

# Urban human-elephant conflict in Zimbabwe: a case study of the mitigation endeavour

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## Abstract

With the expansion of urbanization, urban cases of human-wildlife conflict are increasing worldwide. Africa's population, currently at 1.3 billion, is expected to reach 4 billion by 2100<sup>1</sup>. In this context, human-elephant interactions are expected to increase. Cases of urban elephant conflicts remain poorly documented, although they do exist. In November 2014, the Chirundu Elephant Programme launched an elephant education protocol involving the use of a chilli pepper gas dispenser to deter elephants as an alternative solution to the killing of elephants found scavenging in towns and seen to be a problem. As attempts at deterrence were recorded, the opportunity arose to document an urban case of elephant conflict and its underlying social drivers. From 1 November 2014 to 3 October 2015, elephants were deterred from entering Chirundu, by a team operating on the ground. Results from a soft-systems analysis showed that only a few bulls were responsible for most of the incursions. The elephants fed at any opportunity and displayed enough behavioural flexibility and innovative behaviours to thrive in an urban setting. A lack of environmental awareness and the complete absence of waste disposal systems, combined with the crumbling infrastructure, largely encouraged the conflict situation, maintaining negative attitudes and low elephant acceptance among locals. Elephants have been effectively chased away, and better town planning, environmental education and human involvement in resolving the human-elephant conflict problem were encouraged, so as to increase tolerance to wildlife. As the population of towns are expected to "mushroom" in the coming decades, many emerging in traditional elephant migratory routes and rangelands, the effective methods of non-lethal management need to be developed.

**Additional keywords:** non-lethal management

## Résumé

L'urbanisation progressive des habitats naturels entraîne une multiplication des cas urbains de conflits homme-faune, dans le monde entier. La population africaine, avoisinant actuellement les 1,3 milliard d'habitants, devrait atteindre 4 milliards d'ici 2100. Dans un tel contexte, la fréquence des interactions homme-éléphant pourrait augmenter. Très peu de conflits urbains impliquant les éléphants ont été à ce jour documentés. En alternative à l'abattage des éléphants à problème à Chirundu, l'équipe du Chirundu Elephant Program mène depuis Novembre 2014 un protocole d'atténuation des conflits homme-éléphant en utilisant la version manuelle du propulseur de piment. Ses rapports réguliers ont permis de documenter ce cas de conflit et d'en cibler les dynamiques sociales. Du 1er novembre 2014 au 31 octobre 2015, chaque intervention a été documentée. Les résultats montrent qu'un faible nombre d'éléphants mâles furent responsables de la plupart des intrusions enregistrées toute l'année. Attirés par toute source de nourriture accessible, ces derniers ont montré une flexibilité et une capacité d'innovation comportementales permettant leur adaptation à la

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<sup>1</sup><https://www.theglobalist.com/africa-population-fertility-rate/>

vie urbaine. Un manque de conscience environnementale, de gestion des déchets ainsi que la présence d'infrastructures vulnérables ont largement favorisé cette situation, maintenant les attitudes négatives et le faible niveau d'acceptation des éléphants par les habitants. Les éléphants furent efficacement chassés par le propulseur de piment, et une nette amélioration de la gestion urbaine, la mise en place d'activités de sensibilisation à l'environnement, et la participation des habitants dans la résolution du problème ont été encouragés, afin d'accroître leur tolérance envers les éléphants. Le développement des villes, dans les décennies à venir, se feront dans de nombreux endroits au milieu des voies migratoires traditionnelles des éléphants. Les méthodes efficaces de gestion non létale doivent être développées.

**Mots-clés supplémentaires:** gestion non létale

## Introduction

Human-wildlife conflict (HWC) refers to “*any interaction between humans and wildlife that results in negative impacts on human social, economic or cultural life, on the conservation of wildlife populations or on the environment*” (WWF 2005). As urban and suburban areas expand across the globe, an increasing number of urban cases of HWC are being reported worldwide (Clark 1994; Lyons 2005; Teixeira et al. 2016).

