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Land cover transformation in the Save-Limpopo Lowveld, Zimbabwe

On land cover transformation in the Save-Limpopo Lowveld, Zimbabwe

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Introduction

The loss of biodiversity in sub-Saharan Africa is in large-part attributable to anthropogenic activity; particularly agricultural expansion (Eisner, Seabrook, & McAlpine, 2016), with concomitant deforestation, human-wildlife conflict and illegal harvest (Ripple et al., 2015). Indeed the Millennium Ecosystem Assessment has linked biodiversity decline in Africa to habitat loss through agricultural growth (Perrings & Halkos, 2015), compounded by poverty and poor governance (Dickman, Hinks, Macdonald, Burnham, & Macdonald, 2015).

While fortress conservation is increasingly criticised, protected areas (PAs) are still successful in mitigating species' loss in Africa. PAs provide critical refuge to flora and fauna in an anthropogenic landscape, in particular threatened and endemic species, and further create millions of jobs through the tourism industry (Lindsey et al., 2017). A meta-analysis on the conservation effectiveness of PAs globally found some variance in the capacity of reserves and parks to protect species' populations, but the overall effect to be positive (Geldmann et al., 2013). Similarly, Spracklen et al. (2015) found that PAs can reduce deforestation – although substantial variance exists within and between countries. Despite the positive conservation outcomes of PAs, these can impose social costs on local communities, through foregone economic opportunities and human-wildlife conflict.

The opportunity costs of PAs, and lack of support for wildlife conservation outside of formal reserves has prompted legislation (in some African states) for the devolved responsibility of wildlife management to land-owners or communities (Child, 1996). Wildlife is subsequently seen as a grass-roots resource that has the potential to prosper if land managers, through proprietorship, can integrate wildlife to their own advantage (Child & Chitsike, 2000). Zimbabwe, until recently provided a suitable case-study on the success of this policy, through 1] the country's CAMPFIRE programme that transferred conservation decision-making to poor rural communities (Child, 1996; Taylor, 2009), and 2] the shift from pastoralism to wildlife management on many private properties, and the ultimate unification of these into conservancies (Child & Child, 2015; Nyahunzvi, 2014).

Privately owned conservancies (*de facto* PAs) in Zimbabwe – mostly in the Save-Limpopo lowveld - were targeted under that country's land reform programme, from 2000 onward. Land reform in the Save-Limpopo lowveld (hereafter lowveld) appears to have been more political than environmental; wildlife was all but eradicated on re-settled conservancies, and even a part of Gonarezhou National Park (NP) was occupied (Du Toit, 2004). In the Savé Valley Conservancy alone, 6 454 wild animals were killed illegally from 2001-09 (Lindsey, Romanach, Tambling, Chartier, & Groom, 2011), including critically endangered species such as black rhino (*Diceros bicornis*). Indigenous woodlands were extensively cleared, and wildlife corridors impeded (Du Toit, 2004). Supporters of land reform indicate that local communities simply exercised agency and that localised resource management is no longer exclusionary in nature (Mutekwa & Gambiza, 2017).

Although indigenous woodland loss on lowveld PAs post 2000 has been mentioned in the primary literature, this has not been quantified in the Save-Limpopo Region. Here we use remote sensing to estimate the loss of woodlands in three lowveld PAs; the Chiredzi River and Savé Valley Conservancies, and Gonarezhou NP from 2000-15. We provide some recommendation on ways forward; although our work is perhaps most useful as a scientific baseline of tree cover within the PA extent in the region pre-2000. This acts to counter *shifting baselines* regards future conservation decisions.

