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# Analyzing the sustainability of the environmental and socio-economic externalities of the Limpopo National Park (Mozambique) since its institution

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The institutionalization of the Limpopo National Park (LNP) presented a significant challenge in balancing environmental conservation goals with the needs of local communities. As a component of the Great Limpopo Transfrontier Park (GLTP), the LNP has benefited from collaborative initiatives between Mozambique, South Africa, and Zimbabwe, which have facilitated access to financial and technical resources for the rehabilitation of wildlife populations. Specifically, as several communities remain partially or entirely unsettled, conflicts between humans and wildlife have intensified, with negative implications for both agricultural crop production and livestock management. Nevertheless, the strategies implemented have achieved significant success in preserving biodiversity by facilitating the free movement of wildlife and reducing commercial poaching. In this context, our review aimed primarily to critically analyze the phases related to both the creation and the evolution of the LNP, also considering the relevant role of local traditional practices in defining its management strategy. Secondly, we proposed a strategy that, while imposing restrictions on land use, also incorporates traditional techniques to repel wildlife and reduce habitat fragmentation, potentially contributing to the decrease of interactions between humans and wildlife. Our results highlight the need for a management strategy for the LNP that, unlike the current one, better harmonizes ecosystem protection actions with the basic needs and practices of local communities. In fact, even with the legal limitations in place, many families

living within the park continue to rely primarily on subsistence agriculture, which, in the long term, may further exacerbate the reduction of forest cover. Thus, our findings can provide essential subsidies to more effectively guide the future management of the LNP, ensuring the long-term coexistence of wildlife protection initiatives with the socio-economic resilience of local

KEYWORDS

**recovery, wildlife, local communities, resettlement, institutionalization, conservation**

## 1 Introduction

Protected areas have historically reflected a tension between conservation imperatives and local livelihoods, particularly in post-colonial regions. The establishment of Yellowstone National Park in 1872 in the United States, widely regarded as the world's first national park formally designated for nature protection and public pleasure (Yonk and Lofthouse, 2020). The expansion of protected areas in the 19th century across North America, Australia, Europe, and Africa frequently involved the expropriation of land from local communities residing within wildlife habitats (Watson et al., 2014; Lunstrum and Ybarra, 2018). In many developing countries, particularly across the Africa continent, protected areas often encompass vast territories, thereby requiring substantial management resources to ensure their effective administration. This administrative burden is frequently compounded by the risk of land expropriation form local communities raises concerns about social justice and equitable governance (Scherl et al., 2006). In the Southern Africa region, including countries such as South Africa, Namibia, Botswana, Zambia, Zimbabwe, and Mozambique, the management of the rich biodiversity within protected areas increasingly relies on multi-stakeholder governance systems. The systems bring together governmental institutions (which also oversee land designation and, in certain cases, expropriation), non-governmental organizations, private sector partners, and local communities (IUCN, 2021).

As part of its commitment to biodiversity conservation and sustainable land management, the Mozambique government has designed 25% of its territory (equivalent to 18.57 million hectares) as conservation areas. This portion of Mozambican national territory includes 7 national parks, 9 national reserves, 20 hunting areas (*Coutadas*), 50 wild game farms, and 3 community conservation areas (ANAC, 2015). In particular, in the southern region of Mozambique, at the tri-border area with South Africa and Zimbabwe, a former hunting concession established in 1969, known as "*Coutada 16*", was official declared Limpopo National Park (LNP) on November 27, 2001 (Boletim da República, 2001; Mavhunga and Spierenburg, 2009; Hoogendoorn and Kelso, 2019; Milgroom and Claeys, 2025). The transition was accompanied by a series of legal and administrative mandates that required the resettlement of local communities living within the newly established park boundaries (Lunstrum and Ybarra, 2018). These resettlement mandates, essential to the park's establishment, fundamentally altered the relationship between local communities and their environment, introducing new restrictions, opportunities, and challenges in resource access and land use (Witter, 2013; Witter and Satterfield, 2019).

As a direct consequence, the institutionalization of the LNP directly affected the resource utilization patterns of local communities that depended on the forest for their subsistence (Witter, 2021; Otsuki, 2023). Therefore, the Mozambican government allowed the occupation of the 2326 km² buffer zone, including the practice of agriculture, livestock farming, and the use of the forest for domestic consumption (Notelid and Ekblom, 2021). The same government restricted all forms of hunting (Givá and Raitio, 2017), aiming to conserve biodiversity, safeguarding the well-being and satisfaction of local communities (Vitale et al., 2022). The complex process of resettlement led to a delay in relocating the villages to the buffer zone, which exacerbated the socioeconomic vulnerability of the families involved. These families faced limited access to infrastructure and insufficient means of livelihood (Witter and Satterfield, 2019; Milgroom and Claeys, 2025). This type of socio-environmental conflict, resulting from the discord between conservation objectives and the socioeconomic requirements of local residents, is often seen in protected areas globally (Witter and Satterfield, 2019; Manhiça et al., 2020; Notelid and Ekblom, 2021; Virtanen et al., 2021).

The global wildlife population has declined due to factors such as over-logging, habitat loss, and environmental pollution (Briggs, 2017). This is particularly evident in southern Africa, including areas adjacent to the LNP, where similar socio-political dynamics have been documented (Spierenburg et al., 2008; Martini et al., 2016; Musakwa et al., 2020). Mozambique is experiencing similar issues, where biodiversity loss and ecosystem degradation stem from various human activities, including agricultural production, mining, deforestation, urbanization, livestock grazing, and wildfires (Sitoe. et al., 2012; CEAGRE, 2016; Joaquim-Meque et al., 2023; Bacar and Faque, 2024). As reported by CEAGRE (2016), shifting

**Abbreviations:** GLTP, Greater Limpopo Transfrontier Park; KfW, Kreditanstalt für Wiederaufbau; KNP, Kruger National Park; LNP, Limpopo National Park; PPF, Peace Parks Foundation.

agriculture accounts for 65% of forest area decline, followed by agricultural expansion at 12% and the exploitation of forest products at 8%. Poaching and insufficient implementation of conservation legislation are problems that threaten biodiversity preservation (Ngwenya, 2024).

In Mozambique, both the local and central governments place significant emphasis on biodiversity conservation and the legal establishment of protected areas (ANAC, 2015; CEAGRE, 2016). However, there is still a limited understanding of how institutional processes have influenced the development and effectiveness of the LNP. In particular, this refer to institutional process related to the resettlement of local communities and the regulation of land access and use within the LNP (Watson et al., 2014; Lunstrum and Ybarra, 2018). To our knowledge and as also reported by (Witter, 2021) and (Otsuki, 2023), previous studies have frequently examined either the ecological effects or the social ramifications of displacements without considering a comprehensive analysis of the institutional stages, participatory processes, and obstacles in the sustained governmental oversight of the LNP (Witter and Satterfield, 2019; Milgroom and Claeys, 2025). This approach seeks to enhance the understanding of conservation governance in Southern Africa, by supporting the development of integrated conservation policies that balance ecological priorities with the rights and needs of local communities (Givá and Raitio, 2017; Virtanen et al., 2021). Accordingly, this review pursues the following objectives: (1) to retrace the main stages in the institutional development of LNP, based on the existing legal frameworks, policy documents and academic literature; (2) to examine how local communities have been affected by and involved park's governance processes, with particular attention to land use and access to natural resources; (3) to critically review the documented challenges linked to community resettlement within LNP, especially those concerning the livelihoods.

