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POLICY PERSPECTIVE

Designing a global mechanism for intergovernmental biodiversity financing

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Abstract
The Convention on Biological Diversity and the Nagoya Protocol display a broad international consensus for biodiversity conservation and equitable benefit sharing. Yet, the Aichi biodiversity targets show a lack of progress and thus indicate a need for additional action such as enhanced and better targeted financial resource mobilization. To date, no global financial burden-sharing instrument has been proposed. Developing a global-scale financial mechanism to support biodiversity conservation through intergovernmental transfers, we simulate three allocation designs: ecocentric, socioecological, and anthropocentric. We analyze the corresponding incentives needed to reach the Aichi target of terrestrial protected area coverage by 2020. Here we show that the socioecological design would provide the strongest median incentive for states which are farthest from achieving the target. Our proposal provides a novel concept for global biodiversity financing, which can serve as a starting point for more specific policy dialogues on intergovernmental burden and benefit-sharing mechanisms to halt biodiversity loss.

KEYWORDS
Aichi targets, biodiversity financing, Convention on Biological Diversity, fiscal transfers, international environmental governance, policy proposal, protected areas

1 | INTRODUCTION

The ongoing loss of biodiversity is considered one of the most serious global environmental problems because it threatens the foundation of life-supporting ecosystems (Steffen et al., 2015). Accordingly, the Convention on Biological Diversity (CBD) aims at safeguarding the planet's biosphere through conservation and sustainable use of biological diversity. While the CBD recognizes national sovereignty as a governing principle, it also affirms that the conservation of biodiversity is a "common concern of humankind" and thus a shared responsibility (United Nations & UN, 1992). The parties to the convention agreed upon implementing biodiversity strategies, monitoring, and conservation policies at the national level, but also consented to institutionalizing benefit sharing and funding mechanisms in the international arena.

Overall, there are five strategic goals of the CBD for 2020: (i) mainstream biodiversity policies, (ii) reduce pressure through sustainable use, (iii) safeguard ecosystems, species and genetic diversity, (iv) enhance and distribute benefits equitably, and (v) improve implementation (CBD, 2010). These goals are operationalized in 20 targets, the so-called Aichi targets (CBD, 2010). Most of the associated indicators show some but insufficient progress to reach the Aichi targets by 2020; some show no significant overall progress, some show movement away from the target, and very few target elements show sufficient progress (CBD, 2014). Additional, more ambitious effort beyond the current Aichi targets is required to bend the curve of biodiversity loss (Mace et al., 2018).

One of the main causes of insufficient progress is inadequate financing (Balmford, Gaston, Blyth, James, & Kapos, 2003; Hill et al., 2015; McCarthy et al., 2012; Ring et al., 2018; Waldron et al., 2013). Most conservation spending in developed countries comes from domestic sources while developing countries mainly rely on inter- and transnational biodiversity financing (McCarthy et al., 2012; Ring et al., 2018; Waldron et al., 2013). The international funding comes through UN Agencies like the Global Environmental Facility (GEF) which operates the financial mechanism under the CBD, and further bilateral international agreements (Ring et al., 2018; Waldron et al., 2013). The lack of overall progress towards the Aichi targets has led to calls for additional action and innovative financial mechanisms (CBD, 2014; Mace et al., 2018; IPBES, 2019).

Such mechanisms have been further specified in the Nagoya Protocol: Article 10 declares that a global multilateral access and benefit-sharing mechanism "to support the conservation of biological diversity" shall be considered by the parties (Buck & Hamilton, 2011). The access and benefit-sharing mechanisms are expected to create economic incentives for biodiversity conservation and although the CBD states in Article 20 that developed countries shall provide new and additional funding, no direct (financial) obligations arise from this. The access and benefit-sharing mechanisms are meant to facilitate "fair and equitable sharing of benefits" that originate from the utilization of genetic resources, and "appropriate funding" (Buck & Hamilton, 2011). An equitable sharing of *private* benefits with public administrations (nation states) is at the core of access and benefit-sharing mechanisms. However, conserving biodiversity also provides transnational *public* benefits that spill over to other countries such as climate regulation, existence values, insurance values, maintaining the gene pool and thus options for the future (Bartkowski, 2017; Perrings & Gadgil, 2003). Accordingly, benefits and costs of conservation are unequally distributed (Balmford et al., 2003; Perrings & Gadgil, 2003; Ring, 2008a). Thus, publicly shared but unequally distributed costs and benefits constitute a rationale for an internalization through intergovernmental benefit- and burden-sharing mechanisms to avoid underprovision of the related public goods (Olson, 1969). A *public to public* mechanism design for what constitutes a fair and equitable benefit sharing between states has yet to be developed (Morgera, 2016).

