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Role of sustainable biomass markets in forest conservation

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This draft follows the journal template and responds to the Editor's request for 3,500 words plus graphics. It is now 3,579 (excluding highlights, references, and acknowledgement).

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Title: Role of sustainable biomass markets in forest conservation

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POTENTIAL HIGHLIGHTS (to be reviewed and possible modified by the journal Editor)

- Forests' contributions to conserving biodiversity, addressing climate change, and the provision of diverse products and services to society are not mutually exclusive; management should seek to achieve these goals simultaneously.
- Forest threats, opportunities, best management practices, and related nature-based climate solutions are site- and context- specific.
- Forest management and conservation require investments, long-term commitments, monitoring, and adaptive management, which are more successful when supported by local communities.
- Reliable wood-product markets, stable regulations, and stakeholder engagement can improve economic and conservation outcomes

ABSTRACT

When properly implemented, the production of bioenergy using wood pellets can play a role in addressing threats related to biodiversity and climate change. Reduction in forest loss and degradation is fostered by the integration of sustainable pellet production with other forest markets and strategies to implement nature-based solutions. Local stakeholders should be engaged to devise management practices appropriate for the location and context. Market incentives for sustainable biomass production help conserve forests.

Alarm Bells

Simultaneous alarms are ringing around the world due to extreme weather, wildfires, and biodiversity loss. The alarms come from leaders in climate, biodiversity, and economic sciences and reflect failures to meet forest conservation goals. From 2015-2020, the average global deforestation rate was 10 million hectares per year (over 25,000 hectares daily). This loss is serious because forests ecosystems provide critical services. More than one-fourth of the world's population relies on forest resources for their livelihood, and forests help mitigate climate change by absorbing CO2. Continued deforestation reflects a lack of effective mechanisms and markets to conserve remaining forests. Reversing trends in forest loss requires specific and immediate actions that effectively address forest threats.

The United Nations Convention on Biological Diversity (CBD)[1] has released a "Global framework for managing nature through 2030" that underscores the need for proactive interventions to conserve forest ecosystems. The CBD framework sets goals for protecting nature's contributions to people and recommends policies and incentives for more sustainable forest management and use of agri-pastoral-forest systems. Such systems integrate more trees into productive landscapes. The ability to market forest products is a key incentive to induce landowners to plant and care for seedlings and maintain healthy forests.

The CBD framework also aims to support efforts to mitigate climate change by sequestering an additional 10 $GtCO_2$ per year by 2030 using nature-based climate solutions, which rely heavily on forests. The International Union for the Conservation of Nature (IUCN)[2] defines Nature-based solutions as "actions to protect, sustainably manage, and restore natural and modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits." Nature-based solutions mimic natural processes and offer diverse benefits. Nature-based climate solutions are also foundations for achieving multiple Sustainable Development Goals[3] and are necessary for climate-smart circular economies of the future. In practice, nature-based solutions are management actions that humans can take to improve the conservation of existing natural resources such as soils, forests, grasslands, and wetlands and to enhance the rate of carbon sequestration by increasing the area of natural resources or intensifying productivity in a manner appropriate for each location. Investments and market incentives are essential to develop and implement site-based improved practices and conserve existing forest landscapes.

Forests and nature-based solutions

Forest product markets that support sustainable management and harvests are key components of effective nature-based solutions involving forests. Sustainable forest management principles have been widely recognized since the 1987 Montreal Protocol, but implementation has been spotty, and systems for verification have been slow to develop.

The recent growth of wood pellet industries has provided a major boost to sustainable forest management, certification, and verification systems. Pulp, paper, lumber, and other forest-product industries have evolved over centuries without the intense scrutiny and sustainability requirements that are being applied to the wood pellet industry. In response to these pressures, the pellet industry has become a leader in developing sustainability strategies, responsible sourcing policies, and transparent reporting on the impacts of their activities. Certification of wood pellets contributes to improved accountability for other forest products as sustainability requirements are applied to upstream supply chains. The wood pellet industry also supports protection of HCV[4] areas, training in sustainable forestry practices, and incentives that expand the area of forest formally certified under sustainability standards with third-party verification.

