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SWM SUSTAINABLE WILDLIFE MANAGEMENT PROGRAMME

Towards sustainable wildlife management

An in-depth study for the promotion of community conservancies in Zambia and Zimbabwe

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IX. HUMAN–WILDLIFE INTERACTIONS

Sébastien Le Bel, Ferran Jori, Vincent R. Nyirenda, Musso Munyeme, Tapiwanashe Hanyire, Muhammad Faizan Usman, Evans Nsende, Mike La Grange and George Mapuvire

Introduction

This chapter is concerned with human–wildlife interactions, which can be defined as the spatial and temporal juxtaposition of human and wildlife activities, where humans, wildlife or both are involved (Lischka *et al*., 2018). The studies, which provide socioeconomic information on hunting, fishing and consumption behaviours, are part of the R2 domain of the SWM Programme: *Management of wild species resilient to hunting and fishing is improved*. The objective of this chapter is to capitalize on the information collected on human–wildlife interactions by the SWM Programme in KaZa to inform future interventions. In addition to our findings, the aim is to analyse the local management capacity of dealing with such interactions and to assess whether

Materials and methods

To obtain all the information needed to propose recommendations and innovative approaches, the effort to be made is focused on the analysis of HWCs. To do this, four complementary approaches were implemented from April 2019 to September 2020:

- An analysis of previous literature enabled the SWM Programme team in KaZa to contextualize the results provided by the programme to distinguish approaches aimed at mitigating the negative impacts on the conservation of wild species and the maintenance of local communities' standard of living.
- Reports of field visits related to HWC hotspots were produced by wildlife experts and national and local authorities in charge of wildlife management.
- Field surveys were carried out to understand the perception of local communities about mobile data collection for establishing an HWC reporting and monitoring system. FPIC principles were applied during the interviews.
- Information on HWCs was gathered during household surveys between 2019 and 2020: in Inyasemu CC (initially, 2019 and extended from June to July, 2020), in Mucheni CC (January–March 2019) and in Simalaha CC (initially, 2019 and extended from June to July, 2020). Prior to household surveys, theory of change workshops were conducted in 2018 and modified in December 2019. With regard to HWC, a section of the questionnaire of the household survey collected the following information:
    - experiences of HWC in the last 12 months;
    - the nature of the conflict & types of damage caused by wildlife;
    - the incriminated species;
    - the season of damage & frequency of damage;
    - the extent of the damage;
    - the location of damage; and
    - The mitigation strategy and solutions being utilized.

they constitute an obstacle to the development of sustainable wildlife management plans as it is expressed in the site theory of change. This chapter is organized in two sections: one dealing with human–wildlife conflicts (HWCs) in the three community conservancies (CCs), and the other addressing ways to monitor and mitigate wildlife disease risks and their transmission to rural communities and their livestock.

A. Human–wildlife conflicts

Wildlife is a common resource, but its negative value, such as the conflict between humans and wildlife, overshadows its positive values/services related to conservation and local development prospects. HWCs are complex and result from a combination of human activities, such as unprecedented expansion of human settlements and inappropriate land-use practices, as well as the problematic behaviour of certain wildlife species. Managing HWCs and maintaining an acceptable level of coexistence is a difficult task, requiring interdisciplinary technical understanding of these dynamics to be able to design successful strategies and projects, and assemble effective transdisciplinary teams and long-term collaborations (IUCN, 2020).

A.1. Context

A.1.1. Kavango-Zambezi Transfrontier Conservation Area

HWC is one of the most pressing conservation issues across the Kavango-Zambezi Transfrontier Conservation Area (KaZa-TFCA), where a significant number of people live in a wildlife area (see Chapter II). Key findings of an HWC review conducted in 2016 (Karidozo *et al.*, 2016) highlight the following: (i) Common consequences from HWCs include crop destruction, property damage, human and wildlife death or injury; (ii) Problematic species are elephant (*Loxodonta africana*), lion (*Panthera leo*), spotted hyena (*Crocuta crocuta*), Nile crocodile (*Crocodylus niloticus*) and hippopotamus (*Hippopotamus amphibius*); (iii) Traditional mitigation methods are not efficient and sustainable; (iv) There is a general lack of capacity to mitigate HWCs and these are poorly monitored; and (v) Reducing the intensity of HWC demands a holistic approach to address the root causes of it. KaZa-TFCA has a strategy for reducing crop and livestock damage by wildlife encounters which is still not satisfactory to stakeholders. Nonetheless, technical and social issues are working well in some areas, such as Namibia and Botswana, because villagers are getting adequate benefits from their wildlife (Karidozo *et al.*, 2016). In addition, the KaZa-TFCA is considered a hotspot for the circulation of transboundary animal diseases (TADs) such as foot-and-mouth disease (FMD), bovine tuberculosis (BTB), rabies, brucellosis or anthrax among the five countries due to the free circulation of wildlife populations, some of which are reservoirs of infectious pathogens affecting animal or human health.

A.1.2. Zambia

Zambia, as one of the partner countries of KaZa-TFCA, is also experiencing HWC in the form of crop and property damage, and livestock and human attack which sometimes lead to loss of human life. Most HWCs are in settlements expanding around and/or in wildlife dispersal routes (Karidozo *et al.*, 2016). In the terrestrial environment the problem-causing wild animals include elephants, lions, spotted hyenas, vervet monkeys (*Chlorocebus pygerythrus*), chacma baboons (*Papio ursinus griseipes*) and Cape buffaloes (*Syncerus caffer*), while in freshwater environments, they are Nile crocodiles and hippopotamus (Nyirenda *et al.*, 2011; Gross *et al.*, 2019; Tembo *et al.*, 2020). Social impact of HWC includes its influence in the homestead arrangements, where villages tend to cluster for protection and reinforcement against wild animals. Ecological importance of HWC encompasses restriction of wildlife movements and dispersal by countermeasures such as fencing, use of chilli and traditional methods (e.g. chasing, shouting and use of fire) and road kills (Nyirenda *et al.*, 2017). Due to sheer scale and intensity, HWCs also contribute to political issues in wildlife hotspots, such as Luangwa, Kafue and Zambezi (KaZa-TFCA's Zambezi Chobe Dispersal area) landscapes of Zambia. Against the HWCs, Zambia has no compensation policy for the losses directly or indirectly incurred by humans. However, a combination of non-lethal HWC interventions and awareness-raising are encouraged to cushion the vulnerable people and wildlife (Nyirenda *et al.*, 2018).

A.1.3. Zimbabwe

HWCs in Zimbabwe are one of the major challenges facing marginalized communities, especially those living in areas adjacent to protected areas. Human population increases in areas adjacent to protected areas, and the resultant encroachments into protected areas, as well as increasing livestock populations, have been reported to result in increases in HWCs. HWCs are multifaceted as they can directly affect most of the livelihood assets of the communal people. Some of the conflicts include destruction of crops and thatched houses, people getting killed or maimed and loss of livestock. Recognizing the magnitude and frequency of occurrence of HWCs and the livelihood repercussions thereof, the Government of Zimbabwe initiated a Human and Wildlife Policy Development Process led by Zimbabwe Parks and Wildlife Management Authority (ZPWMA). The proposed Policy Statement was that the "livelihoods of rural communities are secure and their well-being is not compromised through coexisting with wildlife". This shall be achieved through striking a balance between the need for developing community livelihoods and conservation of wildlife resources (Zhuwao *et al.*, 2019).

A.2. Key results

The aim is to report on the current state of HWCs in the three CCs, specifying the nature of the conflict, species involved, the impact of HWCs at CC (villages and households) levels, their spatial and temporal specificities, the social perception of HWCs, the strategy and utilized measures for HWC mitigation.

