



Biodiversity

A force to fight global warming

Natural ecosystems and biodiversity must be made a bulwark against climate change, not a casualty of it, argue **Will R. Turner, Michael Oppenheimer and David S. Wilcove.**

In the tortured history of climate-change negotiations, enlightened thinking has translated into positive action all too rarely. But governments have recently seen the light on a crucial issue: they have recognized the vital role that intact natural ecosystems have in limiting the build-up of atmospheric greenhouse gases.

When delegates convene in Copenhagen next month to strengthen the UN Framework Convention on Climate Change (UNFCCC), an initiative to preserve the world's forests to store and sequester carbon will take centre stage. Reducing emissions from deforestation and forest degradation (REDD) should give developing countries the opportunity to benefit financially by preserving their forests, either through direct payments or by allowing them to market the carbon stored in uncut trees. Its backers hope that with sufficient funding REDD could substantially slow rates of deforestation, especially in the tropics.

REDD is just one of many possible ways to exploit the potential of natural ecosystems to slow climate change and lessen its effects on people. Natural habitats are a hugely valuable tool in the fight against global warming. Use them wisely and they could save many lives and vast sums of money in the decades to come. Abuse them, and much of Earth's biodiversity could be lost, along with the fight against climate change. Urgent action is needed to understand how best to exploit this promise and develop mechanisms that can be woven into the practices of governments, corporations, communities and institutions worldwide.

To achieve such an integrated approach means fighting a host of powerful short-term political and economic interests. The carbon markets created by REDD might invite corruption, as many critics suggest. Yet the rapid progress that has already been achieved in anticipation of REDD — including new financial mechanisms to ensure verified and lasting emissions reductions, and innovative remote sensing and mapping tools to support them — suggests that these challenges are surmountable¹.

There are two good reasons for focusing on natural ecosystems for tackling the threats of climate change. First, forests, peatlands, oceans and other ecosystems control carbon and other

global biogeochemical cycles. The oceans alone sequester about 2 gigatonnes of carbon a year. Reducing deforestation and forest degradation rates would slash global emissions by up to 1 gigatonne of carbon a year, more than the emissions of all passenger cars combined. Restoring the world's marginal and degraded lands to natural habitats could sequester an additional 0.65 gigatonnes annually.

The second reason has to do with practicality: the maintenance and restoration of natural habitats are among the cheapest, safest and easiest solutions at our disposal in the effort to reduce greenhouse-gas emissions and promote adaptation to unavoidable changes (see graphic). The basic materials already exist — so there is no need for technological development. Indeed, ecosystem restoration (for example, replanting forest on previously cleared land) may remain for several decades the only realistic large-scale mechanism for removing carbon dioxide already in the atmosphere².

Natural protection

Environmental carbon storage is worth trillions of dollars to the world's economies, yet it is only one of nature's services. Natural ecosystems will save lives and sustain livelihoods in myriad ways as Earth's climate changes³. For example, healthy mangroves, reefs and wetlands can protect people and property in coastal and inland communities even as climate change threatens to increase tropical cyclone activity. A cyclone in Orissa, India, in 1999 would probably have killed three times as many coastal residents if mangrove forests had not buffered their villages⁴. Even at current storm levels, coastal wetlands in the United States provide protection against hurricanes worth an estimated US\$23.2 billion a year⁵.

Natural ecosystems do many climate-related jobs. Mangroves, for example, store carbon, buffer against storm impacts, support fisheries and harbour diverse species. Ecosystems also support livelihoods by providing alternative sources of income and food, especially useful if climate change disrupts current sources. Such diversification is helpful for everyone, particularly for the most vulnerable countries and communities — those with the

least capacity to cope with climate change.

As important as these services are, what remains to be discovered may be more valuable still. Three decades ago, few imagined that the carbon stored in natural systems would become crucial for combating climate change. Today, enzymes from the gut of a marine crustacean (*Limnoria quadripunctata*), a type of gribble, show promise in breaking down agricultural waste products for biofuels, potentially reducing greenhouse-gas emissions without competing for agricultural land or threatening natural habitats⁶. If a promising biotechnology can emerge from a common woodlouse-like creature that lives on the underside of a busy British pier, what untapped potential — the 'option value' of biodiversity — might lie in the world's wildernesses? One area where this untapped innovation could prove particularly valuable is agriculture. When changes in precipitation and temperature start to test the physiological limits of current crops, farmers could benefit from wild relatives and novel cultivars better suited to the new conditions.