The wood pellet industry relies largely on residues and biomass wastes from the production of lumber, paper, furniture, and other wood products. In contrast, in areas lacking nearby pellet industry demand, logging slash, residues, and woody biomass from deformed trees and non-commercial species are typically left to decompose and can contribute to more intense wildfires. Such wastes and residues release carbon to the atmosphere when they decompose or are burned in the forest, without providing useful energy to society. Many life-cycle analyses illustrate how the use of wastes and residues by a pellet industry increases overall system efficiencies and reduces net climate-forcing emissions.

The recent International Panel of Climate Change (IPPC) report on climate change[5] underscores the critical relationships and feedbacks among forests and other interconnected ecosystems and the need to employ nature-based climate solutions. That report emphasizes the urgent need to take an "all of the above" approach to address climate change via forest conservation, management, and renewables, including the use of sustainable biomass to displace fossil-intensive fuels, chemicals, and materials. Fossil energy represents a direct flow of carbon from stable storage in the earth to the atmosphere. Forest biomass, on the other hand, represents part of a natural carbon cycle. When harvests do not exceed the rate of forest carbon uptake, the use of woody biomass is not increasing net atmospheric CO2 concentration.

Arriving on the heels of the United Nations (UN) Summit on Biodiversity, the IPCC report emphasizes that the world has thus far failed to come close to achieving targets under the Convention on Biological Diversity (CBD) or Sustainable Development Goals related to forest and habitat conservation. The global framework to protect biodiversity and forest ecosystems is based on a theory of change that focuses on the need to identify key threats and take transformative actions to reduce those threats.[6]

Threats to Forests

Identifying and understanding threats to global forests is challenging because many activities that cause damage occur illegally in remotes areas with minimal capacity for effective law enforcement. And most threats involve a combination of enabling factors ranging from physical access (e.g., roads) to institutional capacity (e.g., governance presence and rule of law) and political will. And forests are impacted by climate change as well as human activities. Notwithstanding these challenges, we cannot develop effective solutions that conserve remaining forests and the services they provide unless we first understand the causes of deforestation. Satellite imagery and analyses are now available to provide detailed and near-real-time information on changes in forest cover and qualities. But on-the-ground analyses are essential to understand the causes of those changes. Remote sensing provides useful descriptions of changes in the area of forest cover but does not explain why forests are lost and can rarely provide insights on when incursions into forests first occur, and whether ecosystems are being harmed by pollution, loss of diversity, exotic pests, or other pressures.

Understanding local history and context is critical to disentangle enabling and causal factors behind a specific loss of forest. Site-specific drivers of deforestation can only be identified, understood, and addressed by working locally. And such enabling and causal factors must be addressed early if forests are to be conserved. Investments in forest products, including wood pellets, can support public-private partnerships that are needed for effective forest conservation.

Analysis of threats and opportunities therefore requires involvement of relevant stakeholders in a process that identifies areas with High Conservation Values[4] (HCVs) and develops plans for their conservation. Natural habitats identified as being of HCV have biological, ecological, social, or cultural values that are significant at the national, regional, or global level. Working with local stakeholders, factors responsible for loss of those values and opportunities to stop further degradation or deforestation can be more accurately identified and effectively implemented. Local champions and collaborators are essential to gain an understanding of the context and site-specific processes that lead to forest changes in land cover and to effective conservation.

Relations among forest management, biodiversity, and forest loss and degradation in the context of climate change

Forest management, biodiversity, and forest loss and degradation all affect each other and those relationship are all influenced by ongoing climate changes (Figure 1). Climate change affects forests directly by influencing species composition, growth rates, and mortality and indirectly by altering the intensity and frequency of disturbances that can modify forest structure, function, and composition. In turn, forests affect climate change, for about half of the biomass of a tree is made up of carbon. As a tree grows, carbon is sequestered, and, when it dies, decays, or is burned, carbon is released back to the atmosphere.

Most forest types can be strongly affected by climate change and may require immediate adaptations to the way they have been managed in the past. For example, with increasing temperatures some species may experience lower productivity and increased mortality (e.g., red cedars in Pacific Northwest) or increasing disease and pest outbreaks (e.g., bark beetles) that can lead to more intense wildfires or the need for widespread clear-cuts to control further outbreaks. Climate change can also facilitate the successful spread of new (and potentially invasive) species and significant changes in forest composition and age class, and therefore impacts forest management requirements. For example, researchers examining US hardwood forests found that climate impacts and related proliferation of exotic insects and diseases require recalibration of silvicultural practices and new approaches to adapt to changing conditions. Thus, maintaining optimal forest properties for tree growth and reproduction under the influence of climate change requires continuous and even increasing efforts of forest managers.

