Kyoto Mechanism and the Conservation of Tropical Forest Ecosystem
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Inter-linkages between Biodiversity and the Kyoto Mechanism

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Abstract
This paper discusses observed and projected changes in the Earth's climate and how these changes have and are projected to affect biodiversity and ecosystem goods and services. It then discusses the Kyoto Protocol, especially the elements that relate to land-use, land-use change and forestry, in particular addressing: (i) which activities are eligible and ineligible during the first commitment period; (ii) what is the potential of LULUCF activities to sequester carbon or reduce carbon emissions over the next 50 years; and (iii) the impact of LULUCF activities on biodiversity.

1. Introduction

Human activities are changing the Earth's climate and further human-induced climate change is inevitable. The question is not whether the Earth's climate will change in response to human activities, but rather where (regional patterns), when (the rate of change) and by how much (magnitude). Climate change is projected to adversely affect key development challenges including the provisioning of clean water, energy services and food, maintaining a healthy environment and conserving ecological systems, their biodiversity and associated ecological goods and services - the so-called WEHAB priorities. Water availability and quality is projected to decrease in many arid and semi-arid regions, with increased risk of floods and droughts; the reliability of hydropower and biomass production is projected to decrease in many regions; the incidence of vector-borne (e.g., malaria and dengue) and water-borne (e.g., cholera) diseases is projected to increase in many regions, and so too is heat/cold stress mortality and threats of decreased nutrition in others, along with severe weather traumatic injury and death; agricultural productivity is projected to decrease in the tropics and sub-tropics for almost any amount of warming, and there are projected adverse effects on fisheries; and many ecological systems, their biodiversity and their goods and services are projected to be adversely impacted.

This paper is based extensively on the reports from the Intergovernmental Panel on Climate Change (IPCC), especially on the reports of Working Group I and II of the Third Assessment Report (TAR); the TAR Synthesis Report; the Special Report on Land Use, Land-Use Change and Forestry (LULUCF); and the Technical Paper on Climate Change and Biodiversity. It is also based on the Convention on Biological Diversity Technical Series No. 10 on Interlinkages Between Biological Diversity and Climate Change.

2. Observed and Projected Changes in Climate

The Earth has warmed over the last 100 years and further warming is projected: There is little doubt that the Earth's climate has warmed, on average by about 0.6^{o}C, over the past 100 years in response to human activities, precipitation patterns have changed, sea levels have risen and most non-polar glaciers are retreating. These changes can be primarily attributed to increasing atmospheric concentrations of greenhouse gases resulting from the combustion of fossil fuels and land-use changes. Based on plausible future demographic, economic, socio-political, technological and behavioral changes, IPCC projected that the atmospheric concentration of carbon dioxide would increase from the current level of about 370 ppm, to between 540 and 970 ppm by 2100, without taking into account possible climate-induced additional releases from the biosphere in a warmer world. The IPCC also projected that the Earth's climate would warm an additional 1.4 to 5.8°C between 1990 and 2100, assuming that there are no coordinated international policies to seriously address the issue of climate change. Land areas are projected to warm more than the oceans and high latitudes are projected to warm more than the tropics and sub-tropics; globally averaged precipitation is projected to increase, but with increases and decreases in particular regions, accompanied by more intense precipitation events over most regions of the world; and global sea-level is projected to rise by about 4 to 35 inches between 1990 and 2100. The incidence of extreme weather events is projected to increase, e.g., heat-waves, floods and droughts.

3. Observed and Projected Impacts of Climate Change

Changes in climate over the last few decades of the 20th century have already affected ecological systems and their biodiversity. The observed changes in the climate system (e.g., increased atmospheric concentrations of carbon dioxide, increased land and ocean temperatures, changes in precipitation and sea level rise), particularly the warmer regional temperatures, have already affected biological systems in many parts of the world. There have been changes in species distributions, population sizes, the timing of reproduction or migration events, and an increase in the frequency of pest and disease outbreaks, especially in forested systems. In addition, many coral reefs have undergone major, although often partially reversible, bleaching episodes, when sea surface temperatures have increased by 1°C during a single season, with extensive mortality occurring with observed increases in temperature of 3°C. While the growing season in Europe has lengthened over the last 30 years, in some regions of Africa the combination of regional climate changes and anthropogenic stresses has led to decreased cereal crop production since 1970. Changes in fish populations have been linked to large scale climate oscillations, e.g., El-Nino events have impacted fisheries off the coasts of South America and Africa, and decadal oscillations in the Pacific have impacted fisheries off of the west coast of North America.