A.2.1. Types of human–wildlife conflict

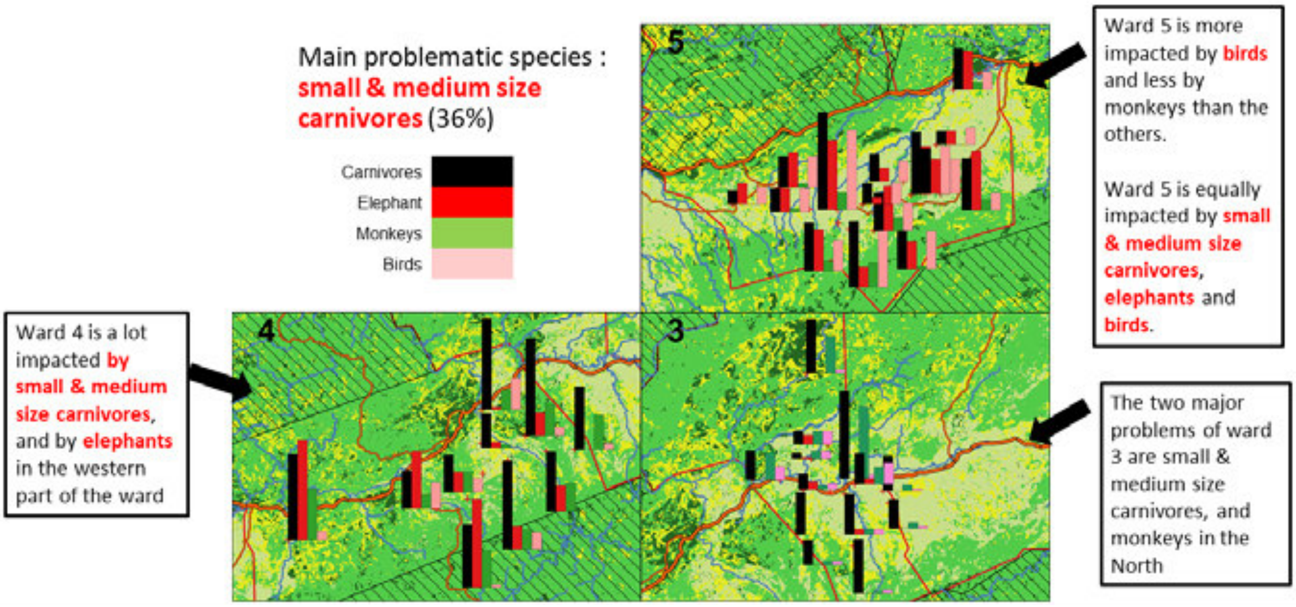
A.2.1.1. Common features

Due to the similarities in landscape and geography, most of the species that frequently come into conflict with humans are common among the three CCs. In particular, conflicts occurring in ICC and SCC are dominated by the same species due to the two conservancies being adjacent to each other and sharing a common geography. Some of the conflict species common to all three conservancies include elephants, hippopotamus, chacma baboons, vervet monkeys, spotted hyenas, leopards, lions, Nile crocodiles and bushpigs (*Potamochoerus larvatus*). Birds such as helmeted guinea fowls (*Numida meleagris*) and red-billed quelea quails (*Quelea quelea*) are also common causes of these conflicts. Herbivores and birds are mainly responsible for crop raiding and damages, whereas carnivores frequently attack domestic animals, incurring huge livelihood losses to the communities living in the three CCs. Moreover, apart from livelihood losses, communities in these conservancies are in constant fear since these animals force them to perceive the presence of wildlife negatively.

A.2.1.2. Mucheni CC (MCC)

Based on the observations made during the survey in 2019, the main impact of HWC at household level remains livestock predation (44 percent), followed by crop destruction (33 percent), fear/ disturbance (17 percent), diseases (4 percent), human casualty (2 percent) and destruction of infrastructure (0.3 percent). The main identified problematic species were small and medium-sized carnivores such as black-backed jackals (*Canis mesomelas*), and spotted hyenas (36 percent), followed by other species such as elephants (15 percent), granivorous birds such as red-billed quelea quails (13 percent), chacma baboons (12 percent), big carnivores such as lions and leopards (10 percent), respectively (Figure IX.1). According to the respondents, conflicts with big carnivores, monkeys, small and medium-sized carnivores and snakes occur year-round with a slightly varying seasonal pattern, whereas birds are mainly a problem from February to June and conflicts with elephants mainly occur from January to June (Le Bel and Usman, 2020).

Figure IX.1: Main problem species and localization in the three wards of MCC reported in 2018 – Information extracted from the household survey conducted in 2019 (*Source:* Authors)



A.2.1.3. Inyasemu CC (ICC)

There is sustained and increasing crop damage by herbivores (elephant, hippopotamus*,* blue wildebeest [*Connochaetes taurinus*]) and monkeys [chacma baboon and vervet monkey]). Other problem animals are bushpigs, common duikers (*Sylvicapra grimmia)*, porcupines (*Hystrix africaeaustralis*), and rats (*Rodentia*). Weavers *(Ploceidae*), guinea fowls, red-billed quelea quails and partridges *(Perdicinae*) are common avian problem species. The crop damage spikes during crop farming season from February to April, exacerbated by damage from birds (Chibesa, 2020).

However, in recent years red locusts (*Nomadacris septemfasciata*) have become more prominent problematic species. Livestock is predated by hyenas, lions, leopards, civets (*Civettictis civetta*), Nile crocodiles and snakes all year round (Nyirenda, 2020).

From the baseline study conducted in 2019, the most adverse effect of the HWCs in the study area was the killing of domestic animals by predators (46 percent), such as the hyenas. The number and type of domestic animals killed by wildlife varies according to the species (which are mostly goats, chickens and on rare occasions calves), time of year (July to April), and availability of natural prey around the villages. Crop damage (37 percent) was also cited as one the most prevalent forms of HWCs across the entire CC proposed area (Banda *et al.*, 2019).

However, various forms of HWCs seem to impact humans in several ways. Among the reported impacts, direct impacts include crop and livestock damage, and occasionally loss of life. Other impacts include property damage, such as damage to infrastructure like water points and houses. Hidden impacts include inducement of fear (12 percent), resulting in opportunity costs and slow performance among school pupils.

A.2.1.4. Simalaha CC (SCC)

There is a slight variation between ICC and SCC. Crop damage is experienced by the same species. Little is reported on predators as problematic species in SCC, with the exception of Nile crocodiles and snakes all year round (Nyirenda, 2020). A full study has yet to be conducted on the impacts of HWC in SCC as well. Although some measures have been promoted, such as wire fencing, there are still some crop damage incidents being reported. Fear of problematic species is among the indirect impacts cited in SCC.

A.2.2. HWC impacts and consequences

A.2.2.1. Common features

HWCs are causing negative impacts by damaging and destroying assets which communities depend on. Due to few available resources, especially during the dry season, humans and wildlife tend to compete for water and food resources. This competition has negative impacts for both humans and wildlife because one or the other get injured or killed in the process. Local communities are also developing a negative perception towards wildlife and conservation because they feel that the benefits of living with wildlife do not outweigh the negative impacts and consequences experienced. Such negative interactions between humans and wildlife have led to a few individuals resorting to violence and seeking revenge by killing wildlife, often killing species that do not have conflicts with humans. This incurs huge problems for conservation of wildlife as well as livelihoods of the communities that have to share the habitat with these animals. Especially in cases where an entire crop field is destroyed overnight by mega-herbivores, such as elephants, or a significant number of livestock are predated by medium and big carnivores, this leads to severe food insecurity for the affected households. In cases where the breadwinner of a household gets injured or killed by wildlife, it can disrupt the entire livelihood dynamic for that household. Hence, even if HWCs are occasional and do not happen every day, once they occur, they can have huge implications for local communities which may last even longer than a year.

