Adaptation Fund, Climate Investment Funds and Global Environment Facility, approved a total of US$2.78 billion of project support in 2016 (ref. [16]).

Next steps

Any form of policy targeted at the super-rich is bound to meet with strong resistance. The rich are over-represented in national governments and there are strong ties between the wealthy and the political elites. Therefore, it is important to raise awareness about these issues and to build social pressure on the super-rich and political elites all over the world.

More research is also needed to understand the motives that might drive the wealthy to become environmentally engaged in their private life as well as in their business operations. For example, major investors could be encouraged to exert influence on the fossil-fuel sector by divesting their assets and reinvesting their money in renewables, however, one would have to understand first which arguments and communication channels should be used to successfully reach this group.

Finally, more efforts are needed to educate the rich. The impacts of unmitigated climate change on ecosystems, agricultural production and water availability in the twenty-first century will lead to large-scale population displacements, disruption of international trade networks, food shortages and an increasing number of conflicts over basic resources[17]. The manifold consequences for human security and health suggest that no amount of money would guarantee the safety, or even survival, of our generation's offspring, including those from super-rich families. Such a message should reach the world's most wealthy and most powerful. ❐

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Grounding nature-based climate solutions in sound biodiversity science

The current narrow focus on afforestation in climate policy runs the risk of compromising long-term carbon storage, human adaptation and efforts to preserve biodiversity. An emphasis on diverse, intact natural ecosystems — as opposed to fast-growing tree plantations — will help nations to deliver Paris Agreement goals and much more.

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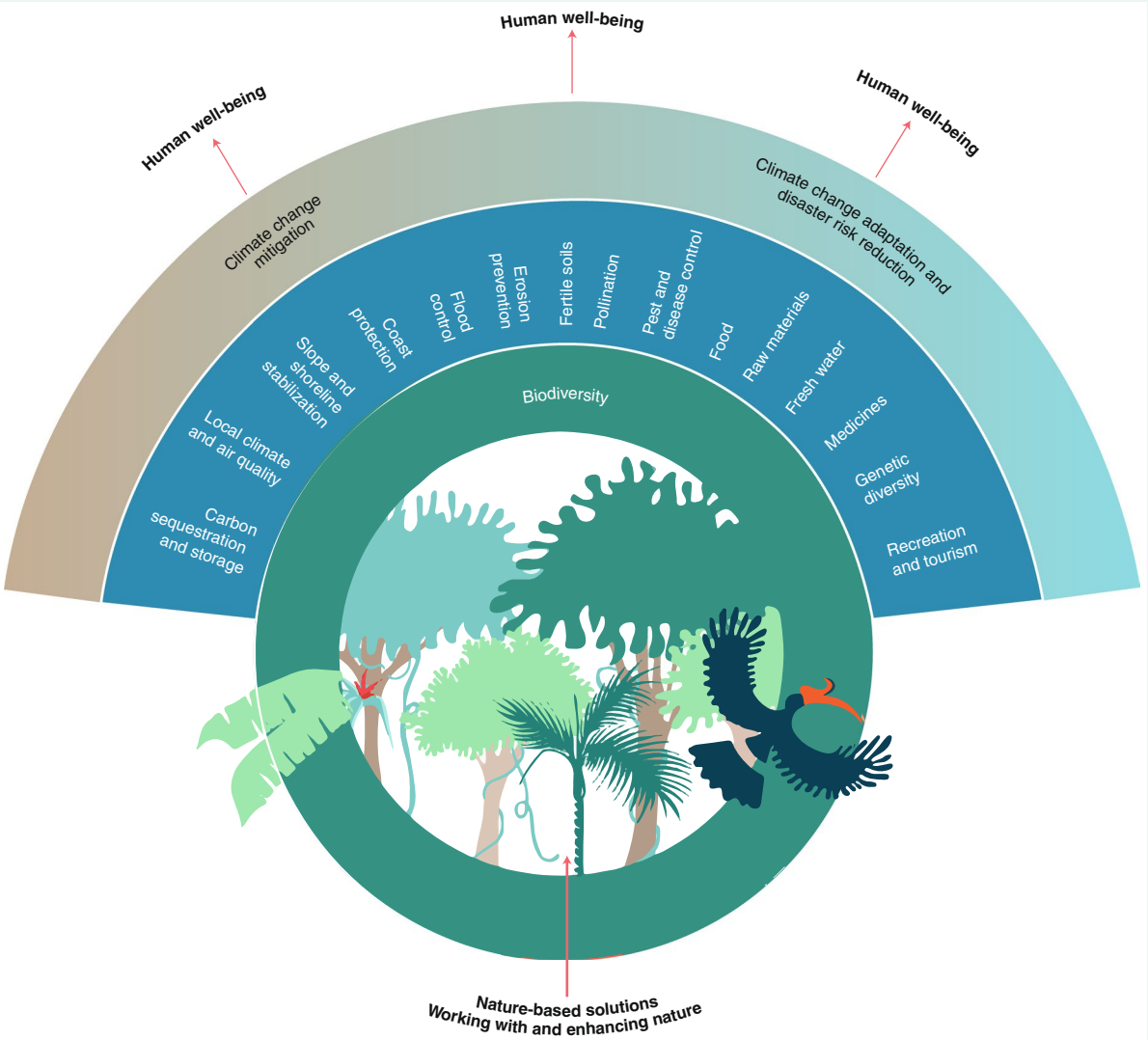
The idea that natural ecosystems can help us fight both the drivers and impacts of climate change has been gaining traction over the past few years, including recent emphasis in the IPCC Special Report[1]. In particular, the Paris Agreement on climate change calls on all parties to acknowledge "the importance of ensuring the integrity of all ecosystems, including oceans, and the protection of biodiversity, recognized by some cultures as Mother Earth", and 66% of signatories to the agreement commit to 'green' or 'nature-based solutions' in their climate pledges (see Nature-Based Solutions Policy Platform; www.nbspolicyplatform.org) (Box 1). Such recognition of nature's value — in particular through policies promoting forests as carbon sinks — was hard-won by negotiators and non-state actors and is vitally important. However, we are concerned by aspects of the narrative reaching policymakers, and call on scientists studying biodiversity and ecosystem functions and services to fully engage with and inform the process by which high-level pledges are translated into on-the-ground actions.

