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Even after armed conflict, the environmental quality of Indigenous Peoples' lands in biodiversity hotspots surpasses that of non-Indigenous lands

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ABSTRACT

Indigenous Peoples lands cover over a fifth of the world's land surface and support high levels of biodiversity. However, for centuries Indigenous Peoples have suffered from deprivation, often dispossession, and even cultural genocide, a process continuing today in some regions. Biodiversity hotspots, global areas of high endemicity that are heavily threatened by habitat loss and other human activities are also affected by conflict. Although covering only 2.4 % of the world's surface, over 80 % of armed conflicts occurred in biodiversity hotspots between 1950 and 2000. Given that many hotspots overlap with Indigenous Peoples' lands, we asked whether the co-occurrence of Indigenous Peoples' lands and high ecological integrity, measured by using Intact Forest Landscapes as units which still contain significant biological diversity, and the Human Footprint as a proxy for anthropogenic impacts, increased the persistence of biodiversity in hotspots where there has been armed conflict. Our results show that, within biodiversity hotspots, armed conflict was more likely to occur on Indigenous Peoples' lands than non-Indigenous lands, yet environmental damage and anthropogenic impacts were both lower. We suggest that Indigenous Peoples have been able to moderate ecosystem degradation processes before, during, and after armed conflict because of their strong ties to their lands and their determination to defend their rights and territories. We argue that recognition and support for the efforts of Indigenous Peoples to protect their lands is not only socially just but also essential for meeting the now pressing global post-2020 conservation targets.

1. Introduction

Biodiversity hotspots, areas in which at least 1500 species of vascular plant are endemic and which have lost at least 70 % of their primary vegetation, cover 2.4 % of Earth's land surface (Myers et al., 2000). The 36 identified hotspots occur across six continents and host nearly 43 % of the world's bird, mammal, reptile and amphibian species as endemics in addition to their botanical importance (Hoffman et al., 2020). However, over 90 % of major armed conflicts (for definition see Upsala University, 2022) between 1950 and 2000 occurred in countries containing hotspots, with over 80 % of these conflicts affecting the hotspots themselves (Hanson et al., 2009). This has often been in addition to environmental impacts resulting from independence struggles and agricultural expansion to accommodate expanding populations (Rudel, 2009)·

Between 1950 and 2000, over two-thirds of biodiversity hotspots experienced substantial discord, with many enduring recurrent instances of armed conflict, sometimes spanning multiple decades (Hanson et al., 2009). In these armed conflicts, not only were combatants and civilians subjected to attacks and casualties, but the political and social disruptions caused by the violence also adversely affected the relationship between local communities and their natural environment, often

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leading to degradation of the latter (Austin and Bruch, 2000; Shambaugh et al., 2001). Additional indirect impacts on biodiversity can result from the displacement of people away from conflict areas causing increased deforestation, resource extraction, and changes in settlement patterns (Draulans and Van Krunkelsven, 2002; Hanson, 2018; Douglas and Alie, 2014; Gaynor et al., 2016; Bongaarts, 2019; Mendiratta et al., 2021).

During the active phase of armed conflicts, biodiversity conservation activities can sometimes persist through continued active engagement by local conservation practitioners, sometimes with ongoing support from international non-governmental organizations (Hanson et al., 2009; Dudley et al., 2002; Daskin and Pringle, 2018). In cases of severe armed conflict, however, ongoing conservation action may no longer be feasible, exacerbating adverse effects on habitats and species (Gaynor et al., 2016; Conteh et al., 2017; Daskin and Pringle, 2018). In some places, environmental damage increases after active fighting has ceased because deforestation and resource extraction are less likely to be disrupted (McNeely, 2003; Grima and Singh, 2019). Drivers of conflict often act in concert, amplifying or offsetting its effects on biodiversity (Dudley et al., 2002). While armed conflict may temporarily deter environmentally destructive activities (e.g., Prem et al., 2020), its overall impact on biodiversity, in both the short and long term, is almost always negative (Gaynor et al., 2016).

