Forestry for a Low-Carbon Future: Integrating Forests and Wood Products Into Climate Change Strategies

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Abstract
An historic achievement was realized in Paris in December 2015 when most of the world’s greenhouse-gas (GHG) emitting countries voluntarily submitted their post-2020 plans for action on climate change. These Intended Nationally Determined Contribution plans are aimed at keeping the global temperature rise well below 2°C, but apparently, the plans will require substantial improvement to attain that goal. Adjusting these plans is undoubtedly complex, but regardless of the specifics, it is difficult to imagine any mitigation or adaptation plan that does not include forests and other woody vegetation. By the process of photosynthesis, plants take in the GHG carbon dioxide (CO₂) from the atmosphere, and use energy from the sun to power chemical reactions with water to form sugar, a building block of life. Woody plants can accrue huge amounts of carbon from the atmosphere and these stocks persist: globally, forests store 861 (±66) Petagrams of carbon. This process of carbon removal and deposition into longlived storages such as forests is defined as carbon sequestration by the United Nations Framework Convention on Climate Change. Natural processes such as plant respiration and organic matter decomposition, as well as both natural and human-caused disturbances, emit CO₂ back into the atmosphere. As such, many factors interact to determine whether a forest will function as a sink that reduces atmospheric CO₂ levels and mitigates global warming, or as a source of CO₂. Fast-growing and well-managed forests capture more CO₂ from the atmosphere than they emit and can accumulate large stocks of carbon in the vegetation and soil. On the other hand, deforestation represents a loss in the capacity to absorb CO₂ from the atmosphere and also results in emissions of CO₂. Land-use change and forestry accounted for 10-12% of global GHG emissions from 2000-2011. However, forests, as a result of their growth, were a net sink for CO₂ over the 2000-2009 period by a variety of estimation methods. Given the critical but variable role of forests in global carbon cycling, it is crucial to communicate to policymakers and other experts involved in climate-change planning how basic forest biology and forest management translate into climate warming mitigation (hereafter referred to simply as ‘mitigation’). This Report by the Food and Agriculture Organization addresses this pressing need at an opportune time. The development of the Report was initiated during the “International Online Conference on the Economics of Climate Change Mitigation Options in the Forest Sector,” which was convened in February 2015. The Report’s goal is to provide urgently required information that is relevant for making decisions regarding policy that aims to foster low-carbon-emission forests. Moreover, it provides guidelines for enhancing socioeconomic benefits of forests in ways that can be tailored to specific needs at the regional level. An Advisory Committee formulated the Report’s outline, organized to contain an Executive Summary, Introduction, six chapters (summarized below) and a Conclusion. Each Chapter concludes with ‘Key messages’ listed as bulleted points. Most Chapters also contain sub-sections entitled ‘Bottlenecks in harnessing potentials’ and ‘Embracing opportunities.’ There are contributions from 113 experts and 22 expert reviewers provided comments on the draft. Acronyms abound, but there is a comprehensive list of definitions at the beginning of the Report.

Disciplines
Forest Sciences | Natural Resources and Conservation | Natural Resources Management and Policy

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Report on Reports:

Forestry for a low-carbon future:

Integrating forests and wood products in climate change strategies.


By Ann E. Russell & B. Mohan Kumar

Overview

An historic achievement was realized in Paris in December 2015 when most of the world’s greenhouse-gas (GHG) emitting countries voluntarily submitted their post-2020 plans for action on climate change. These Intended Nationally Determined Contribution plans are aimed at keeping the global temperature rise well below 2°C, but apparently, the plans will require substantial improvement to attain that goal. Adjusting these plans is undoubtedly complex, but regardless of the specifics, it is difficult to imagine any mitigation or adaptation plan that does not include forests and other woody vegetation. By the process of photosynthesis, plants take in the GHG carbon dioxide (CO₂) from the atmosphere, and use energy from the sun to power chemical reactions with water to form sugar, a building block of life. Woody plants can accrue huge amounts of carbon from the atmosphere and these stocks persist: globally, forests store 861 (±66) Petagrams of carbon. This process of carbon removal and deposition into long-lived storages such as forests is defined as carbon sequestration by the United Nations Framework Convention on Climate Change. Natural processes such as plant respiration and organic matter decomposition, as well as both natural and human-caused disturbances, emit CO₂ back into the atmosphere. As such, many factors interact to determine whether a forest will function as a sink that reduces atmospheric CO₂ levels and mitigates global warming, or as a
source of CO₂. Fast-growing and well-managed forests capture more CO₂ from the atmosphere than they emit and can accumulate large stocks of carbon in the vegetation and soil.\(^4\) On the other hand, deforestation represents a loss in the capacity to absorb CO₂ from the atmosphere and also results in emissions of CO₂. Land-use change and forestry accounted for 10-12\% of global GHG emissions from 2000-2011. However, forests, as a result of their growth, were a net sink for CO₂ over the 2000-2009 period by a variety of estimation methods.\(^5\)