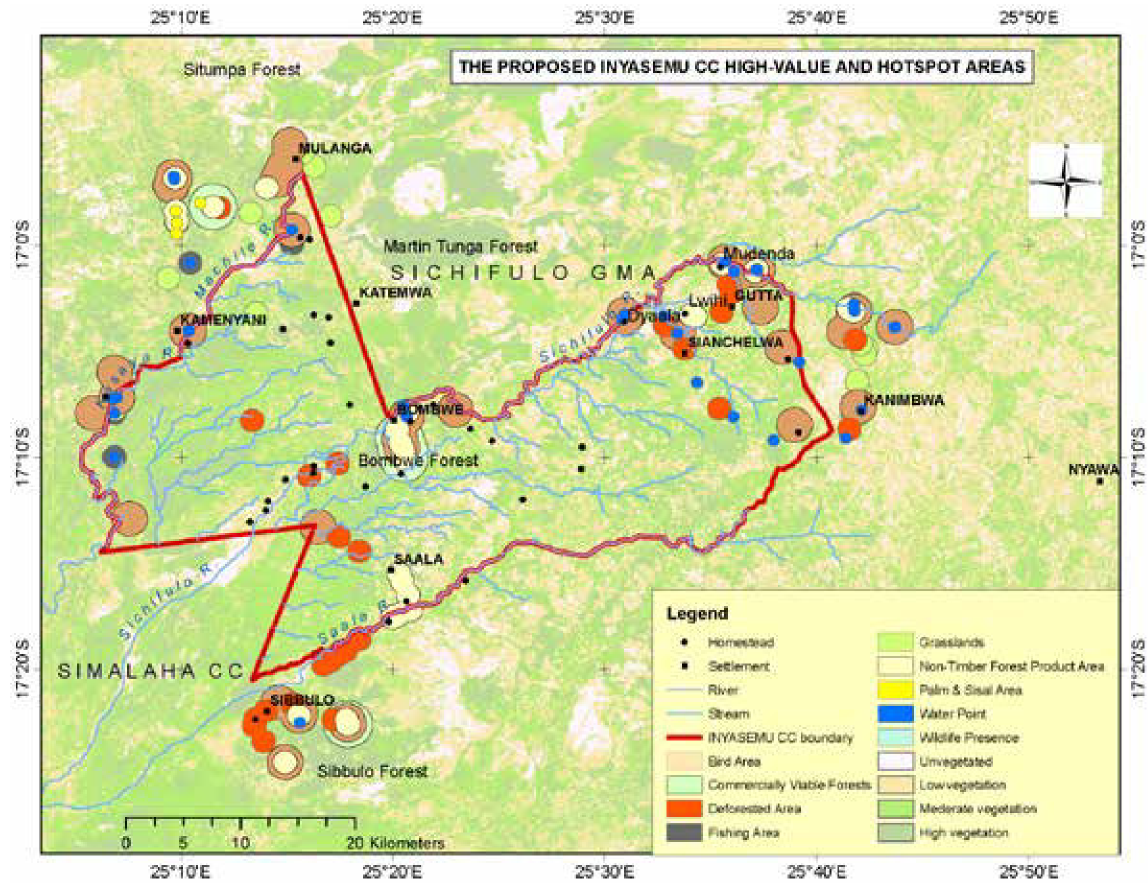
A.2.2.2. Mucheni CC (MCC)

According to the results of the SWM Programme's 2019 household survey, the majority of respondents (95 percent) declared that they have been affected by an HWC event in the last year. Despite HWC incidents being occasional, whenever they occur, they leave a significant impact on the livelihoods of the affected communities. HWC occurs mainly in grazing areas (55 percent), kraals (54 percent), field crops or fallows (48 percent) and homesteads (47 percent). Incidents in forests (31 percent) and near water points (28 percent) are less frequent but can be significant for some species (Le Bel and Usman, 2020). Areas where these conflicts take place depend on the type of animals causing the conflict. For example, conflicts with big carnivores occur mainly close to kraals, grazing areas, homesteads and forests, whereas elephants come into conflict with communities mainly in crop fields and fallows, but also sometimes in the forest and grazing areas. Birds and wild pigs are mainly a problem in crop fields and fallows. Conflicts with monkeys and snakes are widely distributed spatially, so they are a constant threat irrespective of the place.

A.2.2.3. Inyasemu CC (ICC)

All interviewees had experienced at least one form of HWC event in 2019. Such events are not so frequent in the area, but collectively occur on a wide scale. The HWC hotspots in the area are Saala, Bombwe, Sianchelwa and Nyawa (Figure IX.2). The most destructive reported effect of these conflicts is crop and livestock damage, which leads to huge losses for local communities that depend on agriculture for their livelihoods.

Figure IX.2: High value areas and HWC hotspots in the ICC (*Source:* Authors)



On-farm crop damage is usually caused by herbivores and birds, mostly during the crop farming season (February to April). Unprotected dry season gardens situated along perennial streams are also scattered. Rodents incur further damage to stored food throughout the year. Livestock damage by predators such as hyenas also occurs throughout the year, mostly in and close to kraals, grazing areas and forests. Diseases, such as anthrax and African swine fever, are transmitted at the water points, especially during the dry months from September to October (Nyirenda, 2020).

A.2.2.4. Simalaha CC (SCC)

As in ICC, all interviewees had experienced at least one type of HWC incident in 2019. Since SCC is located adjacent to ICC and shares the same landscape and geography, it has a similar pattern of HWC interaction, but with more conflicts, mainly livestock predation, reported along the Zambezi River where there is a high concentration of human activities. Herbivores and birds damage crops from February to April, whereas water points are damaged by various animals searching for water, mainly during the dry season from August to November when water becomes scarce (Nyirenda, 2020).

A.2.3. HWC mitigation framework

A.2.3.1. Common features

To formulate an HWC mitigation strategy[1] for each CC, it is important to consider the distinct characteristics of each of them. A common mitigation strategy cannot be rolled out because expectations of the communities and the local perception towards wildlife can differ significantly from one conservancy to the other. Hence, a participatory approach, respecting Free, Prior and Informed Consent (FPIC) principles, was undertaken in each conservancy with district and local-level stakeholders. Discussions and brainstorming activities were conducted to understand the local needs and context in terms of HWCs. All stakeholders highlighted their expectations and capacities to deal with the HWC issues faced by communities. Formulation of local strategies help set realistic goals and targets that stakeholders can expect to achieve by 2024.

A.2.3.2. Mucheni CC (MCC)

Formulation of the mitigation strategy[1] was a participatory process with representatives from the community (ward and village committees), Binga Rural District Council (BRDC), Forestry Commission, Agricultural Technical and Extension Services (AGRITEX) and Chizarira National Park. The kick-off workshop was organized in Binga, Zimbabwe, from 16 to 19 July 2019. The overall objective of the workshop was to improve coexistence between community and wildlife by the year 2024. As a result of the workshop, the following objectives, and their respective indicators, were developed, which are realistically achievable by 2024 (Mapuvire, 2019):

- reducing crop destruction from 40 percent to 10 percent by promoting conservation agriculture, enabling households to protect their crops effectively and minimizing crop destruction due to proper zoning;
- reducing livestock predation from 4 percent to 2 percent by enabling households to protect their livestock and adopt improved livestock management;

[1] For clarification, mitigating HWC means reducing the impact of HWC by combining: (i) preventive measures to be applied before or after the conflict (reducing risk, increasing social carrying capacity); and (ii) intervention measures to use during the conflict (blocking access, chasing away, removing problem animals).

Figure IX.3: Traditional thorn/pole fencing to prevent the intrusion of carnivores in night bomas (left) and herbivores into crop fields/vegetable gardens (right) (© V. Nyirenda)

- strengthening coordination efforts for HWC prevention;
- reducing wildlife poaching by half with efficient reporting of wildlife-related activities in place and by informing communities about wildlife conservation, HWC and illegal activities.

A.2.3.3. Inyasemu CC (ICC)

The mitigation strategy process was conducted through broad participation by multiple actors, *inter alia,* community representatives. The goal of HWC Management Strategy for ICC emerged as follows (Nyirenda, 2020): "To restore and secure connectivity of viable wildlife populations and maintain habitat integrity across the Inyasemu Community Conservancy in a 10-year period (2021–2031) for better biodiversity conservation and local wildlife-based livelihood benefits". To meet this goal, a proposed strategy that still needs to be approved by the CC stakeholders comprises four objectives:

- safeguarding the local communities and wildlife integrity through effective conservation planning;
- enhancing decision-making by the local communities and their partners through science-based approaches, information management and technology;
- attracting, maintaining and enabling partnerships for more effective HWC management; and
- empowering communities to establish and implement mitigation measures and sustainable livelihoods actions.

A.2.3.4. Simalaha CC (SCC)

A mitigation strategy was also conducted in 2016 through broad participation by multiple actors, *inter alia,* community representatives (i.e. chiefs, indunas and village headmen) under the Sekute Community Trust, Peace Parks Foundation, Department of National Parks and Wildlife, Department of Fisheries, and Forestry Department, within the broad framework of an integrated development plan (Peace Parks Foundation, 2016).

A.2.4. HWC mitigation tools and their monitoring

A.2.4.1. Common features

Mitigation measures applied mainly depend on the type of animal involved in the conflict and the place where it occurs. Currently, most of the measures used are based on traditional knowledge, including:

- chasing away the intruding animal using drums, shouting, fires;
- guarding the fields;
- blocking access to the carnivores by fencing (or ropes).

Wildlife-repelling agricultural practices and land-use planning are rarely applied due to lack of awareness, funding, skills and adequate training. Some individuals also resort to retaliation killing when the animal causes human casualties and when crops are destroyed, or livestock predated.