Methods

The study sites (Chiredzi River and Savé Valley Conservancies, and Gonarezhou NP) within the Save-Limpopo lowveld, Zimbabwe (Fig. 1), are situated approximately 460 m ASL. To assess the loss of woody cover in each PA we used the Hansen Global Forest Change v1.3 product (Hansen et al., 2013). Tree cover in 2000 was quantified using the '*treecover2000*' product, which measures canopy closure for vegetation taller >5 m, per 30 m pixel. Tree loss was measured using the '*lossyear*' product which is an annual measurement of loss of vegetation from a forest to non-forest condition, from 2001 to 2015. Land under subsistence farming and formal agriculture in Chiredzi and Savé Valley conservancies were digitised in ArcMap (v10.2) from a Landsat 7 ETM+ image for August 2000 and a Landsat 8 OTM image for August 2015. August images (early dry season) were chosen as cloud cover was relatively low during this time.

Results and Discussion

Following land reform in 2000, substantial areas of two PAs in Zimbabwe's Save-Limpopo lowveld were transformed from indigenous woodland to subsistence-based farmland (Fig. 2). Indeed, approx. 60% of the Chiredzi River and 16.5% of the Savé Valley Conservancies were converted to subsistence agricultural land (from 2000-2015). Similar findings regards forest transformation following land reform in Zimbabwe have been documented, as well as increased incidence of soil degradation and loss (Jombo, Adam, & Odindi, 2017; Sibanda, Dube, Mubango, & Shoko, 2016).

The rate of indigenous woody cover loss following land reform in the lowveld was substantial (Fig. 3a). Much of this occurred over just one decade; from 2001 to 2010 the rate of woody cover loss in Chiredzi River Conservancy was 708.1 ha annum^{-1} (SD 771.5), 979.7 ha annum^{-1} (SD 862.4) in Savé Valley and 80.6 ha annum^{-1} (SD 60.9) in Gonarezhou NP. There was variance around per annum woody cover loss (Fig. 3b), although it is apparent that much tree cutting occurred over 10 years. The cumulative loss, or full loss of native woody plant cover from 2000 to 2015 was 7547.0 ha in Chiredzi River Conservancy, 10731.6 ha for Savé Valley and 954.2 ha in Gonarezhou NP. Note that 'woody cover' here is a different parameter to 'area of land under subsistence agriculture'; woody cover was defined as canopy closure for all vegetation >5 m in height, and estimated quantitatively through remote sensing (see Methods).

Indigenous trees on lowveld PAs appear to have been removed for a number of reasons; ostensibly cleared to make way for fields, much of the timber would likely have been used as fuel-wood, or sold informally. As indicated by Jombo et al. (2017), land reform was typified by forest clearance for access to arable land, fuel wood, pole construction and wood sale. Tree removal apparently therefore served two purposes; fuel wood and timber sales to augment incomes, and land clearance (for agriculture) to provide further diversification of income (Chigumira 2006 in Jombo et al., 2017). Income generation appears to have been a driver of the illegal harvest of vertebrate fauna resident on these PAs prior to land reform; Lindsey et al (2011) found bushmeat hunting in the lowveld to be conducted by unemployed young men, who used the funds generated from the sale of bushmeat to buy food.

Land reform in Zimbabwe was in part driven by political expediency, and the lack of planning regards resettlement of people on lowveld PAs, and the lack of subsequent support (Lindsey, Romanach, Matema, et al., 2011) perhaps played a role in subsequent deforestation and widespread illegal harvest, as well as the spread of disease such as foot-and-mouth (Du Toit, 2004). Land reform is known to have a negative impact on biological diversity (van der Meer, 2018), in part because the process of transformation from single-large to multiple-small worked plots brings people into direct conflict with wildlife. The process in the Zimbabwean lowveld has also restricted the development of wildlife corridors in the region, linking PAs to the Great Limpopo Transfrontier Park. Wildlife conservation is not fully compatible with land use that involves people, it seems (Sibanda, 2015).

