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From conflict to coexistence: Exploring impacts of non-formal environmental education activities for inter-generational knowledge transfer regarding Human-Elephant Interaction

Nicole Katharina Gerkrath Teixeira de Azevedo

Dissertação de Mestrado em Ecologia Humana e Problemas Sociais Contemporâneos

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Mural painted by Ava Salzman at Gorongosa National Park (GNP) airstrip

“In the end, we will conserve only what we love; we will love only what we understand, and we will understand only what we are taught.” (Baba Dioum)

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Abbreviations

EE – Environmental Education

GNP – Gorongosa National Park

GRP – Gorongosa Restoration Project

HEC – Human-Elephant-Conflict

HWC – Human-Wildlife Conflict

HWCC – Human Wildlife-Conflict and Coexistence

NGO – Non-Governmental Organization

PA – Protected Area

PNG – Parque Nacional da Gorongosa

PPP – Public Private Partnerships

Abstract

Anthropogenic activity often causes direct or indirect landscape change resulting in the fragmentation of habitats and degradation of essential ecosystems and harming of biodiversity. Protected areas can function as an effective solution and cornerstone to conservation, especially when well managed and sufficiently funded, also potentially playing important roles for human health and well-being. However, conflict is often observed when wildlife populations of protected species recover, or communities settle inside protected areas or their direct vicinity, often putting wildlife and human populations at risk. Wildlife engaging in crop raiding or predators attacking livestock are the most observed forms of conflict, resulting in injury or loss of live for both, humans and animals, as well as destruction of crops, or property and psychological stress. Law enforcement, community engagement through participatory management, economic incentives, and conservation education measures are some of the strategies employed to mitigate Human-Wildlife-Conflict.

Environmental education activities are increasing worldwide with the objective to prepare for the implementation of the Sustainable Development Goals, to foster understanding and protection of Nature and its biodiversity, and ultimately to promote harmonious coexistence between people and wildlife. School children are easy to reach and in many places they are targeted for intergenerational knowledge transfer from child to parents and the wider community conveying messages aimed to positively influence environmental behaviour. However, regular assessment and evaluation of environmental education activities are scarce, and little is known regarding their outcome for changes of attitude and behaviour towards ecosystems and wildlife.

Using the Gorongosa National Park (GNP) in Mozambique, as a case study, where Human-Elephant Conflict (HEC) is growing, and the park's human development and conservation teams are testing different mitigation strategies, the present study aims to explore potential effects of an environmental education campaign on intergenerational learning (from children to parents) and change in knowledge, perception and attitudes. To do so, I assessed the findings of two surveys, one pre- and one post intervention questionnaire, administered in seven communities of the park's buffer zone, heavily affected by HEC during the year 2021, with the aim to analyze potential positive effects of

non-formal environmental education interventions on conflict mitigation. Additionally, I evaluated whether knowledge transfer had occurred from children to parents with potential positive effects for the wider community, motivating coexistence.

The results of the pre- and post-tests indicate a good baseline knowledge of all participants, with a positive knowledge gain in the post-test, regarding biological and behavioural traits of elephants. However, a clear link between the knowledge gain of parents and that of children in the sense of intergenerational knowledge transfer, could not be established. The post-test results of many participants, particularly the children and mothers indicate a positive change of attitudes. A similar change was also reflected in a more positive indication for behaviour of participants towards elephants. These findings suggest that the buffer zone communities support GNPs strategies towards coexistence.

To gain deeper insight to participants' perceptions and attitudes, complementary research is recommended, using mid- and long-term studies and qualitative data collection via interviews or focus groups. Alternative research methods guaranteeing participants' anonymity are also recommended, given the cultural, economic and educational imbalance between researchers and community members.

Keywords: Children, Coexistence, Conservation, Environmental Education, Human-Elephant-Conflict, Human-Wildlife-Conflict, Knowledge Transfer, Parents

Resumo

Atividade antropogénica provoca frequentemente alterações diretas e indiretas na paisagem e resulta na fragmentação de habitats, degradação de ecossistemas e perda de biodiversidade. Áreas protegidas podem ser um pilar e uma solução eficaz para a conservação, especialmente aqueles que são bem geridas e que dispões de meios de financiamento adequados, ainda podem ter um papel importante para a saúde e o bem-estar humano. No entanto, muitas vezes podemos observar conflitos provocados pela recuperação de populações de fauna bravia ou espécies protegidas, ou por comunidades que vivem em áreas protegidas ou na sua direta vizinhança, constituindo uma ameaça para a fauna bravia e a população humana. Animais selvagens que estragam colheitas ou predadores que atacam gado são as formas de conflito observados com mais frequência, resultando em ferimentos ou perdas de vida, tanto para pessoas como animais, assim como na destruição de colheitas ou propriedades e sofrimento psicológico. Uma fiscalização reforçada, ações de desenvolvimento humano através da gestão participativa, incentivos económicos e medidas de educação de conservação são algumas das estratégias implementadas para mitigar o conflito entre Homem e fauna bravia.

A nível mundial atividades de educação ambiental estão a crescer com o fim de preparar para a implementação dos Objetivos de Desenvolvimento Sustentável, de criar uma melhor compreensão e proteção da Natureza e da sua biodiversidade, e com o objetivo final de promover uma coexistência harmoniosa entre pessoas e fauna bravia. Em muitos sítios é mais fácil alcançar as crianças em idade escolar que frequentemente se tornam alvo para transferir conhecimento para os pais e a comunidade em geral divulgando mensagens ambientais. No entanto, avaliações regulares dessas atividades de educação ambiental são raras, e pouco se sabe em relação aos resultados no que diz respeito a mudanças de atitude e comportamento perante o ecossistema e a fauna bravia.

Usando o Parque Nacional da Gorongosa (PNG) em Moçambique, como caso de estudo, onde o conflito entre Homem e fauna bravia está a crescer, e as equipas de desenvolvimento humano e de conservação do parque estão a implementar estratégias diferentes para a mitigação do conflito, a presente pesquisa visa explorar os potenciais efeitos de uma campanha de educação ambiental para aprendizagem intergeracional (da criança para os pais) e a mudança de conhecimento, perceção e atitudes. Para tal, examinei

os resultados de dois inquéritos, um pré- e um pós-intervenção, administrados em sete comunidades da zona tampão do parque, que durante o ano 2021 foram gravemente afetados pelo conflito entre Homem e elefante, com o objetivo de analisar os potenciais efeitos positivos de atividades não formais de educação ambiental para a mitigação de conflito. Adicionalmente, analisei se ocorreu transferência de conhecimento da criança para os pais com potenciais efeitos positivos para a comunidade em geral, a fomentar coexistência.

Os resultados dos pré- e pós-testes indicam um bom conhecimento base com um acréscimo positivo de conhecimento em relação a características biológicas ou comportamentais dos elefantes. No entanto, não foi possível estabelecer uma ligação clara entre o aumento de conhecimento no sentido de transferência de conhecimento dos pais para as crianças. Os resultados dos pós-testes, especialmente das crianças e das mães, indicam uma mudança positiva de atitude. Uma alteração semelhante também pode ser observada na indicação de um comportamento mais positivo perante elefantes. Os resultados dos testes sugerem que as comunidades da zona tampão apoiam as estratégias do PNG para a coexistência.

Para conseguir uma compreensão mais detalhada sobre as perceções e atitudes dos participantes recomenda-se estudos adicionais de média e longa duração, recorrendo a análise qualitativa através de entrevistas ou grupos focais. Também se recomendam métodos de pesquisa alternativos que visam proteger o anonimato do participante, perante o desequilíbrio cultural, económico e educacional que existe entre pesquisadores e os membros da comunidade.

Palavras chave: Coexistência, Conflito Homem-Elefante, Conflito Homem-Fauna Bravia, Crianças, Educação Ambiental, Pais, Transferência de Conhecimento

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Introduction

i. Contextualization and relevance of the research topic

Ecology is the science of relationships between living organisms and their environment (Smith and Pimm, 2019), while Human Ecology is about the relationships between people and their environment which is everything in a specific area, including things built by humans (Encyclopedia Britannica, 2016; Marten 2001). In Human Ecology the environment is perceived as an ecosystem which can be of any size or type, from a small pond to a forest, a farm, or large cities to the whole planet Earth (Marten, 2001). Humans are part of the ecosystem, and their social system comprised of knowledge, technology, and values, needs ecosystem services, such as natural resources like air, water, and soil to function (Marten, 2001).

Human Ecology is an interdisciplinary science promoting dialogue between a variety of subjects and can be seen as an answer to the demands of our present world by supplying knowledge in sustainable development (Marten, 2001; Benett et al, 2017). Environmental, socioeconomic, and sociodemographic concepts are important tools for Human Ecology and are part of the analysis of the relation between human action and diverse ecosystems, particularly since many impacts on the ecosystem are strongly influenced by anthropogenic activity, causing rapid changes to the climate and provoking severe damage to the environment (Marten, 2001).

Biodiversity conservation can be defined as the practice of protecting and preserving the wealth and variety of species, habitats, ecosystems, and genetic diversity on the planet (Jepson, 2013), this is primarily achieved through the creation of protected areas (PA) (Robson et al, 2021). The protection of biodiversity is essential to keep the balance of our natural world and its diversity, to guarantee its health and stability which in return is imperative to our well-being (Jepson, 2013). Ecosystem resilience is ensured through biodiversity providing humans with life essential natural resources, however, the over exploitation of some of these resources can damage an ecosystem to a point of irreversible destruction (Pangestu, 2021). The current crisis of biodiversity loss is provoking the extinction of species and destruction of their habitats and affects most negatively the poor and vulnerable living in underdeveloped countries (Pangestu, 2021), therefor a proper

management of biodiversity is essential for long-term positive outcomes for nature and its people (Pangestu, 2021).

The efforts of maintaining and restoring habitats or protecting species from extinction were traditionally led by the natural sciences such as ecologists, conservationist, and biologists, but the focus has shifted over the years from a conservation approach that excluded the presence of humans to a more modern approach where the human presence is an integral part of the protected ecosystem and helps to maintain its balance (Mace, 2014; Howe et al, 2018). Human ecology is part of the social sciences which can help improve conservation efforts and add a better understanding of issues for researchers and practitioners (Encyclopedia Britannica, 2016; Benett et al, 2017). The human dimension of conservation and natural resource management is needed to produce robust and effective conservation guidelines and policies (Benett et al, 2017; Knox et al, 2021**)** Linking PAs to the goal of addressing poverty and livelihood security requires new skill sets and an interdisciplinary science approach (Benett et al, 2017; Knox et al, 2021). Human Ecology can contribute in many aspects to a positive management outcome of protected areas in their surrounding communities (Benett et al, 2017).

PAs, such as national parks, nature reserves, wilderness areas or community conserved areas form a defined geographical space managed through legal or other effective means to achieve long term conservation (Robson et al, 2021). Sub-Saharan Africa is rich in biodiversity and PAs, however many of them are faced with a myriad of complex problems such as adverse weather effects due to climate change, demographic pressure, insufficient funding, weak institutional structures and so on (Robson et al, 2021).

A growing number of PAs in Sub-Saharan Africa, and elsewhere, is managed through public-private partnerships (PPP) between non-governmental organizations (NGOs) and local governments to overcome shortages in funding related to the region's poverty (Fitzgerald and Maleki, 2021). Wildlife management to minimize threat, ensure sustainable harvest and avoid conflict between people and wildlife, as well as investment in tourism to strengthen the local economy, are important parts of the work done by such PPPs managing protected areas (Fitzgerald and Maleki, 2021). Often their work begins with law enforcement and community engagement to prevent poaching and illegal fishing and build trust to preserve the ecosystem for future generations (Fitzgerald and Maleki, 2021).

Although law enforcement is one important step towards a well-managed PA, this alone cannot guarantee the success of habitat and biodiversity protection. Community engagement and a bottom-up approach through adaptive management is increasingly gaining support among conservationists to stop human encroachment, deforestation, HWC, and similar issues (Fitzgerald and Maleki, 2021). Effective management of PAs is often intrinsically linked to the socioeconomic well-being of communities living in and around them (The World Bank, 2021). An interdisciplinary approach engaging the social sciences helps identify people's perceptions and expectations which in return shape their attitudes towards habitat and wildlife protection (Knox et al, 2021).

Community engagement needs to include social and economic well-being as well as educational and health support improvements (Galvin, Beeton and Luizza, 2018). Many PAs administrations run educational and health programs, including the construction of improved facilities as well as skills training (The World Bank, 2021). Environmental education (EE) or conservation education are part of many non-formal education programs aimed to develop awareness and concern for the environment and to address identified environmental, educational and community needs (North American Association for Environmental Education, 2010; Benett et al, 2017). The importance of shaping the younger generation's views and attitudes towards conservation, as well as their influence and the transference of knowledge to the older generation are well recognized, however relatively little is known regarding EE programs' evaluation and their effectiveness and program outcomes (Heimlich, 2010).

An increase in numbers of protected species, but also the fragmentation of habitats, human encroachment, the interruption or destruction of migration corridors, and underlying socio economical and psychological factors are just a few of the many causes for HWC in general and human-elephant-conflict (HEC) specifically (Shaffer, Khadka, Van Den Hoek, na, Naithani. 2019). Many deterrence and mitigation strategies have been put in place, close to none have proven to be a final effective solution to the problem (Evans and Adams, 2018).

Many researchers and practitioners share the view that the combination of a variety of different approaches can contribute to peaceful coexistence, the outputs of social sciences research for example can help understanding the human dimensions of HWC (Benett, 2017), meaningful community education programs (Foerster, Mars, Torres, and Sias, 2021) aiming

to develop skills that prepare communities to face the challenges inherent to conservation, -particularly to those living in the vicinity of protected areas -, (Ardoin, Bowers, and Gaillard, 2020) can help developing more robust strategies to mitigate conflict and help create a better understanding of the challenges conservationists are facing (Foerster, Mars, Torres, and Sias, 2021)

As already mentioned above, Human Ecology, is in my view one of the social sciences that can help contribute to finding solutions for conservation challenges and opening paths from conflict to coexistence.

ii. Objectives and aims of the research

My research objective is to explore the potential contribution of non-formal EE programs to mitigating conflict and achieving coexistence for people living close to problematic species in the vicinity of protected areas.

Restrictions imposed by both, the Mozambican and the Portuguese government during the COVID-19 pandemic forced me to adapt my initial research project to a slightly different scope of intervention, but fortunately I was granted access to the data resulting from a before/after study developed and administered by the department for sustainable development of the GNP, in Mozambique, with the title: “Elephants and Humans: turning conflict into coexistence, intergenerational learning for change”.

My research hypothesis is that meaningful, non-formal environmental education activities can influence children’s knowledge, perceptions, and attitudes towards protected species. Additionally, I hypothesize that such educational activities can lead to knowledge transfer from child to parent(s) and ultimately to the wider community and encourage harmonious coexistence.

iii. Scope and contents of research

The present work consists of five parts: part one contains the theoretical framework and part two is dedicated to the study site, with its geographical and sociodemographic characteristics, the case study and the methodology applied to the research, and part three consists of the results, while part four is dedicated to discussion, limitations and recommendations, and the final part five contains the conclusion of my research.

In the theoretical framework a short review of topic relevant literature is presented, as well as the analysis of related theoretical concepts and this section is subdivided in the following main topics:

1. Ecosystem services and conservation of biodiversity
2. Human-Wildlife Interaction and its ramifications
3. Concepts, challenges, and limitations of environmental education
4. Children as target audience and catalysts transmitting important conservation education messages.

The second part of my dissertation is dedicated to relevant study site characteristics, methodology and results, presenting a case study of two before/after intervention surveys done in GNP, Mozambique.

Here it is important to point out that the survey design, survey administration (pre- and post-test), as well as the data compilation into Microsoft Excel spreadsheets was entirely developed and carried out by members of the department for sustainable development of GNP.

The section dedicated to the study site characteristics and the methodology is subdivided in the following parts: a detailed description of the study site, its climate, geography, biodiversity, as well as social context and main conservation interventions in the area. Followed by the actual case study, comprised of relevant background information, including similar academic underpinning research, the survey design, the survey administration, and finally the data analysis. Section three contains survey findings and results, concluding with the final sections of discussion, limitations, and conclusion.

I. Theoretical Framework

1. Ecosystem services and conservation of biodiversity

The Millennium Ecosystem Assessment identifies four major categories of ecosystem services: the provisioning of resources like food, drinking water, natural fibers and timber; regulation services, such as cleansing or purification of water, decomposing of organic matter or carbon storage; cultural services like creativity and knowledge, resulting from the interaction with nature, and fundamental supporting services, allowing to sustain natural processes, such as water cycles, photosynthesis or creation of soils (NWF, 2022).

Human well-being and supply of resources depend on ecosystem services, and ecosystem functioning, and services often directly depend on biodiversity (Johnson et al, 2017; Isbel, Tilman, Polasky and Loreau, 2014). Cumulative anthropogenic drivers, such as agricultural or urbanization processes have caused degradation and fragmentation of ecosystems, often resulting in the loss of biodiversity (Johnson et al, 2017). On the other hand, over the past decades scientists and researchers have invested time and effort in the study of ecosystems, their resilience and the classification of biodiversity, as well as in defining conservation methods to stop the destruction of habitats and find ways to revert or stop the loss of species and destruction of functioning ecosystems (Isbel, Tilman, Polasky and Loreau, 2014). It is important to recognize a shift from the initial conservation approaches where ecosystems where managed and kept untouched and isolated from humans for biodiversity conservation (Mace, 2014; Howe et al, 2018), over to an approach to protect nature from people, focusing on threats for species and strategies of how to reverse these, to an understanding of nature for people, where the importance of ecosystem services was increasingly recognized, to a current approach seeking sustainable and resilient interaction between nature and people (Mace, 2014; Howe et al, 2018). However, a traditionalistic conservation perspective defending exclusive protected areas with as little as possible human impact as a priority over human development and as a key principle for the survival of certain species remains valid for many ecosystem-management projects, especially in protected areas attempting the conservation of emblematic or endemic species (Grass et al, 2019; Howe et al, 2018).

Sub-Saharan Africa is one of the regions with the highest biodiversity, and at the same time suffers increasing pressure from anthropogenic activity. Impacts on natural resources are a consequence of land-use change, paired with loss of biodiversity, fragmentation of habitats and loss of ecosystem services. Additionally, the region is particularly vulnerable to the impacts of climate change (O'Connell et al, 2019). The creation of protected areas has helped protecting sub-Saharan Africa's biodiversity hotspots, and governance and compliance of the community with conservation policies of these protected areas is of fundamental importance (Ullah and Kim, 2021). Research has shown that positive results for conservation can be achieved by a holistic approach including local communities in decision making processes, while respecting their needs and traditions and sharing economic benefits (Ullah and Kim, 2021).

Although there is a clear need for sustainable, cost effective and strategic conservation of protected areas, while representing an opportunity for synergies between stakeholder groups and an opportunity for poverty alleviation through job creation, rural communities continue to suffer in many places under restrictions cutting their rights to access and control of natural resources (O'Connell et al, 2019).

1.1 Human-Wildlife Interaction

1.1.1 Human-Wildlife Conflict

When defining the term Human-Wildlife Conflict (HWC) several factors need to be taken into consideration: (i) conflict is a confrontation between different interests and typically involves two or more opposed parties with different needs and behaviours, and HWC can also be understood as a threat to property, recreation and human safety (Redpath, Bhatia and Young, 2015; Barua, Bhagwat and Jadhav, 2013; Treves, 2009) ; (ii) it is important to distinguish between human-wildlife impacts and human-human or conservation conflicts (Bhatia, 2019); (iii) HWC is the most frequently reported type of conflict occurring in and close to protected areas (Soliku and Schraml, 2018), being often triggered by encroachment and loss of habitat (Shilongo, Sam and Simuela, 2018); (iv) not all interactions between humans and wildlife are negative, but a negative bias has been observed in research: 71% of research

articles on the subject, published in the past 20 years, focus on the term *conflict* and only 2% use the neutral term *coexistence* (Fig. 1). The current trend is to replace the term *conflict* by more neutral wording like coexistence or interaction, to avoid additional negative impact on people's perceptions in relation to wildlife (Bhatia, 2019).

In the rapidly increasing scientific literature on HWC high-profile species, such as large mammals, represent the most described group of animals provoking conflict, less due to the actual damage they cause, but more because of the division of opinions and feelings they evoke in large sectors of society (Frank, Glikman and Marchini, 2019) It is important to note that conservation conflicts not only have negative effect on biodiversity but can also strongly influence people's well-being on a variety of layers (Baynham-Herd et al, 2018). Therefore, to address conservation conflicts, underlying factors, and social dimensions, such as poverty or inequality, should be taken into consideration, as they can have a strong impact on the outcome of conflict management strategies (Baynham-Herd, 2018). The direct impacts of HWC, such as injury or loss of live or loss of livestock or crops, are the most visible consequences, but hidden impacts are not less important as they can affect people's health or cause indirect costs; Communities living with HWC often feel helpless and without control over the situation (Barua, Bhagwat, and Jadhav, 2013) (Fig. 2).

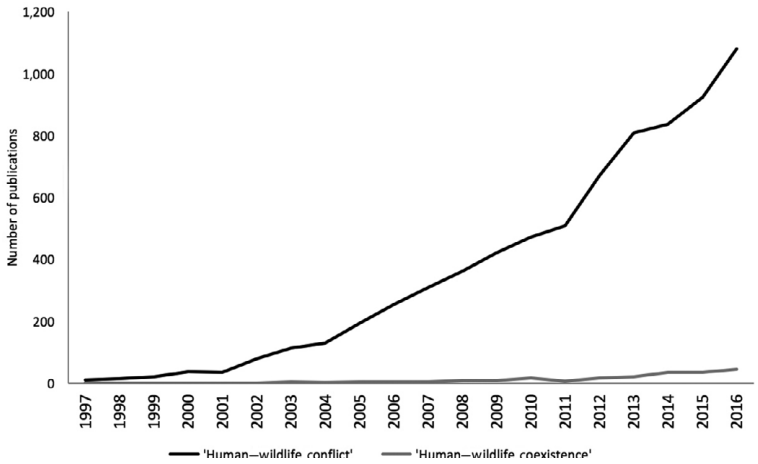


Figure 1. Google Scholar search for *human–wildlife conflict* and *human–wildlife coexistence*. Custom range search was used to generate the number of results for each year, from 1997 to 2016 (on 15 December 2017). (taken from: Frank, Glikman and Machini, 2019, p. 415)

Interactions between humans and wildlife are globally increasing due to habitat fragmentation, human encroachment, and recovery of some wildlife populations (Bhatia, 2019). People's attitudes and behaviours towards wildlife are influenced by wealth, resource dependance, and other correlated socio-economic factors, as well as their level of education, knowledge about wild animals or risks posed by wildlife (Bhatia, 2019). Management of protected areas is investing in many different strategies for humans and animals to learn how to co-adapt and live together, while reducing negative effects on each other (Bhatia, 2019). Furthermore, the clash between protection of biodiversity and human needs, such as food security and poverty alleviation have become a global concern for conservationists (Montero-Botey, Soliño, Perea, and Martínez-Jauregui, 2021) and they increasingly recognize the dilemma that efforts to reverse or halt decline of biodiversity can have adverse effects on poverty alleviation of communities living in the vicinity of protected areas (Adams et al, 2004).

HWC is reported as most intense in developing countries, where a higher percentage of low-income communities live in rural areas from subsistence farming or livestock holding (Treves, 2009; Matseketsa et al, 2019), and where HWC is often perceived as a serious competition for space or food. Many of the worldwide existing protected areas are partially or totally fenced, to limit the movements of wildlife and to keep people and domestic animals out (Shilongo, Sam and Simuela, 2018). Almost every country has protected areas which were created with the purpose of safeguarding fauna and flora, by setting areas aside and restricting access and use of these landscapes (Soliku and Schramls, 2018). HWC is particularly severe and frequent in communities living close to protected areas for large herbivore such as buffalo, hippopotamus, or elephant (Treves, 2009). Practitioners agree that the social needs of people living near protected areas need to be better understood and should be integrated into the conservation planning strategies to gain support of local communities, however in many conservation projects these ideas remain theoretical aspirations (Adams et al, 2004).

Apart from legal and illegal, lethal, and non-lethal interactions (König et al, 2020) conflict management measures can be divided in two main strategies: those aimed at reducing the incidence of Human-Wildlife Conflict before it takes place and those mitigating the impacts after Human-Wildlife Conflict has occurred (Shilongo, Sam and Simuela, 2018). Preventive measures include deterrence through physical, chemical, or psychological barriers, as well as land use and herd management planning, involving stakeholders in participatory processes

(König et al, 2020) while the mitigation of wildlife conflict is addressed through compensation schemes often in combination with awareness campaigns and environmental education to increase people's tolerance (Shilongo, Sam and Simuela, 2018).