In Africa, with rapidly expanding urbanization, the number of cases of urban HWC is expected to increase. To our knowledge, urban conflicts involving elephants remain poorly documented in Africa. In Kariba Town, Zimbabwe, which has encroached in the middle of an animal sanctuary, elephants (*Loxodonta Africana*) have been reported to cross residential areas, destroying properties and sometimes killing people, often leading to retaliatory killings by local people (Mhlanga 2001; Svatwa et al. 2007). This is also the case in Chirundu, a small town located on the eastern banks of the Zambezi River. With an average of 200 trucks travelling through the border post each day, Chirundu is a very active location with services provided for truckers' and passengers' needs (fast food outlets, truck and car washes, kiosks selling basic necessities, etc.). A great deal of rubbish is dumped all over the town, which is attracting elephants. Over the last 15 years, the Zimbabwe Parks and Wildlife Management Authority (ZPWMA) shot and killed the most problematic bulls, temporarily alleviating the problem. This has not, however, solved the problem in the long term for either humans or elephants.

The concept of urban ecology raises the

need to understand how urban landscapes affect the dynamics and behaviour of wildlife populations and to mitigate the problems caused by wildlife in these areas, or by humans spreading into traditional wildlife areas. Wild species and individuals respond differently to urbanization, according to their ability to thrive in disturbed environments (Fischer et al. 2015; McKinney 2002).

In October 2014, the necessity arose to solve the problem of three elephants responsible for daily conflict incidents in Chirundu town. Instead of killing or removing them, an alternative approach was taken locally with the support of the Chirundu Elephant Programme<sup>2</sup> by chasing away undesired elephants using a chilli pepper gas dispenser propelling chilli directly at the three problem elephants (Sébastien Le Bel et al. 2015). Chilli pepper has been reported in many cases to be a promising natural chemical deterrent (Ferrel and Parker 2006), due to capsaïcin, which stimulates nociceptors of the trigeminal system when entering the nasal cavity (Hoare, 2012).

Drawing on a record of attempts recorded by the operating team, this paper represents an opportunity to document an urban case of human-elephant conflict, to understand the underlying social drivers, and to discuss and propose mitigating solutions.

## Study area

Chirundu is a small border town governed by an elected town council. It is located in Zimbabwe's lower Zambezi Valley within the Hurungwe safari area, a 11,000 km<sup>2</sup> area where wildlife hunting is permitted under licence and with professional hunters (Figure 1 a; see colour plates: page v). Situated on the banks of the Zambezi River, Chirundu is located in the middle of an

<sup>2</sup><https://www.facebook.com/Wildlife-Conflict-Management-Chirundu-Elephant-Programme-831221446928996/>

elephant home range, blocking their traditional movement patterns as they migrate to and from the Zambezi River. Apart from the A1 main road leading to the border post, no fencing devices or trenches limit the free movement of wildlife.

With an estimated population over 2,500 people<sup>3</sup> Chirundu has grown rapidly, with a housing footprint that has increased five times between 2008 and 2016, from 12 to 63 hectares. It comprises a high density area of about 44 hectares located within the bottleneck formed by two hills and of an unplanned settlement of 19 hectares on the southern side of the main tarmacked road called “*Baghdad*” made of fragile cabins and wooden shacks. The Council is gradually rehousing these people in a more durable settlement called the “*New Housing Development*” (Figure 1 b & c; see colour plates: page v). Employment has been generated by the border crossing, in the form of food provision and overnight accommodation, and truck maintenance and repair.

The Zambezi Valley has a single rainy season, extending from November to April; rainfall is low, ranging from 650 to 850 mm per year.

## Materials and methodology

### *Target sites and deterrent measures*

From the 1 November 2014 to 31 October 2015, elephants were deterred using a chilli pepper gas dispenser with the aim of driving them out of the conflict areas up to the Jesse-bush (*Combretum-Pтелиopsis* scrub) where they were safe.

