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Article

Forests and Climate Change in Latin America: Linking Adaptation and Mitigation

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Abstract: Climate change can be addressed by mitigation (reducing the sources or enhancing the sinks of greenhouse gases) and adaptation (reducing the impacts of climate change). Mitigation and adaptation present two fundamentally dissimilar approaches whose differences are now well documented. Forest ecosystems play an important role in both adaptation and mitigation and there is a need to explore the linkages between these two options in order to understand their trade-offs and synergies. In forests, potential trade-offs can be observed between global ecosystem services, such as the carbon sequestration relevant for mitigation, and the local ecosystem services that are relevant for adaptation. In addition, mitigation projects can facilitate or hinder the adaptation of local people to climate change, whereas adaptation projects can affect ecosystems and their potential to sequester carbon. Linkages between adaptation and mitigation can also be observed in policies, but few climate change or forest policies have addressed these linkages in the forestry sector. This paper presents examples of linkages between adaptation and mitigation in Latin American forests. Through case studies, we investigate the approaches and reasons for integrating adaptation into mitigation projects or mitigation into adaptation projects. We also analyze the opportunities for mainstreaming adaptation–mitigation linkages into forest or climate change policies.

Keywords: climate change; ecosystem-based adaptation; carbon; ecosystem services; livelihoods; forest policies; REDD+; CDM

1. Introduction

Scientists and policymakers can consider two options for addressing climate change: mitigation, which refers to reducing the sources or enhancing the sinks of greenhouse gases (GHGs), and adaptation, which refers to responding to the effects of climate change [1]. Mitigation and adaptation are two fundamentally dissimilar approaches and present well-documented differences [2,3]. With both these strategies being implemented across Latin America, it is necessary to explore the relationships between them, especially potential synergies or trade-offs, and interactions with development plans and institutions in order to maximize their efficiency [2-6].

Forests play an important role in both adaptation and mitigation, as they provide local ecosystem services relevant for adaptation as well as the global ecosystem service of carbon sequestration, relevant for mitigation. Consequently, just as there are synergies and trade-offs between global and local ecosystem services, there are synergies and trade-offs between mitigation and adaptation in forestry projects: mitigation projects can facilitate or hinder local people's efforts to adapt to climate change, and adaptation projects can affect ecosystems and their potential to sequester carbon [7]. In Latin America, some mitigation projects have demonstrated positive impacts on community adaptation, and some adaptation projects have resulted in an increase in carbon stocks. Nevertheless, no project has exploited these synergies fully. Furthermore, few climate change or forest policies in Latin America have addressed the linkages between adaptation and mitigation in the forestry sector.

In this paper, we examine climate change adaptation and mitigation in the context of tropical forests. We explore linkages between climate change mitigation and adaptation in ecosystems, projects and policies. Case studies from selected Latin American countries illustrate our points.

2. Adaptation and Mitigation in Forests

2.1. Differences and Similarities between Adaptation and Mitigation

Adaptation and mitigation present some notable differences (Table 1). Because of the short-term and local effects of adaptation on livelihoods and development, national or local policymakers tend to view adaptation as more legitimate [8]. Without international negotiations, binding agreements or financial incentives, it is very unlikely that these policymakers would invest in mitigation. At the international scale, by contrast, policies have primarily focused on mitigation, in part because of a taboo on adaptation: the need for adaptation has been perceived as a failure of mitigation or a way to weaken mitigation efforts [9].

Table 1. Main differences between adaptation and mitigation (from [2,3,10-12]).

	Mitigation	**Adaptation**
Objectives	Addresses the causes of climate change (accumulation of greenhouse gases (GHGs) in the atmosphere)	Addresses the impacts of climate change
Spatial scale	Primarily an international issue, as mitigation provides global benefits	Primarily a local issue, as adaptation mostly provides benefits at the local scale
Time scale	Mitigation has a long-term effect on climate change because of the inertia of the climatic system	Adaptation can have a short-term effect on the reduction of vulnerability
Sectors	Mitigation is a priority in the energy, transportation, industry and waste management sectors	Adaptation is a priority in the water and health sectors and in coastal or low-lying areas
	Both mitigation and adaptation are relevant to the agriculture and forestry sectors	

Mitigation and adaptation also share some common features; for example, sustainable development is a common target [5,10,13]. An understanding of the synergies between adaptation and mitigation could underpin discussions on mainstreaming both adaptation and mitigation into climate change policies. Some authors believe the two should be pursued simultaneously because they are complementary and may enable 'win–win' policy options [4,14]. However, others express doubts about the feasibility of implementing adaptation strategies in parallel with mitigation [2,10,15]. There is hence a clear need to analyze the linkages between these strategies [2,15,16].