A.2.4.2. Mucheni CC (MCC)

According to the results of the SWM Programme's 2019 household survey, mitigation measures applied in the MCC are limited to chasing away intruding animals (91 percent) and blocking the access to carnivores (60–64 percent). Adapting existing land use plans and specific agriculture practices remains rare (11–14 percent). Retaliation killing in case of human casualties or crop destruction is considered by more than half of the respondents as a normal practice. When respondents were asked about their opinion about retaliation killing, 53 percent stated that such animals should be killed when they threaten a human being, whereas 55 percent stated that such animals should be killed in case of crop destruction as well, since it seriously impacts the livelihoods of the victim households. To understand the drivers of tolerance as well as local perception about the mitigation of HWC, a pilot study was conducted in Ward 4 of MCC. Based on the results of the study, 85 percent of the respondents claimed that HWC reporting is an issue in their villages and there are instances where these incidents are never reported, especially when the intensity of the conflict is not severe. Moreover, 70 percent of the respondents mentioned that the wildlife authorities either take too long to respond or never respond at all. These percentages highlight the inefficiency of the current HWC reporting and monitoring system, which therefore needs to be improved.

In the neighbouring districts of MCC, forty-eight (48) different tools were reviewed and catalogued to mitigate HWCs. Ways of improving existing tools were identified to simplify their production and utilization. Assessing existing HWC mitigation projects highlighted the importance of promoting better understanding of where to place tools to provide for best long-term protection strategies (La Grange and Bonnici, 2018).

A.2.4.3. Inyasemu CC (ICC)

In the absence of district integrated development plans, as well as general management plans and strategy, mitigation measures are limited: 15 percent of the sample indicated chasing away as the only mitigation measure for problematic animals (e.g. shouting, drumming, use of fires, and human images), while 85 percent indicated that in a matter of life and death, they would kill the animal, and in many cases, authorities are notified. Some respondents report the use of thorn/pole fencing to prevent the intrusion of carnivores in night bomas (Figure IX.3), and protect their crops (Nyirenda, 2020).

Figure IX.4: Example of game fence which is preventing free movement of wildlife (© V. Nyirenda)

A.2.4.4. Simalaha CC (SCC)

The integrated development framework (Peace Parks Foundation, 2016) emphasizes use of multiple solutions to HWCs, which include the use of fence lines (Figure IX.4) and boreholes. However, mitigation measures still widely practised are largely chasing away the problem animals and use of thorn fences to prevent their access. Participants perceive that more should be done by the local communities to better protect their crops, livestock and, more importantly, themselves.

A.3. Way forward

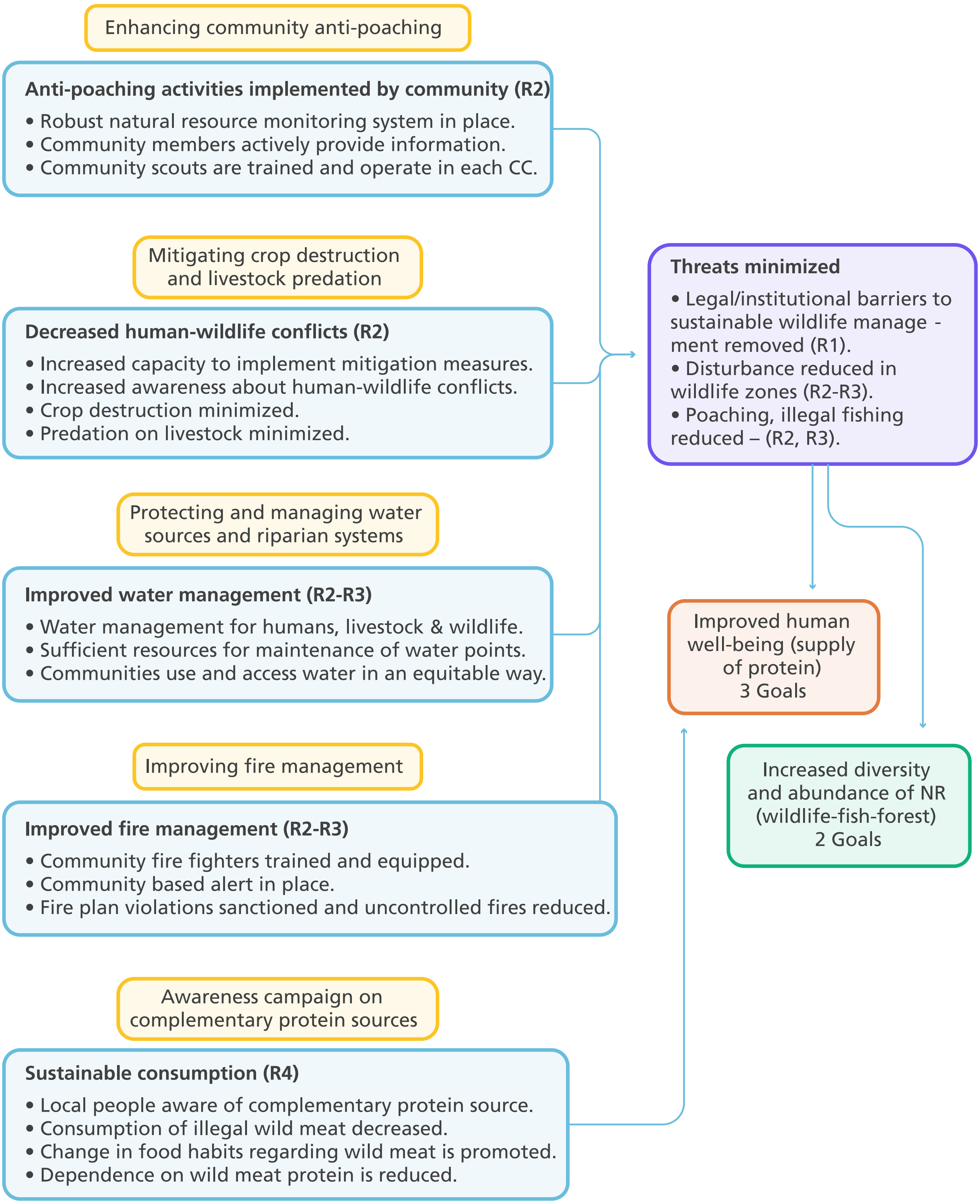
A.3.1. Lessons learned

The baseline surveys conducted in the three CCs confirmed the social and economic footprint of HWCs. As reported in KaZa-TFCA, Zambia and Zimbabwe, HWCs are an ongoing threat to people living side by side with wildlife and also for wild animals being killed in retaliation. Characterized by marked spatial and temporal patterns, HWCs result in significant damage to food crops and livestock. While there is a range of wild species responsible for HWCs, the damage caused by protected species, such as elephants and carnivores, predominates. Unsurprisingly, there are no adequately designed mitigation strategies in place at the local level and the solutions being deployed are few, partially implemented and of little-known effectiveness. The lack of functional information systems limits efforts to understand what are the deep root causes of HWCs, to monitor their seasonal and geographic patterns, and to assess the impact of locally based mitigation strategies and solutions. The socioeconomic cost of HWC is high. Even though the level of tolerance towards wildlife has not been evaluated yet in each CC, the persistence of HWCs appears to be one of the serious constraints, with water, fire management and anti-poaching, to conservation efforts as explained in Chapter III with the KaZa site theory of change. Figure IX.5 provides a focus on HWC.

A.3.2. Recommendations

An HWC mitigation strategy is critical for long-term success in the conservation and management

Figure IX.5: SWM Programme in KaZa theory of change applied to Result 2 displaying the importance of mitigating HWC (*Source:* Authors)



of wildlife. A holistic approach at landscape level that addresses root causes over the long term, as well as short-term mitigation, will pave the way for the CC adoption and development. The recommended objective is to move from a logic of conflict management to a policy of coexistence (Carter and Linnell, 2016) by setting up locally designed platforms for the management of HWCs. The aim is not to eliminate all conflict, but to reduce it to an acceptable level (social tolerance) by taking into consideration the needs and expectations of the affected communities.

At the scale of each CC, the strategy is to propose, organize and promote an intervention frame enabling: (i) the analysis of HWCs at CBOs/village levels to establish a diagnosis of the situation; (ii) the co-construction with local players of mitigation strategy built on traditional knowledge; (iii) the implementation of mitigation measures through the access of smart tools, measures or solutions with ad hoc trainings for capacity building; and (iv) the facilitation of a monitoring system, allowing a collaborative learning process for adaptive management.