Using ping-pong balls filled with chilli oil as projectiles, the chilli pepper gas dispenser is accurate up to 60 meters enabling contact with problem elephants up to this distance; for a detailed description of the dispenser, see Le Bel et al. (2010a). As a safety measure, each intervention was carried out in such a way that the elephants were given an escape route that would not result in destroying property or attacking residents.

Interventions were conducted at any time of the day, when the presence of elephants was

reported in no-go areas such as residential zones, the town centre, or rubbish dumps or when harassing people or damaging trucks or public equipment. Interventions were always conducted in a vehicle, from which the operator could fire one to several shots towards the targeted elephant(s). It sometimes ended up with the operator following the problem elephant(s) on foot in the Jesse bush.

Elephants sought water mainly at the waterholes, and food mainly from rubbish dumps and leftovers found around the market place; however, even food left in trucks queuing at the border post on the main tarmacked road were a source of provision for them.

### *Awareness campaigns*

In addition to deterrent measures, an awareness wildlife outreach campaign was conducted, aiming at encouraging children and adults to adopt responsible practices regarding food waste disposal and responsible behaviour when encountering elephants. The messages were spread during meetings with town council officials, at the Rifa Conservation Education Camp<sup>4</sup> and when visiting classrooms of the Rutendo Primary school. Participants learnt about the programme, were briefed about the chilli dispenser and told about the importance of keeping the environment clean.

## Data collection

For each intervention, the date, the time of day, the location where the elephant(s) were spotted, the structure of the elephant group observed, and their behaviours prior to intervention were recorded.

Bulls observed alone were mentioned as “solitary bull”, and “bachelor group” when observed in a group of at least two individuals. Females and offspring observed together were mentioned as “family group”.

Elephants were reported “foraging” if they were observed feeding on bushes and green grass, “scavenging” if feeding on rubbish dumps and leftovers from shops and market, and “wandering” if observed roaming in town. Elephants were reported as “destructive” if observed smashing houses, shops and vehicles, and “harassing” when intimidating people being close by. “Injuries/death” refers to cases of people having been injured or killed by an elephant.

When bull elephants were recognized, they were

<sup>3</sup>Chronicle:<http://www.chronicle.co.zw/chirundu-more-than-just-a-border-post/>

<sup>4</sup><http://www.wildzambezi.com/directory/99/rifa-conservation-education-camp>

identified by a nickname. In some cases, the designated chilli pepper operator was not there to take action and deter the elephant. However, the observation of the elephant in the town was still recorded. The operator added details describing the reactions of the inhabitants towards the programme, their contributions and perceptions of the conflict. These observations were used to design a conceptual model of the social dynamics and processes fuelling the conflict.

## Data analysis

The information recorded for each intervention was computerized in a database using Microsoft Excel (2016). See the charts in the “Results” section: data processing under R (v.3.3.2) with basic descriptive analysis.

To understand and articulate the perceptions of the reaction team concerning the conflict, a conceptual model of the social dynamics was developed using causal loop diagrams (CLDs). Figure 2 illustrates the labelling convention for CLDs and how to interpret them (Fazey et al. 2006). The arrows indicate that a change in variable “A” causes a change in variable “B”, and the signs “+/-“ indicate the polarity of the causal link. The polarity of the causal link is positive if an increase or decrease in “A” provokes an increase or decrease in “B”, respectively, and negative if it provokes a decrease or increase in “B”.



Figure 2. Labelling conventions for causal links (Fazey et al. 2006).

## Results

### Characterization of the conflict

#### Known and new intruders

During the study period, 347 elephant incursions were recorded in Chirundu town. Bulls were mainly encountered, with 89% of the incidents recorded ( $n = 309$ ) either occurring when they were alone or in bachelor groups. Family groups were less problematic (10%,  $n = 34$ ). Four (4) incursions were not properly described. Five

solitary bulls, respectively nicknamed “Chiliboy”, “Doughnut”, “Hopalong”, “Tusker” and “One Tusker”, as well as a group of six bull sub-adults called the “Teenagers”, were identified in half of the incursions (49%,  $n = 171$ ).

Although elephants were observed all year round, the number of incursions recorded per day was highly variable, with a peak of six incidents per day in January 2015. There were several periods with no data collection: January (10 days), February (20 days), June (11 days) and July (4 days).

