UN-REDD
PROGRAMME

Executive Summary

A safer bet for REDD+: Review of the evidence on the relationship between biodiversity and the resilience of forest carbon stocks

UN-REDD PROGRAMME

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Multiple Benefits Series **10**

The UN-REDD Programme, a collaborative partnership between FAO, UNDP and UNEP, was created in response to, and in support of, the UNFCCC decision on REDD at COP 13 and the Bali Action Plan. The Programme supports countries to develop capacity to reduce emissions from deforestation and forest degradation and to implement a future REDD mechanism in a post-2012 climate regime. It builds on the convening power of its participating UN agencies, their diverse expertise and vast networks, and "delivers as One UN".

The United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) is the biodiversity assessment and policy implementation arm of the United Nations Environment Programme (UNEP), the world's foremost intergovernmental environmental organization. The centre has been in operation since 1989, combining scientific research with practical policy advice.

The United Nations has proclaimed 2010 to be the International Year of Biodiversity. People all over the world are working to safeguard this irreplaceable natural wealth and reduce biodiversity loss. This is vital for current and future human wellbeing. We need to do more. Now is the time to act.

Prepared by

Lera Miles, Emily Dunning, Nathalie Doswald, Matea Osti

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Executive Summary

Key Findings

Resilience of forest carbon stocks to climate change, in terms of resistance to and recovery from its direct and indirect impacts, is essential for the long-term viability of REDD+.

There is strong evidence that the carbon stocks of **intact** forests are more resilient than those of degraded or fragmented forest, and hence that reducing degradation should be a key REDD+ activity.

There is a small amount of evidence to suggest that whilst management decisions can increase planted forests' resilience to change, **naturally occurring** forests may be more resilient. This evidence lends some additional support to the rationale for a safeguard on the conversion of natural forest, already justified in terms of emissions reduction.

If a forest is natural and intact, is there additional benefit from higher levels of **biodiversity**? There is good evidence that resilience increases with biodiversity for grassland and savanna ecosystems, but only a few relevant observations for forest. Ecological theory would indicate that the pattern will hold true, but targeted research on the role of biodiversity in forest carbon stock resilience would help to identify which forests are most likely to retain their stocks in future.

There is a growing belief that the carbon stocks of intact, naturally occurring, biodiverse forests are likely to be more resilient to climate change than those of planted, less diverse forests (e.g. Fischer *et al.* 2006; Bodin and Wiman 2007). Resilience in this context means that forests can resist and or recover from the negative effects of climate change. Resistance and recovery will differ between forests for various reasons. This review examines the role of biodiversity and related factors in carbon stock resilience.

In their efforts to limit the speed and severity of climate change, Parties to the United Nations Framework Convention on Climate Change (UNFCCC) have proposed to Reduce greenhouse gas Emissions from Deforestation and forest Degradation, 'plus' to undertake additional forest-related activities (hence: REDD-plus, or REDD+), in developing countries. The list of these activities is subject to negotiation, but Parties have agreed to consider the role of 'conservation, sustainable management of forests and enhancement of forest carbon stocks' (Decision 4/CP.15[1]). This last activity is thought to include afforestation, reforestation and forest restoration.

The Copenhagen Accord[2] includes a commitment to limit global mean temperature increases to ℃. Even this change is anticipated to affect forest ecosystems through increasing carbon dioxide

[1] FCCC/CP/2009/11/Add.1, Page 11

[2] agreed by a subset of prominent countries at the 15th Conference of Parties to UNFCCC, but only 'noted' by the full set of Parties to the Convention FCCC/CP/2009/11/Add.1, Page 4

concentrations, increasing and more variable temperatures, changes to seasonality and moisture availability, and increasing frequency of climatic extremes and associated fire events. The resilience of forest carbon stocks to each of these changes could be key to the long-term success of REDD+.

Increasing resilience is one way in which biodiversity conservation might benefit REDD+ (it is already clear that, overall, REDD+ can be expected to benefit conservation, although not universally (Miles and Kapos 2008)). Biodiversity is the variability among living organisms including that within species, between species and of ecosystems (UN 1992). Of these aspects, species diversity is most often addressed in the ecological literature. Forests vary in their diversity as a result of historical, random and environmental factors, including the extent of human impact. That is, biodiversity varies amongst intact, naturally occurring forest ecosystems, and is reduced by forest degradation and fragmentation. Planted forests tend to host less biodiversity than naturally occurring forest.