Given the critical but variable role of forests in global carbon cycling, it is crucial to communicate to policymakers and other experts involved in climate-change planning how basic forest biology and forest management translate into climate warming mitigation (hereafter referred to simply as ‘mitigation’). This Report by the Food and Agriculture Organization addresses this pressing need at an opportune time. The development of the Report was initiated during the “International Online Conference on the Economics of Climate Change Mitigation Options in the Forest Sector,” which was convened in February 2015. The Report’s goal is to provide urgently required information that is relevant for making decisions regarding policy that aims to foster low-carbon-emission forests. Moreover, it provides guidelines for enhancing socioeconomic benefits of forests in ways that can be tailored to specific needs at the regional level.

An Advisory Committee formulated the Report’s outline, organized to contain an Executive Summary, Introduction, six chapters (summarized below) and a Conclusion. Each Chapter concludes with ‘Key messages’ listed as bulleted points. Most Chapters also contain sub-sections entitled ‘Bottlenecks in harnessing potentials’ and ‘Embracing opportunities.’ There are contributions from 113 experts and 22 expert reviewers provided comments on the draft. Acronyms abound, but there is a comprehensive list of definitions at the beginning of the Report.
**Description**

The Introduction describes various forest-sector mitigation activities directed towards enhancing carbon stocks (sinks) and reducing GHG emissions (sources). The case is made that greater use of wood for energy and various products would ultimately reduce CO₂ emissions compared to using non-wood products (further amplified in Chapters 6 and 7). Use of wood products has been limited by technology, and also by concern over consequences for the forest. The argument is made that if forests are harvested sustainably, these forests will have a larger carbon storage potential, given the durability of harvested wood products, and the potential for the remaining well-managed forest to function as a carbon sink. It is especially pertinent to consider wood products, given their recent inclusion in the Intergovernmental Panel on Climate Change guidelines.⁶

Chapter 2, ‘Mitigation in the forest sector’, outlines the evolution, processes and key challenges of Kyoto Protocol, a legally binding instrument for mitigation in developed countries, which underpins the need for a quick transition to low-carbon economies. Other focal themes of the Chapter include forestry’s place beyond the Kyoto Protocol, e.g., enhancement of policies aimed at ‘reducing emissions from deforestation and forest degradation’ (REDD+) under the Paris Agreement, along with recognition of the multiple benefits beyond carbon sequestration. The economic potential for mitigation is estimated for afforestation, reduced deforestation and forest management, with data categorized by nine regions in the world. Although REDD+ implementation is advancing in several countries, so far, it is not included in the compliance carbon market. Among the forest activities considered, afforestation and reforestation offer the
best mitigation option because of the short timescale and ease of implementation. Their analyses indicated that CO₂ emissions would be reduced by increasing the use of wood biomass for energy and harvested wood products instead of fossil-fuel-based products.

Chapters 3, ‘Expanding forest and tree cover’, describes the role of forests to mitigate climate change by sequestering atmospheric carbon. It begins with definitions of key concepts such as afforestation and reforestation and describes the role of agroforestry and various landscape-based strategies under the broader option “Reducing Emissions from All Land Uses” for significant terrestrial carbon storage. In particular, agroforestry, tree or shrub-based systems that are designed for beneficial interactions among woody perennial and crop components and/or animal husbandry, often contributes to climate change mitigation. Exemplary case studies are provided of the mitigation potential of afforestation, reforestation, and trees outside forests to abate GHG emissions, their economic feasibility, and the policy options. This Chapter also calls for incentives, regulations and standards to provide certainty and confidence in emerging carbon markets.

Chapter 4, ‘Reducing deforestation and preventing forest loss through REDD+’, highlights that the REDD+ mechanism has both environmental (mitigation potential of ~5 Gigatonnes CO₂ per year) as well as developmental benefits (e.g., incentive schemes). The Chapter does mention that financing options for REDD+ are increasing, albeit gradually. It also describes aspects such as economic feasibility and potential of payments for ecosystem services to provide incentives to retain forest cover as an alternative to forest conversion for agriculture in a sufficiently detailed manner. Economic analyses consider only the realizable value of the cleared land for producing
agricultural outputs and the value of any wood products obtained during land clearing, but do not address other economic and non-monetized values. The Chapter also highlights the issue of excessive supply of REDD+ emission reductions credits in carbon markets and the associated problems of depressed prices and unsold credits. The authors call for significant policy changes to stimulate demand for REDD+ credits by removing bottlenecks in harnessing REDD+ potentials.