# 2 Methodology

## 2.1 Study area description

The LNP is a conservation area within the Gaza province of Mozambique. The area established for the conservation of forest and wildlife resources encompasses 1,123,316 Ha (11,233.16 km²) (Sappa et al., 2023) which is slightly larger than the state of Jamaica, more than four times the size of Luxembourg, and nearly twice the size of Brunei (United Nations, 2024). Three districts were part of this area, with the largest extension being in the district of Chicualacuala (6400 km²), followed by Massingir (2100 km²) and Mabalane (1500 km²) (Bruna, 2019). Currently, the park is covered by four districts, including Mapai, which was elevated to district status in 2016; it was previously an Administrative Post that belonged to the district of Chicualacuala (Boletim da República, 2016). The LNP is surrounded by a buffer zone, which according to UNESCO is an area that ensures complementary protection of natural heritage (Vitale et al., 2022). The LNP is located within the GLTP (or Peace Park), adjacent to the Kruger National Park (KNP) in South Africa and the Gonarezhou National Park in Zimbabwe (Figure 1). The climate of the region is semi-arid with two seasons, the hot and rainy months (November to April) and the dry and cool months (May to October) (Roque et al., 2022). The average annual temperature ranges from 24°C to 30°C (Mapaco et al., 2022; Roque et al., 2021). Data from the district headquarters of Massingir, where LNP is located, indicate an average annual precipitation variation of 500 mm in the southern part, near the Massingir dam, and less than 450 mm in Pafuri, in the north (Stalmans et al., 2004; Milgroom and Giller, 2013; Mapaco et al., 2022). In this region, the soils are clayey, alluvial-derived, and deep, with a sedimentary origin; they have a limited organic matter content (SOC < 2%) (Stalmans et al., 2004; Cambule et al., 2015). The predominant vegetation in LNP is Mopane (*Colophospermum mopane* Kirk ex J. Leonard) characteristic of the Sudan-Zambezi region, Silver Terminalia (*Terminalia sericea* Burch. Ex DC: Silver Cluster-leaf), and Red bush willow (*Combretum apiculatum* Sond.) in higher regions (Cambule et al., 2015).

## 2.2 Narrative review design and thematic framework

A narrative review methodology was employed to analyzed the socio-environmental development of the LNP from its establishment to the present. This qualitative approach was selected for its capacity to synthesize interdisciplinary knowledge across conservation science ecology, and institutional governance, especially in contexts where empirical studies are limited (Elias et al., 2012; Ferrari, 2015; Greenhalgh et al., 2018).

The review was conducted between May 2023 and June 2025 and focused on peer-reviewed literature, technical reports, and official institutional publications. The review followed a three-phase selection process and was structured around five themes: conservation, resettlement, institutions, governance, and human-wildlife interactions, reflecting a multidisciplinary approach. The selection process followed predefined inclusion and exclusion criteria to ensure methodological transparency and thematic relevance. Priority was given to studies published between 2015 and 2025, reflecting recent policy reforms and socioecological transformations affecting the LNP. Earlier publications were included only if they provided essential historical background or ecological baselines. The initial screening targeted studies explicitly addressing LNP. Subsequently, publications concerning other areas of the GLTP were considered only if they presented site-specific data, governance frameworks, or ecological analyses directly applicable to LNP (Gough et al., 2017). This selective inclusion strategy minimized contextual drift and ensured thematic coherence (Grant and Booth, 2009).

Bibliographic searches were conducted using the software Publish or Perish (Harzing, 2024, Version 8.2.3946, Australia), which aggregates content from Scopus, Web of Science, Google Scholar, and JSTOR. References were excluded if they lacked peer review, methodological rigor, or relevance to the LNP's socio-institutional context. Conceptual works that did not include original data or structured analysis were also excluded.


FIGURE 1
The map illustrates the three park areas, which compose the Gran Limpopo Transfrontier Park.

## 3 Development and cross-border ecological connectivity in Limpopo National Park

The GLTP, encompassing approximately 37,572 km², was established to reconnect fragmented conservation areas and restore ecological corridors across national borders (Williams et al., 2016: Roque et al., 2022). Both the Kruger National Park (KNP) in South Africa and the Limpopo National Park (LNP) in Mozambique are integral components of the GLTP. The origins of KNP date back to the early 20th century, with the proclamation of the Sabi Game Reserve and the Singwitsi Game Reserve in 1902 (Friman and Fernández, 2010). These reserves were later consolidated, and on May 31, 1926, the area was formally designated as Kruger National Park, covering 19,485 km² (Van Wilgen and Biggs, 2011; Swemmer et al., 2017). In 2000, the KNP was already under pressure to extend its area, as the decline in the African elephant (*Loxodonta africana*, J.F. Blumenbach) population due to resource scarcity (water and food) was imminent. The African elephant population reached 9,152, and had already exceeded the carrying capacity, estimated at 7,000 animals (Medeiros, 2017). After the 16-year civil war that culminated in the peace agreements signed in 1992, the Global Environmental Facility, through the international final institution "World Bank", financed more in-depth feasibility studies for the project to link transboundary conservation areas and found that it would be a great opportunity for Mozambique to recover from the ecological destruction caused by the war (Abeling, 2011; Lunstrum, 2013; Silva et al., 2018). In this context, the three countries (Mozambique, South Africa, and Zimbabwe) proceeded with the process of celebrating the agreements for the establishment of the GLTP, signed on November 10, 2000 (Spenceley, 2006; Guerreiro et al., 2010; Bazin et al., 2016). With the elevation of the status of *Coutada* to Limpopo National Park, there was a need to integrate the Park into the transboundary conservation area, formalized with the signing of agreements between the three countries in December 2002 (Milgroom and Spierenburg, 2008; Mavhunga and Spierenburg, 2009; Guerreiro et al., 2010; Abeling, 2011). The union of the three conservation areas (Mozambique, South Africa and Zimbabwe) was a gain for the member nations. After the apartheid regime in the Republic of South Africa, with the influence of the World Bank and Non-Governmental Organizations, agreements for the union of natural parks between African states emerged. Apartheid is a political and social regime of racial segregation that prevailed in South Africa from 1948 until the first democratic elections in 1994 (Gradín, 2019). The park development program began in 2001, with the signing of the memorandum between the Ministry of Tourism and the PPF and with funding from various donors (e.g, project Herding for Health, Fundação para a Conservação da Biodiversidade (Biofund), Kreditanstalt fur Wiederaufbau, MozBio) (Barbieri et al., 2019). This union conditioned the sustainability of natural resources (communities awaiting resettlement are only permitted to exploit

forest resources for subsistence (Gruber Sansolo and Ariza Cruz, 2018; Witter and Satterfield, 2019). The union of conservation areas is considered one of the rarest and most advanced projects in the world due to the cooperation of the countries and the trust that allowed the removal of the fence for the free movement of wildlife (Abeling, 2011). The integration of the renowned KNP, with its extensive experience in natural resource preservation since 1898, and the Gonarezhou National Park, created in 1975 (Gruber Sansolo and Ariza Cruz, 2018; Ntuli et al., 2021), has boosted the recovery of wildlife in the Limpopo park. The LNP was opened to the public in 2005 (Schoon, 2012).

