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From euphoria to reality on efforts to reduce emissions from deforestation and forest degradation (REDD+)

Robin B. Matthews · Meine van Noordwijk

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1 Context

The United Nations Intergovernmental Panel on Climate Change (IPCC) recently published its Fifth Assessment Report (AR5) which concluded that warming of the earth's climate is now unequivocal, and that it is clear that this is due to emissions of greenhouse gases (GHGs) from human activities, particularly from the last half of the 20th century onwards (IPCC 2013). Atmospheric concentrations of the GHGs, which include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), are higher than any time over the last 650,000 years. Rapid increases in the emissions, especially in Asia, of short-lived gases such as sulphur dioxide that have a net cooling effect may temporarily slow down the warming, but are no structural solution (Kaufmann et al. 2011; Klimont et al. 2013).

While fossil fuel use remains the dominant concern, conversion of forests into agricultural land is also a major source of GHG emissions. Currently, a gross figure of 13 million ha of forests are lost annually, with net losses, allowing for afforestation and reforestation, at about 5.2 million ha y^{-1} (FAO 2010). Deforestation and degradation together release an estimated 4.4 Gt CO_2 y^{-1} into the atmosphere (van der Werf et al. 2009), both through the burning of the forest biomass, and from the oxidation of carbon stored in the soil under the trees during cultivation and in peatlands under drainage. Degradation, defined as decrease of density or increase of disturbance in forest classes, may represent up to 20 % of this loss (Putz et al. 2008). Other GHGs, such as CH_4 and N_2O may also be emitted during slash-and-burn and subsequent land use. Emissions from land use change in this way represented an estimated 20 % of anthropogenic GHG emissions in the period 1990–2000, although this is now estimated to be around 12 % (2008) due to the continued rise of fossil fuel emissions (Le Quéré et al. 2009).

R. B. Matthews (✉)
James Hutton Institute, Craigiebuckler, Aberdeen AB15 8QH, UK
e-mail: robin.matthews@hutton.ac.uk

M. van Noordwijk
World Agroforestry Centre, Jl. Gunung Batu No. 5, P O Box 161, Bogor 16001, Indonesia

It was decided at the 7th United Nations Framework Convention for Climate Change (UNFCCC) Conference of Parties (CoP) in Marrakech in 2001 that Clean Development Mechanisms (CDMs) of the Kyoto Protocol be largely restricted to the energy and industrial sectors. However, surrounded by many safeguards, afforestation and reforestation activities became eligible as Afforestation/Reforestation Clean Development Mechanisms (A/R CDM), although they have found little application as yet. Emission reduction by avoided deforestation was excluded because institutions were not ready to deal with the 'additionality' (what would have occurred without intervention), leakage (emission reductions in one location causing emission increases in another) and 'permanence' issues at either local or national scale. Apart from ambiguities in the definition of a forest, which also affect the A/R CDM rules (van Noordwijk et al. this issue), there are difficulties in accurate monitoring of the carbon stocks actually preserved. The costs of both applying and verifying rules more complex than those for A/R CDM rules were expected to be too high, while there was uncertainty on the opportunity cost of clearing forests for land uses with higher economic returns.

However, there was growing recognition that the 20 % of global emissions from deforestation could not be neglected, particularly with the realisation that solutions for Annex I countries, such as increased use of biofuels, had led to perverse incentives that were likely to have increased deforestation rates and global GHG emissions rather than reduced them. The concept of Reducing Emissions from Deforestation and Degradation (REDD) essentially began at the 9th UNFCCC Conference of the Parties (CoP-9) in 2003, when the Coalition of Rainforest Countries presented a proposal for so-called Compensated Reductions, in which non-Annex 1 forested countries could voluntarily choose to reduce their national emissions from deforestation below an agreed baseline and gain carbon credits at the end of a commitment period which could be sold on international carbon trading markets or to other governments, thus earning income for the country (Santilli et al. 2005). As this was to be at the national level, it would help to address the issues of national leakage, as displacement of emissions to elsewhere in the country would still be accounted for in national inventories, although this would not be the case for international leakage (Mollicone et al. 2007). The REDD concept generated a flurry of interest, two notable examples being the Stern Review (2007) concluding that reducing deforestation is a highly cost-effective way to reduce emissions relatively quickly, as well as providing environmental and socio-economic co-benefits, and the Eliasch Review (2008) estimating the cost of halving emissions from the forestry sector by 2030 at $17–33 billion annually.

The so-called Bali Action Plan was announced at the 12th UN FCCC Conference of the Parties in December 2007, as a road map towards a new binding climate change agreement to succeed the Kyoto Protocol to be signed at the 15th UN FCCC Conference of the Parties (COP15) in Copenhagen. The Plan included specific mention of policies and incentives for reducing emissions from deforestation and forest degradation in developing countries, and called for countries to work towards improving data collection, estimation of emissions from deforestation and degradation, monitoring and reporting, and addressing institutional needs of developing countries. The Copenhagen CoP-15 meeting, however, proved to be a great disappointment, with no overall climate change agreement being signed, and only an Accord being released with voluntary targets for each country, that followed on the Nationally Appropriate Mitigation Actions (NAMA) concept of the Bali Accord. REDD, however, did not fare as badly as other sectors—its importance was reconfirmed, and the Copenhagen Green Climate Fund was established with promises that it would be worth US$10 billion a year from 2010 to 2012, and eventually US$100 billion a year by 2020. However, no deforestation targets were agreed, international leakage was not addressed, neither were the rights of indigenous people safeguarded.

