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REVIEW ARTICLE

The Triple Challenge: synergies, trade-offs and integrated responses for climate, biodiversity, and human wellbeing goals

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ABSTRACT
Humankind faces a Triple Challenge: averting dangerous climate change, reversing biodiversity loss, and supporting the wellbeing of a growing population. Action to address each of these issues is inherently dependent on action to address the others. Local, national, and international policy goals on climate change, biological diversity, and human wellbeing have been set. Current implementation measures are insufficient to meet these goals, but the Triple Challenge can still be met if governments, corporations, and other stakeholders take a holistic perspective on management of land and waters. To inform this effort, we identify a set of priority policy responses drawn from recent international assessments that, whilst not being the only potential solutions, can form the core of such a holistic approach. We do this through an iterative process using three methodological approaches: (i) structured literature review; (ii) deliberative expert analysis; and (iii) wider consultation, before synthesizing into this paper. Context-appropriate implementation of responses will be needed to capitalize on potential policy synergies and to ensure that unavoidable trade-offs between management of land and waters for climate mitigation, biodiversity restoration, and human wellbeing outcomes are made explicit. We also set out four approaches to managing trade-offs that can promote fair and just transitions: (1) social and economic policy pivoting towards 'inclusive wealth'; (2) more integrated policymaking across the three areas; (3) 'Triple Challenge dialogues' among state and non-state actors; and (4) a new research portfolio to underpin (1), (2), and (3).

Key policy insights:

- Multiple recent global assessments provide a strong scientific basis for action on each of the three aspects of the Triple Challenge – climate, biodiversity, and human wellbeing (with a focus on food and nutrition) – but they do not provide an integrated perspective on how to address them simultaneously.
- Synthesis of these assessments identifies a portfolio of five core policy responses that deliver across the Triple Challenge: (i) rapidly cutting fossil fuel use; (ii) promoting sustainable, healthy diets; (iii) increasing food productivity and cutting food loss and waste; (iv) implementing nature-based

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solutions at scale; and (v) strengthening governance and management of land and waters.

- Even with widespread implementation of that portfolio, trade-offs between climate, biodiversity, and wellbeing outcomes might be unavoidable. Policymakers, researchers, and other actors should explicitly identify such trade-offs, and take steps to ensure management priorities are set through equitable dialogue processes informed by integrated research.

1. Introduction: the Triple Challenge

Simultaneously avoiding dangerous climate change, halting and reversing biodiversity loss, and ensuring human prosperity and wellbeing are three interlinked goals that governments aim to achieve in the first half of this century. An abundance of evidence indicates that, if these goals are to be met, progress in the current decade will need to be dramatic. In light of this, new policy responses are expected to be agreed including through international agreements such as the UN Framework Convention on Climate Change (UNFCCC), UN Convention on Biological Diversity (CBD), and the UN Sustainable Development Goals.

Failing to meet any of the three goals risks severe impacts at scales that range from global to local and jeopardizes the achievement of the other goals (Pecl et al., 2017). Climate change is negatively affecting people and nature, with risks increasing rapidly as average global temperatures continue to rise (IPCC, 2018). The rate of biodiversity loss is accelerating, which is in turn increasing climate risk by reducing the resilience of natural ecosystems and threatening food production (Pörtner et al., 2021). Food insecurity – a major threat to human wellbeing – interacts with climate change and biodiversity loss through pressures on land, waters (freshwater and marine), and greenhouse gas emissions from agriculture (Willett et al., 2019). Thus, climate change, biodiversity loss, and human wellbeing form a Triple Challenge (Figure 1).

Each goal of the Triple Challenge in Figure 1 connects to respective global agreements: the UNFCCC Paris Agreement on Climate Change, the UN Sustainable Development Goals (SDGs), and the UN Convention on Biological Diversity. Although the Paris Agreement states the goal to keep temperature rise 'well below 2°C … pursuing efforts to limit the temperature increase to 1.5°C', we adopt the lower temperature goal to reflect the scale of the additional impacts that the higher temperature rise would have on our well-being and on biodiversity (IPCC, 2018). The SDGs are used here as a multifaceted representation of the global goal on human wellbeing as they call for the eradication of poverty and hunger, as well as the promotion of equality, education and more, alongside goals on climate action and biodiversity. It will take achievement on all these fronts to deliver human wellbeing for all.

Global policy actions related to each of the Triple Challenge goals, as framed within international agreements, have not yet led to sufficient ambition or change in practice. Under the UNFCCC Paris Agreement on Climate Change, nationally determined contributions (NDCs) to reduce greenhouse gas emissions, committed to by COP26, set us on course for a temperature rise of 2.4°C if fully implemented, meaning we are offtrack to achieve the Paris Agreement goal (*The CAT Thermometer*, 2021). Likewise, none of the Aichi Targets on tackling biodiversity loss were fully met by the deadline year of 2020 (Secretariat of the Convention on Biological Diversity, 2020). Many countries are also not on track to meet targets for human wellbeing; for example, one assessment projects that nearly one quarter of the world's young people will live in countries meeting none of the Sustainable Development Goals (SDG) targets by 2030 (Moyer & Hedden, 2020).

Despite the interdependence of the three goals of the Triple Challenge, integration of policy across these areas remains limited, though some promising approaches exist, e.g. integrated jurisdictional initiatives (Pörtner et al., 2021). Addressing the Triple Challenge will require a holistic and integrative approach that spans multiple policy arenas and produces acceptable and just outcomes from global to local scales. Outcomes and consequences will be realized at different societal and political scales. Some societal wins may result in individual losers. Identifying those who are adversely affected by chosen responses to the

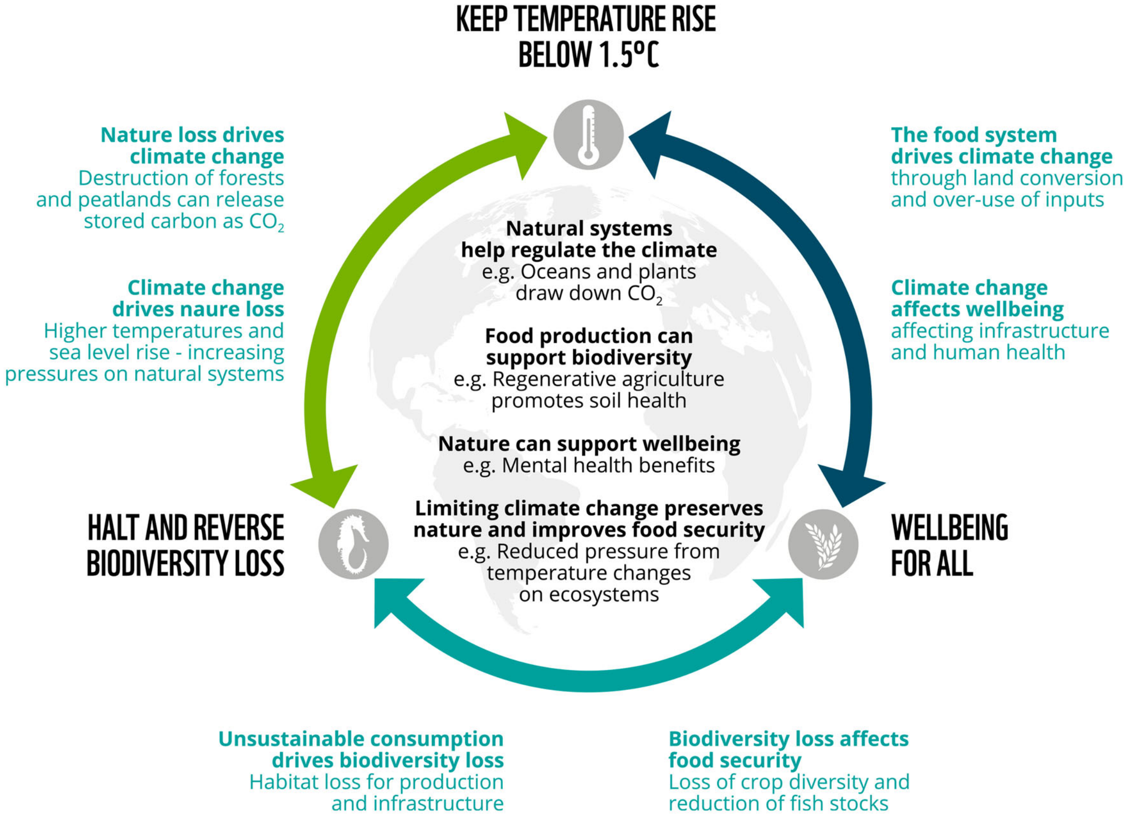

Figure 1. The interdependent goals of the Triple Challenge showing examples of positive feedbacks (within the circle) and examples of negative feedbacks (outside the circle).

Triple Challenge goals and how they can be compensated in acceptable ways will need to be a key element of any policy action.

Several recent global assessments have considered aspects of the Triple Challenge (Dasgupta, 2021; IPBES, 2019; IPCC, 2018, 2019a, 2019b; Pörtner et al., 2021; Willett et al., 2019), but these are not well connected and little attention has been given to the question of how to identify synergies and resolve unavoidable trade-offs in management of land and waters for climate mitigation, biodiversity conservation, and human wellbeing. To respond to the need for more ambitious policy action and integrated approaches, we synthesize these global assessments and other research (FABLE, 2019, 2020; FOLU, 2019; Leclère et al., 2020) to draft a portfolio of priority policy responses with the potential to provide benefits across climate, biodiversity and wellbeing goals. Within the context of human wellbeing, we focus on the food system, given food and nutrition is essential for wellbeing and that the food system is currently one of the largest contributors to biodiversity loss and climate change and, further, our food security in turn depends on a biodiversity and a stable climate (Willett et al., 2019). Building on work previously done on synergies and trade-offs (notably the joint IPCC and IPBES report (Pörtner et al., 2021)), we also examine potential trade-offs between the three goals and narrow the policy framework proposal to four practical approaches to manage them. Finally, we discuss the opportunity to accelerate responses to the Triple Challenge in this decade. Our analysis is novel in (i) its synthesis of recent assessments, each of which has only partially addressed aspects of the Triple Challenge (e.g. climate and food, climate and biodiversity, or food and biodiversity); (ii) its elaboration of a coherent, scalable, and flexible framework of core policy solutions to the Triple Challenge; and (iii) its explicit acknowledgement of unavoidable trade-offs and its identification of approaches to ensure such trade-offs are equitably addressed in decisions about land and water use and management.