Proponents of reform have rightly indicated that poor, marginalised people exercised agency under land reform, and forced a shift from ‘exclusionary governance to pro-people democratic governance of Forest Protected Areas and other resources’ (Mutekwa & Gambiza, 2017). The conservation movement is increasingly aware that PAs impose an opportunity cost on poor, rural people and that humanitarian needs are foremost. Zimbabwean conservationists have, to their credit, largely pioneered devolved community based conservation (Child & Child, 2015), and there has been past success in the country through the CAMPFIRE programme (Taylor, 2009). A number of papers have been published over the past decade that ably discuss ways forward for lowveld PAs, or conservancies and poor communities now resettled in the area (for example Nyahunzvi, 2014), and we have little to add to that debate, other than our support for community based conservation. We are somewhat surprised that much of the discussion around land reform in Zimbabwe implicitly assumes a long-term continuation of a large, rural based populace – and not an urbanised, industrialised future. There also appears to be little discussion around alternative farming techniques that could alleviate land pressures, such as vertical farming.

Our work serves as a quantitative documentation of woody cover loss and land-use transformation of PAs under land reform. This acts to counter *shifting baselines* in future conservation decision making in the region.

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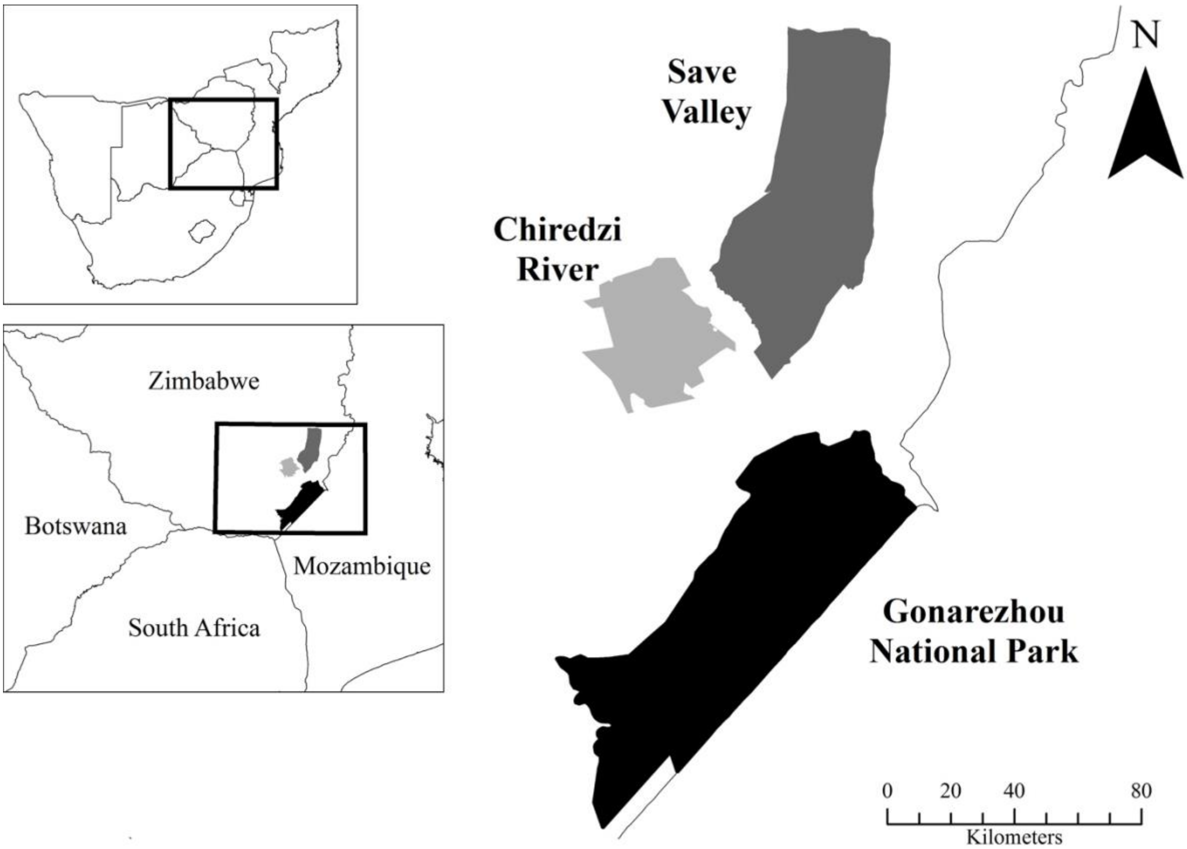


Fig 1 The location of study sites in Zimbabwe's South East Lowveld. Shown here are Gonarezhou National Park, and Chiredzi River and Savé Valley Conservancies.