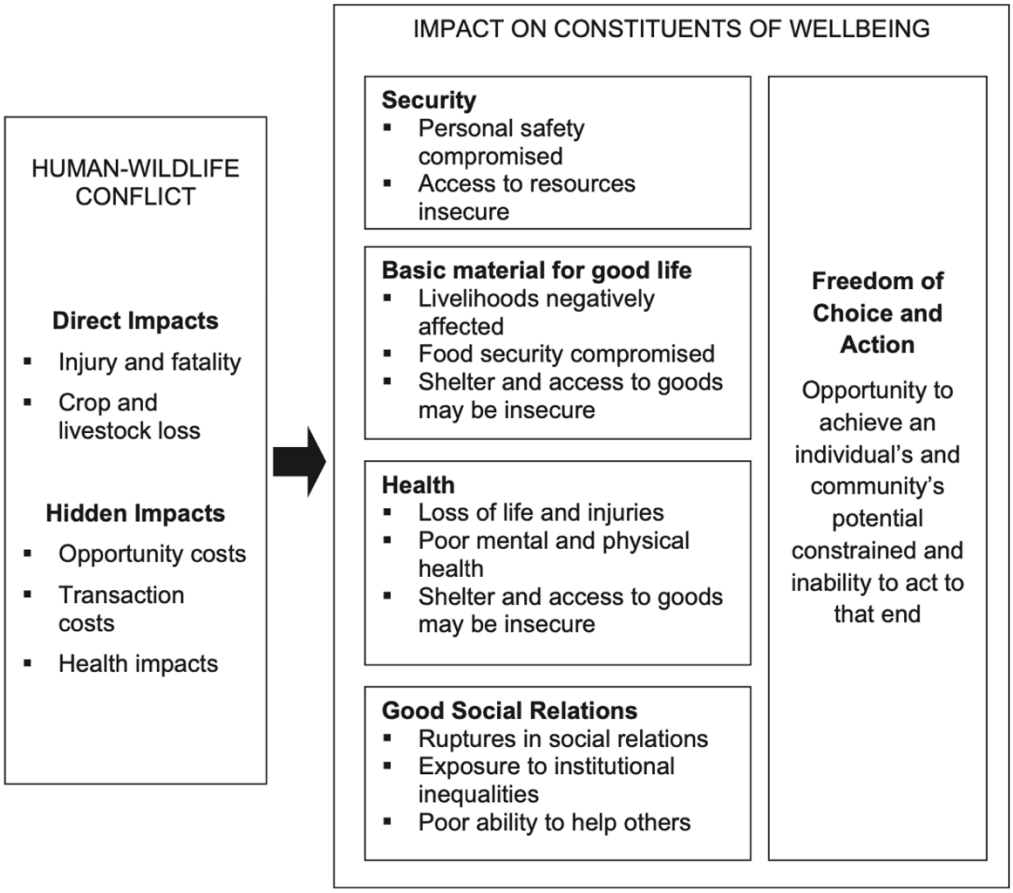


Figure 2. Human-Wildlife Conflict and its adverse impact on components of human wellbeing identified by the Millennium Ecosystem Assessment
(taken from: Barua, Bhagwat, and Jadhav, 2013, p. 312)

1.1.2 Human-Elephant conflict

Elephants are big, highly mobile, powerful, and intelligent animals and their complex interactions with people range from conservation concern, through generating tourism revenues to crop raiding of smallholder farms at night (Evans and Adams, 2018). Elephants should be considered an important actor in conservation politics as many of them live outside or forage outside protected areas in agricultural landscapes competing for space with local

communities, the unsolved illegal poaching for ivory trade is another complex issue to take into consideration (Evans and Adams, 2018).

Elephants are a keystone species for ecosystems, shaping their habitat through dispersal of seeds, uprooting of small trees, and trimming of canopies and shrubs (Shaffer, Khadka, Van Den Hoek and Naithani, 2019). However, elephant populations are shrinking and nowadays can only be found in Asia and sub-Saharan Africa, where their numbers are endangered or critically endangered in the case of the African forest elephant (IUCN, 2021). The African elephant population is much larger than the Asian, they can be found in 37 African countries and 30% of their geographical range is within protected areas (Shaffer, Khadka, Van Den Hoek and Naithani, 2019). Elephants depend on large foraging areas for survival, one herd can roam for up to 500km. They are mega-herbivores and daily need up to 150 kilos of grass, shrubs, tree leaves, roots, and fruits, besides almost 200 liters of water (Shaffer, Khadka, Van Den Hoek and Naithani, 2019).

Like elephants, humans also shape and influence their surrounding landscape and the expansion of human settlements in Sub-Saharan Africa, especially in extremely poor rural communities, depending on subsistence farming, has increased competition for resources such as water and arable land (Shaffer, Khadka, Van Den Hoek and Naithani, 2019). Human encroachment, habitat fragmentation and loss of natural habitat, has fostered Human-Elephant conflict and turned into a major concern for conservation (Shaffer, Khadka, Van Den Hoek and Naithani, 2019).

Crop raiding elephants destroying farmers' yields are the most common manifestation of Human-Elephant conflict, resulting in threat for survival of poor communities, death of people and culling of problem elephants (Shaffer, Khadka, Van Den Hoek and Naithani, 2019). (Fig. 3). Besides food insecurity, these incidents can also provoke psychological consequences and disruption in social activities (Shaffer, Khadka, Van Den Hoek and Naithani, 2019).

Many mitigation strategies have been tested in different areas where Human-Elephant conflict has been reported, most of them aiming at conditioning fear in elephants or altering and restricting their movements (Mumby and Plotnik, 2018). Negative stimuli to scare away elephants are achieved through physical barriers, such as electric fences, fences with pieces of fabric drenched with chili pepper oil, or fences with beehives hanging on wires. Other deterrence methods are deep trenches, deploying of fireworks or yelling and loud noises (Mumby and Plotnik, 2018), all aimed to deter elephants from entering farmlands

(Shaffer, Khadka, Van Den Hoek and Naithani, 2019). Many of these deterrence strategies involve high cost and maintenance efforts, requiring regular patrolling by rangers or maintenance agreements with neighboring communities (Shaffer, Khadka, Van Den Hoek and Naithani, 2019).

Some of the mitigation strategies have negative impacts on peoples' well-being: farmers and their families protecting their crops at night are exposed to risk of injury or death and the risk of exposure to zoonotic or vector-borne diseases such as malaria (Nyhus, 2016; Shaffer, Khadka, Van Den Hoek and Naithani, 2019; Hill, 2004). Additionally, none of these deterrence techniques have proven to have long term efficacy and elephants tend to learn quickly how to destroy or avoid physical barriers (Shaffer, Khadka, Van Den Hoek and Naithani, 2019).

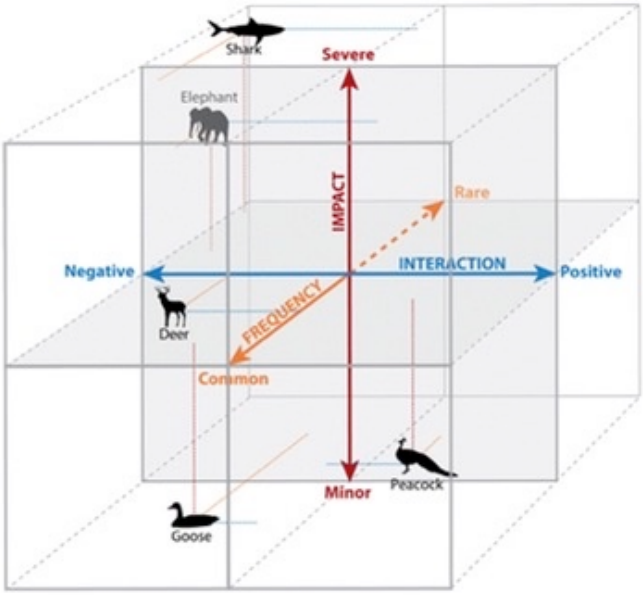


Figure 3. A model for conceptualizing different types of human–wildlife conflict. The x-axis represents a range of interactions or outcomes from negative (e.g., crop damage) to positive (e.g., income from tourism or cultural or religious benefits). The y-axis represents impact on a continuum from minor (e.g., nuisance interactions between people and birds in an urban park) to severe (e.g., loss of life or severe injuries). The z-axis represents frequency of occurrence from common to rare . Different individuals or groups of people may perceive similar interactions in different ways. Other dimensions could be added, such as whether few or many people are impacted, or whether conflict is localized or ubiquitous (taken from: Nyhus, 2016, p. 146).

1.1.3 Coexistence

Pooley, Bhatia and Vasava (2020) and König et al (2020) define coexistence as a dynamic and sustainable state of coadaptation where humans and wildlife share landscapes and interact under effective management ensuring perseverance of wildlife populations and management of risks for humans and livestock within the tolerable limits. It is important to note that coexistence does not imply the absence of conflict, which should be considered as part of life, but it implies trust in effective institutions dealing with the inevitable challenges (Pooley, Bhatia and Vasava, 2020).

Coexistence between humans and wildlife has become an important field in research and conservation management as change of habitats, species recovery or reintroduction and effects of climate change increase interaction between humans and wildlife (Pooley, Bhatia and Vasava, 2020). Interdisciplinary studies considering socioeconomic and ecological factors regarding this topic are increasing rapidly (Nyhus, 2016; König et al,2020) as HWC has turned into a common issue in agricultural, urban, or semi-urban multiuse landscapes and particularly near protected areas (König et al, 2020). Many studies are focusing on the human dimensions of HWC, recognizing the importance of including peoples' attitudes, values, risk perception and emotions to foresee levels of tolerance or behaviours towards wildlife and to achieve coexistence. However, researchers often only evaluate local realities and research lacks understanding of the problem on a larger scale (Frank, Glikman and Marchini, 2019), additionally the effectiveness of many coexistence strategies remains untested (König et al, 2020).

Frank, Glikman and Marchini (2019) argue that coexistence can be divided in two basic components: inter-action, representing the ecological process over a defined space and time, and re-action, representing the human response to that interaction. To achieve coexistence strategic planning in a wider sense than conventional conservation planning is required, involving stakeholders in the decision-making processes, balancing importance of ecological and social issues (Frank, Glikman and Marchini, 2019; König et al 2020) (Fig. 4). For the assessment and monitoring phase of planning, wildlife control strategies, such as lethal or non-lethal control are implemented in many places to manage conservation conflicts. Translocation, exclusionary devices, guarding, and repellents are only some of the methods used in many protected areas (Nyhus, 2016). A growing number of emerging technologies,

like GPS signals, and medical approaches, such as sterilization or reproduction control, are also being used to reduce wildlife conflict (Nyhus, 2016). Evans and Adams (2018) defend that further research on elephants' spatial behaviour and movements can help planning for coexistence creating a kind of 'wildlife cartography' delineating the space where elephants and people are likely to interact.

Equally important is understanding how human tolerance towards wildlife interactions can be increased (Kansky, Kidd and Knight, 2016), by analyzing tangible and intangible costs and benefits related to coexistence with wildlife (Saif et al, 2019). Monetary compensation schemes are frequently implemented, but with varying outcomes and often unrelated to increased levels of tolerance towards wildlife or they may even trigger undesired negative results, such as expansion of agricultural activities (Saif et al, 2019). To measure some of the tangible effects of coexistence direct engagement of stakeholders is necessary to better understand complex dynamics, foster dialogue and critical thinking; this can be achieved through community based natural resource management where communities are given direct access to manage and benefit from wildlife conservation (Jiren, Riechers, Kansky and Fischer, 2021) (Fig.4). The intangible impacts and associated costs are more difficult to measure, they are non-monetary, can be temporally delayed and of psychological nature, such as fear, stress, or grief (Saif et al, 2019). Assessment is difficult, but necessary to understand the mechanisms which can increase tolerance towards wildlife; case studies around HWC with Asian elephants have shown that community cooperation and mutual help can have positive effects on tolerance levels (Saif, 2019). Studies in Mexico have also shown the importance of sociocultural factors that can influence attitudes and tolerance towards species. Conservation efforts need to focus more on wildlife benefits and less on damage, social science research on emotional trauma and behaviour and attitude change can be of fundamental importance for better understanding the fundamentals of coexistence between humans and wildlife (Pooley, Bhatia, and Vasava, 2020).

To achieve coexistence, a change in human behaviour is as important as wildlife control, the mismatch between perception of risk and the actual degree of risk is common and often provokes disproportionate responses (Nyhus, 2016). Elephants are frequently perceived as causing superior damage to crops and to seed silos as rodents or other invertebrates (Nyhus, 2016). On one hand studies of animal cognition in the context of human-wildlife interaction are rare, however cases of animals with reduced fear towards

humans are known, as well as animal's capacity to adapt to human presence, on the other hand, humans can affect animal behaviour in ways which are not yet fully understood by science (Goumas et al, 2020; Pooley, Bhatia and Vasava, 2020).

Although technical fixes can help, they might not be sufficient to transform conflict into coexistence due to underlying, deeper-rooted conflicts (Madden and McQuinn, 2014). The traditional top-down approach for establishing protected areas is shifting to a more participatory process, a mix of top-down and bottom-up approaches empowering local communities by aligning development needs with conservation goals, delegating some management responsibilities to local communities (Soliku and Schraml, 2018). Coexistence is based on successful conflict resolution strategies through increased participation of all relevant stakeholders, conflict management through education of the public is equally important, teaching conservation goals and biodiversity protection strategies, paired with indigenous knowledge can improve tolerance for human-wildlife interaction (Soliku and Schraml, 2018). However, research has paid little attention to traumatic effects of life-threatening encounters of people with wild animals including attacks, loss of crops or livestock, and conservation management continues to focus more on short term prevention and compensation methods, ignoring that behaviour and attitudes can be deeply and long term affected by traumatic encounters with wildlife (Pooley, Bhatia, and Vasava, 2020).

Attitudes and behaviour are distinct, but related concepts: A person's neutral attitude towards a species can change and be negatively influenced through a threatening encounter with that species (Nilsson, Fielding, and Dean, 2019). Or a person's positive attitude toward conservation does not necessarily need to translate into positive behaviour if for example illicit poaching results in important economic benefits (Nilsson, Fielding, and Dean, 2019). Human behaviour and attitudes can be influenced through education and outreach programs (Nilsson, Fielding, and Dean, 2019). However, wildlife management needs to focus more on interpersonal skills besides traditional science knowledge to carefully design strategies compelling to the public (Foerster, Mars, Torres and Sias, 2021). Sustainable coexistence between humans and wildlife can be promoted through environmental education and community outreach programs, these initiatives must be carefully constructed to cater for individuals with varying backgrounds and views (Foerster, Mars, Torres and Sias, 2021). Solid knowledge of social science frameworks can contribute to a better understanding of barriers,

values, attitudes, and norms important for the target audience and ensuring that education program objectives are met (Bennett et al, 2017).

Yanco, Batavia and Ramp (2021) recommend conservation education programs to include innovative and inspirational materials, as well as nature walks, camping or field trips to allow for direct interaction with nature (Sunassee, Bokhoree and Patrizio, 2021), and to encourage compassion towards wildlife to increase pro-environmental behaviours and foster coexistence with wildlife. They argue that compassion and care are important factors to provoke coexistence values and children at primary school age should learn to acknowledge the needs of other beings in shared landscapes (Yanco, Batavia and Ramp, 2021).

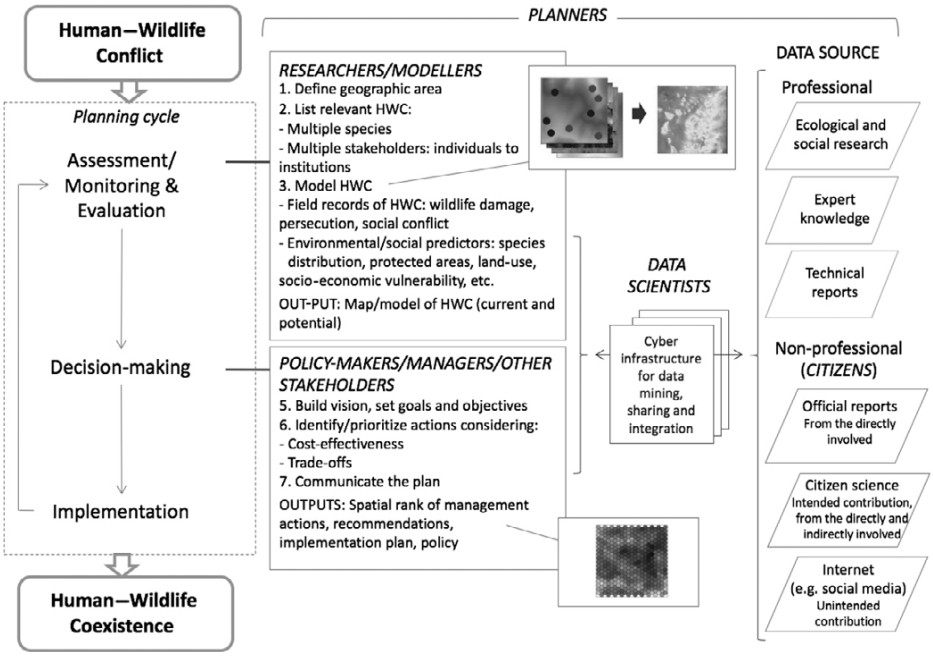


Figure 4. Planning for coexistence: framework for integrating stakeholders (in capital italic letters) and data (taken from: Frank, Glikman and Marchini, 2019, p. 423).

1.2 Environmental Education

The definition for environmental education is based on two founding documents: The Belgrade Charter, which was adopted by the United Nations conference in 1975 as a global

framework for environmental education, and the Tbilisi Declaration, result of the first intergovernmental conference on environmental education organized by UNESCO in 1977 (NAAEE, 2010). The final report of the Tbilisi Conference states the importance of environmental education for all nations in face of the major environmental problems, with detrimental and in some cases irreversible effects, society is facing, furthermore it underlines the complex relation between socioeconomic development and the improvement of the environment (Global Development Research Center, 1978; Hungerford, 2009).

Environmental education is rooted in the 18th century, based on Jacques Rousseau's declarations on the importance of caring for nature (Sunassee, Bokhoree and Patricio, 2021), furthermore it is based on the conviction that people participate as environmentally literate citizens, living appreciatively with nature and able to make responsible decisions considering future generations (NAAEE, 2010). On individual level the purpose of environmental education is to develop awareness, knowledge, values and attitudes, skills, and participation as well as critical sense in well-informed members of communities, concerned about the preservation and improvement of their environment (Global Development Research Center, 1978; Sunassee, Bokhoree and Patrizio, 2021). (Fig.5)

Environmental education is an important tool to connect outcomes from scientific research through direct stakeholder involvement to address conservation issues, to build skills for collaborative and positive environmental action and to transform human behaviour into nature friendly actions (Ardoin, Bowers and Gaillard, 2020; Sunassee, Bokhoree and Patrizio, 2021). Furthermore, access to long term environmental education from a young age up to university education is beneficial for the development of environmental awareness, it can also help foster collective action towards environmental needs and sustainable growth (Sunassee, Bokhoree and Patrizio, 2021).

Umoh (2010) lists awareness, knowledge, attitude, skills, evaluation, and action as the main goals for environmental education to promote positive interaction with ecosystems, underlining the importance of group learning through knowledge transfer from children to parents to neighbours. Active participation in field trips and similar activities have a strong influence on environmental sensitivity and pupils develop a stronger sense of empathy for nature, besides improved social and moral behaviours when involved more actively within their physical environment (Umoh, 2010; Sunassee, Bokhoree and Patrizio, 2021).

Active engagement in educational programs can increase knowledge and risk perception, and reduce conflict in favor of coexistence (Sponarski, Vaske, Bath and Loeffler, 2016). Environmental education programmes reporting positive impact on conservation outcomes honor local knowledge, experiences, practice, and values, and include marginalized groups (Ardoin, Bowers and Gaillard, 2020). Quality environmental education aims to help solving wicked problems such as climate change and biodiversity loss through an interdisciplinary approach involving many stakeholders (Ardoin, Bowers and Gaillard, 2020). The contents of environmental education programs should reflect the individual organization's mission and environmental education programs for communities living in or near protected areas are often implemented to further support conservation management (Brias-Guinart, Pyhälä and Cabeza, 2020) Frequently it is not only the learner who benefits from the educational intervention, but nature itself through measurable individual contributions (Heimlich, 2010).

In many less developed countries poverty is recognized as a responsible part for environmental degradation and the preservation of nature is intrinsically linked to development for the basic needs of the poorest people in the world and the preservation of the environment for future generations (Global Development Research Center, 1978). For example, the African Ministerial Conference on the Environment (AMCEN) has recognized environmental education as an effective means to address environmental and social challenges faced by their nations, to build awareness, change people's attitudes and provide skills to engage in sustainable development (UNEP, 2017). The African Environmental Education and Training Action Plan 2015-2024 as a result recognizes that environmental education is critical for reduction of poverty, human well-being, and a sustainable development of livelihoods on the African continent (UNEP, 2017). This long-term action plan also implies the necessity for people to learn to understand environmental issues and risks, and their causes (UNEP, 2017). Additionally, cultural and indigenous knowledge is considered a valuable resource for environmental education, especially in settings where communities depend directly on natural resources and live in an intimate relationship with the environment (UNEP, 2017).

High illiteracy, due to poor quality education, inadequate access to education, especially for women, a neglected higher education system, and colonial education system structures which have marginalized indigenous knowledge are some of the challenges

environmental education is facing in many African countries (UNEP, 2017). Research from western countries has shown that students with a high academic level show more concern for the environment, young children show the highest empathy for nature and teenagers and young adults develop a higher environmental consciousness, especially those living in a more rural environment (Sunassee, Bokhoree and Patrizio, 2021).

In developed countries most barriers to effective environmental education are related to financial or curricula constraints, as well as concerns regarding training and safety (Anderson and Jacobson, 2018). As a result, many environmental education programmes are passive instead of participatory and often fail to change people's behaviours and attitudes towards wildlife (Sponarski, Vaske, Bath and Loeffler, 2016). Although barriers for environmental education in underdeveloped countries are understudied, the general lack of financial resources and associated lack in quality education can be associated to a reduced number of field experiences (Anderson and Jacobson, 2018).

Figure 5. Objectives of environmental education (taken from: Sunassee, Bokhoree and Patrizio, 2021, p. 223)

1.2.1 Non-formal Environmental Education

It is important to distinguish between non-formal and informal education. The first consists of a structured formal programme associated with a voluntary or non-profit organization, while the latter refers to spontaneous, unguided education conveyed for example by a parent or a friend (Adams, Farrelly and Holland, 2021).

Non-formal environmental education can be defined as free choice learning that takes place outside the formal school setting for example in community-based groups for adults or boys and girls clubs for children (NAAEE, 2010). Non-formal environmental education programs address identified environmental, educational or community needs and support their organization's mission, purpose, and goals (NAAEE, 2010).

Non-formal education is an area of growing importance, although research has been predominantly focusing on the formal education sector. It is particularly important in developing countries where lack of resources often results in lack of quality education, here non-formal education can increase access to education for marginalized groups (Adams, Farrelly and Holland, 2021).

In Africa generally more progress in environmental education is noted in non-formal environmental education programs like eco-clubs, mainly carried out by NGOs who provide a more practical approach giving students a more holistic and enriching learning experience compared to the traditional more factual and technical objective of formal classroom learning (Adams, Farrelly and Holland, 2021). Additionally, NGOs can provide a tailor-made curriculum, based on locally relevant issues needed to increase knowledge and skills for daily community life (Adams, Farrelly and Holland, 2021).

1.2.2 Challenges of changing learner behaviour through environmental education

The article "Changing Learner Behavior through Environmental Education" by Hungerford and Volk has become an often cited classic in environmental education, although the article dates back to 1990, in my view Hungerford's and Volk's critical analysis remain relevant today. Environmental education as defined by the Tbilisi Conference declaration is an ambitious task aiming to educate people to demonstrate responsible environmental

behaviour (Hungerford and Volk, 1990). The objectives defined in the Tbilisi declaration are as follows:

- creating awareness, in the sense of concern for the environment,
- sensitivity in the sense of basic notion of environmental problems,
- attitudes in the sense of wanting to actively participate in environmental improvements,
- skills for solving environmental problems
- participation in the sense of actively working towards resolution of environmental problems

These objectives go well beyond education goals in its classic sense and pose a great challenge to educators, especially in developing countries (Adams, Farrelly and Holland, 2021), trying to put them into practice (Hungerford and Volk, 1990). The assumption that improved knowledge regarding the environment and related issues will translate into increased awareness and motivation to act responsibly towards the environment, is based on traditional thinking linking knowledge to favorable attitudes which in turn promote behaviour or action towards better environmental quality (Hungerford and Volk, 1990) (Fig.6). Although there are many articles on the topic, empirical evidence supporting this suggestion is limited (Damerell, Howe and Milner-Gulland, 2012; Hungerford and Volk, 1990).