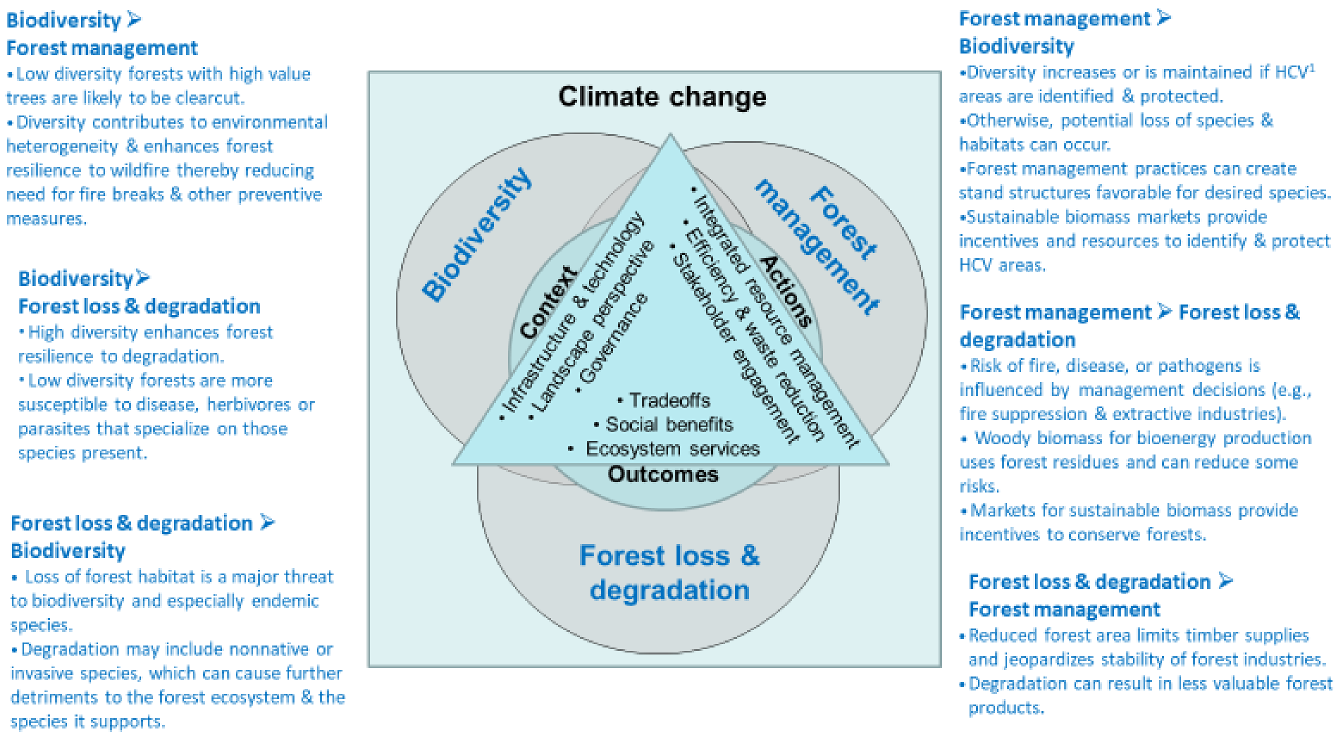

Figure 1. Venn diagram of the nexus among forest management, biodiversity, and forest loss and degradation in the context of climate change. The arrows in the outside columns indicate effects from one part of the nexus to another. Topics in the central triangle area of the Venn diagram influence and are affected by all components of the diagram. Climate change affects all these interactions by influencing species composition, tree growth and mortality, germination success, predation, and herbivore. (*HCV = High Conservation Value)

Strategies to Conserve and Regenerate Forest Resources

Sustainable forest management considers biodiversity conservation, climate change adaptation and mitigation, and ecosystem service provision – including forest-based products ranging from building materials to feed, food, and energy. Solutions proposed for mitigating threats to biodiversity and to mitigate climate change consistently prioritize actions to conserve and manage forests. The strong links among biodiversity, forests, and climate change (Figure 1) require an integrated approach to forest management and related sectors that considers social, economic, and environmental dimensions. Such an approach can help identify strategies to prevent or mitigate detrimental forces while providing incentives for beneficial management.