Largely unnoticed by the international community, Brazilian states have created and implemented innovative Ecological Fiscal Transfers (EFT) since the early 1990s. In order to compensate municipalities for the opportunity costs of hosting protected areas on their territory, in 1991 the state of Paraná implemented a mechanism that distributes a portion of tax revenue to municipalities in proportion to the share of municipal territory designated as protected areas (May, Veiga Neto, Denardin, & Loureiro, 2002; Ring, 2008b). Several other Brazilian states have subsequently implemented their own EFT schemes such that currently 17 out of 26 states have adopted various designs of the instrument (Droste, Lima, May, & Ring, 2017; May et al., 2002; Ring, 2008b). First impact studies show that the implementation of EFT schemes creates an incentive for the receiving municipalities to increase protected areas (Droste et al., 2017; Sauquet, Marchand, & Féres, 2014). In recent years EFT have gained recognition and Portugal has implemented a similar scheme at the national level in 2007 (Droste, Becker, Ring, & Santos, 2018a; Santos, Ring, Antunes, & Clemente, 2012). India has just introduced a major EFT scheme in 2014, redistributing 7.5% of the tax revenue to be transferred to states based on forest cover (Busch & Mukherjee, 2018). Several proposals to consider protected-area related indicators in fiscal transfer schemes have been developed for Switzerland, Germany, Poland, Indonesia and the EU, with a small-scale implementation in France (Droste, Ring, Santos, & Kettunen, 2018b; Irawan, Tacconi, & Ring, 2014; Köllner, Schelske, & Seidl, 2002; Schröter-Schlaack et al., 2014). An adaptation to the global level has been proposed but has not yet been designed or simulated (Farley et al., 2010).

Here, we develop three related proposals for such an intergovernmental transfer mechanism to share financial burdens of biodiversity conservation. We approach this task guided by the principle of fiscal equivalence (Olson, 1969). This principle has been developed for the financing of public goods and services within nation states. It asserts that those who benefit directly from the good in question should also pay for the costs of provision. It is meant to ensure an efficient provision of public goods and services since free-riding on the efforts of others incurs a suboptimal provision; making beneficiaries pay reduces the deadweight loss. In the case of such spillover benefits, the principle of fiscal equivalence calls for intergovernmental transfers in order to compensate those who bear the costs of provision (Olson, 1969). A resulting global EFT mechanism for the benefit sharing across nation states would provide an important and innovative contribution to reaching Aichi targets. This is especially the case since such a mechanism may incentivize nations to supply global benefits of conserving biodiversity through protected areas (Droste et al., 2017, 2018a; Farley et al., 2010; May et al., 2002; Ring, 2008a,b; Sauquet et al., 2014). It is meant to provide input to current efforts within the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services to identify policies that could help to slow down, halt and potentially reverse the current decline in biodiversity (Ring et al., 2018).

2 | DEVELOPING POLICY OPTIONS

We propose three design options of a transfer scheme with recurring payments. The *ecocentric design* is based on the idea that larger protected areas are generally better for biodiversity conservation and thus measures the total extent of protected area per country without relation to the size of the country, the number of protected areas, or any socioeconomic factors. The *socioecological design* adds a fairness element by granting a relatively larger share of the fund to less developed states and therefore computes a ratio of protected areas extent and the Human Development Index (HDI). Thus, the lower the HDI, the larger is the corresponding country indicator. The *anthropocentric design* extends the socioecological design by also accounting for population density. This would maximize the number of people that benefit from protected areas and thus increases the share for countries that have both many protected areas and people. To account for the different contributions to conservation goals, we weight protected areas under all designs by their IUCN category with increasing weights for stricter regulations. Thus, by design, protected areas that conserve more wilderness and pristine ecosystems are more "profitable" because they increase the ecological indicator that ultimately determines the financial flows.