2. Methodology

Our analysis was derived through an iterative process drawing on information and data gathered through three social research methodological approaches:

(i) *Structured literature review*. This assessed recent high-profile policy-focused reports, each of which addressed aspects of the Triple Challenge. They included the Intergovernmental Panel on Climate Change (IPCC) Special Reports on Global Warming of 1.5°C (IPCC, 2018), on Climate Change and Land (IPCC, 2019a), and on the Oceans and Cryosphere in a Changing Climate (IPCC, 2019b); the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) Global Assessment on Biodiversity and Ecosystems Services (IPBES, 2019); the joint IPBES and IPCC Report on Biodiversity and Climate Change (Pörtner et al., 2021); the EAT Lancet Commission on Food, Planet, Health (Willett et al., 2019); and the Dasgupta review on the Economics of Biodiversity (Dasgupta, 2021). The literature review aimed to distil common recommendations relevant to the question of how the world can simultaneously meet climate, biodiversity, and wellbeing goals as set out in international agreements. To supplement this assessment of policy-focused literature, and to ensure that we captured advances in research relevant to the Triple Challenge, we also reviewed recent scientific literature, identified using a search protocol based on a targeted keyword syntax (e.g. 'climate change + biodiversity [change] + food [security] +/− trade off +/− synergy'). Lastly, to aid our understanding of additional, context-specific literature that might provide Triple Challenge insights, we further reviewed literature specifically related to the three trade-off examples (Box 1), and the four proposed approaches to managing trade-offs (section 4 below).

(ii) *Deliberative expert analysis*. We convened a multi-disciplinary group of international expert contributors with policy and/or scientific knowledge in the fields of food systems and diet, climate change, water resource management, forests, agriculture and land use change, soil management, economics, trade and development, ocean science and management, socio-economic resilience, and biodiversity conservation. Through a series of facilitated meetings, and drawing on the outputs of the literature review process, we followed a collaborative and deliberative five-step process, learning from Susskind et al. (1999), that sought to produce a consensus on the priority policy solutions to the Triple Challenge and approaches that could address unavoidable trade-offs. This deliberative process took place between 2019 and 2022 and involved two workshop-based iterate-discuss-refine cycles, with targeted ad hoc discussions among some contributors via e-mail and online discussion to deepen understanding of specific problems and potential solutions. At each stage we sought to refine our recommendations on policy responses and trade-off resolution approaches such that we eventually arrived at a framework which emphasized the highest priority policy responses that, according to the collective expertize in the group, offer the most promising pathway to overcoming the Triple Challenge at multiple scales and in a wide range of contexts.

(iii) *Wider consultation*. Recognizing the need to gather views from outside this group, and especially from a culturally and geographically diverse set of stakeholders, we convened two panel discussions involving a total of nine subject matter experts, private sector representatives and community leaders (the first during the Global Landscapes Forum, June 25, 2020; the second during the Global Landscapes Forum, October 28, 2020). Both panel discussions were held online because of restrictions brought about by the Covid-19 pandemic. This enabled wide participation from a combined audience of several hundred people (precise numbers were not available) spanning every continent. Audience members were able to contribute comments and questions via online chat facilities which were subsequently downloaded for further analysis and reflection. Discussion papers were shared ahead of each panel discussion, and individual consultations were conducted with all panellists to ensure consistent understanding of the scope and purpose of the exercise and to glean insights to enrich the panel discussions and the subsequent analysis. The insights, conclusions, and feedback from each panel discussion was fed into the later stages of the deliberative expert analysis outlined in (ii) above.

Box 1.

Risks and opportunities of expanding forests as a carbon dioxide removal strategy

The protection and restoration of forests is the most common nature-based solution included in Nationally Determined Contributions (NDCs) under the Paris Agreement (Seddon et al., 2021). Global scenarios consistent with limiting warming to below 2°C have involved the expansion of forests by up to almost one billion hectares worldwide (IPCC, 2018). At the same time, the expansion of forests (through reforestation, afforestation, or other restoration) carries risks and opportunities for biodiversity and sustainable development more broadly (Dooley & Kartha, 2018), including a trade-off with the use of land, water, and the sea for food production (Seddon et al., 2021). Although it has been estimated that one billion hectares of non-forested, non-agricultural land is suitable for trees, some of this land will have equal or greater biodiversity value in its current land-use and the need for consent and local support will mean that in practice a much smaller proportion is actually available (Bastin et al., 2019; Dooley & Kartha, 2018; Griscom et al., 2017; IPBES, 2019; Strassburg et al., 2020). Under the Bonn Challenge (*The Bonn Challenge*, n.d.) – an initiative to put 350 million hectares of forests and landscapes into restoration by 2030 – an estimated 45% of pledges in tropical regions are for commercial plantations and 21% for agroforestry (Seddon et al., 2021), which promise much lower carbon and biodiversity benefits than regenerated natural forests (Crouzeilles et al., 2017; Lewis et al., 2019). To manage the risk of trade-offs, securing the climate benefits of forest expansion needs to go hand in hand with food system transformation, and strategies to create co-benefits for biodiversity and people.

The biodiversity and food security impacts of hydropower

Hydropower is the largest source of renewable electricity globally (IHA, 2020), and is likely to continue to generate almost half of renewable energy worldwide, at least until 2025 (Renewables, 2020: Analysis and Forecast to 2020, 2020). An estimated 58,000 large dams have already been built (*World Register of Dams: General Synthesis*, 2020) and only 37% of rivers longer than 1000 km remain free-flowing over their entire length (Grill et al., 2019). A further 3,700 large hydropower dams are proposed or under construction (Zarfl et al., 2015). While there is evidence that some dam reservoirs can be a source of greenhouse gas emissions (Keller et al., 2021), hydropower can be part of strategies to reduce greenhouse gas emissions by displacing fossil-fuel electricity generation. However, dams incur significant costs for freshwater biodiversity and, in many regions, food security. Dam construction is among the leading causes of the loss of freshwater habitats and species populations (Reid et al., 2019), blocking migrations, isolating species populations, and fundamentally altering flow regimes and ambient conditions in upstream and downstream habitats (Ramsar Convention on Wetlands, 2018; Wu et al., 2019; WWF, 2020b). As freshwater ecosystems have suffered, so have many inland (river and lake) fisheries. Such fisheries have been a neglected topic within the sustainable food discourse even though they are an important source of nutrition for billions of people (Lynch et al., 2016). That nutrition is under severe threat as the number of dams built and planned along rivers such as the Mekong, Amazon, and Congo increases (Winemiller et al., 2016). Resolving trade-offs between hydropower, biodiversity, and associated food security is therefore a critical sustainability challenge (Thieme et al., 2021).

The impact of commercial fishing on 'blue carbon' stores

The importance of the large stores of carbon in marine habitats – so-called 'blue carbon' – and the need for their effective management as a nature-based solution for climate change mitigation and adaptation, is increasingly recognized (IPBES, 2019; IPCC, 2019b; Laffoley & Grimsditch, 2009). However, capitalizing on this potential would require widespread reform of fishing practices. Bottom trawl fisheries provide for 23% of global marine fish landings (Cashion et al., 2018), with the majority of this type of fishing taking place in productive coastal shelf seas (Amoroso et al., 2018). Bottom trawling may increase fish capture but can release stored carbon from ocean sediments and impact the biogeochemical processes that drive carbon sequestration and storage. For example, it is estimated that the organic carbon released daily by trawling in the North Western Mediterranean represents as much as 60–100% of the input flux (Pusceddu et al., 2014) – potentially converting sediments undergoing continual trawling in the area investigated into a carbon source rather than a sink. Deep-sea trawling currently conducted along most continental margins also represents a major threat to the deep seafloor ecosystem globally (Pusceddu et al., 2014). The establishment of strict Marine Protected Areas in strategic locations can deliver triple benefits by protecting biodiversity, boosting fisheries' yields, and securing blue carbon stocks (Sala et al., 2021). Currently, however, only 2.7% of the ocean is in such highly protected areas (*The Marine Protection Atlas*, n.d.).

3. Addressing the Triple Challenge: a portfolio of priority policy responses

Through our synthesis of the global assessments (above) and other relevant research (FABLE, 2019, 2020; FOLU, 2019; Leclère et al., 2020), we identified a portfolio of five priority policy responses. These priorities were chosen because: (i) they have significant support across many or all the assessments (see citations for each in Table 1 in Supplementary Materials) and were further supported, through the deliberative expert analysis (ii) they have the potential to bring significant benefits for more than one of the goals in the Triple Challenge at different societal scales; (iii) they have the potential to reduce competition between the goals, thus they may reduce the likelihood or scale of trade-offs between the goals depending on how they are implemented; and (iv) they form a complementary and synergistic portfolio that spans policy arenas. The portfolio of policy responses will apply differently in different contexts and further research is needed to assess the degree to which the Triple Challenge would be met if they were fully implemented, but it is clear this portfolio does not encompass all potential strategies which could be deployed.

3.1. Rapid and deep cuts to fossil fuels use

To avoid levels of climate change that would be dangerous both to biodiversity and to human wellbeing, greenhouse gas emissions must be reduced early, fast, and significantly. The burning of fossil fuels remains the largest contributor to such emissions and therefore their rapid reduction is a pre-requisite for meeting the Triple Challenge (IEA, 2021). Early and rapid fossil fuel reductions, including through energy efficiency and replacement by renewable energy sources, would also reduce reliance on carbon dioxide removal strategies, many of which increase competition for land, freshwater, and ocean resources. However, some lower-carbon alternative energy sources can have negative impacts on biodiversity and food production (e.g. hydropower, Box 1). This demonstrates the need to fully consider trade-offs between sectoral policies and broader societal goals.

