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LETTER

Certified community forests positively impact human wellbeing and conservation effectiveness and improve the performance of nearby national protected areas

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Abstract

Community forests (CFs) aim to improve human wellbeing and conservation effectiveness, though their performance remains contested. A recent innovation in protected area (PA) governance is to combine CFs with forest certification. We assess (1) the impact of certified CFs on wellbeing and conservation effectiveness; (2) gender inequality and elite capture; (3) interaction effects with neighboring national PAs. We used a novel approach that integrates field data consisting of locally identified indicators representative of multidimensional wellbeing, with remotely sensed data on conservation effectiveness and statistical matching to improve causal inference. We found that CFs positively impacted wellbeing, conservation effectiveness, and reduced gender inequality, though they did not reduce elite capture. We also detected positive interaction effects between certified CFs and neighboring national PAs. Our findings suggest that locating contrasting local and national PA governance approaches next to each other may help to maximize wellbeing and conservation benefits within complex multiuse landscapes.

KEYWORDS

community forest, conservation effectiveness, environmental justice, forest certification, governance, impact evaluation, integrated landscape management, matching, protected area, wellbeing

1 | INTRODUCTION

Protected areas (PAs) are a cornerstone of efforts to conserve forests and attention is also increasingly being paid to how PAs can improve the wellbeing of adjacent communities (Naidoo et al., 2019). In response to these twin challenges, diverse and increasingly complex PA governance arrangements have been trialed, though their effectiveness remains contested (Gavin et al., 2018). Rigorous impact

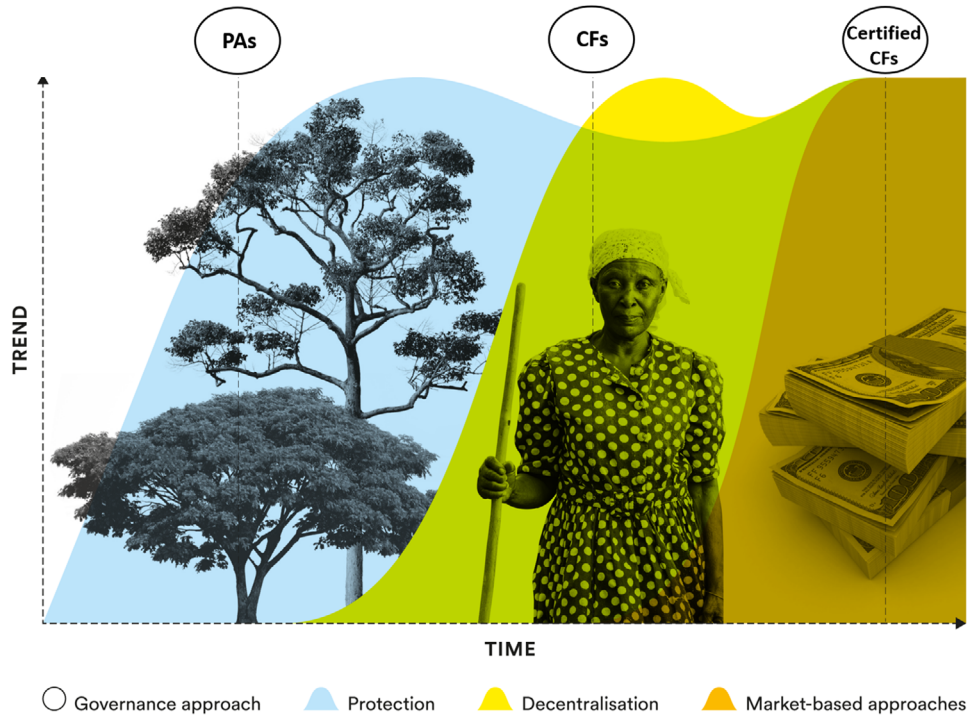

FIGURE 1 Major trends in forest protected area governance through time showing the emergence of community forests (CFs) and certified CFs alongside strictly protected areas (PAs). Trend lines and color layering show how new trends have added to the governance arrangements of earlier trends creating additional governance complexity

evaluations are needed to understand and improve PA performance (Baylis et al., 2016). However, robust evaluations remain rare and tend not to fully account for diverse wellbeing impacts (Woodhouse et al., 2015). Evaluations generally prioritize externally defined, economic indicators. Yet, these often ignore local priorities and noneconomic wellbeing impacts (de Lange et al., 2016), such as how limiting forest access may impact the ability of communities to cope in times of scarcity (Atela et al., 2015). To more comprehensively account for PA impacts, more locally relevant measures are needed (Sterling et al., 2017).

