



Advancing Global Biodiversity Governance: Recommendations for Strengthening the Post-2020 Global Biodiversity Framework

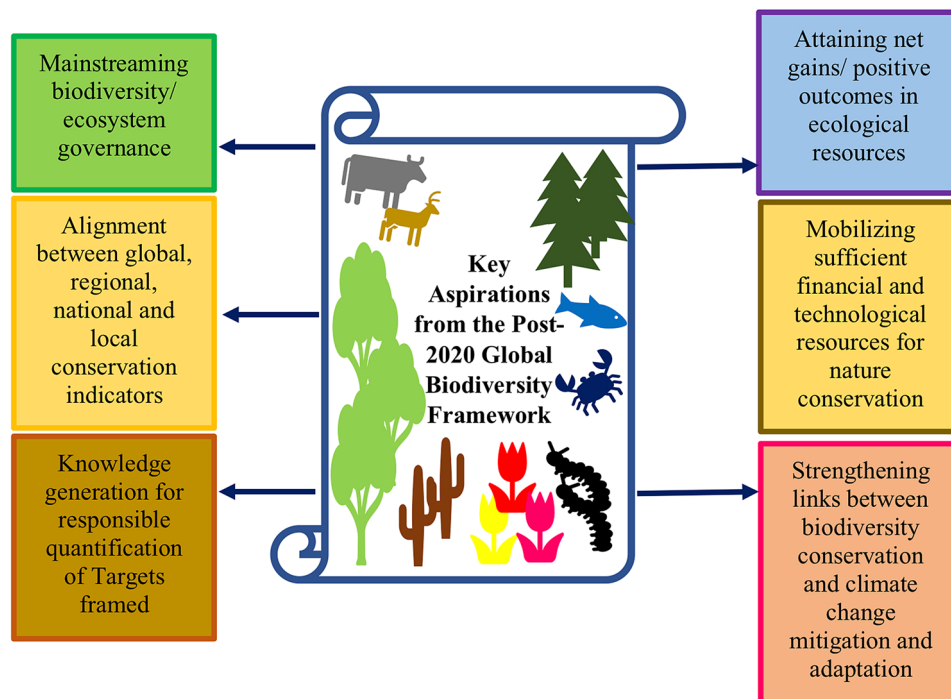
Priya Priyadarshini¹ · Amit Kumar Bundela¹ · Alexandros Gasparatos^{2,3} · Lindsay C. Stringer⁴ · Shalini Dhyani⁵ · Rajarshi Dasgupta⁶ · Chintala Sudhakar Reddy⁷ · Himlal Baral⁸ · Roldan Muradian⁹ · Madhav Karki¹⁰ · Purushothaman Chirakkuzhyil Abhilash¹ · Josep Peñuelas^{11,12}

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Abstract

Reversing ecosystem degradation and halting global biodiversity loss due to climate change and other anthropogenic drivers are essential for socioeconomic development and human wellbeing, as well as for advancing global sustainability. The latest initiative in this direction is the ‘Post-2020 Global Biodiversity Framework’, which establishes a blueprint for global coordinated action towards development of national and regional strategies targeting conservation and sustainable utilization of biodiversity. By supporting the notion of ‘ecological civilization’, it emphasises the need for transformative strategies to conserve, monitor and sustainably manage ecosystems by 2030. Arguably the articulation of fit-for-purpose goals and targets is a key precondition for achieving this vision by enhancing cooperation and influencing the development of implementation strategies and regulatory instruments at national and local levels. The present Policy Analysis critically reviews the key features of the draft Post-2020 Global Biodiversity Framework and suggests recommendations to further strengthen it.

Graphical Abstract



Article Highlights

- Biodiversity conservation is imperative for planetary resilience and human health and wellbeing.
- The Post-2020 Global Biodiversity framework aims to guide biodiversity governance towards ‘ecological civilization’.
- Transformative approaches targeting climate adaptation and mitigation, circularity, biodiversity renewal and nature-based solutions require better inclusion.
- Attainable and widely acceptable indicators for the different targets are necessary to ensure the framework’s effectiveness.
- The interface of climate change mitigation, adaptation and biodiversity conservation should be further strengthened in the framework.

Keywords Ecosystem services · Policy · Sustainable development · Climate change · Wellbeing · Ecological civilization

1 Introduction

There is a need for science-based, pro-active, co-ordinated and inclusive policies and governance instruments to design, implement and effectively monitor transformative strategies that seek to safeguard biodiversity and protect ecosystems (IPBES 2019a; Ortiz et al. 2021). Such instruments can strengthen strategies and approaches required for maintaining the resilience of the biosphere by giving due cognizance to the intertwined dynamics often arising at the interface of human activity and nature conservation (Bennett et al. 2015; Folke et al. 2021).

The *Post-2020 Global Biodiversity Framework* (GBF) of the Convention on Biological Diversity (CBD) (CBD 2021a) is the latest global scale, multi-lateral policy initiative that seeks to catalyse the development of policies and strategies to conserve biodiversity and manage ecosystems in a sustainable manner (CBD 2021a). The Post-2020 GBF was developed following a comprehensive and participatory process between signatory countries to the CBD and other stakeholders (other governments, Indigenous people, local communities, women and youth groups, subnational governments and scientific community to name a few) under the responsibility of the Open-ended Working Group established by the Conference of Parties (COP) to the CBD (CBD 2018) and supported by the Bureau of the COP. The draft Post-2020 GBF was preceded by a zero draft (CBD 2020a) that was also updated as a follow-up to the second meeting of the Working Group (CBD 2020b).

