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BRIEF REPORT

30 by 30 for plant diversity: How can we protect more of nature?

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Societal Impact Statement

Proposals to increase protected area networks to 30% of land area globally will, given habitat conversion, require ecosystem restoration. Trait-based approaches provide tools for this and highlight priorities for protected area expansion—both where functional diversity has the highest values and where it is higher than expected given species richness. Maps of sampled angiosperm species from across Africa show where these diversity metrics deviate. These maps also show the 30% of land with greatest potential to support functional diversity at national and continental scales, of which less than a quarter is protected, demonstrating the need for coordinated trans-national plant conservation efforts.

KEYWORDS
biodiversity, conservation planning, functional over-dispersion, land management, plant functional diversity, restoration

1 | INTRODUCTION

Area-based protection (ABP) of biodiversity includes both statutory protected areas (PAs) and protection provided by other effective area-based conservation measures (OECMs), and these are important tools for conservation. While reviews of ABP have shown variation in effectiveness (e.g. Geldmann et al., 2019), increasing targets have been proposed for the proportion of land globally to be protected, over 35 years, from tripling the then 4% coverage in 1987 (Brundtland, 1987) to an ambitious 50% target (Noss et al., 2012). Currently, 16.02% of land globally receives ABP (UNEP-WCMC & IUCN, 2023), and increasingly, management incorporates human use within ABP (Geldmann et al., 2019). A new target to protect 30% of land by 2030 (Baillie & Zhang, 2018) has recently been adopted by the Global Biodiversity Framework (CBD; Convention on Biological Diversity, 2022). Humans have substantially influenced at least 40% of land globally, with this influence often most intense in high-diversity biomes (e.g. Mediterranean; Jacobson et al., 2019). Expansion of ABP on land that has had the highest biodiversity will thus require both protecting intact remaining threatened habitats and restoring land that is degraded to some extent (Pringle, 2017).

Expansion of ABP is not uncontroversial given a history of policies that have led to the exclusion of people from land (Brockington & Igoe, 2006). If the ABP expansion outlined by the 30% target goes ahead, national and regional governments will most likely oversee this, ideally with trans-national coordination. Globally, ABP decisions have led to protection being largely located on marginal land unlikely to face conversion pressures and even biased away from species-rich ecosystems, for example, in desert areas (Joppa & Pfaff, 2009); additionally, positioning of ABP tends to focus on protecting iconic megafauna (Murphy et al., 2023). This suggests that better inclusion of plant diversity information could be beneficial during any ABP expansion. Here, we focus on Africa and the degree to which current ABP includes land with potential to support high plant diversity.

Plant *species richness* (SR) varies substantially across Africa (Harris et al., 2021); this simple metric has been used to assess spatial diversity patterns. *Functional diversity* (FD; the variability of trait values within a study area) has less often been considered during ABP designation, although it can complement other diversity metrics (Brummitt et al., 2020) as FD gives information on the potential range of ecological functions and strategies. FD is thus relevant for decisions regarding ABP; moreover, spatio-temporal changes in FD represent a useful trajectory indicator in ecological restoration (Funk et al., 2008). Importantly, FD can significantly deviate from SR (Swenson et al., 2012). For example, if an area supports a greater range of ecological strategies than expected for its SR ('over-dispersion' of FD), restoration objectives should reflect this.

Situating ABP where biodiversity metrics are highest is an established principle in conservation planning (Noss et al., 2012). To this end, we identify areas with greatest potential for supporting plant FD at a continental versus national scale. We also highlight, at the continental scale, areas where FD deviates from SR and whether these are protected—supporting their protection on precautionary grounds (given the potential for SR to undervalue the biodiversity and functioning of these areas). Specifically, we ask:

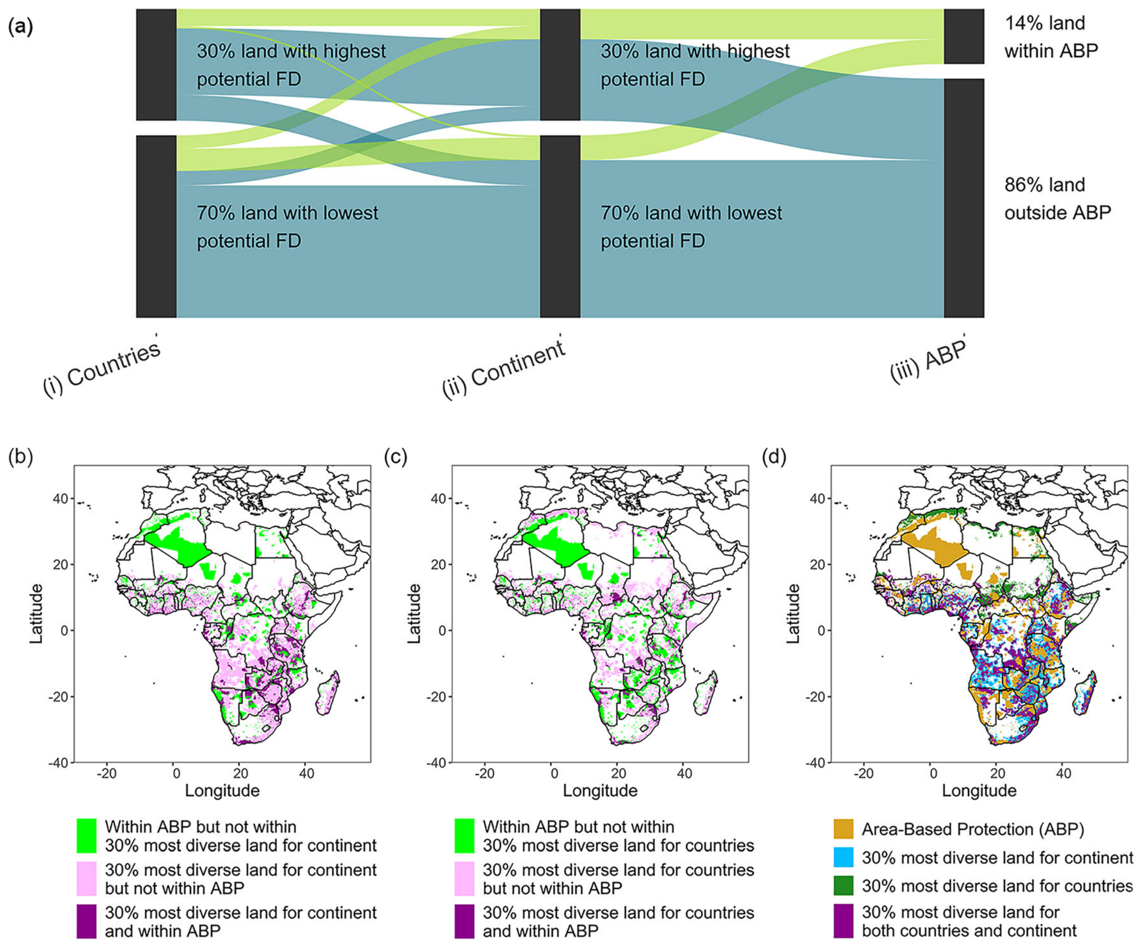

FIGURE 1 What proportion of land already receiving area-based protection (ABP) in Africa is within the 30% of land with greatest potential to support *functional diversity* (FD) at the national versus continental scale? Land outside or within ABP with high (30% land) or low (70% land) potential plant FD: (a) summary showing how the land area currently protected (iii) is divided across a 30%–70% split between the areas with the highest and lowest values of potential FD, this split being estimated (i) for each country in Africa, (ii) for the whole continent (differences between (i) and (ii) illustrate how high diversity areas within individual countries are not always high-diversity areas at the scale of the whole continent, while the ABP is the same at both scales). Most of the 30% of land with highest potential FD, at both the country and continental scale, is unprotected (dark blue-green). At the continental scale, most protected land (pale green) is within the 30% of land with highest potential FD, but this is not the case at the country scale. (b) Spatial intersection at the continental scale of the 30% of land area with the greatest potential FD and protected areas, (c) spatial intersection at the scale of individual countries of the 30% of land area with the greatest potential FD and existing ABP, (d) comparison between (b) and (c).

(Q1) What proportion of land already receiving ABP in Africa is within the 30% of land with greatest potential to support FD at the national versus continental scale?