Over the past 40 years there have been three distinct trends in forest PA governance with complexity of governance arrangements increasing over time (Figure 1). Initially, formal PAs tended to be centrally governed, excluding local participation. However, recognition of the negative impacts of this approach on neighboring communities led towards decentralization and the establishment of Community forests (CFs; Agrawal et al., 2008). The premise underlying this trend is that community participation will synergistically improve both the living standards of local communities and biodiversity conservation (Persha et al., 2011). Initially, this focused on legal devolution of forest tenure. However, in much of Sub-Saharan Africa and across the tropics, land tenure remained with central governments with local communities gaining only access rights and receiving few economic benefits (Sunderlin, 2006). Alternatively, power was vested in local elites, resulting in increased inequality and exclusion of women from governance institutions (Agarwal, 2009; Magessa et al., 2020), while also failing to halt forest degradation (Rasolofoson et al., 2015).

To overcome these shortcomings, a second generation of CFs emerged that integrated market-based approaches to promote revenue generation and aim for equitable benefit distribution (Figure 2), although the effectiveness of market-based approaches to achieve distributional equity has been limited (Pascual et al., 2014). Here we focus on the combination of CFs with Forest Stewardship Council (FSC) certification, which is the most widespread certification scheme in the tropics and aims to incentivize sustainable forest use and offset financial costs by attracting additional timber traders (Burivalova et al., 2017). Gender equality is also promoted through requirements for wage equality and equal employment opportunities (FSC, 2018). Despite the potential for certified CFs to deliver synergistic benefits for human wellbeing and conservation, to date no impact evaluation has reported a combined assessment of multidimensional human wellbeing and conservation effectiveness of CFs with forest certification.

The expansion and increasing connectivity between PAs (Santini et al., 2016), combined with complex governance arrangements creates a need for sophisticated impact evaluation designs that account for spatial and governance

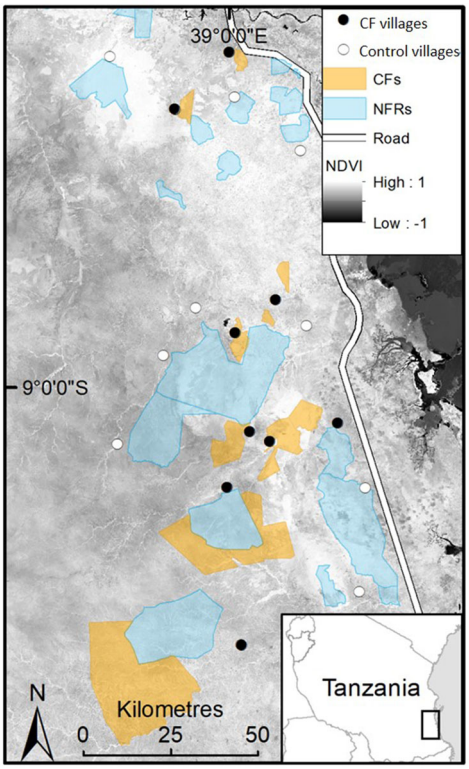

FIGURE 2 Study landscape in Lindi and Pwani regions of Tanzania detailing the 19 identified study villages and 27 protected areas. The main highway stretching north to south along the east coast linking the capital city of Dar es Salaam to the regional capital of Lindi

interactions (Barton et al., 2017; Baylis et al., 2016). Interactions, *sensu* spillovers, can have a positive effect on conservation outcomes as neighboring PAs may buffer each other through complementary patrol effort that benefits both PAs (DeFries et al., 2005). Alternatively, partitioning of forest resources between national and local actors and may strengthen the resource claims of marginalized actors (Kaimowitz, 2003), resolving conflicts between local and national actors, and promoting sustainable use. Alternatively, interactions may be negative, *sensu* "leakage," displacing deforestation to neighboring areas, or increasing conflicts that can have a dramatic effect on observed performance (Joppa & Pfaff, 2010). Yet most studies on PA effectiveness focus on single governance approaches and very few explore the relative effects of co-occuring interventions (Sims & Alix-Garcia, 2017).