A focus on forests

When it comes to high-level multilateral pledges for nature, the current focus is on forests. The Bonn Challenge — launched by the International Union for Conservation of Nature (IUCN) and Germany in 2011 and currently involving 56 nations — is a global effort to restore 150 million hectares of deforested and degraded land by 2020 and 350 million hectares by 2030[2]; the New York Declaration on Forests — signed in 2014 by 37 governments, 63 non-governmental organizations, 53 multinational companies

Box 1 | What are nature-based solutions?

Nature-based solutions (NBS) involve working with and enhancing nature to help address societal goals. They are "actions to protect, sustainably manage and restore natural or modified ecosystems, which address societal challenges (for example, climate change, food and water security or natural disasters) effectively and adaptively, while providing human well-being and biodiversity benefits"[23]. They have also been described as solutions "inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions"[24]. The concept of these solutions has recently emerged against the backdrop of our failure to either stabilize the climate or stem the tide of biodiversity loss. However, high-level pledges for 'nature' tend to translate into targets for afforestation, often monocultures with non-native species, which can over the long-term produce maladaptation to climate change, compromize carbon storage and negatively impact biodiversity and sustainable development in general.



and 16 indigenous community groups — pledges to halve deforestation by 2020 and end it by 2030 (http://forestdeclaration.org/); and the Trillion Trees Partnership is a new 25-year initiative to restore one trillion trees by 2050, the number needed to reverse the global decline in tree cover (https://www.trilliontrees.org/). Such initiatives have inspired a significant number of private companies to voluntarily commit to eradicating deforestation from their supply chain. Added to this, signatories to the Sustainable Development Goals have committed to stop deforestation by 2020, and the United Nations (UN) Rio Convention on Biological Diversity also addresses deforestation, both in terms of biodiversity and enhancement of carbon stocks.

From a climate perspective, this focus on forests is vitally important. Global CO_2 emissions from land-use change (mainly deforestation) represented around 12% of global emissions for 2007–2016, while the terrestrial carbon sink stored around

28% of emissions (3.0±0.8 GtC per year) over the same period[3]. The restoration of 350 million hectares of forest by 2030 (that is, the Bonn Challenge) would add to this, sequestering up to 1.6 GtC per year, equivalent to 14% of the global carbon emissions[2]. Because of this powerful role as both a source and a sink for CO_2, forests have long played a key role in international climate change policy (Box 2) and are increasingly in the limelight.