“Chiliboy” (14%,  $n = 50$ ), “Hopalong” (7%,  $n = 24$ ) and “Doughnut” (7%,  $n = 24$ ) were the main problem elephants in the first three months of the study; they disappeared almost completely by the end of January 2015, except that “Chiliboy” reappeared twice in March and April 2015. They were gradually replaced by newcomer bulls, named “One Tusker” (10%,  $n = 36$ ), “Tusker” (8%,  $n = 28$ ) and the “Teenagers” (5%,  $n = 16$ ), who were involved in the incursions in the last three months of the study (Fig. 3).

#### Wandering around and scavenging

Most of the conflict incidents (34%,  $n = 117$ ) were due to elephants scavenging, or feeding on rubbish dumps or leftovers discarded around the marketplace, shops, and houses. Thus, most of the elephant incursions were spotted within the “High density area”, where the highest concentration of rubbish dumps and easily accessible sources of food discarded by the inhabitants were located (Figure 4; see colour plates: page v).

A few cases (4%,  $n = 15$ ) were reported on, in which elephants destroyed informal dwellings in Baghdad (the new housing development), broke vehicle windscreens and tore the tarpaulins off trucks queuing on the main tarmacked road to access food which they had smelt inside.

In 14% ( $n = 48$ ) of the cases, the operator encountered elephants roaming in town, checking for the presence of rubbish at habitual places. Elephants were spotted foraging on bushes or green grass in 11% ( $n = 37$ ) of the observations. Seven cases were recorded of elephants harassing or intimidating people and three injuries were reported. In many cases, elephant behaviour was not described, although incursions were reported (35%,  $n = 120$ ).

More incursions were recorded on market days, with 73 (21%) and 62 (18%) incursions recorded on Mondays and Fridays respectively (Fig. 5). Thus, the operator eventually predicted the incursions of the

