



HWC management Niassa:

Status quo and recommendations for a way forward

Study commissioned by
WCS Mozambique with funding by the GIZ Partnership against Poaching and Illegal

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Acknowledgements

The development of an outline for the management of human-wildlife conflicts (HWC) in NSR was commissioned by the Wildlife Conservation Society (WCS) with funding from the “GIZ Partnership against Poaching and Illegal Wildlife Trade in Africa and Asia”. In a landscape, such as NSR, which is shared by people and wildlife, HWC management and anti-poaching are strongly interlinked and need to be approached with holistic and integrated strategies. The ultimate goal, a peaceful and mutually beneficial coexistence of people and wildlife at large spatial scale requires mainstreaming HWC management across sectors and needs to unlock the full potential of living with wildlife.

Conducting this work would not have been possible without the valuable input of many people, whom I would like to thank sincerely. I would like to acknowledge 15 interviewees, who work in Niassa Special Reserve or are otherwise affiliated with it to contribute with sharing their multiple and extensive experiences and reflections on human-wildlife conflict and coexistence with me. About 35 hours of expert interviews were conducted. Thank you so much for allocating your precious time to this study. A very special thanks goes to Joana Pereira, PhD student at the Faculty of Sciences from Lisbon University in Portugal, who openly shared her insights and first research findings for this strategy development. Thank you so much also to Samuel Billerio, HWC officer of WCS/NSR, who supported data collection for this work and shared his experiences and insights with me. Furthermore, I would like to express my gratitude to students of Eduardo Mondlane University, and Bilibiza Agroforestry Technical Institute, who conducted field interviews for this study and collected data from the natural resource boards (CGRN).

Note of the author:

The study covers a large array of different topics. Technical terms might have been used in a broader sense, as different stakeholders often use them with slightly different meanings. The main focus was to ensure comprehensibility and coherence.

If you identify any mistakes or have the feeling that information you provided is not reflected correctly/adequately, please get in touch with the author.

1. Introduction and methods

Niassa Special Reserve (NSR) in Northern Mozambique is a peopled conservation area with an estimated number of 58,000 inhabitants (NCP 2020) living in 44 villages, with a strong interface of people and wildlife. With 42,300 km² the reserve is double the size of Kruger NP in South Africa. Villages are concentrated in three main areas plus some dispersed enclave villages throughout the reserve (for details see chapter Spatial planning for human-wildlife coexistence pages 26 ff.).

NSR comprises 31% of Mozambique's protected land and harbours highly significant populations of wildlife, including the largest populations of about 3600 elephants (Grossmann et al. 2016), lion (1,000-1,200), leopard, wild dog (400-450), sable, kudu, wildebeest and zebra. It is connected to the Selous Game Reserve (SGR, 55,000 km²) in southern Tanzania by the Selous-Niassa corridor, and remains connected by a natural corridor of forestry concessions to the Quirimbas National Park (7,506 km²) to its east, on the coast of northern Mozambique. This remains one of Africa's largest contiguous wilderness areas (WCS 2021).

The reserve falls under two provinces (Niassa and Cabo Delgado) and comprises six districts out of which two district administrative centres are located entirely within its boundaries (Mavago and Mecula). NSR is divided into 18 blocks/concessions, which are using the natural resources for generating income through hunting, tourism or philanthropy. Several types of concessions exist:

- purely commercial hunting concessions,
- private hunting/recreational concessions,
- purely conservation oriented,
- mixed forms.

Some concessions contain multiple villages, buffer zones or development zones, others are free of any human settlement. The concessions are obliged to respect the communities present in their concessions, their contracts, however, do not generally define the form of cooperation with the resident communities within a concession. An exception for this is Mariri (Colleen Begg, pers. comm.).

Human wildlife conflict (HWC) describes the interaction between people and wildlife, whereby both parties impact negatively on the other (Madden 2008). In NSR crop damage by herbivores, livestock damage by carnivores, property damage mainly by elephants and accidents with humans with various species are an important concern for the local population. HWC management is weakly developed in most of NSR, and killing of wildlife species in retaliation and a decreased support for conservation activities are the consequences.

Due to the difficult HWC situation in NSR, WCS contracted an independent consultant to develop an outline for a HWC management strategy. Due to the Covid-19 crisis the work had to be conducted remotely with the support of local staff and in collaboration with various partners from December 2020 to February 2021. The outline is based on data and information of various sources:

- HWC data collected by Niassa Carnivore Project (NCP) through the MOMS (Management Oriented Monitoring System) guardians. Analysis and information based on this data is referenced "NCP, unpublished data"

- Interview data collected by Joana Pereira, PhD candidate from Lisbon University in Portugal, Faculty of Sciences. Information was collected from community leaders of 14 selected villages within NSR and additionally 14-15 randomly selected households within those villages. Analysis and information based on this data is referenced “Pereira J., unpublished data”
- Interview data of seven Community Natural Resource Boards, collected by students of Eduardo Mondlane University, and Bilibiza Agroforestry Technical Institute, Mozambique under guidance of Samuell Billerio and the international consultant. Analysis and information based on this data is referenced “Gross&Billerio, unpublished data”
- Expert interviews conducted with 15 experts and stakeholders of NSR. Analysis and information based on this data is referenced anonymously as “Interviewee no.”. A list of interview partners is found in the Appendix.

The collected information provided a good overview on the levels of HWC, challenges and opportunities going along with it. This report creates an overview on the impacts of HWC in NSR, pulls together the drivers of HWC and gives an overview on strategies that need to be considered to develop an HWC management plan. Finally, the report summarizes proposed interventions in a short-term action plan and longer-term goals.

The future of conservation in NSR depends on the success of holistic and integrated HWC management and the development of long-term coexistence strategies benefitting both, people and wildlife.

2. Understanding the impact of HWC in Niassa

HWC is an essential topic for the people living within NSR and all (100%) of the 14 interviewed community leaders rank the management of negative interactions between communities and wildlife living at NSR as high priority (Pereira, J., unpublished data) and out of 28 community resource board representatives (CGRN) 90% rank this topic as priority or high priority. Only 10% give HWC management low priority. While community representatives see the topic of HWC management as priority, from a national perspective HWC in Niassa is seen as solved, while its status quo needs to be maintained (Interviewee 11).

To fully understand the level and impact of HWC various aspects need to be considered. The frequency and severity of damage by wildlife, the resilience and buffer capacity of the farmer and the community he/she lives in, the benefits received from wildlife, the effectiveness of HWC management and the relationship of conservation authorities towards the communities all influence HWC. Given the short time frame of this study and limitations of data available some knowledge gaps still persist, which are indicated in the text.

Wildlife and its interactions with people, is heterogeneously distributed throughout the NSR. Some areas are strongly affected by crop damaging herbivores, while others are prone to crocodile attacks or face livestock predation. Out of 14 interviewed leaders from 14 different villages within NSR, 80% report daily interaction with wildlife, 20% report weekly interaction (Pereira, J., unpublished data), indicating a high level of wildlife damage in the selected villages.

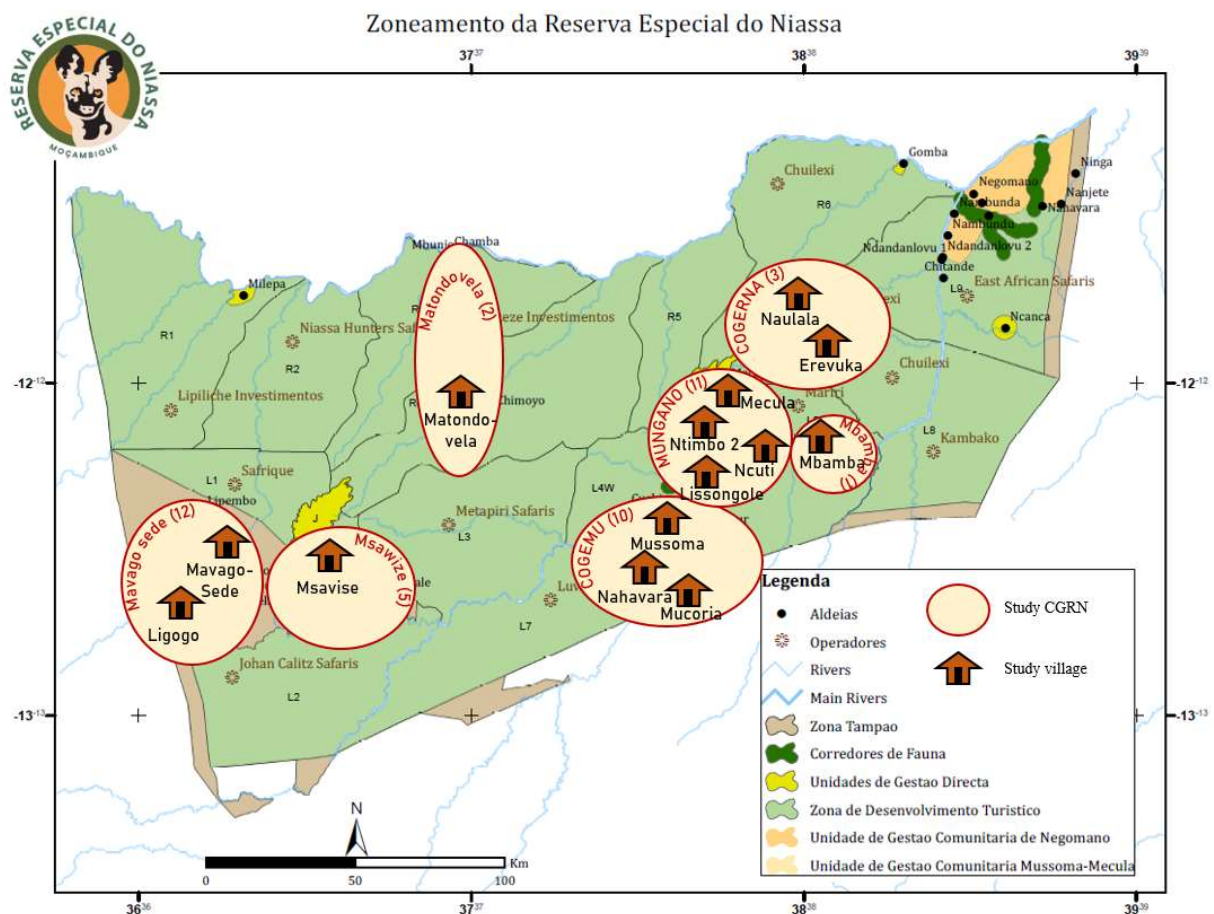


Fig 1: Map of selected interview villages and CGRNs. The seven study CGRNs are indicated as yellow circles with red frame, number indicates total no. of villages in this CGRN. The 14 study villages are indicated as houses.

Crop damage by herbivores in NSR

Out of all damages caused by wildlife species, most damage incidents are reported by herbivores damaging crops on fields (machambas). In 2019 a number of 5555 wildlife damage incidents were reported from 44 villages, in which MOMS guardians are present (NCP, unpublished data), out of which 75.3% were crop damage incidents (Fig 3).

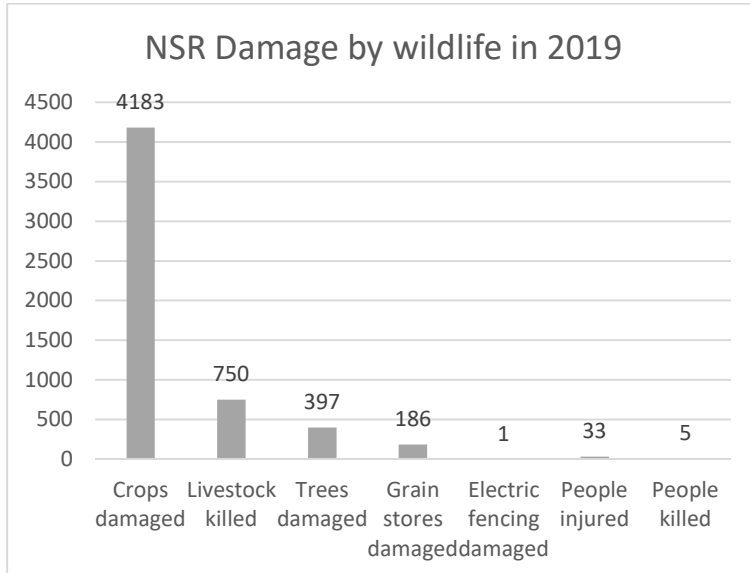


Fig 3: Number of damage incidents by wildlife species in 44 villages of NSR in 2019

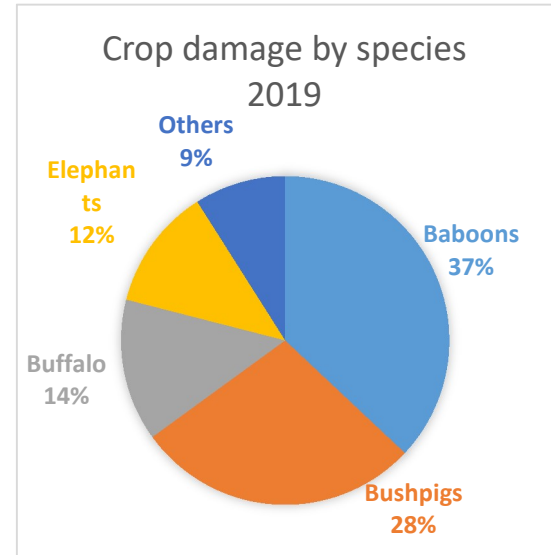


Fig 2: Proportion of crop damage per species in NSR in 2019, n=4183

In the year 2019 the largest proportion of crop damage was caused by baboons (37%), followed by bushpigs (28%), buffalo (14%) and elephants (12%). Antelopes, zebra, rodents, and birds were summarized as “others” and caused the smallest proportion of damage (Fig 2). Even though the highest number of crop damage incidents (frequency) is caused by baboons and bushpigs, elephants and buffalo may still cause larger amounts of damage (severity), once they enter a farm. However, the MOMS data reveals that only a very small percentage of fields was damaged by more than 50% (0.1% in 2015-2020) and this damage was caused by baboons and bushpigs. Most of the damage (80% in 2015-2020) affected less than 25% of the damaged field, whereby elephant and buffalo tended to cause more damage in the category 25-50% (elephant 29.4%, buffalo 17.5%) than in the category below 25% (elephant 10.8%, buffalo 10.9%) (NCP, unpublished data).

For the development of an HWC management strategy, it also has to be understood that frequency and severity of damage are not directly linked to the level of tolerance or intolerance towards a species (Zimmermann et al. 2020). The perception of and attitude towards a species furthermore is influenced strongly by social, cultural and political values (see also chapter 3, page 16 ff.).

Throughout the past more than 10 years wildlife damage was monitored by the Management Oriented Monitoring System (MOMS) through local guardians (for details see chapter 6, page 24 ff.). Starting with a number of 21 MOMS guardians in 21 villages within NSR the programme was continuously developed and the number of MOMS guardians and monitoring villages increased up to 44 in 2019. With an increasing monitoring effort the number of reports of damage incidents increased as well (Fig 4). The number of crop damage caused by elephants stayed comparatively stable over time, damage by buffalo increased. Most obvious was the

increase of crop damage incidents by other species, in parallel with the increased village coverage by MOMS guardians.

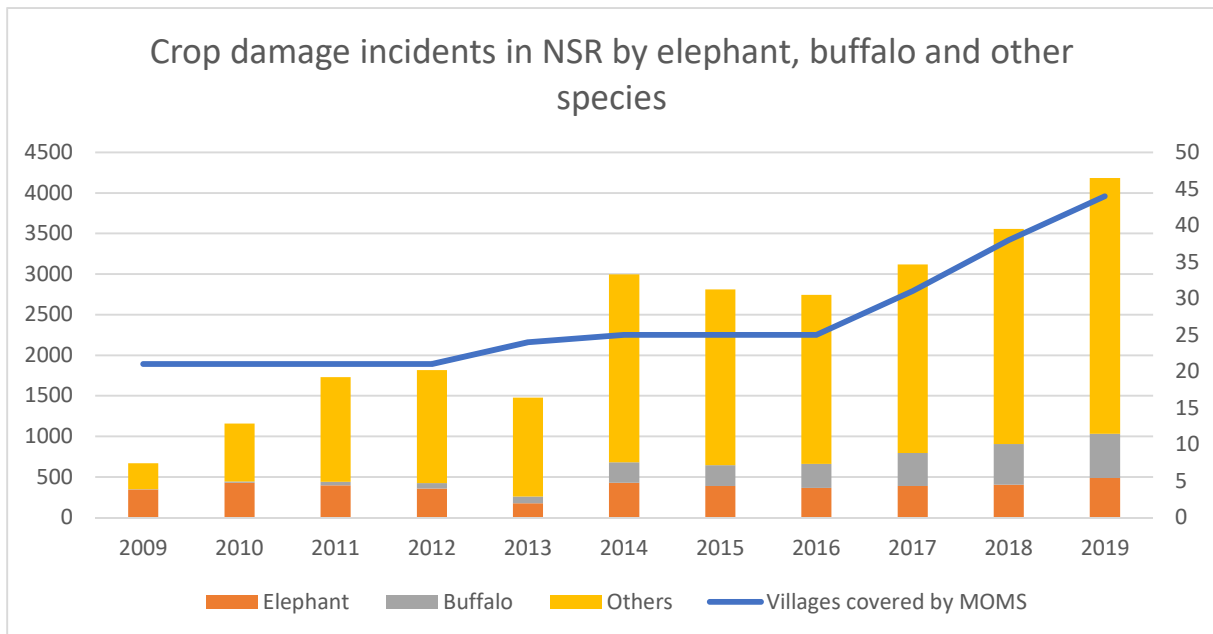


Fig 4: Crop damage incidents in NSR caused by elephant, buffalo and other species throughout the years 2009-2019. The number of villages covered by the monitoring through MOMS guardians is indicated as a blue line.