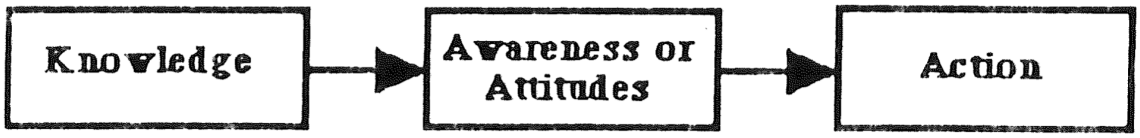


Figure 6. (taken from: Hungerford and Volk, 1990, p. 258)

Hungerford and Volk (1990) argue that behaviour in the environmental dimension can be very complex and make instructional planning difficult for the educator. Theory on behaviour change has demonstrated that responsible environmental behaviour depends on several variables, acting in linear fashion, however, more research is needed to fully understand the relationship between all variables (Hungerford and Volk, 1990). (Fig.7)

Case studies in Zambia and Zimbabwe cited in Adams, Farrelly and Holland's article (2021) on non-formal eco club education programs demonstrate changes in behaviour after practical,

hands on and fun experiences outside the classroom related to tree planting and education on reforestation.

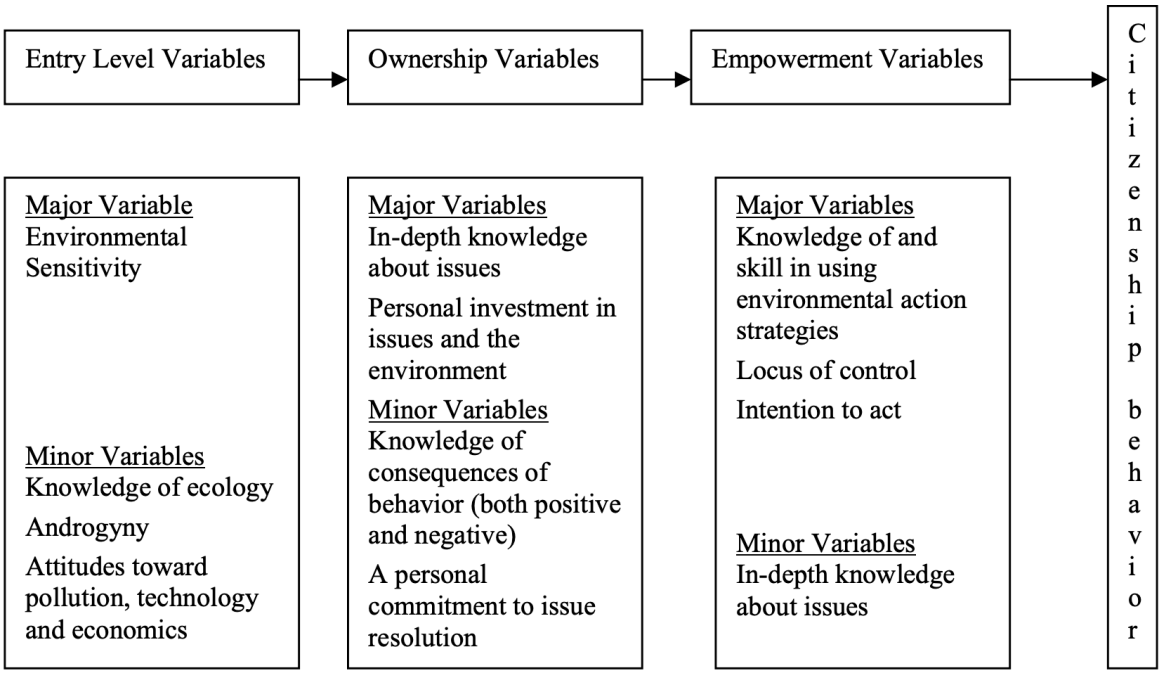


Figure 7. Environmental Behaviour Model: major and Minor Variables Involved in Environmentally Responsible Behaviour (taken from: Hungerford and Volk, 1990, p. 259)

Despite concerted efforts of countries to implement environmental education, innumerous organizations delivering environmental education programs in formal and non-formal formats for adults, children, or communities, there is little evidence for the effectiveness in changing human behaviour (Hungerford and Volk, 1990). The severity and urgency associated to environmental issues worldwide suggest that despite all efforts to provoke change in human behaviour through environmental education, its success is relatively insignificant for the big picture (Hungerford and Volk, 1990). Additionally, there are very few countries that have developed sound strategies for well-articulated environmental education programs and made a serious commitment to deliver research-based curricula preparing future citizens to participate responsibly in environmental protection (Hungerford and Volk, 1990). Finally, environmental education programs and educators seem to focus mainly on conveying information and seldomly focus on ownership and empowerment of learners, helping to develop critical skills for evaluation and investigation of environmental

issues (Hungerford and Volk, 1990). Very few success stories in environmental education focus on general problems, instead they mostly relate to local specific issues, although these specific problems are relevant for the local context, learners are not encouraged to act in a general positive and responsible environmental manner, but act in a single-issue focus (Hungerford and Volk, 1990).

However, it is important to note that little research has gone into evaluation of tangible environmental education program outcomes (Ardoin, Bowers and Gaillard, 2020), but increasing studies examining the complexity of environmental topics tend to propose a nonlinear approach, away from the knowledge-attitude-action paradigm to a more dynamic approach of ecosystemic relationships (Ardoin, Bowers and Gaillard, 2020), including motivation as an important educational component to foster behavioural change (Otto and Pensini, 2017).

1.2.3 Evaluation of environmental education programs

Evaluation has proven effective to help attain objectives of environmental education programs (Kopnina and Meijers, 2014). Carleton-Hug and Hug (2010) define evaluation of environmental education programs as the systematic collection of program contents to improve their effectiveness for future programs, however they alert that the process can be challenging in the absence of clearly defined program objectives (Carleton-Hug and Hug, 2010).

Over several decades researchers and practitioners have demanded evidence of the correlation between environmental education and positive direct environmental outcomes (Ardoin, Bowers and Gaillard, 2020). Although evaluation helps fine tuning educational objectives with the organization's mission, as well as assessing an organization's impact, there is a lack of robust evaluation tools demonstrating direct outcomes of environmental education programs (Heimlich, 2010). Kopnina and Meijers (2014) distinguish between summative and formative evaluation, the first one measuring whether program outcomes can be linked to interventions and the second aimed at improving processes, by analyzing strong and weak points which can affect program outcomes.

In many cases evaluation of an educational program is carried out through simple before/after measures within few days of program completion (Carleton-Hug and Hug, 2010), by simply checking on knowledge gain, but not considering appropriateness or structure of the program itself (Heimlich, 2010) and without considering that sustainable knowledge gain only occurs after a longer period and repeated intervention (Carleton-Hug and Hug, 2010).

There seems to exist some institutional resistance to evaluation, not only due to lack of funding, or lack of institutional policy, but often due to lack of understanding of the importance of evaluation processes, fear of negative consequences or lack of incentives (Carleton-Hug and Hug, 2010). In many cases educators are strongly attached and involved in specific educational programs and lack sufficient objectivity to see advantages in evaluation, instead they fear negative outcomes for their project (Carleton-Hug and Hug, 2010). Fortunately, interest among environmental education practitioners to incorporate evaluation in their work is growing (NAAEE, 2010).

1.3 Children as target audience

The implementation of the Goals for Sustainable Development includes education for sustainable development for children and learners of all ages to prepare for the current and future challenges, such as climate change, environmental degradation, and loss of biodiversity among others (UNESCO, 2022). The Human Rights Council has included the right to a healthy environment as a fundamental right of the child, recognizing children as the most vulnerable group to environmental harm (UNESCO, 2022). Education for sustainable development is a holistic learning approach enhancing cognitive, social, emotional, and behavioural aspects of learning, preparing the learner to take informed decisions and make responsible decisions (UNESCO; 2022). Therefore, environmental education for children is important and most educational programs follow two main objectives: teaching facts about the environment and influencing attitudes (Matsui, 2021).

In many countries children are seen as environmental ambassadors and key stakeholders for the future and represent the main target audience for environmental education as they form an interested audience, need to be prepared for present and future environmental challenges, and are easier to teach than adults (Vaughan, Gack, Solorazano

and Ray, 2003; Stephens, Short and Linnane, 2021). Ecological behaviour and a connectedness to nature, as well as the motivation to be ecologically friendly are developed in early childhood and probably have a lifelong effect on people's environmental knowledge and behaviour (Otto and Pensini, 2017). Furthermore, children can develop positive attitudes towards biodiversity through personal outdoor experiences and a strong nature connectedness (Otto and Pensini, 2017; Ballouard, Brischoux and Bonnet, 2011). For example, Rakotomamonjy et al (2014) have studied the effect of environmental education on children in Madagascar for conservation interventions and affirm that direct experience is an important component of improving understanding of species and biodiversity.

Education and learning are seen to be of fundamental importance to acquire the skills and knowledge for sustainable living and preparing children and young people for their role as agents of change (Percy-Smith and Burns, 2012). However, researchers argue that conveying only objective facts and knowledge does not automatically lead to a change in attitudes and behaviour, suggesting that emotions and illogical behaviour play an important part (Matsui, 2021). For example, Percy-Smith and Burns (2012) argue that education for sustainable development needs to focus on active and critical learning and move away from a global approach, giving children and young people instead the opportunity for active involvement on local community level. Examples for active learning, in contrast to passive education, attribute leadership roles to children in community-based projects or promote peer education among children to develop a sense of their own capabilities to help them become agents of change (Percy-Smith and Burns, 2012). Children need a greater autonomy, with adults acting as co-learners and facilitators, rather than restrictors, to become responsible learners for sustainable development (Percy-Smith and Burns, 2012). Motivation is considered an important factor for successful environmental education, and it is fostered through personal, nature-based out of the classroom experiences and through close contact with nature (Otto and Pensini, 2017).

Due to financial and time constraints, for many educators the internet has become an important tool for providing information and in many cases has become a substitute for field trips (Ballouard, Brischoux and Bonnet, 2011). The shift from outdoor nature experiences to online learning has shifted knowledge about biodiversity to more exotic and appealing species over local species (Ballouard, Brischoux and Bonnet, 2011). Often virtual agents are

used as teachers, with the advantage that these can address emotional factors and create a greater affinity improving learning outcomes (Matsui, 2021).

Education systems in poor countries, which are often among the richest in biodiversity, are often centered on the teacher in the classroom, and lack the resources for pupils and even teachers to have deeper, interdisciplinary, direct experience through local field trips, which can result in lack of knowledge for effective environmental education (Rakotomamonjy et al, 2014; Calvente, Kharrazi, Kudo e Savaget, 2018).

Biodiversity loss, ecological degradation, pollution, demographic growth, are pressing issues for the environment and many educators defend that there is not enough time to wait for children to grow up (Vaughan, Gack, Solorazano and Ray, 2003). Damerell, Howe and Milner-Gulland (2012) also defend in their study that environmental education should not be exclusive for children. However, due to time constraints and illiteracy, it is more difficult to reach adults effectively and therefore many communication strategies rely on children to influence their parents (Marchini and MacDonald, 2020), case studies from the Seychelles for example have shown that children pass on knowledge acquired on the environment and influence household behaviour (Damerell, Howe and Milner-Gulland, 2012).

1.3.1 Intergenerational Knowledge Transfer

The concept of knowledge transfer is defined as a fundamental process central do learning and critical for development, where knowledge is shared among individuals, groups, or organizations without a clear objective and where one party conveys the knowledge, while the other one assimilates it (Paulin and Sunesun, 2012). Intergenerational learning, where experiences, information, beliefs, or values are shared, usually occurs informally from the older generation to the younger and it can be enrichening for both, however, research indicates that this influence can be bi-directional with children conveying knowledge and influencing the behaviour of adults (Istead and Shapiro, 2012; Stephens, Short and Linnane, 2021).

Publications on intergenerational learning remain scarce, but it is recognized that families are a main context for learning benefitting both, parents, and children (Ho, 2010).

The example given by Ho (2010) of Generation X, referring to those born in the 60s and 70s and Generation Y, designating the generation born immediately afterwards, illustrates the shift from more passive classroom memorizing techniques to modern ICT learning, pointing out how Generation Y transfers digital knowledge to the older generation. (Fig. 8) The bi-directional influence of intergenerational learning is particularly strong in smallholder farming contexts, a case study from South Africa demonstrates how early family learning starts by playing on the farm, but also how the younger generation influences farming techniques of their fathers through acquired internet knowledge and implementation of more recent farming practices (Van Niekerk, Mahlobogoane and Tirivanhu, 2015).

Some environmental education programs taught for children are intended to transfer knowledge and increase adults' environmental knowledge and influence attitudes and behaviour (Lawson et al, 2018; Duvall and Zint, 2007), they are also believed to help mitigate conflict and help change perceptions, but this approach is little documented until now (Marchini and MacDonald, 2020). Successful child to adult knowledge transfer has been documented in recycling campaigns, food waste or energy consumption campaigns (Lawson et al, 2018). These campaigns can increase their impacts, reach more people, and give children the motivation to become educators and influence community behaviours (Stephens, Short and Linnane, 2021). Further case studies on children's function as catalysts influencing parental or community environmental behaviours have produced mixed results but noted more positive impacts when children where directly involved and learning from local issues (Istead and Shapiro,2012; Duvall and Zint, 2007).

Intergenerational influence can only occur when environmental education programs are adequately designed to encourage and promote intergenerational learning, and research has shown that the strength of the relationship between child and adult plays an important role in knowledge transference (Stephens, Short and Linnane, 2021). It is also difficult to proof whether knowledge transfer has occurred and positively influenced environmental behaviour (Rakotomamonjy et al, 2014).

Research has shown that experiments with take home materials or homework related to an environmental education program can have an influence on knowledge transfer, as this material might stimulate discussion at home, or have an impact on information dissemination or may require parents' direct involvement (Vaughan, Gack, Solorazano and Ray, 2003; Marchini and MacDonald, 2020; Stephens, Short and Linnane, 2021). These materials also

serve to extend the learning experience, deepen understanding and memory of the gained knowledge (Stephens, Short and Linnane, 2021).

Ballantyne, Fien and Packer (2001) postulate that children's tendency to transmit acquired environmental knowledge to parents or the wider community increases after participation in hands-on activities or powerful experiences. A focus on local environmental problems, involving students in monitoring and giving them ownership experiences can also increase the probability of knowledge transfer (Ballantyne, Fien and Packer, 2001; Duvall and Zint, 2007).

Intergenerational learning can also be useful in developing countries, where the younger generation is reachable at school and can transmit learnings and factual information to the older generation which is less easy to contact (Ho, 2010; Marchini and MacDonald, 2020) Child-to-adult knowledge transfer can also have a positive impact on HWC resolution to the benefit of conservation (Marchini and MacDonald, 2020).

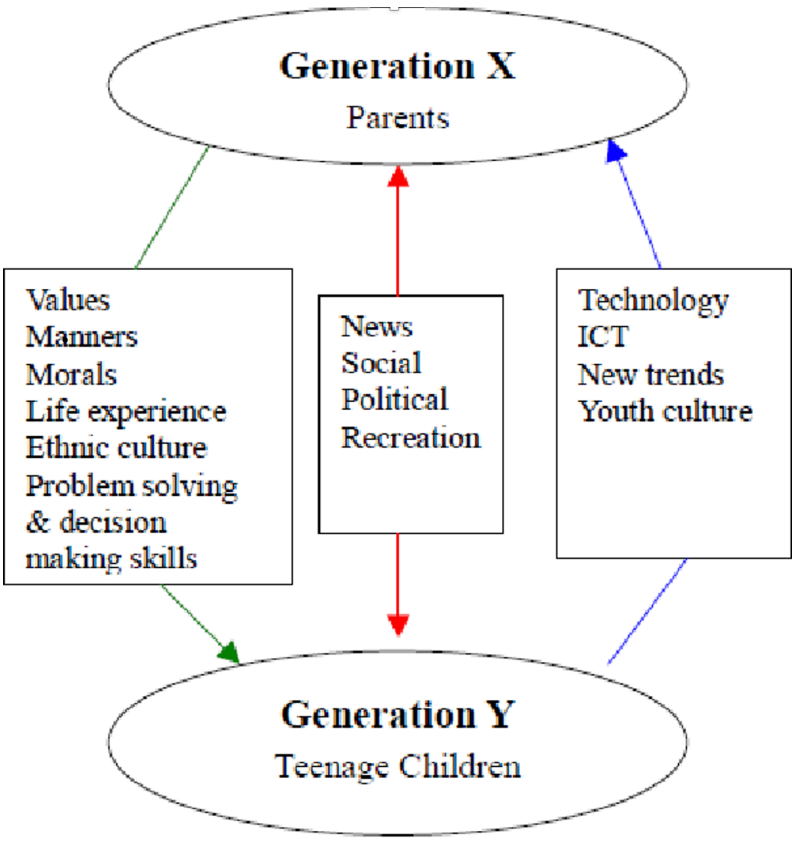


Figure 8. Intergenerational learning between parents and children (taken from: Ho, 2010, p. 72)

II. Study site characteristics, case study and methodology

2. Study approach

Building on the results of a pre- and a post-assessment this study describes specific sociodemographic characteristics of the participants, it also aims to analyze whether knowledge of the respondents has increased from the pre-test to the post-test results, whether the speculative increase of knowledge is related to age or length of residence in the community and whether transfer of knowledge from child to adult has occurred.

Additionally, I am testing the hypothesis that knowledge can influence attitudes towards wildlife, trying to establish relations to gender, age, and place of residence (community).

Finally, I am analyzing the hypothesis that the pre- and post-test results reflect changes in attitude towards coexistence and beyond conflict, which could indicate trends for possible future change in behaviour among the participants.

2.1. Study site

The Gorongosa National Park (GNP) is situated in central Mozambique, in Sofala province, northwest of Beira, at the southern tip of the Great Rift Valley (Fig 9) and until 1971 it was the only National Park in Mozambique (Tinley, 1977).

During the Portuguese colonial occupation, it was first a hunting concession (established in 1920) and was then declared a National Park in 1960. Together with the Gorongosa Mountain, which was included in the protected area in 2010, the park now extends over approximately 4000 km2, and is surrounded by a 5300km2 buffer zone (Gaynor et al, 2018).

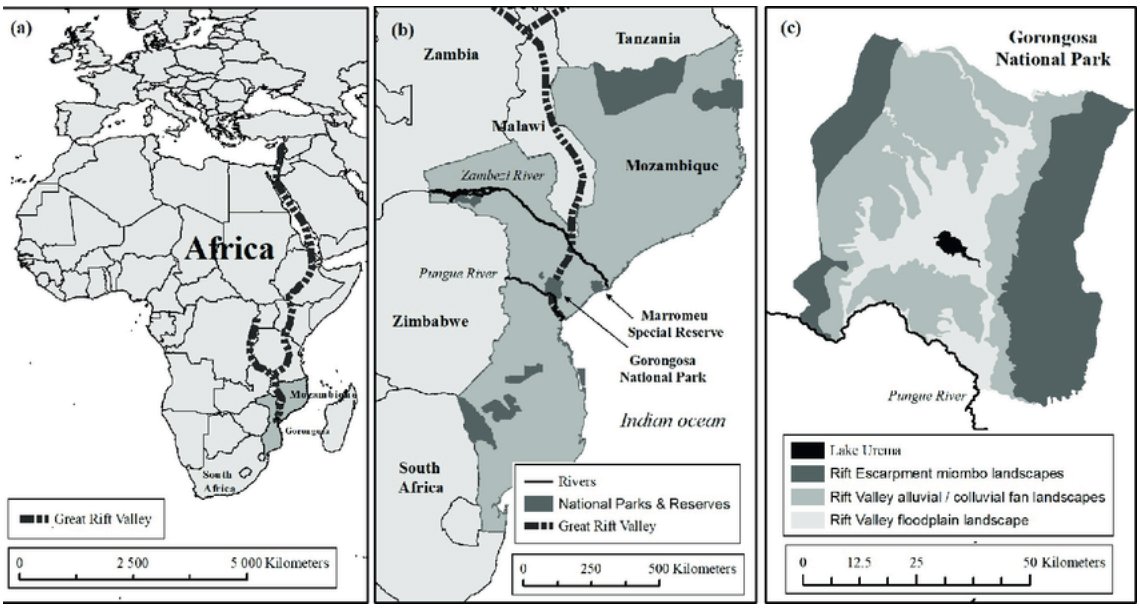


Figure 9. Map of GNP in Mozambique, showing (a) Locality of the Great Rift Valley and of Mozambique within Africa; (b) Location of GNP and other Protected Areas (dark gray) within Mozambique; and (c) Major landscape types of GNP (taken from: Stalmans et al, 2019, p.3).

2.1.1. Geography, climate, and biodiversity

The GNP's ecosystem consists of three important types of landscapes: forest, savanna, and grasslands (Tinley, 1977). Its geography is dominated by an approximately 40 km wide and low area, with elevation between 15 to 80 m above sea level, forming the valley floor of the southern tip of the Great Rift Valley and the slightly more elevated valley flanks, these hilly regions have an elevation of 300 to 400 m above sea level (Stalmans et al, 2019; Herrero et al, 2020).

The vegetation consists of open grasslands, floodplains, dominated by lake Urema, in the low areas, and mixed savannas of grass, shrubs, and trees, and closed thick woodlands in the slightly higher regions (Herrero et al, 2020). The flanks of mount Gorongosa are covered with montane rainforest, while the summit exhibits rocky grasslands (Herrero et al, 2020).

The climate is humid-tropical with two seasons: rainy between December and March and dry for most of the remaining time. Minimum temperatures during the dry season average 15Cº and raise to an average of 30Cº during the rainy season, with an annual rainfall of approximately 700-900mm (Herrero et al, 2020). The equilibrium of these wetlands,

grasslands and savannas depends on natural occurring fires and large herds of herbivores, while PNG's main water source comes from Mount Gorongosa (Yeats, 2010).

The GNP has a wide diversity of herbivores, ranging from waterbuck, over reedbuck, nyala, kudu, sable, impala, duiker and suni, to hippo, buffalo, zebra, and elephants; as well as warthogs, bushpig, porcupine, pangolin, baboons and other primates (Tinley, 1977) and predators, such as lions, painted wolves and leopards (Stalmans et al, 2019). Until 1935 white rhinos were recorded in PNG, as well as rare sightings of black rhino. Cheetahs were present until 1950, as well as jackals and spotted hyena (Tinley, 1977). In 1965 over 300 bird species were recorded in GNP, including African fish eagle, weavers, crowned cranes, hornbill, lilac breasted rollers, turacos, and orioles (Tinley, 1977; Gorongosa National Park, 2020).

Tinley (1977) mentions a total of 2.542 elephants, and 13.293 buffalos, as well as over 6.000 wildebeest and over 3.000 zebras and hippos, during an aerial count in 1972.

During the 15 years of civil war from 1977 to 1992 with FRELIMO and RENAMO fighting in most of the central region of Mozambique, many of Gorongosa's wildlife species were killed to feed the soldiers and to buy arms in exchange of ivory. Gorongosa's large elephant herds were reduced from over two thousand to just over two hundred individuals (Branco et al, 2019). The almost extinction of Gorongosa's bulk grazers has led to overgrowing of high grass with dangerous fires consequently (Yeats, 2010). However, most of the bird and reptile population have stayed intact, and PNG counts today over 400 bird species, including the Green Headed Oriole, endemic to Mount Gorongosa (Yeats, 2010).

2.1.2. Social context and local communities

Mozambique is among the poorest countries of the world, with an estimated 63% of the population living below the poverty line in 2020 (The World Bank, 2021). With poverty falling somewhat faster in urban areas, the imbalance to the rural population has increased after the two tropical cyclones hit Sofala and the North of the country in 2019, reducing agricultural output, the most important source of livelihoods for Mozambicans living in rural areas (The World Bank, 2021).

Sofala is one of the most important provinces of the country, both politically and economically. To the north Sofala is bordering with the provinces of Tete and Zambezia, to the south with Inhambane, to the west with Manica and to the east with the Indian Ocean (GTZ, 2010). Sofala has approximately 2,5 million inhabitants, most of them living in rural areas, and its capital Beira is the second largest city of the country, with an important port. The province has economic importance with forestry and agriculture and the so-called Beira Corridor linking the coast to landlocked neighbours like Zimbabwe, Zambia, and Malawi (GTZ, 2010). Besides agricultural production of food crops for local consumption and sales, the region produces sugar and cotton (GTZ, 2010). Politically the region is known as centre of the opposition party RENAMO (GTZ, 2010).

The last Census (2017) estimates 36,1% of Sofala's population living below the poverty line, HIV/Aids prevalence among the population aged 15-49 is 26% and 35,9% of the children are chronically undernourished, with 26,2% of children between 0-5 being under weight (The World Bank, 2021; UNICEF, 2022)). Illiteracy is high among the adult population with 36,8%, 51,9% of the female population cannot read or write (The World Bank, 2021; UNICEF, 2022)). 34,5% of the households have no access to save drinking water and 64,1% have no basic sanitation (UNICEF, 2022).