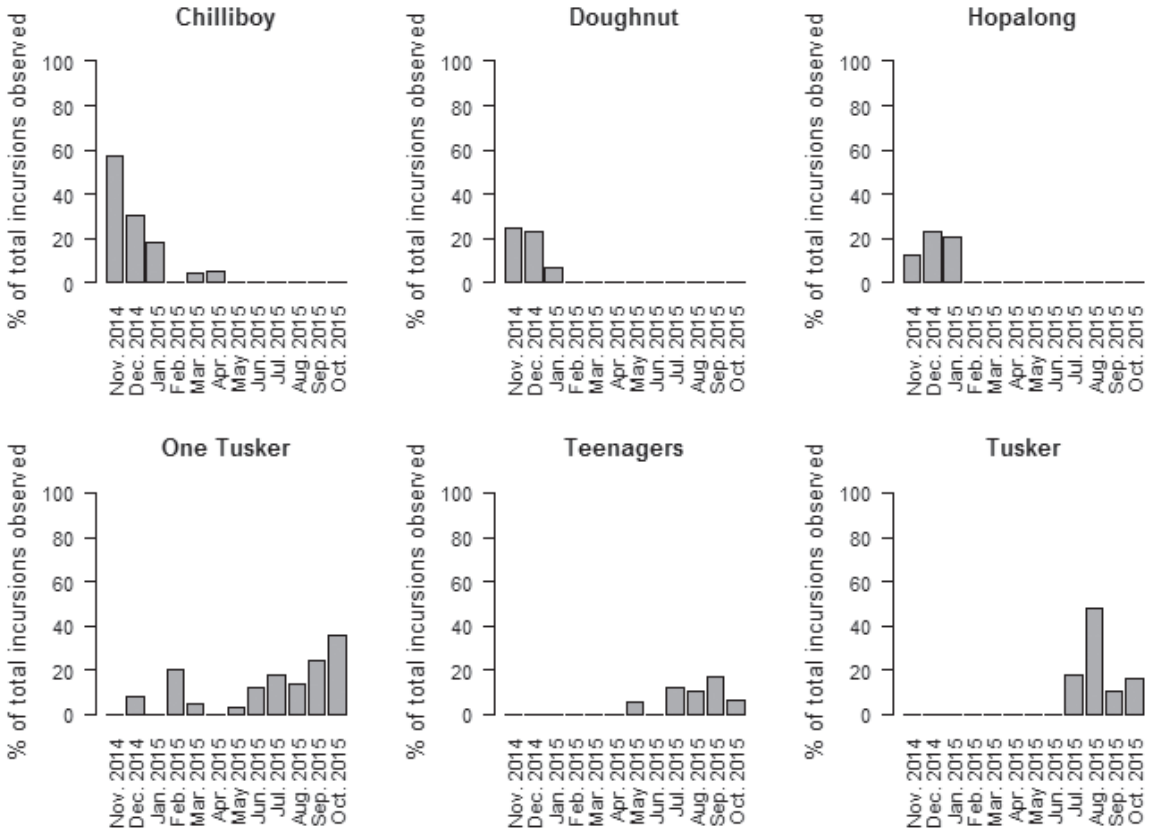


Figure 3. Temporal distributions of the occurrences of well-identified individuals.

elephants, ambushing and deterring them near the marketplace before their arrival.

**Underlying social dynamics and effects of the programme**

Social dynamics underlying the conflict

This first model illustrates the situation as it was described by the operator before the programme started. It highlights some of the feedback dynamics of the system that appeared to enhance and/or maintain a situation of a high level of conflict. This model presents 2 causal loops (Fig. 6).

Attractiveness of the town and habituation of elephants (R1+)

One main factor of attraction is the proliferation of rubbish dumps all around Chirundu. The easy availability of food encouraged the

incursions of elephants who became used to human activities and have lost their natural fear of humans in the process. While elephants became habituated to visiting the town/human activities, they also learned to seek food in more inaccessible places such as vehicles and dwellings. A serious lack of resources and organization on the part of the Council regarding waste collection and disposal inevitably led to the

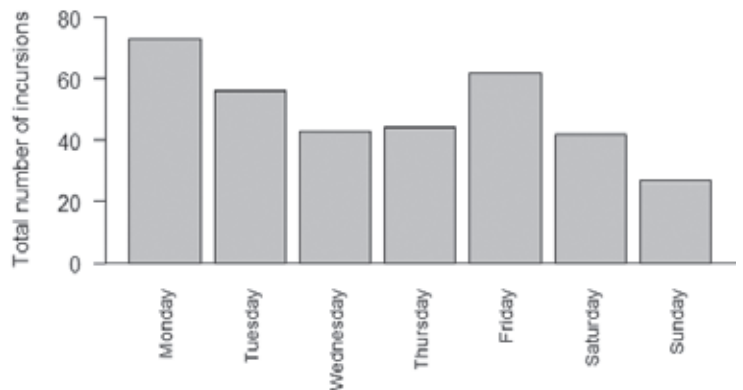


Figure 5. Distribution of elephant incursions according to the day of the week.

accumulation of rubbish dumps in town. The amount of rubbish grew as the number of people living in town increased. The more the rubbish was dumped indiscriminately, the less the Council had the means to clean-up the town.

The heavy truck traffic crossing the border has increased the attractiveness of the town either as a direct source of food being carried on trailers or with the rubbish generated by the development of services provided for transportation.

People's tolerance and the intervention of the National Parks (R2-)

There were many reported cases of people walking alone at night, sometimes drunk, and following elephant paths without a torch. This type of risky behaviour can be linked with an increasing number of conflict incidents, as was the case in each of the three cases of injuries recorded, where elephants had attacked people. This type of behaviour aggravated the conflict, often resulting in people becoming 'paranoid' about elephants.

The pressures on ZPWMA to find solutions increased as the inhabitants' tolerance towards elephants decreased. Problem elephants were killed during Problem Animal Control (PAC) operations, thus stabilizing the system (negative

loop).

By doing so, the system solely relied on crisis management taken by ZPWMA, delaying the need to make major changes. The root of the problem was left unresolved as the elephants' visits quickly resumed and even increased in the period of study.