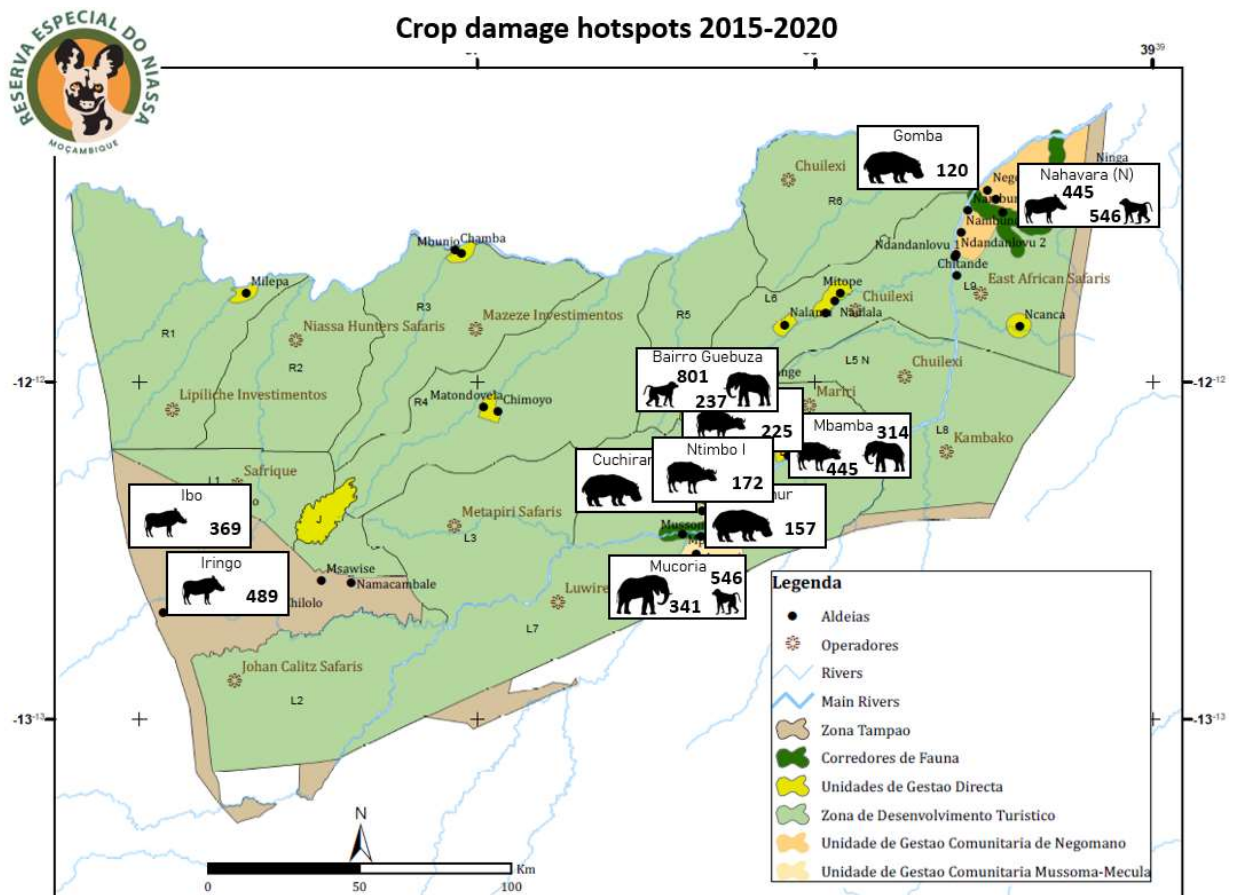


Fig 5: Map of NSR indicating villages with the three highest crop damage incidents by hippo, elephant, buffalo, bushpig and baboon within 2015-2020, based on MOMS data collection.

To understand the spatial distribution of crop damage throughout NSR the three villages with the highest number of crop damage by hippo, elephant, buffalo, bushpig and baboon respectively were identified (Fig 5). Crop damage incidents per village are highest in the central Mussoma-Mecula area. Here, 10 of the 15 top three crop damage hotspots per species are located. All top three elephant and buffalo crop damage hotspot villages are located in this area: Mucori, Mbamba and Bairro Guebuza for elephant; Mbamba, Lichengue, Ntimbo I. Crop damage by hippo is ground in villages/farms close to rivers (Cuchiranga and Manhur in the central Mussoma-Mecula area rank highest, followed by Gomba in the north, at the banks of Ruvuma river). Dmage by bushpig rank highest in in the far western and the far north eastern areas (Iringo and Ibo in the west, Nahavara in Negomano in the east). Baboon damage incidents are also most frequent in the Mussoma-Mecula area (Bairro Guebuza and Mucoria) as well as in the far north east (Nahavara in negomano).

Damage by wildlife is fluctuating over years and regions. In some areas damage by elephants was high in 2009/2010 and has decreased since then (e.g. Msawise, Ntimbo I, and Mussoma) (Fig 6). In other areas crop damage by elephants was reduced during the poaching crisis and rose again from 2017 onwards (Macalange, Nahavara/Mecula, Lisongole) (Fig 7) and in many places crop damage by elephants peaked in a particular year (e.g. Mbamba 2014, Mucoria 2015, Ncuti 2017, Naulala 2020) (Fig 8)

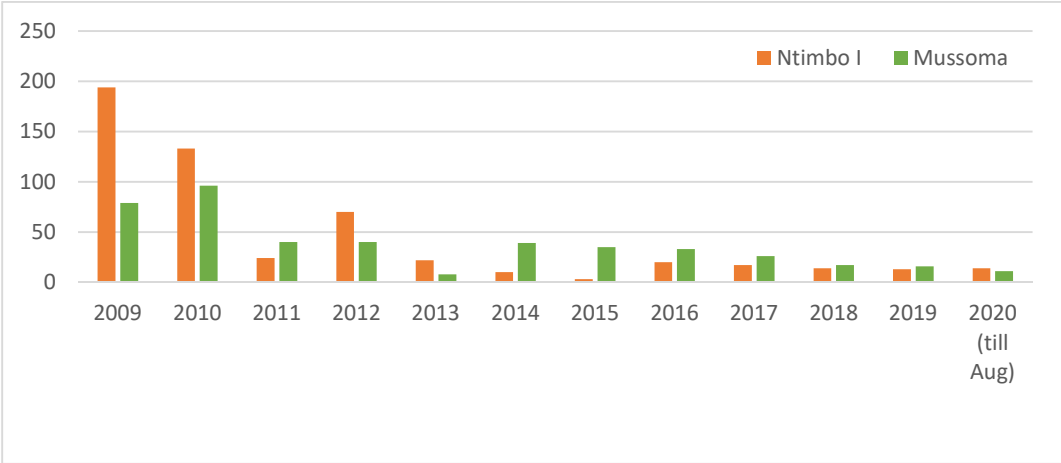


Fig 6: Crop damage incidents by elephants in Ntimbo I and Mussoma in the years 2009-2020

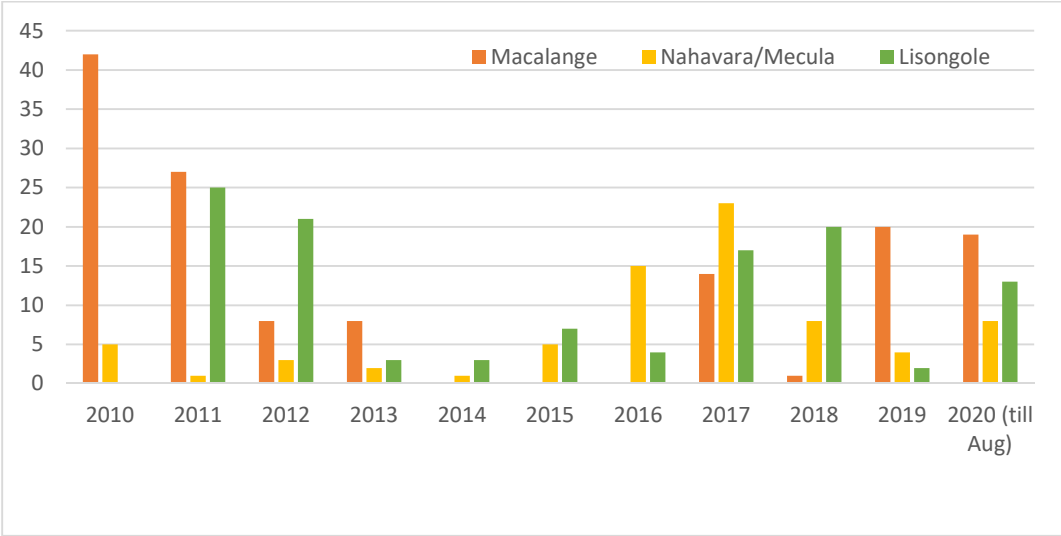


Fig 7: Crop damage incidents by elephants in Macalange, Nahavara/mecula, and Lisongole

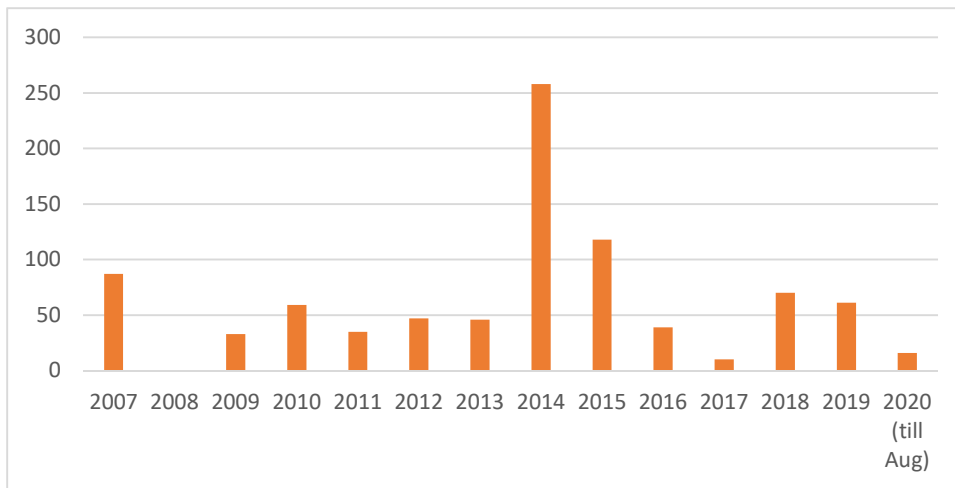


Fig 8: Crop damage incidents by elephants in Mbamba

Elephants and buffaloes mainly damaged staple crops, such as maize, rice, sorghum and millet (together 55.5% for elephants and 66.6% for buffalo), followed by cassava, beans and other vegetables.

Elephants further damaged fruit trees, particularly mango and banana trees within village premises, with a strong increase in the years 2019 and 2020.

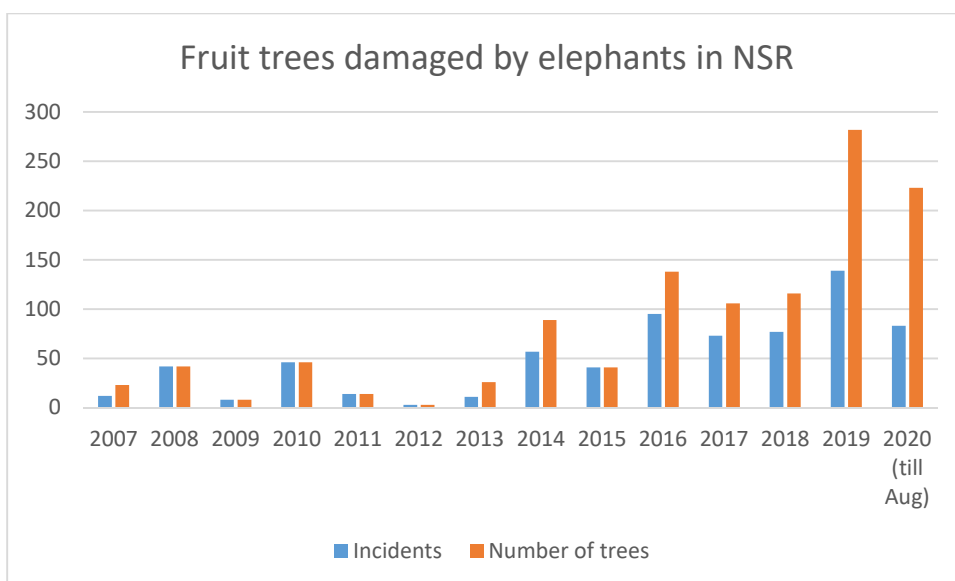
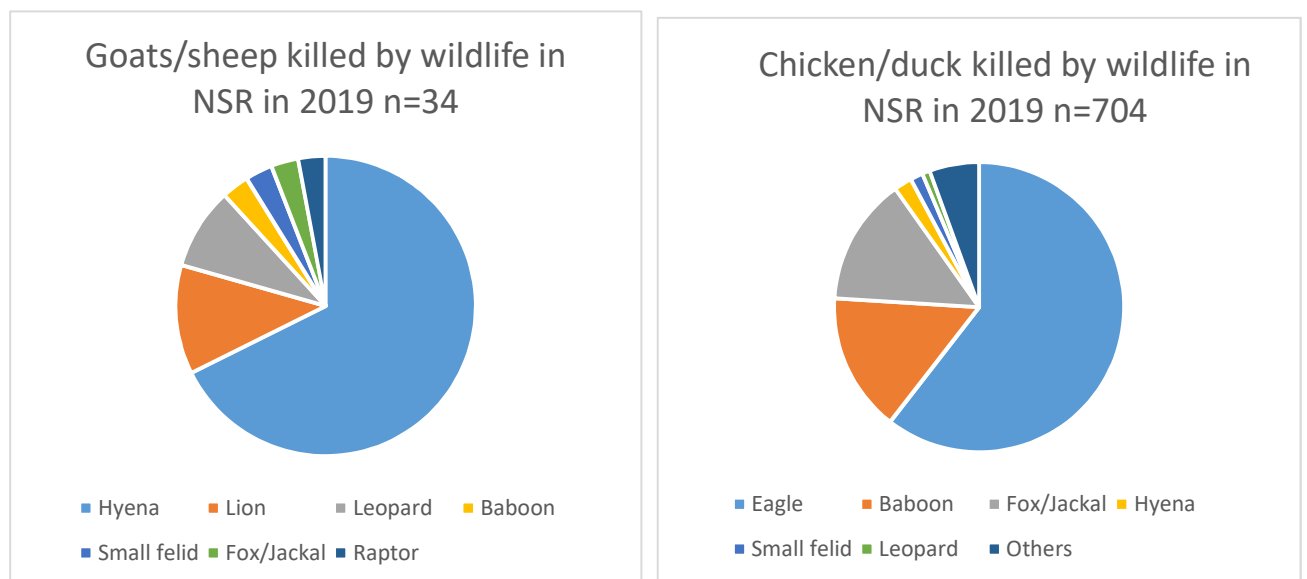


Fig 9: Fruit trees damaged by elephants in NSR, incidents and number of trees are given. Data from 2020 misses the 4 last months of the year.

Livestock predation by carnivores in NSR

In the year 2019 a total of 790 livestock and pets were killed by carnivores in NSR, out of this 704 chicken and ducks and 34 goats and sheep. The reason for low goat and sheep predation most probably is the generally low number of that livestock available in NSR. Cattle is absent from NSR. While any loss is significant to individual households, predation is relatively low in NSR compared to other areas where people live alongside wildlife (NCP 2020).

The primary predators of goats are spotted hyena, leopard, lion, and baboon. Single events have been recorded where goats have been killed by honey badger, snakes, serval, and jackal (NCP 2020). In 2019 hyena accounted for 68% of the predation on goats, while lions and leopards accounted for 10% of the losses respectively. Poultry was mostly killed by raptors (61%), followed by baboons (16%) and foxes/jackals (14%).



NCP notes that while data show a declining trend in hyenas in NSR, their perception is that some stakeholder groups or individuals within NSR believe that hyenas are overpopulated and “worthless” and causing conflict. There are still too many attacks by hyena on livestock and people in NSR. Further surveys need to be done to investigate whether hyena mortality is related to HWC (NCP 2020).