# 4 Park development programs

## 4.1 Donor contribution

The development activities of the LNP began in 2001, with support from various donors, notably the World Bank, which led efforts to establish the National Administration of Conservation Areas (Bruna, 2022), an institution dedicated to the management of conservation areas in Mozambique, overseen by the Ministry of Land and Environment (Colua De Oliveira et al., 2021). The cooperation of international donors in providing technical and financial assistance aims to reduce the progression of ecosystem degradation (Abeling, 2011; Lindsey et al., 2021). The LNP's projects for development, alongside wildlife recovery and park institutionalization, have facilitated the legalization of the park committee and enhanced the livelihoods of buffer zone inhabitants through irrigated crop production programs (Figure 2).

The French Development Agency was the main donor of the LNP, financing the second phase with a budget of € 11.00 M, which focused on three key objectives (Bazin et al., 2016): a) restoring and conserving natural resources in the LNP with funding of € 1.70 M, with activities concentrated on tourism development, natural resource protection and monitoring, scientific research, and environmental management; b) improving the livelihoods and well-being of communities (€ 8.00 M); c) strengthening park management skills (€ 0.70 M). Between 2017 and 2020, the French Development Agency and the PPF provided funding of €0.82 million and €1.15 million, respectively, for enforcement actions against wildlife poaching (Governo de Moçambique, 2018). The German Development Bank, Kreditanstalt für Wiederaufbau (KfW), after the complete demining and support for administrative activities in the first phase (€ 6.10 million), took over the second phase with € 5.80 million allocated for the resettlement of communities that were in the central zone of the park (Ferreira, 2006; Borras et al., 2011; Bazin et al., 2016). The GLTP received financial support from KfW and the Peace Parks Foundation of South Africa, which took over the management of the LNP in collaboration with the Mozambican government (Colua De Oliveira et al., 2021). MozBio, a World Bank program to promote biodiversity conservation, allocated funding of US $ 1.70 M (€1.49 million, as average foreign exchange fluctuation in 2018) most of which was earmarked for the development of LNP infrastructures, with 55.9% allocated for bridge construction, 8.8% for tourist camps, and 35.3% for the program's operation (Governo de Moçambique, 2018). According to the same author, salary expenses are covered by the Government of Mozambique, with an annual expenditure of € 0.25 M, the World Bank, represented by the Biofund program, contributed US $ 0.38 M (€ 0.33 million, average foreign exchange fluctuation in 2018) for operational costs excluding salaries from 2017 to 2020, and the LNP has an annual revenue of € 0.08 million. Western countries France and Germany have allocated their funding to support developing countries as part of biodiversity preservation initiatives. These countries are interested in the potential of ecotourism (as it is globally beneficial) and park development, and through the German bank KfW, they financed the construction of access roads, campsites, and accommodations for tourists (Abeling, 2011).

## 4.2 Challenges in park management

The Mozambican government has interests in the LNP, based on the protection of biodiversity, the financial sustainability of the conservation area, and the enhancement of heritage to improve the living conditions of the local community (ANAC, 2021). However, government funding allocated to the LNP is insufficient to ensure its operation and the payment of salaries for all employees. Salary expenses borne by the Mozambican government cover only 47% of employees, while external funds cover 41% of contracted workers (Figure 3). The donors and the PPF have played a predominant role in strengthening the LNP. However, shared management brings implications due to the lack of clarity in decision-making competencies, making the processes bureaucratic (Baghai et al., 2018). Moreover, conservation initiatives follow the guidelines of the funders (Anyango-van Zwieten et al., 2019; Kachena and Spiegel, 2023), compromising institutional autonomy and accountability (Milgroom and Spierenburg, 2008; Ponte et al., 2021). However, research conducted in the LNP (Spierenburg et al., 2008) and in Tanzania (Ponte et al., 2021) pointed to the trend of loss of governmental power. Meanwhile, assistance to the LNP brings benefits to the Government of Mozambique as it helps strengthen the park's development projects to reinvent itself in the new national and transboundary management system (Lunstrum, 2013). It would be a significant challenge for the Government of Mozambique to assume the management of the LNP without the support of international donors and the South African NGO (PPF), given the country's ongoing political instability and the presence of terrorism in Cabo Delgado. We highlight that prolonged dependence on donors evidences the weakening of institutions and uncertainties about future sustainability (Muchapondwa and Stage, 2015; Anyango-van Zwieten et al., 2019; Dai and Chen, 2023), because many protected areas have deficient funding (Rodríguez-Darias and Díaz-Rodríguez, 2023). However, global assistance can be unpredictable. An explicit example is the unexpected end of USAID funding. This change was implemented by the President of the United States, Donald Trump, through Executive Order No. 14169, signed in Washington, D.C., on January 20, 2025 (Federal Register, 2025). This decision affected Mozambique and other African nations (EATG, 2025). In light of this, the LNP must identify alternative strategies for autonomous and self-sustaining financing. In addition to traditional resources, private