In the following, we exemplify our design options by heuristic calculations to provide an intuition about how the simulated distribution of payments is computed. Formal specification of the calculations can be found in the Supporting Information. Suppose we take any country in the world. In this country, a hypothetical 15,000 km^2 of land is protected under different categories of protection. Stricter protected area categories such as wilderness areas or national parks may provide more effective conservation than a sustainable land use area where less stringent restrictions are in place. To account for these differences, we weight different protected area categories according to their strictness of conservation. For example, a national park is fully accounted for by a weight of 1 but since a sustainable use area is not contributing so much to conservation benefits, it only receives a weight of 0.5. Of the 15,000 km^2 of our example country, 5,000 km^2 are in national parks and 10,000 are sustainable use areas. We therefore compute that there is a total of 10,000 km^2 protected area to account for (5,000 × 1 for the national parks, plus 10,000 × 0.5 = 5,000 for the sustainable use areas). For the *ecocentric* design, this is the only factor we care about. We proceed to calculate these weights for all protected areas according to relevant IUCN categories for all countries and distribute the funds available among all countries according to their share of accountable protected area. The larger the total area under protection, the more transfers a country would get.

Because we may also care about countries' development status, the *socioecological* design combines protected areas with the country's HDI. Suppose we have one country that is "fully developed" (HDI = 1), and a country in which many basic needs of the people are not covered (HDI = 0.33). If we only had these two countries, and both had 10,000 km^2 of accountable protected areas, and we took the HDI into account inversely, the less developed country would get about three times as much from the fund as the developed country to compensate for its development gap.

Now, we may care not only about protected areas and development, but also about population. For the *anthropocentric* design, we also take population density into account. Suppose we have three countries, all of which have an accountable 10,000 km^2 of protected areas, and all are fully developed (HDI = 1) but their population density is different (100, 200, and 300, people/km^2, respectively). In this case the most densely populated country could receive three times as much as the most sparsely populated country, and as much as the two less densely populated countries combined.

In order to analyze these three designs, we can use different indicators to assess and compare them. First, we can calculate the total amount of transfers each country would receive: the *reward*. Second, we can compute how much greater a reward a country would receive if this country alone increased its protected area by say, one per cent of its total area. Let us call this additional transfer the marginal *incentive*. Lastly, the strength of the incentive may vary, depending on how rich a country is. Thus, the *leverage* indicates this strength by relating the incentive to the Gross Domestic Product as a measure of total income per country.

3 | RESULTING FINANCIAL FLOWS AND INCENTIVES

We simulate the resulting monetary flows per national CBD party for an arbitrarily chosen total sum of one billion international dollars for all CBD signatory states with their PA from early 2018. Figure 1 shows the *reward*, the *incentive*, and the *leverage* per country for all three design options.

The *ecocentric* design rewards mostly large countries, since they provide the largest extent of protected areas; it also incentivizes large countries most and provides the strongest incentives relative to GDP in Greenland and Africa. The *socioecological* design benefits poorer countries in Africa, Latin America and Oceania, but also Greenland and parts of Northern Europe. It provides the largest marginal incentives mainly in Africa and South Asia. The *anthropocentric* design benefits small island states, and several densely populated states with large protected areas across South (East) Asia, Africa, Europe and Latin America. The marginal incentives are highest in some Middle-Eastern and small island states. In relation to GDP the *anthropocentric* mechanism design incentives are strongest in small islands, and some African states. The different design options thus come with different