Land management institutions, led by Indigenous Peoples across various regions globally, have demonstrated remarkable persistence and resilience, even amid challenging social, economic, and political conditions (Ford et al., 2020; Brondízio et al., 2021). Despite facing colonial domination, state-sanctioned violence, and the rapid expansion of extractive activities, Indigenous Peoples are connected to approximately 22 % (38 million km^2) of the world's terrestrial land area, spread across 87 countries or politically distinct regions (Garnett et al., 2018). Within these lands, Indigenous Peoples often serve as stewards of global biodiversity (Brondizio and Tourneau, 2016; Walker et al., 2020), as shown by the disproportionate presence of Intact Forest Landscapes (Fa et al., 2020; Sze et al., 2022), terrestrial mammals (O'Bryan et al., 2021), and primates (Estrada et al., 2022). The proactive stewardship of their lands and waters, coupled with their determination to preserve cultural and spiritual ties, has often prevented intensive development in Indigenous Peoples' territories (Balzer, 1999; Sanderson et al., 2002; Gorenflo et al., 2012). However, conflicts, including armed confrontations, impose additional pressure on any people living in a region, including Indigenous communities. Despite the resilience of Indigenous Peoples, these armed conflicts can present significant challenges and threats to the continuity of their sustainable land management practices and biodiversity stewardship.

The social-ecological factors associated with armed conflicts, such as poverty, challenging terrain, population size, and governance issues are complex (Fearon and Laitin, 2003). Thus, the impacts of armed conflict may be affected by the type and duration of the violent engagement, existing governance structures, or whether conflict is active or recently ended (Gaynor et al., 2016; Hanson, 2018; Conteh et al., 2017). Due to these complexities, it is challenging to establish causality for any correlation found between Indigenous Peoples' stewardship and the ecological health of their lands within biodiversity hotspots that have conflict. Nonetheless, uncovering evidence that Indigenous Peoples' lands retain significant biodiversity integrity in conflict-affected areas would further support the argument for strengthening their rights and providing enhanced support for conflict resolution in such regions, considering their global conservation significance.

In this study, we assessed whether biodiversity is more likely to persist on Indigenous Peoples' lands within biodiversity hotspots compared to areas that are not designated as such, even in the presence of armed conflict. By overlaying spatial data on Indigenous Peoples' lands, biodiversity hotspots, conflict and measures of environmental quality, we have been able to identify patterns across multiple hotspots that reinforce the evidence of the critical roles that Indigenous Peoples' lands play in the conservation of biodiversity, explore reasons for the patterns observed and the potential to facilitate and support such contributions.

2. Methods

We combined the following five spatial layers in this analysis as reflective of the matters we investigated:

1. *Biodiversity Hotpots*: We obtained the global map of Biodiversity hotspots (Hoffman et al., 2020) then separated terrestrial 'hotspot area' and marine 'outer limit' polygons by the 'name' attribute. The resulting layer was then intersected with geospatial data for the world's administrative areas (Global Administrative Areas, 2015).
2. *Indigenous Peoples' lands*: We used a published map of Indigenous Peoples' lands (Garnett et al., 2018) which had already been intersected with the world's administrative areas. The measures of Indigenous Peoples' lands used here should be considered conservative as many such areas have not been mapped. As a result, areas not marked as Indigenous Peoples' lands (referred to as 'other lands') do not necessarily indicate an absence of Indigenous Peoples but are areas where the presence of Indigenous Peoples could not be inferred from the available data (Garnett et al., 2018).
3. *Conflict Zones*: We adopt the definition of armed conflict provided by the Upsala Conflict Data Program (Upsala University, 2022): "a contested incompatibility that concerns government and/or territory where the use of armed force between two parties, of which at least one is the government of a state, results in at least 25 battle-related deaths". Conflict zones were determined by combining armed conflict sites data for 265 conflicts across southern Asia, South America, Africa, southern Europe and the Middle East (1946–1988; Buhaug and Gates, 2002; 1989–2008; Hallberg, 2012). We created a conflict zone spatial layer by buffering each armed conflict site center point by its 'Radius'. We constrained each conflict zone to within the extent of the boundaries of the administrative areas (Global Administrative Areas, 2015) as reported in the 'Conflict Territory' attribute. The extended period was chosen to capture as many of the long term impacts on land use as possible, while recognising that substantial variability in the data will occur because the effects of long lasting or older wars are likely to differ from those of short or recent conflict. While we considered the conflict zone a good representation of the core area and extent of armed conflicts, we are aware that in our definition and maps of armed conflict (Buhaug and Gates, 2002; Hallberg, 2012; Upsala University, 2022), the persecution, marginalization, displacement and/or dispossession of Indigenous Peoples is not included. Persecution of Indigenous Peoples has occurred intermittently both inside and outside hotspots for centuries (Mamo, 2020; Le Billon and Lujala, 2020).