The Post-2020 GBF (CBD 2021a), essentially extends the biodiversity conservation and management strategies stated in the Aichi Biodiversity Targets (ABT)¹ 2011–2020 (<https://www.cbd.int/sp/targets/>), and was officially discussed during

the first phase of the CBD-COP15 in Kunming, China in October 2021 (<https://www.cbd.int/conferences/post2020>). This is due to be followed by a second meeting in April–May 2022 leading to the finalization and adoption of the framework. Essentially, the Post-2020 GBF follows the partial achievement of only six ABTs by the end of the 2011–2020 decade, as none of the targets was fully achieved globally (CBD 2020c; Diaz et al. 2020). Learning from this experience, the Post-2020 GBF (CBD 2021a) proposes to shift the focus towards clearly defined roles for stakeholders involved in integrated, inclusive and result-oriented conservation strategies to address anthropogenic drivers resulting in the loss of species and ecosystem functions. This Policy Analysis elucidates the architecture of the Post-2020 GBF, including some preliminary highlights from the CBD-COP15 virtual meeting in October, 2021 (CBD 2021a). Furthermore, this Policy Analysis identifies gaps in the framework’s broad scope and reach, and suggests actionable solutions to strengthen it, thus improving global biodiversity governance.

2 Main Features of the Post-2020 Global Biodiversity Framework

Structured around the overarching vision of ‘Living in Harmony with Nature by 2050’ and developing an ‘Ecological Civilization’, the Post-2020 GBF comprises four long-term goals. These goals broadly seek to facilitate the conservation, restoration and sustainable use of biodiversity and ecosystem services to ensure planetary sustainability and human health and well-being (CBD 2021a). Goal A addresses the need to maintain ecosystem integrity, reduce species extinction rates and safeguard genetic diversity. Goal B proposes the valuation, preservation and sustainable use of nature’s contribution to people. Goal C strives for the equitable utilization of benefits (monetary and non-monetary) arising from biodiversity resources. Goal D aims at reducing financial and other implementation gaps (scientific, technological,

¹ The 20 ABTs were structured around 5 Goals. They were formulated through the Strategic Plan for Biodiversity 2011–2020 that aimed to curb the drivers and pressures of biodiversity loss and promote the sustainable utilisation of biodiversity.

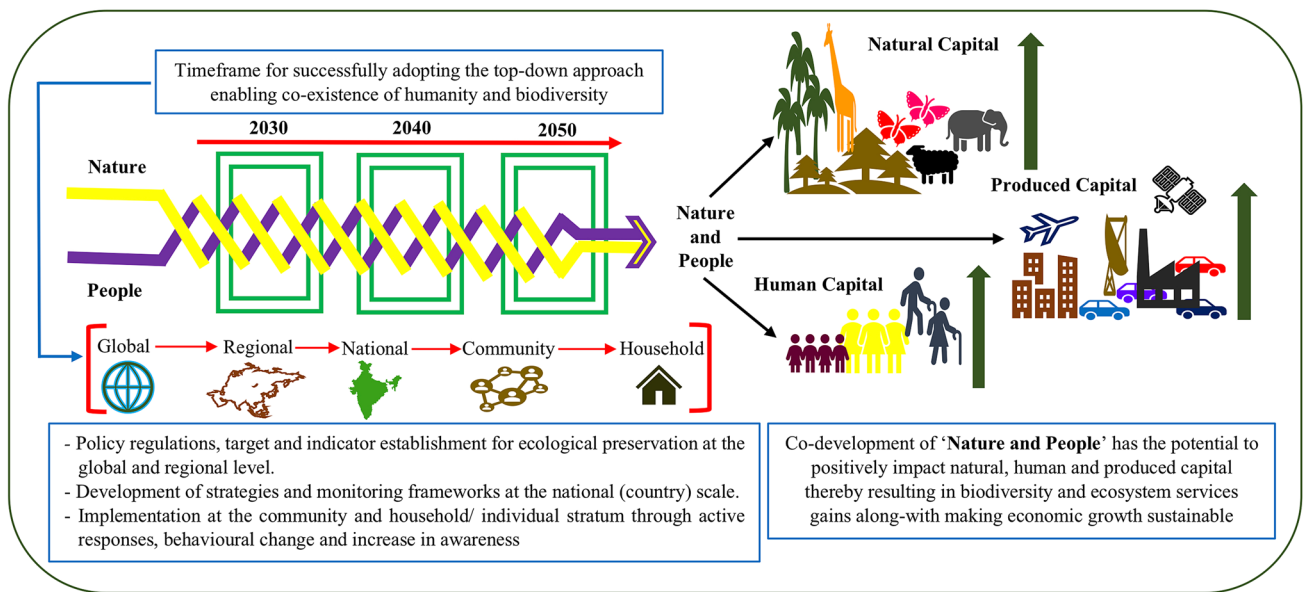


Fig. 1 Mainstreaming biodiversity conservation in by shifting governance efforts from ‘Nature for People’ to ‘Nature and People’. Policies focusing on this transformative narrative could ensure balance, interdependence and self-regulation within the biosphere by highlighting that human welfare and health are implicitly and directly

linked to ecosystem conservation and restoration actions, and the sustainable use of biodiversity. Thus, recovery and gains in biodiversity will positively benefit economic development and vice versa (Dasgupta 2021; IPBES 2019b).

capacity-building) that hinder biodiversity conservation, restoration and recovery actions. Figure 1 further expands upon the ‘Theory of Change’ Framework proposed in the Post-2020 GBF by highlighting that ‘human welfare’ is essentially interwoven with ‘nature conservation’ and not external to it.