For the next 2 years, progress was slow. At the 16th UN FCCC Conference of the Parties meeting in Cancun, Mexico, the REDD Plus (REDD+) mechanism was agreed to include sustainable forest management and the enhancement and conservation of existing forest carbon stocks. Progress was also made on REDD-Readiness activities that developing countries could undertake in line with the phased approach of the scheme, and on the temporary use of sub-national deforestation reference levels, which had been a sticking point because of potential leakage of emission reductions elsewhere in a country. The most contentious area, however, lay in where the financing of REDD+ activities would come from, particularly on whether market mechanisms should be a source of finance, with the Cancun meeting agreeing to defer any decisions on this until the next CoP in Durban in South Africa the following year.

Once again, however, this 17th UN FCCC Conference of the Parties made no advances on sources of long-term funding, with decisions on whether REDD+ funding will be from bilateral aid, market-based carbon trading, or a combination of these, being put off for another year. Some progress was made on setting reference levels (in terms of CO_2 instead of hectares and subject to international peer-review) and monitoring emission reductions, and a weak agreement on social and environmental safeguards. Another notable advance at this meeting was the allowing of emission reductions from restored peatlands to qualify for REDD+ payments.

Despite the lack of agreement on REDD+, however, this has not stopped countries from establishing a number of REDD+ projects using finance from the UN-REDD Programme, the World Bank's Forest Carbon Partnership Facility, the REDD-Plus Partnership, and other entities.

2 The REDD-ALERT project

The REDD-ALERT (Reducing Emissions from Deforestation and Degradation through Alternative Land Uses in the Rainforests of the Tropics) project started in April 2009 in the midst of the euphoria on REDD that this was a win-win idea that not only would be beneficial for developing countries but also for the environment. The 14th UNFCCC Conference of Parties had just taken place in Poznan in Poland, and CoP-15 had yet to happen later in the year in Copenhagen. Up until that time, most of the REDD debate had been focused on international level architectures—what was missing was how emission reduction targets agreed at the national scale were to be translated into changes of behaviour relating to land use at the local scale, while not affecting the rights of minority and vulnerable social groups, or the provision of ecosystem services in general. The main focus of the project was to understand some of these local-level dynamics and how they might be influenced by processes occurring at higher levels. The project ended in December 2012 just as a grudging realisation of the complexities and costs involved was starting.

In this Special Issue, we present a selection of papers describing aspects of the work on the REDD-ALERT project and reflect on key findings of the project against the backdrop of developments in the REDD+ debate over this period.

We begin with a paper by Nijnik et al. who analyse the views of a range of experts on REDD+ using Q-methodology, and identify four attitudinal groups, characterized as pragmatists, sceptics, conventionalists and optimists. This helps to provide the context to the REDD+ process, illustrating that its adoption and success is likely to be as much due to perception by a number of key actors as it is to hard economic rationality, underscoring the need for bespoke solutions rather than one size fits all.

Kuik then describes the development of a simple analytical model of the factors controlling potential leakage of emissions in response to REDD+ interventions, and tests this against a

Computable General Equilibrium (CGE) model. Leakage occurs where decreases in deforestation rate in one area causes increases in deforestation in another area, and is a major concern in accurate accounting of the impacts of land use change on net emissions at the global level, particularly if that leakage is between countries rather than between regions within a country.

White develops a framework based on six different REDD+ models to analyse stakeholder perspectives on REDD+, and uses this to analyse the approaches of the Peruvian Government, an non government organization representing the rights of indigenous people, and the World Bank. He also discusses a mismatch between international timeframes and national processes, with the former pressing for REDD+ processes to be implemented before sufficient national debate has taken place.

van Noordwijk et al. then review the development of both the REDD+ and the NAMAs debates which occurred in parallel, to some extent in competition, despite their many similarities and common goals. Initial ownership of REDD+ was taken by traditional forestry institutions with the focus on carbon, whereas the NAMA discourse was a much broader whole-landscape cross-sectoral approach. They review progress on five major challenges identified in 2007 by the Indonesian Forest Climate Alliance to achieve effective and equitable REDD+ mechanisms, namely, how a forest is defined, land tenure rights, the interdependence of deforestation drivers, the need to include peatlands both on forest and non-forest land, and fair and efficient distribution of benefits accruing from REDD+. They argue that if REDD+ is seen as a subset of the NAMAs, then three out of the five challenges can be resolved, but that land tenure and equitable benefit sharing still need to be addressed.