We aim to determine whether recent trends in PA governance can overcome past shortcomings of PAs to benefit both forest conservation and human wellbeing. We use a PA dominated landscape typical of complex PA governance arrangements in the developing tropics to assess (1) the impact of certified CFs on multidimensional human wellbeing and conservation effectiveness, (2) how certified CFs impact elite capture of benefits and gender inequality, (3) interaction effects with neighboring PAs. We use a novel approach for measuring a locally grounded conception of multidimensional human wellbeing to provide a comprehensive accounting of diverse PA impacts. We integrate this fine-scale field data with remotely sensed measures of forest conservation and statistical matching techniques to enhance causal inference. Finally, our impact evaluation design incorporates both the layering of PA governance approaches and interactions between PAs. Therefore, our evaluation makes progress in representing the complex reality of modern protected area governance.

Tanzania provides a good test case of complex PA governance arrangements. PAs cover 38% of the country, of which 2.5 million ha have been transferred from central government to local communities in the form of CFs (World Bank, 2018). In 2009 communities in Tanzania became the first in Africa to obtain a FSC certification for CFs (FSC, 2018). However, the national government, like governments elsewhere in Africa and Asia (Basnyat et al., 2018), is exploring curtailing local governance. An assessment of the performance of recent innovations in CF governance is therefore urgently needed to inform the future of CFs.

2 | METHODS

2.1 | Site information

Our focus is on a PA dominated landscape in southeast Tanzania where certified CFs have been established on village land in close proximity to existing Protection National Forest Reserves (NFRs; Figure 2). NFRs are administered by the national government and timber extraction is not permitted. In contrast, CFs allow communities to extract timber and nontimber products and retain timber revenues. The national FSC standard requires additional management oversight in the form of a no harvest zone covering 10% of the CF and an externally audited 5-year review of sustainable harvesting plans (FSC, 2018). Communities are supported to meet these requirements by district government and an NGO, Mpingo Conservation & Development Initiative (MCDI).

2.2 | Response variables

We measured multidimensional human wellbeing through a Human Wellbeing Index (HWI) using the Wellbeing Indictor Selection Protocol to identify locally appropriate indicators through consultation with target communities (Loveridge et al., 2020). Data were

collected through a field questionnaire survey in 2019. The survey was composed of 25 indicators representative of five domains of wellbeing (1) material, (2) health, (3) social relations, (4) security; and (5) freedom of choice and action (Narayan et al., 2000). An index of each domain was calculated as the mean of indicators from each domain standardized between 0–1 and the HWI was then calculated as the mean of domain indices, thereby weighting wellbeing domains equally following principles of the Human Development Index. The unit of analysis was individual questionnaire respondents, since human wellbeing contains subjective components that cannot be generalized across households (see Supporting Information).

We calculated change in Normalized Difference Vegetation Index (NDVI) between 2014 and 2019 at a resolution of 30 × 30 m pixels across the study area as a standardized proxy measure of forest conservation effectiveness (see Supporting information). NDVI correlates with ground vegetation biomass and productivity under low to medium vegetation density conditions such as the Miombo woodlands studied here (Oindo & Skidmore, 2010; Pfeifer et al., 2016). We define positive conservation outcomes as all cases where NDVI change was positive as this provides evidence of forest recovery.

To assess social interaction effects between PAs, specifically the presence of village conflicts with neighboring NFRs, we included a Likert scale question in the wellbeing survey, with responses varying from 1 (there are big conflicts) to 5 (the relationship is very good).