To achieve these four long-term goals, the first draft of the GBF proposes the adoption of biodiversity and ecosystem recovery pathways by 2030 through ‘21 action-oriented targets’. Table 1 categorises these targets based on the State-Pressure-Response model (SPRM), with ‘Response Targets’ further sub-categorised as Inputs, Processes, Outputs, Outcomes and Impacts (OECD 2018).

As Table 1 suggests, the majority of the proposed targets are “action-oriented” (i.e. Response target type), focusing on (and expecting to) generate positive and sustainable impacts by 2030 in sectors depending on and/or affecting biodiversity. Although the target definitions employ unambiguous language and easy-to-comprehend terminology following the recommendations of Butchart et al. (2016), the development of specific, measurable and time-bound indicators (CBD 2010) that are essential for the achievement and effective monitoring of progress still remain a major shortcoming associated with target-based governance (Maxwell et al. 2015).

The CBD 2020b already establishes that countries need to develop national targets and indicators based on the Targets outlined in the Post-2020 framework with progress

towards them being periodically reviewed. This reflects to some extent the process adopted by the Inter-Agency and Expert Group on Sustainable Development Goal Indicators wherein the Global Indicator Framework developed for monitoring the Sustainable Development Goals (SDGs) was further agreed to be complemented by regional and national indicators developed by signatory countries (United Nations 2017). The resolution also mandated periodic refinement and review of the indicators to address concerns related to coverage, target alignment and development of metadata (United Nations 2017).

3 Recommendations for Improving the Post-2020 Global Biodiversity Framework

The first phase of the CBD-COP15 resulted in ‘The Kunming Declaration’ that was adopted by around 100 nations, with the discussions focusing on how to “reverse the current loss of biodiversity and ensure that biodiversity is put on a path to recovery by 2030 at the latest, towards the full realization of the 2050 Vision of “Living in Harmony with Nature” (CBD 2021b). The Declaration calls upon the parties to “mainstream” the conservation and sustainable use of biodiversity in decision-making by recognizing its integral contribution for human wellbeing and health. It stresses the need for urgent and integrated action for transformative

Table 1 Characteristics of the 21 action targets proposed in the first draft of the Post-2020 GBF

Broad Categories	Target	Thematic Focus of the Targets	Target Type	Response Target Type
Reducing threats to biodiversity	1	Prevention of land and sea-use change through spatial planning	State and Pressure	Process and Outcome
	2	Restoration of degraded ecosystems (terrestrial, freshwater, marine)	State and Response	Outcome
	3	Development of Protected Area Networks for conservation of biodiversity and its benefits to people	Response	Output
	4	Conservation of species and genetic diversity through ex-situ strategies and mitigation of human-wildlife conflict	State and Response	Process and Output
	5	Sustainable and legal harvesting of wild species	State and Response	Outcome
	6	Management of invasive alien species	State and Response	Process, Output and Outcome
	7	Reduction of pollution sources, including nutrient flows, pesticides and plastic waste	Pressure, Response	Outcome
	8	Minimization of climate change impacts on biodiversity	Pressure, Response	Outcome and Impact
Meeting people's needs through sustainable use and benefit sharing	9	Benefit-sharing of biodiversity resources (provisioning ES) by indigenous and local communities	State and Response	Outcome
	10	Sustainable management of agriculture, aquaculture and forest areas	Response	Output
	11	Enhancement of regulatory ES	State and Response	Outcome
	12	Increasing cultural/recreational ES in urban areas	Response	Output
	13	Measures for increasing access and equitable benefits from genetic resources and indigenous and traditional ecological knowledge (ITEK)	State and Response	Output
Tools and solutions for implementation and mainstreaming	14	Cross-sectoral integration of biodiversity values	Response	Process
	15	Impact of businesses and supply chains on biodiversity	Response	Process, Output and Outcome
	16	Responsible choices and sustainable consumption patterns	State and Response	Outcome
	17	Reduction and management of adverse biotechnological impacts on biodiversity	Response	Outcome
	18	Reduction of harmful and increase in positive incentives for biodiversity	Response	Process and Output
	19	Increasing financial, technological and scientific inputs along-with capacity-building for biodiversity management	Response	Inputs
	20	Role and use of indigenous and local knowledge ILK, education, research and awareness in biodiversity management	State	NA
	21	Increased participation of indigenous people and local communities (IPLC) in biodiversity management	State	NA

Based on the table structure presented in OECD 2019. State-Pressure-Response Model (SPRM) and Response target types after OECD 2018

changes, across sectors, through policy coherence at all levels and the realization of synergies across relevant multi-lateral conventions and international organizations (CBD 2021c). However, despite the framework's wide focus on synergizing biodiversity protection with human development, we argue that some aspects of the Post-2020 GBF can be improved.