To achieve this, an HWC platform (HWC-P) will be set up for each CC. Designed for usefulness and adaptability, the HWC-P aims to address and articulate at the same time the needs of the manager in charge of conservation issues and of addressing the political burdens of HWCs and those of individuals or CBOs who are supporting the costs of living with wildlife. Such a sociotechnical device will ease the access to user-friendly mitigation solutions through an application (E-toolkit), facilitate its use by local communities in the light of legal and institutional frameworks, and improve the local capacity of adaptive management through information services being generated by the HWC-P. Three steps should be articulated in a timely manner as described below.

A.3.2.1. Understanding the needs and expectations of the targeted audiences

Moving from addressing conflicts to promoting coexistence demands launching a process of behaviour changes supported by a smart communication strategy. In line with this, an initial analysis of stakeholders' expectations, information needs but also contributions to HWC mitigation, is paramount. The following feedback from a consultation process in MCC (Mapuvire, 2019) gives an idea of the diversity of stakeholders to be involved and their expectations and needs.

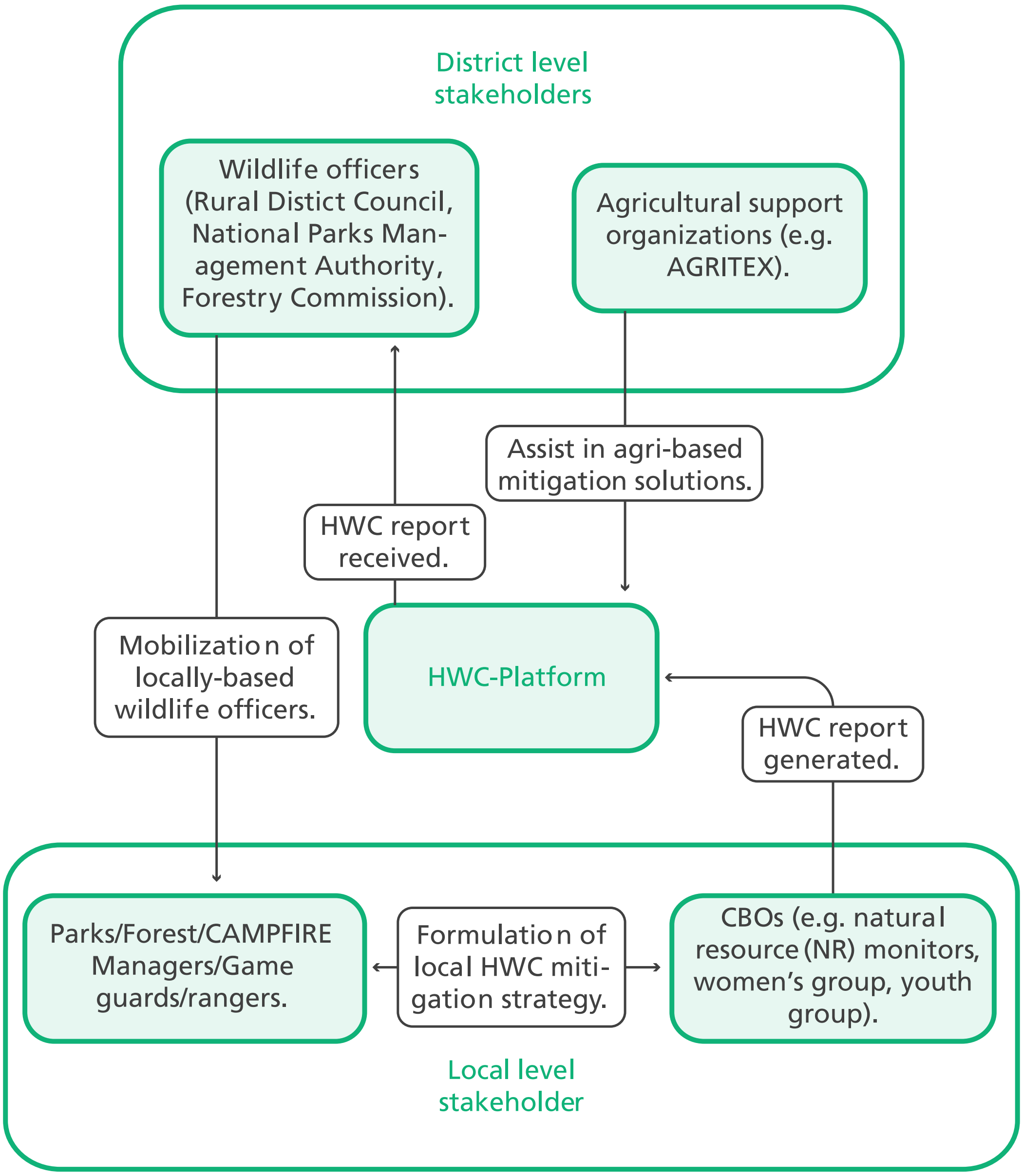
<u>At district level:</u> District Council (Zambia), Rural District Council (Zimbabwe), Parks and Wildlife Management Authority: ZimParks (Zimbabwe), Department of National Parks and Wildlife (Zambia), Forestry Commission (Zimbabwe), Forestry Department (Zambia), conservation organizations, Environmental Management Agency, agricultural support organizations, etc.

- Expectations: fewer complaints, improved reporting, better land-use planning, reduced poaching, less encroachment, reduced deforestation, improved coordination, increased awareness, HWC resistant crops
- Information needs: improved reporting and decision-making, identification of hotspots, HWC-related information sharing

<u>At local level</u>: traditional/local leaders, women's groups, ward councillors/chiefs, ward/village committees, community/villagers, RDC rangers (BRDC substations), game guards, youth groups.

- Expectations: less damage from HWC, women's participation, improved wildlife management, fewer complaints, reduced poaching, youth participation, training for wildlife management

Figure IX.6: Flow of information between decision-makers and the concerned community members via the HWC-P (*Source:* Authors)



- Information needs: HWC mitigation solutions

A.3.2.2. Establishing an operational framework for locally based mitigation strategies

The conceptual design of the HWC-P is a hub facilitating the flow of information between decision-makers and the concerned community members (Figure IX.6) once the roles and responsibilities for each stakeholder have been defined with reference to their needs and expected contributions to the HWC platform. The platform will build local capacities to deal with HWC incidents on their own; wildlife officers will collaborate with the locally-appointed natural resources (NR) monitors and other concerned members of CBOs to design and implement HWC mitigation strategies best suited to the local scenario. Moreover, the role of traditional and political leaders is pivotal to influencing the local communities to play their part in formulation of the HWC strategy.