Projected changes in climate during the 21st century will occur faster than in at least the past 10,000 years with predominantly adverse consequences for developing countries and poor people within them. Low-lying Small Island States and deltaic regions of developing countries in South Asia, the South Pacific, and the Indian Ocean, could eventually disappear under water, displacing tens of millions of people in the process; peoples' exposure to malaria and dengue fever, already rampant in the tropics and sub-tropics, could become even more severe; crop production could significantly decrease in Africa, Latin America and in other developing countries; and fresh water could become even more scarce in many areas of the world already facing shortages. Climate change will also exacerbate the loss of biodiversity, increase the risk of extinction for many species, especially those that are already at risk due to factors such as low population numbers, restricted or patchy habitats and limited climatic ranges, and adversely impact ecosystem services essential for sustainable development. For the 800 million people who go to bed hungry every night, and the 2 billion others exposed to insect-borne diseases and water scarcity, climate change threatens to bring more suffering in its wake. In this way, climate change may undermine long-term development and the ability of many poor people to escape poverty, and will clearly threaten our ability to achieve some of the MDGs.

Projected changes in climate during the 21st century, combined with land use change and exotic/alien species spread, are likely to limit both the capability of species to migrate and the ability of species to persist in fragmented habitats. The projected impacts due to changes in mean climate, extreme climatic events and climate variability include:

- The climatic range of many species will move pole-ward or upward in elevation from their current locations.
- Many species that are already vulnerable are likely to become extinct.
- Changes in the frequency, intensity, extent, and locations of climatically and non-climatically induced disturbances will affect how and at what rate the existing ecosystems will be replaced by new plant and animal assemblages.

4. Kyoto Protocol

While the near-term challenge for most industrialized countries is to achieve their Kyoto targets, the longer-term challenge is to meet the objectives of Article 2 of the UN Framework Convention on Climate Change, i.e., stabilization of greenhouse concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system, with specific attention being paid to food security, ecological systems and sustainable economic development.

Lower emissions will require different patterns of energy resource development and utilization, increases in end-use efficiency and improved land management. The IPCC concluded that significant reductions in net greenhouse gas emissions are technically feasible due to an extensive array of technologies in the energy supply, energy demand and agricultural and forestry sectors (e.g., afforestation, reforestation, slowing deforestation and improved management), many at little or no cost to society. Realizing these emissions reductions involves the development and implementation of supporting policies.

The Kyoto Protocol recognizes that land-use, land-use change and forestry (LULUCF) activities can play an important role in meeting the ultimate objective of the UNFCCC. Biological mitigation of greenhouse gases through LULUCF activities can occur via three strategies: (a) conservation of existing carbon pools, e.g., avoiding deforestation (b) sequestration by increasing the size of carbon pools, e.g., through afforestation and reforestation, and (c) substitution of fossil fuel energy by use of modern biomass.

The estimated upper limit of the global potential of biological mitigation options (a and b) through afforestation, reforestation, avoided deforestation, and agriculture, grazing land, and forest management is on the order of 100 Gt C (cumulative) by the year 2050, equivalent to about 10-20% of projected fossil-fuel emissions during that period,[1] although

[1] The emission of carbon from the combustion of fossil fuels is projected to increase from the current level of 6.3Gt C per year to between 10 and 25 Gt C per year

there are substantial uncertainties associated with this estimate. The largest biological potential is projected to be in subtropical and tropical regions, e.g.,

- The potential afforestation and reforestation, including agroforestry, in developing countries during the first commitment period is as much as 700 Mt C per year. However, credits are limited to about 50 MtC in the first commitment period, and current market indications are that this cap will not be reached.
- The potential carbon credits for avoided deforestation in non Annex 1 countries is theoretically equal the rate of deforestation, i.e., about 1.6 Gt C per year, although only a fraction of this could be achieved over the next few decades. This huge potential caused considerable concerns during the negotiations and the activity was excluded from the CDM at least for the first commitment period.
- The potential carbon credits for forest, crop and grazing land management in developing countries is about 300 MtC per year, but none of this is eligible.
- There is also significant potential for using biomass fuels to displace fossil fuels as a source of energy, but these activities are not accounted for under the LULUCF Articles, except for the standing biomass in the plantations.