3.2. Adoption of sustainable and healthy diet choices

The adoption of locally and culturally acceptable sustainable diets – primarily composed of plant-based foods plus a moderate amount of dairy, eggs, meat, and fish – would support healthy and nutrient-secure populations whilst reducing greenhouse gas emissions (directly and indirectly) and freeing land for habitat recovery with consequent benefits for climate change and biodiversity (FAO et al., 2021; Jarmul et al., 2020; Sun et al., 2022). Although a global scale transition to sustainable and healthy diets would decrease consumption of animal-based foods, this does not mean that consumption of animal-based foods would decrease in all countries and regions at the same rate, or at all. In low-income and food insecure regions, more animal protein might need to be consumed in the future than today, and more sustainable fishing practices might allow wild-caught fish production to rise as fish populations recover. Over 10% of the world's population are undernourished and rising, while over 13% of adults are obese (FAO, 2018); this policy priority will require action on both. Enough food is already produced to feed up to 10 billion people, but this food is often inaccessible to those experiencing hunger or malnutrition due to poverty, inequalities, and other factors (Holt-Giménez et al., 2012; Willett et al., 2019). Transitions towards sustainable diets might incur short-term trade-offs. For example, they may lead to increased water use for agriculture (Jarmul et al., 2020), and a shift from animal proteins to plant proteins has been estimated to increase short-term consumer dietary costs in many low-income countries, although these increases are counterbalanced by lower healthcare costs and a smaller burden of disease in the medium to long term (Springmann et al., 2016, 2021).

3.3. Increased food productivity and cuts to food loss and waste

Current approaches to increasing food production typically rely on a combination of agricultural expansion and intensification. These bring significant consequences, such as reduced extent of natural land cover, biodiversity loss, and aquatic and terrestrial pollution (IPBES, 2019). Less environmentally-damaging alternatives to land conversion and chemical-based intensification include agroecology, regenerative agriculture, organic agriculture, agroforestry, irrigation management, sustainable harvesting of freshwater and marine living resources, and an ecosystem approach to their management (FOLU, 2019; IPBES, 2019). These approaches can raise overall agricultural productivity and reduce the yield gap between different producers and production systems but will have different benefits and consequences depending on context and the scale at which they are implemented (FOLU, 2019; Tamburini et al., 2020).

Maximizing food availability requires reducing food waste by consumers and retailers, as well as food losses along the supply chain, which have been estimated at a third of all food produced (FAO, 2019; UNEP, 2021; WWF-UK, 2021a). Different actions to reduce food loss and waste have varying impacts on climate, biodiversity, and wellbeing depending on the commodities or parts of the supply chain they target and associated impacts on pricing and trade (FAO, 2019). Actions should incorporate measures on fishery bycatch and illegal, unreported, and unregulated (IUU) fishing in order to reduce pressures on marine and freshwater biodiversity.

3.4. Implementation at scale of nature-based solutions

Nature-based solutions have been defined as 'actions that protect, sustainably manage and restore natural and modified ecosystems in ways that address societal challenges effectively and adaptively, to provide both human wellbeing and biodiversity benefits' (IUCN, 2016, p. 1). Examples include the use of natural flood management, forest landscape restoration, and ecosystem-based approaches to climate change adaptation. Their intended purpose is to address major societal challenges, including food security, climate change, water security, human health, and social and economic development (IUCN, 2016). The concept has grown in popularity in recent years, notably as a response to climate change, with estimates of the potential from land-based nature-based solutions to contribute more than 30% of needed climate mitigation (Griscom et al., 2017; Roe et al., 2019). While the potential for nature-based solutions to deliver against multiple objectives is increasingly recognized, they are still underutilized in climate and biodiversity policy and practice (Pörtner et al., 2021; Seddon et al., 2021; WWF, 2020a). Nature-based solutions have also proven controversial given that a wide range of actions or projects that have been positioned as nature-based solutions to climate change have, or potentially have, negative unintended consequences for communities or ecosystems (e.g. as a result of inappropriate tree planting) (Griffiths et al., 2019; Seddon et al., 2020, 2021). The IUCN Global Standard offers guidance for designing and verifying (by the first-party) nature-based solutions that deliver the outcomes desired (IUCN, 2020). Nature-based solutions that deliver in this way can provide an integrated and resilient response to the Triple Challenge, but are dependent on, and must not detract from, the urgent need to reduce fossil fuel emissions from all sectors (Pörtner et al., 2021).

3.5. Improved governance and management of land and waters

Governance arrangements for land and waters should always be context-specific, but a key principle for good governance is the use of proactive and participatory processes at multiple scales, such that rights-holders and stakeholders have a meaningful say in how to balance productive use of land and waters with biodiversity conservation and climate mitigation (Pörtner et al., 2021) Aligning governance forums and agencies that have overlapping but distinct jurisdictions and remits relevant to land and waters will be important. International law requires that human rights should be paramount in policy that has implications for people, including expansion of protected area networks (Newing & Perram, 2019). Ensuring that affected groups of people, especially Indigenous Peoples and Local Communities (IPLCs), are fully able to exercise their rights is essential both in planning and in implementation, and enables improved wellbeing and a just transition.

Science can inform management decisions for land and waters made through strengthened governance platforms. Methodologies such as systematic conservation planning, multi-objective trade-off assessments, and strategic environmental assessment can be used to support management of ecosystems and resources (Curtin & Prellezo, 2010; Hermoso et al., 2021; Hurford et al., 2020; Smith et al., 2022). Designation of specific areas prioritizing management for biodiversity remains an effective biodiversity conservation approach, with those managed by Indigenous Peoples and local communities proving effective at safeguarding good ecological condition (Maxwell et al., 2020). These protected areas and other effective area-based conservation measures can also play a significant role in climate change mitigation (Pörtner et al., 2021; Seddon et al., 2021; Walker et al., 2020). However, prevailing approaches to protected areas seldom pay adequate attention to all aspects to the Triple Challenge; often ignore or marginalize non-terrestrial biodiversity such as freshwater habitats (Acreman et al., 2020); and are inconsistent in their consideration of the priorities and wellbeing of IPLCs (Ban et al., 2019; Schreckenberg et al., 2016).

4. Pathways and trade-offs in delivering Triple Challenge goals

There are multiple possible policy pathways towards meeting each goal. Each pathway may have positive (synergy), negative (trade-off), or no impacts on progress towards one or both of the other goals. Different pathways to achieving the Triple Challenge at a global scale may result in national and local scale trade-offs, and vice versa (IPBES, 2019; IPCC, 2018; Pörtner et al., 2021; Secretariat of the Convention on Biological Diversity, 2020).

To illustrate the scale of the potential trade-offs, we examine three examples from terrestrial, freshwater, and marine domains (Box 1).

As well as identifying synergistic policy options (such as the responses set out in the preceding section), explicitly identifying and considering trade-offs that could act as significant impediments to meeting the Triple Challenge can inform and improve policy and management approaches (Lu et al., 2021; Pörtner et al., 2021). The Mitigation and Conservation Hierarchy approach could help prioritize possible pathways with greater priority being afforded to those options that refrain from (e.g. avoiding high impact activities) or reduce (e.g. minimizing damage from ongoing activities) negative impacts, followed by those that restore (e.g. remediating damage in converted areas), and, finally, renew (e.g. compensating for damage through nature enhancement elsewhere) (Arlidge et al., 2018). The combination of different types of interventions is also important, e.g. solutions focused on protection and restoration of ecosystems are more likely to deliver benefits when combined with demand-side actions to reduce overall pressures (Pörtner et al., 2021).

The economic and social implications of particular pathways will vary between stakeholders and contexts. A dynamic and adaptive approach to decision-making that is responsive to new evidence will also be critical as social and ecological conditions change (Lu et al., 2021; Pörtner et al., 2021).

We propose four mutually supportive approaches that could support decision-making at the portfolio scale (rather than policy by policy).

4.1. Economic and social policy for inclusive wealth

To facilitate equitable solutions to the Triple Challenge, reforms will be needed to the prevailing global economic system and financial architecture. The concept of inclusive wealth, which considers wealth as the sum of all assets including natural and human capital, should be central to such reforms (Dasgupta, 2021). This will require building the values of nature into economic decision-making and analysing how to maximize contributions of biodiversity to the other Triple Challenge goals. It will also involve incentivizing investment in nature-based solutions, and developing appropriate trade, financing, and aid mechanisms that will support a just transition. The concept of a just transition is noted in the Paris Agreement in terms of the imperative for decent work and quality jobs as part of delivering a low-carbon economy (UNFCCC, 2015). We take it to be 'a package of economic and social policies that ensure climate action and nature restoration are delivered fairly and in a way that reduces inequalities' (Baldwin-Cantello et al., 2020, p. 22). Dasgupta (2021) point to the injustice associated with natural capital depletion caused by production of primary products for export – the full costs of which are rarely paid for by importers as the value of natural capital is rarely embedded in the prices of goods sold. This represents an economically inefficient transfer of value from primary product exporters (often in the poorest countries) to importers (often in the richest countries).

The consumption of all commodities (and the process of trading them) has impacts on biodiversity and climate with knock-on impact on human wellbeing (Allan & Matthews, 2016). Direct impacts on wellbeing may be largely positive through improved material wealth, but feedbacks and indirect effects through the other pillars of the Triple Challenge may be more negative. For example, trade in commodities requires large-scale infrastructure development, which has a range of environmental impacts (Laurance et al., 2015; Zu Ermgassen et al., 2019). The direct and indirect impacts of the loss of access to ecosystem services engendered by developments such as dams or mines on human wellbeing are under-appreciated (e.g. Griffiths et al., 2020), as are the effects of mitigation actions designed to compensate for biodiversity loss (Jones et al., 2019).

Financing and trade mechanisms could facilitate appropriate payment for the value of natural capital embedded in products and strengthen accountability for the environmental impacts of business operations and financing decisions. Financing mechanisms can also facilitate payment between countries for protecting and investing in global public goods from which the whole human population benefits, e.g. REDD + . These measures would incentivize greater investment in natural capital and support just transitions, such as that from unsustainable agricultural practices to diversified, regenerative approaches.