Sena and Ndau are the two predominant ethnic groups of Sofala province, and Chisena is spoken by 49% and Chindau by 29,8% of the population respectively (Social Science in Humanitarian Action, 2019). Catholicism in the form of Zionism, a hybrid of African and Christian tradition, is the predominant form of religion, 82% of the Sena people are catholic, many of them converted during the colonial times (Social Science in Humanitarian Action, 2019). Portuguese is predominately spoken in the more urban areas, due to higher levels of education and a bigger multi-ethnic mix needing a common language. In the rural areas less than 45% of the population speak Portuguese and women are less likely to understand Portuguese than men (Social Science in Humanitarian Action, 2019).

Communities are organized through patrilineal systems and families organize by clans, totems, and family kinship systems, with a dominant male lineage in allocation of resources and decision making. The rural villages are organized through *régulos,* the leaders of the community, community group chiefs and population chiefs, called *secretários* (Social Science in Humanitarian Action, 2019). A bride's wealth (*Lobolo*) is paid by the groom's family to the bride's family in kind or cash and is often a driver for migration or debt. Migration to

Zimbabwe or South Africa is frequent among the men of the communities (Social Science in Humanitarian Action, 2019).

Populations in the wider Gorongosa area are predominantly subsistence farmers, shifting between plots obtained through slash and burn method, where they cultivate some sorghum, maize, cassava, sweet potatoes, beans and banana, people also practice fishing and beekeeping (Branco et al, 2019; Tinley, 1977).

Historically the Gorongosa zone has always been a hunting area, since the Bushman, over the arrival of the first Sena tribes, until Portuguese colonization when hunting pressure increased for ivory trade (Tinley, 1977). Outside the park's boundaries intensive hunting continued and lead to the decimation of wildlife populations in the greater Gorongosa area (Tinley, 1977). The overall depletion of natural resources around PNG lead to the invasion by local tribes (Tinley, 1977).

In the 1950s the human population was moved out of GNP by the Portuguese park authorities (Tinley, 1977), but during the civil war, in the early 90s, the RENAMO authorities authorized communities who had previously lived inside the park to move back (Hatton, Couto and Oglethorpe, 2001). Currently an estimate of 5000 people is living inside GNP posing a risk at its ecosystem through fishing, hunting, and farming activities (Gorongosa National Park Mozambique, 2010). Gorongosa's Ecosystem Integrity Teams work closely with these communities to prevent habitat encroachment and degradation, and support families choosing to voluntarily leave the park (Gorongosa National Park, 2020). The restrictions for communities living inside GNP are strict: no new areas can be opened for farming, the felling of trees and poaching are forbidden, and communities have no access to safe drinking water (Matos, Barraza and Ruiz-Mallén, 2021).

GNP fosters sustainable development of the region outside the park boundaries, investing in human development, improvement of access to healthcare and education, job creation and improvement of agricultural practices (Ministério da Terra, Ambiente e Desenvolvimento Rural, 2016), aiming to unlock the economic potential of the surrounding buffer zone and the wider province of Sofala (Gorongosa National Park, 2020). 16% of the park's revenues revert annually to the buffer zone communities (Gorongosa National Park Mozambique, 2010).

The GNP's buffer zone, where approximately 200.000 people live, is a so-called mixed area, authorizing agriculture, controlled burning of arable lands, livestock and harvesting of

natural resources (Gaynor et al, 2018). Some human activities have adverse effects on the biodiversity, ranging from illegal poaching for bushmeat and trophies, over selective logging, and deforestation for charcoal production or slash and burn technique to open new farmlands (Herrero et al, 2020).

The seven communities of this case study are in Nhamatanda district, in the GNP buffer zone, south of the Pungwe river and are densely populated with subsistence farmers producing predominantly maize, but also sweet potatoes, beans, and banana (Branco et al, 2019) (see appendix 1 fig 1, 2 and 3 for additional maps for settlements and cultivation areas in GNP's buffer zone).

2.1.3. Key conservation interventions in the area

The Gorongosa Restoration Project (GRP) is the result of a public-private agreement signed between the Mozambican Government and the Carr Foundation, a US non-for-profit organization; the agreement was signed in 2008 for a 20-year period and has since been extended to 35 years (Gorongosa National Park, 2020). The rehabilitation plan to restore the park's ecosystem after nearly two decades of war, followed by uncontrolled extraction of resources, includes the rehabilitation of park infrastructures, employment and training of staff, maintenance of infrastructures and road systems, as well as scientific study and education (Gorongosa National Park Mozambique, 2010).

The protection of Gorongosa's flora, fauna and endemic habitat is a key objective for the park's conservation interventions, the protection of Mount Gorongosa is fundamental to conserve GNP's hydrological ecosystem. The GRP has created a couple of income generating initiatives for the local communities living on the mountain to stop unsustainable farming practices. The Gorongosa coffee project is one of them: coffee needs tree canopies to provide shade and the reforestation of Mount Gorongosa's slopes helps to protect the soils from erosion (Gorongosa National Park Mozambique, 2010).

Other key conservation interventions are the protection of species from poaching and wildfires, mapping of principal large mammal species, the regular monitoring of wildlife population numbers through every four-year census' and the introduction of critical species.

The GRP also seeks to prevent the presence and introduction of invasive species (Gorongosa National Park Mozambique, 2010).

GNP seeks to establish partnerships with the buffer zone communities for the park management and sharing of benefits, as well as to establish a strategy to minimize human-wildlife conflict (Gorongosa National Park Mozambique, 2010).

The GRP benefits from scientific research carried out on site by partner organizations such as Princeton University and other associated researchers, but also through the interventions from Mozambican students doing their masters in conservation biology directly in GNP (Gorongosa National Park, 2020).

The Gorongosa Biodiversity Exploration Team runs an extensive program of species mapping and documentation and has recorded over 6300 species of plants and animals, over 100 of them new to science, and over 25 endemic to Gorongosa National Park (Gorongosa National Park, 2020).

The GRP has brought the necessary investment to increase protection of all species in GNP and numbers of large mammals are recovering fast, currently the elephant population is estimated at above 800 individuals (Gorongosa National Park, 2020), while the available habitat allows for over 2000 individuals (Ministério da Terra, Ambiente e Desenvolvimento Rural, 2016). To restore Gorongosa's grasslands the park has reintroduced buffalo, wildebeest, and zebras (Yeats, 2010), as well as painted wolves and leopards (Gorongosa National Park, 2020).

2.2. Case study

2.2.1. Background

In the GNP management plan for 2010-2012 (2010) a table for the most important wildlife shows the results from three different aerial counts for the park's elephant population, the pre-war aerial count in 1972 indicates 2.200 individuals, after the 15 years of civil war this number dropped to 108 individuals in 1994, and in 2007 shows a slight recovery to 300 individuals. The last aerial count in 2018 indicates that Gorongosa's elephant population has increased to approximately 800 individuals since the beginning of the GRP (Gorongosa

National Park, 2020). A study by Stalmans et al (2019) on the asymmetric recovery of Gorongosa's large-mammal populations also indicates a steady increase of the elephant population over the past 20 to 25 years. (Fig.10)

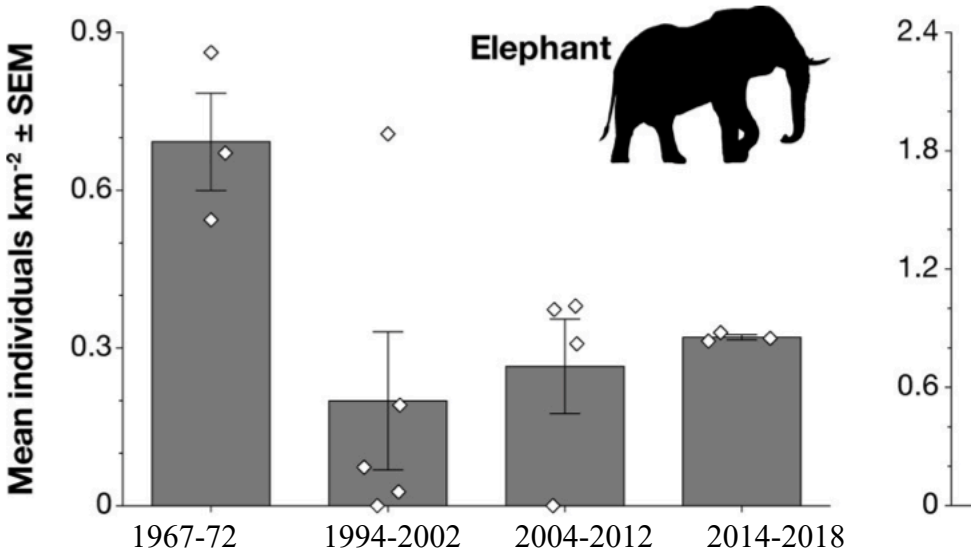


Figure 10. Estimated densities of elephant through time**.** Bars show number of individuals per square kilometer surveyed within the core Rift Valley count block, averaged across all aerial counts within each temporal interval: pre-war surveys from 1969–1972 (n = 3), and post-war surveys in 1994–2002 (n = 5), 2004–2012 (n = 4), and 2014–2018 (n = 3). Diamonds show the values obtained for each survey within each interval. Error bars show ± 1 standard error of the mean. (taken from: Stalmans et al, 2019, p. 8)

The positive recovery of elephant numbers in GNP to close to 800 individuals has the negative downside of increasing interaction with the communities living in the park's buffer zone (Gorongosa National Park, 2020), putting the elephant population's security at great risk through retaliation or illegal hunting, while jeopardizing people's economic and food security through crop raiding elephants (Gorongosa National Park, 2020).

At present the elephants herds only use approximately 10% of their historic range and concentrate in the southern part of GNP, close to the Pungwe river, which forms the southern border of GNP, the park has no fences besides this natural barrier (Gaynor et al, 2018), (Fig 11).

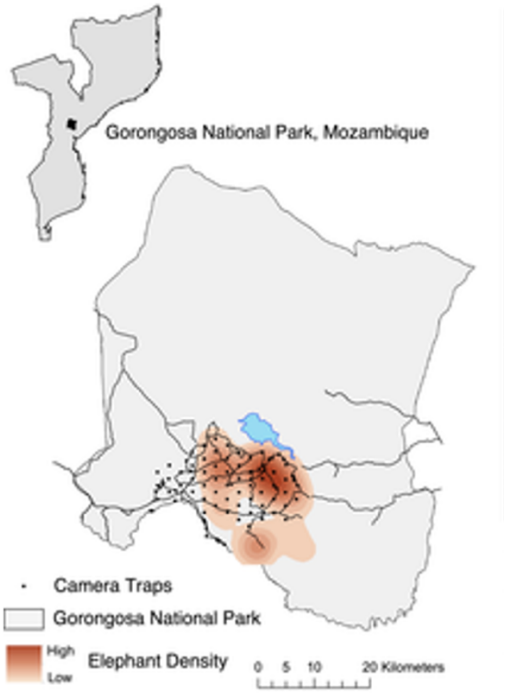


Figure 11. Concentration of elephant herds in southern part of GNP (taken from: Gaynor et al, 2018, p. 876)

Additionally, natural catastrophes, often triggered and increased through the effects of climate change, have influenced the elephants' migration routes: the prolonged floods provoked by Cyclone Idai in 2019, forced several elephants to move to more elevated areas and at present a few of them still remain outside the park's boundaries in the buffer zone, refusing to return to the park (Marcelino Denja, Human Wildlife Coexistence, GNP, May 2022).

Human and elephant coexistence initiatives, as well as people's attitudes and knowledge regarding elephant behaviour, are essential to the dynamic process of coexistence in harmony (Gorongosa National Park, 2020). The Elephant Ecology Project (EEP) studies elephants' behaviour through human shared landscapes and aims to protect the elephants' critical role in maintenance and shaping of the ecosystem (Gorongosa National Park, 2020). GNP invests in Community-based Natural Resources Management (CBNRM) with special focus on women's empowerment, and honey production is one of the income-generating projects directly linked to Human-Elephant Coexistence (Gorongosa National Park, 2020).

Based on Lucy King's research with African honeybees and African elephants' natural fear of bee stings (King, 2020), the park set up several kilometers of beehive fences at critical crossing points along the Pungwe river do deter crop raiding elephants (Fig.12 and 13). Dr. Lucy King is a South African zoologist, currently heading the Human-Elephant Coexistence Program of Save the Elephants, a research and conservation organization working in East, Central and Southern Africa. As part of her PhD, King studied elephants' reaction to African honeybees and based on her findings and the traditional knowledge of indigenous Kenyans, King developed beehive fences where populated beehives, alternating with empty dummy beehives, are hanging on metal wires (King, 2020). When elephants hit these wires, bringing them to swing, they cause alert among the bees, provoking aggressive swarming. The bees sting around the eyes, ears, mouth, and trunk, where the elephant's skin is much less thick. Additionally, the bees release a pheromone attracting other bees to sting at the same point (King, 2020). Elephants not only fear African honeybees, but King's studies also indicate that they transmit warnings to other members of the herd to avoid angry bee swarms.

Figure 12a and b. Beehive fences in Mutondo Community, Nhamatanda district, Gorongosa Buffer Zone (Photos by Nicole Azevedo, May 2022)

The beehive fences and associated honey production are well accepted among the local communities living in the southern buffer zone, most affected by crop raiding elephants (Piano Jantar, Manager of Human-Wildlife Coexistence programs, GNP, May 2022). GNP also supports the communities through building cement silos for better protection and storage of crops. The park rangers control the areas with most elephant crossings, train the communities how to deploy fire works and how to best defend their farms, however there are no hundred percent effective techniques to keep elephants away from mature crops. Elephants are highly intelligent and persistent and permanently try to open new crossing points, avoiding beehive fences and getting access to new crops further into the buffer zone (Piano Jantar, Manager of Human-Wildlife Coexistence programs, GNP, May 2022). In the year 2021 alone crop raiding elephants destroyed 13 hectares of crop and 6.000 kilos of maize in the southern part of the GNP buffer zone (Marcelino Denja, Human Wildlife Coexistence Department, GNP, May 2022).

The GNP department for sustainable development together with the department for human development and the Human-Wildlife Coexistence Programs invest in educational programs to help create knowledge and awareness among the local communities living in the park's buffer zone (Gorongosa National Park, 2020). Part of these programs is information regarding the increased risks for people living in the direct vicinity of an unfenced protected area home to buffalos, painted wolves, crocodiles, and elephants, among many other species (Kansky, Kidd and Knight, 2016; Bhatia, Redpath, Suryawanshi, and Charudut, 2019). Another main objective of these educational programs focusses on the importance of conservation in general and the essential role of keystone species, such as elephants, for the GNP restoration project, the wider ecosystem, as well as the associated generation of tourism revenues (Gorongosa National Park, 2020).

In partnership with the departments for human development and conservation, the department for sustainable development of GNP produced an illustrated guide for Human-Elephant-Bee coexistence for children as a tool for environmental education (Appendix 2). The booklet aims to address the increasing Human Elephant interaction in the park's buffer zone, with special focus on Nhamatanda district, south of the Pungwe river.

The illustrated Guide for Coexistence is divided in three parts, part one conveys basic information and facts about elephants, their preferred food, their habitat, their importance

for the ecosystem, information related to their size, weight, longevity and similar, as well as information regarding their social structure, behaviour when threatened, including recommendation of how to behave during an encounter with elephants. Part two of the booklet is dedicated to facts and information about bees, their social hierarchy, their communication system, the importance of pollinators to the ecosystem, the benefits of honey and associated derivates, such as beeswax, pollen and propolis, and some basic rules how to avoid irritating a bee swarm. The third and final part of the guide to coexistence explains that elephants fear bees and how beehive fences can help keeping elephants away from crops and human settlements and therefor improve the peaceful coexistence of elephants and humans.

3.2.2. Work underpinning the research

This Case Study was developed based on an experiment with Brazilian school children and their fathers, described by Marchini and Macdonald, in their article: “Can school children influence adult’s behavior towards jaguars? Evidence of intergenerational learning in education for conservation” (2020). In the experiment the researchers test the influence of conservation education on increased knowledge, improved attitudes and change of behaviour regarding conservation in general and the protection of emblematic species. The researchers also aimed to test intergenerational knowledge transfer through communication messages directed at the children, functioning as catalysts of information for their parents and the wider community. The experiment is intended to add further insight to the understudied methods of achieving behavioural changes, such as increased tolerance through gained knowledge in human-wildlife conflict, through an illustrated booklet conveying information on Mexican jaguars (Marchini and Macdonald, 2020).

Marchini and Macdonald (2020) divided the children in five different groups and tested the difference between information received passively and actively engaged learning through cognitive elaboration, lectures with assigned homework, discussions, and take-home material. They also tested the hypothesis that information conveyed through institutions like schools would have a more positive effect than information conveyed through local NGO’s.

The case study developed by GNP's department for sustainable development is somewhat less complex and extensive than the research carried out by Marchini and Macdonald, here all participants from the seven selected primary schools responded to the same two surveys, one before and one after intervention, allowing for a comparison of survey results from the pre- and post-tests. However, the GNP case study represents the first survey done with communities from the buffer zone, suffering under HEC and will therefore contribute to a compilation of baseline information regarding the community's knowledge, perceptions, and attitudes towards elephants. Additionally, the survey results can give insight whether knowledge transfer from child to parent has occurred. The survey results can also indicate correlations between some of the sociodemographic data and participants answers to the survey questions and whether some of these answers changed between the pre- and post-test.

Ultimately, this case study can serve as a contribution to indicate the importance of specific environmental education interventions, prepared for, and adapted to specific local contexts, and whose results, measured in this case study, can add insight to a framework helping to foster coexistence between communities and large mammals in a variety of ecosystems.

2.3. Survey design

A questionnaire (see appendices 3 and 4 for Portuguese and English versions of the questionnaire) was designed by the GNP's department for sustainable development, including the following initial sections: introductory statement about study goals, its duration and agreement to participate (informed consent form and declaration of voluntary participation, as well as the information that there are no right or wrong answers to the surveys, and that it is the opinion of each interviewee that matters), additionally each questionnaire was coded with an ID number (in numeric order from 1 to final interviewee per community), plus the interviewees name, to allow to correctly match fathers or mothers with their respective child for the second survey. Socio-demographic information regarding age, gender, degree of kinship, place of residence, length of residence, occupation, and literacy level was also registered. The following parts included variables related to A: General

knowledge about elephants, with an associated point scale from 0 to 10; B: Perceptions of damage caused by elephants to "machambas" (small agricultural plots), perception of the likelihood of elephants invading crops in the next 12 months and the general perception of damage caused by elephants passing through property, with an associated scale of 0 to 15 points. Questions C1 and C2 aim to evaluate the perceived impacts of elephants regarding people's and the community's safety with an associated point scale from 0 to 10; question D evaluated general attitudes towards elephants with an associated point scale from -10 to 10; question E evaluated people's self-reported reactions towards elephants on their property with a point scale from -2 to 2; question F analyses the descriptive norm, namely if neighbours and farmers display aggressive behaviour towards elephants, with an associated point scale from 0 to 8. The final question G aims to evaluate empathy towards and abandoned elephant calf (Table 1).

Table 1: Dependent variables used in this study to explore knowledge, attitudes and perceptions of children and their parents, living in communities in the GNP buffer zone, affected by crop raiding elephants

Conceptual structure (based on Marchini and MacDonald, 2020)			
Dependent variables	Indicator	Description	Rationale
A General knowledge regarding elephant behavior and biological aspects	Correct and incorrect affirmation Point scale from 0 to 10		Create knowledge baseline
Behaviour of elephants	correct	Elephants show signs of alert/aggression before attacking A male elephant is more aggressive than a female elephant	
Behaviour of elephants	incorrect	A male elephant is more aggressive than a female elephant	
Biological aspects	correct	Elephant tusks are like tooth and grow lifelong	
Biological aspects	correct	Elephant claves can weigh 100k when they are born	
Biological aspects	incorrect	Elephants can live a hundred years	

Behaviour of elephants	incorrect	Males live with the herd all year	
Behaviour of elephants	correct	Males are more aggressive during breeding season	
Behaviour of elephants	incorrect	Elephants are not afraid of people, that's why they destroy their crops	
Human behaviour	incorrect	When encountering an elephant, we should run and stay alone	
Fact	correct	Elephants are afraid of bees	
B Perception of elephant's impact on fields	From none (0) to high (5) Point scale from 0 to 15		Evaluate perceived economic impact
	0= none,1=very little, 2= little, 3= medium, 4= high, 5= very high	What degree of destruction have elephants caused to your field?	
	0= none,1=very little, 2= little, 3= medium, 4= high, 5= very high	How high is the possibility of elephants passing through your families' fields and destroy them during the next year?	
	0= none,1=very little, 2= little, 3= medium, 4= high, 5= very high	How much is the degree of destruction elephants have already caused you?	
C Perception of elephant impact on people's and the communities' safety	Point scale from 0 to 10		Evaluate psychological impact
	Indicate number	Number of people hurt or attacked by elephants in your neighbourhood/community	
	Point scale 10 from 0 to	How do you classify the risk of being attacked by an elephant in the next 12 months?	
D Attitude towards elephants	Point scale from -10 to 10		Evaluation of empathy/value
	-1= diminish, 0= stays the same, 1= increases, 2= increases a lot	I would like the elephant population in the region to…	

	-2= very happy, -1= happy, 0= neither happy nor sad, 1= sad, 2= very sad	If elephants were to disappear from where I live, I would feel…	
	-2= like very little, -1= like a little, 0 = don't like nor dislike, 1= like, 2= like a lot	What do you feel regarding elephants? Best described as…	
	-2= disagree totally, -1= disagree, 0= Don't agree nor disagree, 1= agree, 2= agree totally	Elephants have a value, even if this doesn't generate any income for you	
	-2= disagree totally, -1= disagree, 0= the same, 1= agree, 2= agree totally	If you had to walk in the forest near your house and would encounter an elephant, would you feel in danger?	
E Attitude towards chasing or attacking elephants	Point scale from -2 to 2		Evaluation of behaviour
	-2= very useful, -1= useful, 0= the same, 1= little useful, 2= very little useful	Chasing/Attacking any elephant on my property is…	
F Descriptive norm	Point scale 0 to 8		Evaluation of social standard/behaviour
	0= none, 1= less than half, 2= half, 3= more than half, 4= all	How many neighbours think the display aggressive behaviour towards elephants?	
		How many farmers (owners of fields) think of attacking or killing elephants?	
G Practical perception	0= chase away, 1= nothing, 2= help the calf	Confronted with the following situation:	Behavioural disposition
		An elephant calf is found lost in my field, what would I do?	

All seven sections of the survey were elaborated in close link to the above mentioned article by Marchini and MacDonald (2020) applying the author's predictions of improved

perception through conveying factual information regarding an emblematic species, knowledge transfer through children participating in a non-formal education program and transfer of knowledge gained from educational materials (here the illustrated booklet) from the children to their parents, promoting a change of attitude towards elephants (jaguars in Marchini and Macdonald's paper).

In addition to the pre and post-test, immediately before and after the exposure to treatment, Marchini and Macdonald (2020) did a third delayed post-test, approximately three months after the first two surveys to test retention of treatment effects, no such delayed post-test has been administered by the GNP team until now.

A pilot study of the survey was carried out with the educational program promotors from Nhmatanda (Sede) the group was comprised of nine women and six men. After the pilot study minor adjustments, such as substitution of some wording, were made to some of the survey questions, without significantly changing any of the surveys structure.

All procedures performed in both surveys were in accordance with the ethical standards of GNP's research committee. The before and after surveys contain sensitive data (names of participants) and were therefore stored safely by the GNP team for sustainable development, the Microsoft Excel result spreadsheets were anonymized and only contain the numeric ID of each participant.

2.4. Survey administration

Seven communities from the GNP buffer zone were selected for this study (Vinho, Bebedo, Mutondo, Nhamacaza, Mucharuenhe, Mitcheu and Momba; Fig.13), because during the year 2021 they were most affected by frequent invasions of crop raiding elephants during night and even daytime (information supplied by Marcelino Denja, Human Wildlife Coexistence Department, PNG, May 2022). All chosen communities are part of Nhamatanda district, south of the Pungwe river.

