Vulnerability, endurability, and possible avenues of transformability of households in Limpopo National Park (PNL). The figure summarises: (1a,b) shocks and structural vulnerabilities in PNL; (1c) new challenges with the creation of the park; (2a) strategies for endurability; and (2b,c) constraints and possibilities in the context of PNL. Meanwhile, some possible strategies for small-scale transformability are shown in (3a) with (3b) possible constraints and (3c) possibilities to circumvent them.

Even though most households produce their own food, the risk of crop failure is high. In 2012, Milgroom [60] together with household representatives, reconstructed a 10 year crop history, showing that a good harvest occurs once every 5 years, but only 1 to 2 years after a good crop year, most food had to be purchased, borrowed, or gifted from other households. By comparison, in Chicualacuala, a survey of 112 households reported that on an average year, they had difficulties procuring food for 1 to 2 months each year [85]. It is obvious that even in a year of average crop yields, households are dependent on additional sources of income. In addition, the risk of postharvest crop losses, primarily in the storage of grain, is high [87].

Our surveys and those of LNP did not capture the importance of wild plant resources well. Other authors have shown the importance of wild fruit trees, especially during crop failures [60,61]. Inside the park, residents have customary rights to trees in their fields, fallows, and also old farming land where farmers still have resource rights. With resettlement, this vital source of security would be more limited. Indeed, loss of access to wild fruit trees, so essential as famine food, was one of the major concerns for the women in connection with resettlement, as they would no longer have customary rights to land with fruit trees [60,61].

With the proclamation of the park, hunting “for the pot” became a crime, and we therefore could not ask questions directly about the contribution of wild meat. Instead, we tried to circumvent the problem by asking about the use of wild meat in the past. In

2013, most households stated that they had consumed wild meat since time immemorial and at a high frequency. In 2014, as the park had more strongly enforced the bans against hunting, few households would admit to having eaten wild meat ever. We are guessing that hunting for the pot is still common, especially during extreme years, as people simply do not have a choice. However, as wild-meat consumption is now illicit, it is typically hidden from neighbours. The result is a breakdown in social forms of food sharing, which are important for the most vulnerable households. As we learned through follow-up interviews, food sharing and food giving was common in the days when hunting of wild game was possible, but this practice is now non-existent.

Wildlife damages represent a new challenge for households in the park [57,63,64,83,88]. The wildlife human-conflict-prevention unit in the park has remained understaffed and has not been able to sufficiently mitigate such conflicts; the department is now strengthened with more rangers to moderate wildlife damages. Prior to 2019, victims of wildlife damages were not awarded compensation. A compensation scheme was introduced by park management 2019 after attacks on cattle by lions in the Mavodze village (also located in the core area of the park).

4.2. Endurability: Possibilities and Constraints

Household endurability is to a large extent regulated by income, and the household economies of the different villages we have discussed here are markedly different than those we carried out surveys in. Macavene and Massingir Velho have a larger percentage of inhabitants employed in the formal sector and also obtaining relatively high incomes. These villages are closer to infrastructure and urbanised areas where there are more labour opportunities and more people have schooling (the same pattern was observed for Chicalacuala households by Dixon [85]). In the more remote villages, other than migrant labour, there are very few opportunities for salaried labour, and only a few residents have been employed by the park due to low levels of education. However, being situated a long distance from urbanised areas has both positive and negative effects. The village with the lowest average household incomes was Bingo, now cut off from the main road, but in such remote areas, larger cattle herds can be kept and are able to graze over larger areas, facing less competition, and in general, higher water availability (see further discussion below).

Informal labour is probably underrepresented as an income activity as the exchange of labour for food or other resources is probably more common than our survey results suggest. For example, 23% of households interviewed by Milgroom in a larger study that included the villages of Massingir Velho and Macavene reported informal labour being a source of income [60]. Households containing migrant workers or receiving remittances from family members working in South Africa typically have higher household incomes. The role of labour migration in agricultural production is debated. Labour migration has been suggested to be antithetical to agricultural production [89]. Households with one or several members away on work would perhaps be able to invest less time in their farms, but on the other hand, these households tend to be better able to invest financial resources into their farms. Labour migration and agricultural production should thus be seen as complimentary and as essential to household durability [90–93]. Amongst the households interviewed by Milgroom, 33% had incomes derived from migrant labourers or from transborder trade [60], see also [58]. Labour migration, though a fundamental part of the economy, is also a way to counter shocks. Historically, peaks in labour exports correlated with the maize crop failures in 1908, droughts in 1912, and the severe famines in 1913 [89]. In the village of Makandezulo, located in the core area of the park, informants likewise stressed that labour migration increased in years of drought [61]. Young men comprised the majority of labour migrants in the past, but interviews by Ribeiro and Chaúque in Mapai Ngala (situated east of LNP in what can be called its support zone), suggest that labour migration patterns have shifted due to climate effects, as it is now increasingly common for household heads to migrate for labour [80].

Much transnational labour migration is illegal as few LNP residents have passports. The cost of a passport (5000 MZT in 2012, requiring travel and living costs to Xai-Xai, the nearest provincial city at a distance of c. 40 km away) is an unobtainable sum for many households under normal conditions. Therefore, residents prefer to either walk across KNP to enter South Africa (a dangerous trek) or pay for a lift [47]. Facilitating households to obtain the documents necessary to make this journey legally is important and would strengthen workers' rights and security [92]. The proclamation of the park has facilitated movement (as it has led to the creation of new roads and new opportunities for transport), but it has also meant the stronger enforcement of border controls, especially due to concerns with wildlife trade [68]. Reportedly, in the last few years, mobile passport offices have been set up at border posts, facilitating the legal movement of labour, and labour recruitment at the behest of South African farmers has also been facilitated, which is a positive development in terms of job security. Follow-up studies are needed to evaluate the effects of this new policy. In addition, restrictions on the freedom of movement across the borders and economic downturns brought about by the Covid-19 pandemic will no doubt be a matter of inquiry for many years to come.