Chapter 5, ‘Changing forest management Practices’, presents ways in which forest management can increase carbon sequestration and storage while reducing emissions. Sound and sustainable forest management (long rotations, lighter thinning and more biodiverse stands) and uneven-aged forests with mixed species and/or size-classes that favor both carbon and forest productivity were described in a detailed manner. In regard to length of rotation, it was further argued that when bioenergy income and carbon benefits from fossil fuel substitution are taken into account, optimal rotation ages should be shorter. Reduced-impact logging, effective continuous management of insects and diseases and improving fire management that can improve carbon budget outcomes and contribute to climate change mitigation also received careful treatment. Aspects relating to forest management, including the need for improved land management and afforestation of former agricultural land for sequestering substantial amounts of soil carbon were also addressed adequately.

Chapter 6, “Improving and using wood energy,” begins with the finding that >50% of wood harvested annually in the world is used as an energy source. If harvested in a sustainable manner, this renewable energy source has mitigation potential. The thoughtful presentation of the topic
gave careful and detailed consideration of the complexity of determining whether wood energy is carbon neutral; the discussion included topics such as full life-cycle analysis and emission of greenhouse gases other than CO₂. The mitigation potential for specific strategies, such as improved cookstoves and charcoal kiln designs, varies widely across countries and regions, as does the potential for policy reform and economic feasibility. Barriers to progress in the use of wood as energy are discussed, including production difficulties, environmental concerns, economic costs, and market barriers. The chapter concludes with a set of suggestions for encouraging development of wood energy use as a mitigation opportunity.

Chapter 7, “Promoting the use of wood for greener building and furnishing,” demonstrates through life-cycle analysis that wood-derived building products influence the GHG balance more favorably than non-wood options. With more complex life cycles, materials such as concrete, metal and plastics have higher emissions than wood products that are harvested in a sustainable manner. Lack of understanding of the full accounting of carbon costs has hindered wider adoption of wood-based products in ‘green’ building construction. Regional differences in the use of wood in buildings abound, with examples provided of local innovations for climate conditions and wood products available. Changes in building codes and policies, along with improvements in curricula in architecture and engineering would promote greater use of wood-based products and the concomitant reduction in GHG emissions.

Chapter 8, “How to make it happen,” considers that decisions about mitigation options will need to be made locally, a flexibility incorporated in the Paris Agreement. Even within a country, forests and their management may differ, along with sociopolitical factors, such that appropriate
mitigation strategies may vary widely. Co-benefits of mitigation, e.g., contributions to income and livelihoods, energy production, and health benefits through improvements in air and water quality, are important considerations in the decision-making process. The role of plantations in reforestation in meeting demands for wood products is discussed. Implementation of forestry for mitigation is costly, with different sources and types of financing varying with the stage of development of the forestry operation. The benefits beyond climate mitigation, e.g., training and capacity building, reduction in poverty, increase in biodiversity, and overcoming barriers to innovation, should be evaluated. They conclude that greater market finance is hindered by the lack of stronger compliance markets.

**Discussion**

Assigning value to forests for their role as carbon sinks and compensating for emission reductions through avoided deforestation are central themes of many recent international debates on climate change. Yet there are not many comprehensive accounts on this subject. This Report is a welcome synthesis on the topic. It argues that increasing the size of the global terrestrial sink is a principal strategy for mitigation of increased atmospheric CO₂. In particular, the Report describes the role of forests, agroforests and various landscape-based strategies, along with sound and sustainable forest management for significant terrestrial carbon storage. Deforestation and forest degradation release large amounts of the carbon stored in forests. Reducing deforestation and forest degradation in tropics is therefore regarded as one of the most efficient components of near-term emission-reduction strategies. Moreover, it has positive externalities such as biodiversity conservation, watershed management and poverty alleviation.
One particular strength of this Report is its large number of contributors. This Report provides a diversity of opinions and a comprehensive and balanced view of the potential of forests to mitigate global warming. The organization of the Report is very user-friendly in that the ‘Key Points’ sections at the end of every Chapter provide a handy go-to Summary. By incorporating concepts about modern uses of wood products, this synthesis provides a way forward for promoting a greener economy. Yet another forte of the Report is the extensive coverage of previously published work on thematic areas, with over 300 citations, including the most recent ones. The presentation style is lucid and coherent. The Report is also well illustrated with a number of figures, tables and text boxes, each providing materials to elucidate the points discussed.