Hence, we set out to explore three related hypotheses on the factors affecting forest resilience:

(i) It is argued that increasing biodiversity is likely to increase the resilience of forest carbon stocks, not least because of 'functional redundancy' (when many species with differing climate tolerances play a similar role; similar species' relative abundance may then change in response to a changing climate, whilst maintaining the carbon storage function). This is the assumption behind the 'diversity-stability' and 'insurance' hypotheses (Yachi and Loreau 1999; Lehman and Tilman 2000).

(ii) It is argued that the carbon stocks of an 'intact' forest are likely to be more resilient to climate change than those of a fragmented or 'degraded' forest. This is based on evidence that forests subject to existing stresses may be less able to withstand additional stresses (Barlow and Peres 2004; Nobre and Borma 2009).

(iii) It is argued that the carbon stocks of a mature 'natural' forest are likely to be more resilient to climate change than a mature planted forest, because the natural system is likely to contain not only a greater species diversity, but also a greater structural and genetic diversity (Mackey *et al.* 2008). The assumption here is that planted forests are managed in such a way that opportunities for colonisation by native species are reduced, and planted using few tree species, in even-aged stands; it is obvious that these distinctions from natural forest are not universal.

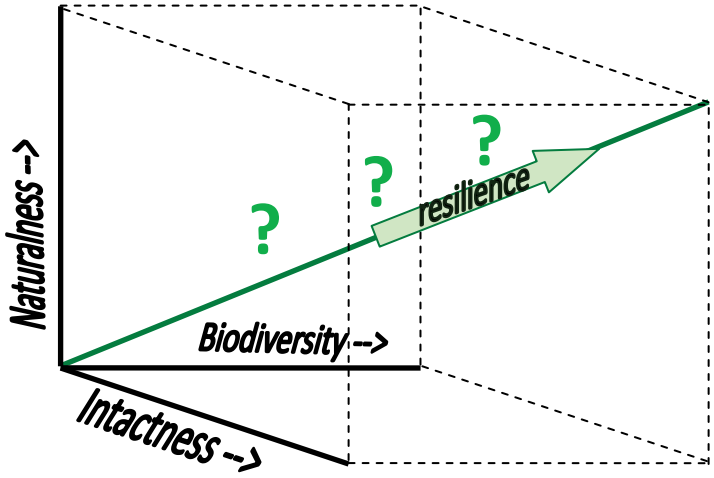

Figure: illustration of the three related hypotheses

Biodiversity, intactness and naturalness all fall along continuous gradients, from low to high, rather than being binary concepts. For simplicity, the Figure above shows a linear relationship between these attributes and resilience of forest carbon stocks; it is likely that the shape of any actual relationships will vary depending upon the forest types and the measures used.

In this paper, we examine the evidence from ecological theory and models, reported observations and experiments that directly address this set of hypotheses. As the set of experimental evidence from forest is small, we also sought out relevant literature on other terrestrial ecosystems. We have not undertaken additional fieldwork or statistical analysis.

Briefly, we conclude that:

(i) There are strong claims in the literature for the role of biodiversity in promoting resilience. While there is also good experimental and theoretical backing for the hypothesis that higher levels of biodiversity will increase the resilience of biomass to climate change, most of this research tackles grassland rather than forest biodiversity. It seems likely that more diverse forest will be more resilient, but much of the hard evidence for this supposition is based on results for other ecosystems.

(ii) There is good evidence that tropical forest intactness will aid resilience of its carbon stocks to climate change. This delivers a strong message that reducing degradation in these forests, caused by anthropogenic fire and destructive logging practices, is key to promoting carbon stock resilience. This has clear implications for national REDD+ strategies: control and monitoring of deforestation alone may be a more risky strategy than if degradation is tackled too.

(iii) There is a small amount of evidence on the comparative resilience of natural and planted forest to climate change impacts (only three papers that met our search criteria). This evidence lends some additional support to the rationale for a safeguard on the conversion of natural forest, already justified in terms of emissions reduction.

There are good reasons to focus REDD+ attention on biodiverse, natural forests, regardless of the evidence on resilience. First, these forests have multiple values in addition to their role in carbon storage and sequestration – such as providing livelihood benefits, biodiversity conservation and vital ecosystem services. Retaining these forests and improving their conservation status will thus contribute to national goals in addition to climate mitigation. Second, in general it is more cost-effective for climate mitigation to prioritise the retention of existing forest above the creation of new forest: per unit area, deforestation involves an immediate and substantial pulse of greenhouse gas emissions, equivalent to the carbon uptake over many years of a newly forested area in the same environment. However, it would be valuable to further investigate the relationship of biodiversity itself to forest carbon stock resilience, devoting more effort to gathering field evidence and undertaking further analyses using existing data.

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