The next set of papers focus on the local level, and investigate the land use change dynamics of specific case studies in Indonesia, and how these might be influenced by REDD+ mechanisms to achieve emission reductions and other benefits. Tata et al. analyse the potential role of REDD+ in the Tripa peat swamp in Aceh province of Indonesia, where orang-utan conservation coincides with oil palm (*Elaeis oleifera*) production and regulations to achieve NAMAs. Much of the CO_2 emission over the last 14 years has been from low return enterprises of less than US$5 ha^{-1}, indicating that compensation from REDD+ may be successful, but the remainder was from high return enterprises such as oil-palm so that investment in alternative employment opportunities may be the only way forward.

Galudra et al. then investigate the dynamics of the relationships between different stakeholders (government, local communities, migrants and state-sanctioned concessionaires) in the Tanjung Jabung Barat (TanJaBar) regency of Jambi in Indonesia, which contain large areas of peatlands. These relationships have changed the traditional dynamics of land use in the region and have increased carbon emissions in recent years. Contrary to other analyses, migrants into the area are particularly important as they influence the land tenure system and alter the balance of power between the other stakeholders. If REDD+ is going to work in reducing land clearing and carbon emissions, it is important to recognise the roles of these different stakeholders rather than just focusing on the large-scale concessionaires and traditional communities, and to obtain the free and prior informed consent (FPIC) for REDD+ from each.

Villamor et al. follow by using role-playing games and agent-based modelling approaches to investigate the role of gender in land use decision-making in the uplands and lowlands of TanJaBar, in which participants could choose between monoculture rubber plantations, oil palm plantations, selling to a coal-mining company, and agroforests supporting high biodiversity and carbon storage. Their results show that women in the regions studied are more receptive to the commercial options and are better at meeting their income targets compared to the men. They conclude that, contrary to expectations, emissions from deforestation may increase if women become more involved in land use decision-making.

Lusiana et al. then use an uncertainty analysis to investigate the optimum size of units for performance measures that can support efficient implementation of REDD+ schemes in TanjaBar. Large size of units (coarse resolution) means that many different land uses in each unit will be aggregated into a 'mean' value, thereby introducing errors due to not knowing what carbon densities to ascribe to each unit, whereas high resolution means that there are more errors introduced in the classification into different land uses, but that the carbon density ascribed to each is more accurate. Results indicated that for an arbitrary 5 % error in overall emission estimates, aggregation to the 1,000 m (1 km^2) scale was the most appropriate, which is compatible with current plans to identify low carbon development trajectories for the area.

Mulia et al. use a coupled human-environment model to investigate different development scenarios for TanJaBar. The Business-As-Usual scenario (BAU), consisting of unrestricted growth including conversion of peatlands into oil palm plantations, results in high CO_2 emissions, whereas scenarios in which forests and agroforests are protected result in much lower emissions. However, these latter scenarios have lower returns per unit area than the former, suggesting that REDD+ incentives at the level currently being discussed are unlikely to prevent this conversion, and that protection of carbon stocks in forests and agroforests will need regulations rather than by economic persuasion.

The next set of papers focus on improving our understanding of the processes involved and better quantification of emissions from tropical peatlands, again with the focus on Indonesia. Hergoualc'h & Verchot review the literature and use a mass balance approach to calculate the emission factors of CO_2, CH_4 and N_2O in seven representative peat land use categories, including intact peat swamp forest, degraded forest (logged, drained and affected by fire), mixed croplands and shrublands, rice (*Oryza sativa*) fields, oil palm, *Acacia crassicarpa* and sago palm plantations. Results show that across all land use categories, CO_2 was the largest component contributing to overall GHG emissions, but that CH_4 and N_2O are also significant.

Marwanto & Agus investigate air temperature and soil moisture content as potential controlling factors of CO_2 fluxes using chambers in oil palm plantations in Sumatra. Surprisingly, results do not show any significant relationship between CO_2 flux rates and these two variables across all measurements, although they do track diurnal temperature patterns and decrease with distance from the drainage canal, indicating that there is some influence. This suggests that when compared across all sites, there may be other factors influencing flux rates besides temperature and soil water content. Husen et al. look at water table depth and the impact of applications of laterite rich in aluminium and iron oxides, which is used as an additive to improve peat soil fertility, on CO_2 emissions. Dariah et al. attempt to separate the soil CO_2 emissions derived from fresh plant organic material and that from soil organic material. The distinction is important, as the first returns CO_2 recently fixed by photosynthesis back to the atmosphere and is essentially carbon-neutral, whereas the latter is releasing carbon that has been stored in the soil for a significant time and therefore represents a net addition to the atmosphere. Total soil CO_2 emission measurements need to be adjusted to take this distinction into account. Husnain et al. measure soil-surface CO_2 fluxes from drained peat under different land-use systems in Riau and Jambi Provinces in Indonesia.

Farmer et al. then attempt to incorporate this information into a robust model of soil carbon losses and CO_2 emissions following land use change from primary forest on peatlands, and use this to estimate the impact on emissions of changes in peatland management. This leads on to a paper by van Noordwijk et al. who discuss the knowledge-to-action value chain in four parallel strands that connect local to global nodes in developing effective schemes to reduce emissions from peatland conversion and deforestation, and the role that models have to play in understanding and evaluating these chains.

Finally, Matthews et al. reflect on the overall contribution of the REDD-ALERT project, including work published both in this Special Issue and in other journals.

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