2.2. Forests and Mitigation

Forests can contribute to achieving the UNFCCC's ultimate goal of avoiding dangerous interference with the climate system. Mitigation strategies through land use, land use change and forestry (LULUCF) have been defined in a number of UNFCCC Conference of the Parties (COP) decisions as well as by the IPCC [17]. The IPCC LULUCF report distinguishes three types of mitigation activities in the forestry sector [17]: afforestation (converting long-time non-forested land to forest); reforestation (converting recently non-forested land to forest); and avoided deforestation (avoiding the conversion of carbon-rich forests to non-forested land). Deforestation and forest degradation cause about 17% of global GHG emissions. Reducing deforestation and promoting afforestation and reforestation may provide up to 30% of the cost-effective global mitigation potential [18].

Of these project types, only afforestation (A) and reforestation (R) projects are eligible under the Clean Development Mechanism (CDM), which is the only international policy instrument promoting mitigation through forests in developing countries. As of February 2011, nine AR projects in Latin America had been registered under the CDM (Table 2).

Table 2. Latin American forestry projects registered as Clean Development Mechanism (CDM) projects by the UNFCCC as of 28 February 2011 [19].

Project name	Country	CDM registration date	Scale [1]
Carbon sequestration through reforestation in the Bolivian tropics by smallholders of "The Federación de Comunidades Agropecuarias de Rurrenabaque (FECAR)"	Bolivia	11 Jun 09	*
Reforestation of croplands and grasslands in low income communities of Paraguarí Department	Paraguay	06 Sep 09	*
Reforestation, sustainable production and carbon sequestration project in José Ignacio Távara's dry forest, Piura	Peru	16 Nov 09	***
Forestry Project for the Basin of the Chinchiná River, an Environmental and Productive Alternative for the City and the Region	Colombia	16 Apr 10	***
Nerquihue Small-Scale CDM Afforestation Project using Mycorrhizal Inoculation	Chile	27 May 10	**
Reforestation as Renewable Source of Wood Supplies for Industrial Use	Brazil	21 Jul 10	***
'Posco Uruguay' afforestation on degraded extensive grazing land	Uruguay	03 Dec 10	**
AES Tietê Afforestation/Reforestation Project in the State of São Paulo	Brazil	07 Jan 11	****
Reforestation of grazing Lands in Santo Domingo	Argentina	11 Feb 11	***

[1] Estimated emission reductions in thousands of metric tonnes of CO_2 equivalent per annum (ktCO2/yr), as stated by the project participants (* less than 8 ktCO_2/yr, ** between 8 and 30, *** between 30 and 120, **** more than 120).

Another initiative, now at the top of the international negotiation agenda, is REDD (Reducing Emissions from Deforestation and forest Degradation). REDD is increasingly seen as a significant, cheap, quick and win–win way to reduce GHG emissions [20]. REDD projects are based on the provision of financial incentives to preserve forests and thus maintain carbon stocks in forest ecosystems [21-23]. A REDD+ approach has been proposed recently for financing not only forest conservation but also the enhancement of forest carbon stocks and sustainable forest management [24,25]. Latin American countries are well represented in the REDD+ debate and many pilot projects are implemented in the region. For example, Peru and Brazil have more than 40 pilot projects and are among the three countries with the highest number of projects, along with Indonesia [26]. Eleven carbon projects in Latin America have been approved by the CCB Standards (Climate, Community and Biodiversity) for their expected contribution to biodiversity conservation and local development (Table 3).

Table 3. Latin American mitigation forestry projects approved by the Climate, Community and Biodiversity Standards as of 28 February 2011 [27].