Meeting the Triple Challenge at the global scale will require reduced footprints in those countries with high consumption levels, and equitable distribution of benefits from natural resource use (Dasgupta, 2021; O'Neill et al., 2018; Pörtner et al., 2021). To go beyond basic physical needs, and meet qualitative goals within the 'safe and just space framework' (e.g. equality, equity, voice), a more fundamental restructure of provisioning systems will be needed (Pörtner et al., 2021; Raworth, 2017). This includes pursuit of social goals through non-material means, reduced income inequality, and improved social support (Dasgupta, 2021; O'Neill et al., 2018). Ultimately, aligning economic policy and finance flows with the Triple Challenge may also require moving beyond GDP growth as a measure of progress (Dasgupta, 2021; Hickel & Kallis, 2020; Otero et al., 2020; Pörtner et al., 2021). In one example, Raworth (2017) proposes 'doughnut economics' as an alternative compass to GDP, including measuring progress on elements of the social foundation need for humans to thrive (e.g. access to education, healthcare, and decent housing, etc.) and proximity to an ecological ceiling (e.g. climate change limits, air pollution levels, etc.) In another, the UK government launched a National Well-being Programme in 2010, recognizing of the limits of measuring progress through GDP (UK Government, 2013).

4.2. Integrated policy making on climate change, biodiversity, and human wellbeing

Integrated policymaking on wellbeing or development (e.g. on diets and nutrition, agricultural subsidies, trade conditions), climate change (e.g. energy investments, nature-based solutions) and biodiversity (e.g. protected areas, restoration priorities, fisheries management) will be critical for coherent policy responses to the Triple Challenge (Pörtner et al., 2021). Integrated policy occurs when 'constituent [policy] elements are brought together and made subject to a single, unifying conception' (Underdal in Candel & Biesbroek, 2016, p. 212). Ideally, policy integration would occur at nested scales from local to national and regional, through to the global level.

Policy integration is often called for, particularly in the context of sustainable development, but is difficult to achieve in practice. Despite isolated successes, governments have seldom integrated policy domains (Jordan & Lenschow, 2010; May et al., 2011; Pörtner et al., 2021). At the international scale, the SDGs can be seen as a valiant attempt at integration, given the breadth of the issues they address, although the extent to which they have integrated ecosystem and biodiversity concerns has been questioned (Dickens et al., 2020; Zeng et al., 2020). Most national governments lack integrated policy frameworks or strategies for sustainable land use (FABLE, 2020). Further, policies between the three goal areas often actively undermine one another, e.g. subsidies for certain food commodities in the US have been linked with negative public health outcomes and run counter to dietary guidelines (Franck et al., 2013; Siegel et al., 2016). Barriers to policy integration, include: (i) vested interests, political power, and policy preferences of relevant actors; (ii) the requirement for public support; (iii) the extent to which international institutions support integration; (iv) the framing of the policy problem (i.e. whether a cross-cutting problem is recognized as such by the policymakers); (v) having a minimum level of human and institutional capacity; (vi) the absence of centralized agencies and leadership; (vii) lack of incentives to attain integration; (viii) 'lock in' effects from pre-existing policies; (ix) existence of dominant policy domains within institutions; (x) the need for and difficulty in changing or aligning policy beliefs of actors involved; (xi) added complexity leading to higher transaction costs in policymaking and possible indecision/paralysis; and (xii) lack of political will to genuinely move beyond symbolic action (Candel & Biesbroek, 2016; Tosun & Lang, 2017).

Conversely, successful policy integration may depend on the existence of a minimum set of enabling conditions: (i) a statement and ongoing visible commitment from political leaders that emphasizes the need for and objectives of integrated policy (Howlett & Rayner, 2007; Jordan & Lenschow, 2010; Tosun & Lang, 2017); (ii) an acknowledged need by decision-makers to re-frame policies in ways that generate common understanding of causes for and solutions to policy problems (Tosun & Lang, 2017); and (iii) the existence or creation of institutions that facilitate the integration process, such as relevant parliamentary committees or executive agencies, or policy entrepreneurs (Brouwer & Huitema, 2018; Meijerink & Huitema, 2010; Tosun & Lang, 2017). The OECD has collected a set of examples of how governments have promoted policy integration and coordination towards sustainable development, including, for example, in Japan where the 'SDGs Promotion Headquarters' has a central position within the Cabinet and fosters close co-operation and information among the relevant governmental agencies (OECD, 2019). For sufficient integration to occur, these enabling conditions must lead to genuine reform of relevant policy instruments, rather than the adaptation of existing instruments or incremental modification of existing goals that are bounded by existing instruments (Howlett & Rayner, 2007).

4.3. Triple Challenge dialogues

Multi-stakeholder processes and platforms are already widely used to identify problems and management options for land and waters (Reed et al., 2016), and have been specifically proposed by others as essential for jointly navigating biodiversity, climate, and social goals (Pörtner et al., 2021). Context-specific 'Triple Challenge dialogues' that build on such processes can be a mechanism for identifying potential policy responses, likely synergies and trade-offs, and preferred pathways for meeting the Triple Challenge. For example, the Climate Assembly UK explored pathways to net zero with a representative group of the public, through which self-identification of the impacts on human health, nature, livelihoods (e.g. farmers) of different land use scenarios led to consideration of these trade-offs and an eventual set of shared recommendations (Climate Assembly UK, 2020; Elstub et al., 2021).

The proposed dialogues should place the Triple Challenge into a real-world context and be designed to inform decisions at the levels at which they are made, for instance at the community and/or jurisdictional and/or landscape scales, or along intra- and international trade routes. Dialogues should include state and non-state actors concerned with food, energy, environment, and other relevant sectors. Importantly, the dialogues should explicitly recognize the rights, incentives, and motivations of resource users or stewards, including Indigenous Peoples and local communities, and should be informed by the best available evidence and knowledge base (both scientific and traditional). As potential trade-offs between outcomes and stakeholders are made transparent, Triple Challenge dialogues can identify potentially acceptable pathways, and feasible mitigating measures for negative impacts. It is important to note that some losses, notably those that relate to cultural values, cannot be mitigated or compensated for.

Multi-stakeholder processes like Triple Challenge dialogues should allow for deliberative policy processes – a form of social dialogue – that are well-suited to addressing values-based dilemmas, complex problems that involve unavoidable trade-offs, and long-term issues. Their effectiveness can be enhanced if they are conducted with genuine transfer of power and influence, such that their recommendations are normally adopted. Effective inclusion requires full and effective participation at all stages of the decision-making process (Pörtner et al., 2021). Dialogue processes incur risks: participants might favour portfolios of responses that will not effectively meet the Triple Challenge goals. Where stakeholder processes identify incompatible viewpoints, decision-making procedures will need to find a way of reconciling contested views such as through Multicriteria Decision Analysis (Davies et al., 2013). Nevertheless, similar multi-stakeholder dialogues have been found to have significant influence on policymakers in the majority of cases (*Innovative Citizen Participation and New Democratic Institutions*, n.d.) and they can help to overcome resistance to change and increase the likelihood that the resulting agreements are implemented (Turkelboom et al., 2018). Examples exist of dialogues resulting in action for zero deforestation landscapes (Wolosin, 2016), low emissions rural development (Stickler et al., 2014), and climate smart landscapes (Kusters, 2015), and in a variety of geographic contexts including Europe (García-Martín et al., 2016), Africa (Milder et al., 2014), and Latin America (Estrada-Carmona et al., 2014).

4.4. More integrated and influential research

More integrated policy development and stakeholder dialogues should be supported by research that assesses the range of benefits and consequences of potential pathways and portfolios of responses to addressing the Triple Challenge. We propose four areas for research to support policymaking and stakeholder dialogues and elaborate further on example research questions to be addressed in Table 2 in Supplementary Materials.

First, there is significant scope for truly integrated analyses of how climate, biodiversity, and human wellbeing are connected. The global assessments on which our work was based only partially recognized these connections and, with notable exceptions (FABLE, 2019; FOLU, 2019; Pörtner et al., 2021), there is limited effort to synthesize, integrate, and look across analysis in the scientific literature. Even the best available analysis of climate–biodiversity-wellbeing connections omits important issues, such as for freshwater and marine resource use (Leclère et al., 2020). For example, the IPCC and IPBES could build on their recent workshop and scientific outcome on global biodiversity and climate interactions (Pörtner et al., 2021) and could integrate global assessment of relevant well-being aspects, especially as they affect management of both land and water. IPBES has itself taken the step to undertake an assessment of the nexus between biodiversity, water, food, and health, with partial coverage of the Triple Challenge, and the first external review of chapters is planned in early 2023 (*Nexus Assessment: Thematic Assessment of the Interlinkages among Biodiversity, Water, Food and Health*, n.d.).

Second, the research community must further collaborate with civil society, communication experts, and research users including businesses, local communities, and policymakers to produce analyses in ways that can influence real world decisions. Triple Challenge policy responses will always be at the mercy of a lack of data, uncertainty, and the consequent requirement to make modelling assumptions. They will also be influenced by political processes, conflicting perspectives, and the power of vested interests. Given the contested nature of decisions about natural resources, we need to develop and deploy narratives and stories alongside evidence from science and from traditional knowledge bases to effectively influence Triple Challenge decision-making.

Third, given the difficulties in achieving integrated policymaking, we need insights into approaches and enabling conditions that aid such integration. There have been limited attempts to empirically assess the real-world outcomes from achieving more integrated policy strategies (Jordan & Lenschow, 2010; Tosun & Lang, 2017). Evidence remains scarce on why integration attempts are successful or unsuccessful, the intended and unintended consequences that result from integration attempts, and how to balance the costs and benefits of investments in integration (Tosun & Lang, 2017).

