Research

Community-based conservation and wildlife conflict: evaluating costs in Namibia

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Introduction

Anthropogenically-driven defaunation is a major environmental challenge [1]. Humans occupy vast areas of the planet and have changed many of the globe's ecosystems [2]. Overexploitation and intensive agriculture are among the most important threats to wildlife [3]. Larger species, including carnivores, are at particular risk because body size is a key predictor of extinction.

Efforts to halt the decline in biodiversity have taken many forms. One approach is community-based conservation[1] (CBC), in which local communities collectively manage natural resources via decentralised governance. CBC works through the devolution of property and access rights to local communities. Thus, it constitutes a bottom-up approach, making local people stewards of shared assets. Its appeal lies within its twin goals of managing natural resources sustainably while alleviating poverty [4,5].

CBC has been used worldwide for decades and there is a large body of literature in various disciplines concerned with its evaluation [6–8]. However, the extent to which CBC achieves its goals has been subject to considerable scholarly debate due to mixed evaluation results and high context specificity [9,10]. A distinct shortcoming is a lack of robust empirical evidence [11]. This can be attributed to the slow adoption of impact evaluation designs in conservation science as quasi-experimental evaluation methods have only recently become popular [12].

In Namibia's Zambezi region, CBC has become integral to managing wildlife through communal conservancies. In this article, I synthesise several studies [13–17] to investigate the impacts of Namibia's CBC approach on vegetation, wildlife and livelihoods, with a focus on human–wildlife conflict and empirical methods.

Background

Community-based conservation in southern Africa

Resource extraction and exploitation in southern Africa intensified in the 19th century, when collective

[1] Also referred to as community-based natural resource management (CBNRM).

management of natural resources by indigenous hunter-gatherer societies was superseded by centralised colonial rule [18]. Despite increased conservation efforts in the 20th century, wildlife continued to decline, highlighting the need for a re-evaluation of conservation approaches. By the turn of the 21st century, a paradigm shift occurred away from centralised, exclusive protected areas towards participatory engagement of local communities [19]. This process was spearheaded by the CBC political ecology narrative, placing inclusive socio-economic development on an equal footing with conservation [4].

Today, conservation in southern Africa is characterised by a continuum of approaches. Centralised structures such as nature reserves and national parks [20] are found alongside decentralised community-led frameworks like CBC. With the help of non-governmental actors, governments have applied CBC to various resources such as water, wildlife, fisheries, pastures and forests throughout southern Africa. In Namibia, community conservancies (CBC schemes) were first established in 1998. There are currently 86 conservancies covering 50 % of public land, a total of 166,184 km², supporting livelihoods for more than 244,000 people[2].

Rural livelihoods, wildlife and conservation

Humans have interacted with wildlife since the earliest hunter–gatherer societies of pre-history [18]. Whilst such interactions can benefit rural communities (e.g. as a source of food), they may also have negative consequences for people, a phenomenon often referred to as 'human–wildlife conflict' (HWC) [21]. HWC occurs in three main forms: competition for resources from natural environments; impacts on cultivated environments such as crops or livestock; and interactions between wildlife and humans or their material property.

Livestock, crucial for many rural incomes, faces threats from wildlife that include predation and disease transmission. Conservation initiatives can increase risk when transboundary animal movement is facilitated, fostering widespread transmission of, for example, foot-and-mouth disease [22]. Crop-raiding, especially by elephants (*Loxodonta africana*), has a substantial impact on some communities. Deterrence strategies, like fencing, may help but require up-front investment, posing trade-offs between costs of prevention and crop losses [23].

Labelling wildlife as detrimental to rural livelihoods ignores the potential benefits it can bring. Wildlife generates revenue through consumptive and non-consumptive tourism in several parts of southern Africa [24]. Coexistence can produce synergies. Both conservation and agriculture can be consistent with higher household income when they are economically interdependent [25] and when the opportunity costs of agriculture are equal to or less than returns from conservation. While CBC initiatives might ease HWC's impact on human well-being, more wildlife may result in greater impacts on crops and livestock, although losses may be offset through compensation payments. Therefore, the interplay of household income, HWC and CBC is a balancing act with the potential to lead to either losses or gains.