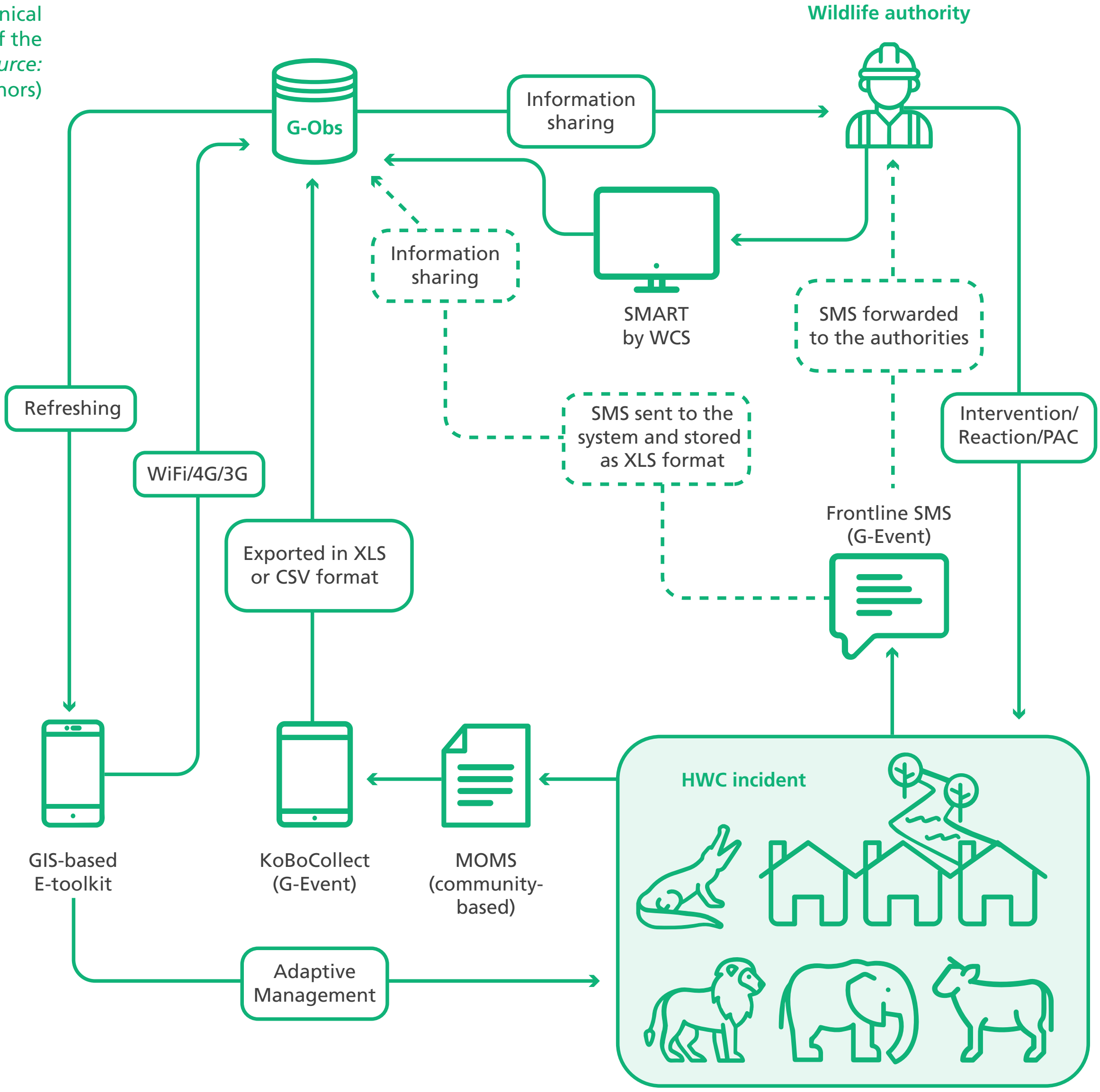


Figure IX.7: Technical architecture of the HWC-P (*Source:* Authors)

Whenever an HWC incident occurs, NR monitors appointed by CBOs will report the incident to the HWC-P using existing or newly developed tools/channels (Figures IX.6 and IX.7). Upon receiving the complaint, district level wildlife authorities will mobilize local-level wildlife officers to report on the site where the HWC incident occurred. Wildlife officers will then collaborate with NR monitors and other concerned members of CBOs to decide on locally based HWC mitigation solutions to be applied. Over time, with more and more HWC incident reporting and interventions, the existing/ foreseen locally designed HWC mitigation strategy will be adjusted/formulated, the implementation for which the local communities are responsible. If a lethal action (problem animal control) is required to eliminate a dangerous animal, the decision is to be taken by the wildlife authorities.

A.3.2.3. Operationalizing new and existing tools for an operational adaptive management system

The technical architecture of the HWC-P shows how the key stakeholders using different tools

Figure IX.8: Examples of bomas promoted in MCC to protect livestock from predators: semi-permanent boma designed for mixed herds (left) and small mobile boma for small herds (right) (© M. La Grange)

will be responsible for establishing a feedback loop for sharing information about HWC incidents and providing adequate solutions to reduce the impact of HWC at CBO levels (Figure IX.7). Three categories of tools will be utilized:

- **Informing decision-makers**: when a conflict occurs, an alert system (such as Frontline SMS or WhatsApp) will first alert decision-makers in a timely manner. Other data collection systems, either paper-based such as MOMS or electronic-based such as SMART or KoBoCollect, facilitate the procedures to collect and manage data resulting from the observation of HWC (Le Bel *et al.,* 2016).
- **Receiving, storing and transforming data flows into information services**: a new-design web interface G-Obs built on QGIS and LizMAP open-source softwares will package the information requested by the different categories of stakeholders (each service having its

Table IX.1: List of preventive and intervention measures according to the targets and objectives of intervention (*Source:* Authors)

Targets and objectives of intervention	Preventive measures		Intervention measures		
	Reducing risks	Increasing Social Carrying Capacity	Blocking Access	Chasing Away	Removing Problem Animal
Human involvement					
Increase tolerance		Compensation Insurance Lion guardian Moral incentives	All fences		
Values and perceptions of wildlife		Education tools Sharing experience			
Wildlife behavioural understanding		Tracker School programme			
Food security & Livelihoods	Alternative crop Livestock husbandry	Herding project Infrastructure Insurance	All fences		
Safety issues and health	Mobile phone Watchtower	GPS collaring	All fences Guard dogs		Problem animal control Translocation Trapping
Well-being and social costs		Moral incentives			
Political issues		Mediation Moral incentives			Problem animal control
Alert	Mobile phone Watchtower			Cow bell	
Management & Implementation	Mobile phone communication	Herding Project Learner professional hunter Lion guardian Mediation	Virtual fencing		
Wildlife conservation					
Decrease attractiveness of the environment for wildlife	Alternative crops Zoning		Removing carcasses		
Decreasing pressure on wildlife	Zoning	Understanding animal behaviour	Virtual fencing		Translocation
Wildlife management	Mobile phone	GPS collaring Trackers Understanding animal behaviour	Virtual fencing		Management quota Translocation Problem animal control
Crop protection					
Protect crop		Learner professional hunter	Guard dogs Fences Bee Fences Chili strings	Chili tools Noisemakers Lights Motorised crew	Translocation
Reduce attractiveness	Alternative crops Zoning		Granaries Virtual fencing		
Livestock protection					
Protect livestock		Community Herding Project Lion guardian	Guard dogs All fences Predator lights Mobile boma	Lights Noises Torches	Translocation
Reduce attractiveness	Zoning Husbandry				
Properties, housing & equipment protection					
Protect housing & equipment			All fences Loosing rocks Trenches	Chili tools Lights Noises	Translocation
Reduce attractiveness of housing & equipment	Zoning		Virtual fencing		

own clients).

- **Choosing adequate mitigation measures**: G-event, a newly designed application for smartphone or tablet, will function as a decision support system. When activated by a wildlife expert, G-event will make it possible: (i) to establish a quick diagnosis of the local HWC context by recording all recent HWC events and to position them on a map; (ii) to select the most appropriate solutions from a list of tools grouped in two categories of measures: preventive measures to be applied before or after the conflict (reducing risk, increasing social carrying capacity) and intervention measures to use during the conflict (blocking access such as bomas (Figure IX.8), chasing away, removing problem animals) (Table IX.1).

B. Animal and human health

Community conservancies targeted by the SWM Programme in KaZa are part of the KaZa-TFCA. As such, they are more likely to be exposed to transboundary animal diseases (TADs) and their pathogens from neighbouring countries due to the lack of harmonization between different disease surveillance systems. Additionally, TFCAs face increased opportunities for transmission of pathogens among wildlife, livestock and human populations, if they come across susceptible or naive populations (Thomson *et al.*, 2013).

The identification of activities to address this challenge was considered in the programme document (R2.3.A1: Assessment of the relevant risks for humans and livestock linked to wildlife and fish utilization). The first activity considered was to perform an inventory of the ongoing knowledge and activities in terms of surveillance of pathogens circulating at the wildlife–livestock–human interface (WLHI). Indeed, a considerable number of research activities in this field have been developed over the last 30 years by CIRAD within the framework of the Research Platform – Production and Conservation in Partnership (RP-PCP). Unfortunately, no activities could be initiated in Year 2 of the SWM Programme in KaZa due to the COVID-19 situation. This diagnostic phase of the health situation is still planned for 2021–2022.

Materials and methods

In order to propose recommendations and innovative approaches to improve monitoring, prevention and response capacity to health risks circulating at the wildlife–livestock–human interface in the three CCs, two complementary steps have been followed:

- an analysis of previous literature and data available in order to establish baseline information on unselected wildlife-borne pathogens affecting human or animal health in the three CCs. Because this information is rather scarce, information from other surveys implemented in areas in close proximity, such as the interface of the Kafue Basin Ecosystem (KBE) or the wildlife–livestock interface of protected areas in proximity (e.g. Hwange National Park), have also been included.
- an identification of the highlights and main knowledge gaps in the three CCs on the basis of the available published information.

The following section provides an overview of current knowledge on the circulation of pathogens at the WLHI and the surveillance systems in place. It will also suggest some recommendations to establish monitoring surveillance strategies in order to develop baseline reference data on the circulation of selected zoonotic or production-limiting diseases in the areas of the SWM Programme in KaZa. The ultimate goal of this section is to develop surveillance systems to monitor the circulation of pathogens from wildlife affecting human and animal health, in order to detect potential emerging pathogens that can affect the health of local communities and domestic animal populations on which they depend for their livelihoods.