Farmers, who are mostly women, have several strategies in place to counteract climatic insecurity and to build durability. Most families have fields spread out in different ecological zones, usually in the fertile loamy soils of the floodplain and in the drier areas away from the floodplain [54]. Households typically rotate their fields, leaving them fallow for a period of about five years [84]. Households with fields in different agricultural zones typically grow a higher diversity of crops than what is the case in villages that are less dependent on agricultural produce (Figure 5 2a). However, new strategies have had to be developed with climate change. Based on the analyses of Dixon [85], in Chicualacuala, which is outside LNP but still in the support zone, farmers have shifted their agricultural practices partly in response to the experienced effects of climate change. This shift included changing from maize to more drought resistant crops, including the more traditional crop of sorghum, which is intercropped with millet, also a traditional crop. Additionally, farmers have switched over to grow more cowpea and millet (and also to new varieties of cowpeas). In total, 80% of the 140 households interviewed here experienced that rainfall was now more irregular; some informants noted more frequent droughts, and others that the rainy season now came later than before [85]. In Mapai Ngala, farmers also report a shift to later and shorter growing seasons [80]. We did not pursue this line of questioning in our own surveys, but individual interviews suggest that when it comes to scheduling the planting and harvesting of sorghum, farmers need to be able to accurately pinpoint the timing of the rainy season, which is becoming increasingly difficult. Maize, on the other hand, can be planted and consumed throughout the year. In light of this, farmers have adapted to the irregularity of rains by planting throughout the rainy season and also extending the size of the fields [87]. Households with access to cattle may open up bigger fields by using ploughs, and this appears to be increasingly common, especially in Mavodze where soil quality is poor and where farmers grow mostly maize. Inside the park, residents have customary land tenure rights, and land is available. It is therefore relatively easy for farmers to expand their fields here. Households that have been resettled to the more populous areas outside the park do not have the same access to land (Figure 5 2b). For instance, the residents of the first village to move from the core area of the park, Nanguene, received 1 ha fields in which they were unable to rotate crops. Residents of Macavene were allotted fields of a similar size, and again, households could not expand their fields [87].

Lack of customary rights over land also have implications for other important sources of income, for example the collection and sale of grass, or selling of reeds, preparing poles, or the production of palm-wine. These off-farm sources of income are rarely listed in the surveys, probably as resulting incomes are small. However small, these incomes are still important for durability and to meet the everyday household expenses [37,94]. Off-farm resource incomes as well as firewood collection are only possible with

access to customary fallow land or old farmland. There is no such access in the populated areas outside the park [60] (Figure 5 2b). In the Nanguene case (the first village to resettle), the lack of access to land for cultivation, grazing, and other wild resources made some households move back to the buffer zones inside the park [60,95]. The erosion of traditional authority and loss of access and control over ancestral places, all issues linked to resettlement, are also seen as threats to endurability and social welfare [59,61,95]. It is therefore important to ensure access and ownership of these ancestral places [96].

Social networks are important for the endurability of households. Most of the families we interviewed have adoptive children or children from other households living with the household. Of the households represented in the livelihood assessments presented here, a total of 23% had borrowed money from another household within the last year and were still repaying the debt. The year 2013 was a relatively good crop year, and thus, if we had carried out this assessment in the disaster years of 2016–2017, these figures may have looked dramatically different. Other common practices are various forms of labour exchange, for instance borrowing cattle for ploughing [42]. There is a general fear that these crucial social networks would be broken up with resettlement. Though the households in the remote areas of the park have exceptionally low incomes, none of the household representatives replied that “we don’t spend money because we have no money”; thus, even very poor households (e.g., households with no livestock and no income) do manage to get basic necessities in a normal year, either through informal labour or through borrowing and receiving help from family and friends. In relative terms, big families are better able to provide basic security for their family members: they can acquire larger herds and open bigger fields and are therefore better able to produce and store wealth, all factors which give them a higher endurability and a higher capacity to mitigate against vulnerability. As many other studies have shown, the poorest households are the smallest households, those of widows with a few children, many of which have no livestock or other incomes. These households are most vulnerable to climate stress and other negative changes, and unless they have a support network, they are at a high risk.

4.3. Transformability: Possibilities and Constraints

A problem when it comes to possibilities for households to transform or at least to reduce vulnerability is that locally there are few opportunities to store surplus, whether it is surplus in resources or capital income. The local crops do not store well between years, and postharvest crop loss remains a problem. Hybrid maize varieties that are more productive store worse over the years than older maize [87]. Most of the households we interviewed gave us the information that they prefer to invest surplus money in cattle (Figure 5 3a). Another way of storing wealth is investing in small enterprises. Households can make extra income from owning a car and providing taxi services to villagers, for instance. The most common source of investment is to open a small quiosque or a bar. The profitability of these quiosques comes from surcharges on wares that are relatively modest in size but may accumulate over time. In good years, a quiosque does allow households to store wealth by stocking up the shop and then selling when agricultural production is low. In bad years, a major limitation is that no one has any money to spend. The problem of cashflow was repeated to us also by shop owners in the villages and in Massingir [97].

Even though some households are relatively wealthy in terms of cattle, there are no means whereby to translate this wealth into security for loans or for investments (Figure 5 2b). In addition, very few families have bank accounts or savings. Conditions for savings accounts are generally favourable in Mozambique, but to open a bank account you need formal employment and a monthly salary [98]. From responses we have had in the surveys, based on follow up questions and comments, there appears also to be a general distrust against banks: in discussions, reference was made to political unrest or theft of money from officials. The 2019 financial compensation paid out to Mavodze households for lion attacks on cattle was paid out in new bank accounts, but reportedly many households preferred to immediately cash out the money rather than to keep it in the bank [99].

The households in our survey and those within LNP report a high percentage of income from the sale of livestock and particularly of cattle. Similarly, in Milgroom's surveys which combined several villages in the LNP core area and the Massingir area, 56% of the households similarly stated that the sale of cattle and/or goat was a source of income and a preferred strategy for dealing with a lack of food [60]. In Bingo, Chimangue, and Machamba in our survey area, livestock sales contribute, on average, to 30% of household incomes, but in these remote villages cattle sales are probably underrepresented. In 2012, the cattle in the villages had not been inoculated and sales had been carried out mostly within the village. From our interview's in and around LNP, farmers prefer to keep cattle in remote areas, where grazing and access to water is better and there is less risk of cattle theft. Notably, 52% of the households we interviewed grazed their cattle at a 5–15 km distance from the village, usually unattended and mostly on abandoned farm land where they had customary rights. The local livestock breed, *Landim*, is resilient to drought, and even in the drought year of 2016, herders report that grazing remained good inside the buffer zones of the park [100,101]. Availability of grazing is a major concern for residents when it comes to resettlement, especially for those having large herds. Another concern relates to resettlement closer to populous areas, which increases the risk of cattle theft; herds now have to be guarded by herd boys which prevents them from going to school [87]. Cattle is both a social institution and money in the bank [102–104]. Concomitantly, cattle cannot be understood in comparison to small livestock or farming produce, as its value in the herd will always be higher than its value sold [105,106].