This article assesses how local resource governance shapes and affects wildlife and livelihood outcomes as well as human–environment interactions including HWC. It seeks to answer the following questions:

1) How does CBC affect conservation-related outcomes?
2) How does CBC affect household income and environmental dependency?
3) How does HWC shape rural livelihoods and does CBC mediate its impacts?

Methods

Study area

The Zambezi region covers 14,785 km² of northeast Namibia, about 1,200 km from the capital, Windhoek. It is bounded by four rivers: the Zambezi in the northeast, the Chobe in the southeast, the Linyanti in the south and the Kwando in the southwest. These form natural borders with Zambia, Zimbabwe and Botswana while the region also has a border with Angola (Fig. 1).

The region is located at the heart of Kavango–Zambezi, the world's second-largest Transfrontier Conservation Area. Numerous wildlife corridors lead through it, making the region a conservation hotspot [26]. As of 2016, it hosted 58 % of Namibia's elephant population. It has three national parks (Bwabwata, Mudumu and Nkasa Rupara) and 15 community conservancies.

[2] http://www.nacso.org.na/

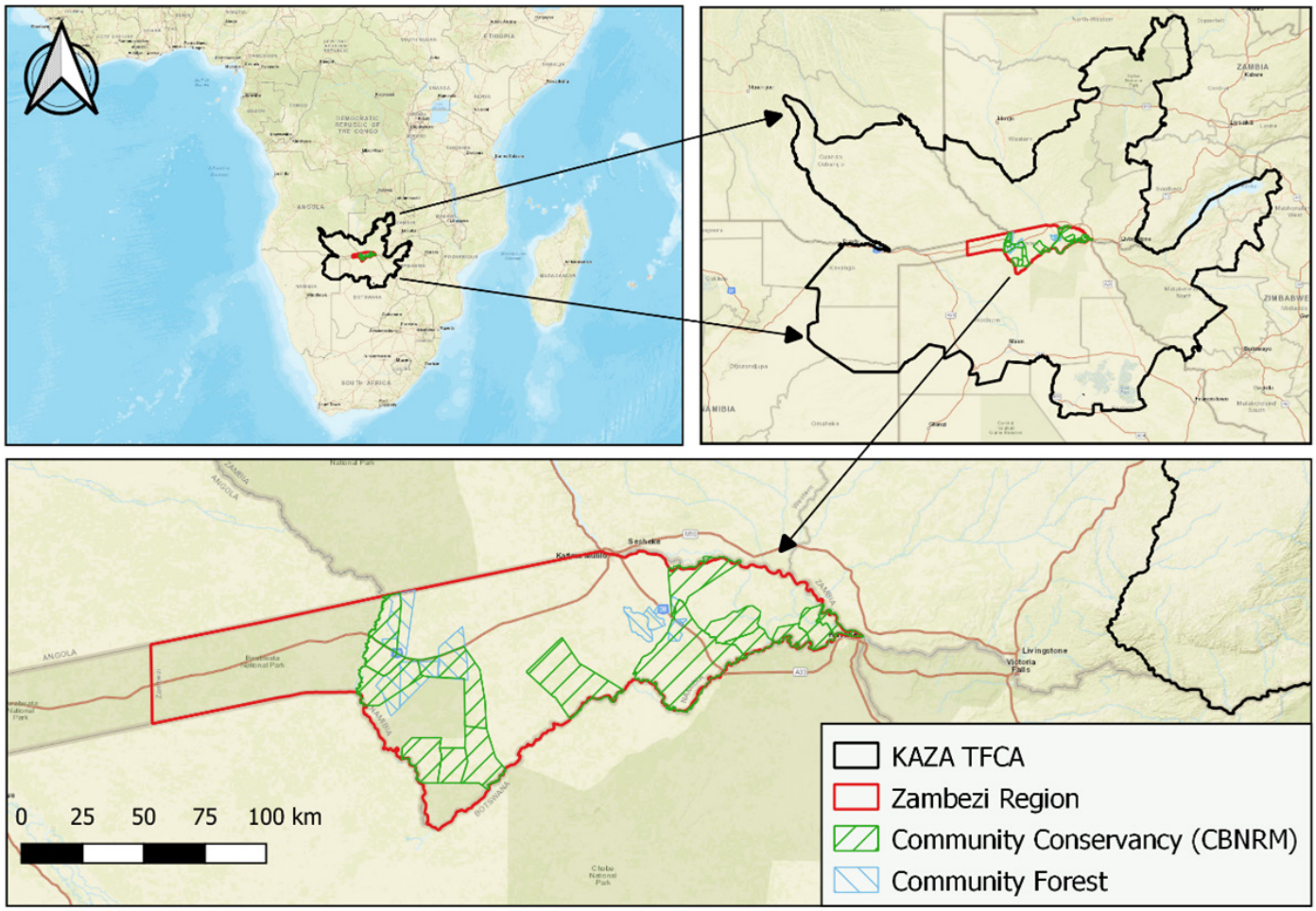

Fig. 1. The location of the Zambezi region, Namibia, within the Kavango–Zambezi Transfrontier Conservation Area (KAZA TFCA), showing community forests and conservancy areas in the region (Source: Meyer et al. [14]).

The region is home to almost 100,000 people, of whom a substantial proportion live inside CBC schemes. Most people depend on crop production and cattle herding with little intensification [27]. Almost 37 % of the working population, and half those aged 15–34, are unemployed and 39 % of people in the region live below the poverty headcount rate, compared to 27 % for the country as a whole [28,29]. Katima Mulilo, the only urban centre in the region, is an economic hub for trade and logistics, food procurement and processing, governmental control and other basic infrastructure such as health care and education [30].

Community conservancies are commonly adjacent to, or have a joint venture with, tourism enterprises such as lodges and campgrounds. Trophy hunting is common and brings in large amounts of money from wealthy tourists. A portion of the income from both consumptive and non-consumptive tourism flows back to communities in the form of cash and in-kind benefits. Compensation payments are also financed through this channel.

Quantifying household income, ecological variables and HWC