2.3 | Research design

PAs tend to be located in remote areas, systematically different from the wider landscape, which has potential to bias impact estimates. We used a quasi-experimental approach to estimate the impact of certified CFs on human wellbeing and NDVI change. Quasi-experimental methods increase the causal inference from observational data by emulating randomized controlled trials. We used statistical matching in the "Matchit" package in R (Ho et al., 2007) to emulate randomization by matching treatment units to control units with similar distributions of confounding variables. The key assumption helping to establish causal inference in statistical matching is that once treatment and control units have been matched, treatment allocation is close to random (Stuart, 2010). Control units thus represent the counterfactual situation, that is, what would have happened in the absence of the intervention (Schleicher et al., 2020). We then define impact as the difference in human wellbeing and conservation effectiveness between matched treatment and control units.

In the study landscape all CFs adhere to both CF legislation and FSC certification requirements and were within 10 km of NFRs. Therefore, we assessed the impact of the certified CFs by matching nine villages that had certified CFs established for at least five years (range: 2009–2014) to 10 control villages without CFs or forest certification, but also within 10 km of NFRs (Table 1). Due to the small sample size and absence of fine-scale baseline data on wellbeing prior to undertaking the study, we implemented a two-stage matching process to ensure identification of an appropriately matched sample. First, village matching was based on confounding biophysical and socioeconomic variables (see Supporting information). The quality of identified matches was then verified by an expert panel of local actors (Mitchell et al., 2018; see Supporting information). Stratified random sampling within matched villages based on gender, local elite status (identified as being a village government representative), and wealth category was then used to select and interview 955 people. We assessed the impact of certified CFs on conservation effectiveness by a further round of matching that built on the village-scale matching to select treatment pixels from certified CFs and control pixels from within the village land of matched control villages.

Previous assessments suggest that within a threshold of 10 km, PAs exert social and ecological impacts (Naidoo et al., 2019). The identification strategy allowed us to test for interactions between certified CFs and NFRs because we specified that all treatment and control villages were within 10 km of NFRs (Figure 2; see Supporting Information). We were able to assess (1) the impact of certified CFs on conflicts between communities and NFR managers by comparing matched villages with and without CFs; (2) the conservation impact of certified CFs on NFRs by comparing matched samples of NFR pixels within 10 km of CFs to NFR pixels more than 10 km from CFs (Table 1).

2.4 | Analysis

We used linear mixed effects models to test for differences in HWI, each wellbeing domain and NDVI change between matched treatment and control groups (see Supporting information). To test whether certified CFs impacted gender inequality and inequality between local elites and nonelites, we included fixed effects for (1) treatment, (2) gender, (3) villager elite status, and (4) interaction terms between treatment and both gender and elite status. To control for spatial autocorrelation, we included random effects for village identity. To control for any residual imbalances in the distributions of confounding variables between treatment and control groups we compared models with and without orthogonal sets of

TABLE 1 Summary of matching comparisons

Impact test (response)	Matching unit (sample size)	Treatment	Control
Certified CFs on human wellbeing (HWI of individual respondents)	Villages (19)	Villages which have established a CF and maintained FSC certification for at least five years, and are within 10 km of NFRs	Villages without CFs or forest certification, but are within 10 km of NFRs
Certified CFs on relations with NFR managers (relations as perceived by individual respondents)	Villages (19)	Villages which have established a CF and maintained FSC certification for at least five years, and are within 10 km of NFRs	Villages without CFs or forest certification, but are within 10 km of NFRs
Certified CFs (NDVI change)	Forest pixels (8,154)	Pixels of certified CFs	Pixels from village land of matched villages
Certified CFs on NFRs (NDVI change)	Forest pixels (8,050)	Pixels of NFRs less than 10 km from certified CFs	Pixels of NFRs more than 10 km from certified CFs

confounding variables (Ho et al., 2007). For wellbeing analyses we included data on confounding variables based on household location collected by GPS during questionnaire surveys. This was important to account for any differences in the distributions of confounding variables between treatment and control groups caused by the small sample size and coarse spatial scale of matching between villages.

We used the MuMIn package in R to undertake model averaging to select preferred models (see Supporting Information). To further explore conservation interaction effects we used mixed effects models of NDVI change with separate samples of CFs and NFRs, including distance to the contrasting PA governance approach as a proxy variable indicating exposure to interaction effects. To assess social interaction effects, we used ordinal logistic regression to model the conflict response variable, incorporating village nesting (see Supporting information).