Project name	Country	CCB approval date	Scale [1]
Native Species Reforestation in Las Lajas, Chiriquí and El Pito, Veraguas	Panama	01 Feb 07	***
Return to Forest, Rivas Province	Nicaragua	11 Apr 08	*
The Juma Sustainable Development Reserve Project: Reducing Greenhouse Gas Emissions from Deforestation in the State of Amazonas	Brazil	30 Sep 08	****
The Monte Pascoal – Pau Brasil Ecological Corridor, Bahia	Brazil	22 Oct 09	*
Avoided Deforestation Through the Payment of Environmental Services in Rainforests Located on Private Lands in the Conservation Area of the Central Volcanic Mountain Range	Costa Rica	28 Oct 09	****
Madre de Dios Amazon REDD Project	Peru	02 Dec 09	****
Boden Creek Ecological Preserve, Toledo	Belize	14 Jul 10	***
Avoided Deforestation in the Coffee Forest	El Salvador	28 Jul 10	****
Reforestation with native commercial species on degraded lands for timber and carbon purposes in Campo Verde, Ucayali	Peru	30 Nov 10	****
The Paraguay Forest Conservation Project, Itapua and Caazapa	Paraguay	6 Dec 10	***
Emas-Taquari Biodiversity Corridor Carbon Project, Goias and Mato Grosso do Sul	Brazil	14 Dec 10	*

[1] Estimated emission reductions in thousands of metric tonnes of CO_2 equivalent per annum (ktCO2/yr), as stated by the project participants (*: less than 8 $ktCO_2$/yr, ** between 8 and 30, *** between 30 and 120, **** more than 120).

2.3. Forests and Adaptation

The linkages between forests and adaptation are two-fold. First, adaptation is needed for forests to maintain their functioning status (‘adaptation for forests’). Forests are vulnerable to climate change and implementing forest adaptation measures can reduce the negative impacts [28]. Second, forests play a role in adaptation of communities and the broader society (‘forests for people’s adaptation’). Forest ecosystems contribute to adaptation by providing local ecosystem services that reduce societies’ vulnerability to climate change [29]. It is increasingly recognized that well-managed ecosystems can help societies to adapt both to current climate hazards and to future climate change by providing a wide range of ecosystem services [21]. For example, mangroves protect coastal areas against storms and waves, which may become stronger with climate change and sea level rise. Forest products provide safety nets for local communities when agricultural crops fail because of climatic events [30]. Hydrological ecosystem services (e.g., base flow conservation, storm flow regulation and erosion control) are of utmost importance for buffering the impacts of climate change on water users. The conservation and sustainable management of ecosystems and their services can generate multiple socio-ecological benefits and promote long-term approaches to climate change adaptation [31].

Under the UNFCCC, least-developed countries are required to produce a National Adaptation Programme of Action (NAPA) in which they assess their vulnerability to climate change and define adaptation priority projects (only one least-developed country is located in Latin America and the Caribbean: Haiti). Among the 468 projects presented in the 44 NAPAs submitted as of June 2010, 77 of them include ecosystem management measures with the explicit objective of reducing societal vulnerability [32]. This emerging approach, which is promoted by the World Bank and several international NGOs and has pilot sites in Latin America, is known as ecosystem-based adaptation [23,33]. Ecosystem-based adaptation (EbA) is a set of adaptation policies and measures that take into account the role of ecosystem services in reducing the vulnerability of society to climate change, in a multisectoral and multiscale approach [26].

In September 2010, the Adaptation Fund of the UNFCCC accepted its first two projects. One of these (Addressing Climate Change Risks on Water Resources in Honduras: Increased Systemic Resilience and Reduced Vulnerability of the Urban Poor) aims to improve water management and decrease water problems for the poor in the Honduras capital region of Tegucigalpa. This project extensively considers the role of forests, including how they capture mist from the atmosphere, and the negative impacts of deforestation in water catchment areas. According to the project document, ecosystem management (including the creation of protected areas) must consider issues of water supply for cities and sensitive ecosystems such as cloud forests [34]. The document recognizes that there are currently no mechanisms in place to conserve the forests providing hydrological ecosystem services and threatened by deforestation and urbanization. In addition to addressing 'forests for people's adaptation', the project includes 'adaptation for forests': 60,000 hectares of biological corridors will be conserved and restored to increase 'connectivity as a climate change adaptation measure for biodiversity conservation'. This project is a positive sign of an emerging inclusion of forests into adaptation policies, as well as adaptation into forest management.