The problem with monocultures

The issue is how these high-level pledges for forests translate into action on the ground. Existing international frameworks provide a definition of forests created for the purpose of assessing forest carbon stocks alone and as a result pledges tend to focus more on the extent rather than the quality of forest to be protected, afforested or reforested (see Nature-Based Solutions Policy Platform and ref. [4]). This is problematic not least because intact forests have been estimated to hold more carbon than degraded forests[5]. Furthermore, the approach encourages the establishment of monoculture plantations of fast-growing species, including exotics. Although such plantations may store carbon in the short term, their capacity to do so over the long term is impaired by changing conditions and disturbances[6] that are becoming more rapid and severe under climate change[7]. For forests to sequester carbon long term, they must be able to resist, recover or adapt to these changes[7], and there is growing evidence that such functional resilience is strongly determined by factors such as ecosystem connectivity, heterogeneity and diversity at multiple ecological levels[8]. For example, recent experimental studies demonstrate that compared to monocultures, diverse plantations of tropical forest are more resilient to wet and dry climate extremes[9], and mixed-species forests are more resistant to pests and disease[10]. Connectivity, meanwhile, is widely viewed as being critical to the adaptive capacity and integrity of intact forests and their biota in the face of environmental change[11].

Therefore, to enable long-term carbon storage mitigation, policy must move away from encouraging single-species plantations and instead support practices that enhance the ecological attributes that underpin functional resilience. Such policies would be more in line with recent evidence that diversity (of species and traits) is key to preserving forest carbon sinks in the face of climate change[12].

What about the rest?

It is vital that the current emphasis on forests does not detract from other ecosystems, many of which are also very important for storing carbon. A new campaign to raise the profile of natural solutions to climate change advocates that restoring and protecting forest can "deliver 30% of the climate solution needed by 2030" (https://www.theforgottensolution.org/). Although the campaign strongly emphasises forests, it is based on a study showing that better stewardship or management in all major natural terrestrial habitats, including grasslands, wetlands and agricultural lands, could help to provide up to 37% of the CO_2 mitigation needed through to 2030 for a greater than 66% chance of keeping warming to less than 2 °C (ref. [13]).

Mangroves, in particular, are one of the planet's most efficient carbon storehouses, with mean long-term carbon burial rates (that is, rates at which organic carbon accumulate in sediments) more than 45 times greater than any other terrestrial ecosystem, including boreal and tropical forests[14]. Peatlands also hold vast reservoirs of carbon (25% of world's carbon) but cover only 2–3% of terrestrial areas[15]. Meanwhile, natural grasslands harbour substantial carbon stores within their soil and can be more resilient than forests to drought and wildfires, making them a more reliable carbon sink in the long term[16]. However, these important carbon stores barely feature in climate change policy. For example, while 42% of signatories to the Paris Agreement include afforestation and/or restoration in terrestrial forest in the mitigation components of their nationally determined contributions (NDCs), only 19% of signatories with coastlines do the same for coastal habitats. Meanwhile, grasslands appear in only 8% of NDCs, and for montane habitats, in only 4% (see Nature-Based Solutions Policy Platform http//:www.nbspolicyplatform.org). Moreover, some of these important, naturally treeless habitats are threatened by afforestation, which is particularly troubling given that the original habitat can often provide greater and more-resilient carbon storage benefits[17].

In other words, forests must not be prioritized at the cost of continuing to destroy or replace other vitally important