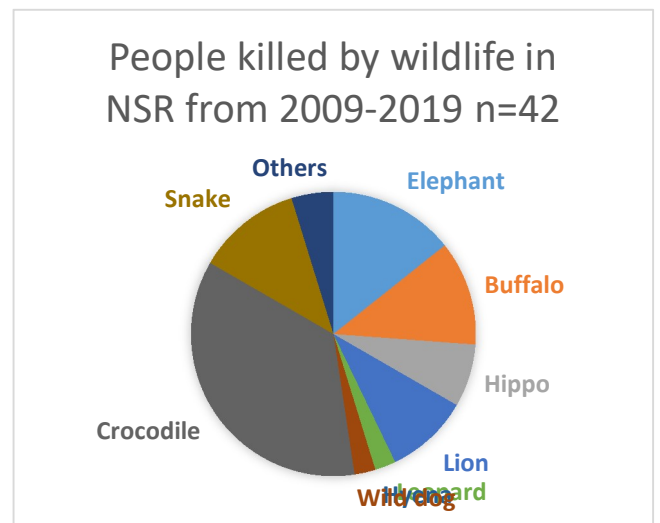
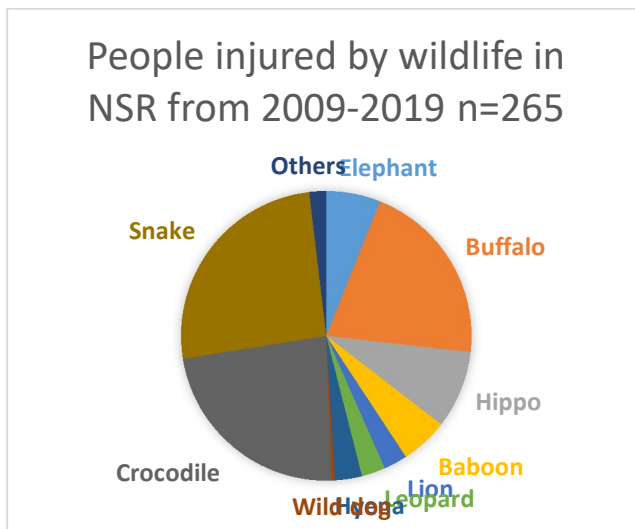
Property damage by elephants in NSR

Property damage does not (yet) play an important role in NSR. From January 2007 to August 2020 43 properties, mainly grain stores were damaged by elephants. Outstanding, however, are the years 2018 and 2019, where 24 grain stores and houses were damaged in Mbamba village, alone. Such a localized event of grain store damage suggests a learning behaviour of elephants, namely, to search food in a specific place, needs to be identified and anticipated quickly, e.g. through specific monitoring, guarding, and rapid response strategies (see chapters 6 and 10). Preventing elephants from searching for stored crops and food in houses must be prevented, as it may escalate HWC (Gross et al. 2020).

Accidents with wildlife in NSR

Within the 11 years from 2009 to 2019, a total of 42 people were killed by wildlife species and 265 people were injured. While every wildlife accident has its own tragedy and every person killed is one too many, the quite stable average number of 4 fatalities and 24 injuries per year is remarkably low in NSR, given the high population number of above 50.000 people, living and working in close proximity to wildlife.

Crocodiles and snakes were involved in about 50% of all fatal and injury causing accidents, and with 36% crocodiles are the most significant cause of death by wildlife species. Elephant and buffalo together make up 26% of all fatal accidents with wildlife, while terrestrial predators make up 14%.



HWC impacts on food security

Farming on smallholdings is the most important agricultural activity. While maize, sorghum and beans are staple crops, cultivated in all areas, rice, cassava and groundnuts are found less often (JP, unpublished data). Sesame is a quite popular cash crop, tobacco is only farmed in selected places. Dry season farming of vegetables is carried out close to rivers. Households abandon old fields for new ones after 6.5 years on average (Cunliffe 2009), abandoned fields take 40 years to fully recover. This implies that a household moves 6 times before an area they first deforested for cultivation fully recovers. This movement may have strong implications for HWC.

Soil fertility and water availability are major determinants for farming, which are diverse in the reserve. Generally, farms located in the western part of NSR are more suitable for farming than villages in the eastern part. Areas outside the reserve largely did not exhibit food insecurity (Cunliffe 2009), compared to those inside and towards the east.

Food security is a major concern for the families living in NSR. While erratic rainfall and drought are climatic risks in the area, crop and livestock damage by wildlife is adding to the risk of food insecurity. Less than 1% of the interviewed households report that they are able to produce enough food throughout the year (JP unpublished data). By contrast, about 30% of the interviewed households state that they are not able to save crops to consume throughout the

year. Here a strong variation between villages can be observed. In Naulala (central north east NSR) 94% of the households interviewed indicated that they were not able to save crops to eat throughout the year, followed by households of Mbamba (67%) and Lissongolo (50%) (both central NSR). In Msawise (western NSR) and Mucoria (central south), however, all interviewed households were able to save parts of their crops for later consumption (JP unpublished data). Furthermore, about 50% of the interviewees were not able to save seeds from their crops and, thus, are dependent on purchasing seeds in the next season (JP unpublished data).

Current data availability is pointing at a significant food insecurity in NSR, but the data is not sufficient to draw detailed conclusions on the nutritional stress that families living in NSR are facing. Malnutrition of children in early age impacts the development of children significantly. Also with regard to the future development of communities in NSR food security needs to improve. Further studies are required to better understand the alimentary situation of families living within NSR and how nutrition can be improved without negatively impacting on wildlife populations. The distribution of surplus meat obtained by professional hunters to boarding schools is a step into the right direction.

HWC impacts on livelihoods

As most households make their living from subsistence agriculture, limited income and crop diversification decreases resilience of the local communities. Post-harvest techniques to store and process surplus production as well as skills to develop and access markets for products are low (Cunliffe et al. 2009). Field crop and post-harvest damage add to the difficult livelihood situation and vulnerability of households, with potentially catastrophic dimensions for single households.

Additionally, households rely on consumptive use of the available natural resources, particularly by mining, fishing, gathering and selling honey, selling tobacco, trading in large cat and zebra skins, selling ivory and eating and selling bushmeat or wild meat (niassalion.org). Besides agriculture, an important source of legal income for the community is fishing (luwire.org). Dried and smoked fish from the multiple rivers is sold to nearby markets. In 2019 a minimum of 36 tons of fish were collected inside NSR (NCP 2019). Fishing licenses need to be obtained to be allowed to fish, which is not restricted to NSR residents. Interviewees 06 and 11 reported a high number of fishermen from communities outside of NSR to be involved in fishing and suggested overfishing of NSRs rivers, while fishermen are exposed to crocodiles and hippos, which may lead to life threatening or fatal accidents.

HWC impacts on daily lives

The presence of wildlife is determining many daily activities of families. While the indirect impact of HWC is understudied in NSR, multiple aspects have been mentioned in expert interviews, particularly in relation to water. Drinking water is not available in all villages and has to be collected at boreholes. About a third of all villages have no water well within the villages (JP unpublished data) and rely on fetching water from streams or wells outside of the villages. If the borehole is located outside the village or in another village, this is mainly the women's job. While travelling on foot in the early morning wildlife encounters are likely. Furthermore, accidents with hippo and crocodiles can be provoked by washing or bathing in the rivers. Interviewee 02 reports of a strong exposure of children towards crocodiles in the

rivers. The water availability in the communities need to be further studied. As water availability is an important factor for settlements, planning the provision of sufficient and safe drinking water strategically needs to be connected to the spatial zonation plans. Wisely used, boreholes may guide development in certain areas, while limiting settlement in others.

Out of 44 villages in NSR 89% of the villages implement protecting measures against wildlife (JP, unpublished data). Guarding fields and livestock against wildlife is labour intensive. In many other areas it has been observed that farmers and children invested high amounts of time in guarding their fields, which decreased their work force for other farming activities, and for children negatively impacted school attendance. The exposure to malaria while sleeping out in the fields is another hidden cost associated with HWC.

While data is lacking for NSR to explore further on the hidden cost, it can be assumed that farming families in particular are negatively impacted by HWC in multiple ways. While developing HWC management schemes these impacts need to be considered as well, particularly for future impact monitoring.

[HWC impacts on wildlife conservation](#)

Besides the direct impact of HWC on food security and livelihoods as well as the indirect effects on daily lives, HWC in NSR strongly reduces tolerance for wildlife species (NCP 2020, interviewee 08). Decreased tolerance towards wildlife species and measures that relate to their conservation prepare the ground for illegal wildlife activities. Retaliation killing and poisoning are obvious results of HWC, but also further impacts can be observed in Niassa. Effects may be that communities accept the presence of poachers within their villages or collaborate with them. This may refer to internal as well as external people involved in poaching and trade in wildlife parts (e.g. ivory, lion and leopard teeth and claws, leopard skins) (interviewee 05).

An increase in bushmeat hunting through snares might also be related to HWC. Decreased tolerance towards wildlife species, increased need due to damage by wildlife species and insufficient benefit through the presence of wildlife may increase bushmeat activities. Through a bushmeat survey conducted by NCP it was found that 55% of hunters believed bushmeat was good for income and food as well as controlling HWC (NCP 2020). Bushmeat snaring has developed into a major threat to the carnivore population in NSR, where lions, hyenas and leopards and their prey are caught as by-catch in snares set up to catch animals for wild meat. The large amount of bushmeat poaching, both subsistence and commercial is likely to be affecting prey populations as well (NCP 2020).

3. Understanding drivers of HWC in NSR

HWC is the consequence of multiple drivers exerting pressure on the people, wildlife and their way of coexistence. These drivers can originate in wildlife behaviour, ecology, geography, and climate and in the anthropogenic influence, such as land use, use of natural resources and economic factors. Given its large size and location at the Tanzanian border, its high and growing human population, an important wildlife population of far ranging, large and protected wildlife species, the presence of mineral resources and in some areas good farming soils, as well as various stakeholders with diverse values, perceptions and objectives, NSR is affected by multiple drivers of HWC.

In order to develop a HWC management scheme the drivers of HWC need to be identified, understood and addressed. Here, a first step is made to summarize drivers of HWC, that were identified during expert interviews, data analysis and literature research. They may not be complete, but serve as a starting point for further processes in the development of a comprehensive HWC management strategy. For this a DPSIR framework was used, defining natural and anthropogenic drivers, which lead to pressures and change the state for wildlife and people, which again generates impacts on both sides. Short-term responses to HWC are targeted at the direct negative impact of HWC, while long-term strategies need to address drivers and pressures.

Therefore, a HWC management strategy for NSR needs to combine short-term measures targeting on immediately decreasing the negative impact of HWC on people and wildlife and simultaneously develop long-term strategies to ensure sustainability and enable the transition from conflict to a beneficial coexistence of people and wildlife. For this an integrated and holistic HWC management scheme needs to be developed, with interplay of legal frameworks, spatial planning, social, financial and technical strategies, backed by comprehensive monitoring.

Understanding the levels of HWC

Multiple studies of the past have shown and explained that HWC does not only include wildlife on the one side and people on the other. It is much more a conflict between different groups of people over the use of resources and over the management of species. Madden&Quinn (2014) and Zimmermann et al. (2020) have characterized the levels of HWC in three layers. While the upper dispute level, which is characterised e.g. by loss of crops can be addressed by practical solutions, underlying and deep rooted conflicts can only be solved through shaping trustful relationship and professionally guided reconciliation processes. History has shown that targeting HWC management only on the dispute level with practical, mostly technical solutions, risks failure in the long-term.

The expert interviews held in NSR point at conflicts over wildlife and at deep-rooted conflicts. As interviewee 01x explained, in NSR the conflict is between conservation and development, interviewee 10 states that the economic forces are too strong for conservation to resist and another interviewee states that the conflict roots in a disagreement between local communities and the management and another points out social conflicts between communities and conservation management. A rather extreme position is that “people simply do not belong to the reserve”. Out of 14 questioned community leaders 50% in 14 villages are dissatisfied with administration of the Niassa Special Reserve, only 20% are satisfied (JP, unpublished data).

Framework for HWC management in NSR

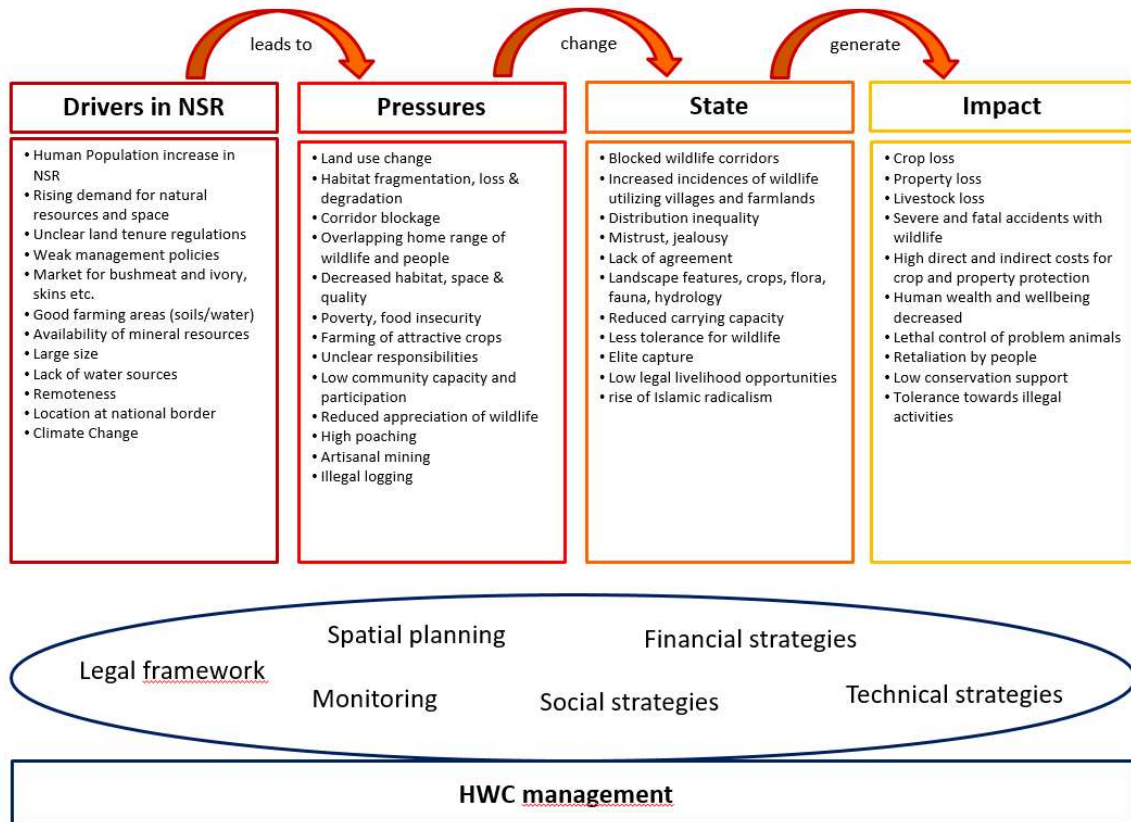


Fig 10 DPSIR Framework for HWC management in NSR

This suggests that in NSR, HWC roots deep in relationships, disagreements, and mistrust between groups of people. Decreasing the number of damage caused by large bodied herbivores (e.g. elephants, hippo, and buffalo), therefore cannot be the only goal of an HWC management scheme.

The Levels of Conflict over Wildlife

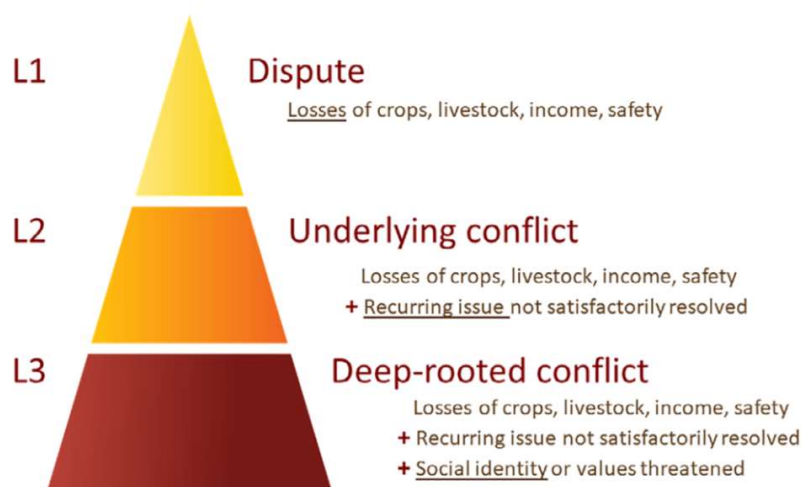


Fig 11 The levels of conflict over wildlife. Source: Zimmermann et al. 2020

Another important fact to be considered is that damage size, risk perception and attitudes are not linear connected. This means decreasing the frequency and/or amount of damage will not directly increase tolerance for conservation and wildlife species. Among the

herbivorous species in NSR baboons and bushpigs are causing most of the crop damage, but elephants and buffalo are perceived as highest risk for crop damage. When decreasing the damage by buffalo and elephant through technical measures, baboon and bushpig damage may still persist, or even increase (due to reduced guarding efforts on fields). Shifting crop damage from one species to another, or from one area to another are effects that need to be considered and discussed comprehensively with community members before any action is taken. If not done so, false expectations may be created and unintended negative side effects evoked. This may lead to even stronger mistrust and discontent between people and conservation management.

4. Development of a holistic and integrated HWC management scheme for NSR

Currently WCS and ANAC strongly focus on conservation management (e.g. management of anti-poaching, management of intelligence, fire control, management of problem animals). Integrating HWC management into this system needs thorough reflection of long-term goals, objectives, and responsibilities to avoid failures, negative side effects and frustration and to improve the relationship between various stakeholders.

The various ecological and anthropogenic drivers, pressures and impact around HWC requires a holistic and integrated HWC management scheme. HWC will not be solved by solely implementing technical methods, it means much more than stopping an animal from moving into a farm. HWC management is about sharing of benefits, of building relationships, and trust, and it has to be mainstreamed into all sectors of conservation and development. Any developed measure needs to be based on a spatial planning, connected with social, and financial HWC management strategies, supported by policies and accompanied by monitoring and evaluation.