We intersected the spatial data for the armed conflict zones, hotspots, and Indigenous Peoples' lands to create a flat spatial layer with four land types: (1) hotspot only; (2) hotspot and conflict zone; (3) hotspot and Indigenous Peoples' lands; and (4) hotspot, conflict zone and Indigenous Peoples' lands.

We chose two measures of environmental quality as being likely to capture many of the mappable environmental impacts of war, acknowledging that some features, such as of large wildlife that can suffer from increased hunting during conflict (Gaynor et al., 2016), are currently unmappable.

1. *Intact Forest Landscapes* (IFL): IFL are geographical regions defined as containing "ecosystems minimally influenced by human economic activity with an area of at least 500 km^2 and at least 10 km wide" (Potapov et al., 2017). We used data current in 2016 (IFL, 2020), eight years after the last conflict data, as we considered that this allowed enough time for forest loss to become apparent since the

most recent conflict considered. Areas affected by low-intensity and historic human influence, such as hunting, scattered small-scale shifting cultivation, horticulture, and preindustrial selective logging may be included in IFL (Watson et al., 2016). In fact, some of the best-conserved and most intact forest landscapes in the world have been actively shaped and managed by Indigenous Peoples over millennia (Gorenflo et al., 2012; Garnett et al., 2018).

2. *Human Footprint* (HFP): HFP is an index of environmental condition of an area that combines data on major roadways, navigable waterways, railways, crop lands, pasture lands, the built environment, light pollution, and human population density. Values range from 0 to 50, where 0 indicates that none of the human pressures specified were detected (Sanderson et al., 2002). For HFP we used data current in 2009 (Venter et al., 2016) as this is the most recent available. We also used the HFP layer to identify 'natural land' defined as land with an HFP of three or less, land with the lowest level of human modification using the seven metrics and thus likely to support the biodiversity most likely to be impacted by such disturbance (Watson et al., 2016).

We converted the spatial layer of the four land types that combined hotspots, conflict zones and Indigenous Peoples' lands from vector to raster format, with a cell size of 1 km by 1 km to align with the HFP and IFL datasets that were also converted to the same cell size and alignment. We then intersected the layer of the four land types with the two spatial data sets that described the environmental conditions of the land (IFL and HFP). For each land type we calculated three variables: (i) mean HFP; (ii) areal extent of 'natural' lands (HFP $\leq$3) and (iii) the areal extent of IFL. All geospatial analyses were conducted in the Mollweide projection using ArcGIS Pro v2.3.0.

3. Results

Of the 36 biodiversity hotspots, 31 included documented Indigenous Peoples' lands (86 %) encompassing 5.6 million km^2 (22 %) of the total combined hotspot area of 25.0 million km^2 (Table S1). About 4.4 million km^2 of the Indigenous Peoples' lands within hotspots had experienced armed conflict (79 %; Fig. 1), much higher than on hotspot areas on other lands (51 %).