Lessons from the field illustrate several ways to balance conservation with productive enterprises while reducing drivers of deforestation and biodiversity loss. The examples below suggest approaches to forest management that simultaneously support socio-economic goals, biodiversity conservation, and greenhouse gas mitigation.

Experiences in Guatemala's Maya Biosphere Reserve, established in 1990, illustrate common issues facing remote forests in many parts of the world. Forests within many parts of this, Guatemala's largest park complex, have been lost due to unregulated and illicit activities including land invasions, oil extraction, and the installation of expansive cattle ranches within established park (core protection zone) boundaries. However, on public lands in the multiple use zone, local communities were granted long term concessions for sustainable forest management. After two decades, several studies and remote sensing analyses have shown that the lands managed by communities for productive use of forests have suffered from less disturbance and loss of forest cover, than several of the neighboring parks, including Laguna del Tigre National Park's extensive wetland forests. Experiences in the Maya Biosphere Reserve illustrate benefits of clearly defined and secure land tenure, the participation of community members with a stake in forest conservation, and proper incentives for management aimed at sustainable production of forest products. When communities were given clear responsibilities and authorities for management and technical assistance for planning and business development, they were able to improve protection of large tracts of public forest lands under concession agreements. During the same period, neighboring lands in national parks and the Multiple Use Zone that lacked community concessions continued to be plundered.

Similar examples underscoring the role of land-tenure and forest governance are found around the globe. In Indonesia, where deforestation is occurring in the last remaining habitat for endangered species such as the Orangutan, land tenure, illegal logging, and governance issues have been identified by the Center for International Forestry Research (CIFOR) as key underlying causes of recent deforestation.[7] And in nearby Myanmar, the primary causes of initial deforestation are large corporate concessions on public lands for timber extraction, corresponding infrastructure development, and civil conflicts associated with weak land tenure[8]. In South America, nearly half of the Peruvian Amazon was first disrupted by oil and gas concessions that created extensive new systems for forest access to support work camps, hundreds of exploratory wells, and more than 104,000 km of seismic lines.[9] Across the Americas, forests have been degraded and cleared through illegal activities ranging from narco-trafficking to the invasion of parks and reserves by organized groups seeking to acquire land.

Responsibility and accountability are essential ingredients to build public trust in sustainable forest management. Chain of custody controls and transparent reporting are tools that have been developed by the wood pellet industry to improve accountability. Furthermore, monitoring by independent third parties is increasingly applied for verification that forests are conserved and BMPs are being employed. When science-based tools and near-real-time satellite imagery are utilized, problems can be identified and corrected quickly. In addition to reporting by industry, compliance with key indicators can be verified by anyone who desires to take the time to analyze data available from reliable sources, such as the Forest Service Forest Inventory and Analysis (detailed, long-term data) and in increasing array of other products that provide analysis and reporting of forest cover and disturbance.

Bioenergy production can be a part of management for restoration and implementation of strategies that contribute to natural climate solutions [10,11] and thereby support achievement of several

SDG targets. Conservation, restoration, and improved land management actions that increase carbon storage or avoid greenhouse gas emissions can be implemented in forests and, when combined with such strategies in wetlands, grasslands, and agricultural lands around the world, could provide over one-third of the climate mitigation needed by 2030 to stabilize warming to below 2 °C.[10] Natural solutions along with aggressive reduction in fossil fuel emissions that accompany the replacement of coal by wood pellets provide ways to deliver on the Paris Climate Agreement as well as improve soil productivity, clean air, and water and maintain biodiversity. In addition, knowledge gained from monitoring and rigorous analysis should be used to inform continual improvement of forest management and should be reflected in decision-making.

When our set of recommendations for protecting high-conservation value forests[12] is compared to the "ten golden rules for restoring forests" developed by scientists working with Kew Royal Botanical Gardens in the United Kingdom,[13] a great deal of similarity is apparent. Below we integrate and synthesize key recommendations from both sources, focusing on aspects that are relevant to wood-based bioenergy production.

(1) Begin with a place-based approach and, as a first priority, identify areas of High Conservation Value (HCV). Work with stakeholders to develop strategies for long-term protection of HCV areas. This task requires an evaluation of primary threats to the integrity of HCV areas and clear specification of management goals. For example, many distinct management units can be defined and designed so that biomass harvests support multiple objectives identified with stakeholders.