*Effects of the programme on the dynamics of the system:*

This second model (Fig. 7) sums up the situation after the programme started, with a new positive causal loop (R3+).

Direct interventions of the operator (R3+)

Among the 347 incursions reported in the diary, 294 involved attempts to deter the elephant(s). In most of the cases the operator fired one or two projectiles towards the problem elephant(s) before engaging in a chase with a vehicle when the elephant(s) did not leave the area. For the deterrence of the five solitary bulls four to five shots were necessary.

As many unmeasured external parameters may influence the behaviour of elephants, the extent to which these interventions directly reduced the attractiveness of the town could not be measured in this study. However, a direct effect can be confirmed, as the elephants quickly associated the sound and sight of the

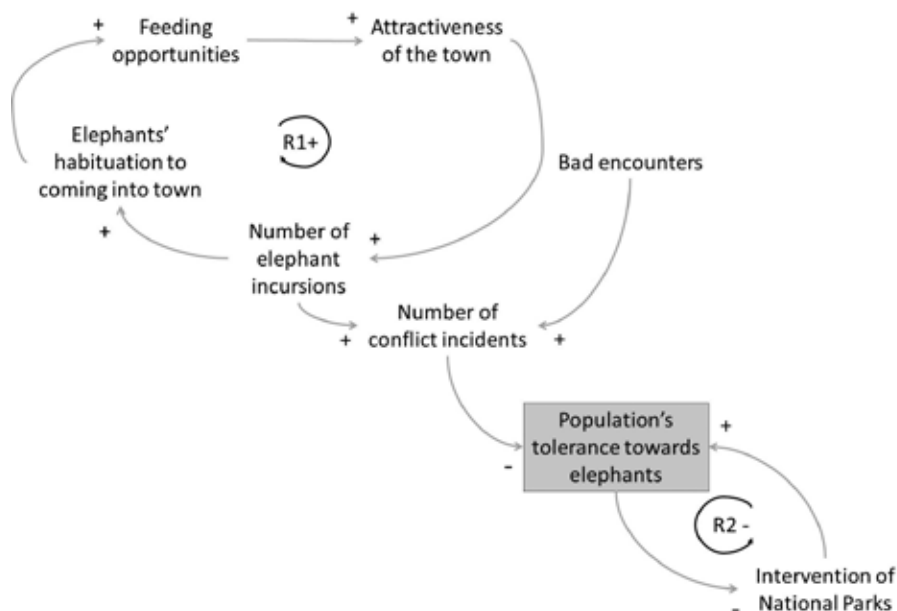


Figure 6. The conflict system described by the operator before the implementation of the programme.

operator’s vehicle with an unpleasant experience, running away upon approach.

The direct interventions of the operator and its quick visible effects on the elephants’ behaviour resulted in increasing support from the town inhabitants as they started reporting elephant incursions to the operator in order to prompt his immediate response.

Urban management and awareness campaigns (R1+ and R2+)

From the 1 December 2014, the Council allocated a refuse truck to remove waste every market day, reducing the attractiveness of the town for elephants. In addition, a local donor provided support with the provision of dustbins to facilitate rubbish collection and waste disposal.

The extent to which awareness campaigns, conducted among the inhabitants with the aim of encouraging them to adopt responsible behaviour, was not measured. However, people generally became more cooperative in keeping the town clean and in reporting cases of dangerous behaviour, suggesting combined positive reinforcement, both

peoples’ tolerance of elephants and cooperation, as well as the deterrent interventions (R3+). Furthermore, the intervention of ZPWMA was no longer the only mitigation solution to be applied (R2-).

## Discussion

### Urban elephants

The data analysis showed that a small number of recognizable habituated bull elephants were responsible for most of the problem incidents recorded in town, reinforcing the evidence that “habitual raiders” represent a small segment of the elephant population (Chiyo et al. 2011; Hoare 2012). Thus, suggesting that bulls take higher risks than females to meet their nutritional requirements and enhance their reproductive success (Chiyo et al., 2011).