The eligibility of LULUCF activities under the Clean Development Mechanism (CDM) in the first commitment period are limited to afforestation and reforestation projects. Carbon credits using such projects during the first commitment period cannot exceed one per cent of base year emissions of a Annex I Party, times five. This is equivalent to about 50 MtC per year for all Annex I countries. This could be achieved by about 5 to 10 million ha of new plantings in agroforestry or reforestation prior to 2008. The current rate of establishment of plantations throughout the developing world is about 4.5 M ha per year but a high proportion of these plantings are not additional; i.e. they would have occurred without the incentives of the Kyoto Protocol and are, thus, not acceptable for credit under the CDM. With strict enforcement of the additionality rule and the lack of a significant market for credits from sinks projects in the CDM it is likely that there will be a very limited use of sinks in the CDM in the first commitment period.

No credits through the CDM in the first commitment period are allowed for better forest management, reduced impact logging, forest protection (avoided deforestation), reduced tillage agriculture or grazing management for which there is in principle significant potential and which could contribute to the sustainable development goals of many developing countries.

Within the context of the Kyoto Protocol, additionality, leakage, and permanence are important concepts for carbon storage in relation with the implementation of mitigation activities. A project credited under the Clean Development Mechanism is additional only if it would not have occurred without the stimulus of the Mechanism and if it removes more greenhouse gases from the atmosphere than would have occurred without the project. Leakage refers to the situation where activities related to carbon sequestration or conservation of existing carbon pools triggers an activity in another location, which leads in turn, to carbon emissions. Permanence refers to the longevity and stability of soil and vegetation carbon pools, given that they will undergo various management regimes and be subjected to an array of natural disturbances.

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[2] Afforestation requires planting trees on land that has not contained a forest for over 50 years

[3] Reforestation requires planting trees on land that was not forested in 1990

LULUCF activities must contribute to the conservation of biodiversity and sustainable use of natural resources; any later reversals of uptake must be accounted; and the accounting system must exclude removals of greenhouse gases from the atmosphere resulting from elevated carbon dioxide above pre-industrial levels, indirect nitrogen deposition, and the dynamic effects of age structure resulting from activities and practices before the reference year (1990).

Afforestation[2] and reforestation[3] can have positive, neutral, or negative impacts on biodiversity depending on the ecosystem being replaced, management options applied, and the spatial and temporal scales. The value of a planted forest to biodiversity will depend to a large degree on what was previously on the site and also on the landscape context in which it occurs. The reforestation of degraded lands will often produce the greatest benefits to biodiversity but can also provide the greatest challenges to forest management. Afforestation and reforestation activities that pay attention to species selection and site location, can promote the return, survival, and expansion of native plant and animal populations. In contrast, clearing native forests and replacing them with a monoculture forest of exotics would clearly have a negative effect on biodiversity. Afforestation of other natural grasslands and other native habitat types could also lead to declines or losses of biodiversity.

Plantations of native tree species will support more biodiversity than exotic species and plantations of mixed tree species will usually support more biodiversity than monocultures. Plantations of exotic species support only some of the local biodiversity but may contribute to biodiversity conservation if appropriately situated in the landscape. Planting of invasive exotic species, however, could have major and widespread negative consequences for biodiversity.

Slowing deforestation and forest degradation can provide substantial biodiversity benefits in addition to mitigating greenhouse gas emissions and preserving ecological services. Since, the remaining primary tropical forests are estimated to contain 50-70 percent of all terrestrial plant and animal species, they are of great importance in the conservation of biodiversity. Tropical deforestation and degradation of all types of forests remain major causes of global biodiversity loss. Any project that slows deforestation or forest degradation will help to conserve biodiversity. Projects in threatened/vulnerable forests that are unusually species-rich, globally rare, or unique to that region can provide the greatest immediate biodiversity benefits. Projects that protect forests from land conversion or degradation in key watersheds have potential to substantially slow soil erosion, protect water resources, and conserve biodiversity.