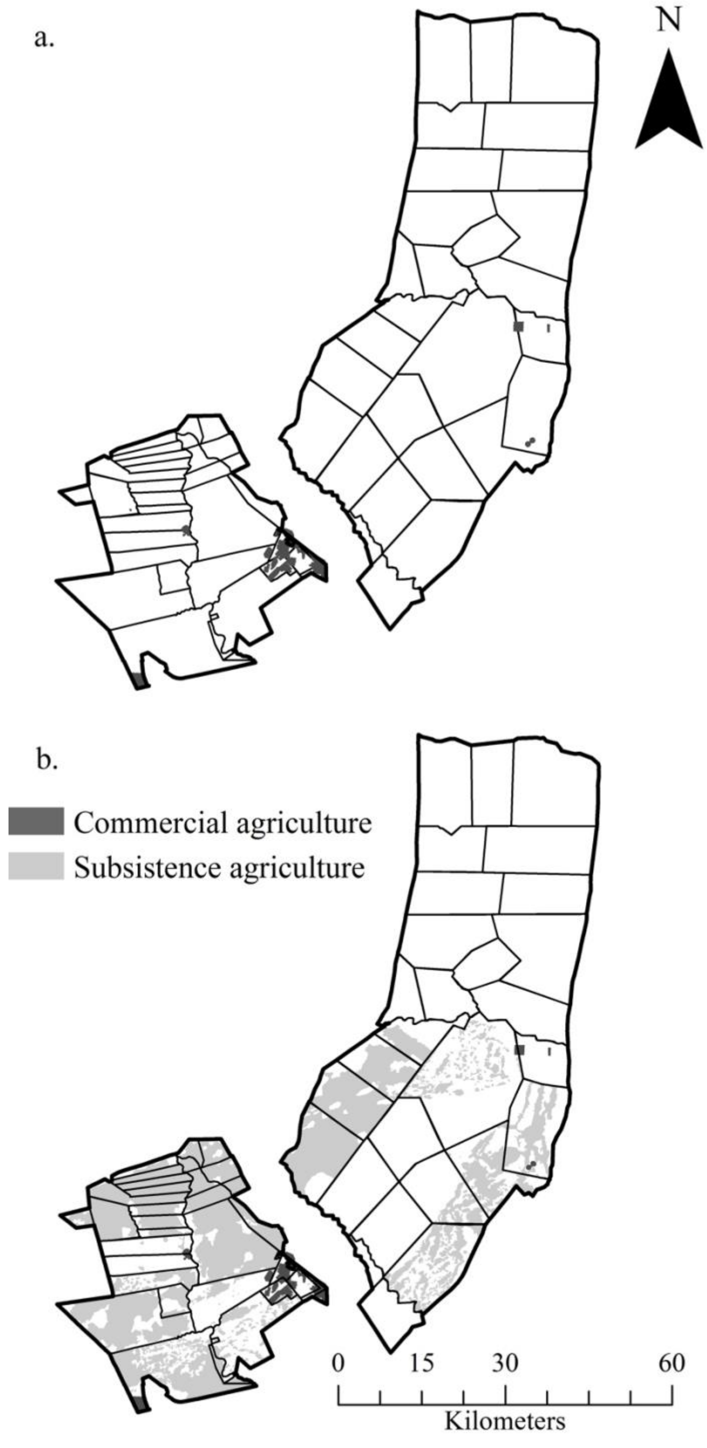
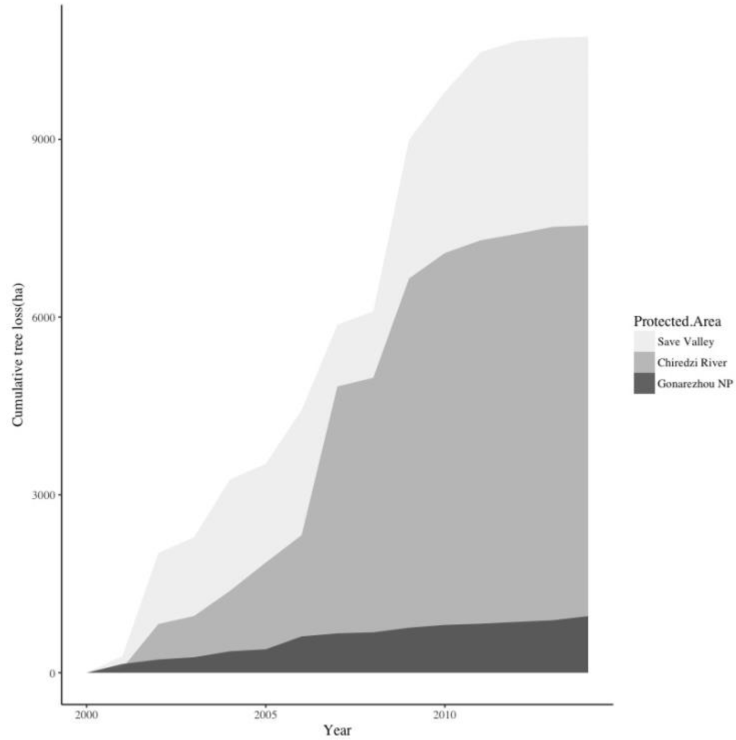