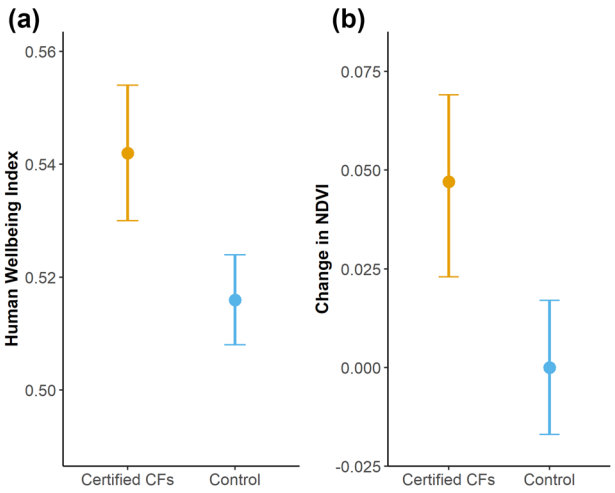

FIGURE 3 Impact of Certified community forests (CFs) on (a) wellbeing and (b) change in normalised difference vegetation index (NDVI). Error bars show model standard error estimates

3 | RESULTS

Certified CFs located close to NFRs had a positive impact on human wellbeing (estimate = 0.026, *SE* = 0.012, $p = 0.035$) and NDVI change (estimate = 0.047 *SE* = 0.024, $p = 0.047$; Figure 3). Across the study area NDVI remained stable between 2014 (mean NDVI = 0.66, *SD* = 0.11) and 2019 (mean NDVI = 0.67, *SD* = 0.13). Negative NDVI change occurred close to village centers and NDVI change was positively associated with increasing distance from villages (estimate = 0.036, *SE* = 0.002, $p = < 0.001$).

Across the study area, men experienced higher wellbeing than women (Figure 4a). However, gender inequality in wellbeing was reduced in villages with certified CFs (Figure 4a). Certified CFs did not influence the difference in wellbeing between village elites and nonelites and the impact of certified CFs was not uniform across wellbeing domains. The health, security, and freedom domains of wellbeing were improved (Figure 4b). Specifically,

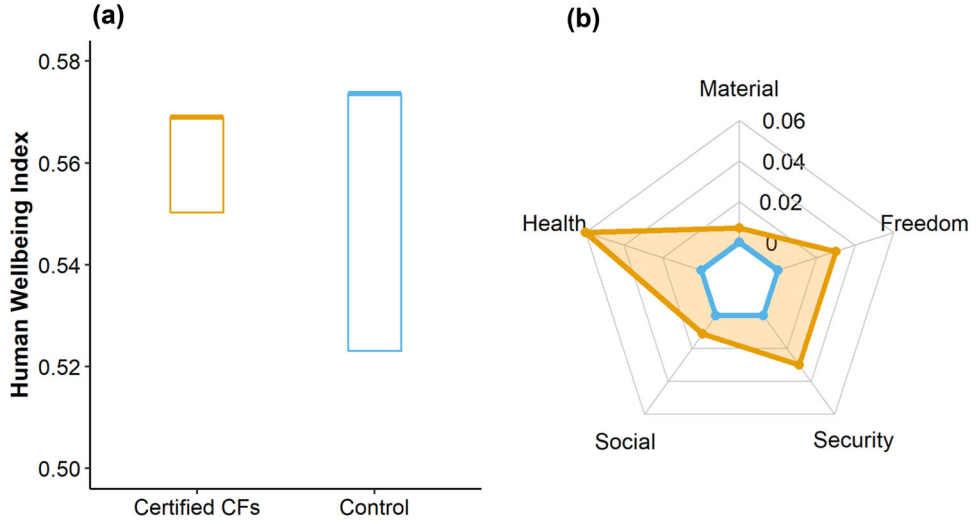

FIGURE 4 (a) Difference in gender inequality between villages with certified CFs and villages without CFs. Thick and thin horizontal lines represent estimated wellbeing of men and women respectively; Estimated change in gender inequality = −0.03, *SE* = 0.01, *p* = 0.008. (b) Estimated difference in the wellbeing scores for the five domains of wellbeing between Certified CFs (orange) and villages without CFs (blue); Estimated impact of CFs on Material wellbeing = 0.007, *SE* = 0.017; *p* = 0.697; Health = 0.060, *SE* = 0.025, *p* = 0.015; Social relations = 0.011, *SE* = 0.035, *p* = 0.744; Security = 0.030, *SE* = 0.013, *p* = 0.024; Freedom = 0.030, *SE* = 0.013, *p* = 0.024.