First, following mounting evidence regarding the strong links between climate change and biodiversity

(Trisos et al. 2020; IPBES 2019a),² it is arguably important to better acknowledge and strengthen the inter-related aspects present between climate change adaptation and

² The acknowledgement of these links has recently catalysed joint activities between the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) and the Intergovernmental Panel on Climate Change (IPCC) (IPCC, 2021; Pörtner et al., 2021).

mitigation, biodiversity conservation and sustainability. One approach could be by further improving Target 8 (Table 1) through global efforts directed towards development of indicators and monitoring strategies that link climate-biodiversity observations (O'Connor et al. 2020). Beyond providing an impetus towards bridging existing research gaps at the interface of climate change, biodiversity loss, and ecosystem degradation (Pörtner et al. 2021), it can lead to more effective development of biodiversity conservation and climate change adaptation and mitigation strategies (Arneth et al. 2020). In this sense, indicators that identify and link species or ecosystem vulnerability to climate change offer worthwhile additions to the Post-2020 GBF, allowing for a better understanding and progress at the aforementioned interface (Pacifiçi et al. 2015).

Second, it would be worthwhile to improve the overall inclusivity of the Post-2020 GBF through the incorporation of various concepts and terminologies that have gained traction in broader sustainable development discourses and are linked to biodiversity conservation and its sustainable use. Prominent examples that have been refined over years in several academic publications and grey literature include concepts, such as Nature-based Solutions (Cohen-Shacham et al. 2019; Dhyani et al. 2020; IUCN, 2020; Seddon et al. 2020), bio-economy (Luhás et al. 2021; Stark et al. 2022) circular economy (Breure et al. 2018; Priyadarshini and Abhilash 2020), circular bio-economy (Tan and Lamers 2021), planetary health diet (EAT 2019) and inclusive wealth (Dasgupta 2021; Managi and Kumar 2018). Although, there is a mention of ‘trends in circular economy monitoring and practices’ as a monitoring component within Target 14 (CBD 2020d; UNEP-WCMC 2020), up to the writing of this article no mention of the concept is found within CBD (2021d), the document proposing headline indicators for the Post-2020 GBF. Considering the traction and acceptability of such concepts in various diverse practitioner and policy-making communities globally (let alone academic fields), their integration within the framework could both forge broader support for the overall framework and enhance indicator-setting exercises. For example, better accounting of natural assets within economic value chains using inclusive wealth as a measure of quantification in place of GDP (Gross Development Product) (Dasgupta 2021; Priyadarshini et al. 2021) can lead to better accounting of natural capital at the national stratum and in turn benefit biodiversity conservation. Similarly, since unregulated resource extraction is closely linked to habitat destruction and biodiversity loss, development of resource efficiency or circular economy indicators (D’Amato and Korhonen 2021) could positively influence Target 15 of the Post-2020 framework (CBD 2020d; UNEP-WCMC 2020).

Third, while it is positive that Targets 15 and 18 highlight the dependence of economic activity on biodiversity and the negative biodiversity outcomes of current production practices and economic incentives respectively (CBD 2021a), it could be worthwhile to also promote actions/strategies that lead to “positive biodiversity outcomes” or “net biodiversity gains” (Arlidge et al. 2018; Leclère et al. 2020). In this sense, it would be worthwhile to include within the framework biodiversity renewal measures, such as rewilding, urban greening, assisted ecosystem recovery/re-establishment, and ecosystem creation (Milner-Gulland et al. 2021), offering them equal credence alongside habitat restoration, as a means of further preventing ecosystem degradation across the world (Sato and Lindenmeyer 2017). Even though the monitoring of biodiversity offset programs at the country scale has been proposed as an indicator for the Post-2020 GBF (UNEP-WCMC 2020), the development of proactive strategies not limited to the mitigation of project-specific loss/risks to ecosystem can further support the mainstreaming of biodiversity across varied sectors (Milner-Gulland et al. 2021). Therefore, ‘renewal’ could be made more visible, for example, through explicit mentions, within Targets 1–4 of the framework which focus on restoration, recovery and other area-based conservation methods. Additionally, avoiding or mitigating the negative biodiversity trade-offs of green technologies and infrastructure (e.g. renewable energy) (Gasparatos et al. 2021) could also be mentioned within the framework considering their rapid proliferation to meet climate change mitigation objectives. This would further strengthen the aforementioned links between climate change mitigation and biodiversity conservation.

An essential requirement of the framework is the alignment of administrative functions and regulatory measures, through bottom-up approaches (provincial–national–regional–global). Such alignment could foster data generation related to local floral and faunal diversity which could in turn ensure that local-scale adaptation and conservation efforts potentially contribute towards global biodiversity management targets (IUCN 2021). This would simultaneously require knowledge generation using inputs from diverse disciplines and systems (e.g. natural sciences, social sciences, citizen science) (Hagerman et al. 2021) as well as quantitative assessment of biodiversity and ecosystem services at the local scale (state, district or city level) to strengthen efforts at national stratum (Di Marco et al. 2016; Shepherd et al. 2016). Fostering involvement of indigenous communities and their associated traditional and local knowledge (which has been duly acknowledged throughout the framework) can play a pivotal role in this regard by aiding cataloguing of species diversity and services at the ecosystem level (Nitah 2021; Priyadarshini and Abhilash 2019; Dasgupta et al. 2021).