Fourth and finally, there is an urgent need for researchers to identify and evaluate potential Triple Challenge solutions in different contexts, including identifying how combinations of actors can combine to deliver the priority policy responses outlined above (Section 3 and Figure 2). Within food systems, for example, there has been a multitude of analyses of top-down approaches to meeting environmental and health targets (Clark et al., 2020; Springmann et al., 2018). Whilst these analyses have been useful to illustrate the potential benefits of different strategies (e.g. transitions to healthier dietary patterns), it remains unclear which sets of actors could help implement these strategies.

5. Accelerating the global response in the next decade

There are signs that decision-makers are starting to recognize the Triple Challenge, at least in concept. For instance, since its launch in September 2020, more than 90 Heads of State and Government, including the

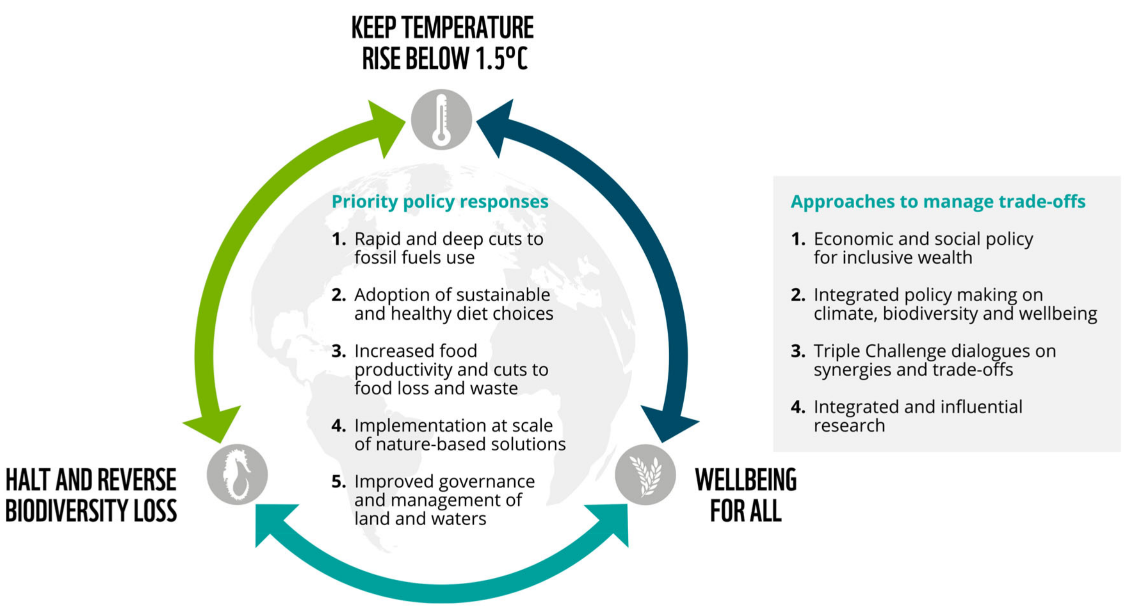

Figure 2. Priority policy responses to respond to the Triple Challenge (within the circle) and approaches to manage trade-offs (outside the circle).

leaders of five of the world's largest economies, endorsed the 'Leaders' Pledge for Nature' (*Leaders Pledge for Nature*, 2020). The Pledge highlighted the interdependent nature of climate change, biodiversity, and human wellbeing. The UNFCCC COP26, held in Glasgow in 2021, resulted in a step forward for policy integration, with several key outputs noting the links between climate, biodiversity, and human wellbeing (UK Government, 2021). However, ahead of COP26, the proportion of enhanced NDCs submitted by governments that incorporated nature-based solutions had increased to 92% (WWF-UK, 2021b) – yet further opportunities remain untapped. Beyond inter-governmental agreements, integration of climate change and biodiversity into fiscal policy and private financial decision making, as suggested by the Dasgupta Review (Dasgupta, 2021) has been boosted by the establishment by the Financial Stability Board's Task Force on Climate-related Financial Disclosures (*TCFD - Task Force on Climate-Related Finacial Disclosures*, n.d.) and Taskforce for Nature-related Financial Disclosures (*Taskforce on Nature-Related Financial Disclosure*, 2022). These task forces aim to advise companies and other organizations on how to disclose climate- and nature-related risks and opportunities. If their recommendations are implemented, they have the potential to encourage the shifting of substantial financial capital away from investments that contribute to climate change and/or biodiversity loss and towards solutions to the Triple Challenge.

The next decade presents unprecedented prospects for the creation of an integrated global policy framework addressing the Triple Challenge. Although overall ambition on greenhouse gas emission reductions remained too low, positives could be taken from COP 27 decisions in November 2022, which recognized the role of nature-based solutions and agreed a new four-year plan on climate action on agriculture and food security. Further, the Kunming-Montreal Global Biodiversity Framework agreed in December 2022 also supported nature-based solutions (Target 8) and not only promoted sustainable agriculture but set a target to halve global food waste by 2030 (Target 16.) Implementation is now the imperative. National governments are already committed to communicate responses to climate change through Nationally Determined Contributions (NDCs) and long-term strategies under the Paris Agreement, to biodiversity through National Biodiversity Strategies and Action Plans (NBSAPs), and to report progress towards the SDGs. There is potential for the Triple Challenge to be better reflected through the NDCs, NBSAPs, and SDG progress reports they submit prior to each relevant conference. This could include integration of the five policy priorities outlined above as well as use of the four approaches to managing trade-offs in determining the national plans and preparing for international agreements.

6. Conclusion

Recent global assessments provide a substantial evidence base for the climate and biodiversity crises and the interlinked challenges facing human wellbeing. It is clear from this evidence that the world is not on track to meet climate and biodiversity targets, or to meet some SDGs. The fundamental links between climate, biodiversity, and wellbeing mean that a failure to meet any of these Triple Challenge goals individually will generate cascading risks to others.

Five priority policy responses can form the core of an integrated approach to meeting the Triple Challenge: (i) rapidly cutting fossil fuel use; (ii) promoting sustainable, healthy diets; (iii) increasing food productivity and cutting food loss and waste; (iv) implementing nature-based solutions at scale; and (v) improving governance and management of land and waters. Additional policy interventions implemented at local to national scales will also be needed and some trade-offs between policy outcomes and between different groups of people are likely to be unavoidable. These trade-offs need to be understood, explicitly acknowledged, and managed in an inclusive and equitable way. Four approaches – economic and social policy for inclusive wealth; integrated policymaking; multi-stakeholder Triple Challenge dialogues; and a more integrated and influential research base – can support decision-making on trade-offs. Public finance, aid, trade, and economic policy frameworks will need to be reshaped to ensure that the benefits and costs of the required societal transitions are shared fairly, globally and locally.

These findings are broadly consistent with the work of IPBES and IPCC in examining the interlinkages between climate change and biodiversity responses, which ran in an overlapping time period during 2019–2021. The actions we propose are broadly known as part of the wider response set for climate, biodiversity, and wellbeing goals, but we add further weight to their importance through our Triple Challenge lens, and package them in a prioritized and complementary set for policymakers and those seeking to inform them. Further research is needed to assess the extent to which each policy response can be implemented in specific contexts, the degree to which the Triple Challenge would be met if they are implemented, and how to assess 'real world' attempts to implement these approaches to managing trade-offs. Given the urgency of the Triple Challenge we must learn while doing.

Meeting the Triple Challenge will require a societal transformation whereby the value of a stable climate, flourishing biodiversity, and universal human wellbeing, and the connections between them, are recognized at all levels of implementation. The decade of implementation following agreements reached in 2021 and 2022 provide a unique opportunity to accelerate this transformation by giving national state and non-state actors the opportunity to collectively adopt and implement actions that underpin an integrated response commensurate with the scale of the Triple Challenge. Doing so would set us on a pathway towards a positive future where we live in a healthy society and stable climate, surrounded by thriving natural systems.

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References

Acreman, M., Hughes, K. A., Arthington, A. H., Tickner, D., & Dueñas, M.-A. (2020). Protected areas and freshwater biodiversity: A novel systematic review distils eight lessons for effective conservation. *Conservation Letters*, *13*(1), e12684. https://doi.org/10.1111/conl.12684

Allan, T., & Matthews, N. (2016). The water, energy and food nexus and ecosystems: The political economy of food and non-food supply chains. In F. Dodds & J. Bartram (Eds.), *The water, food, energy and climate nexus* (pp. 78–90). Routledge.

Amoroso, R. O., Pitcher, C. R., Rijnsdorp, A. D., McConnaughey, R. A., Parma, A. M., Suuronen, P., Eigaard, O. R., Bastardie, F., Hintzen, N. T., Althaus, F., Baird, S. J., Black, J., Buhl-Mortensen, L., Campbell, A. B., Catarino, R., Collie, J., Cowan, J. H., Durholtz, D., Engstrom, N., … Jennings, S. (2018). Bottom trawl fishing footprints on the world's continental shelves. *Proceedings of the National Academy of Sciences*, *115*(43), E10275–E10282. https://doi.org/10.1073/pnas.1802379115

Arlidge, W. N. S., Bull, J. W., Addison, P. F. E., Burgass, M. J., Gianuca, D., Gorham, T. M., Jacob, C., Shumway, N., Sinclair, S. P., Watson, J. E. M., Wilcox, C., & Milner-Gulland, E. J. (2018). A global mitigation hierarchy for nature conservation. *BioScience*, *68*(5), 336–347. https://doi.org/10.1093/biosci/biy029

Baldwin-Cantello, W., Clark, M., Cornelius, S., Francis, A., Ghazoul, J., Gordon, J., Halevy, S., Matthews, N., Smith, P., Tickner, D., Walmsley, S., Wright, M., & Young, L. (2020). *Triple Challenge: Synergies, trade-offs and integrated responses to meet our food, climate and biodiversity goals.* WWF. www.wwf.org.uk/triple-challenge

Ban, N. C., Gurney, G. G., Marshall, N. A., Whitney, C. K., Mills, M., Gelcich, S., Bennett, N. J., Meehan, M. C., Butler, C., Ban, S., Tran, T. C., Cox, M. E., & Breslow, S. J. (2019). Well-being outcomes of marine protected areas. *Nature Sustainability*, *2*(6), 524–532. https://doi.org/10.1038/s41893-019-0306-2