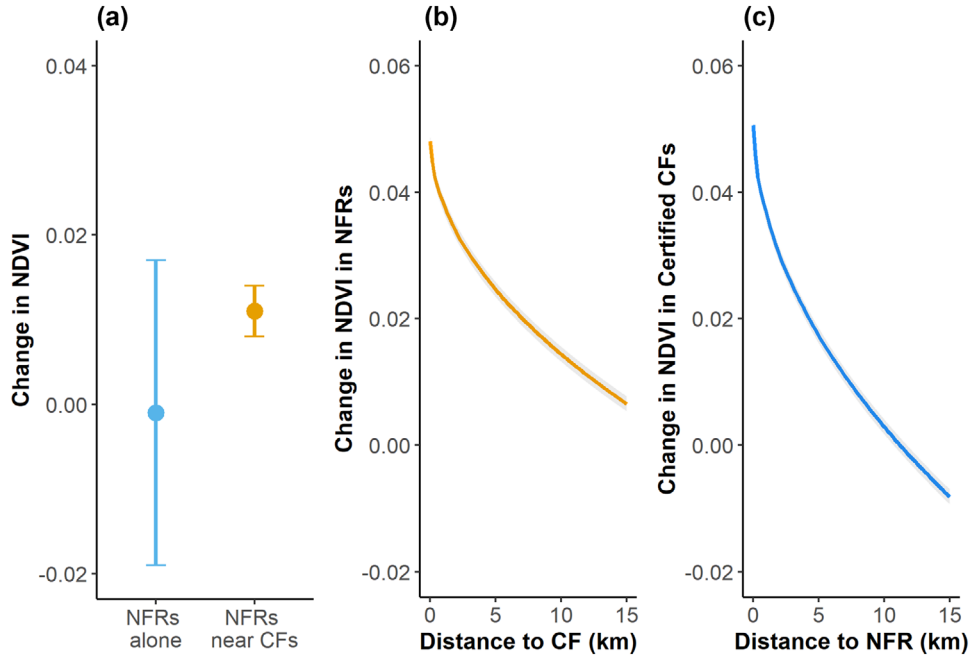

FIGURE 5 (a) The impact on NDVI change of having certified CFs within 10 km of National Forest Reserves (NFRs) = 0.011, *SE* = 0.002, *p* = < 0.001. How NDVI change in (b) NFRs is affected by distance to CFs = −0.013, *SE* = < 0.001, *p* < 0.001), and (c) in CFs by distance to NFRs = −0.015, *SE* = < 0.001, *p* < 0.001) with grey shading showing model estimated standard errors (see Supporting Information Tables S3).

certified CF communities had higher mean indicator scores for access to clean water, food security and education facilities (see Supporting information Table S8). But domains of material wellbeing and social relations were not different between villages with and without certified CFs.

NFRs within 10 km of certified CFs had positive NDVI change compared to matched NFRs more than 10 km from CFs (Figure 5a). In both NFRs and Certified CFs, NDVI change was more positive closer to the contrasting governance approach and negatively associated with increasing distance (Figure 5b and c). Communities with

Certified CFs positively impacted community relations with neighboring NFR managers by reducing conflicts (estimate = 1.212, $SE = 0.204$, $p = < 0.001$).

4 | DISCUSSION

Our findings suggest that certified CFs (1) positively impact both human wellbeing and conservation effectiveness, (2) reduce gender inequality, though not elite capture, and (3) improve conservation and social interaction effects with neighboring NFRs.