Elephants were attracted all year round by easily accessible and irresponsible rubbish disposal, altering their natural seasonal foraging patterns and inciting them to stay in the vicinity of the town. Contrary to their wild counterparts, who are human averse (Osborn 2004), “urban” bull elephants appeared highly tolerant

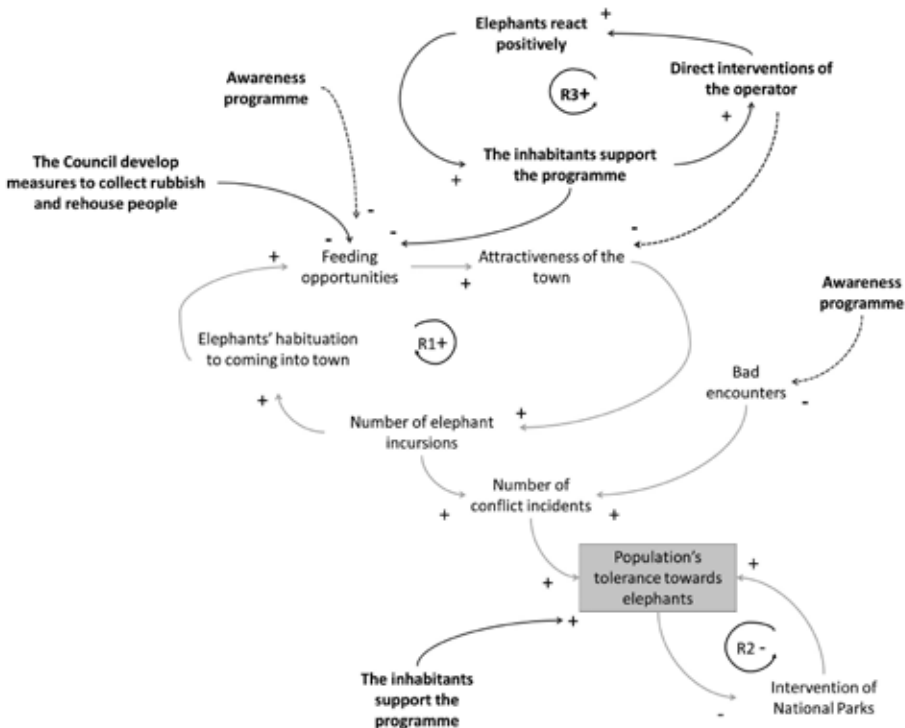


Figure 7. The conflict system after the implementation of the programme. The causal loop R3+ illustrates the positive effects on the level of the conflict that could result when the Council and the inhabitants started to support the program. Dotted arrows illustrate uncertain effects.

of disturbance; they are apparently not perturbed by human noises, high levels of human activity, and are not scared of human presence anymore.

In this study, bull elephants exhibited major learning capacities and the ability to develop innovative behaviours to reach food hidden in trucks, informal dwellings, and food stores. Observers noted that elephants frequented the town more often on market days—Monday and Friday—and they were, in several cases, seen to arrive exactly at the time at which the vendors started to sell their goods.

Human activities can strongly influence wild animal behaviour (Krishna et al. 2016), and this conflict situation can be viewed as an adaptation of elephants to humans/human activity, learning foraging strategies for living in a highly disturbed and urbanized environment (Lowry et al. 2013). This might be particularly true for adult bulls, which are naturally bolder than females, thereby being more risk—and disturbance—tolerant (Vines and Lill 2016).

### *Mitigation measures*

Despite being strongly reliant on the food opportunities offered by the town, “Chilliboy”, “Doughnut” and “Hopalong” disappeared suddenly and almost completely by the end of January, coinciding with the onset of the rains. In determining the reason for their disappearance, poaching cannot be ruled out, as there is a high level of poaching is high in the area.

Although the long-term deterrent effect of the chilli pepper was difficult to assess, a change in the elephants’ fine-scale spatial and temporal movement patterns should be considered (Jachowski et al. 2013; Krishna et al. 2016).