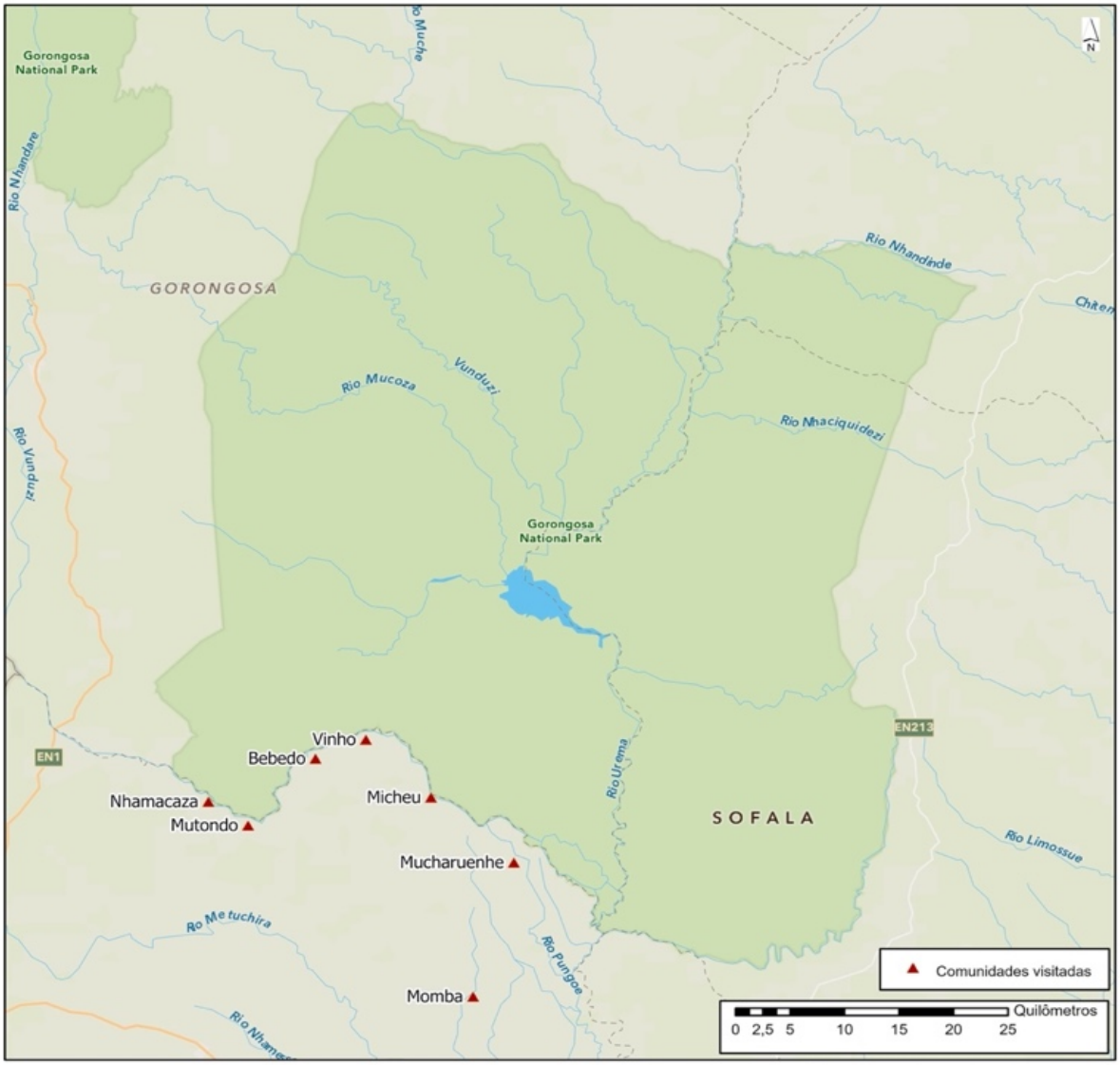


Figure 13. Study area, indicating the 7 communities of Nhamatanda district, south of Pungwe river, in the PNG buffer zone, were the 1st and 2nd survey were done at the local primary schools of Nhamacaza, Mutondo, Bebedo, Vinho, Micheu, Mucharuenhe and Momba community.

GNP's department for human development runs environmental education clubs in the seven primary schools selected for this study. The eco clubs are non-formal environmental education after school activities for children aged 8 to 16, most clubs have an average of eighty to hundred participants, approximately 10 children per year group. For the two surveys, pre- and post-test, all boys and girls aged 12 to 14 years, attending these clubs, were invited to participate, aiming for approximately 20 children per participating community.

Additionally, one parent of each child, was invited to attend also both surveys, aiming for a balanced number of fathers and mothers.

The first questionnaire was administered between the 28th of September and the 7th of October, with a total of 216 participants. Each participant answered the survey questions individually in the local language, the survey forms were filled in by the interviewer. After responding to this first questionnaire, the parents left, and each child received the booklet, "Guia de Coexistência. Humano, Elefante, Abelha (Guide for Coexistence. Human, Elephant, Bee), together with a box of colouring pencils, to take home. The booklet was presented to the children page by page, and its contents were explained in detail in Sena, the local language, spoken in Nhamatanda district. The second questionnaire was administered approximately a month and a half later in the same 7 communities (see above), between the 15th and the 18th of November 2021, with a total of 189 participants. Again, each participant answered the survey questions individually in the local language and the survey forms were filled in by the interviewer.

The chosen dates for the administration of both surveys depended largely on logistical reasons: both surveys were taken during dry season, allowing for easier access to remote communities without an existing road system, both surveys had also to be administered during the academic year, to guarantee students participation. The winter holidays are in July/August and the Christmas holidays, as well as the wet season are in November/December.

2.5. Data analysis

The completed surveys of 216 participants for the pre-test and 189 participants for the post-test were collated by the members of the department for sustainable development of GNP and transferred to Microsoft Excel spreadsheets.

For the pre- and post-test data analysis I only used the results from the 189 participants who completed both surveys.

I used descriptive statistics for means, percentages, standard deviation, maximum and minimum to describe socio-demographic characteristics and cross tabulation to further analyse frequencies of type for all communities.

Additionally, I used paired samples t-tests for all pre-test and the post-test results to compare means regarding knowledge, perceptions, and attitudes (survey questions A to G, Table 1).

Spearman's rank correlation coefficient was used to examine correlations between knowledge, age, and length of residence in the community, as well as descriptive statistics with non-parametric measures, such as crosstabulation, to quantitatively analyse relation between pre- and post-test results.

Crosstabulation was also used to examine change of attitude, social norm, and empathy, and to determine change for specific variables, such as type and community.

Kruskal Wallis test was applied to further examine differences between groups of participants.

All statistical analyses were conducted in IBM SPSS Statistic Data Editor, 28.

III. Results

3. Socio demographic characteristics of study participants

The total of participants for the pre-test were 216 people, and 189 for the post-test. Mutondo had the highest rate of participants with a total of 42, which all participated in both tests. Vinho had the highest rate of dropouts, from 27 participants in the pre-test, only 19 returned to the post-test, the lowest post-test number of participants for all seven communities (Table 2 and 3). Bebedo and Vinho community had both only 2 fathers participating in the surveys (Table 3), the lowest number of participating mothers was in Mucharuenhe with a total of 5 (Table 3). A total of 123 children, out of whom 62 boys and 61

girls, participated in the pre-test, with 115 returning for the post-test. The number of mothers participating dropped between the two tests from 54 to 42 and the fathers from 39 to 32.

All mothers are farmers, additionally two mothers work for GNP community projects as “Madrinhas”, helping young mothers with nutrition and childcare. For this support, the “Madrinhas” receive twice a year a basket from GNP, with basic food supplies and other essential goods.

Most of the fathers are farmers, only four different professions are registered: a cook for GNP, a schoolteacher, a bricklayer, and a currently unemployed driver.

Regarding literacy levels, 20 (37.7%) out of 54 the mothers have not a single completed school year, 11 (20.8%) have 2 completed years of schooling and a total of 6 mothers (11.3%) have 7 completed years of schooling. Most of the mothers (58.5%) have between 0 to 2 years of schooling. The literacy levels of the fathers are higher, 20.5% of the fathers attended 7 years of schooling, 12.8% attended 9 years of schooling and 10.3% attended 10 and 4 years of schooling respectively (Table 2).

A noteworthy difference in socio-demographic characteristics is the low literacy level of the mothers, a mean value of 2.5 completed school years, compared to the fathers, with a mean value of 6.2 completed school years.

Table 2. Sociodemographic characteristics of participants

		CHILDREN/STUDENT				MOTHER				FATHER				TOTAL			
		Before (N=123)		After (N=115)		Before (N=54)		After (N=42)		Before (N=39)		After (N=32)		Before (N=216)		After (N=189)	
		n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
Sex	**Female**	61	(49.2)	58	(50.4)	54	(100.0)	42	(100.0)	NA	NA	NA	NA	115	(53.2)	100	(52.9)
	Male	62	(50.4)	57	(49.6)	NA	NA	NA	NA	39	(100.0)	32	(100.0)	101	(46.8)	89	(47.1)
	Total	123	(100.0)	115	(100.0)	54	(100.0)	42	(100.0)	39	(100.0)	32	(100.0)	216	(100.0)	189	(100.0)
Age (years)	**Minimum**	7		7		19		20		18		18		7		7	
	Maximum	20		20		86		86		75		75		86		86	
	Mean ± SD	13.80 ± 0.177		13.77 ± 0.185		41.28 ± 0.741		41.52 ± 2.157		43.54 ± 2.481		43.47 ± 2.813		24.96 ± 1.224		24.96 ± 1.224	
Schooling (years)	**0**	0	(0.0)	0	(0.0)	20	(37.7)	16	(39.0)	1	(2.6)	0	(0.0)	21	(9.8)	16	(8.5)
	1	0	(0.0)	0	(0.0)	2	(3.8)	2	(4.9)	3	(7.7)	2	(6.3)	5	(2.3)	4	(2.1)
	2	0	(0.0)	0	(0.0)	11	(20.8)	6	(14.6)	3	(7.7)	3	(9.4)	14	(6.5)	9	(4.8)
	3	0	(0.0)	0	(0.0)	5	(9.4)	5	(12.2)	0	(0.0)	0	(0.0)	5	(2.3)	5	(2.7)
	4	1	(0.8)	1	(0.9)	3	(5.7)	2	(4.9)	4	(10.3)	4	(12.5)	8	(3.7)	7	(3.7)
	5	15	(12.2)	11	(9.6)	4	(7.5)	3	(7.3)	3	(7.7)	3	(9.4)	22	(10.2)	17	(9.0)
	6	52	(42.3)	48	(41.7)	0	(0.0)	0	(0.0)	4	(10.3)	4	(12.5)	56	(26.0)	52	(27.7)
	7	55	(44.7)	55	(47.8)	6	(11.3)	5	(12.5)	8	(20.5)	5	(15.6)	69	(32.1)	65	(34.6)
	8	0	(0.0)	0	(0.0)	1	(1.9)	1	(2.4)	2	(5.1)	2	(6.3)	3	(1.4)	3	(1.6)
	9	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	5	(12.8)	5	(15.6)	5	(2.3)	5	(2.7)
	10	0	(0.0)	0	(0.0)	1	(1.9)	1	(2.4)	4	(10.3)	4	(12.5)	5	(2.3)	5	(2.7)
	11	0	(0.0)			0	(0.0)			0	(0.0)			0	(0.0)		
	12	0	(0.0)			0	(0.0)			2	(5.1)			2	(0.9)		
Community	**Bebedo**	16	(13.0)	16	(13.9)	7	(13.0)	7	(13.9)	2	(5.1)	1	(3.1)	**25**	(11.6)	24	(12.7)
	Mitcheu	18	(14.6)	17	(14.8)	8	(14.6)	8	(19.0)	6	(15.4)	6	(18.8)	**32**	(14.8)	31	(16.4)
	Momba	16	(13.0)	15	(13.0)	8	(14.8)	6	(14.3)	5	(12.8)	4	(12.5)	**29**	(13.4)	25	(13.2)
	Mucharuenhe	19	(15.4)	15	(13.0)	5	(9.3)	5	(11.9)	8	(20.5)	6	(18.8)	**32**	(14.8)	26	(13.8)
	Mutondo	21	(17.4)	21	(18.3)	10	(18.5)	10	(23.8)	11	(28.2)	11	(34.4)	**42**	(19.4)	42	(22.2)
	Nhamacaza	16	(13.0)	15	(13.0)	8	(14.8)	4	(9.5)	5	(12.8)	3	(9.4)	**29**	(13.4)	22	(11.6)
	Vinho	17	(13.8)	16	(13.9)	8	(14.8)	2	(4.8)	2	(5.1)	1	()	**27**	(12.5)	19	(10.1)
Residence time (years)	**Minimum**	1		1		1		1		2		2		1		1	
	Maximum	20		20		65		65		58		58		65		65	
	Mean ± SD	11.17 ± 0.374		11.23 ± 0.385		27.02 ± 2.031		28.23 ± 2.397		24.49 ± 2.247		25.31 ± 2.532		17.49 ± 0.84244		17.63 ± 0.908	

Table 3: Crosstabulation Community versus Type (child, mother, father and total)

			Type			
			Child	Mother	Father	Total
Community	Bebedo	Count	16	7	2	25
		% in Type	13,0%	13,0%	5,1%	11,6%
	Mitcheu	Count	18	8	6	32
		% in Type	14,6%	14,8%	15,4%	14,8%
	Momba	Count	16	8	5	29
		% in Type	13,0%	14,8%	12,8%	13,4%
	Mucharuenhe	Count	19	5	8	32
		% inType	15,4%	9,3%	20,5%	14,8%
	Mutondo	Count	21	10	11	42
		% in Type	17,1%	18,5%	28,2%	19,4%
	Nhamacaza	Count	16	8	5	29
		% in Type	13,0%	14,8%	12,8%	13,4%
	Vinho	Count	17	8	2	27
		% in Type	13,8%	14,8%	5,1%	12,5%
Total		Count	123	54	39	216
		% in Type	100,0%	100,0%	100,0%	100,0%

3.1 Comparisons between pre- and post-tests

The comparison of all pre- and post-test mean results using paired samples t-test can be found in Table 4 (see also appendix 6 for a detailed description of results for the remaining questions regarding perception of negative impacts caused by elephants, perceived risk of attack by elephants, and attitudes and behaviour towards elephants). The comparison for pre- and post-test results regarding knowledge-gain is described in more detail below.

Regarding the perceived negative impact caused by elephants, destruction to “machambas” (small agricultural plot) and property in the past and the perceived fear of future negative impacts caused by elephants reduces from the pre- to the post-tests, results

have statistical significance (p-value o.oo1 regarding perceived destruction in the past and p-value 0.002 regarding fear of future perceived negative impact). The perceived fear of being attacked by an elephant reduces for all participants, although values remain low, they are statistically significant.

Regarding attitudes towards elephants a significant change to a more positive attitude can be registered regarding the children and the fathers, however values remain close to neutral.

Regarding aggressive attitudes towards elephants a significant change occurred from the pre- to the post-test results, with a more positive expression for the children and the mothers, while the fathers attitude remains closer to neutral and slightly negative. For the perception of aggressive behaviour towards elephants in the community, no significant change could be registered from the pre- to the post-test results. Regarding attitude towards helping an abandoned elephant calf, here a significant change can be registered for the children and the mothers.

3.1.1 Knowledge

According to the pre-test assessment, general knowledge of the participants regarding behavioural and biological features of elephants was relatively high in all seven communities. Children scored just under six correct answers (5.8) out of ten, while the fathers results were slightly above six correct answers (6.4) and the mothers results were below six correct answers (5.7) out of ten (Tables 4 and 5) (see appendix 6 for the complete pre- and post-test results).

The post-test results indicate a clear knowledge gain for the children with a mean of 9.1 points scored, 3.3 points higher than in the pre-test. The fathers score improved slightly less, 2.5 points, to a mean of 8.9 correct answers out of ten. The mothers show a slightly higher improvement of 3 points, with a mean of 8.7 correct answers out of a total of ten (Tables 4 and 5).

Improved results regarding knowledge in the post-test are statistically significant for all participants (children, mothers, and fathers) (Table 4).

Below a clustered boxplot graph illustrates (Graph 1) that the knowledge regarding elephants was medium to good in all seven communities, results were highest in Bebedo and Mitcheu (just below 7 correct answers out of 10) in the pre-test, followed by Mucharuenhe and Vinho (6 correct answers), the pre-test results were lowest in Nhamacaza, Mutondo and Momba (only 50% of correct answers). In the post-test results Bebedo and Mutondo show highest scores regarding knowledge with 10 and just under 10 points respectively. The remaining five communities scored 9 out of 10 correct answers in the post-test. It is important to note that the difference in knowledge gain from the pre-test to the post-test is much bigger in Mutondo (from 5 correct answers to just below 10), than in Bebedo (from7 correct answers to 10).

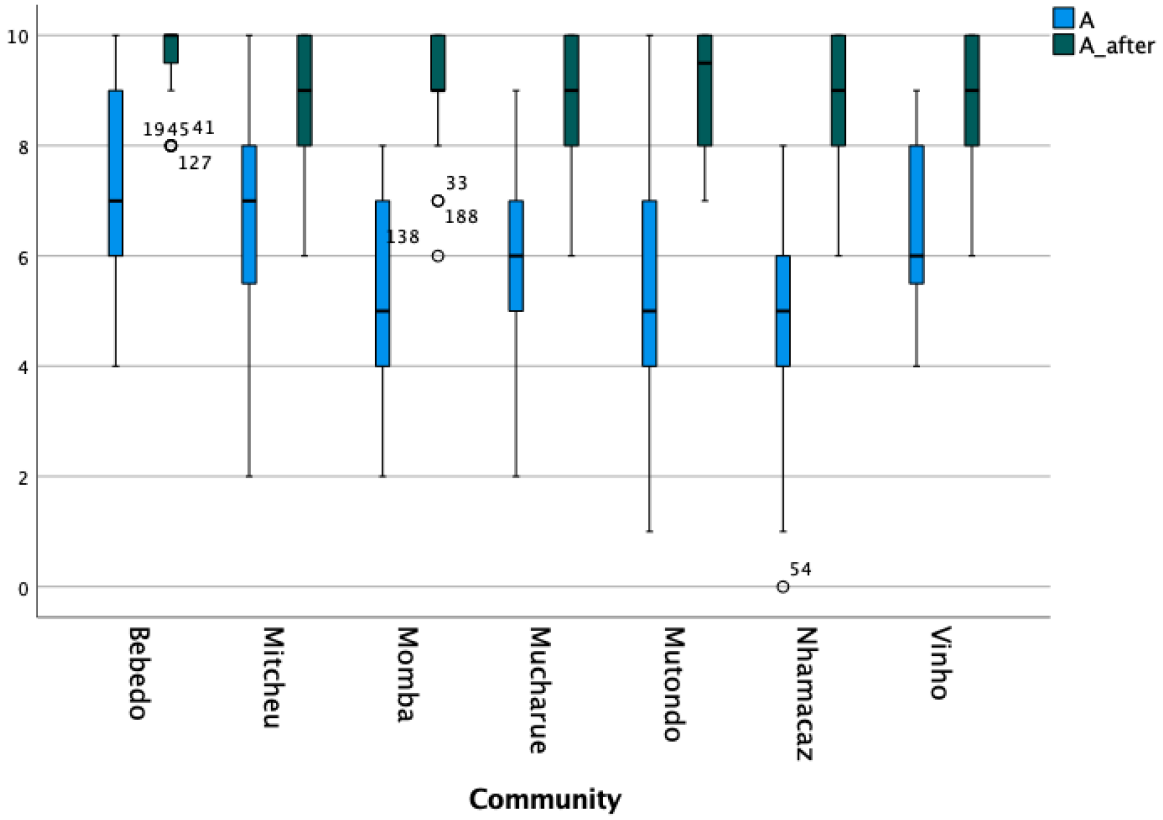
Table 4: Pre- and post-test results for all participants (children, mothers, fathers and total) for all survey questions, Paired Samples T-Tests

Question	Score	CHILDREN (N=115)				MOTHER (N=42)				FATHER (N=32)				TOTAL (N=189)			
		Before	After	*Dif*	*p*	Before	After	*Dif*	*p*	Before	After	*Dif*	*p*	Before	After	*Dif*	*p*
A	Mean ± SD	5.82 ± 1.976	9.10 ± 1.092	-3.278 ± 2.020	**<0.001**	5.79 ± 2.159	8.76 ± 1.246	-2.976 ± 2.136	**<0.001**	6.47 ± 1.704	8.97 ± 0.967	-2.500 ± 1.606	**<0.001**	5.92 ± 1.981	9.00 ± 1.111	-3.079 ± 0.994	**<0.001**
B1	Mean ± SD	1.91 ± 1.876	1.29 ± 1.588	1.894 ± 0.177	**0.001**	2.38 ± 2.083	2.29 ± 2.028	0.095 ± 2.250	0.785	3.53 ± 1.900	2.63 ± 1.93	0.906 ± 1.820	**0.008**	2.29 ± 2.007	1.74 ± 1.835	0.556 ± 1.974	**<0.001**
B2	Mean ± SD	1.89 ± 1.781	0.96 ± 1.307	0.930 ± 1.886	**<0.001**	1.48 ± 1.685	2.38 ± 2.060	-0.905 ± 2.458	**0.022**	2.72 ± 1.746	2.03 ± 2.148	0.688 ± 1.693	**0.029**	1.94 ± 1.788	1.46 ± 1.767	0.481 ± 2.123	**0.002**
B3	Mean ± SD	1.78 ± 1.771	1.01 ± 1.484	0.774 ± 1.915	**<0.001**	2.55 ± 2.178	1.74 ± 1.795	0.810 ± 2.743	0.063	3.31 ± 1.925	2.41 ± 2.014	0.906 ± 2.085	**0.020**	2.21 ± 1.973	1.41 ± 1.731	0.804 ± 2.141	**<0.001**
C1	Mean ± SD	1.05 ± 1.337	0.96 ± 1.327	0.096 ± 1.522	0.502	1.43 ± 2.297	1.17 ± 2.140	0.262 ± 2.2090	0.447	2.16 ± 2.897	1.56 ± 2.368	0.594 ± 2.993	0.270	1.32 ± 1.945	1.11 ± 1.744	0.217 ± 1.995	0.137
C2	Mean ± SD	2.04 ± 2.864	1.27 ± 2.210	0.774 ± 3.234	**0.012**	2.24 ± 3.114	2.07 ± 2.278	0.167 ± 3.913	0.784	3.66 ± 3.882	1.84 ± 2.689	1.813 ± 5.083	0.052	2.36 ± 3.150	1.54 ± 2.326	0.815 ± 3.769	**0.003**
D	Mean ± SD	0.53 ± 4.027	3.24 ± 3.752	-2.713 ± 4.580	**<0.001**	1.50 ± 4.723	2.69 ± 4.039	-1.190 ± 5.977	0.204	2.53 ± 3.943	4.34 ± 2.914	-1.812 ± 3.596	**0.008**	1.08 ± 4.224	3.31 ± 3.710	-2.22 ± 4.802	**<0.001**
E	Median	0	1		**0.021**	-0.5	1.5		**0.036**	-1	-0.5		0.880	0	1		**0.003**
	IQR [P25;P75]	[-2; 1]	[-1; 2]			[-2; 2]	[-1.25; 2]			[-2; 2]	[-2; 1.75]			[-2; 1]	[-2; 2]		
F	Median	0	0		0.611	0	0		0.848	0	0		0.237	0	0		0.320
	IQR [P25;P75]	[0; 3]	[0; 2]			[0; 2]	[0; 2]			[0; 2]	[0; 0]			[0; 2]	[0; 2]		
G	Median	1	1		**0.004**	1	1		**0.037**	1	1.5		0.927	1	2		**0.001**
	IQR [P25;P75]	[0; 2]	[1; 2]			[0; 2]	[1; 2]			[0; 2]	[0.25; 2]			[0; 2]	[1; 2]		

Table 5: Pre- and post-test by type (Child, Father, Mother) for knowledge, Paired Samples T-tests

Type			Mean	N	Std. Deviation	Std. Error Mean
Child	Pair 1	A	5.82	115	1.976	.184
		A_after	9.10	115	1.092	.102
Father	Pair 1	A	6.47	32	1.704	.301
		A_after	8.97	32	.967	.171
Moter	Pair 1	A	5.79	42	2.159	.333
		A_after	8.76	42	1.246	.192

Graph 1: Clustered boxplot showing overall results for knowledge (A and A_after) in pre- and post-test by community



3.2 Correlation analysis for knowledge, age, and length of residence

The above statistical analyses have shown a knowledge gain for all respondents of the pre- and post-tests. Before further analyzing possible consequences of improved knowledge,

I have examined whether knowledge is correlated to age or length of time living in the community, using Spearman's rank correlation coefficient.

This nonparametric measure has determined that there is no significant correlation between knowledge, testing before and after intervention results, age, and length of residence in the community (Table 6).

Table 6: Correlation between pre- and post-test results for knowledge, age and length of residence, Spearman's correlation coefficient

		A	A_after	Age	Length of residence
A	Correlation coefficient	1,000	,278**	,089	,008
	Sig. (2-tailed)	.	,000	,194	,903
	N	216	189	216	215
A_after	Correlation coefficient	,278**	1,000	-,096	-,128
	Sig. (2-tailed)	,000	.	,188	,079
	N	189	189	189	188
Age	Correlation coefficient	,089	-,096	1,000	,634**
	Sig. (2-tailed)	,194	,188	.	,000
	N	216	189	216	215
Length of residence	Correlation coefficient	,008	-,128	,634**	1,000
	Sig. (2-tailed)	,903	,079	,000	.
	N	215	188	215	215

**. The correlation is significant at 0,01 (2-tailed).

3.3 Has knowledge transfer occurred from children to parents?

Regarding the occurrence of knowledge transfer limitations regarding the pre- and post-test results for children and their respective parents do not allow to determine whether knowledge transfer from child to adult occurred (further detail in part IV. Discussion).