B.1. Available knowledge on pathogen circulation at the WLHI

Management of diseases (including zoonoses that are transmissible between animals, mostly wildlife, and people) in the KaZa area are a concern for public health, economic and conservation reasons. CIRAD, through its research partners in Zimbabwe and the region, has been studying the circulation of several infectious diseases such as anthrax, FMD, tick-borne diseases (TBD) and BTB at the WLHI in the KaZa-TFCA for more than 20 years, and has produced an enormous amount of information on this topic. These studies provide instrumental background knowledge for the identification of animal health and disease risk challenges in order to design future pathogen monitoring activities and associated mitigation measures.

B.1.1. Available information on pathogen circulation

The site area of the SWM Programme in KaZa is characterized by a mosaic of wildlife conservation areas and rural communities living from livestock production, which generates multiple situations of cohabitation of humans, livestock and wildlife. As a result, the area is susceptible to host a wide range of emerging and re-emerging zoonotic diseases that have posed complex conservation, agroecological, anthropological, socioeconomic as well as public health challenges. Some of these diseases have been identified because they are easily detectable due to high mortalities or specific clinical signs in rural communities or their livestock. For instance, anthrax outbreaks occur regularly and almost annually during peak dry seasons, extending into the rainy season in the outskirts of the site of the SWM Programme in KaZa, causing repeated epidemics in cattle, wildlife and humans with serious ecoanthropological footprints. Rabies viruses maintained by wild carnivores such as banded mongoose (*Mungos mungo*), African wild dog (*Lycaon pictus*), spotted hyena (*Crocuta crocuta*) or several jackals (*Canis adustus, C. mesomelas*) often interact with non-vaccinated domestic dogs. As a result, human cases of rabies in that region are common and on the increase, especially in children. BTB is another endemic and classic zoonotic disease that has persisted in the Kafue ecosystem (Tembo *et al.*, 2020). The disease has since spilt over to humans from wildlife and livestock. In addition, some transboundary animal diseases with high impact on livestock health and productivity, such as FMD, African swine fever, BTB or avian influenza are of concern in the transboundary area of KaZa (Jori *et al.*, 2013; Brito *et al.*, 2016).

B.1.2. Diagnostic capacity

The University of Zambia (UNZA), through the School of Veterinary Medicine, is well equipped to diagnose novel, emerging, re-emerging and zoonotic diseases using modern molecular sequencing methods. This laboratory has recently been involved in the diagnosis and nationwide surveillance of COVID-19, Ebola virus, anthrax and bubonic plague. The availability of multi-pathogen molecular sequencing is an important asset on the Zambian side regarding the capacity of diagnostic methods for wildlife species.

Despite limited diagnostic capacity in Zimbabwe, the Victoria Falls Wildlife Trust laboratory is currently operating in the site area of the SWM Programme in KaZa and monitoring wildlife cases in close collaboration with the Central Veterinary Laboratory in Harare. Other diagnostic and surveillance platforms by a consortium of scientific cooperation partnerships initiated by CIRAD in Zimbabwe and the region are collaborating with the National Veterinary Services (including the Victoria Falls Wildlife Trust laboratory) and UNZA at the School of Veterinary Medicine. Additionally, CIRAD through its RP-PCP programme is facilitating the development of a biomolecular diagnostic platform to strengthen the molecular diagnostic capacity at veterinary faculties in both Zambia and Zimbabwe for wildlife diseases.

B.2. Identified gaps and lessons learned

B.2.1. Identified gaps

The following gaps were identified:

- Despite an important amount of research being conducted on disease over the years through international partnerships, there is no information on this topic referring to the three CCs of the SWM Programme in KaZa.
- In addition, the situation in the three CCs is likely to change due to increasing human and livestock population growth or plans to boost wild ungulate numbers for management purposes. Therefore, it requires the establishment of a local and specific disease information collection system to monitor those future changes.
- Surveillance data collected in other parts of the KaZa-TFCA is based mostly on short-term studies and biased towards pathogens affecting domestic animals or humans (See BTB, TBD or FMD). However, this is only the tip of the iceberg from a large panel of diseases that can circulate at the WLHI (Magwedere *et al.*, 2012), affecting wildlife or livestock production and human health.
- Specific wildlife disease surveys are extremely rare, mainly due to the high financial costs of large-scale wildlife capture operations and the challenges of collecting and conserving biological material in remote areas.
- Additionally, available traditional disease diagnostic methods have been, to date, pathogen-specific and required invasive techniques to extract the appropriate biological sample to detect a single specific pathogen or its related antibodies.
- The reporting and data collection system is largely paper-based and often takes several days to reach decision-makers and to send a team to the field for an outbreak investigation. This implies a slow response capacity to potential emerging zoonotic disease outbreaks.
- Official links and information channels among livestock veterinary services, wildlife management units and public health services in the field for the management of disease outbreaks such as rabies, anthrax or BTB are almost non-existent.

B.2.2. Lessons learned and opportunities for improvement

There is a tradition in the area of community-based management activities. Local communities are the first to detect disease events in free-ranging grazing areas. In addition, basic livestock support infrastructures (sale pens, dip tanks) will be developed in the three CCs where associations will be organized around livestock dipping activities. Those communities can play a role in reporting health events in free-ranging animal populations and in control activities such as vaccination of domestic animals.

The presence of the RP-PCP with an ongoing collaboration between veterinary faculties in Zambia and Zimbabwe provides the SWM Programme sites in KaZa with well-equipped laboratories and excellent capacities based on modern molecular technologies such as metagenomics. This allows the possibility of monitoring the presence of multiple pathogens out of one single animal or environmental sample but also to inform on the potential transmission dynamics of pathogens between individuals and locations (Gardy and Loman, 2018).

Mobile phone reporting systems are efficient and applicable methods of animal health surveillance and early warning systems even in remote and resource-limited settings (Robertson *et al*., 2010). Considering that this kind of approach is being developed within the three CCs for reporting HWC, the application of the same technology to disease monitoring could tremendously reduce the time for information transmission, decision-making and response capacity in the field.

Hunting camps and safari activities currently present, or planned, in the three CCs, offer the possibility of having access to regular wildlife samples. If some safari rangers or hunting camp staff are trained properly, they could provide a good source of biological material for pathogen monitoring at very low cost.

Nowadays, biological samples for pathogen monitoring can easily be collected through the use of Flinders Technology Associates (FTA) cards or filter papers. This method can be implemented in the field with very limited training and the collected material can easily be preserved at room temperature for several days. This procedure facilitates the collection and preservation of biological samples in the field in order to monitor pathogen circulation in a host population of animals or humans.

B.3. Way forward

The promotion of sustainable wildlife management activities in the SWM Programme site in KaZa requires an effective strategy to address the possible health risks induced by the expected increased interactions between humans and wild and domestic animal populations. This strategy needs to be "community centred" as well as based on a "multisectoral One Health" approach that considers wildlife, livestock, environmental and public health. The overarching objectives of this approach should include, but not be limited to, the following:

- Develop a strategy to detect, prevent and respond to outbreaks of emerging zoonotic and production limiting diseases at the WLHI.
- Enhance the participation of local stakeholders in the reporting and monitoring of health events affecting animals (domestic and wild) or communities.
- Organize training courses to facilitate the adoption and utilization of data monitoring and collection tools across the multidisciplinary surveillance network, community level inclusive.
- Promote the development of a multidisciplinary "One Health" network of communication including research partners, environmental sector, national animal health and public health facilities as well as the local communities of stakeholders.

B.3.1. Development of an innovative surveillance system to monitor wildlife and domestic borne disease risk at the WLHI

It is recommended that a modern and efficient surveillance system for wildlife and domestic borne disease risks be developed by combining genomic diagnostics and epidemiology with innovative real-time digital disease detection and reporting tools. This system will be supported by a multisectoral team of experts from different fields in the "One Health" sphere as key technical advisors in the implementation of the programme.

B.3.1.1. In wildlife

Some of the wildlife extractive activities planned in the three CCs (see sport hunting, Chapter V) can provide the basis to launch wildlife health surveys on exploited wildlife populations. Considering the financial and logistic challenges to sampling wildlife species, this approach can allow the sampling of wildlife populations at a reduced cost.