3. Linkages between Mitigation and Adaptation in Latin America: Rationale and Examples

We present the rationale for considering adaptation and mitigation jointly in forest projects, using examples from Latin America. As the linkages between forests and adaptation are two-fold ('adaptation for forests', 'forests for people's adaptation'), we distinguish between forest adaptation and community adaptation.

3.1. Linkages between Mitigation and Forest Adaptation

Mitigation projects can facilitate the adaptation of forests to climate change, and forest adaptation can increase the sustainability of mitigation projects (Table 4).

Table 4. Linkages between mitigation and forest adaptation.

Linkage	Rationale	Examples in Latin America
Mitigation influences forest adaptation	REDD+ or CDM project can increase forest resilience	No explicit reference found
Forest adaptation influences mitigation	Adaptation measures can increase the permanence of carbon in a changing climate	Klinki Forestry Project (Costa Rica), Return to Forest (Nicaragua)

Mitigation projects have the potential to facilitate the adaptation of forests to climate change by reducing anthropogenic pressures on forests, enhancing connectivity between forest areas and conserving biodiversity hotspots. Reducing pressures on ecosystems, such as habitat destruction and degradation, increases ecosystem resilience and forms part of the strategies for reducing the vulnerability of forests to climate change [35,36]. Forest mitigation projects, such as REDD+ or CDM projects, can enhance landscape connectivity and reduce fragmentation, which facilitate the migration of plants under climate change. Another strategy for forest adaptation to which REDD+ can contribute is the conservation of a large spectrum of forests—for instance, ecosystems across environmental gradients or biodiversity hotspots—for their value and their possible greater resilience [28].

However, mitigation project managers may have to adjust their management strategies and include additional adaptation measures for reducing the impacts of climate change on forests, as such impacts may jeopardize the mitigation potential of the projects [11,37]. An example is the incorporation of forest management practices such as sanitation harvest or increased thinning, as these can reduce the occurrence of pests and diseases. Another practice is the use of drought-resistant varieties in planted forests, which would reduce the vulnerability of tree species to water stress while increasing carbon sequestration rates. The promotion of native species through protection and natural regeneration in degraded forests, as well as the promotion of multispecies plantation forestry incorporating native species instead of the monoculture plantation of exotic species, can also reduce vulnerability. Finally, mitigation projects should also include fire protection measures to reduce forest vulnerability to fire hazards caused by warming and droughts [37].

It is important that all these measures be mainstreamed into mitigation project design to ensure the permanence of carbon sequestration. However, no approved methodologies for CDM AR projects address issues of forest adaptation and it seems that very few mitigation projects incorporate measures for adapting forests to climate change [38]. An exception is the Klinki carbon project in Costa Rica, in which climate-related risks were identified (fire, storms, and pest outbreaks) and specific measures were adopted (e.g., testing of different mixtures of native and nonnative species, adequate thinning to reduce vulnerability to storms and fire). Another exception is the Return to Forest project in Nicaragua (Table 3), a mitigation project that proposes to plant a diversity of tree species, including native drought-tolerant species.

3.2. Linkages between Mitigation and Community Adaptation

Mitigation projects can facilitate the adaptation of local communities to climate change, and community adaptation projects can conserve or increase carbon stocks directly or avoid indirect impacts on deforestation (Table 5).

Table 5. Linkages between mitigation and community adaptation.

