



# Patterns and perceived sustainability of provisioning ecosystem services on the edge of a protected area in times of crisis

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## ABSTRACT

Beyond their conservation mandate, one of the underestimated strengths of protected areas (PAs) is the provision of safety nets to rural communities in times of social or climatic crises. Here we draw on our long-term research in Zimbabwe to illustrate the multiple services provided by PAs to subsistence farmers in the context of environmental change, socio-economic pressures and political crises. We studied the social-ecological determinants of the contribution from PAs to nutrition, material and energy provisioning services crucial to rural livelihoods. The contribution from PAs decreased with increasing distance from PAs, and showed a corresponding increase with population growth on the edge of PAs, except for nutrition. The distance from PAs and the population increase on the edge also contributed to the perceived stress on resources, an index of perceived sustainability in ecosystem services provision. Access to PAs and perceived stress varied with wealth, gender and age. Our results highlight potential drivers of the sustainability of PA-dependent subsistence livelihoods, including (1) changing resource availability, (2) changing human population, (3) honey pot-effects, and (4) buffering capacity of PAs. We stress the need to implement long-term monitoring of these social-ecological processes to support the management of PAs.

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## 1. Introduction

Protected areas (PAs) constitute major instruments to limit the impacts of human development on ecosystem structure and function around the globe. During the past century, the justification for PAs has shifted from a biocentric (protect nature from people) to an anthropocentric (protect nature for people) perspective (Mace, 2014). There is thus a growing recognition that apart from conserving biodiversity, PAs should perform several other functions, such as protecting watersheds and soils, shielding human communities from natural disasters, or even civil conflicts, and stimulating local and regional economies (Chape, Spalding and Jenkins, 2008). The ecosystem services which PAs provide thus complement those from production landscapes (Martin-Lopez et al., 2011) and this function is essential in the context of increasing human footprint, demand, and uncertainties related to global change (Ervin et al., 2010). However, maintaining some degree of ecosystem integrity, through the protection of biodiversity (habitat and ecosystem

functions) is key for assuring a sustainable supply of goods and services to human societies (Maass et al., 2016). Hence, measuring the actual contributions of PAs to human well-being and how these can affect the ecological integrity of PAs themselves (Adams et al., 2004; Martin-Lopez et al., 2011) will be a first step for assessing the potential contribution of PAs to the resilience of PA-centred social-ecological systems.

Over the past 20 years, governments and influential donor organizations have come to realize that the long-term integrity and the role of PAs as ecosystem service providers, relies first on the support of rural communities living adjacent to them (Ferraro and Kiss, 2002; West and Brockington, 2006; Andrade and Rhodes, 2012). It is particularly relevant in low-income nations where people's access to PA resources influences their attitudes towards PAs, especially in the tropics (see Bragagnolo et al., 2016 for a review). This support can be gained by involving the neighbouring communities in PA management (Andrade and Rhodes, 2012) and by sharing the benefits from PAs with local people, especially considering the negative impacts of many conservation activities on the livelihoods of indigenous communities (Brockington and Igoe, 2006; Redpath et al., 2013). Despite stringent restrictions on harvesting, access to natural resources inside PAs is probably the largest

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tangible benefit for neighbouring communities (Tomicevic et al., 2011). Wild natural resources are safety nets that buffer local people's welfare against extreme events or increasing population pressures (Luckert et al., 2000). Natural resources also underpin a diversity of cultural identities, for example totems and traditional beliefs associated with particular species, and are central to local ecological knowledge that in turn provides support for conservation (Shackelton and Gumbo, 2010). Perceptions of the ecosystem services provided by PAs are often dominated by provisioning services, i.e. nutrition, material and energy. However, local people near parks also value cultural and regulating services (Sodhi et al., 2010).

The services provided by PAs may attract more people, a phenomenon termed the “honey-pot” effect (Wittemyer et al., 2008). The attractive nature of ecosystem services is controversial (Joppa et al., 2009) and increasing human populations on the edge of PAs is a global concern, irrespective of the underlying causes and mechanisms (Scholte, 2003; Joppa et al., 2009; Scholte and De Groot, 2010). This may have major impacts on conservation success through over-exploitation of natural resources and disturbances (Oglethorpe et al., 2007) or PA isolation (Newmark, 2008), but also deeply affects the connections between the PAs and their adjacent human societies (Hoole and Berkes, 2010; Guerbois et al., 2013). Growing human populations compete for space and natural resources at the edge of conservation areas, and put pressure on resources within PAs. Changing populations can also result in shifting mindsets with consequences for PA management. For instance, profit-seeking migrants established in the villages at the edge of Hwange National Park express a less positive attitude towards the PA, and claim more from it, than people more rooted in the area (Guerbois et al., 2013). In Asia, Sodhi et al. (2010) found that long-term residents living at the edge of several Southeast Asian National Parks valued the ecosystem services provided by the protected forests more than newcomers.