3.4 Are there participants who have changed attitude after the intervention?

Here, I compared the pre- and post-tests results for the variable regarding aggressive behaviour of participants towards elephants (E and E_after), in cross-tabulation, evaluating whether the intervention has contributed to change of attitudes among the participants

(Table 7), for one specific type (children, mother, father) (Table 8) or for one specific community (Table 9).

The percentage of respondents who did not change attitude in the post-test is highest at the extremes, respectively representing a negative attitude, meaning that they believe chasing away an elephant is very useful, or a positive attitude, meaning that chasing away an elephant is not useful at all (Table 7).

Although a positive change of attitude occurred in a high percentage (accumulated 60.2%), a quarter of the participants reverted from slightly negative (-1) to a more negative attitude (-2) and an even higher number of participants (28.3%) changed from a positive attitude in the pre-test to a negative attitude in the post-test (Table 7). Nevertheless, it is important to note that over fifty percent of the children (50.4%) and mothers (54.8%) progressed to a more positive attitude towards elephants, while one third of the fathers (37.5%) express a negative change in the post-test results (Table 8).

Regarding the individual communities Mitcheu (61.3%) and Vinho (52.6%) show the biggest regression in attitude in the post-test results, while the two communities with the highest score in knowledge gain (Bebedo and Mutondo) also show a clear progression in attitude towards elephants in the post-test results with 66.7% of participants from Bebedo and 59.5% of the participants from Mutondo progressing to a more positive attitude (Table 9).

Table 7: Crosstabulation aggressive attitude of participants towards elephants comparing pre- and post-test results (E versus E_after)

			E_after					
			-2	-1	0	1	2	Total
E	-2	Count	19	5	5	9	35	73
		% in E	26,0%	6,8%	6,8%	12,3%	47,9%	100,0%
	-1	Count	5	2	2	1	10	20
		% in E	25,0%	10,0%	10,0%	5,0%	50,0%	100,0%
	0	Count	6	0	0	2	3	11
		% in E	54,5%	0,0%	0,0%	18,2%	27,3%	100,0%
	1	Count	5	7	3	7	17	39
		% in E	12,8%	17,9%	7,7%	17,9%	43,6%	100,0%
	2	Count	13	9	2	9	13	46

	% in E	28,3%	19,6%	4,3%	19,6%	28,3%	100,0%
Total	Count	48	23	12	28	78	189
	% in E	25,4%	12,2%	6,3%	14,8%	41,3%	100,0%

Diagonal in red – nº of participants who maintained their attitude unchanged
Green – 47.9% changed their attitude from -2 (very useful) to 2 (very little useful).
Yellow – 60.2% changed from -2 (very useful) to 1 (little useful) or 2 (very little useful)
Orange – 25.0% changed to more negative attitude (from -1 to -2)
Blue – 28.3% revert negatively (from 2 to -2)

Table 8: Cross tabulation for change of aggressive attitude (E) versus Type (child, mother, father and total)

			Type			
			Child	Mother	Father	Total
Change of attitude	Regressed	Count	36	11	12	59
		% in Type	31,3%	26,2%	37,5%	31,2%
	No change	Count	21	8	12	41
		% in Type	18,3%	19,0%	37,5%	21,7%
	Progressed	Count	58	23	8	89
		% in Type	50,4%	54,8%	25,0%	47,1%
Total		Count	115	42	32	189
		% in Type	100,0%	100,0%	100,0%	100,0%

Table 9: Cross tabulation for change of aggressive attitude (E versus Community)

			Community							
			Bebedo	Mitcheu	Momba	Mucharuenhe	Mutondo	Nhamacaza	Vinho	Total
Change of Attitude E	Regressed	Count	3	19	6	8	8	5	10	59
		% in Community	12,5%	61,3%	24,0%	30,8%	19,0%	22,7%	52,6%	31,2%
	No change	Count	5	5	9	6	9	6	1	41
		% in Community	20,8%	16,1%	36,0%	23,1%	21,4%	27,3%	5,3%	21,7%
	Progressed	Count	16	7	10	12	25	11	8	89
		% in Community	66,7%	22,6%	40,0%	46,2%	59,5%	50,0%	42,1%	47,1%
Total		Count	24	31	25	26	42	22	19	189
		% in Community	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

3.5 Do post-test results reflect a change in attitude towards a change in behaviour?

Post-test results indicate that a change in behaviour towards an abandoned elephant calf can be observed in a positive as well as in a negative way, related to regression in attitude or progression in attitude, if compared with the post-test results for participants' attitude towards attacking or chasing away elephants. The participants (15.3%) who indicated that attacking or chasing away an elephant is very useful, also indicate that they would chase an abandoned elephant calf from their "machamba". While those participants (59.6%) who indicated that attacking or chasing an elephant is very little useful, also indicate if they would find an abandoned elephant calf in their "machamba", they would try and help it. The remaining participants (46.3%) do not indicate any change of behaviour towards the abandoned calf (Table 10).

Although age or length of residence in the community do not show a significant correlation to change of attitude towards attacking or chasing away elephants (Table 11 and 12), gender seems to be of importance: results presented in the section above (3.4) have shown that over half of the children and mothers progressed in the post-test results to a positive attitude, believing that chasing away or attacking elephant is very little useful. While 60% of the mothers and 45.2% of the children also show a change in behaviour in the post-test results indicating they would help an abandoned elephant calf found on their property (Appendix 6, section 9). The progression in attitude which could be observed in the post-test results for Mutondo and Bebedo communities, is also reflected in the post-test result for these both communities regarding behaviour: 71.4% of the participants from Mutondo and 50% of the participants from Bebedo indicate in the post-test results that they would help an abandoned elephant calf (Appendix 6. Section 9).

Table 10: Cross tabulation Change of attitude (E) versus post-test results regarding helping an abandoned elephant calf (G_after)

			G_after			
			0	1	2	Total
Change of attitude E	Regressed	Count	9	13	37	59
		% in Change of attitude E	15,3%	22,0%	62,7%	100,0%
	No change	Count	8	19	14	41
		% in Change of attitude E	19,5%	46,3%	34,1%	100,0%
	Progressed	Count	11	25	53	89
		% in Change of attitude E	12,4%	28,1%	59,6%	100,0%
Total		Count	28	57	104	189
		% in Change of attitude E	14,8%	30,2%	55,0%	100,0%

Table 11: Kruskal Wallis test for change of aggressive attitude (E) and age and length of residence

	Change of attitude E	N	Mean Rank
Age	Regressed	59	95,28
	No change	41	99,17
	Progressed	89	92,89
	Total	189	
Length of residence	Regressed	59	104,83
	No change	41	84,23
	Progressed	88	92,36
	Total	188	

Test statistics[a,b]

	Age	Length of residence
Kruskal-Wallis H	,375	3,738
df	2	2
Assymp. Sig.	,829	,154

a. Test Kruskal Wallis

b. Grouping variable: Change of attitude E

Table 12: Kruskal Wallis test for behaviour towards an abandoned elephant calf (G _after) and age and length of residence

Ranks

	G_after	N	Mean Rank
Age	0	28	96,20
	1	57	98,52
	2	104	92,75
	Total	189	
Length of residence	0	28	91,02
	1	56	105,08
	2	104	89,74
	Total	188	

Test statistics[a,b]

	Age	Length of residence
Kruskal-Wallis H	,428	3,040
df	2	2
Assymp. Sig.	,807	,219

a. Test Kruskal Wallis

b. Grouping variable: G_after

IV. Discussion

4. Discussion

The overall results of the pre- and post-test surveys are promising for a first intervention aimed at HWC reduction towards coexistence, in particular the findings regarding knowledge, attitude and behaviour.

Findings regarding knowledge indicate a statistically significant knowledge gain regarding the first section of the survey, where participants were asked to indicate whether affirmations about biological and behavioural aspects regarding elephants were correct or incorrect. The knowledge gain is clearly visible in the post-test results for the children, the

mothers and the fathers, it is also visible for the results of all communities, with special emphasis for Bebedo and Mutondo. However, it is not possible to determine that the increased knowledge regarding elephants is due to the intervention, the existence of a control group, only doing the surveys without receiving the illustrated guide for coexistence, would have been necessary to confirm these results. The research project developed by Marchini and MacDonald (2019), based on which this research study was created, used a control group to establish a clear cause-effect relationship, which cannot be established here. Nevertheless, the increased knowledge can help these communities to take informed action and develop skills on behalf of their direct environment (Ardoin, Bower and Gaillard, 2020), additionally, increased knowledge is also believed to give people a sense of empowerment, which can lead to positive attitude and behaviour (Heimlich and Ardoin, 2008).

Regarding the occurrence of knowledge transfer, the research findings do not allow to establish a clear cause- effect relationship. Sociodemographic characteristics indicate that the mothers' literacy level of 2.5 completed school years is very low, and it is likely that they cannot read or write in Portuguese, which is not their first language (The World Bank, 2021; Social Science in Humanitarian Action, 2019). All the correct answers to the survey questions about biological and behavioural aspects of elephants can be found in the illustrated guide. However, it seems unlikely for the mothers to be able to read the guide, therefor the question persists of how much the mothers might have learned through knowledge transfer from their respective children, but since coding was used to guarantee anonymity for all participants no kinship can be established between children and respective parent to compare survey results and establish a link between survey results for children and their respective parent.

The survey findings regarding attitudes towards elephants show that over 60% of the participants change their attitude from believing that attacking or chasing away an elephant would be very useful to affirming in the post-test that such attitude would be very little useful. Besides the obvious positive effect on peoples' personal safety, this change in attitude can also be interpreted as a more positive inclination towards coexistence. It is also important to note that over 50% of the children and mothers changed to a more positive attitude, these research findings can be seen as an important result to build further environmental and coexistence education strategies upon, research indicates that environmental attitudes are formed in early childhood and that it is often the women who display a more positive attitude towards environmental issues (Braun, Cottrell and Dierke, 2018).

Finally, over 50% of the participants who indicated a change in attitude in the post-test results, also indicate the intention towards a more positive behaviour, when asked whether they would help an abandoned elephant calf. Similar results apply for those communities who also indicated a change to a more positive attitude in the post-test results, also indicating a more positive behaviour towards the abandoned elephant calf. The inclination to a more positive behaviour is particularly strong among the children and should be seen as an important indicator to build upon for future conservation education interventions (Adams, Farrelly and Holland, 2021), however, a delayed third survey could be of interest to verify if perceptions and attitudes, as well as knowledge gain, remain unchanged.

To make better use of the survey findings some of the results need to be viewed in the direct context of the communities living in the GNP buffer zone: During the year 2021 alone, elephants destroyed 13 hectares of crops and over 6.000 kilos of maize, most subsistence farmers own just under a hectare of farmland, which often gets destroyed during one single crop raiding event (information supplied by Marcelino Denja, Human Wildlife Coexistence Department, PNG, May 2022). It would be important to implement further research strategies to better understand whether participants gave honest answers to all survey questions or whether they held back their honest views out of fear for consequences (Boer and Baquette, 1997; McNeeley, 2012), additional interviews with open end questions and focus groups to gain further insight could be important tools to start creating a framework for coexistence for the local reality of Gorongosa National Park.

For future interventions aiming to assess conservation interventions, confidentiality (McNeeley, 2012), cultural characteristics, as well as socio-economic background of the survey groups (Boer and Baquette,1997), and language barriers (Laher, Fynn and Kramer, 2019) should be considered in greater detail. The relation between park management, representing authority and power, and the local communities also should be taken into consideration (Laher, Fynn and Kramer, 2019).

Additionally, some parts of the survey findings should be reviewed to extract more detailed results: the pre-and post-test sections regarding whether participants would prefer elephants to disappear from the region, whether they like elephants and whether they associate elephants with economic value for the region should be analyzed separately to allow findings closer related to conservation and coexistence strategies. The present findings

do not allow to distinguish between participants who recognize the importance of elephants for the region and those who do not attribute any value to elephants. Additionally, the questions should be phrased clearer: strategies for coexistence need to focus on economic and environmental benefits of conservation of species and ecosystems and affected communities should be able to understand and recognize these benefits. Equipping the community members with better tools and skills to face the potential threat of crop raiding elephants through better knowledge regarding elephant behaviour can be a first step in the right direction, however these are only the results of one first short-term intervention. To understand whether participants are willing to change attitudes and behaviour towards elephants, further mid- and long-term interventions to measure change are required.

Although the research findings do not allow to establish a link for intergenerational knowledge transfer, applying child orientated environmental interventions should be an important objective for addressing coexistence, its potential has not been sufficiently explored (Marchini and Macdonald, 2019), but the influence of children on their parents, direct family and the wider community should not be underestimated (Marchini and Macdonald, 2019; Kansky, Kidd and Knight, 2016). The pre- and post-test results regarding attitude and behaviour show that the children progressed significantly, and environmental education activities should integrate children's natural empathy for emblematic species, as well as take advantage of the formal education context at schools making it easier to reach children than adults (Marchini and Macdonald, 2019). Ibrahim Ali (2002) did very interesting research on Kenyan Children's view about parks and wildlife, claiming the importance of education for conservation planning and arguing that conservationists and educators need to join efforts to create meaningful content for conservation education. Ali's research revealed that some children have a clear understanding of the economic benefits of PAs as a potential driver for poverty alleviation through tourism or job creation, some children also see a potential in PAs to resolve growing HWC. These children stated the need to protect all animals, not only for conservation, but also to prevent the neighbouring communities from crop loss, injury, and death provoked by wildlife. The pupils interviewed by Ali (2002) viewed elephants as important species to attract tourism, however, they did not seem to have understood the ecological value of keystone species like elephants.

The findings of this first intervention should be shared with all participants and could be used as a "buffer-zone-communities-baseline-assessment" regarding knowledge about

elephants, to build upon for further conservation strategies towards coexistence, paired with a study like the one done by Ali (2002) for further medium- and long-term research with the children from the GNP eco clubs regarding intergenerational knowledge transfer. The necessity to measure the effectiveness of these programs remains imperative to evaluate change of behaviour. The focus of the educational programs also needs to shift from simply conveying information (Hungerford and Volk, 1990) like done here with the distribution of the illustrated guide for coexistence, to a more dynamic approach (Ardoin, Bowers, Gaillard, 2020) where the children are exposed to meaningful, active and emotionally important experiences (Otto and Pensini, 2017).

4.1. Limitations and recommendations

To make better use of the survey findings a clear separation between questions focusing on biological and questions focusing on behavioural aspects regarding elephants in section A of the survey would be useful. These separate results would help determine further strategies for coexistence: a higher score in behavioural aspects could be an indicator for participants' real-life experience with elephants, meaning that those respondents who scored better regarding behavioural aspects know how an elephant would react in certain situations, also the participant is likely to know what to do if encountering an elephant.

The same recommendation applies to section D, the questions regarding attitudes towards elephants could give deeper insight if analyzed separately, supplying information whether participants like elephants, how they rate their value etc. Additionally, regarding value of the species, a clear distinction between economic and ecological value would be interesting for further result.

For section B, regarding perceived negative impact caused by elephants a clearer wording is recommended: two of the questions refer to the participants' perception of destruction caused by elephants in the past, one questions mentions destruction caused to "machambas", but the second question gives no reference and might have caused a duplication in results, if participants mentioned the perceived damage caused to their "machambas" in both sections.

V. Conclusion

The above-described case study aimed to assess impacts of non-formal environmental education programs delivered in eco-clubs run by the GNPs team for community engagement for children living in the park's buffer zone. This intervention was aimed to measure intergenerational knowledge transfer from children to parents regarding HEC.

Over hundred children, plus one of their respective parents, participated in two surveys, one pre-test and a second post-test, which took place after the distribution of an illustrated guide about Human-Elephant-Bee Coexistence, explaining biological and behavioural aspects for elephants and bees, as well as the importance of beehive fences for deterring crop raiding elephants. The illustrated guide was only handed to the children after the departure of their parent.

This first intervention towards coexistence in some of the buffer zone communities affected by human-elephant interaction establishes a baseline regarding knowledge, it also assessed participants perceptions and attitudes regarding destruction caused by elephants or fear of being attacked by these large mammals.

Results of the pre-test indicate that general knowledge regarding elephants was relatively high among the community members. No significant indicators for knowledge transfer could be established regarding the post-test results, while the remaining findings showed relatively low scores for perception of negative impacts or destruction, attitudes and behaviour towards elephants.

However, this first intervention, combined with deterrence strategies and further community-based approaches for social support, with regular monitoring to evaluate success, could indicate a path for reducing HEC in GNPs buffer zone towards harmonious coexistence.

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Appendix 1: Additional maps for settlements and cultivation areas in GNP's buffer zone (Fig 1, 2 and 3):

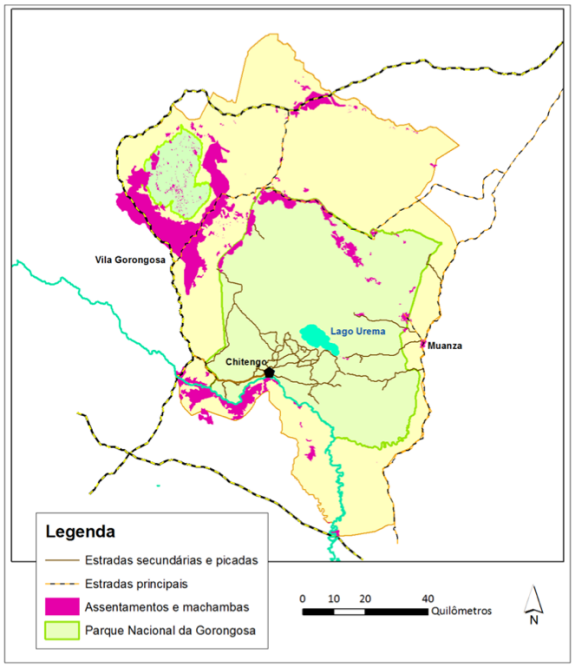


Fig 1: Settlements and cultivation areas around the GNP, 2016

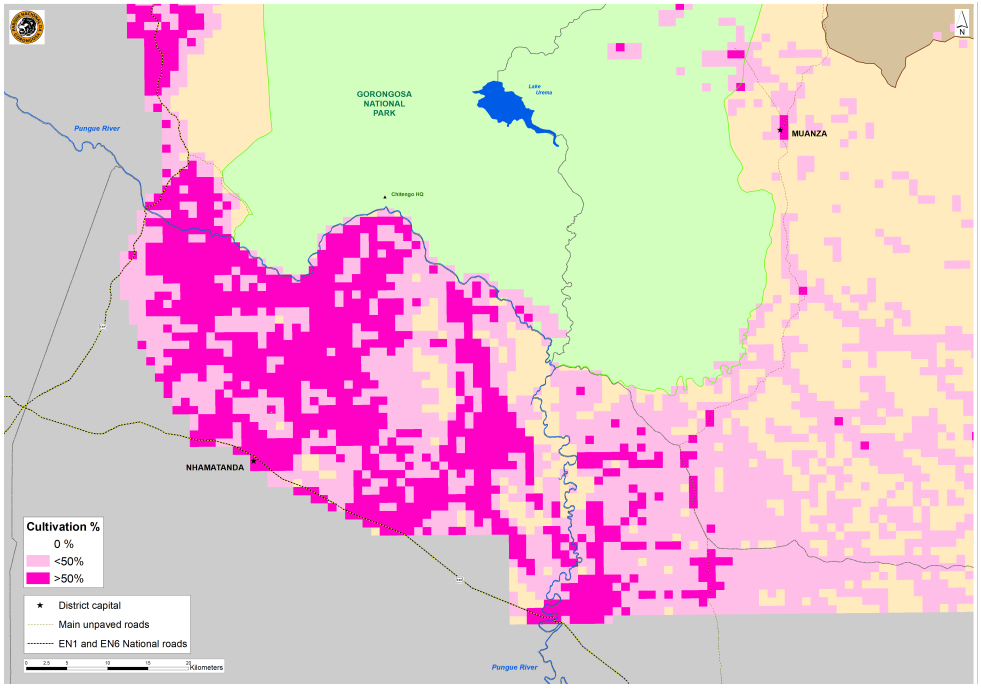


Fig 2: Indicators of increased cultivation South of Pungue, 2022

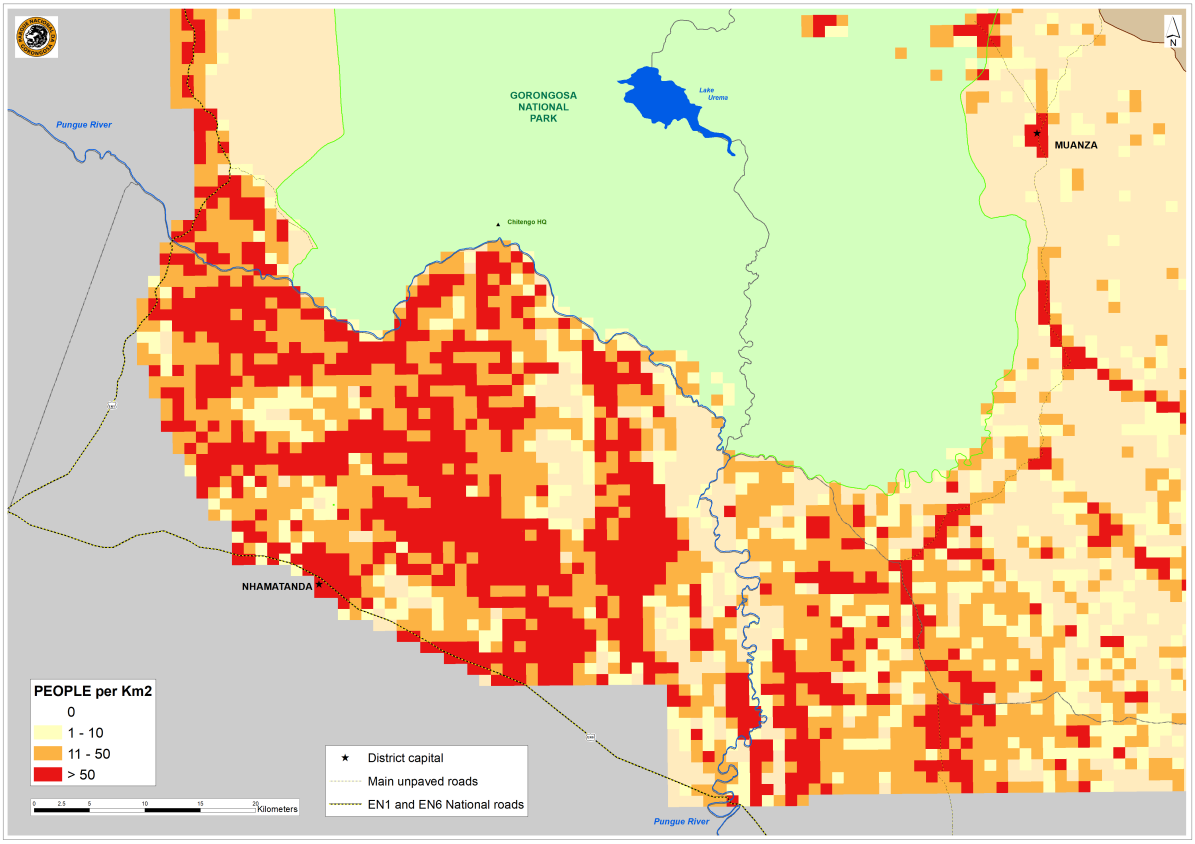


Fig 3: Indicators of increased population South of Pungue, 2022

Appendix 2: Illustrated Guide for Coexistence

GUIA DE COEXISTÊNCIA HUMANO-ELEFANTE-ABELHA

MARISA CLEMENTE RODRIGUES
MARCOS BERA CHOVA

ILUSTRAÇÃO: GISELLY SCALON ZANCHETA

Dedicamos a todas as crianças que nos inspiram.
Elas são a força motriz da nossa criatividade.

Patrocinado por:

USAID
FROM THE AMERICAN PEOPLE

Olá, Nyutchi! Vamos começar por falar sobre os elefantes, pode ser?

Claro, Ndzou! Estou curiosa para aprender.