Linkages	Rationale	Examples in Latin America
Mitigation influences community adaptation	REDD+ or CDM influences livelihoods and local ecosystem services, and thus affects community adaptation	Noel Kempff (Bolivia), Chinchiná (Colombia), Scolel Té (Mexico), Juma (Brazil)
Community adaptation influences mitigation	(i) Ecosystem-based adaptation projects conserve ecosystems (and thus carbon). (ii) Ecosystem-based adaptation projects can benefit the clean energy sector (iii) Adaptation in agriculture can preserve agricultural yield in a changing climate and avoid displacement of agriculture to forested areas	(i) Tegucigalpa water (Honduras), Colombian mountains (Colombia), AdapCC (Peru) (ii) Chingaza (Colombia) (iii) No explicit reference found

3.2.1. Mitigation Projects

The livelihoods of rural communities in Latin America depend largely on access to land and natural resources. Ecosystem-based mitigation projects will have a direct impact on livelihoods and their adaptive capacity [39]. The benefits of ecosystem conservation for livelihoods and adaptation depend on institutional factors, such as rights and access to forests. Recent research has found that the transfer of ownership of larger areas of forest commons to local communities, coupled with payments for improved carbon storage, can contribute to climate change mitigation without adversely affecting local livelihoods [40]. Mitigation projects can protect the ecosystem services that are relevant for people's adaptation, such as water regulating services or the provision of forest products used as safety nets. However, ecosystem types or locations with high carbon sequestration may not necessarily secure the provision of other ecosystem services or the best adaptation benefits [10,41]. For example, large-scale afforestation and reforestation aiming at carbon sequestration could reduce runoff and water available off-site [42].

Mitigation projects can have positive impacts (e.g., diversified incomes and economic activities, increased infrastructure or social services, strengthened local institutions) and/or negative impacts (e.g., land or rights deprivation, dependence on external funding) on the sustainable development of the rural poor and thus on their capacity to adapt to climate change [28,43,44]. Some mitigation projects in Latin America have demonstrated positive impacts on livelihoods and, in a few cases, on adaptation. One is the Noel Kempff Mercado Climate Action Project in Bolivia, which provides communities with economic opportunities that encourage forest conservation, such as the adoption of sustainable management practices [45]. The Klinki program in Costa Rica, which focuses on reforesting areas that had been cleared for pastureland, aims to build capacity through the training of the farmers and to install multifunctional plantations with short-term and long-term income generation, which in turn enhance social adaptive capacity [38].

In Colombia, the forestry project of the Chinchiná watershed, registered under the CDM (Table 2), aims at consolidating sustainable forest processes, ensuring hydrological regulation and conserving biodiversity. In this mitigation project, reforestation is expected to control soil degradation and favor community adaptation through the implementation of agroforestry and silvo-pastoral systems and the creation of new income opportunities. Mexico was a pioneer in the design and development of carbon offset projects with the Scolel Té project initiated in Chiapas in 1996 [46]. In this project, which is notable for strong local participation, around 60% of the carbon sale price goes to farmers; they use this revenue to cover the costs of establishing forestry and agroforestry activities and for livelihood needs (food, medicines, house improvement) [47,48].

In the Brazilian state of Amazonas, the Juma Sustainable Development Reserve Project implemented by Amazonas Sustainable Foundation was the first REDD+ initiative to be validated in Latin America by the CCB Standards [49,50]. The Juma project benefits local communities with direct payments through the program Bolsa Floresta, which is implemented in 13 projects in addition to the Juma project and covers 10 million ha and 6000 families [51]. Although the project was developed as a mitigation project, many aspects of its design and benefit sharing address both mitigation and adaptation concerns. The project created a new mechanism building on earlier federal experience using social stipends to pay for environmental services based on a commitment to reducing deforestation in primary forests. More than 90% of the families who participated in the preparatory educational workshops signed this formal commitment. The project also requires that communities maintain firebreaks in shifting cultivation areas and commit to ensuring all children attend school [49].

3.2.2. Adaptation Projects

Adaptation projects can affect GHG emissions through changes in forestry or agricultural practices. Such changes directly affect ecosystems and carbon stocks, thus having an impact on mitigation. Ecosystem-based adaptation projects can directly benefit climate change mitigation, through either increasing or maintaining carbon stocks. The synergies between ecosystem services explain the mitigation impacts of an adaptation project [52]; for example, mangroves simultaneously contribute to protecting coastal areas and to storing carbon. Soil and water conservation are relevant local regulation services for buffering against potential disturbances from climate change; as such, the conservation of these services can be prioritized by an adaptation project. These services can also reduce carbon loss from soils as well as increase the biomass growth rate of forests, thus contributing to mitigation. However, there may be trade-offs between carbon and the local ecosystem services prioritized by an adaptation project. For example, conserving water may be achieved with low-carbon ecosystems.