Forest protection through avoided deforestation may have either positive or negative social impacts. The possible conflicts between the benefits of protecting forested ecosystems and costs such as restrictions on the activities of local populations, reduced income, and/or reduced products from these forests, can be minimized by appropriate stand and landscape management, as well as using environmental and social assessments.

Agroforestry systems have substantial potential to sequester carbon and can reduce soil erosion, moderate climate extremes on crops, improve water quality, and provide goods and services to local people. Agroforestry incorporates trees and shrubs into agricultural lands to achieve conservation and economic goals, while keeping the land in production agriculture. The potential to sequester carbon globally is very high due to the extensive agricultural land base in many countries. Agroforestry can greatly increase biodiversity, especially in landscapes dominated by annual crops or on lands that have been degraded. Agroforestry plantings can be used to functionally link forest fragments and other critical habitat as part of a broad landscape management strategy.

Bio-energy plantations provide the potential to substitute fossil fuel energy with biomass fuels but may have adverse impacts on biodiversity if they replace ecosystems with higher biodiversity. However, bio-energy plantations on degraded lands or abandoned agricultural sites could benefit biodiversity.

Renewable energy sources (crop waste, solar- and wind-power) may have positive or negative effects on biodiversity depending upon site selection and management practices. Replacement of fuelwood by crop waste, the use of more efficient wood stoves and solar energy and improved techniques to produce charcoal can also reduce the pressure on forests, woodlots, and hedgerows. Most studies have demonstrated low rates of bird collision with windmills, but the mortality may be significant for rare species. Proper site selection and a case-by-case evaluation of the implications of windmills on wildlife and ecosystem goods and services can avoid or minimize negative impacts.

Hydropower has significant potential to mitigate climate change by reducing the greenhouse gas intensity of energy production but also can have potential adverse effects on biodiversity. Large-scale hydropower development can have other high environmental and social costs such as loss of biodiversity and land, disruption of migratory pathways and displacement of local communities. The ecosystem impacts of specific hydropower projects vary widely and may be minimized depending on factors including type and condition of pre-dam ecosystems, type and operation of the dam (e.g., water-flow management), and the depth, area, and length of the reservoir. Run of the river hydropower and small dams have generally less impact on biodiversity than large dams, but the cumulative effects of many small units should be taken into account.

Adaptation is necessary not only for the projected changes in climate but also because climate change is already affecting many ecosystems. Adaptation activities can have negative or positive impacts on biodiversity, but positive effects may generally be achieved through: maintaining and restoring native ecosystems; protecting and enhancing ecosystem services; actively preventing and controlling invasive alien species; managing habitats for rare, threatened, and endangered species; developing agroforestry systems at transition zones; paying attention to traditional knowledge; and monitoring results and changing management regimes accordingly. Adaptation activities can threaten biodiversity either directly—through the destruction of habitats, e.g., building sea walls, thus affecting coastal ecosystems, or indirectly—through the introduction of new species or changed management practices, e.g., mariculture or aquaculture.

5. Conclusion

There is a clear opportunity to implement mutually beneficial activities that take advantage of the synergies between the United Nations Framework Convention on Climate Change and its Kyoto Protocol, the Convention on Biological Diversity and broader national development objectives. These opportunities are rarely being realized due to a lack of national coordination among sectoral agencies to design policy measures that exploit potential synergies between national economic development objectives and environmentally focused projects and policies. In addition, there is a lack of coordination among the multilateral environmental agreements, specifically among the mitigation and adaptation activities undertaken by Parties to the UNFCCC and its Kyoto Protocol, and activities to conserve and sustainably manage ecosystems undertaken by Parties to the Convention on Biological Diversity.

A range of tools and processes are available to assess the economic, environmental and social implications of different climate-change-mitigation and adaptation activities within the broader context of sustainable development. Environmental impact assessments and strategic environmental assessments are processes that can incorporate a range of tools and methods including decision analytical frameworks, valuation techniques, and criteria and indicators.

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