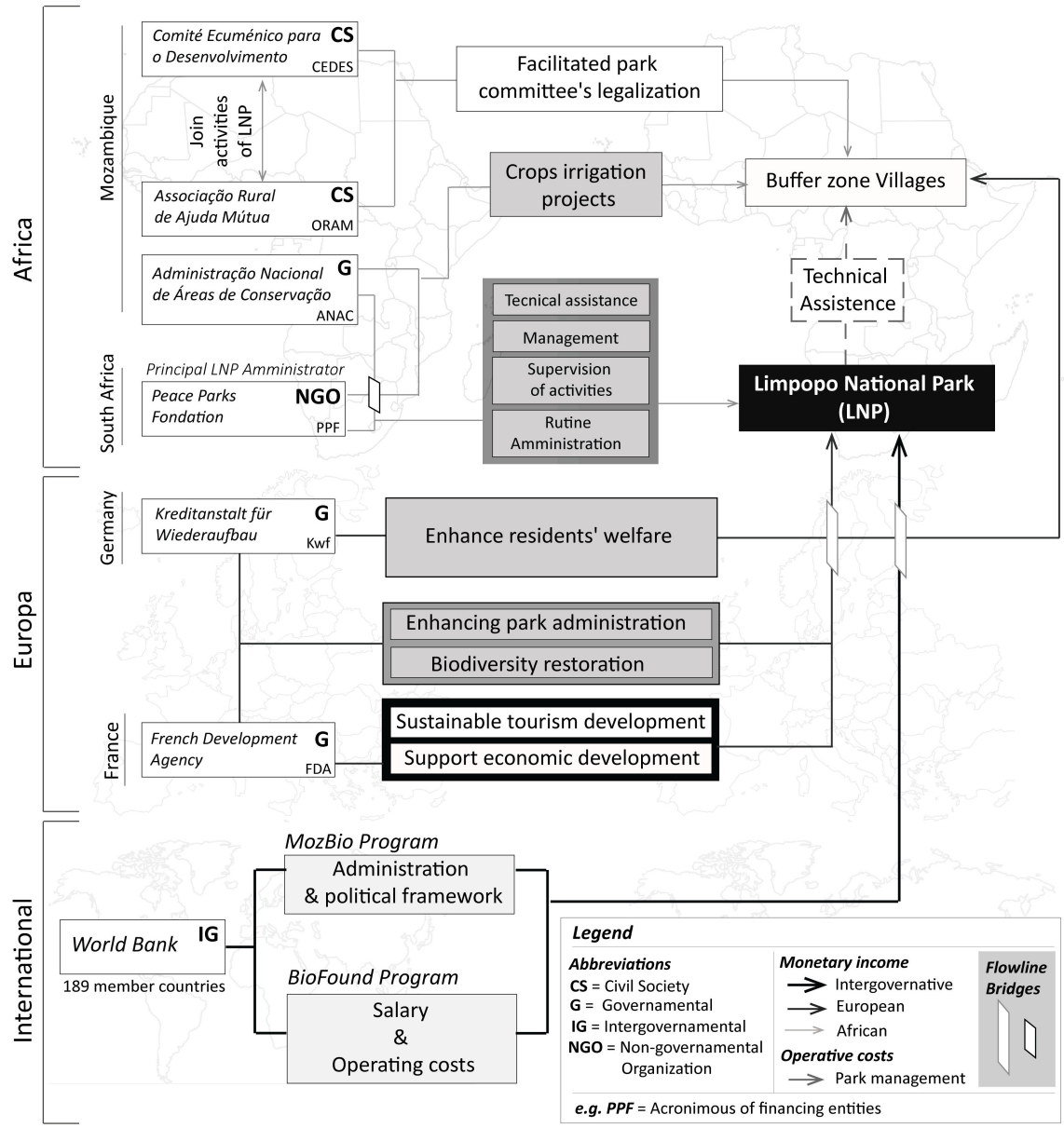


FIGURE 2
Actions developed by projects in the LNP and in the villages in the buffer zone.

and public sources, incentives for ecosystem services, and biodiversity credits (Bakarr, 2023; Den Heijer and Coppens, 2023), these models are vital for sustaining conservation policies (Bakarr, 2023; Dai and Chen, 2023; Den Heijer and Coppens, 2023).

# 5 Dynamics of the park population – resettlement process

## 5.1 Livelihoods and challenges

The Mozambican civil war, from 1976 to 1992, allowed many households residing within the park and the buffer zone to migrate to neighboring countries, South Africa and Zimbabwe, in search of safety. During this period, until the proclamation of the park, the wildlife population was decimated, the area was abandoned, poaching intensified, and there was no law enforcement (Lunstrum, 2016; Massé, 2016; Strong, 2019). Meanwhile, there was a border separating the LNP from the KNP (Lunstrum, 2016). In 1994 and 1995, some families joined the repatriation process to their areas of origin (Connor, 2003). In 2001, when the park was proclaimed, about 7,000 people lived within the boundaries of the conservation area, along the Shingwedzi River (Spierenburg et al., 2008). In 2021, nearly 1380 families lived within the boundaries of the LNP in 4 villages (ANAC, 2021). Approximately 22,750 people resided in the buffer zone in 2016, dispersed across 51 villages along the banks of the Limpopo, African elephants, and Schingwedzi rivers (Bazin et al., 2016; Milgroom and Spierenburg, 2008). Before the creation of the park, the subsistence of

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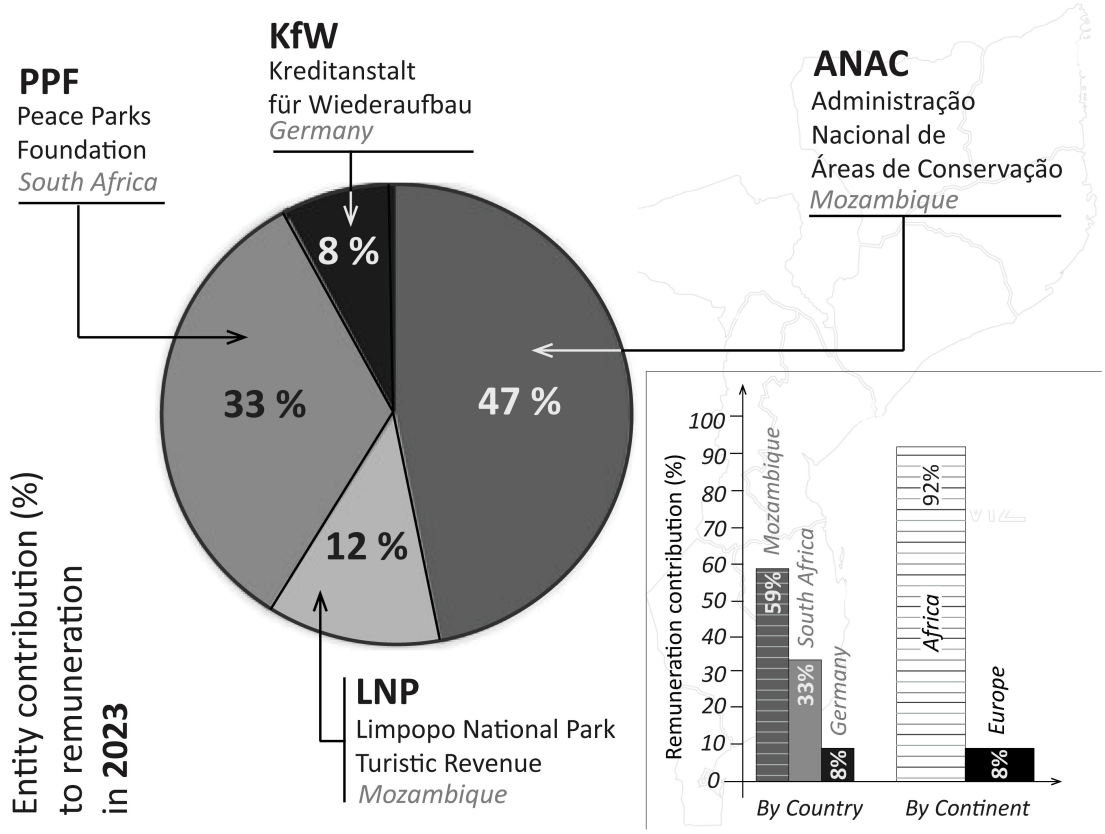


FIGURE 3
Proportion of personnel employed in Limpopo National Park (LNP) in 2023 (ANAC, 2023), classified by entity (Pie Charts), nation, and continent (Histogram).

these communities, as well as that of the buffer zone, was primarily related to the practice of agriculture, fishing, hunting, and cattle ranching (Lunstrum and Ybarra, 2018; Witter, 2021; Otsuki, 2023). Rainfed agriculture, developed on the fertile lands along the riverbanks, is the main food sustenance activity for families, while cattle ranching is considered a cultural practice and a source of wealth (Macandza and Ruiz, 2012). In these regions, few employment opportunities or sources of income generation have been observed, forcing many young men to move to Maputo or South Africa in search of work to support their families (Notelid and Ekblom, 2021; Zaffarano et al., 2023). Within the park and in the buffer zone, the villages are separated by distances ranging from 5 to 30 km, and each of them covers a community radius of 4 km, consisting of housing, cultivated fields, and pastures for cattle (Cook et al., 2015). The communities located within the park do not have access to public services, markets, electricity, and have a poor or non-existent mobile phone network in some areas, with degraded dirt roads that are impassable during the rainy season (Notelid and Ekblom, 2021).