(Q2) To what extent is land where SR deviates from FD currently protected?

2 | DATA AND METHODS

Our spatial projections of plant diversity are from a representative, random sample of 1% of all African angiosperm species (Harris et al., 2021, 2023). Spatial boundaries of African ABP, both PAs and OECMs, came from Protected Planet (UNEP-WCMC & IUCN, 2023). FD was previously calculated as the volume of the convex hull (functional richness) within trait space using three traits (maximum plant height, leaf area, seed volume) for species present within each pixel; species distributions were interpolated using species distribution modelling; this cannot overcome all spatial biases and uncertainties within underlying data, however (see Harris et al., 2021, 2023).

To answer Q1, we identified the 30% of pixels with greatest potential FD values at the continental scale and at the scale of individual countries; we then recognised those subsets that intersect with existing ABP. To answer Q2, sampled SR was used in combination with a null model to assess the deviation between FD and SR, expressed as a standardised effect size (SES.FD). We considered pixels where SES.FD > 1.96 or where SES.FD < −1.96 as showing significant over- or under-dispersion of FD, respectively (see Methods S1 for full details). Statistical analyses were performed in R, maps were visualised using GGPLOT and plots using GGFORCE.

3 | RESULTS AND DISCUSSION

3.1 | Answering Q1: Less than a quarter of the 30% of land with highest potential to support plant functional diversity is currently protected

Currently, 14.39% of Africa's land area receives ABP (Figure 1a iii), a proportion higher than in Europe (13.67%), but still lower than the global level (16.02%). We identified the 30% of land with greatest potential to support plant FD at the continental scale, and >¾ of this land also had a high potential at the individual country scale (Figure 1d). At the continental scale, the intersection between the 30% of land with greatest potential to support FD and existing ABP is less than 7% of land area (Figure 1a ii & b), and this proportion falls to less than 6% at the individual country scale (Figure 1a i & c). These results indicate that ABP is rarely located in areas of highest plant FD. Current ABP is better aligned with cross-continental, rather than within-country, variation in plant FD (Figure 1d), suggesting that international agreements have influenced national decisions to achieve trans-national conservation objectives.

Not all ABP will be designated with the objective of conserving angiosperms. ABP in Cameroon, for example, has historically been largely based on hunting reserves, with low emphasis on plant diversity (Murphy et al., 2023). Furthermore, patterns of cross-taxon congruence are complex, hence prioritising other life forms cannot be assumed to also optimally capture plant diversity (Eckert et al., 2023). Our results suggest that the existing spatial placement of ABP within Africa does not align well with protecting plant FD.