The three proxies used to assess environmental condition were all more favourable for Indigenous Peoples' lands than on other lands, regardless of conflict.

IFL covered <0.8 million km^2 (3 %) of hotspots. Over half (51 %) of the area of these IFL was within Indigenous Peoples' lands regardless of whether there had been conflict. IFL covered 7 % of the Indigenous Peoples' lands affected by conflict but 2 % of the other conflict-affected lands. For areas without conflict, equivalent percentages were 8 % and 2 % respectively. Of the 23 hotspots with both Indigenous Peoples' lands and other lands that also supported IFL, the area of IFL relative to the area of land type within each hotspot was disproportionately higher on Indigenous Peoples' than on other lands, regardless of whether armed conflict occurred during the studied time period (Fig. 2).

Average HFP for hotspots on Indigenous Peoples' lands affected by conflict was 7.3 compared to 10.3 for other conflict-affected lands. For areas without conflict, equivalent scores were 5.0 and 9.0, respectively (Table S2). For 80 % of hotspots within Indigenous Peoples' lands, mean HFP was lower on Indigenous Peoples' lands than for the full hotspot area overall, regardless of whether the area had been affected by conflict (Fig. 3).

Natural lands made up 25 % of hotspot areas on Indigenous Peoples' lands affected by conflict compared to 10 % for other conflict-affected lands. For areas without conflict, equivalent scores were 47 % and 23 %, respectively (Table S2; Fig. 2b). For hotspots containing both Indigenous Peoples' and other lands and HFP data ($n = 30$), the area of natural lands relative to the area of land type within each hotspot was disproportionately higher on Indigenous Peoples' than on other lands, regardless of whether armed conflict occurred during the studied time period (Fig. 4).

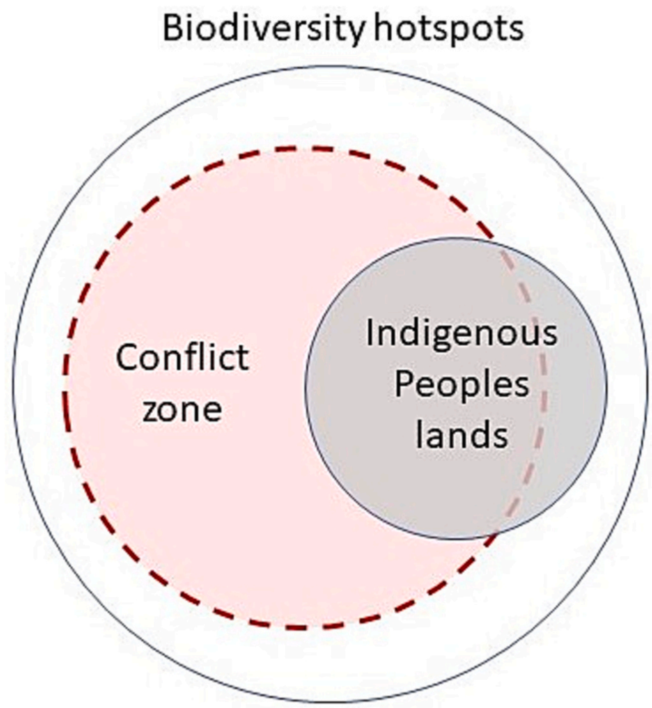

Fig. 1. Intersections among biodiversity hotspot areas, Indigenous Peoples' lands and the conflict zone. Circles and intersections are proportional to area, with the largest circle scaled to the total area of biodiversity hotspot areas (25 million km^2).

4. Discussion

Our study reveals a significant correlation between the presence of armed conflict and better proxy scores for environmental health within biodiversity hotspots on Indigenous Peoples' lands compared to other lands. Previous research has acknowledged the prevalence of armed conflict in both biodiversity hotspots (Hanson et al., 2009) and Indigenous Peoples' territories (IWGIA, 2022). However, in our analyses we demonstrate that, despite the occurrence of armed conflict within hotspots, the negative environmental impacts on Indigenous Peoples' lands are likely to be less than in other lands. We attribute this finding to two main factors.