Bastin, J.-F., Finegold, Y., Garcia, C., Mollicone, D., Rezende, M., Routh, D., Zohner, C. M., & Crowther, T. W. (2019). The global tree restoration potential. *Science*, *365*(6448), 76–79. https://doi.org/10.1126/science.aax0848

Brouwer, S., & Huitema, D. (2018). Policy entrepreneurs and strategies for change. *Regional Environmental Change*, *18*(5), 1259–1272. https://doi.org/10.1007/s10113-017-1139-z

Candel, J. J. L., & Biesbroek, R. (2016). Toward a processual understanding of policy integration. *Policy Sciences*, *49*(3), 211–231. https://doi.org/10.1007/s11077-016-9248-y

Cashion, T., Al-Abdulrazzak, D., Belhabib, D., Derrick, B., Divovich, E., Moutopoulos, D. K., Noël, S.-L., Palomares, M. L. D., Teh, L. C. L., Zeller, D., & Pauly, D. (2018). Reconstructing global marine fishing gear use: Catches and landed values by gear type and sector. *Fisheries Research*, *206*, 57–64. https://doi.org/10.1016/j.fishres.2018.04.010

Clark, M. A., Domingo, N. G. G., Colgan, K., Thakrar, S. K., Tilman, D., Lynch, J., Azevedo, I. L., & Hill, J. D. (2020). Global food system emissions could preclude achieving the 1.5° and 2°C climate change targets. *Science*, *370*(6517), 705–708. https://doi.org/10.1126/science.aba7357

Climate Assembly UK. (2020). *Climate assembly UK – The parth to net zero*. House of Commons. https://www.climateassembly.uk/report/read/final-report.pdf

Crouzeilles, R., Ferreira, M. S., Chazdon, R. L., Lindenmayer, D. B., Sansevero, J. B. B., Monteiro, L., Iribarrem, A., Latawiec, A. E., & Strassburg, B. B. N. (2017). Ecological restoration success is higher for natural regeneration than for active restoration in tropical forests. *Science Advances*, *3*(11), e1701345. https://doi.org/10.1126/sciadv.1701345

Curtin, R., & Prellezo, R. (2010). Understanding marine ecosystem based management: A literature review. *Marine Policy*, *34*(5), 821–830. https://doi.org/10.1016/j.marpol.2010.01.003

Dasgupta, P. (2021). *The economics of biodiversity: The Dasgupta review, Abridged version*. HM Treasury. https://www.gov.uk/government/publications/final-report-the-economics-of-biodiversity-the-dasgupta-review

Davies, A. L., Bryce, R., & Redpath, S. M. (2013). Use of multicriteria decision analysis to address conservation conflicts: Multicriteria decision analysis. *Conservation Biology*, *27*(5), 936–944. https://doi.org/10.1111/cobi.12090

Dickens, C., McCartney, M., Tickner, D., Harrison, I. J., Pacheco, P., & Ndhlovu, B. (2020). Evaluating the global state of ecosystems and natural resources: Within and beyond the SDGs. *Sustainability*, *12*(18), 18. https://doi.org/10.3390/su12187381

Dooley, K., & Kartha, S. (2018). Land-based negative emissions: Risks for climate mitigation and impacts on sustainable development. *International Environmental Agreements: Politics, Law and Economics*, *18*(1), 1–20. https://doi.org/10.1007/s10784-017-9382-9

Elstub, S., Farrell, D. M., Carrick, J., & Mockler, P. (2021). *Evaluation of climate assembly UK*. Newcastle University. https://www.parliament.uk/globalassets/documents/get-involved2/climate-assembly-uk/evaluation-of-climate-assembly-uk.pdf

Estrada-Carmona, N., Hart, A. K., DeClerck, F. A. J., Harvey, C. A., & Milder, J. C. (2014). Integrated landscape management for agriculture, rural livelihoods, and ecosystem conservation: An assessment of experience from Latin America and the Caribbean. *Landscape and Urban Planning*, *129*, 1–11. https://doi.org/10.1016/j.landurbplan.2014.05.001

FABLE. (2019). *Pathways to sustainable land-use and food systems. 2019 Report of the FABLE consortium*. International Institute for Applied Systems Analysis (IIASA) and Sustainable Development Solutions Network (SDSN).

FABLE. (2020). *Pathways to sustainable land-use and food systems. 2020 Report of the FABLE Consortium*. International Institute for Applied Systems Analysis (IIASA) and Sustainable Development Solutions Network (SDSN).

FAO. (2018). *Building climate resilience for food security and nutrition*.

FAO. (2019). *Moving forward on food loss and waste reduction*.

FAO, IFAD, UNICEF, WFP, & WHO. (2021). *The state of food security and nutrition in the world 2021*. FAO. https://doi.org/10.4060/cb4474en

FOLU. (2019). *Growing better: Ten critical transitions to transform food and land use*. The Food and Land Use Coalition.

Franck, C., Grandi, S. M., & Eisenberg, M. J. (2013). Agricultural subsidies and the American obesity epidemic. *American Journal of Preventive Medicine*, *45*(3), 327–333. https://doi.org/10.1016/j.amepre.2013.04.010

García-Martín, M., Bieling, C., Hart, A., & Plieninger, T. (2016). Integrated landscape initiatives in Europe: Multi-sector collaboration in multi-functional landscapes. *Land Use Policy*, *58*, 43–53. https://doi.org/10.1016/j.landusepol.2016.07.001

Griffiths, V. F., Bull, J. W., Baker, J., Infield, M., Roe, D., Nalwanga, D., Byaruhanga, A., & Milner-Gulland, E. J. (2020). Incorporating local nature-based cultural values into biodiversity No Net Loss strategies. *World Development*, *128*, 104858. https://doi.org/10.1016/j.worlddev.2019.104858

Griffiths, V. F., Bull, J. W., Baker, J., & Milner-Gulland, E. J. (2019). No net loss for people and biodiversity. *Conservation Biology*, *33*(1), 76–87. https://doi.org/10.1111/cobi.13184

Grill, G., Lehner, B., Thieme, M., Geenen, B., Tickner, D., Antonelli, F., Babu, S., Borrelli, P., Cheng, L., Crochetiere, H., Ehalt Macedo, H., Filgueiras, R., Goichot, M., Higgins, J., Hogan, Z., Lip, B., McClain, M. E., Meng, J., Mulligan, M., … Zarfl, C. (2019). Mapping the world's free-flowing rivers. *Nature*, *569*(7755), 7755. https://doi.org/10.1038/s41586-019-1111-9

Griscom, B. W., Adams, J., Ellis, P. W., Houghton, R. A., Lomax, G., Miteva, D. A., Schlesinger, W. H., Shoch, D., Siikamäki, J. V., Smith, P., Woodbury, P., Zganjar, C., Blackman, A., Campari, J., Conant, R. T., Delgado, C., Elias, P., Gopalakrishna, T., Hamsik, M. R., … Fargione, J. (2017). Natural climate solutions. *Proceedings of the National Academy of Sciences*, *114*(44), 11645. https://doi.org/10.1073/pnas.1710465114

Hermoso, V., Vasconcelos, R. P., Henriques, S., Filipe, A. F., & Carvalho, S. B. (2021). Conservation planning across realms: Enhancing connectivity for multi-realm species. *Journal of Applied Ecology*, *58*(3), 644–654. https://doi.org/10.1111/1365-2664.13796

Hickel, J., & Kallis, G. (2020). Is green growth possible? *New Political Economy*, *25*(4), 469–486. https://doi.org/10.1080/13563467.2019.1598964

Holt-Giménez, E., Shattuck, A., Altieri, M., Herren, H., & Gliessman, S. (2012). We already grow enough food for 10 billion people … and still can't end hunger. *Journal of Sustainable Agriculture*, *36*(6), 595–598. https://doi.org/10.1080/10440046.2012.695331

Howlett, M., & Rayner, J. (2007). Design principles for policy mixes: Cohesion and coherence in 'new governance arrangements'. *Policy and Society*, *26*(4), 1–18. https://doi.org/10.1016/S1449-4035(07)70118-2

Hurford, A. P., McCartney, M. P., Harou, J. J., Dalton, J., Smith, D. M., & Odada, E. (2020). Balancing services from built and natural assets via river basin trade-off analysis. *Ecosystem Services*, *45*, 101144. https://doi.org/10.1016/j.ecoser.2020.101144

IEA. (2021). *Net zero by* 2050. IEA. https://www.iea.org/reports/net-zero-by-2050

IHA. (2020). *2020 Hydropower status report. Sector trends and insights*. International Hydropower Association.

Innovative Citizen Participation and New Democratic Institutions: Catching the Deliberative Wave en OECD. (n.d.). Retrieved January 7, 2021, from https://www.oecd.org/gov/innovative-citizen-participation-and-new-democratic-institutions-339306da-en.htm

IPBES. (2019). *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.

IPCC. (2018). *Summary for policymakers. Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*.

IPCC. (2019a). *Summary for policymakers. Climate change and land: An IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems*.

IPCC. (2019b). *Summary for policymakers. IPCC special report on the ocean and cryosphere in a changing climate*.

IUCN. (2016). *Definitional framework on nature-based solutions, world conservation congress*. https://www.iucn.org/sites/dev/files/content/documents/wcc_2016_res_069_en.pdf

IUCN. (2020). *IUCN global standard for nature-based solutions: First edition*. https://portals.iucn.org/library/sites/library/files/documents/2020-020-En.pdf

Jarmul, S., Dangour, A. D., Green, R., Liew, Z., Haines, A., & Scheelbeek, P. F. (2020). Climate change mitigation through dietary change: A systematic review of empirical and modelling studies on the environmental footprints and health effects of `sustainable diets'. *Environmental Research Letters*, *15*(12), 123014. https://doi.org/10.1088/1748-9326/abc2f7

Jones, J. P. G., Bull, J. W., Roe, D., Baker, J., Griffiths, V. F., Starkey, M., Sonter, L. J., & Milner-Gulland, E. J. (2019). Net gain: Seeking better outcomes for local people when mitigating biodiversity loss from development. *One Earth*, *1*(2), 195–201. https://doi.org/10.1016/j.oneear.2019.09.007

Jordan, A., & Lenschow, A. (2010). Environmental policy integration: A state of the art review. *Environmental Policy and Governance*, *20*(3), 147–158. https://doi.org/10.1002/eet.539

Keller, P. S., Marcé, R., Obrador, B., & Koschorreck, M. (2021). Global carbon budget of reservoirs is overturned by the quantification of drawdown areas. *Nature Geoscience*, *14*(6), 402–408. https://doi.org/10.1038/s41561-021-00734-z.