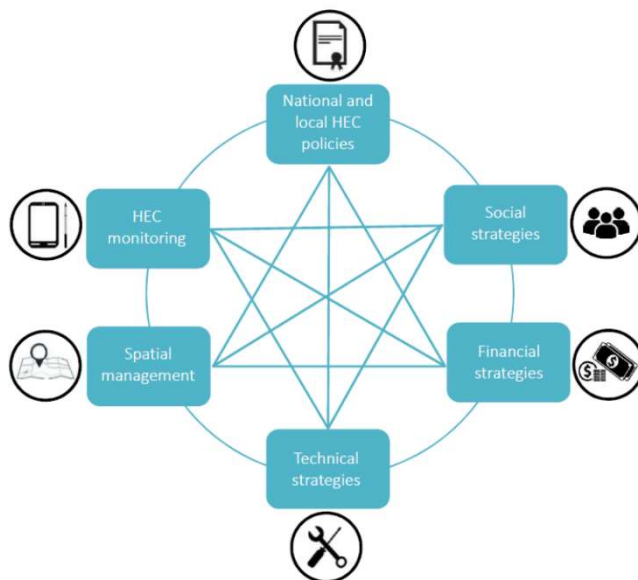


Fig 12: Framework of a holistic HWC management scheme, considering legal framework, monitoring, spatial planning, social, financial and technical strategies. Source: Gross 2019

When scaling up and professionalizing HWC management, a collaborative and community-based approach should be considered. The limitations of top-down HWC management with a strong technical focus are obvious and have failed in many other African landscapes, as they tend to pit people against wildlife, are highly cost and labour intensive and miss out on a sustainable long-term perspective. Affected communities need to be regarded as partners and collaborators in joint HWC management. Roles and responsibilities have to be clearly defined and common objectives have to be developed. Importantly, affected communities need capacity and well-

functioning transparent and equal structures to act as strong partners in HWC management.

Once developed, the HWC management strategy, responsibilities and rights have to be understood by all involved groups, such as rangers, concession holders, administration, users of natural resources, farmers etc.

The role of communities in HWC management

Affected communities living within NSR are the central partners in HWC management. Ideally, these communities will develop into equal and professional partners in conservation. The current state of collaboration between communities and conservation (the reserve) is weak, if not negatively influenced and conflict laden (interviewee 11). Seemingly, conservation and

development are seen as competing or contradictory by various interest groups (interviewee 01).

In some concessions, however, stronger community-based approaches have been tried, such as in Mariri. Here, the local community was involved in the selection of their concession holder and a common human wildlife coexistence strategy with integrated HWC management actions was developed. This case was developed as a model to demonstrate that community-based conservation is a viable option in NSR. Many lessons for the future of people and wildlife in NSR can be drawn from this example.

In NSR communities have traditional leaders, administrative leaders and elected natural resource boards, called Committees des Gestao de Recursos Naturais (CGRN). These boards are representing the community and its interest in using and conserving the natural resources. As such they should be the main partners for both, community-based conservation and sustainable development. In NSR a high heterogeneity in CGRN capacity has been observed.

Out of the 11 CGRNs currently existent in NSR 28 representatives of seven CGRNs (Mussomasede, Mavago sede, Msawize, Matondovela, Mecula-Sede, Ngolange, Naulala) were interviewed for the development of this management strategy outline (Gross&Billerio, unpublished data). While only two of the CGRNs are existent since 2012, four have been founded within the past three years. The knowledge of the CGRN members regarding their responsibilities and duties varies strongly between well-informed members, understanding the role of CGRNs for conservation and development (21%) to members having no clear idea about the role of the CGRN (21%).

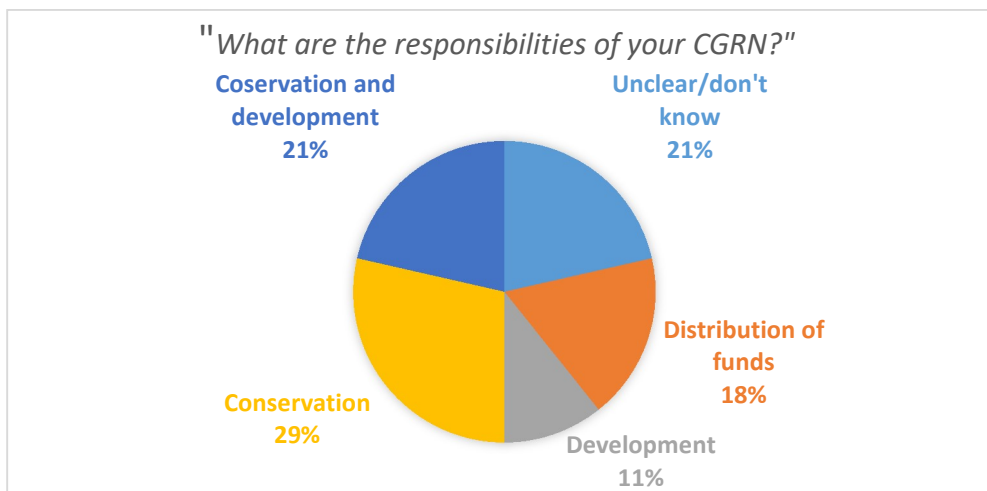


Fig 13 Responsibilities of CGRNs mentioned by its board members (n=28)

The majority of the interviewed members of the CGRN regard HWC as a priority or high priority issue (89%) and 71% state that their committee is involved in HWC management, mainly through raising awareness on the issue and informing the NSR management regarding conflict species. In many statements CGRN members explain their interest in being involved in HWC management and dialogue between reserve administration and community, but also explain the need for capacity building and strategies. Other members, however, seem to lack understanding on how such processes could be initiated.

The rapidly conducted interviews surely only show a fraction of the on the ground situation of the CGRNs. However, the responses suggest a need to build up capacity within these

committees, to make full use of their structures and enable the members to take over a stewardship role. Due to the strong heterogeneity, which may also be a result of new CGRN installations, all committees have to be brought up to the same knowledge and operational standard. Some newly formed CGRN have been trained in 2020 by the NGO Estamos through 10 training modules (WCS 2020). The training modules are business focussed and seem to lack the connection between conservation and development, specifically challenges and opportunities of living with wildlife. The involvement of local NGOs for training purposes is an excellent step. However, the context of a special reserve needs to be considered and correctly framed in such trainings. Responsibilities and processes need to be clearly defined and transparently communicated to community members. As such communities can be guided and enabled to find their way of coexistence. Investing in CGRNs capacity means investing in partners for conservation management.

The role of the HWC officer

NSR is seen as an important partner for HWC management in the reserve by the CGNR and the wish for more exchange and meetings was brought up. This invitation is an important evidence for an openness to collaborate, which needs to be developed and may not be abused.

By the employment of the HWC officer in August 2020 an important step was made by WCS/NSR. The role of the HWC officer needs to be clearly defined and transparently communicated. As HWC management needs collaborative approaches it needs to be based on trust. Trust can only be developed by reliability in actions. Therefore, the creation of false expectations needs to be strictly avoided and processes need to be defined. The development of standardized operation procedures for addressing HWC on various levels are helpful guidelines, which can be comprehensively communicated and understood.

The clear definition of the role of the HWC officer also requires a clear designation of duties, responsibilities and their limitations. The HWC officer is fully charged with supporting communities in living with wildlife in a peaceful way and may not be misused as informant. Playing double roles risks deteriorating relationships with communities or even worse.

The expectation of the various stakeholders toward the HWC officer are high and failures need to be avoided. This requires exact planning, full transparency and high communication skills. Furthermore, HWC management is an emerging and developing field, so capacity development and continuous training are prerequisites. To remain reliable and responsive for the communities, the HWC management needs to be well staffed and equipped. A team of skilled and trained team members needs to be built up at the base and within communities, to avoid long waiting times when support is needed. As quick and professional response is a key to successful HWC management suitable vehicles (bicycles, motor bikes, 4x4) for HWC management teams are required.

The role and responsibilities of the HWC officer and team also have to be clearly communicated and understood by the departments of NSR management and administration. HWC management requires integrated approaches and adaptive management. Cross-sectorial exchange and communication fosters the development of synergies and effective management approaches, e.g. by integrating HWC management training in educational activities, considering of HWC drivers in development actions and exchange on conservation compliance with law enforcement staff.

5. Legal framework for human wildlife coexistence

In Mozambique, land and forests are managed by the Directorate of Lands and Forests (DNTF) within the Ministry of Agriculture (MINAG) (Siteo et al. 2014). The Conservation Law of Mozambique, which was approved in 2014 establishes basic principles and norms for protection, conservation, restoration and sustainable use of the biological diversity in Conservation Areas, as well as an integrated administration, for the sustainable development of the country (Conservation Law no. 16/2014: article 2). The law states that the ‘State administers the conservation in a participative way, by establishing appropriate mechanisms for the participation of public, private and community entities’ (Conservation Law no16/2014: article 2). The national and foreign Public, Private, and Community Partnerships (PPCPs) are also encouraged as a source of funding (Matusse 2019), the management structure of NSR falls under this definition. As such, an integrated management was installed as well as the incentive to create mechanisms for the self-sustainability of the reserve. The private sector was called upon to participate actively in this management, attract human resources and raise the financial resources necessary to implement the plan, while the law seeks to create ways to also introduce local communities into management.

Furthermore, The Forestry and Wildlife Law also adds to the regulative framework for the use and management of natural resources, whereby the principles governing the law (Act No 10, 7th July 1999, Chapter 1, Article 3) include “...promoting the conservation, management, and utilisation of forest and wildlife resources without contradicting the local customary practices and according to the principles of conservation and sustainable utilisation of forest and wildlife resources in the framework of decentralisation.”

The National Land Law enhances partnerships between local communities and investors. According to this policy local communities shall participate in the management of natural resources, conflict resolution, land titling processes, and identification and definition of land occupied by communities. In addition, the law states that communities should be consulted before land-use rights can be issued to outsiders. This provision is meant to protect local communities, particularly poor people, from losing their land that was acquired by customary rights.

Even though the legal frameworks affecting NSR do not specify on HWC they strongly emphasize the participatory role local communities should play in the management of resources. This is further defined in the Law of State Local Authorities (Law 8/2003) and its regulation (Decree 11/2005), through the establishment of decentralisation principles, transferring the power of decision-making to local institutions in coordination with higher bodies at district and province levels.

In summary, the legal frameworks in Mozambique strongly support a human wildlife coexistence approach, with the inclusion of local communities in co-management, the sustainable use of natural resources and the involvement of the private sector.

Based on these legal frameworks the administration of NSR lies within the National Administration of Conservation Areas (ANAC), a body supervised by the Ministry of Land, Environment and Rural Development (MITADER). ANAC is a collective person in public law,

endowed with administrative, patrimonial and financial autonomy, set up by Decree no. 9/2013 of 10 April, with the following main objectives:

- To handle the effective administration of the National Parks and Reserves, official hunting reserves, game parks and other conservation areas legally instituted and placed under its administration.
- To conserve biological diversity within the National System of Conservation Areas, to guarantee the sustainable use of the conservation areas, and to develop infrastructures to manage and develop economic activities and establish partnerships for the development of the areas under its management.

For the management of NSR an international NGO was selected. Since 2012 WCS is the co-managing partner of ANAC, whereby in the past years the co-management arrangements responsibilities were not clearly defined and in the past years any agreement was lacking (WCS 2018). This contributed to a lack of shared vision and clarity on strategy which particularly negatively impacted on developing partnership with local communities. With the signature of the co-management agreement of WCS with HE Minister of Land and Environment the basis for better defined responsibilities will be laid.

A protocol to assist HWC management in NSR has been put in place in 2010, aiming at minimising HWC through coordinated actions between various actors such as local government, local communities, the private sector and the Niassa Reserve Management Unit (now NSR). The protocol lists monitoring, community based methods of HWC management, spatial planning education and capacity building, but lacks guidance on implementation, structure and processes.

Furthermore, the General Management Plan for NSR is urgently needed as a basis to define the obligations, rights, rules and regulations of all parties in NSR on conservation, resource utilization, spatial use, development activities and regulation of HWCs. The management plan has been pending for years and the coordination process of development is protracted.

If not sufficiently regulated in the General Management Plan, the development of a community engagement guideline, which defines processes on how and when communities should be involved and consulted needs to be initiated. The implementation of such a guideline increases the knowledge of the law by local community members, creates transparency and may increase compliance during the community consultation processes. This is particularly important for the development of a HWC management system and implementation of technical measures for prevention, response to and mitigation of HWC.

A zonation plan has been newly developed, but not yet been agreed upon (Baldeu Chande, pers. comm.). It foresees community development zones with narrow wildlife corridors and new buffer zones. While a zonation plan is highly important as a basis for the HWC management development, the current plan still leaves many questions unanswered (see Spatial Planning, page 26).

Recommendations

- The General Management plan is a central document for holistic HWC management planning and needs to consider HWC management across sectors

- The General Management plan needs to define roles and responsibilities regarding HWC (e.g. who is responsible for safety of people and their assets in inside the reserve, on the rivers, in the fields and in the villages)
- Development of regulations considering HWC management in zonation plan
- Revision of the protocol to assist HWC management in NSR, according to holistic HWC management and add guidance on implementation
- Development of a community engagement guideline, defining processes ad areas of community involvement
- Suggestions for the revision of the Revision of the Ministerial Decree 93/2005 of the Forestry and Wildlife Law, on the 20%, should be considered, to include regulations on the distribution, considering levels of HWC and coexistence (incl. conservation performance) as criteria.

6. HWC monitoring – status quo and recommendations

A standardized monitoring of HWC is the basis for evidence-based decision making in HWC management. In NSR monitoring of HWC has been conducted by the Management Oriented Monitoring System (MOMS) of the Niassa Carnivore Project (NCP) since the year 2006. In parallel the district collects HWC data via local authorities, which is summarized on provincial level and handed over to ANAC in Maputo on national level (Rezia Cumbi, ANAC, personal communication). Since its start in August 2020 WCS/NSR is also collecting data on HWC, which reaches the office and to which response teams may react (see technical strategies).

The need for an objective data collection is uncontested, because subjective data cannot be related to the real extent (Gross 2019). Also, the location of the damage is seen as very important for mapping areas of high damage and changes over time. HWC monitoring data can also be used for evaluation of various HWC management measures, if some crucial aspects are taken into consideration.

MOMS data collection

The MOMS data collection is a uniform and simple system, conducted by trained MOMS community wildlife guardians originating from 44 local villages. This program was started in 2006 with five guardians and has since grown. MOMS community wildlife guardians are paid monthly subsidies for part time work by NCP, provided with all materials needed including ongoing mentorship, support, and skills training (NCP 2019). The MOMS data collection is a collaboration between the Niassa Carnivore Project (NCP), the NSR and the Niassa communities who live inside the protected area. In recent years, the collaboration also includes the community managers of Luwire and Chuilexi Conservancy. MOMS is entirely managed and supported financially by NCP, its data are shared with the NSR to take management decisions. The real time WhatsApp group reports on human wildlife conflict allowing for rapid response.

Data is collected on paper and owned by the communities. Copies are handed out to NCP for computing and data analysis. As the community owns the data on damage caused by wildlife, but also wildlife sightings and wildlife fatalities, this is a strong tool for the benefit of the community.

However, the data is not without its own biases (e.g. individual differences in effectiveness at collecting data, support from local communities to report mortality, fear of repercussions) but is the most consistent data available for NSR, reaching back to 2006 (NCP 2020). The data is freely available to NSR management team on a Google Drive database (NCP 2019).

Further analysing MOMS data by developing heat maps, analysing spatial development over time, as well as correlating HWC with species occurrence and movement data would enable the identification of risk areas and predict potential HWC shifts with increasingly successful conservation efforts.

WCS/NSR HWC monitoring

Since 2020 the WCS/NSR HWC officer collects additional information to the MOMS data. Informed by WhatsApp or radio he is made aware of large scale and severe damage that need quick response (see also Rapid Response under “Technical strategies”). For these events GPS locations are collected and the type and success of response is added to the data sets.

Biased data through autocorrelation

As mentioned above, HWC data collected in NSR is not without bias. An important issue regarding the HWC monitoring data is the problem of autocorrelation, as data is collected on farmers/victims level. This might not be too problematic for carnivores (for which the database originally was designed) or for large industrial agriculture, but it may be very relevant for large herbivores moving through a landscape characterized by the presence of smaller fields of various farmers in one machamba area.

Large herbivores do not only damage one field and move back to their natural habitat, but damage crops on fields of different farms located in the same area (e.g. a farming block). As an example, the same elephant damages the fields of five different farmers. The data collected on farmers' level does not show the connection between these five incidents. When analysing the data it is not taken into consideration that the five sets of data are connected. They are analysed as if they were independent. Why is that important? In areas with smaller fields located close together, elephants will very likely damage more fields of different farmers than in an area with large scattered fields. The analysis, however, will reveal a higher frequency of damage in the farming block. The same applies to ecological factors and group sizes of elephants (which are not influenced by the field size), which will be biased in the analysis. Analysing the frequency of crop damage over time might also get biased, as over time and with growing human population field size may reduce and become more compact. Even if the number of crop damage events will stay the same and elephants will damage the same extent of crops, data analysis based on farmers' level would reveal an increase in damage frequency (adjusted from Gross 2019). This issue may not be that relevant for carnivore damage on livestock, as in NSR mostly all livestock killed in one event belongs to one farmer.

Recommendations

- Design HWC data collection based on damage events (cluster farmer level damage to damage event by a specific group of animals and location)
- Transfer HWC data collected by MOMS into real time systems: The community-based data collections have strong positive effects on involvement of communities and information transparency, which needs to be maintained without doubt. To increase usability of data for HWC management planning and evaluation, further options should be discussed. As data is entered into excel tables by NCP staff members anyway, it might be also be entered into other systems which are in use (e.g. SMART or Earth Ranger), which would allow combining HWC data with other spatial conservation monitoring data.
- Development of HWC heat maps
- Integration of severity/ extent of damage
- Analysis wildlife damage over time and to consider population dynamics (e.g. through effective conservation actions)
- Re-consider how data is collected by WCS/NSR and MOMS, to avoid duplication
- Coupling species-specific HWC data with movement data and with data on illegal activities might generate valuable insights for HWC and conservation management.