We collected primary household data during a survey in 2018, covering a representative sample of 652 households with a 12-month recall period [31]. This also provided household-level information on experience of HWC, including the type of damage (crops, livestock or property) and wildlife involved. Further, we quantified income from different sources including agriculture, formal and informal employment, environmental sources and wildlife tourism. We quantified environmental income from wild and uncultivated products following the principles of the Poverty Environment Network, an initiative to standardise the collection of socio-economic and environmental data [32].

In general, where HWC occurs depends on ecological factors, like resource distribution and habitat connectivity, as well as human factors such as occupation of natural landscapes [16]. To evaluate changes in vegetation and land use, we used Landsat satellite images at 30 × 30 m

resolution from 1985 to 2017 following published methodology [33]. We used a mix of citizen science observations and systematic monitoring data provided by the Namibia Environmental Information Service to analyse elephant presence during the period 1992–2009.

We used the geographic location (GPS coordinates) of each household to derive variables such as human occupation of land, which we measured as the share of land set aside for conservation at the conservancy level as well as areal coverage by buildings. We also measured wildlife habitat connectivity around households using the inverse of a resistance layer estimated for elephant landscape connectivity in the study area in 2010–2016 [34].

Estimating causal effects of HWC and CBC

People may choose to join CBC schemes based on specific factors or conditions in their area and so might differ in important ways from those who do not, such as experiencing more severe HWC or being more proactive with regards to its mitigation. Therefore, a simple comparison of means between members versus non-members would likely be biased due to non-random self-selection. Instead, we used non-experimental methods such as panel models, matching and instrumental variables to estimate the effects of CBC and HWC on various outcomes. For example, matching generates unbiased estimates by finding pairs of households (a CBC member and a non-member) based on similarities of observed characteristics and pre-CBC outcomes [35]. Panel data allow controlling for unobserved but time-fixed confounders via a fixed-effects estimator [14–16].

In order to analyse what drives HWC, we specified an empirical model to identify spatial and household-level determinants. In the model, the dependent variable was a dummy variable taking the value of 1 if a household reported HWC during the 12-month survey recall period and 0 otherwise. We checked for various determinants of HWC, with special emphasis on spatial variables derived from household locations. To estimate the effect of HWC on household-level outcomes, we used ordinary least squares regression analysis.