Addressing the main challenges for enhancing protected areas resilience will require understanding the reliance on ecosystem goods and services in times of crisis (Mikkelsen et al., 2007; Cumming, 2016). Social factors such as population density, wealth, value-systems or inequalities in combination with ecological factors should be integrated to understand the interdependencies between ecosystem services from PAs and rural population dynamics (Martin-Lopez et al., 2011; Cumming et al., 2015). Such a social-ecological systems (SES) approach is also better able to identify and assess the relationships among multiple ecosystem services than social or ecological data alone (Bennet et al., 2009).

In this paper, we investigate the interdependencies between people living in a communal area and two adjacent PAs with contrasting status in times of socio-economic and political disruptions. The Long-Term Social-Ecological Research programme (Hwange LTER – Zone Atelier Hwange) which operates in this area since 1999 offer a unique opportunity to study such dynamics. Hwange National Park is an IUCN Category II park where extractive use is prohibited, while Sikumi Forest Area is an IUCN Category IV protected area where extractive use is controlled. The absence of fences in this system allows for some porosity between the different areas (Murwira et al., 2013; De Garine-Wichatitsky et al., 2013). Direct access and natural resource use are legally prohibited in the national park, but thatching grass extraction has been authorized occasionally. In contrast, access to natural resources such as firewood collection in the Sikumi Forest Area is permitted and regulated. For instance, only women can collect dead wood on Thursdays and axes and carts are banned. Following the severe droughts in the 80–90 s, local communities were authorized to graze cattle up to 3 km within the Sikumi Forest boundaries. One interesting attribute of the study area is that access to natural resources and land-uses in communal areas are still determined internally, by

traditional leaders, and are often managed at the village scale. The 2000s period was marked by political, economic and climatic crises in Zimbabwe following a decade of economic growth in the 1990s. In the 1990s, prosperous international tourism (Bond and Cumming, 2006) attracted more people to the edge of Hwange National Park in search of employment (see Guerbois et al., 2013). Fast Track Land Reform and its associated political turmoil resulted in a 90% drop of overseas tourist in 2002 (ZPWMA, n.d.<sup>1</sup>). Zimbabwe was then subjected to numerous sanctions, which along with the disrupted economy, resulted in growth contraction, with a drop of GDP per capita from 680 USD in 2000 to 350 USD in 2008 (World Bank, 2015). The national economic crises resulted in massive de-urbanisation, attracting more people to the study area in search of more secured livelihoods. The mass movement of people resulted in a 61% population increase in the communal area under study between 2000 and 2010, compared to a 16% population increase between 1990 and 2000 (Guerbois et al., 2013). The people living on the edge of Hwange National Park rely essentially on subsistence farming and natural resources use, with natural resource access varying among different land-uses (Giller et al., 2013, Guerbois unpublished data). In this context, population increase often translates into more land converted into crops and increased competition for space and natural resources. The change in demographic over the two decades (1990–2010) influenced people's perceptions and uses of natural resources. The people living on the edge of Hwange National Park rely on subsistence farming and natural resources, with natural resource access varying among different land-uses (Giller et al., 2013; Guerbois unpublished data).

We believe that the crises in the 2000s amplifies dependencies on natural resources for subsistence farmers living at the edges of the PAs, and therefore presented an ideal case study for testing how these changes might have affected the spatial contribution of PAs and the sustainability of the subsistence livelihood. In this paper, we aim to (i) determine the perceived role of ecosystem services (nutrition, material and energy) to the subsistence community and in particular the contribution from PAs on a distance gradient from their boundaries, (ii) determine the perceived trends in the provision of these ecosystem services, (iii) identify the factors that shape people's reliance on PAs for the provision of identified ecosystem services including social characteristics (age, gender and wealth) and context variables (distance to PA, population change) and (iv) identify which of these factors can also explain the perceived stress (a proposed proxy to measure sustainability) in provisioning services in this PA-dependent socio-ecological system.

## 2. Material and methods

### 2.1. The study area

The study area is situated South East of the small town of Dete in Matabeleland North Province (Zimbabwe), (–18.62° S, 26.85° E). It lies at the eastern end of the Kavango-Zambezi Transfrontier Conservation Area, at the edge of Hwange National Park (14,652 km<sup>2</sup>). The Hwange ecosystem, classified as an agro-ecological region IV and V (Mugandani et al., 2012), is characteristic of dystrophic semi-arid savanna systems, with low fertility soils (mostly Kalahari sands) and erratic annual rainfall (606 mm, inter-annual CV = 25%, Chamaille-Jammes et al., 2007). The dominant vegetation types include miombo, baikaea and mopane woodlands at higher elevations, and bushed grasslands in the low-lying areas.

The social-ecological system of interest includes the Main Camp

<sup>1</sup> ZPWMA (Zimbabwe Parks and Wildlife Management Authority), Hwange Main Camp tourism office, unpublished data, accessed on 20 April 2015.

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