- Biological material such as blood, serum, tissues and organs can be collected from:
    - Animals culled by problem animal control (PAC) patrols, such as big herbivores (elephants, buffaloes), primates (chacma baboon, vervet monkey), carnivores (hyena, lion, leopard, civet cats), hippos and crocodiles.
    - Hunting activities implemented in hunting camps, for instance in Chete Safari area, can allow the collection of biological samples (blood, sera, tissues, swabs and FTA cards) from wildlife species hunted as trophies, such as ungulates (buffalo, bushbuck (*Tragelaphus scriptus*), impala (*Aepyceros melampus*), bushpig, greater kudu (*Tragelaphus strepsiceros*), duiker, warthog (*Phacochoerus africanus*), giraffe (*Giraffa angolensis*), plains zebra (*Equus quagga burchellii*) or to a lesser extent carnivores (lion, leopard, hyena) or some bird species.
- Blood samples can be opportunistically collected from wild animals immobilized or captured for the purpose of clinical interventions, ecological studies or translocations of game between areas. For instance, the SWM Programme in KaZa is considering the reintroduction of some plains game to boost wildlife populations in some areas of the programme. It will be necessary to sample those individuals before releasing them to make sure they are not carrying pathogens that could affect livestock and public health.

The goal is to select sample collection protocols that optimize the isolation of targeted and non-targeted pathogens. The analysis will explore a variety of sampling methods (e.g. different FTA cards and swabs) and will use different sample types (e.g. tissue samples, swabs from different body sites, FTA cards with blood or saliva) that will be tested with different metagenomics diagnostic tools to identify the most optimal performances.

Whenever possible, innovative non-invasive techniques to collect wildlife samples can be deployed in game management areas to collect saliva, faeces, water, soil and other samples for pathogen detection (Khomenko *et al.*, 2013). For some diseases, the surveillance system can be made more efficient if part of the sample preparation and processing can be decentralized to provincial laboratories in the KaZa-TFCA region.

B.3.1.2. In domestic animals

The surveillance strategy in domestic animals can be based on passive surveillance if some veterinary surveys are implemented for national animal disease surveillance programmes. In addition, some active surveillance surveys of certain zoonotic diseases particularly relevant from the public health perspective can be organized in order to have an overview of animal-borne diseases. Where necessary, comprehensive and sustained parallel-surveillance systems of wildlife can be implemented in livestock species adjacent to protected areas that share common pool resources such as water and grazing land. These will be indicative of any possible active disease transmission within that ecosystem and will be key in acting as early warning systems.

In this respect, animals reared at the wildlife–livestock interface provide the best target group for assessing spillover of infections which could potentially reach humans. Veterinary surveys in populations exposed to wildlife (sentinel populations), including ruminant species but also domestic dogs, can provide a good indication of what might be circulating in wildlife species, at a lower cost. Similarly, surveillance campaigns should be targeting those areas and periods with higher risk for certain disease events. The dry season, for instance, is prone to an increase in interactions between domestic and wild ruminants at water points.

B.3.2. Involvement of key stakeholders and local communities in an integrated disease surveillance system

Some stakeholder categories are privileged observers of events related to wildlife populations or wildlife–livestock interactions (game wardens, hunters, animal control patrols, traditional herdsmen). The development of awareness campaigns and involvement of these key informants is instrumental to identify disease problems at an early stage and respond quickly to a disease event. They could then serve as focal points in their community for the exchange of information with the official human and animal health services. Similar key informants could be identified and trained in hunting camps, for instance to report abnormal events and collect samples in case specific disease surveys are organized in wildlife populations.

Training of selected key informants will be organized within the communities to engage their participation in disease surveillance and reporting of abnormal disease events. This is particularly relevant for early detection of outbreaks of epidemic zoonosis such as anthrax, rabies, Rift Valley fever, Animal or Human Trypanosomiasis or Crimean-Congo haemorrhagic fever, for instance.

B.3.3. Provision of a strategy of data collection, storage and information flow related to animal health, disease management and diagnostic sampling and testing

At local level, the project will contribute to identifying persons acting as focal points and to building capacity within different structures to be involved in the opportunistic sampling and data collection processes at the level of hunting camps, village/community level, PAC patrols and local representatives of the veterinary services. Equally, the project will work to strengthen the capacity of local health structures in order to facilitate their contribution in the process of data collection, sample transmission, reporting and communicating health information. Short training workshops will be organized in the fields of biological samples collection (FTA cards, tissues, blood) and data collection through the use of smartphones or tablets. These will be accompanied by the organization of capacity building workshops to facilitate monitoring and collection of samples and health information, the development of national epidemiological networks and the application of epidemiological tools for better detection and monitoring of diseases.

The presence of public health risks in wildlife suggests a need to collate data to build up an integrated veterinary and public health database that allows for the timely exchange of information with the public health, veterinary and wildlife authorities. Such a system will allow for rapid and coordinated response, should some emerging health threats be detected. This is timely given that most of these zoonotic diseases are neglected and there are no control programmes in place for their surveillance and reporting.

To a greater degree, field data collection and flow should prioritize real-time mobile phone animal and human health data collection systems which offer significant benefits in terms of timeliness of disease reporting and improved data integrity. This method based on the use of open-source software KoBoToolbox (KoBoToolbox, 2020) is already being used in the collection of HWC incidents and should be prioritized. This field data collection system will allow the storage of health information in real time in a centralized database available to different partners of the project in order to improve detection, response and control of zoonotic pathogens.

B.3.4. Support of implementation of risk mitigation strategies among animal populations and exposed stakeholders

In the long term, based on the results obtained from the surveillance system, the project will establish a risk control and mitigation strategy in collaboration with the veterinary services in the area. These can include the following aspects.

B.3.4.1. Awareness campaigns on preventive measures against potential zoonotic risks

The stakeholders most exposed to domestic and wild animal contact (herders, game harvesting teams, wildlife management patrols) will receive training on preventive hygiene practices and follow awareness campaigns against major zoonotic pathogens circulating in the area, so that they can contribute to the detection of abnormal morbidity and mortality events in wildlife populations.

Similarly, local human health officials at ward level will be trained on the management of zoonotic disease outbreak response.

B.3.4.2. Support to vaccination campaigns of exposed communities and domestic animals

The project can prevent the occurrence of some recurrent outbreaks of wildlife-borne diseases in domestic animals (such as rabies, anthrax, FMD, avian influenza), by facilitating vaccination campaigns of domestic animals. This can be done through the participation in vaccination awareness campaigns among rural communities, the facilitation of cold rooms for vaccine storage, or by engaging the dip tank livestock associations in the vaccination campaigns.

C. Recommendations to pool resources in order to jointly address HWC and One Health challenges

Both HWC and health challenges at the WLHI negatively impact the human population's standard of living and conservation effort as described in the global theory of change (See Chapter III). Attempts to mitigate HWC or disease outbreaks require the involvement of individuals or directly concerned CBOs. To achieve this, the project team suggests the implementation of a pilot surveillance system based on collection of field samples from wildlife and livestock and the mobilization of community members selected by CBOs and trained by the official authorities (health and wildlife sectors). Those NR monitors will operate in the front line of any HWC or disease event by helping to source, in a timely manner, the information and samples that decision-makers need.

Figure IX.9 explains how both surveillance systems can operate by mobilizing the same human resource, the same tool to facilitate the flow of information, and the same information system to produce information services in order to guide practitioners on the best measures to apply. Table IX.2 below shows how the surveillance system will work step by step.

- Step 1: Incidents occur and are acknowledged by the concerned community members.
- Step 2: Trained NRMs alert the concerned authorities.
- Step 3: Data areuploaded and stored in the database; in parallel, sampling exercise is conducted for disease investigation.
- Step 4: Information is generated and displayed to the respective decision-makers.
- Step 5: Action is taken on the ground.

Table IX.2: Step-by-step process for the combined surveillance system (*Source:* Authors)

	Human–wildlife conflict	Disease outbreak
1	HWC incident occurs and the NRM is informed.	Wildlife/livestock mortalities or disease are reported to NRM by CBOs.
2	NRM reports the HWC incident using SMS or WhatsApp and records it using G-Events/KoBoCollect/MOMS.	NRM reports the event to health authorities using SMS or WhatsApp and records it using G-Events/KoBoCollect/MOMS.
3	SMS/Report is received and saved in the database.	Local health authorities or NRM take samples and send them to the laboratory. SMS/Report is received and saved in the database.
4	Central database then automatically generates information as requested by the respective clients.	Outbreak is confirmed by the laboratory. Confirmation report is sent and saved in the database.
5	Regulatory authorities work in collaboration with CBOs to develop HWC mitigation strategies and implement relevant measures.	Awareness campaign and adequate outbreak response is organized with health authorities to prevent spread and protect stakeholders.

Figure IX.9: Suggested combined community-based surveillance system for HWC & diseases outbreaks (*Source:* Authors)