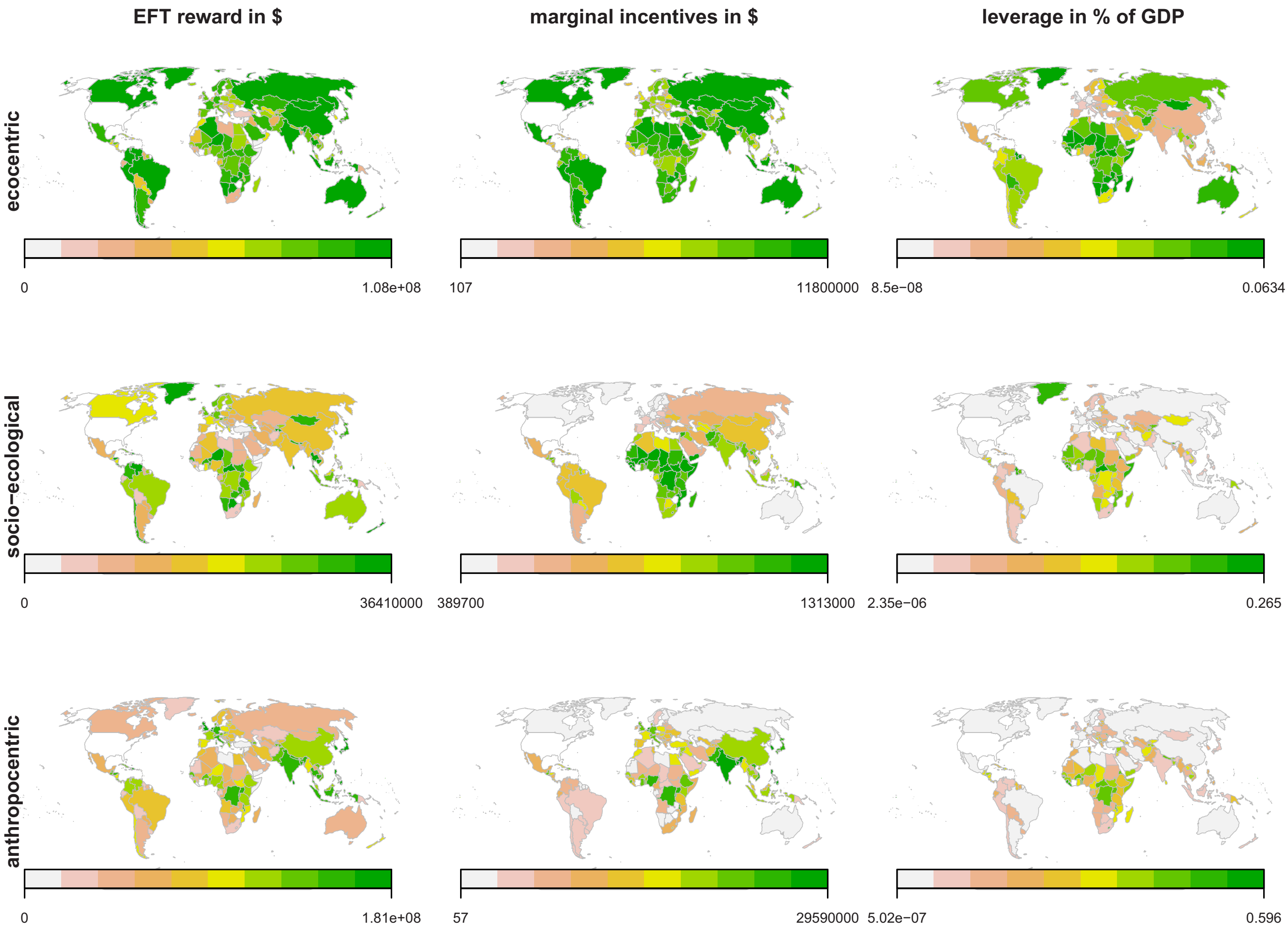

FIGURE 1 Global maps of different EFT designs and the resulting incentives. Incentives are computed as the marginal and per GDP change in EFT flows for a unilateral protected area increase of 1% of total area per country, ceteris paribus. The countries are color coded in deciles and the legends display an equal spacing per decile. Maps have a Robinson projection. Source: authors' elaboration

allocative patterns, and the question of which pattern may be more suitable to help the realization of international conservation policy goals remains.