Improvement, simplification and harmonization of country-scale monitoring efforts could also improve assessment of regional-scale progress against the targets. This would have positive ripple effects for measuring progress across all targets. Therefore, it would be valuable to leverage high quality and consistent datasets across the world, or agree on certain key underlying measures. For example, the Group on Earth Observations Biodiversity Observation Network (GEO BON) has proposed a framework of essential biodiversity variables (EBVs) which is emerging for monitoring compositional, structural and functional components of biodiversity. These EBVs form a core set of measurements for capturing biodiversity change and are produced by integrating in-situ monitoring with remote sensing at relevant spectral, spatial and temporal scales (Skidmore et al. 2021). Similarly, the integration of inter-annual and spatial variability indices developed from remotely sensed data can be used for identification of biodiversity hotspot regions requiring conservation (Silveira et al. 2021). Development of such datasets could positively benefit Targets 1–3 of the framework which focus on identification, management and conservation of biodiversity rich landscapes and seascapes (CBD 2021a).

Investments for nature (Seidl et al. 2020) have been given due recognition within many targets of the framework due to their perceived significant role in realising the 2050 Vision for biodiversity, offering several opportunities. For example, in addition to the already proposed headline indicator for Target 19 (i.e. official development assistance for biodiversity) (CBD 2021d) defining indicators related to ecological fiscal transfers (Busch et al. 2021) and payment for ecosystem services and forest concessions (Young and Castro 2021) could help mobilise private finances. This could further strengthen the implementation of the framework by not only generating funds but also increasing the interest of potential stakeholders from the private sector.

Finally, the recent COVID-19 pandemic has highlighted the strong links between zoonotic diseases, landscape change, ecosystem degradation and human wellbeing (Morand and Lajaunie 2021; WWF 2020). Therefore, understanding the functional links and pathways connecting biodiversity with human health (Marselle et al. 2021; Hammen and Settele 2019) and the development of related targets and indicators that address them need to be given equal credence alongside targets addressing drivers, pressures and strategies for ecosystem degradation and restoration (McElwee et al. 2020; OECD 2019). This facet was given due consideration in the recently concluded CBD-COP15 virtual discussions and ‘The Kunming Declaration’ and is expected to be more strongly integrated in the Post-2020 framework agreement to be developed by May 2022.

4 Conclusion

The Post-2020 GBF offers the international community of policymakers and other diverse stakeholders an opportunity to mainstream biodiversity within global discourses and decision-making. The framework is strategically important as it will enter implementation with less than a decade remaining under the timeframe of the SDGs (2030) and with the global risks posed by climate change being strongly acknowledged in UNFCCC-COP26. Although it is a big leap forward in terms of global coordinated action for biodiversity conservation and sustainable utilisation, the Post-2020 GBF still requires improvements to the scope, specificity and monitoring process of indicators, as well as the spatial and temporal coverage of several targets. Additionally, further strengthening the interface between climate change mitigation/adaptation and biodiversity, ensuring greater inclusivity by incorporating concepts and terminologies that have gained traction in broader sustainable development discourses (e.g. bio-economy, circular economy), as well as increasing the visibility of biodiversity renewal measures through explicit mentions in relevant targets, is required.

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Declarations

Conflict of interest Authors have no conflicts of interest.













References

- Arlidge WNS, Bull JW, Addison PFE et al (2018) A global mitigation hierarchy for nature conservation. *Bioscience* 68(5):336–347. <https://doi.org/10.1093/biosci/biy029>
- Arneth A, Shin YJ, Leadley P, Rondinini C, Bukvareva E, Kolb M, Midgley GF, Oberdorff T, Palomo I, Saito S (2020) Post-2020 biodiversity targets need to embrace climate change. *Proc Natl Acad Sci* 117(49):30882–30891. <https://doi.org/10.1073/pnas.2009584117>
- Bennett EM, Cramer W, Begossi A (2015) Linking biodiversity, ecosystem services and human well-being: three challenges for designing research for sustainability. *Curr Opin Environ Sustain* 14:76–85. <https://doi.org/10.1016/j.cosust.2015.03.007>
- Breure AM, Lijzen JPA, Maring L (2018) Soil and land management in a circular economy. *Sci Total Environ* 624:1125–1130. <https://doi.org/10.1016/j.scitotenv.2017.12.137>
- Busch J, Ring I, Akullo M et al (2021) A global review of ecological fiscal transfers. *Nature Sustain* 4:756–765. <https://doi.org/10.1038/s41893-021-00728-0>