To understand these dynamics in more depth we interviewed ten cattle herders in Chicumbane village. All interviewed cattle owners stressed the need for a local cattle market, and they all stated “lack of markets” as the main obstacle for them to expand cattle rearing as a business. Informal markets are established in Mapai Central, but they are not formally regulated, and cattle theft is a constant worry. One informant was looking to expand his enterprise and had strategically shifted to the nonlocal and larger breeds of cattle for better market prices, in essence aiming to transform his cattle rearing into a larger business. The informant saw price regulations at the provincial level as a main obstacle preventing him from expanding his business. As seen during the droughts in 2015–2016, cattle prices dropped completely in the Limpopo Valley [107]. At the same time cattle prices were maintained at a relatively constant and high price in the Mozambique urban areas. A comparison can be made here with the Sengwe corridor in southeastern Zimbabwe, where veterinary services are better implemented, and where farmers are specialised in cattle rearing. Here, 75% of household income comes from the sale of livestock, and farmers are hoping to expand cattle sales in Mozambique because of higher prices here [86]. Meanwhile, Mozambique has also committed to increase its production in cattle, but so far little actual investment has been made when it comes to small-scale livestock herders [39,98,99]. For LNP, the creation of locally organized but monitored cattle markets, that would include both inoculation programmes, veterinary services, and cattle registration, would mitigate against cattle theft and result in higher prices as well as reduce the spread of diseases—a win–win situation both for cattle owners and LNP. LNP has also now started a pilot project along these lines, which includes the formal employment of cattle guards paid by the park [108].

To households in the area, the creation of LNP has led to increases in vulnerability and new challenges with respect to durability as discussed above, but it has also brought new opportunities. In 2013, as we carried out the assessments, there had been, since 2011, an influx of wealth due to the explosion of the illicit trade in wildlife, especially of rhino horn [67,109]. In LNP, the increase in wealth locally was most noticeable in the increase of vehicles and new kiosques and bars. Already by 2014, the number of vehicles had decreased: reportedly, many cars had been sold at a bargain price to people outside the park [110]. LNP had enforced stronger antipoaching measures, and by 2017, park borders were intensively patrolled. Massingir and other nearby towns also experienced a brief bonanza linked to the exploding wildlife trade, but the businesses that popped up in

2013 are now largely defunct. Despite the observable influx of wealth, having revisited the villages and the closest town Massingir several times since then, little of this wealth seems to have trickled down into the local economy or otherwise improved the livelihoods of the average household. The large losses of young men who were killed while engaging, or allegedly engaging, in poaching activities are devastating, and their absences will be long lasting for the communities. Though poverty is a strong driver for engaging in the illicit trade in wildlife, the general disenfranchisement of young men, in combination with obstacles and decreased opportunities for labour migration as discussed above and just the general lack of employment or other opportunities, has exasperated the situation. A larger part of the funding for antipoaching measures should be channelled to provide options for those at risk of being involved [67,68].

Other potential areas of transformability emerging within the park include the benefits of sharing the park and linked investments. The Mozambique forest and wildlife law 10/99 prescribes that 20% of park levies should be allocated to representational district committees where local associations can apply for funding for projects. Lack of clarity in the administration and application process of the 20% levy funds has resulted in few projects claiming this money [54]. In addition, residents seem to be suspicious or reluctant to form the required resource associations, as they would prefer to venture into new businesses privately or in other constellations. Nevertheless, gradually, local resource associations have applied for the 20% levy funds, mostly agricultural associations receiving funding for small-scale irrigation projects. One example is the agricultural association of Chicumbane which started irrigation agriculture in 2012. The association produced a large crop of tomatoes, but there were few means to transport the surplus to nearby towns (the closest is Mapai station) or further [111]. The lack of markets for the sale of agricultural products thus remains a constraint for households [17,39,112]. Another serious constraint for irrigation projects is that they would still be vulnerable to climate variability, as was seen in the extreme droughts of 2016–2017 when no irrigation was possible. These constraints should be considered when planning and advising such projects.

5. Conclusions

In conclusion, LNP households are exceedingly vulnerable to climate change, but there are a number of strategies already in place to ensure their endurability. The cultivation and sale of agricultural yields generate important revenues in normal years, but during drought years and extreme flood years, the risk of total crop failure is significantly high, even amongst households with the facilities for irrigation agriculture. Unfortunately, the recurrence of such events is projected to become even more common in the future, and this needs to be acknowledged in agricultural and development planning.

As reviewed above, the proclamation of the park and bans on access to resources, including land and wild meat, have increased the vulnerability of households. The effects of resettlement which have included restrictions on customary resource rights and more limited access to land are serious constraints to endurability. With resettlement, households completely dependent in wild resources for their survival risk being further disadvantaged as they would no longer have the same access to these wild resources. There must be a security network for these households who are destitute. Recent compensation schemes for livestock losses due to wildlife should be expanded to also cover crop losses. However, the overall effect of the park on households in the area, in terms of creating both constraints and possibilities, needs to be carefully assessed in follow-up longitudinal studies of household wealth and other factors using both formal surveys and in-depth interviews.

Generally, the capacity to build surpluses or expand production during cultivation is constrained by a lack of local markets and transport to the nearest towns. Possible strategies for transformability could include households becoming more specialised in the production of value-added goods, i.e., dried or processed products that can be stored and sold, provided there are buyers. However, such reorientations of more subsistence based

agricultural production to commercial crop production cannot come at the cost of household food security. The strongest asset when it comes to adaptive capacity and transformability is cattle production. While cattle sales tend to increase in times of shock, when crop yields are limited, even during a good rainfall year, such as 2012, the sale of cattle was common. Cattle rearing has great potential to become a source of community transformability, but there need to be local markets and carefully reviewed price regulations. Such a change also requires improved and appropriate veterinary services. Villages that are resettled to more urbanised areas would not be able to keep as big of herds as they had inside the park; this is also a great concern, especially for those who own large herds. A forward-thinking strategy to compensate for this can include combined cattle markets with inoculation programmes, veterinary services, and cattle registration to ensure that the value of cattle will increase even though the cattle herds become smaller.