These bulls were replaced by newcomers—who quickly became used to visiting the town, and took advantage of the rubbish. This observation supports the hypothesis of new individuals taking the place of previous ones who have disappeared (Hoare 2001), thus proving the futility of killing problem elephants (Hoare 2012).

### *Social drivers and effects of a deterrent programme*

Human attitudes and activities are decisive in the structure and functioning of urban environments (Soulsbury and White 2015). Our study was

limited by the fact that it was based on the operator’s own report of the situation and lacked the assessments and viewpoints of all the stakeholders. Nevertheless, it provided food for thought and highlighted some of the human behaviours and social dynamics that might induce and promote conflict situations that are potentially resolvable. The use of a soft systems methodology helped to shape interventions in such problematic situations where no straightforward solutions exist (Checkland and Poulter, 2006).

While it appears difficult to stop the flow of people settling in town, as well as the consequent expansion and the increasing numbers of rubbish dumps, our study highlighted the Council’s lack of means to organize waste disposal, and the lack of environmental awareness. These deep-rooted factors increased the tendency for elephants to visit the town influencing the long-term functioning of the conflict<sup>5</sup>. Relying totally on actions taken by ZPWMA to manage the conflict and perceiving no benefit from living with dangerous animals, the atmosphere of insecurity prevailing in the town encouraged negative attitudes and decreased the tolerance of people towards elephants and elephant damage.

The strategy adopted by the Chirundu Elephant Programme combined three ways of mitigating the human-elephant conflict in an urban situation:

- Reinstating a fear of humans among the habituated elephants through direct repellence using chilli pepper gas dispensers;
- Decreasing the attractiveness of the town to foraging elephants by promoting the clearing up of rubbish and the improved management of waste sites in the town;
- Environmental education and awareness initiatives to generate more positive attitudes towards wildlife (Dearborn and Kark 2010).

Today, most of the inhabitants have come to understand the link between the problem of careless disposal—of rubbish and elephant incursions. As the council is now providing dustbins, people are more willing to clean-up their rubbish. This suggests that the increased support to the programme from all the stakeholders was a result from both positive reaction from elephants to the mitigation programme and awareness campaigns, but specific effects of each of these two factors could not be quantified.

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<sup>5</sup><http://www.chronicle.co.zw/chirundu-more-than-just-a-border-post/>



This support from the inhabitants increased even though the programme had no visible effect on the number of elephant incursions in town. Having a role in resolving the conflict, the inhabitants are gradually changing their perceptions of the conflict and are, in the long term, expected to enhance their tolerance (Decker and Purdy 1988).

## Conclusion

The effective management of this urban conflict involving elephants who have already adapted their behaviour to take advantage of a landscape heavily dominated by humans is challenging (Ditchkoff et al. 2006). Equally challenging might be the inducement of behavioural modifications in individuals that are naturally risk-tolerant, have high learning and memorization capacities, and are behaviourally innovative.

After one year of interventions, elephants still visited Chirundu, although they were deterred by the local team. Despite no visible decrease in the number of elephant incursions and conflict numbers, the deterrence programme benefitted from widespread support and collaboration from the residents.

Further research is recommended for the long-term impacts of the chilli pepper use to change elephants' behaviour. However, as the disappearance of the first cohort of bulls left a vacant space for newcomers and as the local team's interventions could not be durably sustained, long-term mitigation strategies should not consider repelling tools to be a stand-alone solution (Le Bel et al. 2010b).

In an urbanizing world, the number of animals having to adapt to urban behaviours will increase, leading to more and more contact with humans and necessitating strategies for coexistence (Conniff 2018). Our study suggests that well thought-out preventive strategies promoting the active participation of all stakeholders might mitigate the negative consequences of this trend, improving the public's wildlife acceptance capacity<sup>6</sup> and promoting the move from conflict

towards coexistence (Dickman 2010), inviting discussion for further research.

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<sup>6</sup><http://www.savetheelephants.org/about-ste/press-media/?detail=new-wildlife-migratory-corridors-report-will-help-close-gap-between-conservation-and-urban-development>

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