4 | DESIGN CHOICE BASED ON CONSERVATION POLICY GOALS

The design choice is based on the following consideration: The strongest incentive should go to those countries that are the farthest from reaching the Aichi target. They are the ones that need to increase protected area share the most and should thus be incentivized most. In this, we follow the idea of a standard-pricing approach, which stems from the intuition that the optimal policy choice may be inferred from its relative contribution to the policy goal in question (Baumol & Oates, 1971). We therefore base the comparative analysis of design choices on assessing a corresponding conservation policy goal. We evaluate how far countries are from reaching Aichi target 11, which states inter alia that, by 2020, 17% of all terrestrial land shall be under protected status (Figure 2).

We proceed by grouping the countries' distances to Aichi target 11 by quartiles and compute the distribution of both marginal incentives and leverage per quartiles for each of the three mechanism design options. Figure 3 provides combined violin and box plots of incentives per design for both marginal and per GDP incentives (summary statistics are in the Supporting Information). With regard to design choices, these simulations provide a basis for a comparative assessment. First, the median incentives in the socio-ecological design are consistently highest for all quartiles. Second, in contrast to both the *anthropocentric* and the *ecocentric* design designs, the *socioecological* design provides the highest median in terms of both incentive (about 2 to 20 times as high) and leverage (3–24 times as high) for the quartile of countries that