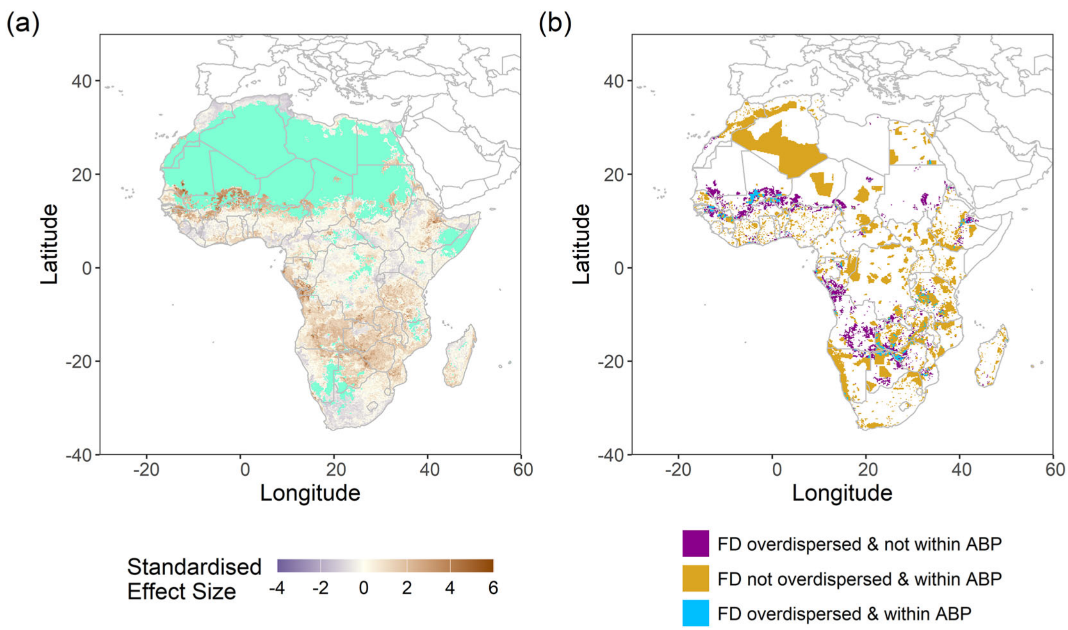

FIGURE 2 To what extent is land where *species richness* (SR) deviates from *functional diversity* (FD) currently protected? Deviation between FD and SR based on a null model approach: (a) deviation expressed as standardised effect size (SES.FD), with areas coloured turquoise having a sampled SR too low to estimate FD, (b) areas where FD is over-dispersed and their intersection with current area-based protection (ABP) (no areas were categorised as under-dispersed when using a threshold of SES.FD < −1.96).

3.2 | Answering Q2: 9% of land shows higher FD relative to SR and, of this, 21% is protected

Continent-wide, 9% of land shows FD over-dispersion (SES.FD > 1.96) at the continental scale (Figure 2), and no FD under-dispersion is detected. Twenty-one percent of land classified as over-dispersed (e.g. in the Sahel) is currently protected. At the same time, >½ of the land classified as over-dispersed overlaps with the continent's 30% of land with highest potential FD. This constitutes good news for conservation, since protecting that 9% of the continent will help prioritise the most functionally distinct and diverse areas for plants, in line with the CBD's Global Biodiversity Framework.

4 | CONCLUSIONS

ABP in Africa has been established over a period of more than a century, with the total area doubling since 1990. More than doubling this again to achieve 30% of land by 2030 will be a challenge. If undertaken, such expansion would benefit from a continued shift towards decentralised and democratic decision-making around ABP (see Ribot et al., 2010), implementing management approaches where human use is compatible with conservation, and away from damaging exclusionary policies (Brockington & Igoe, 2006). Strategies for ecological restoration that exclude land suitable for intensive use are likely to unduly restrict the activities of more marginalised people (Dutta et al., 2020). Furthermore, we recognise that our analyses come with limitations as they are based on a single metric of FD, calculated on three traits capturing only a few plant functions, for 1% of the continental flora. We encourage future conservation and restoration studies to include other metrics detailing different diversity facets (e.g. phylogenetic; related to evolutionary history or distinctiveness), more traits linked to other key plant functions (e.g. resprouting ability related to disturbance responses), more species (ideally beyond plants and iconic animals), and information regarding conservation actions outside ABP.

Situating ABP in areas with the potential to support the highest plant diversity would mark a departure from locating ABP on land otherwise unsuitable for intensive human use, as arguably has occurred in some Northern African desert areas (e.g. Algerian Sahara). Encouragingly, some areas where FD is over-dispersed are already protected (21%), and our results suggest that the majority of land with disproportionately high FD is also within areas with the highest potential to support plant FD—key insights for setting conservation priorities. If an expanded, continent-wide network of ABP within a negotiated, inclusive, cross-country approach can be achieved (as recommended by the CBD's Global Biodiversity Framework), the potential for land to support plant diversity needs to be considered. Cognisant of the risk of overstating conclusions drawn from spatial projections of single and simplified metrics (Wyborn & Evans, 2021), we nonetheless suggest that plant functional diversity can be useful in complementing other metrics used in conservation and restoration planning.

AUTHOR CONTRIBUTIONS

Timothy Harris, Neil Brummitt and Mark Mulligan conceived the original research idea; Timothy Harris sourced the data and undertook the analyses, with support from Neil Brummitt and Mark Mulligan. Timothy Harris and Gianluigi Ottaviani wrote the manuscript. All authors contributed to and authorised the final version.

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CONFLICT OF INTEREST STATEMENT

The authors declare no competing interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in the Figshare Digital Repository at https://doi.org/10.6084/m9.figshare.24115812 [reference number: 24115812].

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SUPPORTING INFORMATION

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

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