O que comemos:

PAPAIA

BANANA

MALAMBE

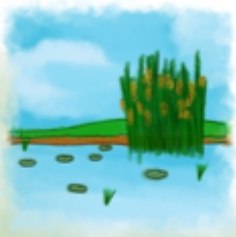
MILHO

MANDIOCA

Onde vivemos:

FLORESTA

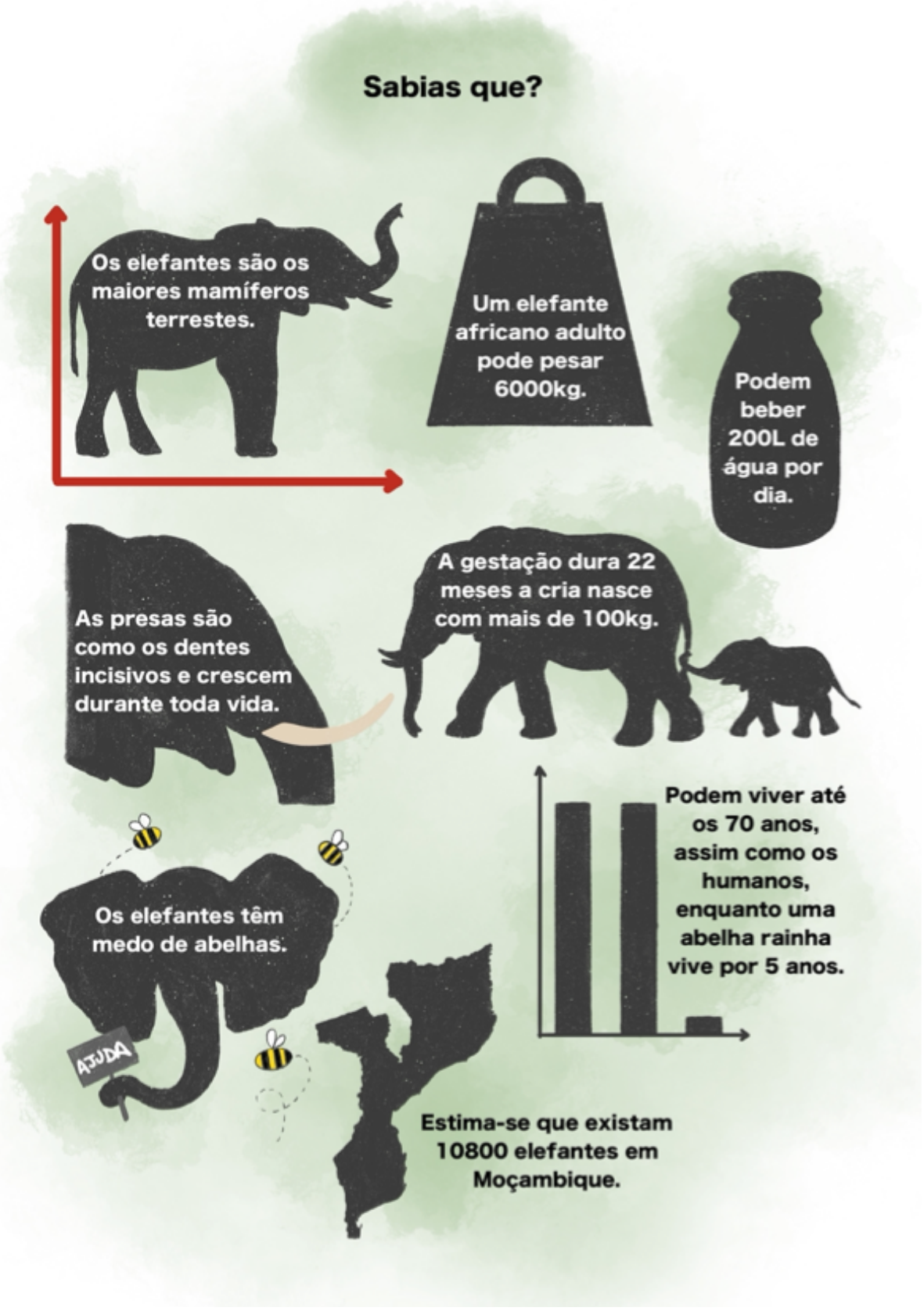
SAVANA

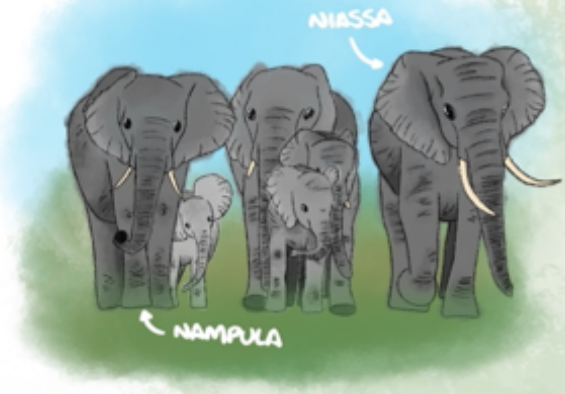


PÂNTANO

DESERTO

Sabias que somos considerados uma espécie de extrema importância, pois dispersamos muitas sementes e mantemos a biodiversidade do ecossistema?

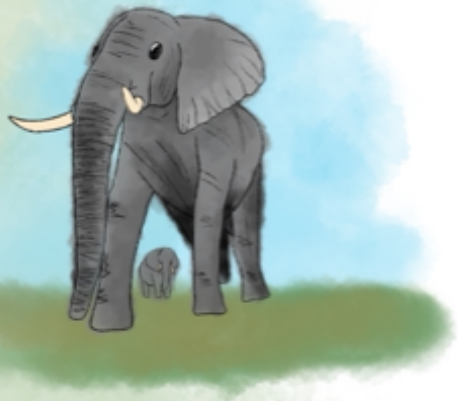

Sabias que?
Os elefantes são os maiores mamíferos terrestres.
Um elefante africano adulto pode pesar 6000kg.
Podem beber 200L de água por dia.
As presas são como os dentes incisivos e crescem durante toda vida.
A gestação dura 22 meses a cria nasce com mais de 100kg.
Podem viver até os 70 anos, assim como os humanos, enquanto uma abelha rainha vive por 5 anos.
Os elefantes têm medo de abelhas.
AJUDA
Estima-se que existam 10800 elefantes em Moçambique.



A minha avó, a Niassa, é a fémea mais velha do meu grupo, e por isso é chamada de matriarca.

Quando era pequenino, a minha mãe, a Nampula, era muito brava para proteger as crias.

Assim que eu crescer e chegar à puberdade, vou embora da manada e viverei sozinho ou com mais algum macho.



Só vejo o meu pai, o Inhambane, na época da reprodução, quando os machos interagem com as fémeas. Nessa mesma época, eles costumam ficar mais reactivos, pois têm altos níveis de testosterona, que serve para ganhar dominância em relação aos outros machos.

Na maior parte do tempo somos passivos. Ficamos assustados ou nos sentimos ameaçados quando alguém:

Se aproxima.

Faz ruídos extremos.

Aponta luzes.

Por isso, não te esqueças: temos uma visão moderada, porém escutamos e cheiramos muito bem. Além disso, podemos lembrar-nos de experiências anteriores, ou seja, se alguma vez um humano nos assustou, vamos lembrar e ter mais medo.

Caso nos encontres, não te mostres como uma ameaça, tenta seguir as seguintes regras:

Anda devagar.

Não chegues muito perto.

Faz algum som para que te vejamos.

Não te aproximes por trás.

Nós costumamos dar sinais antes de atacar, como:

Orelhas para trás.

Abanar a cabeça.

Secreções de glândulas (manchas entre os olhos e orelhas).

Por isso, quando nos manifestarmos assim, tenta:

Não correr.

Ficar calmo.

Bater palmas.

Colocar as mãos no ar.

Ficar em grupo.

Como podes dividir o mesmo território connosco?

Evitar constuir casas e machambas nos nossos corredores de passagem.

Conhecer as nossas rotas e onde costumamos procurar água e comida.

Usar métodos repelentes para nos ensinar a não atravessar as machambas.

Somos mais ativos durante a noite, por isso não uses lanternas onde possamos estar.

Evitar movimentações nos nossos caminhos recentes.

Aprender sobre nosso comportamento.

Nyutchi, já falámos muito sobre os elefantes, vamos falar sobre abelhas agora? É verdade que vocês têm uma rainha?

Sim, Ndzou! A nossa colmeia é divida em castas, e todos somos fundamentais para seu funcionamento.

Esta é a rainha Gorongosa, a única fémea fértil da colónia.

Quando ela atinge a maturidade sexual, deixa a colónia e encontra vários zangões para acasalar.

Depois volta para a colmeia, onde começa a ovipositar mais de 2000 ovos por dia. Pos isso é que existem tantas abelhas.

Os zangões têm a função de reproduzir a rainha e podem aquecer e arrefecer a colmeia.

As abelhas são fundamentais para a manutenção dos ecossistemas, sabias porquê?

Ao visitarem as plantas em busca do seu alimento: pólen e néctar acabam por fertilizar a flor. E com isso o processo de produção de fruta e depois sementes é beneficiado pela presença destes insectos tão importantes.

E além do mel, fazemos outros produtos também, como:

A Geleia Real, que alimentamos a nossa rainha para que fique grande e forte.

A Cera, que usamos para fazer os favos e os humanos podem produzir velas, batons e sabonetes.

A Própolis, usada para tapar os burados da colmeia, enquanto os humanos produzem remédios.

O Pólen, utilizado para alimentar as larvas, pois é rico em vitaminas e os humanos podem também comer.

Dentro da colónia, cada abelha passa por várias tarefas durante toda a sua vida:

Assim que nasce a abelha começa o seu trabalho como empregada de limpeza.

Depois torna-se abelha nutriz, alimentando as crias do ninho.

Daí começa o seu trabalho como construtora, em que ajuda no fabrico dos favos onde a rainha vai depositar os ovos e onde outras operárias vão armazenar as reservas de comida.

Então vem a abelha guarda do enxame, que protege a colónia de possíveis ameaças.

E por último a abelha forrageira, que vai buscar alimento, água e resina para manter a colónia saudável e garantir que existem reservas de comida durante a época de escassez.

Sabias que as abelhas se comunicam?

Elas têm "perfumes" que chamamos de feromonas e fazem danças específicas para comunicar onde está a fonte de alimento na natureza, e quais as plantas que devem visitar como fonte de nutrientes.

A dança mais famosa é a dança do "8". Onde as abelhas usam o sol como ponto de referência para georeferenciar a sua fonte de alimento.

Nós, os elefantes, temos muito medo de abelhas porque as ferroadas doem bastante.

As abelhas só são agressivas quando sentem o seu ninho ameaçado.

Por isso, quando encontrares o nosso enxame, segue as regras:

Não grites.

Fica calmo.

Afasta-te do enxame.

Nunca atires nenhum objeto.

Não abanes a mão à volta da cara.

Não tentes tirar mel sem acompanhamento de um adulto.

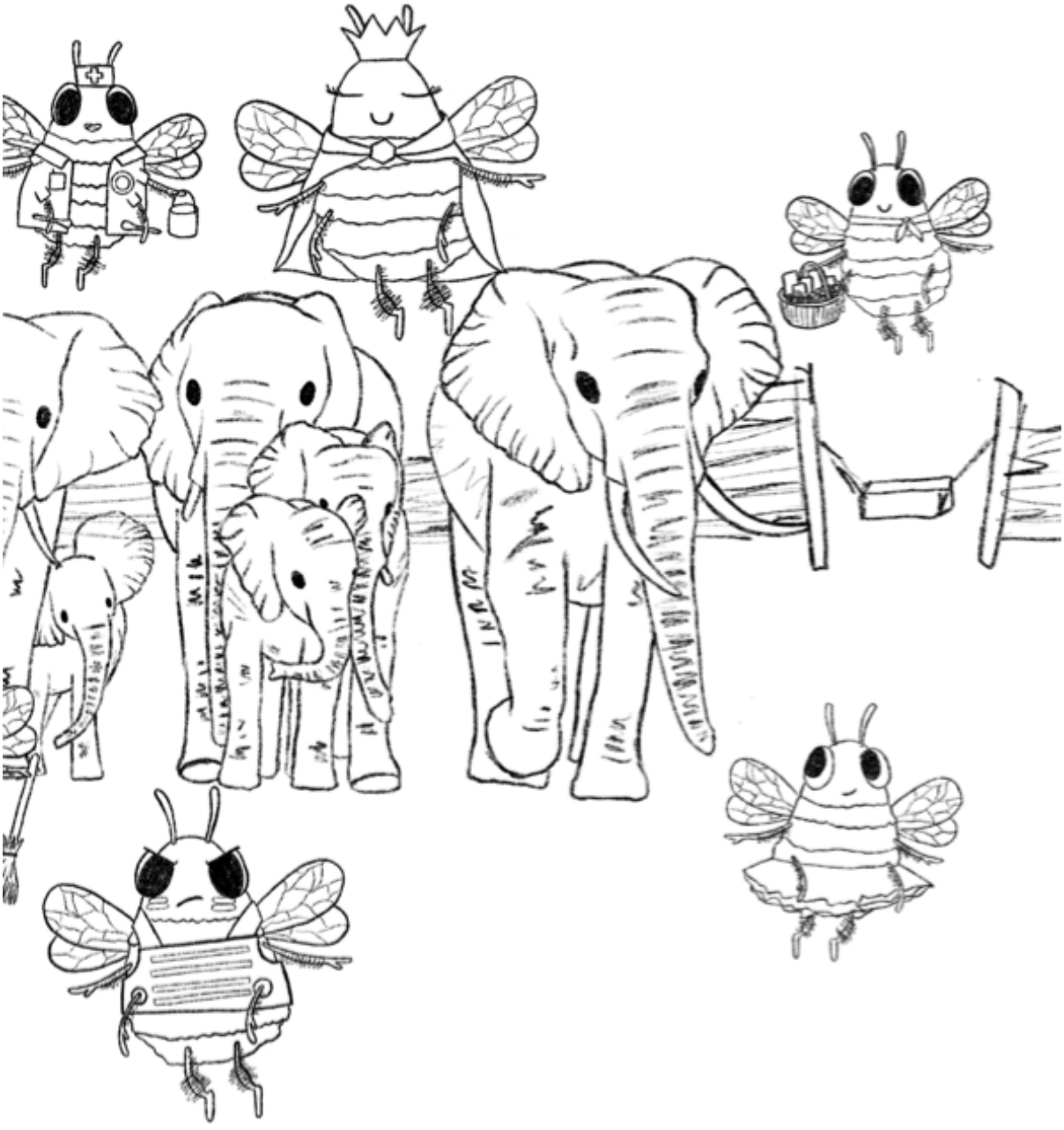
Nyutchi, tenho uma notícia triste: muitos elefantes e humanos estão morrendo por acontecerem conflitos por espaço e alimento.

Mas Ndzou, eu aprendi que com a ajuda das abelhas, os humanos estão a evitar os conflitos e a ajudar pessoas e elefantes a conviver em harmonia.

Agora fiquei muito curioso. Nyutchi, explica-me um pouco mais como é que vocês, as abelhas, ajudam a diminuir o conflito.

Os humanos podem construir vedações de colmeias suspensas. E olha só: quando os elefantes passam e sentem o nosso zumbido, rapidamente se afastam e vão procurar comida em outro local. Assim ninguém é prejudicado.


GISELLY



O respeito pela natureza resulta na harmonia entre todos os seus elementos, e assim nasce a COEXISTÊNCIA, onde:

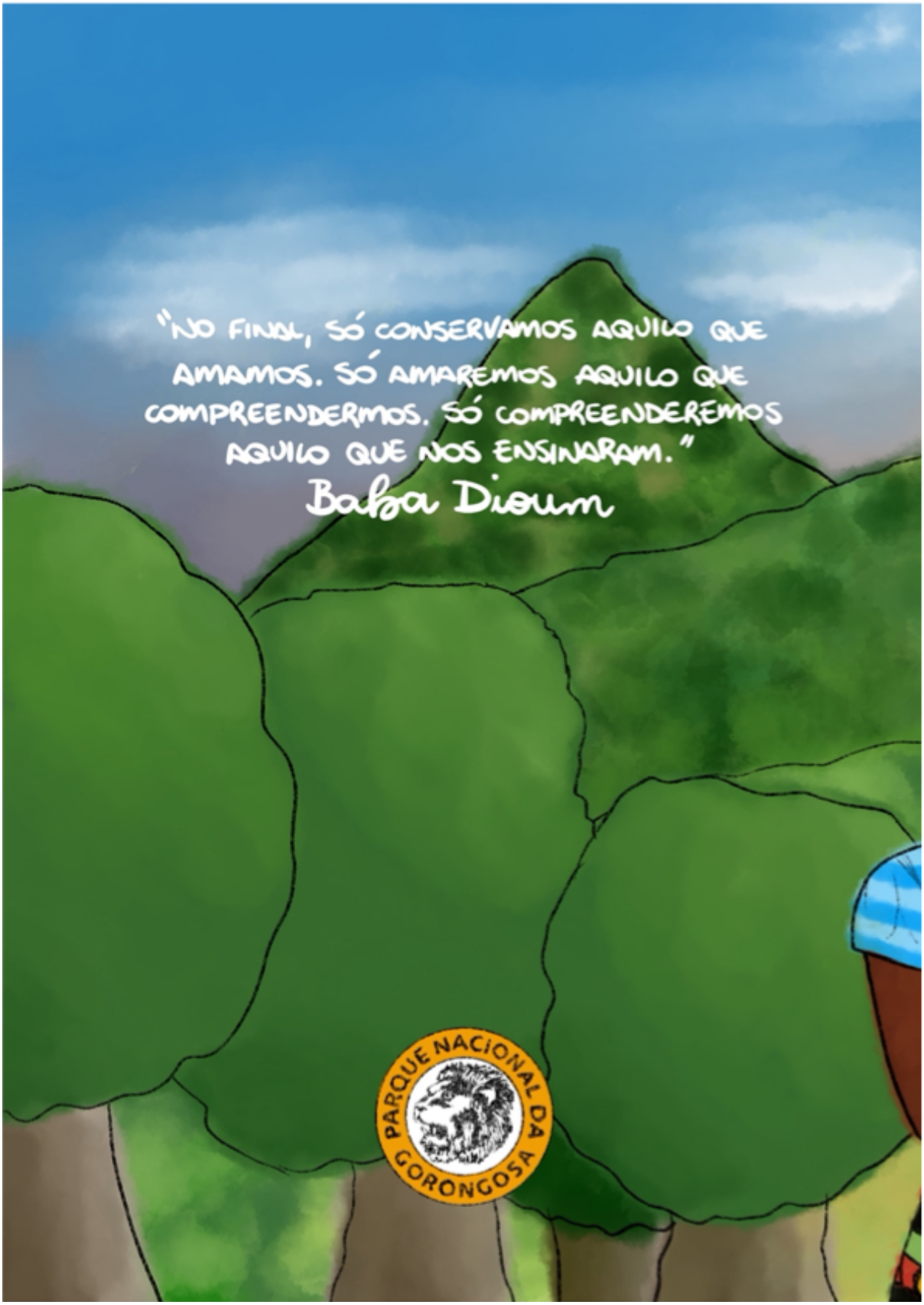
As abelhas ganham uma nova casa para produzir mel.

COEXISTÊNCIA EM HARMONIA

Os elefantes deixam de ser uma ameaça.

As pessoas protegem suas machambas.

E juntos estamos prontos para conservar o meio ambiente.


"NO FINAL, SÓ CONSERVAMOS AQUILO QUE AMAMOS. SÓ AMAREMOS AQUILO QUE COMPREENDERMOS. SÓ COMPREENDEREMOS AQUILO QUE NOS ENSINARAM."
Baba Dioum
PARQUE NACIONAL DA GORONGOSA

Appendix 3: Survey Portuguese version

Departamento de Desenvolvimento Sustentável Sector de Apicultura 2021

Programa de Vedações de Colmeias para Coexistência Humano-Elefante

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Scope do estudo:

O Departamento de Desenvolvimento Sustentável, desenvolveu um Guia Ilustrado para Crianças, intitulado de "Guia de Coexistência Humano-Elefante-Abelha" que servirá de ferramenta para educação ambiental. Em parceria com o Departamento de Desenvolvimento Humano e Departamento de Conservação, queremos abordar questões referentes ao conflito humano-elefante, que muito se verifica na zona tampão do Parque, especialmente no Distrito de Nhamatanda, a sul do Rio Pungue.

Um total de 4500 exemplares do Guia serão distribuídos nos próximos meses (Agosto - Outubro), com o intuito de informar sobre as vedações de colmeias suspensas, usadas para prevenir a passagem de elefantes de dentro do Parque até às áreas onde se encontram as comunidades. A implementação dessas colmeias tem sido feita desde 2018, mas a população ainda recorre a medidas violentas para afastar os elefantes. Nos últimos anos, alguns incidentes têm sido relatados. Por esse motivo, queremos verificar se ao realizarmos ações diretas com as crianças (distribuição do manual junto com ação educativa), pode ter impacto na percepção delas e dos seus pais sobre o conflito e comportamentos que podem levar à coexistência harmoniosa entre as espécies.

Informações prévias:

Perfil do entrevistado

1. Idade
2. Local de residência (comunidade e bairro)
3. Há quanto tempo mora na região
4. Ocupação (somente para os pais)
5. Nível de educação (somente para os pais)

Variáveis Dependentes (a serem avaliadas no questionário):

1. Conhecimento sobre os elefantes
2. Atitudes dos elefantes
3. Percepções sobre o impacto na segurança
4. Percepções sobre o impacto nas machambas
5. Atitudes de ataque/violência
6. Norma descritiva

Tratamentos:

1. Questionário na Pré-entrega do Guia (crianças e pais)
2. Um mês após a entrega (pais e crianças) *long-term learning*

A quem se destina:

1. **140 alunos** (por exemplo apenas da 7a classe) 20 alunos em 7 escolas diferentes

2. Os pais desses alunos (mãe/pai) aqui é preciso atingir um balanço de número igual entre pais e mães

1

Departamento de Desenvolvimento Sustentável Sector de Apicultura 2021

Programa de Vedações de Colmeias para Coexistência Humano-Elefante

Questionário

Elefantes e Humanos: tornando o conflito em coexistência, aprendizagem intergeracional para a mudança.

Escola: _____
Nome do Entrevistador: _____ Nome do Entrevistado: _____

1. Fui informado sobre a natureza do estudo, o seu propósito, a sua duração e o que se espera de mim:

   ☐ Sim ☐ Não

2. Concordo em participar no estudo: ☐ Sim

   ☐ Não

3. Compreendo que a participação no estudo é voluntária e que posso parar de participar a qualquer momento sem dar uma razão para esta decisão e sem que ela tenha qualquer influência sobre a forma de tratamento posterior.

   ☐ Sim ☐ Não

(Informar de que não há respostas certas ou erradas, interessa-nos a sua opinião pessoal)

Pai Mãe Criança (sublinhar qual está a ser entrevistado) ID do questionário (Colocar de acordo com a lista): _____

Perfil do entrevistado	
Idade	
Sexo	
Grau de parentesco com a criança	
Local de residência (comunidade e bairro)	

2

Departamento de Desenvolvimento Sustentável Sector de Apicultura 2021

Programa de Vedações de Colmeias para Coexistência Humano-Elefante

Há quanto tempo mora na região	
Ocupação/profissão atual (se estiver desempregado ou for reformado, então qual a última profissão) - (somente para os pais)	
Escolaridade (que completou)	

Variáveis/questões e categorias de resposta

Das seguintes afirmações diga quais são verdadeiras e quais são falsas.