7. Spatial planning for human-wildlife coexistence

Macro and micro level spatial planning is fundamental for HWC management and for developing long-term perspectives for people and wildlife sharing the same landscape. Spatial planning allows defining zones for specific actions and utilization of natural resources, based on scientific evidence considering wildlife needs and behaviour, population dynamics, HWC drivers and well as people's needs and aspirations.

Coexistence between people and wildlife in a landscape such as NSR can be achieved by defining safe zones for people to live and make their living by following the principles of sustainability and reducing actions that may drive HWC. Simultaneously safe zones for wildlife movement need to be defined, which need to be constantly maintained (e.g. wildlife corridors). The challenge in spatial planning is to adequately balance the current and future needs of both, people and wildlife and to define the limitations of land-use conversion and growth.

A zonation plan for NSR has recently been drafted and is still under discussion. The Plan foresees three main zones: buffer zones, community management zones, tourism development zones. While the rules and regulations for these zones are not yet defined, in the buffer zones industrial exploitation of natural resources shall be allowed (mining, industrial agriculture), while in the community management zones community-based conservation and sustainable development shall take place (personal comm. Baldeu Chande) and movement of wildlife shall be allowed in defined corridors. There still seem to be some critical issues that require further discussion and agreement, on what these zones mean for the operators in whose blocks these fall (WCS 2020 and interviewee 06).

Working together with the affected communities to develop comprehensive and feasible planning within the buffer and community management zones needs to be priority in this process.

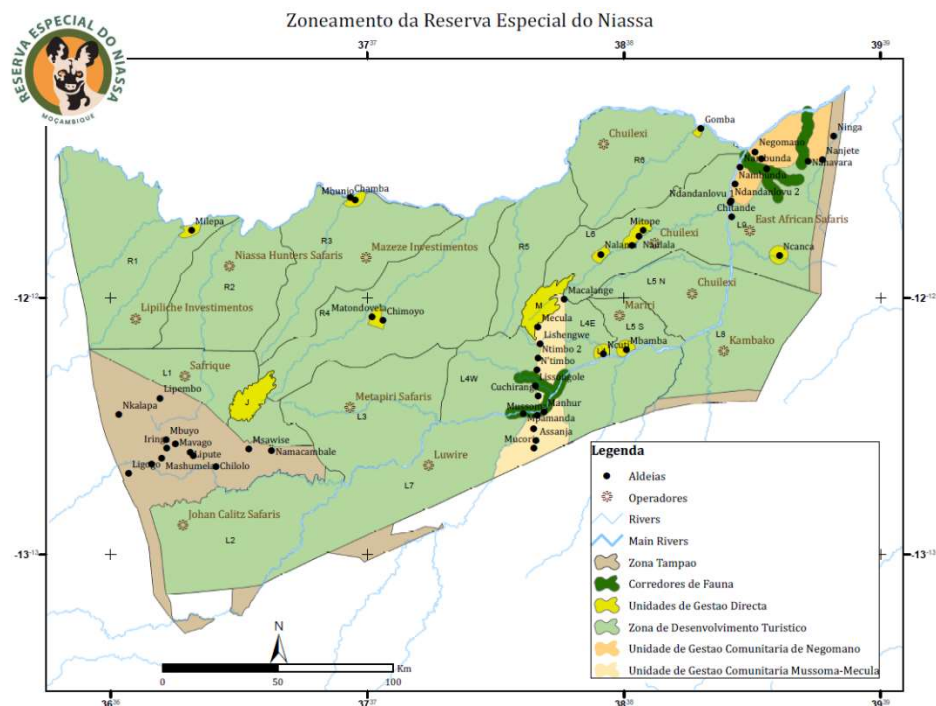


Fig 14 Most recent zonation map of NSR. Community development zones are marked in soft yellow, buffer zones in brownish colours. Wildlife corridors are marked dark green.

Macro-level planning

On macro-level geographic, geomorphic and climate features need to be considered as well as wildlife habitats and movements. The maintenance of connectivity for various species within NSR is of utmost priority to decrease HWC in the future. With the objective of rising wildlife populations, the future movement patterns, particularly of keystone species such as elephants, buffaloes and large carnivores need to be considered. Aerial surveys have been carried out continuously in NSR since 1998 (Fig 15). The movement patterns of elephants have further been studied in NSR by deploying satellite collars.

In NSR, the approx. 44 villages are not homogeneously distributed (Fig 16) and can be divided into three groups, which are relevant for the development of HWC management strategies:

- Buffer zone villages: clustered settlement, farmland and industries in Mavago area
- Villages in the community development zones: clustered settlement and farmland in Mecula/Mussoma and Negomano area
- Single enclave villages dispersed in the NSR (Ee.g. Mbamba, Naulala, Matondovela)

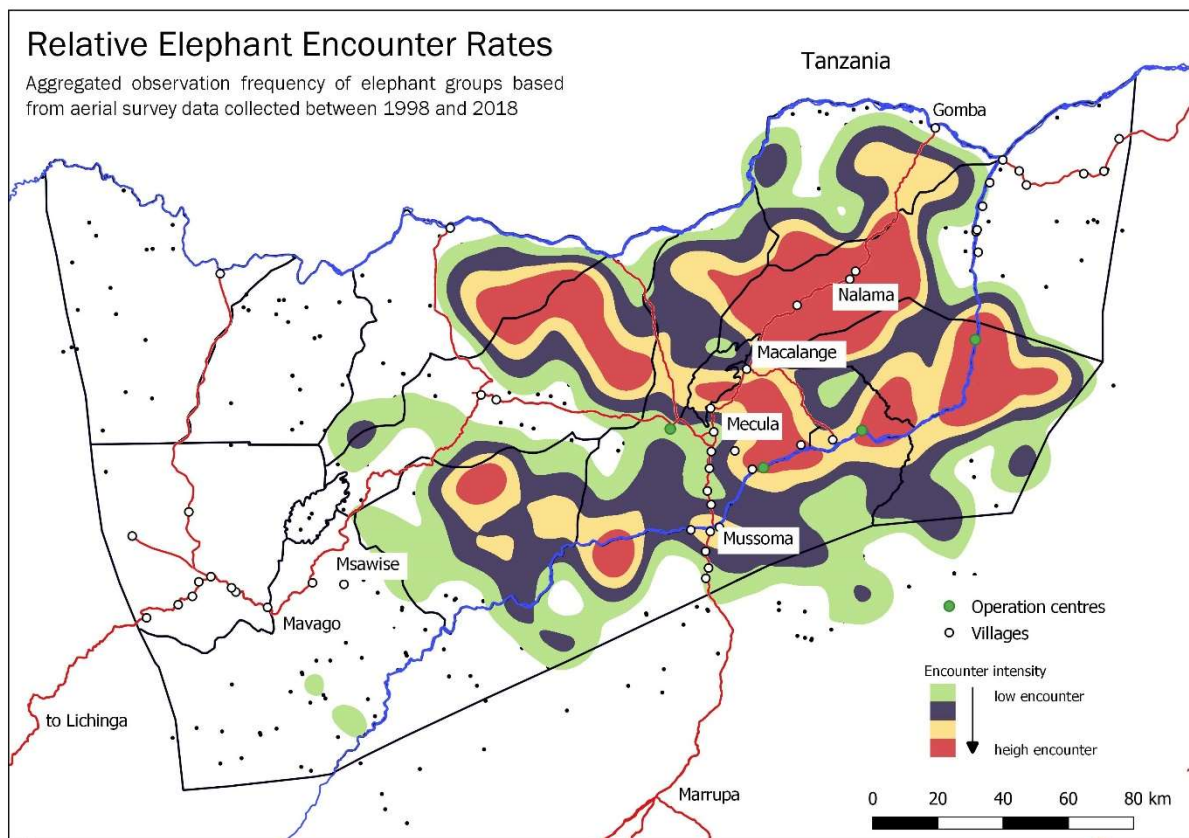


Fig 15 Relative elephant encounter rates

Houses and huts

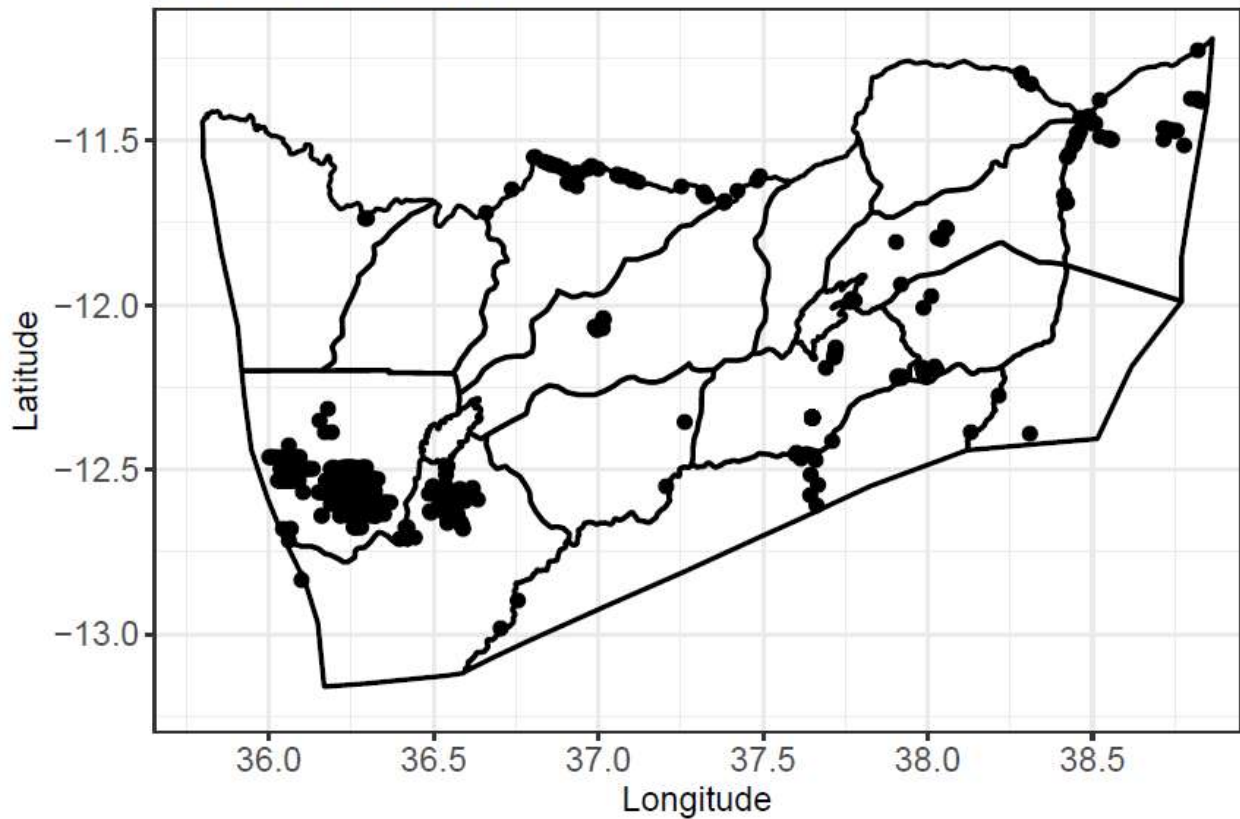


Fig 16 Human settlement sightings in NSR in 2016, source: WCS Aerial Survey 2016

Mavago Buffer zone

While the buffer zone in Mavago area is characterized by fertile soils and reliable rainfall, farming has developed in this areas and a growing number of villages is found in this area (maps by Niassa Imperial Tobacco Project 2006). With the given trend in agricultural and industrial development this “buffer zone” will most probably lose its habitat features for wildlife in the future. Various interviewees explained that wildlife densities are comparably low in the western part of NSR: speculations on the reasons behind this vary from high poaching to low water availability, and less nutritious vegetation. Taking into consideration the Selous-Niassa corridor plans of the early 2000s (Balduş et al. 2003), the western part of NSR may play a major role for wildlife population connectivity. Therefore, a clarification on the potential of this area for wildlife population development has to be stronger prioritised. Depending on the wildlife population development in the western part and the type of agricultural production in the buffer zone (e.g. attractive or not attractive crops) HWC may strongly increase at the buffer zone boundary in the future.

Community management zones

The community management zones Mussoma-Mecula and Negomano are characterized by high village densities along a main road (Mussoma-Mecula), and the Lugenda River (Negomano). In both areas permeability is challenging, as fields and villages are growing into each other and wildlife passing risks moving on farmland or villages. Here, planning requires the definition of safe wildlife corridors through these “anthropogenic barriers”, and simultaneously create safe space for people. In the Mussoma-Mecula community management zone a corridor along the river(s) has been suggested. While a wildlife corridor is very much needed to connect the

western and the eastern part of NSR, the location along the rivers might not be suitable for elephants (Falk Grossmann, pers. comm.). Furthermore, villages located along the river would be strongly affected. The feasibility of this corridor needs to be considered (see micro level planning in this section).

Dispersed enclave villages

The loosely dispersed villages in NSR are mainly located at rivers and largely have a traditional set up of conglomeration habitations, surrounded by fields and farms. For spatial planning on macro level the growth control of these villages and farmlands needs to be considered. Growing human populations require increasing space for farming and living. Currently, land for cultivation and settlement is freely available for any community member in case of need (Gross&Billerio, unpublished data). This may lead to an increasing number of villages spreading along development lines (rivers, roads) and with it, growth of farmland. Such development needs planning and regulations, to decrease HWC. A critical area for such development lies within Chuilexi Conservancy, and its villages Nalange, Naulala, Erevuka, Mitope. Uncontrolled growth of these villages will lead to the creation of a barrier along the river, driving HWC, particularly with elephants, relying on this area as connection between the north-western and the south-western part of NSR. This has particular relevance due to the blockage of movement by the Mussoma-Mecula community management zone. The elephant dispersal data from aerial surveys as well as elephant movement data after the poaching crisis indicate a strong presence and movement of elephants particularly in this area (Fig 17).

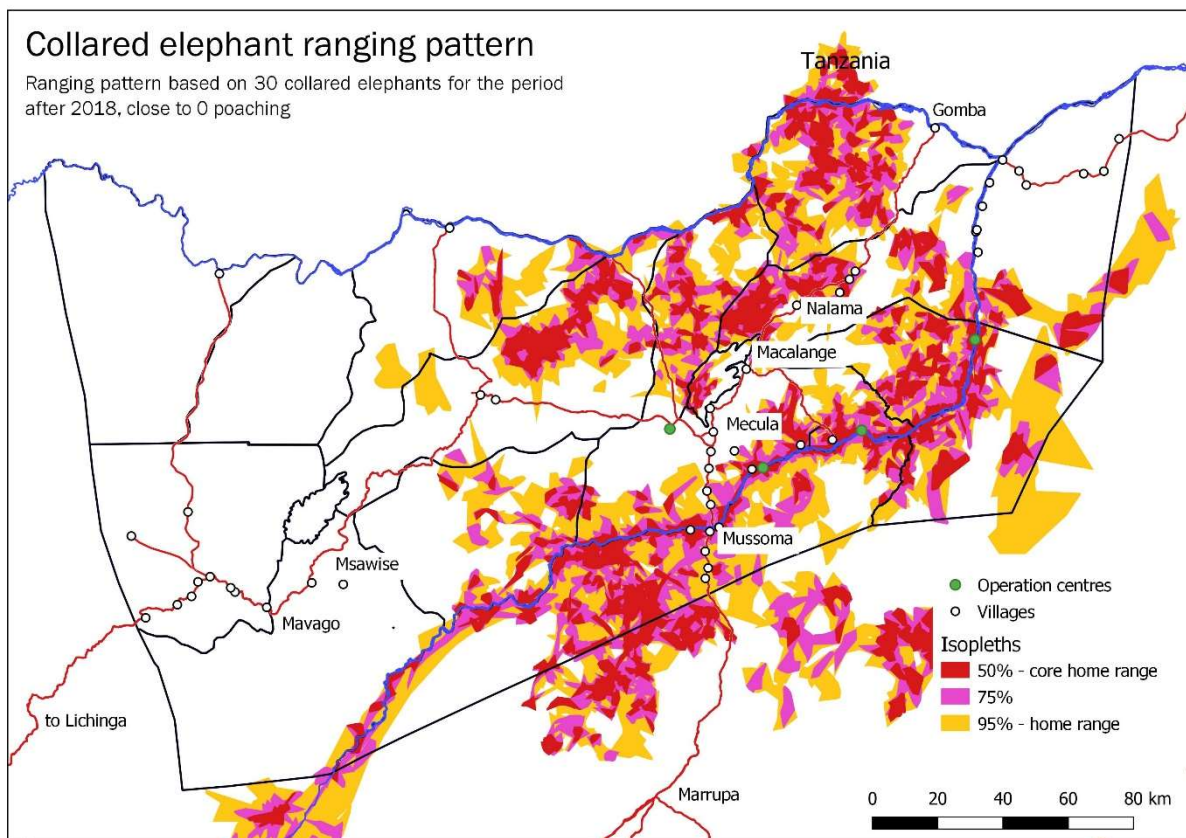


Fig 17 Collared elephant ranging patterns since 2018 (after poaching crisis) show a) elephant overlap with villages/farmland and b) elephant movement towards north (Tanzanian border) but also c) out of NSR in the south and in the east.

Surroundings of NSR

NSR is not placed in a vacuum, but is strongly influenced by surrounding towns, infrastructure and wildlife habitats. While concentrating planning of conservation and development actions within NSR, outskirts of NSR might also have to be considered for planning. Macro level planning therefore must open its view also to the areas around NSR (Fig 17).