The first is that the lands remaining with Indigenous Peoples' are often those that settlers considered to be of low commercial worth during colonisation because they are too steep, remote, or infertile, at least compared to other lands (Leonard et al., 2020). However, given that a greater proportion of the Indigenous Peoples' land within hotspots was affected by conflict than was that in other lands, these same features may now lend themselves to guerilla warfare against the State. Many of the wars of independence and subsequent insurgencies have been within rainforest (Rudel, 2009) and Indigenous Peoples' lands have been used by combatants as hideouts e.g., guerillas in Colombia (Baptiste et al., 2017; Reardon, 2018). Also, under certain circumstances, Indigenous peoples themselves are sometimes active combatants against a state whose authority they do not recognize. For example, the Karen and Chin peoples in Myanmar, who live in the Indo-Burma hotspot- which has the largest area of Indigenous Peoples' lands with conflict, have reportedly been fighting state forces since Myanmar became independent of the British (Dunford, 2019).

Secondly, the presence of Indigenous Peoples or their active resistance may have contributed to the preservation and regeneration of

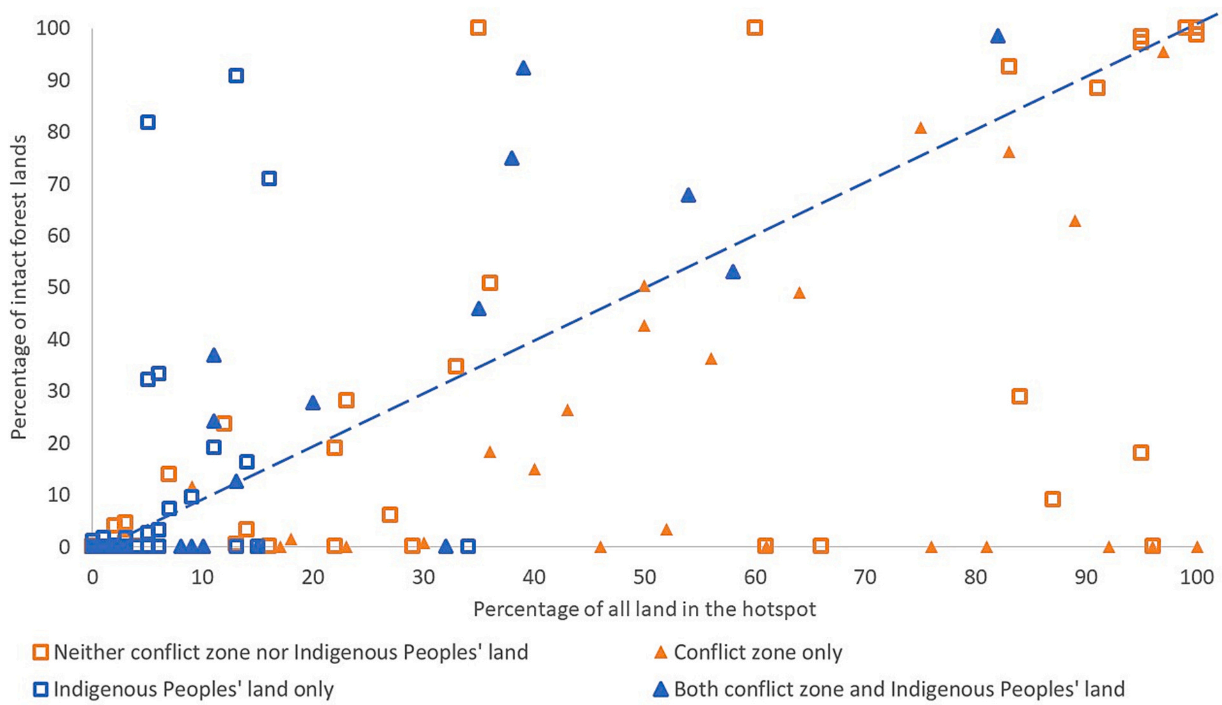