Author Contributions: Conceptualization, M.N. and A.E.; methodology, M.N. and A.E.; formal analysis, M.N. and A.E.; data curation, M.N. and A.E.; writing—original draft preparation, M.N. and A.E.; writing—review and editing, M.N. and A.E.; visualization, M.N. and A.E.; project administration, M.N. and A.E.; funding acquisition, M.N. and A.E. All authors have read and agreed to the published version of the manuscript.

Funding: The work was carried out within the project “Landscape transformation and socio-ecological management, Limpopo National Park, Mozambique” by the Swedish Research Council (VR, dnr 2012–1063).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The livelihood assessment data from Machamba, Chimangue and Bingo is available here <http://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-435525> (accessed on 6 January 2021). Livelihood assessment data from Massingir Velho and Macavane is available at request from Limpopo National Park <https://www.peaceparks.org/parks/limpopo-national-park/> (accessed on 6 January 2021).

Acknowledgments: We are grateful to the Management of Limpopo National Park which has aided with logistics and support, particularly Anthony Alexander, the project manager of Limpopo National Park (now project manager of the whole GLTP) who also guided us to the livelihood assessment data from Macavane and Massingir Velho. We are indebted to the wildlife human conflict officer Guilherme Dos Santos Maluleque who has followed and guided our work since 2005. We are truly grateful for his advice and friendship. This paper would not have been possible without the support of traditional and village leaders in Bingo, Machamba, Chimangue, or the kind reception from households in these villages. We thank also our translator and friend, Ranger Gabriel Agostinho Froi and Nkhansani Bingo Baloi for assisting us with translation and advice. We thank our research assistant in Chicumbane, Hilario Maluleke. In addition, we are grateful to chief Rodrigues Maluleque of Chicumbane village for informing us on the Chicumbane Agricultural Association and assisting us in other matters of importance. We are deeply grateful to the two reviewers for their comments and suggestions which have greatly improved the paper and to our colleague Anna Shoemaker for revising the English.

Conflicts of Interest: The authors declare no conflict of interest. The funders or the LNP park management had no role in the design of the study; in the analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

Appendix A

The questionnaire used for surveys in Machamba, Chimangue, and Bingo is presented in Table A1. Grey highlights indicate the questions which was modified or added to our surveys in comparison to the surveys carried out by LNP. The LNP survey was more extensive regarding household assets and resources. Meanwhile, we included questions related to climate vulnerability, the sharing of resources, and damages from wildlife.

Table A1. Summary of questionnaire used for this study.

FAMILY STRUCTURE AND ASSETS	
Family history	How long has the family lived in this village? Where did the family live during the war? In the past did people work in another country? Do you have family in other parts of the country?
Family structure Assets	How many wives does (did, if deceased) the head of the household have? What is the age structure in the family?: How many elders (older than 50), adults (49–20), youth (19–14), children (younger than 13)? How many children (below 18) from other families live in your household? How many adoptive sons/daughters do you have in the household? How many in the family work in other parts of Mozambique? How many in the family work in another country? No of traditional houses, no of cement houses, no of cars etc.
SCHOOLING	
Grade of schooling	Grade of schooling of head of household or of other members in the household? How many of the children in the household go to school? If you have children of school age that are not in school can you specify the reason why they are not in school? What is the distance to school? How do children go to school?
INCOME	
source of income	From where does the household get most of its income? Do you get money or food from family working in other places? If yes specify what/how much?
Spending	How much money does the household spend on average per year? On what does the household spend most of its money?
Debts	Has anyone in the household had to borrow money? If yes, from whom? If yes, do you have to spend money to repay the loan?
Banking Transport	Does anyone in the household have a bank account? If yes, how much money (more or less) do you have in the bank account? What mode of transport do you normally use when visiting another village or town?
Social networks	In the last month did you or someone in the household receive help from friends or extended family? If yes how? In the last month did you or someone in the household help friends or extended family? If yes how? Did you lend someone money in the past month? Did you borrow money from someone in the past month? In the last month did you go to the village leader for help? If yes for what?
FOOD	
Food	From where do you get most of your food? Own production, buying (<i>Interviewee was asked to estimate how much food came from own production and from buying, e.g., less than 50%, 50%, or 75% or more</i>)
Livestock	How many animals does the household own at the moment? What is the main reason for raising livestock?
Land use	How many fields does the household have and how big are they (in ha/or size of football fields)? Are they located in the same place or different places? How long (in mins) does it take to go to your fields? What crops do you grow? How far do you graze your cattle (in km)? <i>Does someone go with the cattle or do the cattle go alone?</i> How long do you go to collect firewood (km)?
Past use of game	Before the park, how often did you eat wild meat? If yes, how often (<i>Always, often, sometimes</i>)? Before the park, how often did you sell wild animal products? If yes, how often (<i>Always, often, sometimes</i>)?
HEALTH	
Health Child mortality	Were you or another family member sick last year? If yes, what was the problem and how did you treat the disease? Does anyone in your family suffer from a chronic disease? If yes specify can you specify the problem? Did you or anyone in the household miss work or

	school because of sickness? How many mosquito nets does the households own? How long does it take to get to go to the nearest clinic? How long does it take to go to the traditional healer?
Child birth	How many children in the household failed to complete 5 years of age Where do you give birth? Local clinic in Mashamba, hospital in Massingir, at home? (<i>If you gave birth at home was there someone from the village who assisted?</i>). Have many mothers has the household lost in childbirth?
CLIMATE VARIABILITY AND WATER SECURITY	
Water	Where do you collect water? How long do you have to walk to collect water (in mins). Is water available every day of the year? Have you heard of conflicts of water in the community during the last year?
Climatic variability?	Between 2000–2013, how many times has the area been affected by climatic variability? Floods (no times), cyclones (no of times), droughts (no of years) Did you receive a warning of the flood/cyclone/drought. <i>If yes from where</i> ; Was anyone in your household hurt in the disaster?
WILDLIFE COMMUNITY CONFLICTS AND CRIME	
Wildlife conflicts	Have you experienced conflict with wildlife during the last year (e.g., from oct 2012–2013). If yes, what type of conflicts? If yes, did you receive any help from any of the following: PNL/village leader/political leader?
Crime	Have you heard of/or experienced any crimes committed to you or in the community? If yes, what type of conflicts? If yes, did you receive any assistance after the crime from PNL/village leader/Political leader/police?