(2) Engage stakeholders (meaning all parties influencing or influenced by the forest area) to determine how to manage the forest and take advantage of traditional and local knowledge. Encourage local participation in all activities.

(3) Strive to develop inclusive management plans that can achieve multiple goals and services for society, including benefits for traditionally disadvantage groups and conservation of local species of concern – i.e., species identified as threatened, endangered, or of special cultural value.

(4) Carefully select any areas to be managed for restoration and adaptation interventions. Use site-appropriate, native, and resilient species and materials. Monitor effects in these areas, as well as other areas that can serve for comparison (control areas) to help inform future decisions and advance goals. Start small & build on successes.

(5) Think long-term and plan ahead for potential future needs including infrastructure and the capacity to deal with supply chain disruption and extreme events (salvage operations or flood, drought, wildfire, pests, etc.).

(6) Implement systematic monitoring and evaluation with frequent reviews of progress. Share timely information with stakeholders and invite feedback. Apply an adaptive management approach aiming to support continual improvement in management.

(7) Adopt market incentives that are appropriate for economic sustainability and that support the application of best practices adapted to local conditions.

Challenges in estimating effects of bioenergy on carbon flux

Using woody biomass to replace fossil fuels in climate-mitigation strategies is controversial in large part because the climate effects of bioenergy and biogenic products are extremely complex to measure properly. It is inappropriate to consider wood pellets produced from industrial residues independently from the overall system that provides the feedstock. Yet, expanding analytical system boundaries further increases complexity and the potential for variation in projections. For example, multiple studies find that the effects of a defined biogenic carbon supply chain (such as wood pellets) can vary by several orders of magnitude depending on many variables, including the counterfactual conditions (what would occur in the absence of the supply chain), the assumed useful life of harvested products (e.g., in building materials), the carbon-intensity and climate impacts of supply chains for materials being displaced by forest products, and by when and how the products and any residues or wastes are eventually returned to nature (to decompose, burn, be used as mulch, etc.).[14],[15]

While climate effects of using wood-based products to substitute for fossil-based alternatives can have strong and immediate benefits under several realistic scenarios, they could also have deleterious effects, particularly in near-term time horizons, under other assumptions. The complicated nature of these assessments generates controversy, misinformation, and confusion for the public and policy makers. The provision of clear documentation of the fossil-based emissions and employment implications when comparing the status quo of a proposal, is the recommended starting point. This approach can help build understanding and support better decisions that are based on realistic costs and benefits for a specific, place-based, project.

Conclusions

It is feasible to combine incentives for management, restoration, conservation, production, and monitoring into a single forest management plan adapted to local conditions. Stakeholder perspectives and local context must be considered when designing ways to conserve biodiversity and forest habitats while producing products such as wood pellets for bioenergy. Working to improve management and reduce degradation in forest landscapes requires timely interventions to help realize targets for climate, biodiversity, and other Sustainable Development Goals. Conservation of HCV areas within forests can be achieved by joining forces with communities, industries, local governments, and other stakeholders to identify and invest in opportunities that improve land management and productivity. Targeted interventions can effectively conserve areas that are high priorities to local and global communities.

Many nations are embarking on large reforestation and afforestation campaigns to support their nationally determined commitments under the Paris Climate Accords. And forest areas designated for protection and conservation continue to expand around the globe on both public and private lands. Keeping these forest ecosystems productive in the face of extreme weather events, invasive pests, and climate change requires investments in monitoring and proactive management. And to retain lands in forests over the long term, markets must be prepared to absorb the forest products and residues which are generated as coproducts of the production of timber, paper, furniture, etc., and industries designed to use wood to displace fossil-intensive fuels, chemicals, and materials. Rather than burning biomass onsite to dispose of it, which persists as the most common land management practice around the globe, recognizing the market values of biomass value will result in incentives for its best use.

Biomass markets are important components for more sustainable, inclusive, and circular economies. Biomass markets need to provide secure and long-term demand for wastes and residues to provide the right signals for investors in the forest products and energy industry. And as more biomass wastes and residues are processed into fuels, chemicals, and materials to displace fossil-intensive fuels and products, multiple climate, environmental, and social development goals can be supported.

NOTE: The article is partially based on the paper by Kline and Dale[12] that can be consulted for further details on strategies that work to conserve forests.

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SUGGESTED RESOURCES FOR FURTHER INFORMATION

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