Fig. 2. Within biodiversity hotspots, the percentage of each land type and the percentage of Intact Forest Landscapes (IFL) extent that each land type accounts for. The dashed line represents a 1:1 ratio between the percent of hotspot area and percent of IFL; all points to the left of the dashed line indicate land types within a hotspot area that have a higher percentage of IFL extent relative to their area. Data is shown for the 23 biodiversity hotspot areas with IFL and both Indigenous Peoples' lands and non-Indigenous lands.

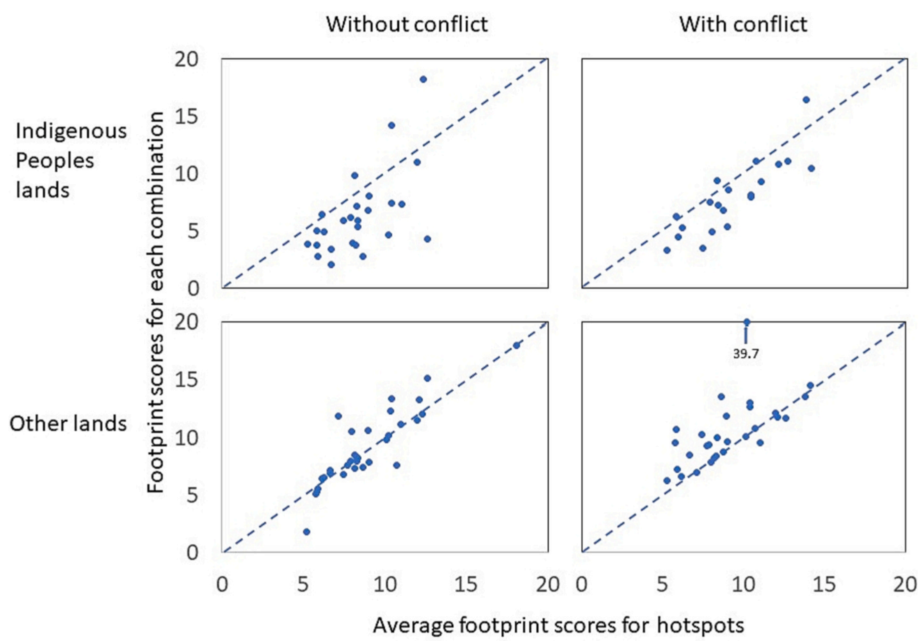

Fig. 3. Comparisons of the mean Human Footprint scores for each hotspot regardless of area with the mean HFP scores for each combination of Indigenous Peoples lands and other land and of land with and without conflict. One hotspot with a Human Footprint score more than double any other is indicated with a arrow.

their lands, preventing environmental degradation even though there are armed hostilities (Zanotti, 2016; Orta-Martínez et al., 2018). In some cases, the conflicts in hotspots between Indigenous Peoples actively resisting either the State or people given legal authority by the State (e.g. mining and logging companies) has been explicitly to retain control of forest resources (Armstrong and Brown, 2019). In such cases, the motivations of the Indigenous Peoples may not be explicitly to protect the environment but their actions have nevertheless led to positive outcomes for the environment (Armstrong and Brown, 2019; Scheidel et al., 2020).