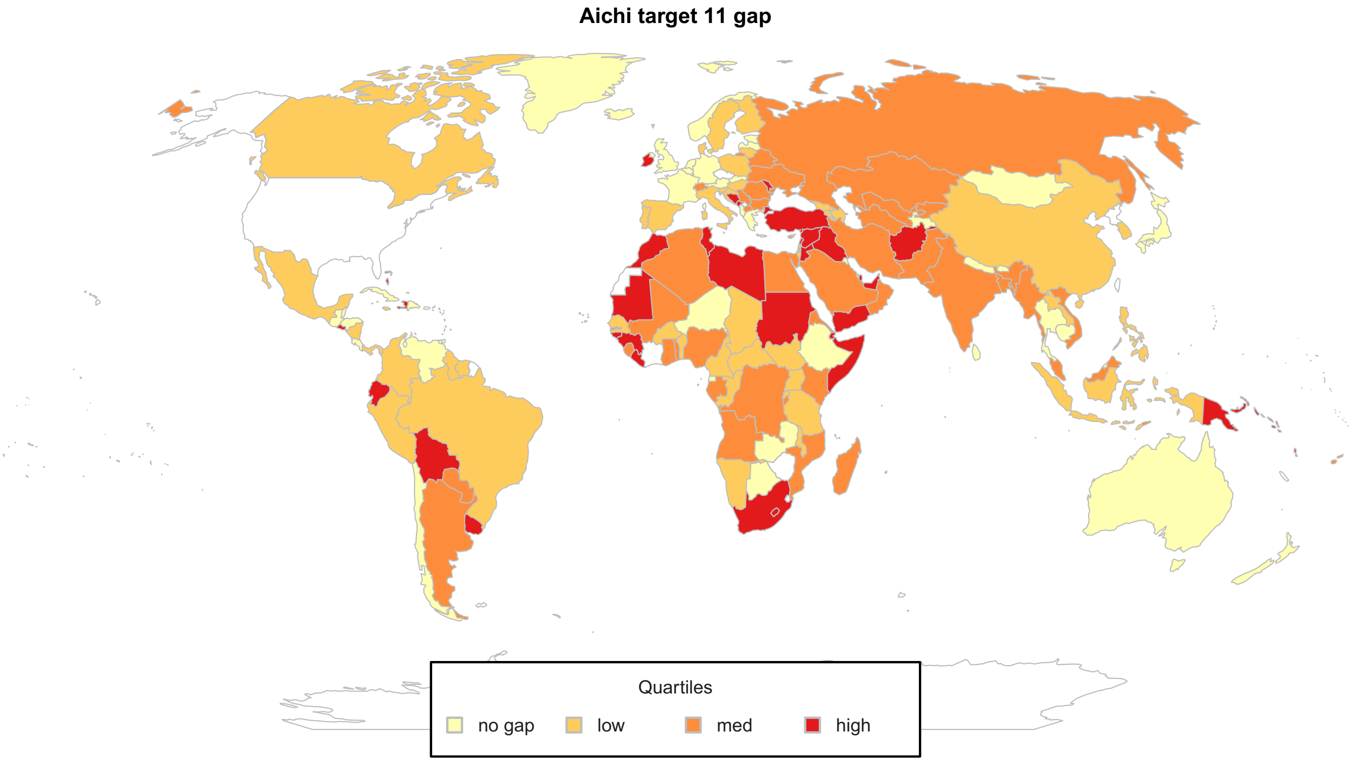

FIGURE 2 Global map of countries' gaps to fulfill Aichi target of 17% terrestrial protected areas by 2020, calculated as 17 minus the current percent protected area coverage. Only IUCN categorized protected areas are considered. The countries are grouped in quartiles. Quartile colors are light yellow for a gap of less than 0 up to 1.06, light orange for up to 8.86, dark orange for up to 15.20, red for up to 17.00. Non-CBD countries are white. The map has a Robinson projection. Source: authors' elaboration

have the largest distance to reaching Aichi target 11. Third, the *socioecological* design has an increasing median incentive per quartile, thus sets stronger incentives the larger the policy gap, and is the only design that gets this order right. In these regards, the socioecological design outperforms the other choices.

5 | DESIGN CHOICE IMPLICATIONS

Comparing the proposed design options, the socioecological design option allocates the fund such that those countries showing the least progress towards reaching a 17% protected area share by 2020 receive the strongest financial incentive to designate additional protected areas. Thereby we would expect these countries to have the highest probability to respond to an implementation of the global EFT by increasing their protected area share. The mechanism can thus help to reach Aichi target 11. Although Aichi target 11 is one of the few targets that shows sufficient progress on a global level, our policy gap analysis shows that country implementations differ greatly. Since the socioecological design sets incentives where the gap is largest, it may help to meet the target nationally. Recent contributions also argue that humanity needs to protect half the Earth in order to safeguard biodiversity (Wilson, 2016). Also others have already called for more ambitious future targets (Mace et al., 2018). We would thus expect that Aichi target 11 will be increased for the post 2020 biodiversity targets.

Furthermore, we only assessed protected areas that were categorized within the IUCN classification system and thus omitted a substantial share of diverse nationally but not internationally classified protected areas. Yet, a global mechanism design needs to rely on a standard that allows for comparability across nations. The IUCN classification scheme provides such a standard which also allows us to apply a weighting scheme for different contributions of protected area categories to conservation policies. While this could incentivize a classification of national protected areas within the IUCN scheme, we acknowledge that this choice neglects certain national categories of protected areas in our current EFT designs and future work could include those with an appropriate classification. In particular, this regards place-based cultural institutions for conservation, as is recognized in Aichi target 11 as "other effective area-based conservation means." Incentivizing conservation through protected areas may furthermore have adverse effects on community-driven