Kusters, K. (2015). *Climate-smart landscapes and the landscape approach – An exploration of the concepts of their practical implications*. Tropenbos International.

Laffoley, D., & Grimsditch, G. D. (2009). *The management of natural coastal carbon sinks*. IUCN. https://www.iucn.org/resources/publication/management-natural-coastal-carbon-sinks

Laurance, W. F., Peletier-Jellema, A., Geenen, B., Koster, H., Verweij, P., Van Dijck, P., Lovejoy, T. E., Schleicher, J., & Van Kuijk, M. (2015). Reducing the global environmental impacts of rapid infrastructure expansion. *Current Biology*, *25*(7), R259–R262. https://doi.org/10.1016/j.cub.2015.02.050

Leaders Pledge for Nature. (2020). Leaders pledge for nature. https://leaderspledgefornature.org

Leclère, D., Obersteiner, M., Barrett, M., Butchart, S. H. M., Chaudhary, A., De Palma, A., DeClerck, F. A. J., Di Marco, M., Doelman, J. C., Dürauer, M., Freeman, R., Harfoot, M., Hasegawa, T., Hellweg, S., Hilbers, J. P., Hill, S. L. L., Humpenöder, F., Jennings, N., Krisztin, T., … Young, L. (2020). Bending the curve of terrestrial biodiversity needs an integrated strategy. *Nature*, *585*(7826), 7826. https://doi.org/10.1038/s41586-020-2705-y

Lewis, S. L., Wheeler, C. E., Mitchard, E. T. A., & Koch, A. (2019). Restoring natural forests is the best way to remove atmospheric carbon. *Nature*, *568*(7750), 7750. https://doi.org/10.1038/d41586-019-01026-8

Lu, N., Liu, L., Yu, D., & Fu, B. (2021). Navigating trade-offs in the social-ecological systems. *Current Opinion in Environmental Sustainability*, *48*, 77–84. https://doi.org/10.1016/j.cosust.2020.10.014

Lynch, A. J., Cooke, S. J., Deines, A. M., Bower, S. D., Bunnell, D. B., Cowx, I. G., Nguyen, V. M., Nohner, J., Phouthavong, K., Riley, B., Rogers, M. W., Taylor, W. W., Woelmer, W., & Youn, S.-J. (2016). The social, economic, and environmental importance of inland fish and fisheries. *Environmental Reviews*, *24*(2), 115–121. https://doi.org/10.1139/er-2015-0064.

Maxwell, S. L., Cazalis, V., Dudley, N., Hoffmann, M., Rodrigues, A. S. L., Stolton, S., Visconti, P., Woodley, S., Kingston, N., Lewis, E., Maron, M., Strassburg, B. B. N., Wenger, A., Jonas, H. D., Venter, O., & Watson, J. E. M. (2020). Area-based conservation in the twenty-first century. *Nature*, *586*(7828), 217–227. https://doi.org/10.1038/s41586-020-2773-z

May, P. J., Jochim, A. E., & Sapotichne, J. (2011). Constructing homeland security: An anemic policy regime. *Policy Studies Journal*, *39*(2), 285–307. https://doi.org/10.1111/j.1541-0072.2011.00408.x

Meijerink, S., & Huitema, D. (2010). Policy entrepreneurs and change strategies. *Ecology and Society*, *15*(2), http://www.jstor.org/stable/26268135 https://doi.org/10.5751/ES-03509-150221

Milder, J. C., Hart, A. K., Dobie, P., Minai, J., & Zaleski, C. (2014). Integrated landscape initiatives for African agriculture, development, and conservation: A region-wide assessment. *World Development*, *54*, 68–80. https://doi.org/10.1016/j.worlddev.2013.07.006

Moyer, J. D., & Hedden, S. (2020). Are we on the right path to achieve the sustainable development goals? *World Development*, *127*, 104749. https://doi.org/10.1016/j.worlddev.2019.104749

Newing, H., & Perram, A. (2019). What do you know about conservation and human rights? *Oryx*, *53*(4), 595–596. https://doi.org/10.1017/S0030605319000917

Nexus assessment: Thematic assessment of the interlinkages among biodiversity, water, food and health. (n.d.). IPBES. Retrieved October 19, 2022, from https://ipbes.net/nexus

OECD. (2019). *Governance as an SDG accelerator: Country experiences and tools*. https://doi.org/10.1787/0666b085-en

O'Neill, D. W., Fanning, A. L., Lamb, W. F., & Steinberger, J. K. (2018). A good life for all within planetary boundaries. *Nature Sustainability*, *1*(2), 2. https://doi.org/10.1038/s41893-018-0021-4

Otero, I., Farrell, K. N., Pueyo, S., Kallis, G., Kehoe, L., Haberl, H., Plutzar, C., Hobson, P., García-Márquez, J., Rodríguez-Labajos, B., Martin, J.-L., Erb, K.-H., Schindler, S., Nielsen, J., Skorin, T., Settele, J., Essl, F., Gómez-Baggethun, E., Brotons, L., … Pe'er, G. (2020). Biodiversity policy beyond economic growth. *Conservation Letters*, *13*(4), e12713. https://doi.org/10.1111/conl.12713

Pecl, G. T., Araújo, M. B., Bell, J. D., Blanchard, J., Bonebrake, T. C., Chen, I.-C., Clark, T. D., Colwell, R. K., Danielsen, F., Evengård, B., Falconi, L., Ferrier, S., Frusher, S., Garcia, R. A., Griffis, R. B., Hobday, A. J., Janion-Scheepers, C., Jarzyna, M. A., Jennings, S., … Williams, S. E. (2017). Biodiversity redistribution under climate change: Impacts on ecosystems and human well-being. *Science*, *355*(6332), eaai9214. https://doi.org/10.1126/science.aai9214

Pörtner, H., Scholes, R. J., Agard, J., Archer, E., Bai, X., Barnes, D., Burrows, M., Chan, L., Cheung, W. L., Diamond, S., Donatti, C., Duarte, C., Eisenhauer, N., Foden, W., Gasalla, M. A., Handa, C., Hickler, T., Hoegh-Guldberg, O., Ichii, K., … Ngo, H. (2021). *IPBES-IPCC co-sponsored workshop report on biodiversity and climate change (version 2)*. Zenodo. https://doi.org/10.5281/ZENODO.4782538

Pusceddu, A., Bianchelli, S., Martín, J., Puig, P., Palanques, A., Masqué, P., & Danovaro, R. (2014). Chronic and intensive bottom trawling impairs deep-sea biodiversity and ecosystem functioning. *Proceedings of the National Academy of Sciences*, *111*(24), 8861–8866. https://doi.org/10.1073/pnas.1405454111

Ramsar Convention on Wetlands. (2018). *Global wetland outlook: State of the world's wetlands and their services to people*. Ramsar Convention Secretariat.

Raworth, K. (2017). *Doughnut economics: Seven ways to think like a 21st-century economist ([Paperback] edition)*. Penguin Books.

Reed, J., Van Vianen, J., Deakin, E. L., Barlow, J., & Sunderland, T. (2016). Integrated landscape approaches to managing social and environmental issues in the tropics: Learning from the past to guide the future. *Global Change Biology*, *22*(7), 2540–2554. https://doi.org/10.1111/gcb.13284

Reid, A. J., Carlson, A. K., Creed, I. F., Eliason, E. J., Gell, P. A., Johnson, P. T. J., Kidd, K. A., MacCormack, T. J., Olden, J. D., Ormerod, S. J., Smol, J. P., Taylor, W. W., Tockner, K., Vermaire, J. C., Dudgeon, D., & Cooke, S. J. (2019). Emerging threats and persistent conservation challenges for freshwater biodiversity. *Biological Reviews*, *94*(3), 849–873. https://doi.org/10.1111/brv.12480

Renewables 2020: Analysis and forecast to 2025. (2020). IEA. https://www.iea.org/reports/renewables-2020#executive-summary

Roe, S., Streck, C., Obersteiner, M., Frank, S., Griscom, B., Drouet, L., Fricko, O., Gusti, M., Harris, N., Hasegawa, T., Hausfather, Z., Havlík, P., House, J., Nabuurs, G.-J., Popp, A., Sánchez, M. J. S., Sanderman, J., Smith, P., Stehfest, E., & Lawrence, D. (2019). Contribution of the land sector to a 1.5 °C world. *Nature Climate Change*, *9*(11), 11. https://doi.org/10.1038/s41558-019-0591-9

Sala, E., Mayorga, J., Bradley, D., Cabral, R. B., Atwood, T. B., Auber, A., Cheung, W., Costello, C., Ferretti, F., Friedlander, A. M., Gaines, S. D., Garilao, C., Goodell, W., Halpern, B. S., Hinson, A., Kaschner, K., Kesner-Reyes, K., Leprieur, F., McGowan, J., … Lubchenco, J. (2021). Protecting the global ocean for biodiversity, food and climate. *Nature*, *592*(7854), 397–402. https://doi.org/10.1038/s41586-021-03371-z.

Schreckenberg, K., Franks, P., Martin, A., & Lang, B. (2016). Unpacking equity for protected area conservation. *PARKS*, *22*(2), 11–28. https://doi.org/10.2305/IUCN.CH.2016.PARKS-22-2KS.en

Secretariat of the Convention on Biological Diversity. (2020). *Global biodiversity outlook 5 – Summary for policy makers*.