Many Indigenous communities defend their territories and livelihoods against environmental degradation through non-violent grassroots mobilization (Bruch et al., 2019; Fernández-Llamazares et al., 2020; Global Witness, 2021). The commitment to the environment

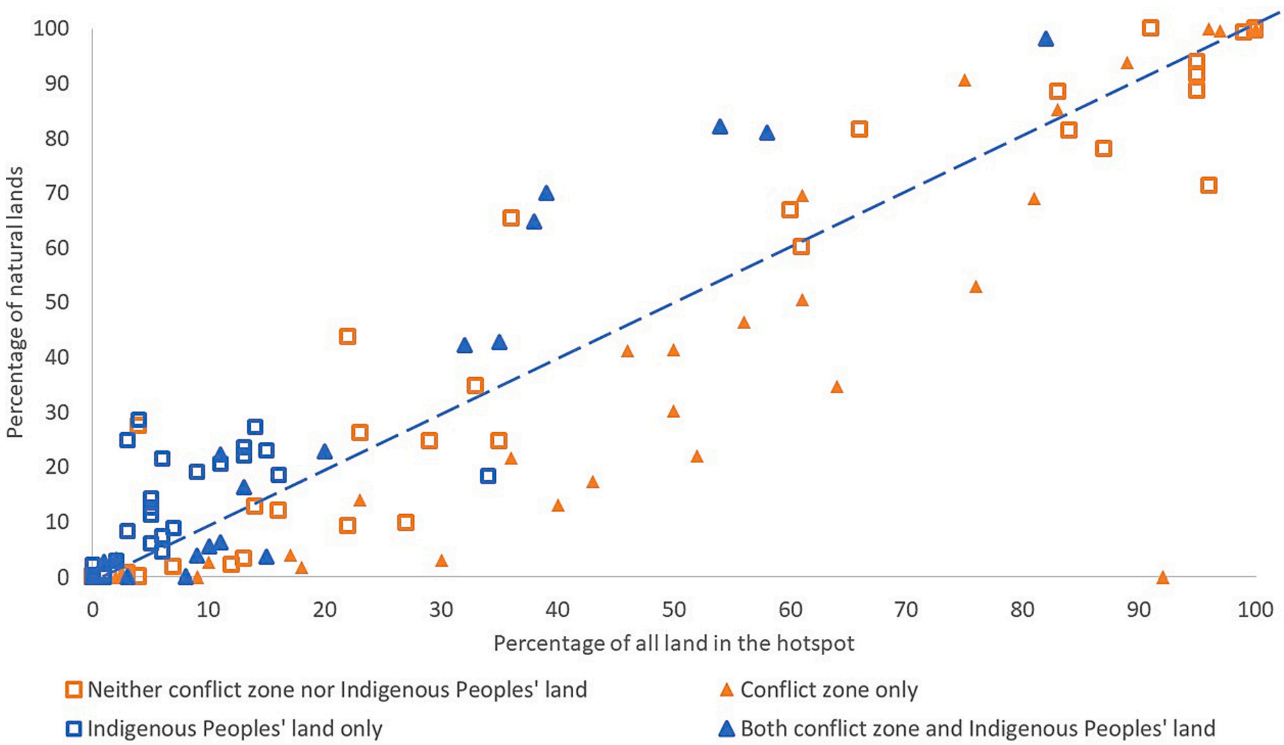

Fig. 4. Comparison between the percentage of each land type within a hotspot area and the percentage of natural land extent that each land type accounts for within a hotspot area. The dashed line represents a 1:1 ratio between the percent of hotspot area and percent of natural land extent; all points to the left of the dashed line indicate land types within a hotspot area that have a higher percentage of natural land extent relative to their area. Data is shown for the 30 biodiversity hotspot areas with HFP data and both Indigenous Peoples' lands and non-Indigenous lands.

indicated by such activism is increasingly acknowledged in both scientific and policy circles (Le Billon and Lujala, 2020; Scheidel et al., 2020, 2023). However, rarely is Indigenous environmental activism rewarded by the State (Bruch et al., 2019; Global Witness, 2021) and there are even examples of conservation organizations siding with the State to appropriate lands from Indigenous Peoples in conflict zones (e.g. southern Myanmar; Woods and Naimark, 2020). In some such cases, the intervention by conservation advocates has been counter-productive, resulting not only in the disempowerment of Indigenous Peoples but also pitting them against conservation, to the detriment of the environment (e.g. Batwa in eastern Congo; Simpson and Geenen, 2021).