Results

Effect of CBC on conservation-related outcomes

Overall, we found a net increase in woodland cover within the study area since 2014 while elephant counts remained comparatively stable. On average, CBC was associated with a small (+0.2%) increase in elephant presence and a decrease (−2.1%) in vegetation cover. However, CBC conserved vegetation (+1.4%) in areas with abundant wildlife around tourism accommodation facilities, suggesting a positive externality of wildlife conservation in areas where communities can benefit from tourism [14].

Effect of CBC on household income and environmental dependence

Households that were CBC members had, on average, higher incomes than non-members [15]. CBC members also generated more income from environmental resources, for example through the collection of wild fruits and firewood, which made them more dependent on the environment. This strategy was driven by households living near touristic accommodation facilities, as this aligned better with the abundant vegetation resulting from conservation and tourism [16].

Impact of HWC on rural livelihoods and its mediation by CBC

A quarter (24%) of all surveyed households reported experiencing some form of HWC. The most commonly implicated species was the elephant, mentioned by 13% of households and representing over half (54%) of all reported HWC. Mammalian carnivores including the cheetah (*Acinonyx jubatus*), spotted hyena (*Crocuta crocuta*) and lion (*Panthera leo*) together accounted for 16% of HWC, similar to the hippo (*Hippopotamus amphibious*) and buffalo (*Syncerus caffer*). The crocodile (*Crocodylus niloticus*) was implicated in 7% of cases. High standard deviations (SD) indicate that HWC occurrences were highly volatile (Table 1).

The proportion of CBC conservancy[3] designated for conservation stands out as the most significant driver of HWC (Fig. 2). Habitat connectivity, woodland cover, crop

[3] CBC schemes are not exclusively used for conservation but also include designated areas of agricultural usage.

farming and keeping livestock also correlated with higher levels of reported HWC. In contrast, woodland cover change, i.e. a reduction in woodland cover around the household, and the share of income generated from formal employment (as a proxy of capacity to adapt to HWC) were associated with lower levels of HWC.

CBC-member households had higher incomes and income diversity compared to non-members (Fig. 3, first and second panels). However, HWC led to negative perceptions of CBC at both household and community levels (Fig. 3, third and fourth panels).

Table 1. *Proportion of households in the Zambezi region of Namibia that reported experience of human–wildlife conflict (HWC) during a 12-month recall period and the species implicated (Source: Meyer & Börner [15]).*

Species	Mean	SD
All HWC combined, of which:	0.24	0.42
▪ Elephant (*Loxodonta africana*)	0.54	0.50
▪ Hippopotamus (*H. amphibious*)	0.17	0.37
▪ Buffalo (*Syncerus caffer*)	0.16	0.37
▪ Mammalian carnivores	0.16	0.37
▪ Crocodile (*Crocodylus niloticus*)	0.07	0.26
▪ Other	0.16	0.37

Discussion & Conclusions

We found that wildlife (elephant) abundance and household income both increased with membership of CBC schemes. The financial benefit of such schemes has previously been documented in our study area [36]. CBC members generated higher levels of income from the environment but there was no indication that employment of household members in tourism contributed significantly to livelihoods, although it is a potential source of employment [17,37]. CBC schemes seem to be fostering environmentally-oriented livelihood strategies, but only when households are in relative proximity to tourism centres that provide undisturbed landscapes, for example at most waterfronts and the surroundings of lodges and campsites.