## 5.2 Resettlement and social impacts of Limpopo National Park creation

The recognition of the social impact of the displacement of families from protected areas, which began in the 1970s, is considered an ecological concern, as well as a concern of governments, regarding the conservation of natural resources (Adams and Hutton, 2007; Massé, 2016). The LNP was granted a high category in the International Union for Conservation of Nature classification for protected areas. According to the law that regulates conservation areas, humans are not allowed to coexist in the same space with wildlife (Milgroom and Spierenburg, 2008). The government's primary concern at that time was to recover the wildlife devastated during the Mozambican civil war, without any participation from the communities located within the park boundaries and the buffer zone (Spierenburg et al., 2008; Strong, 2019). The establishment of the LNP and the reintroduction of wildlife made it necessary to relocate the inhabitants who were in eight villages along the Shingwedzi River (Milgroom and Spierenburg, 2008). Initially, a process of voluntary family relocation was proposed, contrary to the World Bank's principles; however, over time, the communities experienced the repercussions of forced relocation, particularly following the enactment of laws prohibiting hunting and unrestricted access to resources for commercial purposes (Milgroom and Spierenburg, 2008; Massé, 2016; Hübschle, 2017a).

Witter (2021) states that during the community consultation process, the park managers informed the communities that restrictions on resource use would be applied after resettlement; however, they prohibited the hunting of large animals while

allowing subsistence farming, gathering of fruits, roots, construction materials, firewood, and fishing. The establishment of the park created a climate of revolt among local communities, which led to opposition to the allocation of concession areas for tourism resorts (Abeling, 2011).

## 5.3 Historical displacements and resettlement resistance in park

In the act of negotiating the resettlement with the residents, only two communities (Nanguene and Macavene) agreed to join the process, and the remaining LNP residents refused (Ekblom et al., 2017). The transformation of the "*Coutada 16*" into LNP generated a sense of outrage in the communities, as they had experienced several episodes of displacement over time. The construction of the dam in 1977 allowed for the relocation of a community to Mavodze (Bruna, 2022). The first wave of displacement began with the formation of concentrated communal villages during the post-independence socialist regime in the 1980s, intending to facilitate the allocation of public services, communication, and improved housing (Maloa and Maloa, 2024). The second wave of village abandonment occurred during the Mozambican civil war from 1976 to 1992, and the third was marked by floods in the Elephants River in 2000 (Lunstrum, 2010; Milgroom and Ribot, 2020; Otsuki, 2021). The displacement of communities breaks the bond between the person and the place, destroys a history built over generations, and affects sociocultural identity (Lunstrum, 2016; Strong, 2019). Moreover, the vulnerability of families increases because in resettlement areas there are limitations of space for agriculture and livestock (Borras et al., 2011; Bruna, 2019; Massé, 2016), which affects the socioeconomic conditions of these families.

## 5.4 Wildlife reintroduction and resettlement challenges in LNP

The reintroduction of wildlife in the park made a significant contribution to the restoration of fauna, but it also led to an increase in human-wildlife conflict situations. Wildlife interferes with the livelihoods of communities, resulting in economic losses caused by the destruction of crops and predation of livestock (Massé, 2016; Strong, 2019; Notelid and Ekblom, 2021). Similar occurrences were evidenced in the Selous Game Reserve (Tanzania) (Gayo et al., 2021), in the Makgadikgadi-Pans National Park (Botswana) (Feldmeier et al., 2024), and in the Aberdare National Park (Kenya) (Morang'a et al., 2023), where wildlife recovery intensified community tensions. To minimize the tension between the community and the park, conservation area managers persuaded the communities along the Shingwedzi River to withdraw from the ecological corridor (Otsuki, 2023). In 2011, the South African government pressured the Mozambican government to expedite the resettlement process of communities located within the conservation area, in response to the increase in poaching cases (Notelid and Ekblom, 2021). The high incidence of wildlife poachers and the collaboration of some members of households residing in the LNP allowed the German Development Bank, KfW, the founder of the resettlement program, to change its approach to an involuntary transfer of communities, following the international standard set by the World Bank (Bazin et al., 2016; Milgroom and Ribot, 2020; Otsuki, 2021). Involuntary resettlement is accompanied by community consultations, fair compensation for assets, physical infrastructure, and housing, as established by the parties (Otsuki, 2023). Hübschle, (2017a) states that some communities adhered to the transfer process because external pressure affected their livelihoods, but the procedure was very slow and marked by conflicts between the LNP and the residents.

## 5.5 Land allocation and resettlement challenges in Massingir

In 2009, the government of Mozambique granted ProCana 30,000 hectares of land intended for the resettlement of the park's residents, but the project did not progress due to the financial crisis (Borras et al., 2011). However, the state revoked the land use rights and allocated the same area to another investor, Massingir Agro-Industrial, who also did not comply with the business plan (Bruna, 2022). Despite the failures of previous projects, the government began to divide the land, as in the case of the 500 ha concession granted to Verdant Citrus Massingir (Verdant Orchards, 2024). The government identified other areas for resettlement. The government of the Massingir district has been facing land pressure since the 2000s (Otsuki, 2023), and there have been frequent cases where biodiversity conservation involves the relocation of families, necessitating the assurance of fair compensation, with guarantees of viable options to improve the quality of life for the resettled (Karanth, 2007). In the LNP resettlement, families received brick houses, a one-hectare agricultural plot, agricultural supplies, financial compensation, support for livestock transport, and financial assistance for adaptation (Milgroom and Ribot, 2020). With the reintroduction and rapid restoration of wildlife, the park has become an unsafe place due to human-wildlife conflict, requiring the Government to expedite the resettlement process of communities to safe zones (Witter, 2013; Strong, 2019).

The resettlement process in the LNP began in 2003, and in 2008 the first community (Nanguene) was transferred (Milgroom and Ribot, 2020; Otsuki, 2023). Out of the eight settlements depicted in Figure 4 within the protected area, 5 have been relocated (Otsuki, 2021). The 31 households of Makandazulo A relocated between 2003 and 2010 on their own initiative due to human-wildlife conflicts and were also included in the compensation packages offered as part of the process (Witter and Satterfield, 2019).