Usually, however, fair and inclusive conservation can reduce the risk of conflict while also providing tangible benefits to both ecosystems and human communities (Conca and Dabelko, 2002; Bruch et al., 2016; Ajroud et al., 2017). Better integration of rights-based approaches, Free, Prior, and Informed Consent (FPIC), and inclusive decision-making must be considered non-negotiable components of any socially-just conservation efforts aspiring to support Indigenous Peoples in their aspirations for ongoing stewardship of their lands (IPBES, 2019; E/C.19/2019/7; Tauli-Corpuz et al., 2018; although see Mitchell and Wagner, 2023 on the limits of FPIC).

Understanding how Indigenous Peoples' lands have maintained high ecological integrity despite armed conflicts is a crucial initial step towards effective conservation in the biodiversity hotspots under consideration. Based on existing knowledge, a key aspect of this process involves encouraging governments to acknowledge and respect Indigenous Peoples' enduring connections to their traditional lands by ensuring secure land tenure and associated rights. Our research findings align with those of other studies (Brondizio and Tourneau, 2016; Fa et al., 2020; Walker et al., 2020; O'Bryan et al., 2021; Estrada et al., 2022; Sze et al., 2022), which emphasize the integral connection between supporting Indigenous Peoples' rights and advancing socially-just biodiversity conservation (see also Kennedy et al., 2023). By doing so, we can work towards fulfilling the Convention on Biological Diversity's vision of "Living in harmony with nature" by the year 2050.

5. Conclusion

Our research shows a correlation between various measures of environmental quality and Indigenous Peoples lands, even in areas with armed conflict. The consistency of our results with other, broader studies showing a strong positive relationship between different indicators of environmental quality and Indigenous Peoples' lands suggests that the place-based linkage to Indigenous Peoples is likely to be genuine. However, our evidence is correlative, and we cannot ascribe cause to the patterns we have observed. Also, the effects of some of the older conflicts will have been diluted by subsequent events, and will certainly have had varying impact within the areas we have considered affected by conflict depending on both the biophysical and social environment. We therefore strongly recommend that the broad scale correlative results we have uncovered should be followed up by more detailed research and analysis at local, national and regional scales. The diversity of rights, tenures and experiences of Indigeneity, with their respective histories of domination by, and resistance to, settler colonial powers, in addition to the variations in the types and timing of armed conflict that has so often affected both Indigenous Peoples and biodiversity hotspots, makes more detailed analysis with existing data inherently risky. Such research will need to tease out the factors operating at a local level in the environment and among the societal groups affected by the conflict to determine to what extent the patterns we have observed can be attributed directly to the role Indigenous Peoples play in environmental management and stewardship.

The findings of this paper suggest that Indigenous Peoples could be sometimes providing the last line of defence for some of the world's biodiversity hotspots. A corollary to this is that our moral imperative to support Indigenous Peoples in these areas (as enshrined in the United

Nation's Declaration on the Rights of Indigenous Peoples) is likely to result in positive conservation outcomes. In some places, this may involve strengthening Indigenous Peoples' rights to land but in others the support may involve strengthening the local economy and reducing poverty for multiple stakeholders to reduce the probability of conflicting recurring – there can be no prescriptive policy response without assessment of local conditions and needs. Nonetheless, at a broader policy level, our research strengthens further the need for Indigenous Peoples to be full partners in global biodiversity conservation initiatives.

Positionality statement

The authors of this study acknowledge their standpoint as non-Indigenous scientists from the 'Global North'. We recognize that our understanding of Indigenous issues is partial and situated, and largely influenced by our background as conservation scientists. Nonetheless, we see the protection of Indigenous Peoples' rights as a fundamental moral duty, irrespective of the contributions our research can make in safeguarding public conservation interests.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

All data are available online. We have only used data already published or openly accessible and referenced. We have provided the links to the used datasets.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.biocon.2023.110288.

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