References

- Berkes, F.; Colding, J.; Folke, C. *Navigating Social–Ecological Systems: Building Resilience for Complexity and Change*; Cambridge University Press: Cambridge, UK, 2003; pp. 1–31.
- Folke, C. Resilience: The emergence of a perspective for social–ecological systems analyses. *Glob. Environ. Chang.* **2006**, *16*, 253–267.
- Adger, W.N. Vulnerability. *Glob. Environ. Chang.* **2006**, *16*, 268–281.
- Cutter, S.L.; Barnes, L.; Berry, M.; Burton, C.; Evans, E.; Tate, E.; Webb, J. A place-based model for understanding community resilience to natural disasters. *Glob. Environ. Chang.* **2008**, *18*, 598–606.
- Magis, K. Community resilience: An indicator of social sustainability. *Soc. Nat. Resour.* **2010**, *23*, 401–416.
- Béné, C.; Godfrey Wood, R.; Newsham, A.; Davies, M. *Resilience: New Utopia or New Tyranny? Reflection about the Potentials and Limits of the Concept of Resilience in Relation to Vulnerability Reduction Programmes*; IDS Working Paper 405; Institute of Development Studies: Brighton, UK, 2012; pp. 15–22.
- Clare, A.; Graber, R.; Jones, L.; Conway, D. Subjective Measures of Climate Resilience: What is the Added Value for Policy and Programming? *Glob. Environ. Chang.* **2017**, *46*, 17–22.
- Jones, L. Resilience isn't the Same for All: Comparing Subjective and Objective Approaches to Resilience Measurement. *Clim. Chang.* **2019**, *10*, e552, doi:10.1002/wcc.552.
- Ansah, I.G.K.; Gardebreek, C.; Ihle, R. Resilience and household food security: A review of concepts, methodological approaches and empirical evidence. *Food Secur.* **2019**, *11*, 1187–1203.
- Walker, T.S.; Tschirley, D.L.; Low, J.M.; Tanque, M.P.; Boughton, D.; Payongayong, E.M.; Weber, M.T. *Determinants of Rural Income, Poverty and Perceived Well-Being in Mozambique in 2001–2002*; Ministry of Agriculture: Maputo, Mozambique, 2004; pp. 1–77.
- Walker, T.; Boughton, D.; Tschirley, D.; Pitoro, R.; Tomo, A. Using Rural Household Income Survey Data to Inform. Poverty Analysis: An Example from Mozambique. In Proceedings of the International Association of Agricultural Economists Conference, Gold Coast, Australia, 12–18 August 2006; pp. 1–15.
- Handa, S.; Mlay, G. Food consumption patterns, seasonality and market access in Mozambique. *Dev. S. Afr.* **2006**, *23*, 541–560.
- Osahr, H.; Twyman, X.; Adger, W.N.; Thomas, D.S.G. Effective livelihood adaptation to climate change disturbance: Scale dimensions of practice in Mozambique. *Geoforum* **2008**, *39*, 1951–1964.
- Hahn, M.B.; Riederer, A.M.; Foster, S.O. The livelihood vulnerability index: A pragmatic approach to assessing risks from climate variability and change—a case study in Mozambique. *Glob. Environ. Chang.* **2009**, *19*, 74–88.
- Silva, J.A. Rural Income Inequality in Mozambique: National Dynamics and Local Experiences? *Rev. Reg. Stud.* **2013**, *43*, 23–50.
- Eriksen, S.; Silva, J.A. The vulnerability context of a savanna area in Mozambique: Household drought coping strategies and responses to economic change. *Environ. Sci. Policy* **2009**, *12*, 33–52.