- Butchart SHM, Di Marco M, Watson EM (2016) Formulating smart commitments on biodiversity: lessons from the Aichi targets. *Conserv Lett* 9(6):457–468. <https://doi.org/10.1111/conl.12278>
- CBD (2010) Examination of the outcome-oriented goals and targets and associated indicators and consideration of their possible adjustment for the period beyond 2010. UNEP/CBD/COP/DEC/X/7, Published on 29th October 2010. <https://www.cbd.int/doc/decisions/cop-10/cop-10-dec-07-en.pdf>
- CBD (2018) Comprehensive and Participatory process for the preparation of the post-2020 global biodiversity framework. CBD/COP/DEC/14/34, Published on 30th November 2018. <https://www.cbd.int/doc/decisions/cop-14/cop-14-dec-34-en.pdf>
- CBD (2020a) Zero Draft of the Post-2020a Global Biodiversity Framework. CBD/WG2020a/2/3, Published on 6th January 2020a. <https://www.cbd.int/doc/c/da8c/9e95/9e9db02aaf68c018c758ff14/wg2020-02-03-en.pdf>
- CBD (2020b) Update of the Zero Draft of the Post-2020b Global Biodiversity Framework. CBD/POST2020b/PREP/2/1, Published on 17th August 2020b. <https://www.cbd.int/doc/c/3064/749a/0f65a7f9def86707f4eaeafa/post2020-prep-02-01-en.pdf>
- CBD (2020c) Global Biodiversity Outlook 5: Summary for Policy Makers, Convention on Biological Diversity. <https://www.cbd.int/gbo/gbo5/publication/gbo-5-spm-en.pdf>
- CBD (2020d) Post-2020d global biodiversity framework: scientific and technical information to support the review of the updated goals and targets, and related indicators and baselines proposed indicators and monitoring approach for the post-2020d global biodiversity framework. CBD/SBSTTA/24/3Add.1. Published on: 25th November 2020d. <https://www.cbd.int/doc/c/ddf4/06ce/f004afa32d48740b6c21ab98/sbstta-24-03-add1-en.pdf>
- CBD (2021a) First Draft of the Post-2020 Global Biodiversity Framework. CBD/WG2020/3/3, Published on 5th July, 2021a. <https://www.cbd.int/doc/c/914a/eca3/24ad42235033f031badf61b1/wg2020-03-03-en.pdf>
- CBD (2021b) Press Release (13/10/2021b). UN Biodiversity Conference's High-Level Segment sees creation of Kunming Biodiversity Fund, adoption of Kunming Declaration, building political impetus for adoption of ambitious post2020 global biodiversity framework. <https://www.cbd.int/doc/press/2021b/pr-2021b-10-13-cop15-hls-en.pdf>
- CBD (2021c) Kunming Declaration from the High-Level Segment of the UN Biodiversity Conference 2020 (Part 1) under the theme: "Ecological Civilization: Building a Shared Future for All Life on Earth". <https://www.cbd.int/doc/c/99c8/9426/1537e277fa5f846e9245a706/kunmingdeclaration-en.pdf>
- CBD (2021d) Proposed Headline Indicators of the Monitoring Framework For The Post-2020 Global Biodiversity Framework. Convention on Biological Diversity, CBD/WG2020/3/3/Add.1, Published on 11th July, 2021d. <https://www.cbd.int/doc/c/d716/da69/5e81c8e0faca1db1dd145a59/wg2020-03-03-add1-en.pdf>
- Cohen-Shacham E, Andrade A, Dalton J et al (2019) Core principles for successfully implementing and upscaling Nature-based Solutions. *Environ Sci Policy* 98:20–29. <https://doi.org/10.1016/j.envsci.2019.04.014>
- D'Amato D, Korhonen J (2021) Integrating the green economy, circular economy and bioeconomy in a strategic sustainability framework. *Ecol Econ* 188:107143. <https://doi.org/10.1016/j.ecolecon.2021.107143>
- Dasgupta R, Dhyani S, Basu M, Kadaverugu R, Hashimoto S, Kumar P, Johnson BA, Takahashi Y, Mitra BK, Avtar R, Mitra P (2021) Exploring Indigenous and Local Knowledge and Practices (ILKPs) in Traditional Jhum Cultivation for Localizing Sustainable Development Goals (SDGs): A Case Study from Zunheboto District of Nagaland. *Environmental Management, India*. <https://doi.org/10.1007/s00267-021-01514-6>
- Dasgupta P (2021) *The Economics of Biodiversity: The Dasgupta Review.*, HMT, London, UK. <https://www.gov.uk/government/publications/final-report-the-economics-of-biodiversity-the-dasgupta-review>
- Dhyani S, Karki M, Gupta AK (2020) Opportunities and Advances to Mainstream Nature-Based Solutions in Disaster Risk Management and Climate Strategy. In: Dhyani S., Gupta A., Karki M. (eds) *Nature-based Solutions for Resilient Ecosystems and Societies*. Disaster Resilience and Green Growth. Springer, Singapore. https://doi.org/10.1007/978-981-15-4712-6_1
- Di Marco M, Watson JEM, Venter O, Possingham HP (2016) Global biodiversity targets require both sufficiency and efficiency. *Conserv Lett* 9(6):395–397. <https://doi.org/10.1111/conl.12299>
- Diaz S, Zafra-Calvo N, Purvis A et al (2020) Set ambitious goals for biodiversity and sustainability. *Science* 370(6515):411–413. <https://doi.org/10.1126/science.abe1530>
- EAT (2019) *Food Planet Health: Healthy Diets from Sustainable Food Systems*, Summary Report of the EAT-Lancet Commission. https://eatforum.org/content/uploads/2019/01/EAT-Lancet_Commission_Summary_Report.pdf
- Folke C, Polasky S, Rockström J et al (2021) Our future in the Anthropocene Biosphere. *Ambio* 50:834–869. <https://doi.org/10.1007/s13280-021-01544-8>
- Gasparatos A, Ahmed A, Voigt C (2021) Facilitating policy responses for renewable energy and biodiversity. *Trends Ecol Evol* 36:377–380. <https://doi.org/10.1016/j.tree.2021.01.013>
- Hagerman SM, Campbell LM, Gray NJ, Pelai R (2021) Knowledge production for target-based biodiversity governance. *Biol Cons* 255:108980. <https://doi.org/10.1016/j.biocon.2021.108980>
- Hammen VC, Settele J (2019) Biodiversity and the loss of biodiversity affecting human health. *Encyclopedia Environ Health* (second Edition). <https://doi.org/10.1016/B978-0-12-409548-9.11585-4>
- IPBES (2019a) Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. IPBES secretariat, Bonn, Germany, pp56. <https://doi.org/10.5281/zenodo.3553579>
- IPBES (2019b) Global assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. IPBES secretariat, Bonn, Germany. 1144 pages. ISBN: 978-3-947851-20-1. <https://doi.org/10.5281/zenodo.3831673>
- IPCC (2021) Summary for Policymakers. In: *Climate Change 2021: The Physical Science Basis*. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. In Press https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf
- IUCN (2020) *IUCN Global Standard for Nature-based Solutions: first edition*. International Union for Conservation of Nature and Natural Resources, Gland, Switzerland. <https://portals.iucn.org/library/node/49070>
- IUCN (2021) *IUCN's Key Messages First Draft of the Post-2020 Global Biodiversity Framework*, Position Paper. International Union for Conservation of Nature and Natural Resources. <https://www.iucn.org/theme/global-policy/our-work/convention-biological-diversity-cbd/post-2020-global-biodiversity-framework>
- Leclère D, Obersteiner M, Barrett M et al (2020) Bending the curve of terrestrial biodiversity needs an integrated strategy. *Nature* 585:551–556. <https://doi.org/10.1038/s41586-020-2705-y>
- Luhar J, Mikkilä M, Kylkilähti E et al (2021) Pathways to a forest-based bioeconomy in 2060 within policy targets on climate change mitigation and biodiversity protection. *Forest Policy Econ* 131:102551. <https://doi.org/10.1016/j.forpol.2021.102551>
- Managi S, Kumar P (2018) *Inclusive Wealth Report 2018: Measuring Progress Towards Sustainability*. Routledge, London. <https://doi.org/10.4324/9781351002080>