Micro-level planning

The macro-level zonation plan needs to be implemented on micro-level together with the affected communities. As HWC levels are heterogeneously distributed in NSR, this needs to be considered in micro-level planning.

The goal of micro-level planning is to encourage and increase sustainable development within the community management areas and buffer zones and to discourage uncontrolled growth into areas designated to tourism development and wildlife habitats. The development of basic infrastructure (water access, health posts, electricity, roads etc.) has to be well planned and implemented on micro level in accordance with macro-level plans. Also, HWC management infrastructure needs to consider macro level plans and prevent unintended negative side-effects.

About a third of all villages have no water well within the villages (JP unpublished data) and rely on fetching water from streams or wells outside of the villages. This increases the risk of wildlife encounters and needs to be considered in planning.

Mavago Buffer zone

While buffer zones are still part of the NSR and benefit through its income, their contribution to the reserve cannot be decoupled from reserve micro-level planning. The rules and regulations for the buffer zone have not been defined, but a stronger development also of industrial activities (mining and industrial agriculture) is discussed (Baldeu Chande pers. comm.). In case larger scale industries and economic income generation takes place, it needs to be regulated how their income contributed to NSR and how negative effects to the reserve and its wildlife (e.g. through the loss of habitat) can be compensated to NSR.

Depending on the development in the buffer zone and the level of HWC, further HWC management actions need to be developed.

Community management zones

The aim of the community management zones should be to create safe space for people and their sustainable and applied livelihood development. As subsistence farming is the main livelihood of people in this area, the identification and development of suitable farming areas and practices is an important aspect of the micro level spatial planning. Suitable farming areas are defined by fertile soils, sufficient water availability and low wildlife abundance/movement. Conservation agriculture can play a major role in reducing the need to shift farms and maintain fields in a defined and well protected area, outside of corridors and wildlife dispersal areas.

The presence of crops which are attractive and palatable for herbivorous species, such as elephants, hippos and buffaloes triggers HWC. The choice and placement of crops therefore needs to be well planned and considered on micro level.

In the community management zones farming along the rivers is a major concern, particularly in the Mussoma area. Generally, farming is not allowed within 200 metres in NSR (pers. com.

Derek Littleton), but it is still carried out, driving HWC with hippos and crocodiles. Additionally, to this, in the community management areas wildlife corridors are planned along the rivers (Fig 14). Here, settlements and farming have to be discouraged and viable alternatives need to be developed. This may be realized through participatory planning processes, the strategic placement of infrastructure and financially incentivising the designation of corridors to wildlife.

Dispersed enclave villages

Micro-level spatial planning for HWC management in dispersed villages requires a strong community-based approach, which defines areas for living and farming and areas set aside for wildlife and tourism development. A good example on how such a nodal village can be well secured against wildlife intrusion is the village of Mbamba. Here, the community has decided on implementing a strategy with multiple HWC management layers. While the village is secured by an elephant and buffalo safe trench, the farms around the village are guarded and fenced.

Villages in the east (Mbamba, Mecula) recorded lower production due to erratic rainfall, problem animals, poor soil fertility (Cunliffe 2009). Therefore, adjusting farming practices in these areas should be considered (crop choice, location of fields, crop protection). Whatever the technical measures to protect crops, livestock, and habitations are, planning on the strategy within the spatial context is required as a first step. It also has to be understood that strategically placed protection measures have spatial limitations. Growth, and shifting of farming areas, extension and spreading of villages etc. need to be guided on track by communal planning.

Recommendations

- Spatial planning to consider HWC aspects and safe areas for people and safe areas for wildlife on macro-level
- Zonation plan needs to consider HWC risk areas and wildlife corridors/movement areas
- Definition of community development zones requires correct baseline data, definition of maximum growth rate and consequences in case of exceeding growth
- Macro-level planning to also consider areas around NSR, particularly for development actions, but also wildlife corridors
- Spatial planning and its regulations need to sensitively consider how to deal with influx of people
- Exploration of the western part of NSR to clarify potential for wildlife development
- Micro-level HWC management and land-use planning based on macro-level plans to be conducted in participatory way: Identification of areas for sustainable settlement and agricultural growth and areas to be actively kept open
- Identification of HWC management measures suitable for the three different community categories

8. Social strategies

Social strategies for HWC management include participatory and inclusive approaches, community outreach and education. As conflicts can only be resolved by the inclusion of all parties taking a role in that very conflict, the participation of stakeholders plays a vital role in HWC management. When working towards long-term solutions to HWC, it has to be understood that HWC is a conflict of people over wildlife and over the use of natural resources. Building up good working relationships and a basis of trust requires transparent governance and communication (Gross 2019). Involving communities and their representatives, district administration, concession holders, conservation NGOs and other stakeholders into an open dialogue with shared information is highly important. In general, meaningful local participation with clearly defined roles and strong community ownership of the process will lead to higher acceptance and tolerance of the conservation work.

In NSR first approaches for the development of social HWC management strategies have been made (start of an educational programme, participation in community meetings, consultation for the General Management Plan, and capacity development activities), but still need to be scaled up (interviewee 01, 02 and 12).

Stakeholder involvement

Involving all affected parties of a conflict is necessary for the development of long-term solutions, as all partners need to agree on planning. As explained by interviewee 11 the underlying issues of HWC in NSR are caused by a lack of trust between various parties. Building up communication between all stakeholders is an important first step. Thereby, not only the obvious interest groups, such as concession holders, conservation representatives and community representatives need to be involved, but also district administration, development organisations, religious leaders and local users associations. Data collection on the stakeholder structure in NSR has been started (JP unpublished data) and needs continuation and strategic development. Interviewee 01 pointed at the divide between conservation and development in NSR. While the district administration is seen as development representative, WCS/NSR is seen as conservation representative. In order to not pit conservation against development, but to create joint concepts and synergies, the constructive involvement of the district administration and joint planning approaches seems to be a major requirement.

The consultation process for the General Management Plan also integrates stakeholder involvement. As the desired outcome (broad agreement on the plan) has not been achieved throughout the past six years, an improvement of the process seems to be necessary. In case stakeholder involvement processes are not designed and guided professionally, they risk to turn out not to be constructive. Consultations on HWC management strategies need a transparent planning and process as well as rules and regulations of the process that all participants agree upon. The involvement of a third party neutral to guide the process is strongly advisable in situations with a high complexity and various conflict layers, such as in NSR.

Community outreach

Community outreach is conducted by WCS/NSR through consultations and a few livelihood development activities (interviewee 01). Representatives of the CGRN state that they would

appreciate more presence of NSR staff in their meetings (Gross&Billierio, unpublished data). Investing into the relationships with community representatives, farmers and other livelihood development groups (e.g. bee keeper associations, women groups, youth groups) is needed to build up a common understanding on how conservation and development can be achieved simultaneously in NSR, and how human wildlife coexistence can be designed to benefit both, people and wildlife. This is particularly important as currently conservation and development are largely seen as controversies in NSR (interviewee 01, 12).

Much more investment needs to be made in building up trust by transparent and comprehensive processes, strong communication and inclusive participation (interviewee 11 and 12). In Mariri it has been demonstrated that the investment into community involvement improves relationships between concession holder, conservation and community, creates benefits from conservation, decreased HWC, and decreases illegal activities (interviewee 08 and 09).

However, while building up community outreach with the aim to promote human wildlife coexistence and sustainable development, options to start small scale pilot projects to demonstrate benefits through sustainable livelihood development and HWC management measures, needs to be available. Here, strategic partnerships with the humanitarian and development sectors might create synergies.

Building up strong community representation

The local communities play a major role in HWC management, developing sustainable livelihood options and, thus, moving from conflict to coexistence. Fundamental to any community-based conservation approach is the existence of transparent, respected and well-functioning community representations. In NSR communities are represented by the elected CGRN (see page 18), a structure, which is well set to connect conservation and development and play a leading role in the development and implementation of HWC management. Building up these local institutions is fundamental for any community-based HWC management approach. While some institutions are well set up and reliable partnerships have been developed (e.g. Mbamba), others are still new (Mavago area) or have strong development needs (Gross&Billierio, unpublished data).

The process of empowering CGRNs has started in NSR, by setting up more CGRN, to better represent the community. Trainings of the CGRNs have started (see also section “the role of communities in HWC management”, page 18) but need to be scaled up. Also, more focus has to be set in these trainings on integrating HWC management and on how to move from conflict to coexistence. Building up and empowering these local institutions, capacitating and guiding them towards coexistence strategies is seen as a key component in the development of a successful HWC management scheme in NSR.

Education for coexistence

Specifically designed educational activities and raising awareness for the importance of wildlife conservation are crucial for the long-term coexistence between wildlife and people. Furthermore, basic education is fundamental for the development of improved livelihood options, well-functioning participatory processes and equal inclusion of all community

members. The generally low education level and high illiteracy in NSR is an obstacle that needs to be addressed.

Improving basic education

Generally, the education level in NSR is low and illiteracy is high (Kock et al. 2014). Particularly in some less accessible areas, such as Nahavara and Naulala, only 50% of household heads went to school, while in Mecula all household heads have had some basic school education (JP unpublished data). The low educational level as well as the heterogeneity has direct implications for employment levels in tourism. Several concession holders explain that frequently local candidates for employment do not meet the required criteria, and thus, cannot be employed for more qualified positions (interviewees 03, 06, 07), which again evokes jealousies and inequalities.

Investing in basic education means preparing the ground for sustainable development and balancing inequalities. As education programmes may further be used as entry points to build up constructive relationships with the community, building strategic partnerships with development and educational organisations should be explored.

Conservation education

Currently conservation education activities run by WCS/NSR are covering environmental clubs, radio disseminations, annual festivals and scholarship programmes for students. One education officer develops the programmes and works with community assistants. The performance of the educational sector within WCS/NSR needs serious upscaling (interviewee 01) and requires integration of HWC management and coexistence topics.

In NSR education for coexistence needs to be developed and carried out in a strategic way. As human wildlife coexistence is a cross-cutting issue, education programmes for various target groups can be developed around it. Knowledge on wildlife behaviour and safety measures at home can be targeted in lower school levels, whereas topics such as safe farming practices or benefits derived from wildlife may be subjects at higher school levels. For this, teachers need to be continuously trained on specific topics and provided with some easy to use educational tools and guides.

Informal educational events on HWC for adult target groups may be combined with health camps, water campaigns, and be mainstreamed into any other consultations and capacity development programmes. Integrating issues on human wildlife coexistence into any sustainable development programmes and into the work with Sustainable Development Committees would create an understanding for the connection between conservation and development in NSR and the role every community member plays in it.

Recommendations

- Professionalization of stakeholder involvement through systematic stakeholder analysis and stakeholder mapping
- Development of a stakeholder engagement plan for various processes
- Implementation of strategic stakeholder involvement processes facilitated by a third party neutral, to obtain agreement on HWC management and the General Management Plan
- Build up capacity and empower all CGRNs; adjust existing training plan to NSR context and scale up on human wildlife coexistence strategies, sustainable development and conservation

- Enforcement of community outreach and regular participation in community meetings
- Objective of community outreach should be on how conservation and development can be achieved mutually and how HWC can be turned into coexistence on macro-level
- Consider higher transparency for communities in processes on quota setting (e.g. by co-development approaches)
- Increase transparency for communities on income generated through trophy hunting
- Enforce community consultation in the selection process of investors
- Small scale pilot projects for sustainable livelihood development or other coexistence strategies to be implemented as entry point to build up a good working relationship and trust with communities
- Create joint concepts and synergies with district administration to connect conservation and development
- Build strategic partnerships with development and humanitarian organisations
- Build strategic partnerships to improve education of pupils in NSR and decrease illiteracy
- Integrating issues on human wildlife coexistence into any sustainable development programmes
- Design and conduct teachers training on HWC a coexistence, to integrate into curriculum
- Continuously conduct teachers training and accompany with monitoring and evaluation
- Production of teachers materials on HWC and coexistence to support interactive lessons on the topic

9. Financial strategies

Whether looking into colonial times, or into the recent ivory poaching crisis, NSR has a history of brutal exploitation of wild species and other natural resources, while the local human population was generally not benefitting. In order to foster beneficial human wildlife coexistence, a system change needs to be initiated. People making their living in NSR through sustainable and wildlife aware livelihoods must directly benefit from the presence of wildlife. As participation in wildlife crime by villagers in the NSR is motivated by unemployment, poverty and food insecurity (interviewee 01, 08, 09) comprehensive and effective financial strategies are needed to balance the inequities deriving from the costs incurred by living with wildlife.

Various financial strategies have been developed in the past and have been successfully implemented in other parts of the world. Coupling payments to conservation or HWC management performance have proven to be highly effective, in case of strategic and comprehensive implementation.

20% benefit share

In NSR currently a benefit share of 20% of the income through investors is in place, but compensation or ex-gratia payments for losses incurred due to wildlife are not covered by the government or any other sources. The benefit share of income through investors bears the potential as a strong financial conservation and coexistence tool, however, its potential is not being fully exploited at present.

The share of 20% of the tangible benefits between the state and local communities in reserves is based on the Forestry and Wildlife Law, operationalized through Ministerial Decree 93/2005. To receive these funds, communities must complete several steps, including organisation and formalisation of a community management committee, recognition of the committee by the district administration, and opening of a bank account for the community.

The current structure and low capacity of the CGRNs cause various constraints in the distribution of the benefits share.

- a) CGRN which cover too many villages risk that funds are not distributed transparently and do not reach smaller or underrepresented villages (interviewee 02 and 06)
- b) CGRNs without a bank account need to partner with the district administration and risk to not receive the funds they deserve (Gross&Billerio, unpublished data)
- c) The distribution of the 20% is not well regulated and it is not transparent and comprehensible which CGRN received how much money. This causes strong discontent between the communities (interviewee 02, 06, 07, 08, 09)
- d) The payment of the 20% is decoupled from any conservation performance
- e) The 20% is generally used for construction work, purchase of communal or individual construction material or community projects, and does not offset any losses due to wildlife (Gross&Billerio, unpublished data)
- f) The 20% is generally not used for HWC management actions (Gross&Billerio, unpublished data)

The general idea behind the 20% benefit share is to offset missed economic opportunities and cost incurred by living with wildlife. As such it bears the potential to create an important income

stream for communities, if concessions are well managed, remain valuable and generate income. However, many questions on the process remain unclear and currently those people suffering most from the presence of wildlife, e.g. bearing the highest costs of crop damage, or losing a family member, are not the ones benefitting from the funds. Clarifying and re-designing the payment modalities and processes into a transparent, comprehensible and equitable scheme is an important task for the future.

Compensation or performance payments

When it comes to HWC mitigation, the compensation of losses is a matter to be discussed. The idea behind compensation is that a) people who suffer damage through no fault of their own receive some support to cope with the loss, and b) those responsible for the damage pay. The HWC scenario in NSR is complex, due to various players. First of all NSR is a national reserve, whereby the government has leased out concessions to private investors. Communities within NSR are receiving 20% from the benefits generated (see above). These 20% are not used to offset damage by wildlife, but to foster development activities.

In case of crop or livestock damage, who would be the one to pay? Is it the concession holder, who directly manages wildlife populations? Or is it the government, to decide to put NSR and its wildlife under protection, or NGOs paying for the protection of wildlife? Or is it the communities themselves, who attract wildlife with palatable crops or livestock? Obviously, there is no clear answer to this question as multiple partners have an interest in the presence of wildlife and in the use of the resources of NSR.

To get over the difficulties on clearly answering the question regarding ownership and payment modalities there are two schemes that have been installed in the African context: a) insurance schemes and b) coexistence performance payments.

While insurance schemes pay offset losses of killed livestock and damaged crops, coexistence performance payments incentivise living with wildlife.

Livelihood insurance schemes

Insurance schemes have been widely used as a tool to mitigate the direct negative impacts of wildlife damage. Payments are tied to damage incidents and are funded at least partially through premium/membership payments. Policyholders pay premiums to an insurer before incidents occur with the agreement that specified damages, should they occur, will be paid for.

Insurance schemes have been developed for several events (e.g. weather-related damage, theft, etc.). Increasing numbers of innovative schemes are being launched with a focus on providing enhanced protection for climate-related weather impacts to smallholders across the African continent, as well as in Asia. Collectively, these schemes have reached over one million individuals with many already seeing benefits through improved resilience (Wildson-Holt&Steele 2019). However, insurance schemes for HWC related incidents have been limited in scope, with insuring for livestock predation or crop damage conducted at a small scale in several places worldwide with varying levels of success (Leslie et al. 2019). To be successful, the implementation of insurance schemes must be bound into holistic HWC management schemes, be closely linked with preventive measures; take into consideration the social and ecological context, be site specific, and build upon stakeholder trust and effective monitoring of success. The main challenges of such schemes are related to timely and accurate verification

of damage, clear rules and guidelines, prompt and fair payment, and sufficient sustainable funds.

In Kenya AB consultants facilitate the process of implementing public-private partnerships to insure small scale farmers for crop damage caused by elephants (Barbara Chabbaga pers. comm.). Thereby, the potential of linking communities, private insurance companies, government and private donors is explored. This project is intended to help the governments of that country to pilot new insurance schemes, involve communities, improve damage verification, and speed up payment processes. Furthermore, the project explores how financial sustainability of premium payments can be enhanced by making them mandatory or bundling insurance services with other products.

However, the public private partnerships for HWC insurance schemes have not yet been comprehensively implemented or adequately evaluated. Large national insurance schemes intensify the assumption that wildlife belongs to the government and, hence, the government is the one to pay for the compensation of losses. Therefore, insurance schemes, if not based on community level, risk to further alienate communities from the value of living with wildlife and makes it difficult to convey the philosophy of ownership and coexistence.