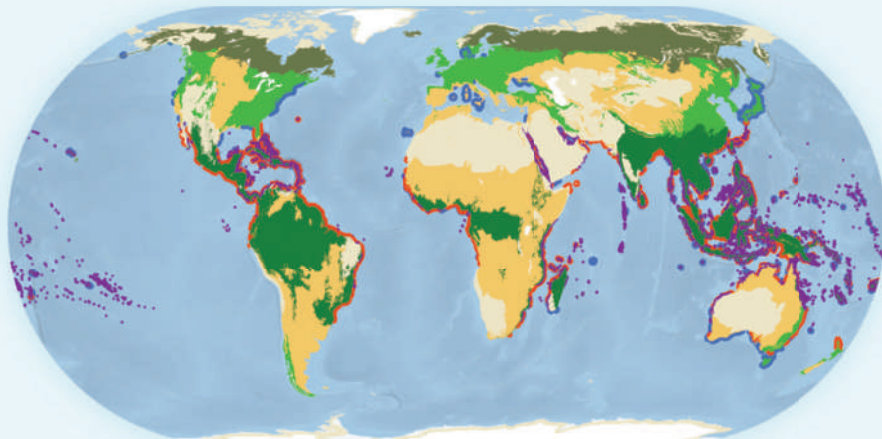
The danger is that we will overlook these benefits in natural systems or, worse, lose them. Vast areas of wilderness and undeveloped land are already falling to human abuse, either directly via habitat destruction or indirectly through the effects of climate change. One-fifth of all vertebrates are now threatened with extinction⁷, and habitat destruction is estimated to cost \$2 trillion–5 trillion annually in lost ecosystem services such as the provision of water and carbon storage, vastly more than the cost of safeguarding those services.

Halting this decline requires identifying and securing key intact ecosystems and the climate services they provide, restoring lost or degraded ones, and limiting future losses, all in partnership with the communities that need those services most. At present, climate change is seen as one problem for nature and another for people. This must stop. If human adaptation to climate change compromises biodiversity, then the loss of forests and other natural ecosystems will accelerate climate change, increasing the need for adaptation even as the planet's capacity to accommodate it diminishes. An integrated approach makes the circle virtuous: by conserving biodiversity, we decelerate climate change while increasing the adaptive capacity of people and ecosystems alike.

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THE BENEFITS OF BIODIVERSITY

The maintenance and restoration of natural habitats are among the cheapest, safest and easiest solutions that could aid the effort to reduce greenhouse-gas emissions and promote adaptation to unavoidable climate change.



Biome	Percentage of habitat lost	Percentage of species threatened	Examples of benefits for climate-change adaptation/mitigation
Tropical forests	30	22	Avoided carbon emissions, water regulation/purification, reduced erosion and flooding, biodiversity 'option value'
Temperate forests	48	15	
Boreal forests	2	5	
Grasslands, shrublands and Mediterranean habitats	57	17	Water regulation/purification, crop wild relatives
Deserts and tundra	21	12	Avoided carbon emissions from soil
Seagrasses	29	16	Carbon absorption and avoided emissions, limiting coastal erosion, fisheries stability, reducing cyclone impacts, biodiversity 'option value'
Mangroves	37	11	
Coral reefs	20	27	

Sources: WWF; UNEP-WCMC; Waycott, M. et al. *Proc. Natl Acad. Sci. USA* **106**, 12377-12381 (2009); Millenium Ecosystem Assessment; IUCN Red List

combating climate change. National governments, including Costa Rica and the United States, have already begun to acknowledge the importance of natural ecosystems for adaptation in their submissions to the UNFCCC. They need to ensure that any agreement emerging from Copenhagen contains substantive measures to promote the conservation of these ecosystems. Parties to the UNFCCC must also develop key principles for managing and restoring climate services that can be incorporated into international treaties, such as the Convention on Biological Diversity's inland waters biodiversity programme, now under development, as well as environmental assessments by development banks. Knowledge and resources for harnessing climate services should be shared internationally, with developing countries being supported by developed countries.

The future of economies and livelihoods across the planet depends on integrating biodiversity conservation into climate-change planning. If REDD is allowed to fail and degraded lands are also not restored, it is likely to be very difficult to avoid dangerous temperature increases. If coastal and wetland ecosystems are not preserved and restored, tropical storms will become more deadly and more economically damaging. If the diversity of life in the world's wildlands and waters disappears, so do eons of natural innovation that could yield breakthroughs. Working with natural systems rather than against them would unleash a powerful, essential force for halting climate change and reducing its impacts.

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See Editorial, page 251, and News Feature, page 266. For the whole biodiversity special, see www.nature.com/darwin.

There is a real possibility that Copenhagen will create a mechanism for REDD but not a means to pay for it. So the parties to the UNFCCC must initiate financial incentives immediately, engaging public and private sources of funding so that REDD can be rolled out on a global scale. Action is also needed to help governments to monitor natural and modified ecosystems for true net emissions — including those that arise through the displacement of food crops by biofuels and other land-use changes. Policies that provide benefits to, and respect the rights of, local communities are crucial for sustaining and enhancing the ability of natural ecosystems to mitigate climate change.

We also need to try to find ways to value and market the other climate services that natural

habitats provide — acknowledging that such services do not exist everywhere — and to weave these benefits into the fabric of our economies. For example, residents of Quito, Ecuador, pay via their utility bills to protect upstream habitats that provide much of their fresh water. Yet, in most cases, communities and corporations are either unaware of, or ignore, the degree to which aspects of climate security, such as their water supply, depend on natural ecosystems.

Climate reserves

For centuries, people have safeguarded natural habitats as public parks and privately owned reserves for nature conservation, sustainable resource production and other goals. They must now be harnessed for the additional goal of