## 5.6 Human-wildlife conflict and ecosystem degradation in LNP

The lengthy resettlement process in the LNP incurs high costs due to population growth, the prevalence of polygamy, and early marriages, all of which intensify conflicts between humans and

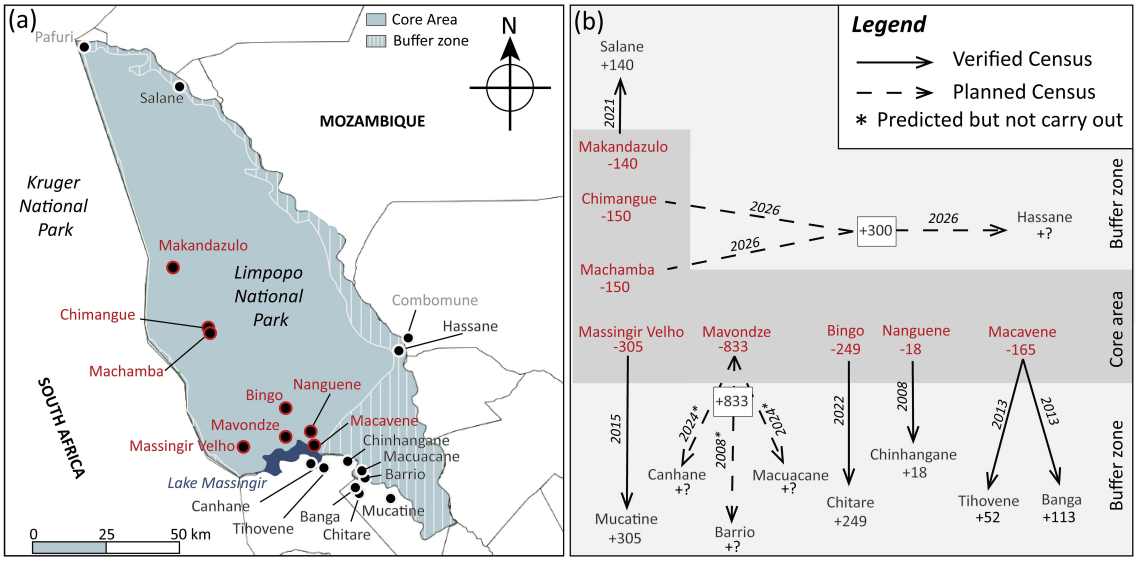


FIGURE 4
Map illustrating the origin and destination of emigrated families within the Limpopo National Park **(a)**, as reported by ANAC (2021); Bruna (2022); Milgroom and Claeys (2025); and the distribution of emigration by the number of families relocated and the year of the corresponding census **(b)**.

wildlife (Milgroom and Spierenburg, 2008; Mammides, 2020; Otsuki, 2023). Around 72% of the families interviewed in the LNP reported a decrease in agricultural production due to the incursion of African elephants into their fields and livestock losses caused by lion predation (Notelid and Ekblom, 2021). Although the census data from 2006 to 2014 do not provide information on carnivores, they indicate an increase in the herbivore population (Table 1). In contrast, the African elephant's population declined between 2010 and 2014, probable due to poaching. It is believed that this megafaunal mammalian species has since increased in the park following a substantial decrease in wildlife hunting. However, between 2012 and 2017, there was a notable decline in lion populations, attributed to fatalities from poisoning, and traps set by park inhabitants in retribution for livestock predation (Everatt et al., 2019).

The tense climate experienced in the LNP is not an isolated case; similar conflicts between conservation units and communities have been reported across the country as well as in other African countries. The example of Maputo National Park and Chimanimani National Park shows that African elephants cause human fatalities and destruction of crops (Manhiça et al., 2020; Virtanen et al., 2021). Studies conducted in Narok County, Kenya (Mukeka et al., 2019), the Cape Province, South Africa (Viollaz et al., 2021), the Central Rift Valley, Ethiopia (Temesgen et al., 2022), and the Selous Reserve, Tanzania (Gayo et al., 2021), have reported retaliatory actions against wildlife as a response to human-wildlife conflict.

In Makgadikgadi-Pans National Park (Botswana), carnivores are responsible for livestock losses on properties, and the legislation allows the culling of predators found in these areas (Feldmeier et al., 2024). According to Morang'a et al. (2023), in Aberdare National Park (Kenya), an electric fence was constructed to protect buffer zone communities from wildlife attacks, in response to the intensity of poaching, resource exploitation, and human-wildlife conflict. The destruction of crops by African elephants, combined with the lack of alternative livelihood options, can have detrimental consequences for conservation efforts. The LNP recorded a reduction in poaching and an increase in subsistence hunting (Notelid and Ekblom, 2021; Ntuli et al., 2021). Similar trends have been documented in other regions of Africa, such as Alitash National Park in Ethiopia (Ayalew and Melese, 2025) and Kakum Conservation Area in Ghana (Galley and Anthony, 2024), where hunting has increased as a compensatory response to crop loss. In this region, evidence suggests diversification of livelihoods and community participation in management (Viollaz et al., 2021; Gebo et al., 2022a; Temesgen et al., 2022).

Studies have shown that aligning conservation efforts with the needs of local communities is essential (Bencin et al., 2016; Gatiso et al., 2022). The Kavango-Zambezi Transfrontier Park in Namibia serves as a successful example of coexistence between wildlife and the communities, involving the zoning of agricultural and livestock areas, community conservation areas, and habitat connectivity (Meyer and Börner, 2022). These actions, combined with the knowledge, practices, and attitudes of the residents, are crucial for enabling humans and wildlife coexistence (Bencin et al., 2016; Gebo et al., 2022b; Meyer and Börner, 2022), and presuppose collaboration and trust between the parties (Nkansah-Dwamena, 2023).

In the Save Valley Conservancy in Zimbabwe, traditional ecological knowledge has been highlighted in the management of the conservation area (Dhliwayo et al., 2023). In the conservation areas of King Nehale, Nyae Nyae, and EhiRovipuka in Namibia, the use of predator-proof fences has promoted a balance between conservation goals and socioeconomic needs (Gargallo, 2021).

The Kavango-Zambezi Transfrontier model could be adapted to the LNP, as it has been implemented in a similar ecological and socioeconomic context, where communities depend on agriculture

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TABLE 1 Number of estimated individuals of herbivores and carnivores in the LNP.

| Name | Species | Number of animals | | | | | References |
|---|---|---|---|---|---|---|---|
| | | 2007 | 2010 | 2012 | 2014 | 2017 | |
| Buffalo | *Syncerus caffer*, Sparman | 189 | 1035 | | 1339 | | [4]; [5]; [6] |
| Bushbuck | *Tragelaphus scriptus*, Pallas | 2 | 21 | | 9 | | [4]; [5]; [6] |
| Elephant | *Loxodonta africana*, J.F. Blumenbach | 297 | 1425 | | 1081 | | [4]; [5]; [6] |
| Giraffe | *Giraffa camelopardalis*, L. | 11 | 116 | | 71 | | [4]; [5]; [6] |
| Hippo | *Hippopotamus amphibius*, L. | | 9 | | 57 | | [4]; [7] |
| Hyena | *Crocuta crocuta*, Erxleben | | | 105 | | 100 | [3] |
| Impala | *Aepyceros melampus*, Lichtenstein | 143 | 354 | | 1126 | | [4]; [5]; [6] |
| Kudu | *Tragelaphus strepsiceros*, Pallas | 183 | 628 | | 1468 | | [4]; [5]; [6] |
| Leopard | *Pantherapardus*, L. | | | 3 | | | [7] |
| Lion | *Panthera leo*, L. | | | 66[a] | | 22[a] | [2]; [3] |
| Nyala | *Tragelaphus angasii*, Angas | 215 | 913 | | 1394 | | [4]; [5]; [6] |
| Sheetah | *Acinonyx jubatus*, Schreber | | | 17 | | | [1] |
| Warthog | *Phacochoerus aethopicus*, Pallas | 1 | 149 | | 24 | | [4]; [5]; [6] |
| Waterbuck | *Kobus ellipsiprymnus*, Ogilby | 44 | 42 | | 271 | | [4]; [5]; [6] |
| Wildebeest | *Connochaetes taurinus*, Burchell | 66 | 312 | | 247 | | [4]; [5]; [6] |
| Zebra | *Equus quagga*, P. Boddaert | 194 | 494 | | 394 | | [4]; [5]; [6] |

The "a" letter in superscript is a real count. [1];[2]; [3];[4];[5];[6];[7] are the (Andresen et al., 2012; Everatt et al., 2014, 2019; Grossmann et al., 2014; Swanepoel, 2007; Stephenson, 2010, 2013), respectively.

and livestock. Its effectiveness could be further enhanced by incorporating traditional practices present in the model applied at the Ranthambore Reserve. We recommended conducting in-depth studies on the application of such models to support sustainable humans and wildlife in the LNP.