- Marselle MR, Hartig T, Cox DTC et al (2021) Pathways linking biodiversity to human health: a conceptual framework. *Environ Int* 150:106420. <https://doi.org/10.1016/j.envint.2021.106420>
- Maxwell SL, Milner Gulland EJ, Jones JPG, Knight AT, Bunnefeld N, Nuno A, Bal P, Earle S, Watson JEM, Rhodes JR (2015) Being smart about SMART environmental targets. *Science* 347(6226):1075–1076. <https://doi.org/10.1126/science.aaa1451>
- McElwee P, Turnout E, Chiroleu-Assouline M et al (2020) Ensuring a Post-COVID economic agenda tackles global biodiversity loss. *One Earth* 3(4):448–461. <https://doi.org/10.1016/j.oneear.2020.09.011>
- Milner-Gulland EJ, Addison P, Arlidge WNS et al (2021) Four steps for the Earth: mainstreaming the post-2020 global biodiversity framework. *One Earth* 4(1):75–87. <https://doi.org/10.1016/j.oneear.2020.12.011>
- Morand S, Lajaunie C (2021) Biodiversity and COVID-19: a report and a long road ahead to avoid another pandemic. *One Earth* 4(7):920–923. <https://doi.org/10.1016/j.oneear.2021.06.007>
- Nitah S (2021) Indigenous peoples proven to sustain biodiversity and address climate change: now it's time to recognise and support this leadership. *One Earth* 4(7):907–909. <https://doi.org/10.1016/j.oneear.2021.06.015>
- O'Connor B, Bojinski S, Röösl C, Schaepman ME (2020) Monitoring global changes in biodiversity and climate essential as ecological crisis intensifies. *Eco Inform* 55:101033. <https://doi.org/10.1016/j.ecoinf.2019.101033>
- OECD (2018) Mainstreaming Biodiversity for Sustainable Development. OECD Publishing, Paris. <https://doi.org/10.1787/9789264303201-en>
- OECD (2019) The Post-2020 Biodiversity Framework: Targets, indicators and measurability implications at global and national level. Interim Report. <https://www.oecd.org/environment/resources/biodiversity/post-2020-biodiversity-framework.htm>
- Ortiz AMD, Outhwaite CL, Dalin C, Newbold T (2021) A review of the interactions between biodiversity, agriculture, climate change, and international trade: research and policy priorities. *One Earth* 4(1):88–101. <https://doi.org/10.1016/j.oneear.2020.12.008>
- Pacifici M, Foden WB, Visconti P et al (2015) Assessing species vulnerability to climate change. *Nature Clim Changes* 5:215–224. <https://doi.org/10.1038/nclimate2448>
- Pörtner HO, Scholes RJ, Agard J et al (2021) IPBES-IPCC co-sponsored workshop report on biodiversity and climate change. IPBES and IPCC. <https://doi.org/10.5281/zenodo.4782538>
- Priyadarshini P, Abhilash PC (2019) Promoting tribal communities and indigenous knowledge as potential solutions for the sustainable development of India. *Environ Dev* 32:100459. <https://doi.org/10.1016/j.envdev.2019.100459>
- Priyadarshini P, Abhilash PC (2020) Fostering sustainable land restoration through circular economy governed transitions. *Restor Ecol*. <https://doi.org/10.1111/rec.13181>
- Priyadarshini P, Dubey PK, Singh A, Chaurasia R, Abhilash PC (2021) The Dasgupta review: resetting the stage for a new paradigm. *Front Ecol Environ*. <https://doi.org/10.1002/fee.2451>
- Sato CF, Lindenmayer DB (2017) Meeting the global ecosystem collapse challenge. *Conserv Lett* 11(1):1–7. <https://doi.org/10.1111/conl.12348>
- Seddon N, Chausson A, Berry P, Girardin CAJ, Smith A, Turner B (2020) Understanding the value and limits of nature-based solutions to climate change and other global challenges. *Philos Trans R Soc B* 375(1794):20190120. <https://doi.org/10.1098/rstb.2019.0120>
- Seidl A, Mulungu K, Arlaud M et al (2020) Finance for Nature: a global estimate of public biodiversity investments. *Ecosyst Serv* 46:101216. <https://doi.org/10.1016/j.ecoser.2020.101216>
- Shepherd E, Milner-Gulland EJ, Knight AT et al (2016) Status and trends in global ecosystem services and natural capital: assessing progress towards aichi biodiversity target 14. *Conserv Lett* 9(6):429–437. <https://doi.org/10.1111/conl.12320>
- Silveira EMO, Radeloff VC, Martinuzzi S et al (2021) Spatio-temporal remotely sensed indices identify hotspots of biodiversity conservation concern. *Remote Sens Environ* 258:112368. <https://doi.org/10.1016/j.rse.2021.112368>
- Skidmore AK, Coops NC, Neinavaz E, Ali A, Schaepman ME, Paganini M et al (2021) Priority list of biodiversity metrics to observe from space. *Nature Ecol Evol* 5:896–906. <https://doi.org/10.1038/s41559-021-01451-x>
- Stark S, Biber-Freudenberger L, Dietz T et al (2022) Sustainability implications of transformation pathways for the bioeconomy. *Sustain Prod Consum* 29:215–227. <https://doi.org/10.1016/j.spc.2021.10.011>
- Tan ECD, Lamers P (2021) Circular bioeconomy concepts—a perspective. *Front Sustain* 2:701509. <https://doi.org/10.3389/frsus.2021.701509>
- Trisos CH, Merow C, Pigot AL (2020) The projected timing of abrupt ecological disruption from climate change. *Nature* 580:496–501. <https://doi.org/10.1038/s41586-020-2189-9>
- UNEP-WCMC (2020) Indicators for the Post-2020 Global Biodiversity Framework. Information Document prepared for SBSTTA24 by UNEP-WCMC in collaboration with the Biodiversity Indicators Partnership. UN Environment Programme World Conservation Monitoring Centre. <https://www.cbd.int/sbstta/sbstta-24/post2020-indicators-en.pdf>
- United Nations (2017) Resolution adopted by the General Assembly on 6 July 2017, A/RES/71/313. <https://undocs.org/A/RES/71/313>
- WWF (2020) The loss of nature and the rise of pandemics: protecting human and planetary health by Barney Jeffries. World Wildlife Fund. https://d2ouvy59p0dg6k.cloudfront.net/downloads/the_loss_of_nature_and_rise_of_pandemics___protecting_human_and_planetary_health.pdf
- Young CEF, Castro BS (2021) Financing mechanisms to bridge the resource gap to conserve biodiversity and ecosystem services in Brazil. *Ecosyst Serv* 50:101321. <https://doi.org/10.1016/j.ecoser.2021.101321>