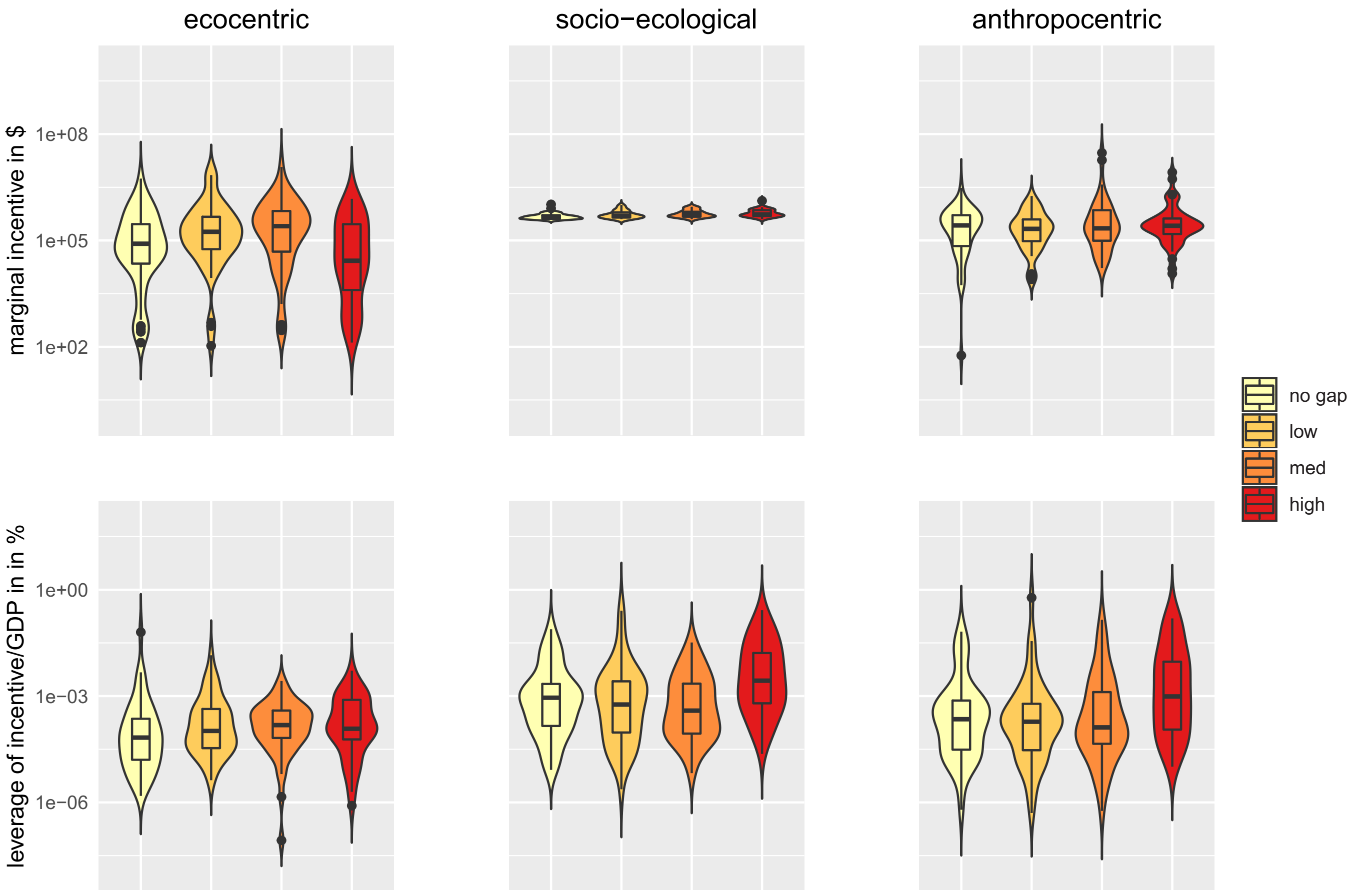

FIGURE 3 Per quartile distribution plots of incentives for the design options. The outer violin shape displays the data distribution through indicating probability density by width. The inner boxplot shows the median at the bar, first and third quartile points as limits of the box, and outliers as points. The first row indicates the marginal incentive in terms of an EFT change from a unilateral per country increase of its protected area share by 1%. The second row indicates the incentives as an EFT change in percentage of GDP. Countries are categorized into quartiles according to countries' distances to fulfill the Aichi target of 17% terrestrial protected areas by 2020. The quartiles are "no gap" for a distance of less 0 up to 1.06, "low" for up to 8.86, "med" for up to 15.20, and "high" for up to 17.00. The *Y*-axes are log to base 10 transformed and equal across the design options per row. Source: authors' elaboration

conservation initiatives. Important future extensions of the current proposal should thus include biodiversity targeting, directing flows where biodiversity is highest or most threatened, the inclusion of marine protected areas, and the consideration of local livelihoods.