Seddon, N., Chausson, A., Berry, P., Girardin, C. A. J., Smith, A., & Turner, B. (2020). Understanding the value and limits of nature-based solutions to climate change and other global challenges. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *375*(1794), 20190120. https://doi.org/10.1098/rstb.2019.0120

Seddon, N., Smith, A., Smith, P., Key, I., Chausson, A., Girardin, C., House, J., Srivastava, S., & Turner, B. (2021). Getting the message right on nature-based solutions to climate change. *Global Change Biology*, *27*(8), 1518–1546. https://doi.org/10.1111/gcb.15513

Siegel, K. R., McKeever Bullard, K., Imperatore, G., Kahn, H. S., Stein, A. D., Ali, M. K., & Narayan, K. M. (2016). Association of higher consumption of foods derived from subsidized commodities with adverse cardiometabolic risk among US adults. *JAMA Internal Medicine*, *176*(8), 1124–1132. https://doi.org/10.1001/jamainternmed.2016.2410

Smith, R. J., Cartwright, S. J., Fairbairn, A. C., Lewis, D. C., Gibbon, G. E. M., Stewart, C. L., Sykes, R. E., & Addison, P. F. E. (2022). Developing a nature recovery network using systematic conservation planning. *Conservation Science and Practice*, *4*(1), e578. https://doi.org/10.1111/csp2.578

Springmann, M., Clark, M., Mason-D'Croz, D., Wiebe, K., Bodirsky, B. L., Lassaletta, L., de Vries, W., Vermeulen, S. J., Herrero, M., Carlson, K. M., Jonell, M., Troell, M., DeClerck, F., Gordon, L. J., Zurayk, R., Scarborough, P., Rayner, M., Loken, B., Fanzo, J., … Willett, W. (2018). Options for keeping the food system within environmental limits. *Nature*, *562*(7728), 519–525. https://doi.org/10.1038/s41586-018-0594-0

Springmann, M., Clark, M. A., Rayner, M., Scarborough, P., & Webb, P. (2021). The global and regional costs of healthy and sustainable dietary patterns: A modelling study. *The Lancet Planetary Health*, *5*(11), e797–e807. https://doi.org/10.1016/S2542-5196(21)00251-5

Springmann, M., Godfray, H. C. J., Rayner, M., & Scarborough, P. (2016). Analysis and valuation of the health and climate change cobenefits of dietary change. *Proceedings of the National Academy of Sciences*, *113*(15), 4146–4151. https://doi.org/10.1073/pnas.1523119113

Stickler, C., DiGiano, M., McGrath, D., Nepstad, D., Swette, B., Chan, C., & McGrath-Horn, M. (2014). *Fostering low-emission rural development from the ground up*.

Strassburg, B. B. N., Iribarrem, A., Beyer, H. L., Cordeiro, C. L., Crouzeilles, R., Jakovac, C. C., Braga Junqueira, A., Lacerda, E., Latawiec, A. E., Balmford, A., Brooks, T. M., Butchart, S. H. M., Chazdon, R. L., Erb, K.-H., Brancalion, P., Buchanan, G., Cooper, D., Díaz, S., Donald, P. F., … Visconti, P. (2020). Global priority areas for ecosystem restoration. *Nature*, *586*(7831), 7831. https://doi.org/10.1038/s41586-020-2784-9

Sun, Z., Scherer, L., Tukker, A., Spawn-Lee, S. A., Bruckner, M., Gibbs, H. K., & Behrens, P. (2022). Dietary change in high-income nations alone can lead to substantial double climate dividend. *Nature Food*, *3*(1), 29–37. https://doi.org/10.1038/s43016-021-00431-5

Susskind, L., McKearnan, S., & Thomas-Larmer, J. (1999). *The consensus building handbook: A comprehensive guide to reaching agreement*. SAGE Publications. https://doi.org/10.4135/9781452231389

Tamburini, G., Bommarco, R., Wanger, T. C., Kremen, C., Heijden, M. G. A., Liebman, M., & Hallin, S. (2020). Agricultural diversification promotes multiple ecosystem services without compromising yield. *Science Advances*, *6*(45), eaba1715. https://doi.org/10.1126/sciadv.aba1715

Taskforce on Nature-related Financial Disclosure. (2022). Taskforce on nature-related financial disclosure. https://tnfd.global/about/

TCFD – Task Force on Climate-related Finacial Disclosures. (n.d.). UNEP FI. Retrieved February 11, 2022, from https://www.unepfi.org/climate-change/tcfd.

The Bonn Challenge. (n.d.). The Bonn Challenge. Retrieved January 11, 2021, from https://www.bonnchallenge.org/

The CAT Thermometer. (2021). Climate Action Tracker. https://climateactiontracker.org/global/cat-thermometer/

The Marine Protection Atlas. (n.d.). The Marine Protection Atlas. Retrieved April 29, 2021, from https://mpatlas.org/

Thieme, M. L., Tickner, D., Grill, G., Carvallo, J. P., Goichot, M., Hartmann, J., Higgins, J., Lehner, B., Mulligan, M., Nilsson, C., Tockner, K., Zarfl, C., & Opperman, J. (2021). Navigating trade-offs between dams and river conservation. *Global Sustainability*, *4*, e17. https://doi.org/10.1017/sus.2021.15.

Tosun, J., & Lang, A. (2017). Policy integration: Mapping the different concepts. *Policy Studies*, *38*(6), 553–570. https://doi.org/10.1080/01442872.2017.1339239

Turkelboom, F., Leone, M., Jacobs, S., Kelemen, E., García-Llorente, M., Baró, F., Termansen, M., Barton, D. N., Berry, P., Stange, E., Thoonen, M., Kalóczkai, Á, Vadineanu, A., Castro, A. J., Czúcz, B., Röckmann, C., Wurbs, D., Odee, D., Preda, E., … Rusch, V. (2018). When we cannot have it all: Ecosystem services trade-offs in the context of spatial planning. *Ecosystem Services*, *29*, 566–578. https://doi.org/10.1016/j.ecoser.2017.10.011

UK Government. (2013). *National wellbeing*. HM Government. https://www.gov.uk/government/collections/national-wellbeing

UK Government. (2021). *The Glasgow climate pact*. UK Government. https://ukcop26.org/wp-content/uploads/2021/11/COP26-Presidency-Outcomes-The-Climate-Pact.pdf

UNEP. (2021). *Food waste index report* 2021.

UNFCCC. (2015). *Paris agreement*. UN.

Walker, W. S., Gorelik, S. R., Baccini, A., Aragon-Osejo, J. L., Josse, C., Meyer, C., Macedo, M. N., Augusto, C., Rios, S., Katan, T., Souza, A. A., de Cuellar, S., Llanos, A., Zager, I., Mirabal, G. D., Solvik, K. K., Farina, M. K., Moutinho, P., & Schwartzman, S. (2020). The role of forest conversion, degradation, and disturbance in the carbon dynamics of Amazon indigenous territories and protected areas. *Proceedings of the National Academy of Sciences*, *117*(6), 3015–3025. https://doi.org/10.1073/pnas.1913321117

Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., Garnett, T., Tilman, D., DeClerck, F., Wood, A., Jonell, M., Clark, M., Gordon, L. J., Fanzo, J., Hawkes, C., Zurayk, R., Rivera, J. A., De Vries, W., Majele Sibanda, L., … Murray, C. J. L. (2019). Food in the anthropocene: The EAT–Lancet Commission on healthy diets from sustainable food systems. *The Lancet*, *393*(10170), 447–492. https://doi.org/10.1016/S0140-6736(18)31788-4

Winemiller, K. O., McIntyre, P. B., Castello, L., Fluet-Chouinard, E., Giarrizzo, T., Nam, S., Baird, I. G., Darwall, W., Lujan, N. K., Harrison, I., Stiassny, M. L. J., Silvano, R. A. M., Fitzgerald, D. B., Pelicice, F. M., Agostinho, A. A., Gomes, L. C., Albert, J. S., Baran, E., Petrere, M., … Sáenz, L. (2016). Balancing hydropower and biodiversity in the Amazon, Congo, and Mekong. *Science*, *351*(6269), 128–129. https://doi.org/10.1126/science.aac7082

Wolosin, M. (2016). *Jurisdictional approaches to zero deforestation commodities*. WWF. https://wwf.panda.org/wwf_news/?283050/JAZD

World Register of Dams: General Synthesis. (2020, April). International commission on large dams. https://www.icold-cigb.org/GB/world_register/general_synthesis.asp

Wu, H., Chen, J., Xu, J., Zeng, G., Sang, L., Liu, Q., Yin, Z., Dai, J., Yin, D., Liang, J., & Ye, S. (2019). Effects of dam construction on biodiversity: A review. *Journal of Cleaner Production*, *221*, 480–489. https://doi.org/10.1016/j.jclepro.2019.03.001

WWF. (2020a). *Enhancing NDCs through nature based solutions*.

WWF. (2020b). *Living planet report 2020: Bending the curve of biodiversity loss*. http://www.deslibris.ca/ID/10104983

WWF-UK. (2021a). *Driven to waste: The global impact of food loss and waste on farms*.

WWF-UK. (2021b). *NDCs – A force for nature?* https://wwf.panda.org/wwf_news/?4238891/NDCS-nature

Zarfl, C., Lumsdon, A. E., Berlekamp, J., Tydecks, L., & Tockner, K. (2015). A global boom in hydropower dam construction. *Aquatic Sciences*, *77*(1), 161–170. https://doi.org/10.1007/s00027-014-0377-0

Zeng, Y., Maxwell, S., Runting, R. K., Venter, O., Watson, J. E. M., & Carrasco, L. R. (2020). Environmental destruction not avoided with the sustainable development goals. *Nature Sustainability*, *3*(10), 795–798. https://doi.org/10.1038/s41893-020-0555-0

Zu Ermgassen, S. O. S. E., Utamiputri, P., Bennun, L., Edwards, S., & Bull, J. W. (2019). The role of "no net loss" policies in conserving biodiversity threatened by the global infrastructure boom. *One Earth*, *1*(3), 305–315. https://doi.org/10.1016/j.oneear.2019.10.019