17. Silva, J.A.; Eriksen, S.; Ombe, Z. Double Exposure in Mozambique's Limpopo River Basin. *Geogr. J.* **2010**, *176*, 6–24.
18. Silva, J.A.; Matyas, C.J.; Cunguara, B. Regional inequality and polarization in the context of concurrent extreme weather and economic shocks. *Appl. Geogr.* **2015**, *61*, 105–116.
19. Arndt, C.; Strzepeck, K.; Tarp, F.; Thurlow, J.; Fant, C.; Wright, L. Adapting to climate change: An integrated biophysical and economic assessment for Mozambique. *Sustain. Sci.* **2011**, *6*, 7–20.
20. Matyas, C.J.; Silva, J.A. Extreme weather and economic well-being in rural Mozambique. *Nat. Hazards* **2013**, *66*, 31–49.
21. Rouault, M.; Richard, Y. Intensity and spatial extension of drought in South Africa at different time scales. *Nat. Hazards* **2003**, *29*, 139–154.
22. Usman, M.; Reason, C. Dry spell frequencies and their variability over southern Africa. *Clim. Res.* **2004**, *26*, 199–211.
23. McSweeney, C.; New, M.; Lizanco, G. *Climate Change Country Profiles: Uganda/Ethiopia/Mozambique*; UNDP: Oxford, UK, 2008.
24. Disaster Recovery Framework. In *Recovery from Recurrent Floods 2000–2013; Recovery Framework Case Study*, UN Development Programme; GFDRR, UNDP, United States, 2014; pp. 1–33. Available online: <https://www.preventionweb.net/publications/view/42553> (accessed on 6 January 2021).
25. Ekblom, A.; Gillson, L.; Notelid, M. Waterflow, landscape dynamics and water-management of the lower Limpopo. *Wires Water* **2017**, e1228, doi:10.1002/wat2.1228.
26. UN Office for the Coordination of Humanitarian Affairs. *Mozambique: Strategic Drought Response Plan 2016*; UN Residents Coordinators Office: Maputo, Mozambique, 2016; pp. 1–28.
27. Hoegh-Guldberg, O.; Jacob, D.; Taylor, M.; Bindi, M.; Brown, S.; Camilloni, I.; Diedhiou, A.; Djalante, R.; Ebi, K.L.; Engelbrecht, F.; et al. Impacts of 1.5 °C global warming on natural and human systems. In *Global Warming of 1.5 °C*; Masson-Delmotte, V., Zhai, P., Eds.; World Meteorological Organization: Geneva, Switzerland, 2018; pp. 175–311.
28. Engelbrecht, F.; Adegoke, J.; Bopape, M.-J.; Naidoo, M.; Garland, R.; Thatcher, M.; McGregor, J.; Katzfey, J.; Werner, M.; Ichoku, C.; et al. Projections of rapidly rising surface temperatures over Africa under low mitigation. *Environ. Res. Lett.* **2015**, *10*, 85004, doi:10.1088/1748-9326/10/8/085004.
29. Haensler, A.; Hagemann, S.; Jacob, D. How will the future climate of the southern African region might look like: Results of a high-resolution regional climate change projection. *Nova Acta Leopold.* **2010**, *112*, 183–191.
30. Engelbrecht, C.J.; Engelbrecht, F.A.; Dyson, L.L. High-resolution model-projected changes in mid-tropospheric closed-lows and extreme rainfall events over southern Africa. *Int. J. Climatol.* **2013**, *33*, 173–187.
31. Muinga, C. *A Economia de Moçambique e os Conflitos e Tensões à Volta das Condições de Produção e Reprodução Agrícola Desafios Para Moçambique*; IESE—Instituto de Estudos Sociais e Económicos: Moçambique, Maputo, 2020. Available online: <https://www.iese.ac.mz/wp-content/uploads/2020/12/CMuianga-Desafios-2020.pdf> (accessed on 6 January 2021).
32. Arndt, C.; Hussain, M.A.; Jones, E.S.; Nhate, V.; Tarp, F.; Thurlow, J. Explaining the evolution of poverty: The case of Mozambique. *Am. J. Agric. Econ.* **2012**, *94*, 854–872.
33. Hanlon, J. Renewed Land Debate and the 'Cargo Cult' in Mozambique. *J. S. Afr. Stud.* **2004**, *30*, 603–662.
34. Ministry of Agriculture. *Strategic Plan. For Agricultural Development (PEDSA)*; Ministry of Agriculture: Maputo, Mozambique, 2011; pp. 1–69.
35. AfDB. *Transition Towards Green Growth in Mozambique Policy Review and Recommendations for Action*; AfDB: Abidjan, Ivory Coast, 2015; pp. 1–71.
36. Mdee, A.; Ofori, A.; Chasukwa, M.; Manda, S. Neither sustainable nor inclusive: A political economy of agricultural policy and livelihoods in Malawi, Tanzania and Zambia. *J. Peas. Stud.* **2020**, 1–24, doi:10.1080/03066150.2019.1708724.
37. Mather, D. *Measuring the Impact of Public and Private Assets on Household Crop Income in Rural Mozambique 2002–2005*; Department of Policy MINAG—Directorate of Economics: Maputo, Mozambique, 2009; pp. 1–4.
38. Pauw, K.; Thurlow, J.; Uaiene, R.; Mazunda, J. *Agricultural Growth and Poverty in Mozambique: Technical Analysis in Support of the Comprehensive Africa Agriculture Development Program (CAADP)*; Mozambique Strategy Support Programme; International Food Policy Research Programme: Maputo, Mozambique, 2012; pp. 1–24.
39. Parkinson, V. *Climate Learning for African Agriculture: The Case of Mozambique*; University of Greenwich: London, UK, 2013; pp. 1–62.
40. Sasson, A. Food security for Africa: An urgent global challenge. *Agric. Food Secur.* **2012**, *1*, 2.
41. Giller, K.E. The food security conundrum of sub-Saharan Africa. *Glob. Food Secur.* **2020**, *26*, 100431.
42. Milgroom, J.; Giller, K.E. Courting the rain: Rethinking seasonality and adaptation to recurrent drought in semi-arid southern Africa. *Agric. Syst.* **2013**, *118*, 91–104.
43. Cunguara, B.; Hanlon, J. Whose wealth is it anyway? Mozambique's outstanding economic growth with worsening rural poverty. *Dev. Chang.* **2012**, *43*, 623–647.
44. Castel-Branco, C. Growth, capital accumulation and economic porosity in Mozambique: Social losses, private gains. *Rev. Afr. Polit. Econ.* **2014**, *41*, 26–48.
45. Nhate, V.; Massingarella, C.; Salvucci, V. *The Political Economy of Food Price Policy: Country Case Study of Mozambique*; WIDER Working Paper No. 2013/037; UNU World Institute for Development Economics Research: Helsinki, Finland, 2013; pp. 1–11.
46. Harries, P. *Work, Culture and Identity: Migrant Labourers in Mozambique and South. Africa c. 1860–1910*; James Currey: London, UK, 1994; pp. 27–48.