Although not traditionally a topic covered in Forestry Reports, the inclusion of agroforestry systems is a strength. All too often there exists an artificial dichotomy between agriculture and forestry, which must be eschewed as these two sectors are often interwoven on the landscape and share many common goals. Where economic and social factors preclude returning deforested, degraded, or unproductive crop land to natural forest, agroforestry offers a carbon-rich, socially and economically acceptable alternative, especially for small landholders. Over the next 50 years, agroforestry systems could potentially mitigate 1.1-2.2 Petagrams C in the one billion ha that they occupy throughout the world. In addition, if unproductive croplands were converted to agroforestry systems, an additional 0.586 Teragram carbon per year could be sequestered over the next 25 years.

The focal audience, policymakers and investors, is clearly an important one, and this Report summarizes the role of forests in mitigation and adaptation for this readership. The authors propose a mix of options in the forestry sector, e.g., afforestation, reforestation, reducing...
deforestation, forest management and carbon substitution through the use of wood products and wood energy. They have adopted the flexibility concept of the Paris Agreement, i.e., that specific mitigation strategies are best decided locally, which allows those trying to create a greener future to tailor their strategy to the situation at hand. This could be both a strength and a weakness. While not attempting to foist off a ‘one-size-fits-all’ approach, the overarching strategies tend to come across as a bit vague, however.

The concern is that without specific guidance for creating mitigation plans that are both ecologically and economically sound, the locally developed strategies may not be sustainable. From the ecological perspective, it is troubling that mitigation plan descriptions are based only on carbon uptake from the atmosphere, given that trees also require nutrients and water to conduct photosynthesis. As such, wood product harvest represents an export of a site’s carbon and nutrients. Nitrogen, phosphorus and cation stocks may be replenished naturally via complex interactions among trees, microbes, fungi, soil, and parent material, but this is not a given. Accounting that explicitly ensures maintenance of soil nutrient stocks would prevent adverse consequences of wood harvest with respect to soil fertility, plant nutrition, and forest productivity. Similarly, regard for water requirements of trees in forest projects situated in grassland biomes could prevent unintended consequences for a community’s groundwater supplies, as well as future forest productivity.

From the economic perspective, aspects relating to deep-seated uncertainties in estimating the resultant carbon stocks and pricing of carbon in the international market received only a superficial treatment in this Report. The authors cite several instances in which it is difficult to assess the effects of investment in certain forest mitigation projects. This topic would
benefit from inclusion of discussion of new technologies in remote sensing that allow for cost-effective, detailed assessment of carbon sequestration in forests.8

Perhaps an approach that is not overly prescriptive will allow policymakers and investors more space for innovative solutions. The hope is that they will work together with ecologists, sociologists, economists, and practitioners on the ground to develop workable, holistic solutions for mitigation. The stakes are high with regards to climate change. Moreover, the payoff will also encompass the conservation of biodiversity and other natural resources such as water and air quality, as well as the enhancement of humanity’s social, economic, and spiritual well-being.

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Experimental 16-yr-old plantations at La Selva Biological Station, Costa Rica.
Inset: Planting trees in abandoned pasture at the onset of the experiment
B&W photo: 1988, Photographer unknown
Color Photo: Jan 2004, A.E. Russell

Note: I’d like to use this for the title page
Wood products harvested from agroforestry system in Alagappanagar, Kerala, India
Photo: (2005) A.E. Russell
Teak plantation at Kerala Agricultural University, Vellanikkara, Kerala, India
Photo: (2005) A.E. Russell
Coconut-based agroforestry system near Mannuthy, Kerala, India
Photo: (2005) A.E. Russell
Coconut-based agroforestry system in background, rice paddy in foreground near Mannuthy, Kerala, India
Photo: (2005) A.E. Russell
Poplar-based agroforestry (poplar+mango+pear+turmeric) in Yamunanagar, Haryana, India
Photo: B.M. Kumar
Coffee+shade tree system in Wayanad, India
Photo: B.M. Kumar
Vineyard agroforestry involving *Sorbus domestica* in Montpellier, France
Photo: B.M. Kumar
Silvoarable agroforestry systems involving walnut (Juglans nigra x regia) in Montpelier, France
Photo: B.M. Kumar