Variáveis/Questões	**Resposta**
A. Conhecimento sobre os elefantese ameaças (0 a 10)	**Colocar pontuação: 0 = Se errado ou 1 = Se certo**
1. Os elefantes costumam manifestar sinais de ameaça antes de atacar (verdadeiro)	**1**
2. Um elefante macho adulto é mais agressivo do que uma fêmea (falso)	**0**
3. As presas dos elefantes são como dentes incisivos que crescem durante toda a vida (verdadeiro)	**1**
4. Quando nascem, as crias de elefante podem pesar 100kg? (verdadeiro)	**1**
5. Os elefantes podem viver mais de 100 anos? (falso)	
6. Normalmente, os machos adultos vivem com a manada/grupo de elefantes fêmeas durante todo o ano (falso)	
7. Os machos ficam mais agressivos na época de reprodução (verdadeiro)	
8. Os elefantes não têm medo de pessoas e é por isso que destroem as	

3

machambas (falso)	
9. Quando encontramos um elefante devemos correr e ficar sozinhos (falso)	
10. Os elefantes têm medo de abelhas? (verdadeiro)	
B. Percepção do impacto dos elefantes nas machambas (0 a 15)	**0 = nenhum 1 = muito pouco 2 = pouco 3 = médio 4 = alto 5 = elevado**
1. Qual o grau de destruição que a passagem dos elefantes já causou à sua machamba?	
2. Qual a possibilidade de que os elefantes passem nas machambas da sua família durante o próximo ano e as destruam?	
3. Qual o grau de destruição que a passagem dos elefantes já lhe causou?	
C. Percepção do impacto dos elefantes na segurança das pessoas/comunidade (0 a 10)	
1. Número de pessoas alguma vez feridas ou atacadas por elefantes na sua vizinhança/comunidade	**(colocar número)**
2. Numa escala de 0 (min) a 10 (max), classifique a seguinte afirmação. Como classifica o risco de ser atacado por um elefante nos próximos 12 meses?	
D. Atitude perante os elefantes (-10 a 10)	
1. Gostaria que a população de	**-2 = diminuísse muito**

elefantes na região...	**-1 = diminuísse** **0 = ficasse igual** **1 = aumentasse** **2 = aumentasse muito**
2. Se os elefantes desaparecessem para sempre da região onde mora, o que sentiria?	**-2 = muito feliz** **-1 = feliz** **0 = nem feliz nem triste** **1 = triste** **2 = muito triste**
3. O que sente em relação aos elefantes? é melhor descrito como...	**-2 = gosta muito pouco** **-1 = gosta pouco** **0 = nem gosta nem desgosta** **1 = gosta** **2 = gosta muito**
4. Os elefantes têm o seu valor, mesmo se isso não gerar nenhuma renda para si...	**-2 = discorda totalmente** **-1 = discorda** **0 = não concorda/nem discorda** **1 = concorda** **2 = concorda totalmente**
5. Se tivesse que andar na floresta perto da sua casa e encontrasse um elefante, iria sentir-se em perigo...	**-2 = discorda totalmente** **-1 = discorda** **0 = igual** **1 = concorda** **2 = concorda totalmente**
E. Atitude perante afastar/atacar elefantes (-2 a 2)	
1. Afastar/Atacar qualquer elefante que apareça na minha propriedade é...	**-2 = muito útil** **-1 = util** **0 = igual** **1 = pouco útil** **2 = muito pouco útil**
F. Norma descritiva (0 a 8)	**0 = nenhum deles** **1 = menos de metade** **2 = metade** **3 = mais que a metade** **4 = todos**
1. Quantos vizinhos acham que têm comportamentos agressivos perante	

os elefantes?	
2. Quantos agricultores (donos de machambas) pensam em atacar ou matar elefantes?	
G. Percepção da prática Perante a seguinte situação: Uma cria de elefante encontra-se perdida na minha machamba, o que faria?	**0 = afastava** **1 = nada** **2 = ajudo a cria**

Appendix 4: Survey English version:

Department for Sustainable Development Apiculture Sector 2021

Beehive Fence Program for Human Elephant Coexistence

Scope of Research:

The Department for Sustainable Development produced an illustrated guide for children, called "Guide for coexistence Human-Elephant-Bee" as a tool for environmental education. In partnership with the Department for Human Development and the Department for Conservation, we would like to address questions regarding the Human-Elephant Conflict, which can be observed in the park's buffer zone, especially in Nhamatanda district, South of the Pungué river.

A Total of 4500 copies will be distributed in the next months (August-October), with the objective to convey information regarding the suspended beehive fences, used to prevent the passage of elephants from the park to the areas where the communities are. The implementation of the beehives has been started in 2018, however, people still deploy violent measures to chase away elephants. In the past years incidents have been reported. For this reason, we want to test if activities directed at the children (distribution of the guide, together with educational activities) can have impact on their and their parent's perception regarding the conflict and behaviours that can lead to coexistence between species in harmony.

Prior information:

Profile of the participant:

1. Age
2. Place of residence (community and neighbourhood)
3. Length of residence in the region
4. Occupation (parents only)
5. Literacy level (parents only)

Dependent Variables (to be evaluated in the survey):

1. Knowledge regarding elephants
2. Attitudes of elephants
3. Percepções regarding o impact non segcurity
4. Perceptions regarding impacto on agricultural plots
5. Attitudes to attack/violence
6. Descriptive norm

Treatment :

1. Questionnaire prior to distribution of Guide (children and parents)
2. One month after distribution (parents and children) *long-term learning*

For whom is it intended:

1. **140 pupils** (for example only 7th grade) 20 pupils in 7 different schools
2. The parents of these pupils (mother/father) here we need to achieve a balance/equal number of fathers and mothers

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Questionnaire

Elephants and Humans: turning conflict into coexistence, intergenerational learning for change

School: _____

Name of the interviewer: _____

Name of the interviewee: _____

1. I was informed about the nature of this study, its purpose, its duration and what is expected of me

   ☐ Yes ☐ No

2. I agree to participate in the study:

   ☐ Yes ☐ No

3. I understand that the participation in this study is voluntary and that I can stop participating at any time with no need to explain my decision and without any further consequences in treatment for myself.

   ☐ Yes ☐ No

(Inform that there are no right or wrong answers, we are interested in your personal opinion)

Father Mother Child (underline who is being interviewed) ID of questionnaire (Fill in accordance with the list): _____

Profile of the interviewee	
Age	
Sex	
Degree of kinship	
Place of residence (community and neighbourhood)	

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Department for Sustainable Development Apiculture Sector 2021 Beehive Fence Program for Human Elephant Coexistence For how long do you live in the region?	
Current occupation/profession (if unemployed or retired, indicate last occupation) - (only for the parents)	
School years (completed)	

Variables/questions and answer categories

Indicate which of the following affirmations are false or correct

Variables/Questions	**Answer**
A. Knowledge regarding elephants' threats (0 to 10)	**Indicate score: 0 = if wrong or 1 = if correct**
1. Elephants manifest warning signals before attacking (true)	**1**
2. An adult male elephant is more aggressive than a female (false)	**0**
3. Elephant tusks are like incisor teeth which grow during all their life (true)	**1**
4. Elephant calves can weigh up to 100K when they are born (true)	**1**
5. Elephants can live over 100 years (false)	
6. Usually, the adult males live with the herd/group of female elephants throughout the whole year (false)	
7. The males are more aggressive during the breeding season (true)	
8. Elephants are not afraid of people, that's why they destroy their fields (false)	

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9. When we encounter na elephant we should run and stay alone (false)	
10. Elephants are afraid of bees (true)	
B. Perception of impact of elephants on the fields (0 to 15)	**0 = none 1 = very little 2 = little 3 = medium 4 = high 5 = very high**
1. What degree of destruction have passing through elephants already caused to your fields?	
2. How big is the possibility of elephants passing through your families' fields and destroying them during the next year?	
3. How big is the destruction elephants have already caused you?	
C. Perception of impact of elephants on people's/the communities' safety	
1. Number of people hurt or attacked by elephants in your neighbourhood/community	**(insert number)**
2. On a scale from 0 (min) to 10 (max), classify the following afirmation How to you classify the risk of being attacked by an elephant in the next 12 months ?	
D. Attitude towards elephants (-10 a 10)	
1. Would you like the population of elephants in the region...	**-2 = to diminish a lot**

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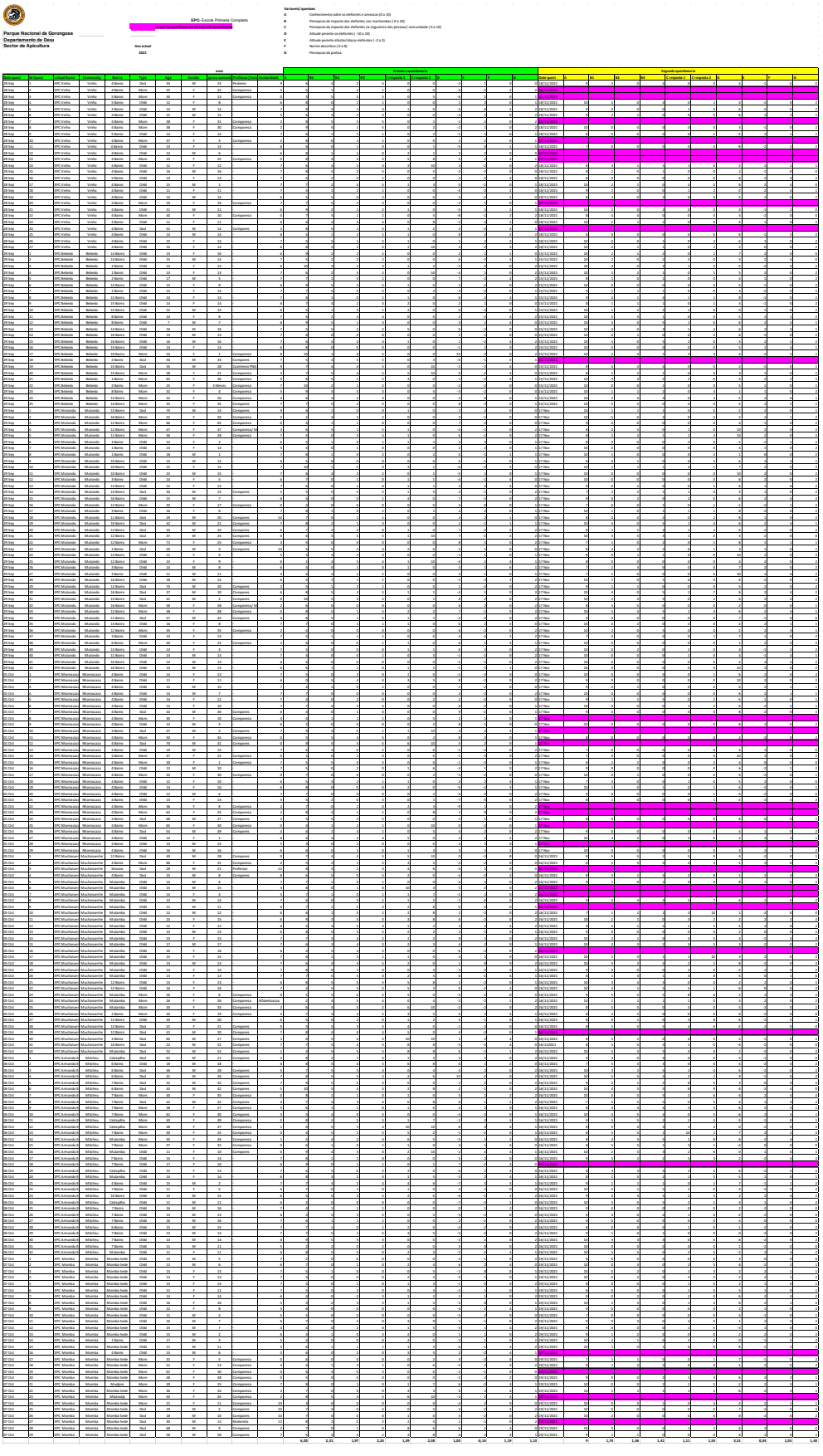
	-1 = to diminish **0 = to stay the same** **1 = to increase** **2 = to increase a lot**
2. If elephants would dissapear forever from the region where you live, how would you feel?	**-2 = very happy** **-1 = happy** **0 = not happy nor sad** **1 = sad** **2 = very sad**
3. What do you feel regarding elephants? Best described...	**-2 = like them very little** **-1 = like them little** **0 = don't like nor dislike them** **1 = like them** **2 = like them a lot**
4. Elephants have their value, even if that doesn't represent any income for you...	**-2 = totally disagree** **-1 = disagree** **0 = nor agree nor disagree** **1 = agree** **2 = totally agree**
5. If you had to walk in the forest near your house and would encounter na elephant, you would feel in danger...	**-2 = disagree totally** **-1 = disagree** **0 = the same** **1 = agree** **2 = agree totally**
E. Attitude towards chasing away/atacking elephants (-2 to 2)	
1. Chasing away/Atacking any elephant showing on my property is…	**-2 = very useful** **-1 = useful** **0 = the same** **1 = little useful** **2 = very little useful**
F. Descriptive Norm (0 to 8)	**0 = none of them** **1 = less than half** **2 = half** **3 = more than half** **4 = all**
1. How many neighbours do you think display aggressive behaviour towards elephants?	

2. How many farmers (owners of fields) think of attacking or killing elephants?	
G. Perception of Practice Confronted with the following situation: An elephant calf is lost on my field, what would I do?	**0 = chase it away** **1 = nothing** **2 = help the calf**

Appendix 5: GNP Survey results for pre- and post-test



Parque Nacional de Gorongosa
Departamento de Dess
Sector de Apicultura

EPC- Escola Primaria Completa

Ano actual
2021

Variaveis/ questoes
A Conhecimento sobre os elefantes e annexus (0 a 10)
B Percepcao do impacto das elefantes nas machambas (0 a 20)
C Percepcao do impacto das elefantes na seguranca das pessoas/ comunidade (0 a 10)
D Attitude perante os elefantes (-10 a 10)
E Attitude perante afastar/atacar elefantes (-2 a 2)
F Normas descritivas (0 a 8)
G Percepcao de politica

Appendix 6: Detailed description of pre- and post-test results for questions B to G

1. Perception of negative impact of elephants

In the pre-test the children's perception indicate that elephants have caused relatively little destruction to their families' "machambas", showing a mean value of 1.9, this value changes in the post-test to a slightly lower mean value of 1.2. For the mothers the pre-test results indicate a slightly higher mean of 2.3, which reduce to 2.2 in the post-test results. The highest perception of damage caused to agricultural plots by elephants is the fathers', with a mean of 3.5, standing for 'medium' perception of destruction. This value reduces in the post-test results of the fathers to 2.6. The total result decreases from 2. 2 in the pre-test to 1.7 in the post-test, however only the change of perception of the children and the fathers has statistical significance, with the p-value of 0.001 for the children and 0.008 for the fathers (Table 1).

Tabel 1: Perception of negative impact caused to "machambas" by elephants (B1), Paired Samples T-tests

Type			Mean	N	Std. Deviation	Std. Error Mean
Child	Pair 1	B1	1.91	115	1.876	.175
		B1_after	1.29	115	1.588	.148
Dad	Pair 1	B1	3.53	32	1.900	.336
		B1_after	2.63	32	1.930	.341
Mom	Pair 1	B1	2.38	42	2.083	.321
		B1_after	2.29	42	2.028	.313

Again here, the results indicate low means of perceived risk of future negative impacts caused by elephants, the children, and mothers present similar scores with 1.8 and 1.4 respectively, while the fathers indicate a mean score of 2.7 in the pre-test results (Table 2). For all three categories of participants (children, mothers, and fathers) the registered change in perception form the pre- to the post-test results is statistically significant, with a p-value of 0.001 for the children, 0.022 for the mothers and 0.029 for the fathers.

Table 2: Perception of risk of damage caused by an elephant in the near future (B2), Paired Samples T-Tests

Type			Mean	N	Std. Deviation	Std. Error Mean
Child	Pair 1	B2	1.89	115	1.781	.166
		B2_after	.96	115	1.307	.122
Dad	Pair 1	B2	2.72	32	1.746	.309
		B2_after	2.03	32	2.148	.380
Mom	Pair 1	B2	1.48	42	1.685	.260
		B2_after	2.38	42	2.060	.318

Like the results presented in question B1, the perception of negative impact caused by elephants is relatively low among the children, higher among the fathers and slightly less high among the mothers in question B3 (Table 3).

Only for the children (p-value 0.001) and the fathers (p-value 0.020) a statistically relevant significance can be observed.

Table 3: Perception of destruction caused by elephants (B3), Paired Samples T-Tests

Type			Mean	N	Std. Deviation	Std. Error Mean
Child	Pair 1	B3	1.78	115	1.771	.165
		B3_after	1.01	115	1.484	.138
Dad	Pair 1	B3	3.31	32	1.925	.340
		B3_after	2.41	32	2.014	.356
Mom	Pair 1	B3	2.55	42	2.178	.336
		B3_after	1.74	42	1.795	.277

2. Perceived risk

All participants indicate a low number of people they know having been hurt or attacked by elephants, with means ranging from 1.05 (children), over 2.1 (fathers) to 1.4

(mothers) in the pre-test, with no statistically significant change between the pre- and post-test for any of the participants (Table 4).

Regarding the perceived risk of being attacked in the next 12 months all participants indicate relatively low scores with means ranging from 2.04 (children), to 3.6 (fathers) and 1.4 (mothers) out of a total of 10 points maximum. The differences between pre- and post-test results do not represent any statistically significant results for the fathers and the mothers, but for the children the p-value of 0.012 represents statistical value, albeit low.

Table 4: Perceived risk of being attacked by an elephant, Paired Samples T-Tests

Type			Mean	N	Std. Deviation	Std. Error Mean
Child	Pair 1	C resposta 1	1.05	115	1.337	.125
		C resposta 1_after	.96	115	1.327	.124
	Pair 2	C resposta 2	2.04	115	2.864	.267
		C resposta 2_after	1.27	115	2.210	.206
Dad	Pair 1	C resposta 1	2.16	32	2.897	.512
		C resposta 1_after	1.56	32	2.368	.419
	Pair 2	C resposta 2	3.66	32	3.882	.686
		C resposta 2_after	1.84	32	2.689	.475
Mom	Pair 1	C resposta 1	1.43	42	2.297	.354
		C resposta 1_after	1.17	42	2.140	.330
	Pair 2	C resposta 2	2.24	42	3.114	.481
		C resposta 2_after	2.07	42	2.278	.352

3. Attitudes

The overall attitude towards elephants from all participants is close to neutral in the pre-tests, without any strong visible tendency, although minor changes occurred from the

pre- to the post-test, only regarding the results of the children and the fathers we can register a statistically relevant significance (Table 5).

Table 5: Attitude towards elephants, Paired Samples T-tests

Type			Mean	N	Std. Deviation	Std. Error Mean
Child	Pair 1	D	.53	115	4.027	.376
		D_after	3.24	115	3.752	.350
Dad	Pair 1	D	2.53	32	3.943	.697
		D_after	4.34	32	2.914	.515
Mom	Pair 1	D	1.50	42	4.723	.729
		D_after	2.69	42	4.039	.623

4. Aggression towards elephants

Results of the paired sample t-test indicate close to neutral means for all participants in both, the pre- and post-tests regarding attacking or chasing away elephants (Question E) and no statistically significant changes in results (Table 6)

Table 6: Aggressive behaviour towards elephants, Paired Samples T-tests

Type			Mean	N	Std. Deviation	Std. Error Mean
Child	Pair 1	E	-.14	115	1.643	.153
		E_after	.41	115	1.675	.156
Dad	Pair 1	E	-.06	32	1.777	.314
		E_after	-.12	32	1.641	.290
Mom	Pair 1	E	-.40	42	1.712	.264
		E_after	.52	42	1.714	.265

5. Descriptive norm

The results of the paired sample t-test indicate very similar means for the pre-test, 1.2 for the children, 1.3 for the fathers and 1.1 for the mothers, meaning that the respondents believe that less than half of the neighbours and farmers of their community display aggressive behaviour towards elephants.

The comparison of the results from the pre- and post-test don't show any statistically significant changes in results (Table 7).

Table 7: Perception of aggressive attitudes towards elephants in the community, Paired Samples T-tests

Type			Mean	N	Std. Deviation	Std. Error Mean
Child	Pair 1	F	1.23	115	1.672	.156
		F_after	1.14	115	1.627	.152
Dad	Pair 1	F	1.31	32	1.975	.349
		F_after	.72	32	1.529	.270
Mom	Pair 1	F	1.12	42	1.641	.253
		F_after	1.07	42	1.438	.222

6. Empathy

The results of paired sample t-test indicate a mean close to neutral (do nothing) for all participants, with 1.1 for the children, 1.1 for the fathers and 1 for the mothers respectively. There are no statistically significant differences in results of all participants from the pre- test to the post-test (Table 8).

Table 8: Attitude towards helping an elephant calf, Paired Samples T-tests

Type			Mean	N	Std. Deviation	Std. Error Mean
Child	Pair 1	G	1.15	115	.808	.075
		G_after	1.46	115	.729	.068
Dad	P	G	1.19	32	.931	.165
	air 1	G_after	1.25	32	.842	.149
Mom	Pair 1	G	1.02	42	.811	.125
		G_after	1.36	42	.656	.101

8. Descriptive norm analysis per community

The paired sample T-test above has already indicated a low mean value for all participants in the pre- and post-tests regarding their perception of aggressive behaviour among neighbours or farmers of their community. Here, the cross tabulation of F_after for each community also shows high percentages of 0 known cases of aggression, with 73.1% for Mucharuenhe being the highest, followed by 68.2% for Nhamacaza, 64.3% for Mutondo, 58.3% for Bebedo, 58.1% for Mitcheu, 52.6% for Vinho, and 52% for Momba (Table 9).

Table 9: Cross tabulation for Community versus aggressive behaviour towards elephants in the community (F_after)

			F_after							
			0	1	2	3	4	6	7	Total
Community	Bebedo	Count	14	2	3	0	5	0	0	24
		% in Community	58,3%	8,3%	12,5%	0,0%	20,8%	0,0%	0,0%	100,0%
	Mitcheu	Count	18	1	1	3	7	1	0	31
		% in Community	58,1%	3,2%	3,2%	9,7%	22,6%	3,2%	0,0%	100,0%
	Momba	Count	13	4	4	4	0	0	0	25
		% in Community	52,0%	16,0%	16,0%	16,0%	0,0%	0,0%	0,0%	100,0%
	Mucharuenhe	Count	19	1	2	1	3	0	0	26
		% in Community	73,1%	3,8%	7,7%	3,8%	11,5%	0,0%	0,0%	100,0%
	Mutondo	Count	27	5	2	2	6	0	0	42
		% in Community	64,3%	11,9%	4,8%	4,8%	14,3%	0,0%	0,0%	100,0%
	Nhamacaza	Count	15	3	1	1	1	0	1	22
		% in Community	68,2%	13,6%	4,5%	4,5%	4,5%	0,0%	4,5%	100,0%
	Vinho	Count	10	1	5	0	3	0	0	19
		% in Community	52,6%	5,3%	26,3%	0,0%	15,8%	0,0%	0,0%	100,0%
Total		Count	116	17	18	11	25	1	1	189
		% in Community	61,4%	9,0%	9,5%	5,8%	13,2%	0,5%	0,5%	100,0%

9. Empathy with abandoned elephant calf

The cross tabulation comparing the pre- and post-test results indicates that out of the 54 participants who would chase away the abandoned calf 26 (48.1%) changed their view to helping the calf and 20 (37%) indicated in the post-test that they would no longer chase the calf away but do nothing instead. However, out of 78 participants who indicated they would help the calf in the pre-test, 13 (16.7%) changed their view to chasing the calf away in the post-test. A total of 85.2% refers in the post-test they would either do nothing (30.2%) or help the calf (55%) (Table 10).

Table 10: Cross tabulation pre-test post-test results regarding helping an abandoned elephant calf (G *G_after)

			G_after			
			0	1	2	Total
G	0	Count	8	20	26	54
		% in G	14,8%	37,0%	48,1%	100,0%
	1	Count	7	25	25	57
		% in G	12,3%	43,9%	43,9%	100,0%
	2	Count	13	12	53	78
		% in G	16,7%	15,4%	67,9%	100,0%
Total		Count	28	57	104	189
		% in G	14,8%	30,2%	55,0%	100,0%

Green: change from 0 to 2

Orange: change from 2 to 0

Blue: accumulated change to 0 or 1

The cross tabulation by type indicates that 60% of the children would help the calf, 26.1% of the children would do nothing and 13.9% of the children would chase the calf away. 45.2% of the mothers would do nothing, 45.2% would help the calf, and 9.5% of the mothers would chase the calf away. 50% of the fathers would help the calf, 25% would do nothing and 25% would chase the calf away (Table 11).

Table 11: Cross tabulation Type (child, father, mother) versus helping abandoned elephant calf (G_after)

			G_after			
			0	1	2	Total
Type	Child	Count	16	30	69	115
		% in Type	13,9%	26,1%	60,0%	100,0%
	Mother	Count	4	19	19	42
		% in Type	9,5%	45,2%	45,2%	100,0%
	Father	Count	8	8	16	32
		% in Type	25,0%	25,0%	50,0%	100,0%
Total		Count	28	57	104	189
		% in Type	14,8%	30,2%	55,0%	100,0%

The results of cross tabulation for the communities indicate that Mucharuenhe and Mutondo show a positive change with 65.4% and 71.4% of the respective population changing their behaviour to helping the calf (Table 12). Bebedo indicates a slightly positive to neutral change with 50% of the community indicating 1= do nothing in the post-test results, however Mitcheu (22.6%) and Vinho (26.3%) indicate negative changes to 0 = chasing the calf away (Table 12).

Table 12: Cross tabulation Community versus helping abandoned elephant calf (G_after)

			G_after			
			0	1	2	Total
Community	Bebedo	Count	2	12	10	24
		% in Community	8,3%	50,0%	41,7%	100,0%
	Mitcheu	Count	7	6	18	31
		% in Community	22,6%	19,4%	58,1%	100,0%
	Momba	Count	3	10	12	25
		% in Community	12,0%	40,0%	48,0%	100,0%
	Mucharuenhe	Count	5	4	17	26
		% in Community	19,2%	15,4%	65,4%	100,0%
	Mutondo	Count	2	10	30	42
		% in Community	4,8%	23,8%	71,4%	100,0%
	Nhamacaza	Count	4	9	9	22
		% in Community	18,2%	40,9%	40,9%	100,0%
	Vinho	Count	5	6	8	19
		% in Community	26,3%	31,6%	42,1%	100,0%
Total		Count	28	57	104	189
		% in Community	14,8%	30,2%	55,0%	100,0%