47. Norman, W.O. Living on the Frontline: Politics, Migration and Transfrontier Conservation in the Mozambican Villages of the Mozambique-South Africa Borderland. Ph.D. Thesis, London School of Economics and Political Science, London, UK, 2004; pp. 69, 72, 113.
48. Rogers, G. The faint footprint of man: Representing race, place and conservation on the Mozambique-South Africa borderland. *J. Refug. Stud.* **2009**, *22*, 392–412.
49. Van Ameron, M.; Büscher, B. Peace parks in Southern Africa: Bringers of an African Renaissance? *J. Mod. Afr. Stud.* **2005**, *43*, 159–182.
50. Ramutsindela, M. *Transfrontier Conservation in Africa: At the Confluence of Capital, Politics and Nature*; CABI: Oxfordshire, UK, 2012; p. 75–106.
51. Spierenburg, M.; Steenkamp, C.; Wels, H. Enclosing the local for the global commons: Community land rights in the Great Limpopo Transfrontier Conservation Area. *Conserv. Soc.* **2008**, *6*, 87–97.
52. DeMotts, R. *The Challenges of Transfrontier Conservation in Southern Africa: The Park Came after Us*; Lexington Books: Lanham, MD, USA, 2018; pp. 1–49, 65–72, 108–109.
53. BRL. *Development of the Limpopo National Park and its support zone: Feasibility Study Draft Report*; BSA, Agence Francaise de Developpement, Ministry of Tourism Mozambique and Nepad Project Proposal and Feasibility Fund, DBSA, AFD: Maputo, Mozambique, 2006; p. 25.
54. Givá, N. *Parks with People? Action Research in Bridging Conservation and Livelihoods in Limpopo National Park, Mozambique*; Swedish Agricultural University: Uppsala, Sweden, 2017; pp. 34, 35, 116.
55. Lunstrum, E. Terror, territory, and deterritorialization: Landscapes of terror and the unmaking of state power in the Mozambican “civil” war. *Ann. Assoc. Am. Geogr.* **2009**, *99*, 884–892.
56. Lunstrum, E. Mozambique, Neoliberal Land Reform, and the Limpopo National Park. *Geogr. Rev.* **2008**, *98*, 339–355.
57. Milgroom, J.; Spierenburg, M. Induced Volition: Resettlement from the Limpopo National Park, Mozambique. *J. Contemp. Afr. Stud.* **2008**, *26*, 435–448.
58. Bocchino, C. Is Mozambique the New South African Frontier? The Socio-Economic Impact of the Great Limpopo Transfrontier Conservation area on the Livelihood Strategies of Border Communities in the Pafuri Administrative Post. Ph.D. Thesis, University of Bologna, Bologna, Italy, 2008; pp. 214, 219–230.
59. Lunstrum, E. Reconstructing history, grounding claims to space: History, memory, and displacement in the Great Limpopo Transfrontier Park. *S. Afr. Geogr. J.* **2010**, *92*, 129–143.
60. Milgroom, J. *Elephants of Democracy: An Unfolding Process of Resettlement in the Limpopo National Park*. Ph.D. Thesis, Wageningen University, Wageningen, The Netherlands, 2012; pp. 58, 99, 102, 103, 131.
61. Witter, R. Taking Their Territory with Them When They Go: Mobility and Access in Mozambique’s Limpopo National Park. Ph.D. Thesis, University of Georgia, Athens, GA, USA, 2010; pp. 181–185.
62. Spierenburg, M. ‘We agreed to move, but we did not do so freely’. Resettlement from the Limpopo National Park, Mozambique. In *Worlds of Human Rights: The Ambiguities of Rights Claiming in Africa*; Derman, B., Hellum, A., Sandvik, K., Eds.; Brill: Leiden, The Netherlands, 2013; pp. 101–129.
63. Witter, R. Elephant-induced Displacement and the Power of Choice: Moral narratives about resettlement in Mozambique’s Limpopo National Park. *Conserv. Soc.* **2013**, *11*, 406–416.
64. Witter, R.; Satterfield, T. Invisible losses and the logics of resettlement compensation. *Conserv. Biol.* **2014**, *28*, 1394–1402.
65. Limpopo National Park. *Resettlement Action Plan for Massingir Velho Village*; Limpopo National Park, Massingir, Mozambique, 2013; Unpublished.
66. Limpopo National Park. *Resettlement Action Plan for Macavene Village*; Limpopo National Park, Massingir, Mozambique, 2013; Unpublished.
67. Rademeyer, J. *Killing for Profit: Exposing the Illegal Rhino Horn Trade*; Zebra Press: Cape Town, South Africa; 2013, pp. 215–296.
68. Massé, F.; Lunstrum, E. Accumulation by securitization: Commercial poaching, neoliberal conservation, and the creation of new wildlife frontiers. *Geoforum* **2016**, *69*, 227–237.
69. Hübschle, A.M. *A Game of Horns: Transnational Flows of Rhino Horn*. Cologne: International Planck Research School on the Social and Political Constitution of the Economy; Max Planck Institute: Berlin, Germany, 2016; pp. 308–312.
70. Lunstrum, E.; Givá, N. What drives commercial poaching? From poverty to economic inequality. *Biol. Conserv.* **2020**, *245*, 108505.
71. Lunstrum, E. Green Militarization: Anti-Poaching Efforts and the Spatial Contours of Kruger National Park National Park. *Ann. Assoc. Am. Geogr.* **2014**, *104*, 816–832.
72. Lunstrum, E. Conservation meets militarisation in Kruger National Park National Park: Historical encounters and complex legacies. *Conserv. Soc.* **2015**, *13*, 356–369.
73. Smith, D. Thousands of Rhinos, 500 Poachers. Grim Toll in the Hunt for Prized Horns. *The Guardian*, 18 October 2015. Available online: <https://www.theguardian.com/environment/2015/oct/18/rhino-horn-boom-impooverished-african-poachers> (accessed on 6 January 2021).
74. Reardon, T. Using evidence of household income diversification to inform study of rural nonfarm labor market in Africa. *World Dev.* **1997**, *25*, 735–747.
75. Falkingham, J. *Identifying the Poor: A Critical Review of Alternative Approaches*. A Paper Commissioned by DFID; London School of Economics: London, UK, 2001, pp. 5–11.