The other key pressure factor identified in the park, with direct implications for the biodiversity loss, is the practice of dryland farming. Agricultural expansion exacerbates habitat degradation, undermining ecological connectivity and long-term sustainability in the park (Seoraj-Pillai and Pillay, 2016; Yuan et al., 2024).

In this context, reducing land use by communities requires both financial investment and training to diversify livelihood strategies. Research has suggested promoting self-regulated community initiatives through ecotourism projects, handicrafts, wild fruit commercialization, and beekeeping (Kachena and Spiegel, 2023). However, the prolonged occupation of families within the park may complicate the resettlement process, leading to claims for agricultural and pasture areas. In the Movonze community, land and irrigation claims were observed during the waiting period prior to resettlement (Otsuki, 2023). The Satpura Tiger Reserve in India offers a comparable an example of prolonged resettlement, with inhabitants continuing to claim land after relocation (Sarma and Barpujari, 2023). Similary, in the KNP, despite the resettlement process have concluded years ago, land claims persist (Ramutsindela and Shabangu, 2013; South African National Parks, 2021).

## 5.7 Initiatives and challenges in mitigating human-wildlife conflict

Several initiatives have been undertaken to alleviate the human-wildlife conflict affecting local communities. In 2013, a 56 km long fence was built to separate the wildlife movement zone from rural settlements, to prevent the destruction of crop fields and livestock (Bazin et al., 2016; Givá and Raitio, 2017). In the buffer zone, a survey conducted in 2012 to assessed the feasibility of establishing six ecological corridors within the LNP (Macandza and Ruiz, 2012). However, the concept of these corridors lacks robust scientific support, relying primarily on historical wildlife movement data and missing modern research evaluating their effectiveness (Roque et al., 2022).

Human-wildlife conflicts persist in the park, and some families already feel threatened, leading them to abandon the park. Some parts of the fence (56km) protecting the settlements in the LNP were destroyed to allow wildlife access to ecological corridors, which contributed to the increase in human-wildlife conflicts. The relocation of communities from within the park is a solution to alleviate the families, but the conflict will intensify in the buffer zone. In the Abedade National Park (Kenya), an electric fence was built to delimit the conservation area, and some benefits were achieved, such as combating poaching, halting resource exploitation, and reducing human-wildlife conflicts, because some wild animals can cross the fence (Morang'a et al., 2023).

# 6 Restoration of wildlife and enforcement actions

## 6.1 Wildlife restoration and transboundary conservation in LNP

The management plan applied in the LNP allowed for the restoration of wildlife populations, including the five major tourist-attracting species: African elephants, rhinoceroses (*Diceros bicornis*, L.), buffaloes (*Syncerus caffer*, Sparman), lions (*Panthera leo*, L.), and leopards (*Panthera pardus*, L.), which had been decimated during the Mozambican civil war (Lunstrum, 2010; Ntuli et al., 2019). The large wildlife, such as African elephants, require vast areas to move around in search of food (Ntuli et al., 2019). In South Africa, winter presents lower temperatures compared to the Mozambican side, and in terms of climate, the union of the parks brings an advantage. (Mavhunga and Spierenburg, 2009) reveal that before the implementation of the fence separating the parks on the South African and Mozambican sides, during the winter, migratory routes of wild fauna were observed crossing the KNP towards the LNP. The reactivation of migratory routes brings numerous 1138 advantages to wildlife, allowing for an increase in the genetic 1139 diversity of threatened species and the recovery of their 1140 populations, reduces competition for space, provides a variety of 1141 habitats, and facilitates the search for food, especially in the context 1142 of climate change (Ntuli et al 2019, Roque et al 2021, Roque et al 2022). The goal line of the governments of the three countries is to make the transboundary conservation area more natural. (Witter, 2013) claims that the political efforts between the countries are reflected, in practice, in the replacement of residents by tourists, rural settlements by tourist destinations, livestock by wildlife, and cultivated areas by wildlife habitats.

In the first phase of the LNP restoration, between 2001 and 2008, about 4725 individuals were reintroduced from KNP, including African elephants, lions, buffaloes, giraffes (*Giraffa camelopardalis*, L.), waterbucks (*Kobus ellipsiprymnu*, Ogilby), blue wildebeests (*Connochaetes taurinus*, Burchell), kudus (*Tragelaphus strepsiceros*, Pallas), nyalas (*Tragelaphus angasii*, Angas), impalas (*Aepyceros melampus*, Lichtenstein), and zebras (*Equus quagga*, P. Boddaert) (Mabunda et al., 2012; Spierenburg et al., 2008). The second phase of translocation was possible in 2015, following successive delays due to excessive pressure from wildlife hunting, the resettlement of the Nanguene and Macavene communities, and the wildlife reintroduction convention (Bazin et al., 2016). Results from the 2013 inventory in LNP reported 26 species of wildlife weighing over 10kg (Stephenson, 2013). In the 2019 and 2021 inventory, 49 species were observed (Roque et al., 2022). The process of restoring some large wildlife species still represents a significant challenge. According to (Roque et al., 2022), some species, such as the African elephant, the African buffalo, and the plains zebra, show significant numbers; however, the recovery of other species, such as the giraffe, the eland (*Taurotragus oryx*, Pallas), the blue wildebeest, and the white rhinoceros (*Ceratotherium simum*, Burchell), is slower.

## 6.2 Coordination and challenges in combating wildlife poaching in the GLTP

In Southern African countries (e.g. Mozambique, South Africa, Zimbabwe, Tanzania), conservation areas are affected by poaching perpetrated by some community members, and a fragility of the institutions designated for resource monitoring has been observed (Ntuli and Muchapondwa, 2018). The only common resource in the GLTP is wildlife, but differences in laws and administration between countries hinder the combating of trafficking (Ntuli et al., 2019). In South Africa, poachers of protected species can face sentences of 10 years, a maximum fine of 10 million rand, or an amount equivalent to three times the value of the species (Government Gazette, 2023). In Mozambique, the penalty for wildlife crimes is 8 to 12 years in prison, along with a corresponding fine (Boletim da República, 2014). Commercial poaching refers to the killing of wildlife for the trafficking of wildlife parts (e.g. ivory, rhino horn, animal skin), occurring mainly within conservation areas, while subsistence poaching takes place in buffer zones or community-owned lands (Witter and Satterfield, 2019; Ntuli et al., 2021). It is understood that the presence of wildlife poachers in conservation areas is an attack on the security of the heritage, as important species for commercial tourism are killed (Adams, 2020). The mortality resulting from rhino poaching in KNP was 36 in 2008, 146 in 2010, 722 in 2013, peaking at 892 in 2015, and 530 in 2017 (Ferreira et al., 2019; Lunstrum, 2014).