Coexistence performance payments

In Mariri an innovative approach similar to the “Wildlife Credits scheme” of Namibia was has been implemented. Performance payments are paid to the community of Mbamba, according to criteria, which were defined in community meetings. Positive conservation/coexistence performance increases payment, negative performance decreases payment. Some examples are:

- Money is paid for number of months no elephant is killed in the block
- Money is taken off for elephants, lions, hyenas killed or snared
- Money is paid for children finishing schools etc.

These payments add up to roughly 20.000-25.000 USD a year and are funded by philanthropy. These schemes have resulted in very low snaring numbers and an increase in wildlife population. A strength of the performance payments is the direct and transparent link of conservation to a benefit. In Mbamba village with about 2000 inhabitants (460 households) this direct link can be communicated comprehensively. In larger communities such schemes might face further challenges.

However, coupling performance payments with offsetting losses by a community-led insurance scheme might be a viable option for communities in NSR.

REDD+

An different type of performance payment is the scheme to Reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries (REDD+), which is under discussion for NSR (WCS 2020). In various places, REDD+ schemes have already been combined with HWC management, such as in Nepal, Kenya, Zambia and Cambodia. This bears the potential for another income stream to foster coexistence between people and wildlife.

Recommendations

- Explore concepts for coexistence performance payments coupled with local, community based insurance schemes
- Linking REDD+ programmes to HWC management and coexistence to be explored

- Build up performance payments instead of insurance/compensation to strengthen ownership: Pay for living wildlife, not for dead livestock

10. Technical strategies

Multiple technical strategies have been developed worldwide, to improve income through wildlife tolerant businesses, prevent damage by wildlife species or deter wildlife, in case damage could not be prevented. In NSR several methods have been used, such as the construction of carnivore proof livestock shelters, community patrols, strategic guarding, fencing, trenching, the construction of wildlife safe grain stores, use of beehive fences, chilli guns etc. Out of 45 villages in NSR 89% implement some sort of protection measures against wildlife, mainly scaring with loud noise (drums, cans) followed by using fire, fencing and guarding (JP, unpublished data).

Also adjusting crop choice and farming practices as well as the development of alternative, wildlife aware income opportunities and livelihoods fall under the technical strategies. All these strategies have a potential to be successful, but need to be adjusted to the specific ecological and cultural context and none of them is the panacea to solve HWC. Importantly, for any technical measure the way they are implemented, monitored and maintained is critical to success. Any of these measures may be successful but also may fail, and the reason for success or failure mostly lies in HOW the measure was implemented.

It has to be understood that HWC will not be solved technically alone. Technical measures need to be bound into other social and financial strategies, guided by monitoring and research and backed up by policies. Here, a selection of technical strategies for HWC management is described, which either have been piloted in NSR or have a potential for success in NSR.

Sustainable livelihood development

Sustainable development considers ecologic, social and economic factors and aims at balancing economic growth with ecologic carrying capacity and social equity. In landscapes which are shared by wildlife and people, the ecologic component is strongly influenced by wildlife and needs to be factored into all development activities, as a challenge or opportunity.

Market-based strategies benefitting individuals, while not harming wildlife, are an important tool in the set of HWC management strategies. The general idea behind it is, to reduce livelihood practices which may trigger HWC (e.g. farming of attractive crops, production of livestock attractive to carnivores) and at the same time are low in value, by businesses which are more suitable to wildlife rich areas and generate higher income. This can be achieved through the farming of cash crops which are less attractive or even unpalatable to some herbivores and adding value to traditionally grown crops for sale. Also, the production of handicraft products, honey or fish can decrease the vulnerability of farmers to damage by wildlife. An important factor for success, is market access. Building up “wildlife friendly” businesses implies building up capacity for small business management and bears a viable economic potential which fosters sustainable business instead of aid.

Also skill-transfer partnerships formalised through social contracts between private companies and local communities could be developed to enforce the development of sustainable

livelihoods, whereby communities are accompanied to gradually provide economically viable services (e.g. production of a specific product or crop). Such business-like partnerships, with economic rationale, can function as powerful incentives – if appropriately accompanied throughout.

As the high vulnerability of people increases significance of losses to wildlife, decreasing vulnerability through livelihood development is an important measure for HWC managing. When such measures are further linked to conservations, synergies between development and conservation can be produced.

Farming strategies

In NSR most damage by wildlife occurs on fields through herbivores feeding on or trampling crops. Conservation agriculture, whereby soil quality is maintained through low tillage and crop rotation, is a strategy that bears great potential for wildlife rich areas (interviewee 08, 09 and 11). In NSR piloting of conservation agriculture has started and needs professional upscaling, while considering crop choice and strategic placement of fields (see micro level spatial planning). Combining conservation agriculture with block farming away from wildlife corridors and combining it with other technical strategies for crop protection, such as choice of less attractive or early maturing crops and community based-guarding or fencing may create multiple benefits, such as safer income, decreased damage, less rotation of fields and decreased land conversion. Besides the successful trials in Mariri, similarly successful results have been achieved in Botswana's Eastern Okavango Panhandle with “elephant aware agriculture concepts” of the Ecoexist Trust (www.ecoexistproject.org).

The plantation of hundreds of fruit trees to improve food security and uplift people's livelihood in NSR (interviewee 01) is seen critically. While fruit trees surely can create incentives to not shift from that area, the opposite may also be the case. Fruit trees strongly attract wildlife, such as elephants and baboons, and living in the vicinity of fruit trees may become dangerous and challenging. Given the high level of HWC, particularly crop damage and enormous labour and cost of protecting attractive crops, the introduction of fruits trees needs reconsideration.

Livestock production

Livestock production in wildlife rich areas needs to be handled with specific care. Small livestock production, such as ducks, chicken, rabbits etc. has been promoted and supported by NCP, benefitting 149 households and approximately 1000 people (NCP 2020). Small livestock production needs to be accompanied by a good veterinarian support for vaccination as well as predator proof pens and corrals. Upscaling livestock production in NSR in the first place means upscaling livestock husbandry and livestock safety.

Goats and sheep are still found in small numbers in NSR, but numbers are growing and the production of goats is supported by WCS/NSR (WCS 2019). Goats do not serve the daily protein intake of families, as small livestock does, but are kept for special occasions (e.g. funeral, wedding) and as economic asset. Furthermore, goats are attractive prey species for larger predators and need to be kept in safe pens at night, and need guarding during the day. The propagation of goat farming in NSR has to be critically analysed regarding sustainability aspects considering HWC. Given the high number of people living in NSR, a supply of protein through goat production would require a massive number of goats, which will without doubt compete with wildlife and increase HWC.

Any livestock production programme needs to be backed by a vaccination programme to reduce disease transmission. This has been carried out by WCS/NSR together with NCP for dogs. Sterilisation of dogs to reduce uncontrolled dog population increase is an important effort to prevent further HWC.

Fish farming

The demand for fish as source of protein and for income generation is high (interviewee 01, 08,09). MOMS guardians have recorded a total fish catch of 36,4 tons of fish in 2019 (NCP 2020). Fishing in the rivers, however, increases exposure towards crocodile and hippo and may further overexploit fish resources, which also may increase croc attacks on livestock and people.

Fish farming has been implemented successfully in many places with similar ecological setting and should be explored as an option to increase food security and income for people living in NSR and at the same time to reduce exposure towards crocodiles.

Beekeeping, craft production etc.

In NSR, NCP has piloted bee keeping and craft production as sustainable livelihood options, which are not driving HWC. When well implemented by good training concepts, starter support and continuous monitoring of small-scale activities can develop into collaborative business schemes. Combined with education for coexistence, business based strategies can be powerful tools for reducing HWC, and increasing resilience and tolerance.

Strategic water supply

The lack of water in NSR is a serious issue for many households living in NSR. As long ways to fetch water puts people at risk of accidentally running into wildlife, water supply ideally should be available within villages. Furthermore, fetching water, washing and bathing in rivers puts women and children at risk of crocodile attacks.

Combined with macro and micro level spatial planning, the construction of boreholes for safe drinking water supply can be used strategically in HWC management. Providing water, where people have safe space to develop their livelihoods creates incentives to settle in these areas and stay at those places. The construction of water points moreover can be used as an entry point into community collaboration as well as partnerships with development and/or humanitarian aid organisations. The construction of boreholes in wildlife corridors and important wildlife habitat should be strictly discouraged. A water point development plan based on groundwater availability and geology, as well as wildlife movement and community development plans is the basis for using water supply strategically in HWC management.

Separating wildlife from people and their assets

Separating people and wildlife species through a barrier can avoid negative impact on both sides. However, fences also reduce free access to the area on the other side of the fence, restricting access to natural resources etc.

Depending on the spatial distribution of villages, farms and corridors, in NSR barriers can be placed in various ways between wildlife and people:

- around dispersed nodal villages
- around farms
- along corridors
- along development zones

Trench

Around the village of Mbamba an enormous trenching endeavour has recently been completed. The village is surrounded by a 4 km long elephant and buffalo safe trench, which was planned and constructed with full participation of the Mbamba community. A total of 238 people were involved in digging and earned more than 12,000 USD for their labour (Collen Begg pers. comm.). A team was set up to monitor the trench construction and the community is carrying out maintenance. The trench has proven to be elephant and buffalo safe. Roads crossing over the trench, however, need to be guarded, to make sure no wildlife crosses here (e.g. bushpigs).

Community-based trench construction needs to be based on good micro-level planning, as the installation is not flexible and expanding and changing the trench outline is not easily possible.



Fig 18 Mbamba community members are digging the elephant and buffalo safe trench. Photo: Mariri



Fig 19A gabion is constructed to provide stability to the trench: Photo: Mariri



Fig 20 Small pedestrian bridges allow access to farms. Photo: Mariri



Fig 21 The trench secures all households of Mbamba village. Photo: Mariri

Permanently installed electric fencing

In NSR several permanently installed fences have been constructed, others are in planning. The demand for fences is high and is said to be strongly favoured by communities (93%) as HWC prevention measure (JP, unpublished data). These fences are permanent installations, which need to be very robust and well maintained to withstand particularly elephants. Elephants are clever enough to learn to push over poles, use their tusks to snap the electrified wires, remove electric components or lay logs across the fence. Well-designed heavy-duty electric fences (with electrified outriggers) can be effective deterrents, but they are very costly and suffer from unreliable electricity sources.

Heavy-duty fencing around a village will restrict the movement of people into the surrounding area. This access restriction can be very critically seen by members of the communities, who may use the protected area for feeding their livestock, collecting fire wood or other resources. If not accepted by the local population, fences will easily get cut through and damaged (Gross 2019). Moreover, fencing in one area may shift the conflicts to other areas, which would prevent overall reduction of losses and HWC. Therefore, fences need to be bound into a detailed macro and micro level spatial planning.

Furthermore, fences themselves can exacerbate pressure on wildlife, as they offer a ready supply of wire, which can be used to produce snares for poaching (Woodroffe et al. 2014). Particularly in areas with a low tolerance for wildlife damage and a low support for wildlife conservation activities, the risk of increased poaching by the installation of wire fences needs to be calculated with care and combined with social HWC management strategies.

Fences need to be permanently maintained to restrict elephant movement effectively. Once elephants realise that they can cross a barrier they will be more inclined to repeat the effort. Thus the maintenance of fences must be financially and technologically within the capacities of the people maintaining them, if they are to serve as long-term solutions. Maintenance responsibility needs to be clarified before installation and has proven to be most significant for the failure or success of an electric fence. Many fencing projects of the past, which were set up to prevent HWC have failed, mostly due to low maintenance, as a result of low community participation and maintenance budgets. Fence construction need to be strongly bound into social strategies, to create ownership, participation and high motivation for maintenance.

The most ambitious fencing project of NSR is a 42 km fence around Mecula town. So far, potential contractors joined a site visit to inspect the area in order to prepare their cost estimates. Furthermore, a meeting was held in Mecula town, attended by the NSR infrastructure manager, technicians from the Mecula district government, the SDPI and the District Secretariat and the local traditional leadership, to present the phases of the project for the construction of the electric fence (WCS 2020).

To ensure this fencing project will be successful, a detailed community engagement plan needs to be developed, defining the participatory planning process and communicating transparently the advantages and disadvantages of such an endeavour. The community needs to fully support the fence and its maintenance, which needs sufficient funding. Supporting maintenance work through incentive payments, similar to conservation performance payments (see Financial Strategies), has proven to be successful in other places.

Mobile electric fences

Mobile electric fences made from polywire (a polyurethane cord, threaded with strands of wire) are used in NSR to restrict the access of elephants onto farms or settlements while leaving natural habitat open for free roaming wildlife. Farming blocks are fenced in the rainy season, and after the harvest has been brought in, the fence is taken down and can be placed around villages, where the crops are stored in the dry season. Before the installation of any fence around farmland it has to be considered that a shifting effect of damage to other unprotected areas is likely to occur. They have proven effective in several areas, if correctly installed and maintained.

The use of mobile electric fences needs to go along with participatory micro level land use plans and to promote farming in one block. Mobile electric fences can also be well combined with wildlife aware sustainable conservation agriculture.

Crocodile fences

Crocodile attacks on people generally are opportunistic and also occur if natural food is available (KAZA TFCA 2019). However, in some areas human activity such as overfishing and poaching has resulted in low wildlife populations and fish stocks in the rivers. Resultantly, due to shortage of food resources, crocodiles turn to livestock and to become man-eaters (KAZA TFCA 2019). In NSR people in most rural areas depend on rivers and dams for their domestic use, and may therefore be a target to crocodiles.

A reduction of injuries and fatalities of people and their livestock caused by crocodiles can be achieved through multiple actions. The reduction of reliance on rivers is one important measure to consider (see Fish farming, page 41 and Strategic water supply, page 42). Where no alternative water sources are available, the construction of crocodile proof barriers at water collection locations can strongly increase safety (KAZA TFCA 2019). Maintenance of the enclosures plays an obvious factor in the efficacy of crocodile exclusion enclosures (IUCN CSG 2021). Monitoring (see page 24 ff.) of crocodile attacks and detailed observation of attack sites should be scaled up and be conducted in more detail, so that data can feed into adapted strategies, definition of danger zones and creating safe passages.



Fig 22 Crocodile exclusion enclosure in Sri Lanka, Photo: IUCN CSG



Fig 23 Crocodile exclusion enclosure being maintained, Photo: IUCN CSG

Beehive fences

Beehive fences, which were initially developed by Lucy King/Save The Elephants, have been successfully trialled in NSR. For a beehive fence strong poles (which were treated against termites) are installed and one beehive is hung between poles every 10 meters, in such a way

that the hive can swing. Then, a fence wire is installed, connecting the hives with each other, so that a contact with the fence will result in swinging hives, to which bees will react with buzzing or even leaving the hives for defence (King 2014). Any type of hive can be used for the installation (King et al. 2011, King 2014). The hive needs to be protected with a little roof against direct sun light and rain. The protection success of a beehive fence is determined by the occupation rate of the hives. As hives are naturally populated, the occupation rate depends on the environment (availability of flowering plants, temperature, and availability of water) and the maintenance of the hives.

In NSR four experimental beehive fences were constructed in 2012 in Mbamba and two in Macalange villages. The trial was successfully run and significantly reduced in the pilot farms. On top of crop protection, about 7.5 litres of honey were harvested providing US\$150 of revenue from sale.

Other fences

Planting thorny hedges and living fences or constructing bamboo fences may deter various species, such as bushpigs, but also hippo. They are all used in NSR to a higher or lesser extent. Even though such barriers would not keep out elephants or buffalo from attractive maize or rice fields, they can be effective in securing less attractive crops against trampling and easy passage through the field. Chilli fences can be highly effective as well, if well maintained and in case elephant pressure is not too high.

Corralling of livestock

Due to the presence of small and large carnivores in NSR all livestock also needs to be well corralled. Predator proof corrals or pens are built of bricks, woven bamboo and chicken wire. It is entirely possible to protect livestock from carnivores, but more difficult to protect it from baboons and eagles unless completely enclosed corral or hutches are built, which are too expensive for most families (NCP 2020).

NCP supports the construction of safe corrals through community guardians. These assist their communities with in building effective safe corrals by constructing model shelters in corrals in each village that others can copy and learn from. At Mariri Environmental centre three different types of corrals for ducks, chicken and other poultry were constructed for demonstration purposes (NCP 2020).

Safe shelters

To avoid attacks by carnivores on people, NCP has spent a lot of effort in the past ten years to help people by identifying safe shelters and behaviours that make people vulnerable to attack. Attacks on people can be minimised if people sleep in safe shelters in their fields in the wet season when 80% of the attacks by carnivores have occurred (NCP 2020). These safe shelters, also called “Sanja” have been used for hundreds of years by local people and represent the best way for people to reduce risk.

Combining safe shelters with strategic and cohesive guarding (see page 49) improves direct safety of people and guarding efforts for farms. Improved “Sanjas” can be placed on earth mounts for better visibility and enclosed by an elephant safe trench. Strategically placed along a guarding line, such safe shelters can play an important role in community-based HWC management.

Maintaining HWC prevention measures

Most technical HEC measures strongly depend on adequate maintenance. This maintenance generally is to be conducted by specific members of the farming community. In many HWC management programmes in Africa, Asia and Europe the issue of a maintenance breakdown is observed. This maintenance breakdown is characterized by initial high motivation for the implementation of the measure and the commitment for maintenance, and a drastic decline in maintenance efforts over some time. The problematic point seems to be that only if the benefit of maintaining a measure is visible, high input by community members or individuals is given. However, when the measure shows success the damage ultimately declines and with that seemingly the stimulus to remain active. The benefit is not visible anymore (e.g. because wildlife stops coming) and maintenance input goes down. If then damage happens because of low maintenance, it is claimed the measure was not working. Besides this many technical HEC measures require strong labour input. In case of relatively low expected benefits (e.g. the regular harvest of a staple crop), motivation for extra work might be low. Here a need has been identified for the development of approaches to maintain the motivation for the continuation of successful measures. Keeping the personal connection to users, constantly monitoring their activities and success and regular communication about challenges and perspectives seems to be one option to achieve this goal (Gross 2019). Incentive payments for good maintenance efforts and deducting penalties in case of bad performance may be another tool to enforce good maintenance efforts.