Box 2 | Forests in climate policy

Forest management for carbon stock enhancement was introduced in the context of the UN Framework Convention on Climate Change (UNFCCC) in 1992 and the concepts of afforestation and reforestation for climate change mitigation were first introduced in the Kyoto Protocol in 1997. The Bali Action Plan in 2007 brought the programme on Reduced Emissions from Deforestation and land Degradation (REDD) to the negotiating table, with Forest Monitoring, Reporting and Verification (MRV) under the UNFCCC reported as change in carbon stock over time. In Poznan in 2008, the concept of REDD+ was introduced to give the 'conservation, sustainable management for forests and enhancement of forest carbon stocks' the same level of priority in the negotiations as deforestation and forest degradation. Parties rapidly realised that the MRV metric leads to serious unintended consequences (for example, potential for contravening land rights) and so the concept of 'safeguards' was introduced to the negotiating text in Bonn in 2009. Subsequent negotiations attempted to widen the scope of the framework to include non-carbon benefits linked to the social, environmental and governance benefits of the activities covered by REDD+. In the 2015 Paris Agreement, parties are encouraged to adopt "…policy approaches and positive incentives for activities relating to reducing emissions from deforestation and forest degradation, and the role of conservation and sustainable management of forests and enhancement of forest carbon stocks in developing countries; and alternative policy approaches, such as joint mitigation and adaptation approaches for the integral and sustainable management of forests, while reaffirming the importance of incentivizing, as appropriate, non-carbon benefits associated with such approaches". In response, 49 signatories collectively pledged to restore 57 million hectares of forest in their Nationally Determined Contributions[25]. Most recently, at the 24th Conference of the Parties of the UNFCCC in December 2018, the Polish presidency announced the "Ministerial Katowice Forests for Climate Declaration", which encourages all parties to take action to conserve and enhance sinks and reservoirs of greenhouse gases, emphasising "healthy, biologically diverse, and resilient forests adapted to climate change"[26]. However, the declaration does not specify that carbon emissions must be drastically cut in parallel with conserving and enhancing forests for mitigation and adaptation. We stress that the implementation of any forest-based agenda needs to coincide with severe cuts in fossil fuel emissions if we are to achieve the goals of the Paris Agreement.

ecosystems. To achieve this balance there is a need to be more inclusive when discussing the importance of nature-based solutions to climate change and when encouraging policymakers to take them into account.

Diversity is key for human adaptation

In the drive to harness natural ecosystems to slow warming, it is also important not to lose sight of their essential role in supporting human adaptation to climate change. Prioritizing a variety of ecosystems and promoting their functional resilience will also secure a suite of ecosystem services vital for adaptation[18], in addition to ensuring reliable mitigation services. Natural habitats in watersheds can secure and regulate water supplies and protect communities from flooding and soil erosion; mangroves, reefs and salt marshes offer protection from storm surges and coastal erosion; and agroforestry (planting trees among crops or crops within forest) can maintain and enhance yields in drier, more variable climates[19]. Moreover, there are many economic benefits of these nature-based adaptation solutions through avoided losses to climate change related disasters. For example, coastal wetlands in the northeast of the United States are estimated to provide US$23.2 billion per year in storm protection services[20], while in the absence of reefs, annual damages from flooding would double and costs from frequent storms would triple globally[21]. In other words, restoring and protecting nature really isn't just about storing carbon and slowing warming, it's also about cost-effective protection of ecosystems to help shield us from floods, droughts, landslides, storms, heatwaves, fire and other disasters increasingly common under climate change. Ultimately, it is about working with nature in such a way that ecosystems continue supporting human development and well-being in the face of change (Box 1).

Biodiversity and climate change integration

All this highlights the need for much stronger links between ecosystem scientists, social scientists studying human adaptation and resilience, and those designing and implementing climate change policy. While the understanding of the role that biodiversity at all levels, including a diversity of habitats, can play in mitigating and adapting to climate change is growing rapidly, policy development and implementation for climate change and biodiversity remain largely separate. The result is a lack of robust targets for nature in climate pledges, beyond areas of forest to be planted or restored. As climate pledges get revised, it is important that this knowledge is informing the process and helps raise ambition for nature. Examples of what can be achieved through this integrated approach are already emerging (www.nbspolicyplatform.org).

Biodiversity at the heart of climate solutions

Nature-based solutions were in the limelight towards the end of 2018 at the Global Climate Action Summit instigated by California governor Jerry Brown, as well as both UN Rio Convention Conferences. On the back of the Global Climate Action Summit, nature-based solutions were identified as one of six action portfolios for the UN Climate Change Summit in September 2019. Meanwhile, the UN Convention for Biological Diversity at its 14th Conference of the Parties formally decided to integrate climate change issues into national biodiversity strategies and vice versa[22]. This rapidly growing recognition of nature's importance in a warming world is to be celebrated. However, as agendas for nature get translated into actions, the importance of diverse, intact natural ecosystems must not be forgotten. In the fight against climate change, forests make excellent allies. However, unless a diversity of species-rich resilient ecosystems are restored and protected — guided by science and implemented through local stewardship — the battle cannot be won.

We hope that those advocating for action and funding in the wake of the UN Framework Convention on Climate Change (UNFCCC) meeting in Poland in December will bear this in mind. ❐

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