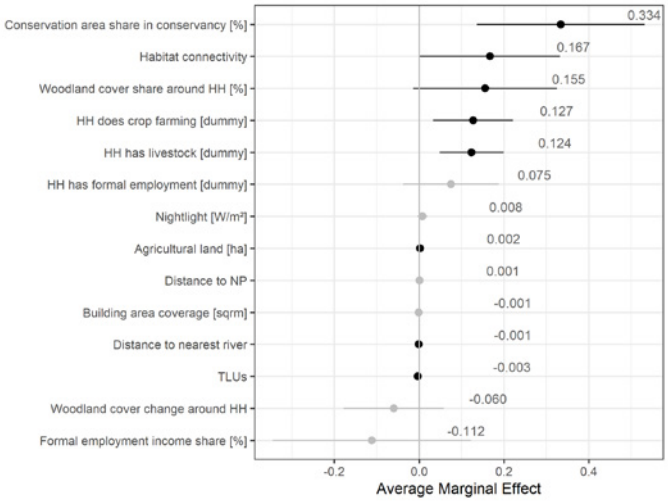

Fig. 2. Spatial and household-level determinants of HWC, where a 1-unit increase in the covariate named on the y-axis changes the probability of HWC by the value given on the x-axis. For example, a 1% increase of the conservation area inside a conservancy increases the probability of HWC by 0.334. Values (point estimate and confidence intervals) shown in black indicate a significant difference at a .1 significance level (Source: Meyer & Börner [15]).

According to our results, based on a regionally representative sample of households in the Zambezi region, HWC had no tangible effect on household income or income diversification. This contrasts with contemporary narratives from the same study area. For example, one study described the impacts as considerable but the assessment relied on expert opinion rather than analysis of data collected at the household level [38]. It was also reported that returns from sustainable trophy hunting did

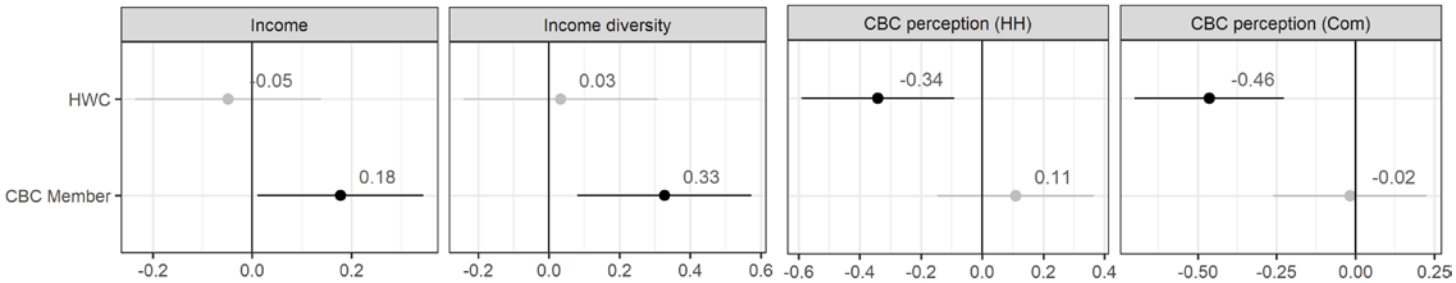

Fig. 3. Ordinary least squares estimates of the effects of human–wildlife conflict (HWC) and membership of community-based conservation (CBC) schemes on household income, income diversity and perceptions of CBC at household and community levels. Values (point estimate and confidence intervals) shown in black indicate a significant difference at a .1 significance level (Source: Meyer & Börner [15]).

Photo: Maximilian Meyer

not offset crop losses to wildlife [39], but this cost–benefit analysis was based on HWC in a single conservancy. Our findings suggest that previous notions of the socio-economic impacts of HWC may have been somewhat over-estimated.

HWC has received considerable attention in conservation research [38,40]. Our study adds to understanding of the determinants of HWC, particularly spatial aspects such as core conservation areas, habitat connectivity and agricultural practices. Conservationists and landscape planners could collaborate to harmonise conservation and socio-economic development through prediction and therefore anticipation of potential conflict hotspots.

Our results show that CBC positively affects household income, especially that from the environment, as well as benefiting wildlife. Success in wildlife conservation can lead to increased human–wildlife interactions and conflict. Thus, CBC may increase HWC and households that experience HWC have negative perceptions of CBC. However, we found that HWC did not decrease income or livelihood diversity. We therefore argue that the costs of HWC are perceived to be higher than they are in reality, and future education and awareness campaigns may help to clarify this potential misperception. Moreover, the benefits of higher income create synergies in CBC, despite a higher likelihood of HWC. We conclude that, overall, CBC brings considerable benefits and is an effective tool to achieve both of its intended purposes: wildlife conservation and socio-economic development.

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