The epicenter of wildlife in the Limpopo transboundary park is located in KNP, and the PPF has been developing most of the actions to combat illegal hunting on the South African side (Ramutsindela, 2016; Witter and Satterfield, 2019; Witter, 2021). Most of the wildlife poachers operating in the KNP are Mozambican, crossing the border into the South African side armed with firearms (Shaw and Rademeyer, 2016). Attempts at pursuit have been thwarted because the KNP forest guards are not allowed to cross the border into the Mozambican side (Lunstrum, 2014). The impoverished youth of the LNP, guided by local chiefs, are the main perpetrators of environmental crimes (Otsuki, 2023), forming the second link in the wildlife trafficking chain that reaches the final consumer in Asia (Haas and Ferreira, 2018). Poaching in the park brought dire socioeconomic consequences to the communities; many young people were detained and killed, leaving widows and children orphaned (there are no records or numbers confirmed by the district government or the LNP). In 2013 to 2014, it was reported that about 75% of the poachers in GLTP were Mozambican (Hübschle, 2017b) and from 2010 to 2015, approximately 500 people from the poor villages of Mozambique were killed (Smith, 2015; Bazin et al., 2016). Resistance to conservation arises from the loss of resources that communities inherited from their ancestors, the increase in poverty levels, intimidation, and violence resulting from suspicion of involvement in poaching activities (Ntuli and Muchapondwa, 2018; Ntuli et al., 2021; Otsuki, 2023). With the intensification of poaching, there was a need for coordination between countries to protect the border between Mozambique and

South Africa. According to (Ramutsindela, 2016), the KNP established a military force of the South African National Defense Force to combat rhinoceros poaching, with the collaboration of the Mozambican State, and it was officially named Operation Corona. The actual number of South Africa National Defense Force personnel deployed in Operation Corona along the border between South Africa and Mozambique, and consequently between KNP and LNP, is not disclosed for security reasons. However, the military deployed at the KNP-LNP border comprises 1,500 soldiers stationed throughout South Africa. (DefenceWeb, 2012. Stephenson, 2010) states that in response to the actions of the KNP, the LNP introduced more robust protection measures, including the use of light aircraft (Cessna© 210 Centurion, WICHITA, KS, USA) (PPF, 2023), Helicopter (Robinson© R44, TORRANCE, CA, USA) (Selyer, 2016), four-wheel-drive and high ground clearance vehicles (e.g. Land Rover Ltd. Defenders, SOLIHULL, UK) (PNL, 2025), canine operations using mixed-race dogs (75% Bloodhound and 25% Doberman) (Peace Parks TV, 2021). Furthermore, the protection measures were expanded in 2018 with the hiring of 29 inspectors and the additional training of forest guards in service (the information is confidential for criminological reasons) (Witter, 2021). The institutionalization of the conservation area and the creation of the GLTP represented significant advances that fostered confidence in wildlife sharing among the three countries, leading to several noteworthy initiatives (Figure 5). There are three actions involved: (1) the emergence of various technical and financial support programs for the LNP; (2) the gradual reintroduction of wildlife from KNP; (3) the resettlement of communities located within the park. The development projects of the LNP enabled the construction of infrastructure, strengthened monitoring actions aimed at reducing poaching rates. The LNP is considered a conservation area with potential for the development of ecotourism (Mabunda et al., 2012; South African National Parks, 2021).

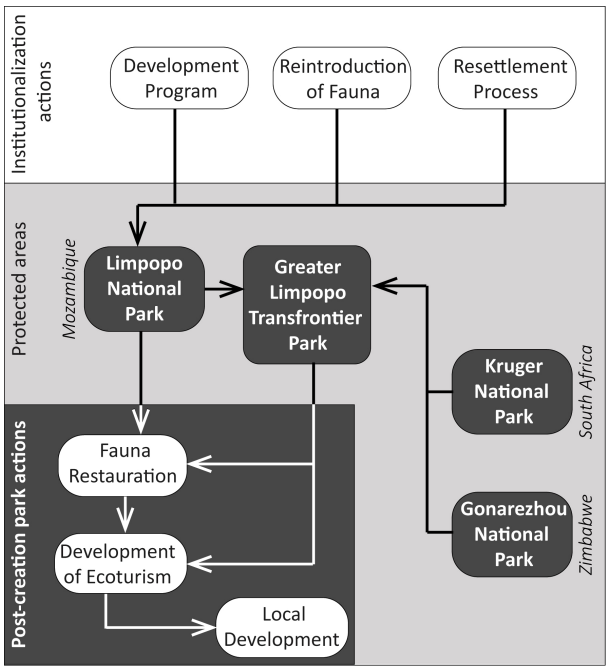


FIGURE 5
Wildlife restoration process in Limpopo National Park (LNP).

## 7 Conclusion

This narrative review offers an integrative perspective on conservation-induced displacement, uniquely contextualized within the LNP. The institutionalization of the LNP facilitated the adoption of a management framework that curtailed subsistence hunting, commercial hunting, and other income-generating activities reliant on the exploitation of natural resources. The LNP management concept has enhanced the conservation of natural resources by facilitating the interchange of wildlife among countries, promoting intellectual collaboration, and diminishing commercial hunting. The LNP has received complete conservation status, and the management model implemented is incompatible with the customary activities of the inhabitants. Notwithstanding limitations on forest utilization, populations awaiting resettlement engage in shifting agriculture, which results in the degradation of plant cover and biodiversity. The escalation of confrontations, the devastation of crops, and assaults on animals heighten the vulnerability of the park's inhabitants. The situation encountered in the LNP may lead to an increase in subsistence hunting for sustenance and result in voluntary relocation in pursuit of safer areas. This may eventually lead to a diminishment of the efforts invested over the years, as evidenced in Tanzania, when popular insurrection resulted in the slaughter and poisoning of lions in protection of humans and their possessions. The safeguarding of communities and their assets can be accomplished by the implementation of a management plan that facilitates the coexistence of humans and wildlife, using traditional practices. These findings call for a redefinition of conservation strategies that are both ecologically effective and socially just, particularly in regions undergoing forced resettlement. Since the conservation unit's establishment two decades ago, donors have financed the majority of initiatives. Securing internal finance is a priority for the LNP to guarantee the enduring efficacy and sustainability of conservation efforts and to alleviate the risks linked to variations in external funding. Future policy design should prioritize inclusive planning and participatory governance mechanisms to mitigate long-term social and ecological trade-offs.

## Author contributions

JM: Conceptualization, Writing – original draft. AF: Writing – review & editing. AS: Funding acquisition, Writing – review &

editing. MT: Supervision, Writing – original draft. LL: Supervision, Writing – original draft.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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