We found evidence of heterogenous social impacts with health, security, and freedom domains of wellbeing positively impacted, but no observed impacts on the material and social relations domains. This is in accordance with global analyses of CFs, which suggest that trade-offs between outcomes are more common than uniform benefits (Hajjar et al., 2020), and shared community benefits are more common than individual financial benefits (Burivalova et al., 2017). In the CFs studied, a hybrid form of revenue distribution was employed that includes both egalitarian and merit-based distribution (McDermott et al., 2013). The largest proportion of funds (50% egalitarian distribution) is spent on village development projects that all villagers should benefit from, such as improvements in village health and education provision. Whereas 40% of timber revenue is paid directly to forest managers (merit-based) and the remaining paid to NGO and governmental agencies for technical support. This form of benefit distribution is distinct from CF programs in other countries such as Nepal and Kenya, where timber revenue is distributed through direct financial disbursements to households (Braber et al., 2018; Walpole & Leader-Williams, 2001). This divergence in governance and observed wellbeing impacts likely represents a trade-off between individual, material wellbeing and community, nonmaterial wellbeing. While the observed nonmaterial benefits highlight the value of using broadly framed social impact evaluations to capture diverse impacts of PAs on human wellbeing (Woodhouse et al., 2015).

Unlike findings from CFs elsewhere in Tanzania and globally (Hajjar et al., 2020; Magessa et al., 2020), we did not find evidence of increasing inequality between local elites and nonelites. However, we found that inequality was not reduced by certified CFs, suggesting that a greater emphasis on equitable benefit sharing may be needed if CFs are to contribute to overcoming structural inequalities. We found evidence of increased gender equality, likely due to the form of CF governance studied here. Unlike other regions of Tanzania, CFs were augmented by FSC certification. FSC transparency requirements enable greater public scrutiny, supporting democratic decision making and fairer distribution of benefits and gender equality is specifically promoted through gender-specific requirements for participation in training and employment opportunities (FSC, 2018; Martin et al., 2019). The cost of delivering these equity benefits is that certification programs have significant documentation requirements that present technical capacity challenges for nonspecialists (Burivalova et al., 2017). To overcome the capacity gap, in this case an NGO, MCDI supports community institutions and this long-term governance capacity building is likely a necessary ingredient for success.

The study of PA interaction effects is in its infancy (Baylis et al., 2016; Sims & Alix-Garcia, 2017). Our results indicate the presence of a buffering effect between PAs, as conservation effectiveness was improved by locating contrasting governance approaches of certified CFs and NFRs close to each other. The positive impact of Certified CFs on community relations with NFR managers provides additional support for the presence of synergistic effects between national and local PA governance. We suggest that moving beyond impact evaluations of single governance approaches operating in isolation, to recognizing the contribution of multiple governance approaches operating in concert represents an important future direction for impact evaluations. Such advances have a wide range of applications including understanding the impact of PA zonation and the cumulative impacts of mining operations in the growing field of integrated landscape management (Sayer et al., 2013).

Overall, we suggest that discussions concerning recentralization of CFs should be reconsidered in the light of the observed positive impacts. Our study supports calls to look beyond simplistic win-win framings of PAs in favor of seeking to understand complex PA impacts in order to better serve diverse and particularly marginalized actors (Agarwal, 2009; Baylis et al., 2016). Specific policy implications of our study concern the potential to utilize the observed synergistic effects between PAs. Locating autonomously governed national PAs and CFs next to each other might be a more impactful policy option than power-sharing approaches between national and local actors in the same PA, which have so far yielded poor results (Keane et al., 2020; Persha & Meshack, 2015). We propose that the next trend in the evolving governance of PAs might focus on novel configurations of national and local PA governance approaches to develop coherent PA networks that optimize conservation and wellbeing benefits within complex multi-use landscapes.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHORS' CONTRIBUTIONS

RL led the manuscript conceptualization, fieldwork, data processing, analysis, and manuscript development. SMS supported conceptualization and manuscript review. MP supported remote sensing analysis and manuscript review. JAO supported matching analysis and manuscript review. MM supported fieldwork coordination and manuscript review. DS supported remote sensing analysis. JL supported figure development and manuscript review. PJP supported statistical analysis. ARM supported conceptualization, statistical analysis, and manuscript review.

ETHICS STATEMENT

The research design was reviewed and approved by the University of York Environment Department Ethical Review Committee

DATA ACCESSIBILITY STATEMENT

The primary data that support the findings of this study are openly available in Reshare data depository at https://reshare.ukdataservice.ac.uk/855056/

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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