76. Howe, L.; Galobardes, B.; Matijasevich, A.; Gordon, D.; Johnston, D.; Onwujekwe, O.; Patel, R.; Webb, E.A.; Lawlor, D.A.; Hargreaves, J.R. Measuring Socio-Economic Position for Epidemiological Studies in low-and Middle-Income Countries: A Methods of Measurement in Epidemiology Paper. *Int. J. Epidemiol.* **2012**, *41*, 871–886.
77. Howland, O.; Noe, C.; Brockington, D. The multiple meanings of prosperity and poverty: a cross-site comparison from Tanzania. *J. Peasant. Stud.* **2019**, *48*, 180–200, doi:10.1080/03066150.2019.1658080.
78. Scoones, I. *Sustainable Rural Livelihoods: A Framework for Analyses*; Institute of Development Studies, University of Sussex: Brighton, UK, 1998; pp. 1–22.
79. Chambers, R.; Conway, G. *Sustainable Rural Livelihoods: Practical Concepts for the 21st Century*; IDS discussion paper 296; Institute of Development Studies, University of Sussex: Brighton, UK, 1992; pp. 1–33.
80. Brockington, D.; Howland, O.; Loiske, V.-M.; Mnzava, M.; Noe, C. Economic growth, rural assets and prosperity: exploring the implications of a 20-year record of asset growth in Tanzania. *J. Mod. Afr. Stud.* **2018**, *56*, 217–243.
81. Tanner, T.; Lewis, D.; Wrathall, D.; Bronen, R.; Cradock-Henry, N.; Huq, S.; Lawless, C.; Nawrotzki, R.; Prasad, V.; Rahman, M.A.; et al. Livelihood resilience in the face of climate change. *Nat. Clim. Chang.* **2015**, *5*, 23–26.
82. Ribeiro, N.; Chaúque, A. *Gender and Climate Change: Mozambique Case Study*; Heinrich Böll Stiftung: Berlin, Germany, 2010; pp. 1–47.
83. Silva, J.A.; Loboda, T.; Strong, M. Examining aspiration's imprint on the landscape: Lessons from Mozambique's Limpopo National Park. *Glob. Environ. Chang.* **2018**, *51*, 43–53.
84. Lopes, P.J. *Conservation History, Hunting Policies and Practices in the South Western Mozambique Borderland in the 20th Century*; University of the Witwatersrand: Johannesburg, South Africa, 2017; p. 181.
85. Dixon, R. Baseline Household Survey Results: Chicualacuala District, Mozambique. In *CGIAR Resesearch Program on Climate Change; Agriculture and Food Security (CAAFS)*: Copenhagen, Denmark, 2013; pp. 1–36.
86. Chirozva, C. *Exploring Future Ecosystem Services: A Scenario Planning Approach to Uncertainty in the South East Lowveld of Zimbabwe*; Centre for Applied Social Sciences, University of Zimbabwe: Harare, Zimbabwe, 2010.
87. Milgroom, J. *Alternative Sustainability Futures for Post-Resettlement in the Limpopo National Park*; Wageningen University: Wageningen, The Netherlands, 2010; pp. 122, 129.
88. Givá, N.; Raitio, K. Parks with People' in Mozambique: Community Dynamic Responses to Human–Elephant Conflict at Limpopo National Park. *J. S. Afr. Stud.* **2017**, *43*, 1199–1214.
89. First, R. *Black Gold: The Mozambican Miner, Proletarian and Peasant*; St. Martin's Press: Brighton, UK, 1983; pp. 28, 183.
90. van der Berg, J. A Peasant Form of Production: Wage-Dependent Agriculture in Southern Mozambique. *Can. J. Afr. Stud.* **1987**, *21*, 375–389.
91. De Vletter, F. Migration and development in Mozambique: Poverty, inequality and survival. *Dev. S. Afr.* **2006**, *24*, 137–153.
92. Mercandalli, S.; Anseeuw, W. Migration and resilience of rural households' livelihoods in the face of changing political and economic contexts: The case of South Mozambique (1900–2010). *Afr. Stud.* **2017**, *76*, 221–242.
93. Mercandalli, S. L'agriculture dans le sud du Mozambique une activité fondée sur les migrations de travail. In *Diversité des Agricultures Familiales de Par de Monde: Exister se Transformer, Devenir*; Bosc, P.M., Sourisseau, J.M., Eds.; Quae: Versailles, France, 2015; pp. 127–142.
94. Cunguara, B.; Langyintuo, A.; Darnhofer, I. The role of nonfarm income in coping with the effects of drought in southern Mozambique. *Agric. Econ.* **2011**, *42*, 701–713.
95. Milgroom, J.; Ribot, J. Children of another Land: Social Disarticulation, Access to Natural Resources and the Reconfiguration of Authority in Post Resettlement. *Soc. Nat. Res.* **2020**, *33*, 184–204.
96. Ekblom, A.; Notelid, M.; Witter, R. Negotiating identity and heritage through authorised vernacular history, Limpopo National Park. *J. Soc. Archaeol.* **2017**, *7*, 49–68.
97. Anonymous Local Businessman, 1 July, Personal Communication, Massingir, Mozambique, 2016.
98. Anonymous Bank Official, BCI Bank, 1 December, Personal Communication, Massingir, Mozambique, 2013.
99. Anonymous Game Ranger, Limpopo National Park. (Massingir, Mozambique). Personal communication, 20 December 2019.
100. Rocha, A.; Starkey, P.; Dionisio, A.C. Cattle production and utilisation in smallholder farming systems in southern Mozambique. *Agric. Syst.* **1991**, *37*, 55–75.
101. Maciel, S. National Strategies for the Conservation: Improvement and Utilisation of Animal Genetic Resources in Smallholder Systems in Mozambique. 2000. Available online: https://www.ilri.org/InfoServ/Webpub/fulldocs/AnGenResCD/docs/SouthAfrican_AARNET/natmoza.htm (accessed on 16 June 2016).
102. Comaroff, J.L.; Comaroff, J. Goodly Beasts, Beastly Goods: Cattle and Commodities in a South African Context. *Am. Ethnol.* **1990**, *17*, 195–216.
103. White, H. The Materiality of Marriage Payments. *Anthropol. S. Afr.* **2017**, *40*, 297–308.
104. Hoag, C. The Ovicaprine mystique: Livestock commodification in postindustrial Lesotho. *Am. Anthropol.* **2018**, *120*, 725–737.
105. Steele, M.C. The economic function of African-owned cattle in colonial Zimbabwe. *Zambezia* **1981**, *9*, 29–48.
106. Mtswetwa, R.M.G. Myth or reality: The 'cattle complex' in South East Africa, with special reference to Rhodesia. *Zambesia* **1987**, *6*, 23–35.
107. All Africa. Mozambique: 100 Cattle Die in Drought Stricken Mabalane. All Africa. 2016. Available online: <http://allafrica.com/stories/201601120121.html> (accessed on 20 March 2016).
108. Peaceparks. Herding 4 Health. Available online: <https://www.peaceparks.org/h4h/> (accessed on 20 December 2020).

-
109. Massé, F. Securing Conservation: The Politics of Anti-Poaching and Conservation Law Enforcement in Mozambique. Ph.D. Thesis, York University, Toronto, ON, Canada, 2017; p. 67.
 110. Anonymous Game Ranger. (Limpopo National Park, Massingir, Mozambique), Personal communication, 2 August 2016.
 111. Rodrigues, M. (Chicumbane Agricultural Association, Chicumbane, Mozambique). Personal communication, 2 July 2015.
 112. Jeannette, V.; Notenbaert, A.; Moyo, S.; Herrero, M. Household livelihood strategies and livestock benefits dependence in Gaza province of Mozambique. *Afr. J. Agric. Res.* **2011**, *6*, 560–572.