Authors and Affiliations

Priya Priyadarshini¹  · Amit Kumar Bundela¹  · Alexandros Gasparatos^{2,3}  · Lindsay C. Stringer⁴  · Shalini Dhyani⁵  · Rajarshi Dasgupta⁶  · Chintala Sudhakar Reddy⁷  · Himlal Baral⁸  · Roldan Muradian⁹  · Madhav Karki¹⁰  · Purushothaman Chirakkuzhyil Abhilash¹  · Josep Peñuelas^{11,12} 

✉ Purushothaman Chirakkuzhyil Abhilash
pca.iesd@bhu.ac.in

- ¹ Institute of Environment and Sustainable Development, Banaras Hindu University, Varanasi 221005, India
- ² Institute for Future Initiatives (IFI), University of Tokyo, Tokyo 113-0033, Japan
- ³ Institute for the Advanced Study of Sustainability (UNU-IAS), United Nations University, Tokyo 150-8925, Japan
- ⁴ Department of Environment and Geography, University of York, Wentworth Way, Heslington YO10 5NG, York, UK
- ⁵ CSIR-National Environmental Engineering Research Institute, Nagpur, Maharashtra, India

- ⁶ Nature Resources and Ecosystem Services, Institute for Global Environmental Strategies (IGES), Hayama, Japan
- ⁷ National Remote Sensing Centre, Indian Space Research Organisation, Hyderabad 500-037, India
- ⁸ Climate Change, Energy and Low Carbon Development, CIFOR-ICRAF, Bogor Regency, Indonesia
- ⁹ Universidade Federal Fluminense, Niteroi, Rio di Janeiro, Brazil
- ¹⁰ Institute of Forestry, Tribhuvan University, Kirtipur, Nepal
- ¹¹ CSIC, Global Ecology, CREAM-CSIC-UAB, 08193 Bellaterra, Catalonia, Spain
- ¹² CREAM, 08193 Cerdanyola del Valles, Catalonia, Spain