Wildlife deterrents

A long list of deterrents has been developed to repel wildlife before entering farmland or to drive it away, when it has entered. Aim of any deterrent strategy should be to prevent wildlife entering fields, to avoid positive reinforcement of crop damage behaviour through feeding success. Obviously it is also more difficult to chase away any species from attractive food sources, when it has already started to feed. When wildlife is detected too late, driving the species away can be difficult. Particularly if a herd or larger group is present, driving wildlife away can become a risky business.

Using acoustic (yelling, hitting metal objects), and visual signals (burning fire and lighting torches) in combination with scaring elephants through throwing stones, burning objects and even fire crackers are the most common deterrence methods used in NSR (Gross&Billerio, unpublished data). These measures need critical reflection and should not be propagated as “the thing to do”. The reason is that if used inappropriately wildlife, particularly elephants can easily habituate or get stressed in a way that aggressive behaviour is provoked. Clear strategies on how to scare away various wildlife species need to be developed, based on experience in NSR and elsewhere and comprehensively communicated to the farming population.

Fox lights

Fox lights (solar predator deterrent lights) have been successfully trialled by NCP in various settings (NCP 2020) and are part of their toolkit to reduce carnivore conflicts. Strategic use of fox lights and close monitoring of eventual habituation effects, should be bound into HWC management strategies.

Chilli bombers

The chilli bomber is a simple device to shoot ping-pong balls filled with a chilli-oil extract against elephants. The ping-pong balls need to be fired with strong force, so that it will reach the elephant and then break when hitting its skin. The chilli bomber was initially designed by Mike La Grange in Zimbabwe, based on the function of a potato gun (Le Bel et al. 2010, Le Bel et al. 2013) and has been promoted in NSR through NCP/Mariri (Collen Begg, pers. comm.)

The use of the chilli bomber requires specific training and exercise and can be effectively used against elephants, but also buffaloes (Agoshtino Jorge, pers. comm). The chilli bomber has been refurbished in a project in South Luangwa, Zambia, to function reliably with a piezo igniter, to make it independent from electrical charging.

HWC Prevention and Response

If, despite well-developed HWC prevention measures wildlife species manage to enter farmland or villages or attack fishermen on the rivers, or people while travelling, a quick, effective and professional response is needed. Given the size of NSR, the inaccessibility during certain times and the high number of people living in NSR, a decentralised Rapid Response structure with strong involvement of communities and concession holders, seems to be the way forward. Rapid Response needs to be well organised with a uniform system all over NSR, clear and comprehensive standardized operational procedures and sufficient capacity building and equipment.

Currently, Rapid Response is developed within Mariri, Chuilexi and Luwire blocks with strong involvement of the concession holders and covered by WCS/NSR in other parts of NSR. To ensure rapid response to serious incidents of human wildlife conflict a WhatsApp group was developed, and phones provided for all MOMS guardians to be in touch with community teams of Mbatamila, Luwire, Chuilexi, Mariri or NCP. The HWC officer is contacted in case of particularly dangerous or difficult situations and responds with a team, if possible. This team currently includes five men who are experienced with elephants, which is very helpful. However, these men are losing physical fitness due to age (Sam Billerio, pers. comm.) and need to be supported by younger staff members. It is highly important to organise a knowledge and skill transfer from the experienced HWC response team members to younger team members.

Generally, the HWC response team urgently needs upscaling, to be fully operational and to demonstrate impact on improved safety. Capacity training, the development of Standard Operation Procedures (SOPs) and decision trees is highly important for professionalization. An example has been developed by NCP for dealing with carnivore conflicts, which should be analysed and discussed for adjustment/learning.

The response team of WCS/NSR further needs sufficient equipment, increased mobility and well developed relationships with community HWC response groups. Building community-based HWC response structures is highly important. Hereby, performance monitoring and supervision needs to play an important role, to make sure these teams operate effectively. A step-wise concept on a) farmers level community response, b) community HWC response team involvement, c) support of NSR HWC response team, depending on severity and persistence of wildlife species should be considered.

Furthermore, the involvement of every community member in HWC safe behaviours, the role of community-based rapid response teams in HWC management and support by institutionalized rapid response (concession and/or WCS/NSR) needs to be planned in a participatory way, documented and comprehensively communicated. Therefore, educational materials for various target groups need to be developed and disseminated, e.g. in theatre campaigns.

Similarly, river response teams for aquatic HWC need comprehensively planned and implemented structures and standard operation procedures.

Strategic and cohesive guarding

Active guarding of fields is commonly practiced to prevent and decrease crop damage by wildlife in NSR. During farming seasons, farmers shift with their families to the fields where mainly staple crops are farmed. Traditionally, every household protects its own field. Farming households would put up a simple temporal shelter (see “Safe shelters”, page 46) on the ground of their field and guard and sleep there. Those fields are generally scattered in the farming area, leaving some barren land in between. As some farmers may have several fields apart and not every farming family may be able to guard, naturally, not every field is guarded. When wildlife enters a field or a farming area they generally are not directly detected and start feeding. Then, when farmers finally do become aware, they try to scare them away. Wildlife wander off to another field, where they continue feeding, until they are scared off again to the next field. Such guarding practices might be useful to some extent in keeping wildlife away from one’s own crops, but they disrupt psychosocial wellbeing and livelihood activities of farmers and they are ineffective from the collective perspective (Gross et al. 2020).

The strategic community based guarding approach improves the traditional guarding practice of local farmers by defining a common protection line, to which all guarding efforts are shifted. By this the complete protection of a whole farming block can be achieved through the efforts of the whole community of farmers cultivating land in a specific area. At the strategically defined guarding line watchtowers are set up every 100 meters. Farmers take guarding shifts on the watch towers and look out for elephants approaching from the adjacent bush- or grassland. They are equipped with strong solar chargeable LED torches, mosquito nets and blankets. The moment a farmer detects an elephant, he/she will call foot patrols, who will rush to the site and chase the animal away with deterrent methods. The deployment of chilli bombers in community based guarding concepts has proven to be successful in Zambia and is also used in Mariri.

Community based, cohesive guarding needs to be combined with spatial planning on micro level, crop choice, education and rapid response teams.

Geofencing

Geofences can be used as an early warning system against elephants in a specifically defined area, warning on the presence of a specific collared individual. Once detected, safety measures can be taken or deterrents can be prepared, before elephants have reached crops or habitations. In NSR elephants have been collared to understand their spatial movement. Programming of a geofence was also applied, to trial this way of high-tech early warning.

Geofences are spatial shapefiles which are programmed into the collars of elephants. The moment an elephant crosses the programmed boundary of a geofence an alarm will be sent to a central point, where response will be coordinated. Despite great achievements in real-time tracking of elephants, we are still far from a “remote control” of elephants. The response to alarms still needs to be done manually and is risky, labour and cost intensive. Furthermore, the value of geofences in HWC prevention is still limited due to the initial challenges of capturing and collaring elephants, the requirement of internet connectivity or network coverage to transfer alerts, and considerable subscription costs of regular data transfer.

In NSR geofences have not touched their potential, as collared elephants were not the ones involved in regular crop damage behaviour (Falk Grossmann pers. comm.). This shows that before deploying sophisticated high-tech devices, ground work has to be done properly. So far, crop damage behaviour by elephants is not well studied in NSR, elephant movement has not been comprehensively understood. Investing in better understanding the herds and individuals, their favoured sites and habitats, their crop damage behaviour etc., by involving community members (MOMS, guardians, community-based rapid response teams, trained volunteers), e.g. with citizen science approaches for individual identification, could be a good step towards well informed decision making for deploying collars in the future.

Recommendations

- a) Sustainable livelihood strategies
 - Prioritization of the development of market-based strategies for sustainable and wildlife aware livelihood development
 - Strengthen Farming strategies to be combined with spatial planning
 - o Placement of farms out of wildlife corridors
 - o Conservation agriculture combined with crop choice of unattractive crops
 - o Combination with crop protection strategies
 - o Re-consider fruit tree plantation, which may drive HWC
 - Strengthen livestock production
 - o Scale up small livestock
 - o Re-consider goat production, which may drive HWC
 - o Dog vaccination and sterilisation to be continued
 - Conduct feasibility study for fish farming
 - Fish production in ponds, to decrease fishing in rivers
 - Upscale bee keeping and craft production and develop market access
- b) Strategic water supply
 - Development of a borehole development plan taking into consideration corridors and development zones
 - Use of water points to foster settlement in certain areas and discourage in others
- c) Separating wildlife from people and their assets
 - The use of trenches, permanent or mobile electric fences needs to be planned in a participatory way, to enhance ownership by the affected communities
 - Crocodile exclusion enclosures to be trialled at high risk zones, where appropriate and in accordance with micro-level land spatial planning

- Maintenance of all prevention measures need to be considered from the planning phase onwards and needs budget plans
 - Continuous monitoring of the maintenance of prevention measures and evaluation
 - Potential to upscale beehive fences in suitable areas needs to be explored and integrated in micro-level farming
 - Construction of predator proof livestock shelters should be part of any livestock development programme and should be coordinated with NCP
 - Construction of safe shelters (Sanja) for farmers guarding fields need to be promoted and combined with community based guarding strategies
 - Elephant safe “Sanjas” to be trialled by constructing a combination of trench and earth mount
 - Continuous monitoring and encouragement of maintenance is key to success of HWC prevention measures
- d) Use of wildlife deterrents
- The use of wildlife deterrents to scare away megaherbivores needs to be reconsidered, as unintended negative side effects can occur (habituation, increase of damage)
 - Strategic use of fox lights and close monitoring of eventual habituation effects, to be bound into HWC management strategy
 - Consideration of upscaling strategic use of chilli bombers with community based rapid response teams (chilli bombers to be refurbished with piezo igniters)
- e) HWC prevention and response
- HWC team to be upscaled and equipped appropriately
 - Capacity building training plan to be developed and implemented
 - Decentralisation of response
 - Building up community- structures for HWC response
 - Development of SOPs regarding HWC actions
 - Enforce security for people: better follow-up with fatalities and injuries
 - Development of river response team with SOPs, and sufficient equipment
 - Cohesive and strategic systems to be developed based on micro-level land use planning (block farming, crop selection etc.)
 - Scale up on understanding crop damage behaviour of elephants, to better target elephant individuals for collaring
 - Geofencing strategy to be reconsidered, due to lack of sufficient HWC management ground work

11. Action plan

Short term	Long term
Legal Framework for HWC management	
Finalize General Management Plan, including HWC management in a holistic way	Revision of the Ministerial Decree 93/2005 of the Forestry and Wildlife Law, on the 20%, to include regulations on distribution, also considering people suffering from HWC
General Management plan to define roles and responsibilities regarding HWC	
Development of regulations considering HWC management in zonation plan	
Revision of the protocol to assist HWC management in NSR, according to holistic HWC management and add guidance on implementation	
Development of a community engagement guideline, defining processes and areas of community involvement	
HWC Monitoring	
Design HWC data collection based on damage events, particularly for herbivores	Transfer HWC data collected by MOMS into real time systems (hybrid paper + digital systems)
Strengthen MOMS data collection and include details on damage size and type	
Development of HWC heat maps	Analysis of wildlife damage over time and related to wildlife presence/population dynamics (e.g. elephants)
Integration of severity/ extent of damage in HWC monitoring	Coupling species-specific HWC data with movement data and with data on illegal activities to generate insights for HWC and conservation management
Re-consider how data is collected by WCS/NSR and MOMS, to avoid duplication	
Development of evaluation plans (e.g. before/after or intervention/control schemes) for newly implemented HWC management measures	
Spatial planning	
Spatial planning to consider HWC aspects and safe areas for people and safe areas for wildlife	Macro level planning to also consider areas around NSR, particularly for development actions, but also wildlife corridors
Integration of HWC risk areas and wildlife corridors/movement areas into zonation plan	
Sensitively consider how to deal with influx of people into NSR in spatial planning and its regulations	
Participatory micro-level HWC management and land-use planning based on macro-level plans	Exploration of the western part of NSR to clarify potential for wildlife development

Identification of HWC management measures suitable for the three different community categories	
Social strategies	
Professionalization of stakeholder involvement through systematic stakeholder analysis and stakeholder mapping	Development of a stakeholder engagement plan for various processes
Implementation of strategic stakeholder involvement processes facilitated by a third party neutral, to obtain agreement on General Management Plan	Consider higher transparency for communities in processes on quota setting (e.g. by co-development approaches)
Build up capacity and empower all CGRNs (adjustment of existing training plan to NSR context, scale up on human wildlife coexistence strategies, sustainable development and conservation)	Create joint concepts and synergies with district administration to connect conservation and development
Enforcement of community outreach and regular participation in community meetings, including sustainable development and coexistence strategies	Enforce community consultation in the selection process of investors
Increase transparency for communities on income generated through trophy hunting	Build strategic partnerships to improve education of pupils in NSR and decrease illiteracy
Use small scale pilot projects for sustainable livelihood development or other coexistence strategies to be implemented as entry point to build up a good working relationship and trust with communities	Build strategic partnerships with development and humanitarian organisations
Integrating issues on human wildlife coexistence into any sustainable development programmes	
Teachers training on HWC a coexistence, to integrate into curriculum	Continuously conduct teachers training and accompany with monitoring and evaluation
Production of teachers materials on HWC and coexistence to support interactive lessons on the topic	
Financial strategies	
Explore concepts for coexistence performance payments coupled with local, community based insurance schemes	Linking REDD+ programmes to HWC management and coexistence to be explored
Build up performance payments instead of insurance/compensation to strengthen ownership: Pay for living wildlife, not for dead livestock	
Technical strategies	
Sustainable livelihood strategies	
Prioritization of the development of market-based strategies for sustainable and wildlife aware livelihood development	Conduct feasibility study for fish farming
Strengthen Farming strategies to be combined with spatial planning: Placement of farms out of wildlife corridors, Conservation agriculture	Exploration of feasibility to centralise fishing permits to NSR, to strengthen situation of local fishermen and increase stewardship

combined with crop choice of unattractive crops, Combination with crop protection strategies, Re-consider fruit tree plantation, which may drive HWC	
Strengthen small livestock production (poultry): Scale up small livestock, Re-consider goat production, which may drive HWC, Dog vaccination and sterilisation to be continued	Fish production in ponds, to decrease fishing in rivers
Upscale bee keeping and craft production and develop market access	
Strategic water supply	
Development of a borehole development plan taking into consideration corridors and development zones	Use of water points to foster settlement in certain areas and discourage in others
Separating wildlife from people and their assets	
Use of trenches, permanent or mobile electric fences to be planned in a participatory way	Maintenance of all prevention measures need to be considered from the planning phase onwards and needs budget plans
Crocodile exclusion enclosures to be trialled at high risk zones, where appropriate and in accordance with micro-level land spatial planning	Continuous monitoring of the maintenance of prevention measures and evaluation
Construction of predator proof livestock shelters to be part of any livestock development programme, to be coordinated with NCP	Potential to upscale beehive fences in suitable areas needs to be explored and integrated in micro-level farming
Construction of safe shelters (Sanja) for farmers guarding fields need to be promoted and combined with community based guarding strategies	
Elephant safe "Sanjas" to be trialled by constructing a combination of trench and earth mount	
Use of wildlife deterrents	
Use of wildlife deterrents to scare away megaherbivores needs to be reconsidered, as unintended negative side effects can occur (habituation, increase of damage)	Consideration of upscaling strategic use of chilli bombers with community based rapid response teams (chilli bombers to be refurbished with piezo igniters)
Strategic use of fox lights and close monitoring of eventual habituation effects, to be bound into HWC management strategy	
HWC prevention and response	
HWC team to be upscaled and equipped appropriately	Cohesive and strategic systems to be developed based on micro-level land use planning (block farming, crop selection etc.)
Capacity building training plan to be developed and implemented	
Organise decentralisation of HWC response	

Building up community- structures for HWC response	
Development of SOPs regarding HWC actions	
Enforce security for people: improve follow-up with fatalities and injuries	
Development of river response team with SOPs, and sufficient equipment	
Scale up on understanding crop damage behaviour of elephants, to better target elephant individuals for collaring	
Geofencing strategy to be reconsidered, due to lack of sufficient HWC management ground work	

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13. Appendix

List of Interview partners, qualitative expert interviews by video call

Name	First name	Organisation	Country
Begg	Colleen	Mariri Investimentos/NCP	Mozambique
Billero	Samuell	WCS/NSR	Mozambique
Chabbaga	Barbara	AB Consultants Kenya	Kenya
Chande	Baldeu	ANAC	Mozambique
Cordesse	Stephane	Metapiri Safaris	Mozambique
Cumbi	Rezia	ANAC	Mozambique
Cuna	Niltin	WCS/NSR	Mozambique
Ebersohn	Wim	Chuilexi Conservancy	Mozambique
Grossman	Falk	WCS	Tanzania
Jorge	Agoshtinho	NCP	Mozambique
Littleton	Derek	Luwire Wildlife Conservancy	Mozambique
Moore	Jumbo	Kambako Safaris	Mozambique
Pereira	Joana	Lisbon University	Portugal
Perry	Laura	Luwire	Mozambique
Pinto	Maria	University Paris	France