Fig 2 Spatial representation of land cover change in Chiredzi River and Savé Valley Conservancies. Data here show: Fig 2a the proportion of land under 'commercial cropping' and wildlife at the start of 2000, and then Fig 2b the proportion of land under 'commercial cropping' and 'subsistence agriculture' by 2015. The default background colour is land given to wildlife.



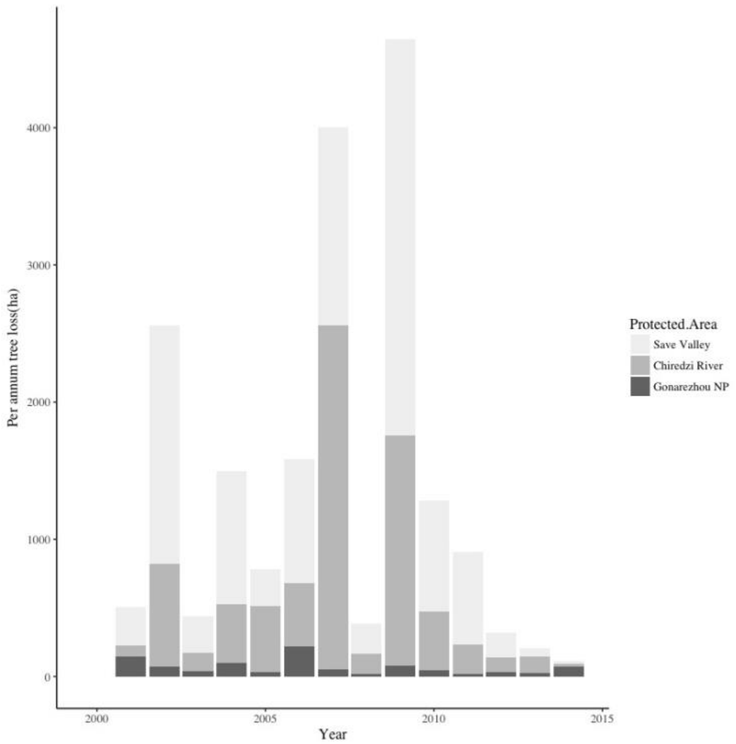


Fig 3 Annual tree loss in Gonarezhou NP and Chiredzi River and Savé Valley Conservancies from 2000-2015. Data here are Fig 3a cumulative tree loss in hectares from 2000-15 across all PAs, and Fig 3b per annum tree loss from 2000-15 for each PA.