Regarding the expenditure side, the original EFT in Brazil come with no further spending strings attached. The resulting fiscal flows are not project-based or tied to specific spending purposes defined at higher levels of government and in this way guarantee local sovereignty in deciding expenditure priorities. A scheme without earmarking may thus be more attractive from the perspective of recipients. While such a design transferred to the global level would set incentives through conditioning the transfers on performance of protected area provision, it would simultaneously grant the maximum spending autonomy and might thus be relatively acceptable for sovereign governments. This design has the benefit of being minimally prescriptive in terms of where and what type of areas to protect while providing fiscal incentives for voluntary and self-determined action. At the same time, (an at least partial) earmarking of the transfers may ensure that parts of the transfers are actually used for conservation purposes and could thus increase effective management at the level of receiving countries. From the perspective of potential donors, the assurance that the funds are (at least partially) spent on conservation purposes may be preferable to an entirely unconditional scheme since the usage of the funds is (partially) specified. The corresponding trade-off between national spending autonomy and earmarking for conservation purposes is thus one that is implicit in but not solved by our proposal. However, we would consider partial ear-marking a potential solution.

Regarding funding sources, the current proposal leaves untouched where the funding could or should come from. Several proposals have been articulated. Farley et al. (2010) propose raising funds through a global cap-and-trade mechanism on CO_2 emissions; Hill et al. (2015) propose a global currency transactions tax; Droste et al. (2018b) propose the payments made by member states to the EU. Arriagada and Perrings (2011) have proposed two options: (1) direct investment in conservation supply through the GEF and (2) a Payments for Ecosystem Services (PES) scheme. For the purpose of a global EFT, the latter two options show promise because the GEF already operates the financial mechanism under the CBD and EFT bear some similarities to PES and Reducing Emissions from Deforestation and forest Degradation (REDD+) schemes. PES and REDD+ schemes, however, are often bilateral (or even subnational) agreements whereas a global EFT would be a multilateral mechanism. Channeling funds through the agreed upon CBD financial mechanism, the GEF, thus seems most appropriate and is in line with Hein et al.'s (2013) proposal for a "Global Biodiversity Fund." This nevertheless does not provide a definite answer as to where the funds should come from. While in theory, the resource mobilization could be pluralistic, ranging from philanthropic to unilateral national pledges, the implementation and sources of the fund will have to remain subject to international negotiation—as the example of the still not fully financed Green Climate Fund shows.

6 | AN EVIDENCE-BASED, SIMULATED BUT NONPRESCRIPTIVE POLICY PROPOSAL

We contribute a first policy design study on a global-scale intergovernmental fiscal transfer scheme to support biodiversity conservation. We have simulated how different global EFT design options would distribute incentives and assessed their relative contributions to reaching the Aichi biodiversity targets. We show that the socioecological design that combines the extent of protected area per country and each nation's development status would provide the strongest median incentive for states which are farthest from achieving the target. By design the transfers would be conditional on protected area coverage weighted by IUCN protected area category and are thus a type of performance-based fiscal transfer (Droste et al., 2018b). Such a design has the benefit of having been implemented in similar forms among Brazilian states and in Portugal, such that actual experiences can be further explored and analyzed regarding design principles and outcomes (Droste et al., 2017, 2018a).

The main value added by this proposal, however, lies in the upscaling of an existing instrument for biodiversity conservation to the global level. The proposed mechanism fleshes out a neglected gap of burden and benefit sharing in the current regime complex for biodiversity protection (Raustiala & Victor 2004). As such it fills a gap on how an access and benefit-sharing mechanism can be implemented beyond bi- and multilateral agreements and provides an innovative contribution to the current debates by specifying an allocative transfer mechanism. We would expect that our three-fold mechanism design proposal may serve as a starting point for a more specific science-policy dialogue on benefit and burden sharing of biodiversity conservation between the CBD, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, and the broader sustainable development community.

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The source code and data for the computational analysis can be found at a personal GitHub repository: https://github.com/NilsDroste/EFT-world. The authors gratefully acknowledge the comments by Julie Lockwood, Mark Lubell and two anonymous referees that provided considerably constructive help to improve the article. The Supporting Information provides details on methods, data, and descriptive statistics.

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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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