The adaptation project in Honduras, described above, is an example of a project with impacts on mitigation, even though its contribution to mitigation is not made explicit in the project document. A Colombian initiative is the Joint Program for Integration of Ecosystems and Adaptation to Climate Change in the Colombian Mountains. This program combines mitigation and adaptation activities in the landscape by protecting ecosystems (peat bogs, wet grasslands intermingled with shrublands and forest patches) for water regulating services in the upper watershed of the Cauca River [53]. Another initiative in Colombia is the Integrated National Adaptation Plan (INAP), which aims at addressing the impacts of climate change across the country with public policy interventions and the implementation of EbA measures [33,54]. Pilot projects are being implemented in the most vulnerable ecosystems of the country (e.g., mountain forests, paramos) identified in its first National Communication to the UNFCCC. For mountain forests, the flagship project is located in the Chingaza Mountains, which provide water to Bogota, the capital city. The project includes adaptation measures (e.g., ecosystem restoration, fire management), as well as activities related to mitigation (e.g., carbon monitoring). This project does not consider mitigation funding for forest conservation activities but the project developers are assessing the possibility of becoming associated with the Santa Ana project, a CDM hydroelectric project located downstream and benefiting from soil and water conservation in the Chingaza Mountains.

In northern Peru, an adaptation project, the GTZ Project AdapCC, has collaborated with an association of coffee producers (CEPICAFE) to identify adaptation strategies and analyze funding opportunities related to mitigation. Agroforestry in coffee production zones and upstream reforestation are expected to reduce the impacts of climate change on coffee production (by improving water regulation and soil fertility and reducing landslides and erosion) and provide mitigation benefits by enhancing carbon stocks in the landscape. To finance the reforestation, CEPICAFE signed a contract with Caf édirect, an international fair-trade company based in the UK, which will buy carbon credits to offset its own emissions. Ten percent of this funding will be reinvested in adaptation measures for coffee plantations. Similar approaches have been promoted in Nicaragua with the association Cafenica and in Mexico with a cooperative of small producers called Mas Caf é (http://www.adapcc.org/).

In addition to the direct impacts of adaptation projects on ecosystems, some indirect impacts can result if the project prevents activity displacement or forest overharvesting. The impacts of climate change on local communities may lead to changes in land uses or ecosystem management and, thus, affect carbon stocks and mitigation. For instance, during extreme climatic events, some communities increase their harvesting of forest products as a coping strategy [30]. More frequent or more intensive climatic shocks can induce overharvesting and forest degradation. The negative impacts of climate change on agricultural yields may cause an expansion of agricultural areas to the detriment of forests. Changes in rainfall and temperature may induce a displacement of crops into regions that are currently forested, causing deforestation. For example, in Central America, crops that require cool temperatures (e.g., arabica coffee, ornamental flowers) should be cultivated in the future at higher altitudes in forested mountains [55]. For these reasons, adaptation projects that reduce the vulnerability of communities in forested areas or in the surrounding region have the potential to avoid deforestation and forest degradation. To ensure the sustainability of REDD+ or CDM projects, community adaptation to climate change should be integrated into these projects. To our knowledge, no mitigation initiatives in Latin America have explicitly considered community adaptation in the forested areas or the surroundings. This can be explained by the current sectoral approach to adaptation, which overlooks the links between sectors, for example the links between agricultural adaptation and forest conservation. Strengthening the links between adaptation and mitigation will require an increased consideration of interactions between sectors.

4. Discussion

4.1. Main Reasons for Integrating Adaptation and Mitigation in Projects

Mitigation projects need adaptation. The negative effects of climate change on ecosystems and people can potentially jeopardize the success of REDD+ or CDM projects. By increasing the resilience of socio-ecological systems and project sustainability, adaptation can contribute to the permanence of carbon and mitigation benefits. Furthermore, incorporating adaptation into a mitigation project can increase its perceived legitimacy and acceptance among local and national stakeholders. As mitigation is sometimes seen as driven by global interests, integrating adaptation into mitigation projects increases the attention given to local issues. Adaptation can maximize the local co-benefits of mitigation projects and contribute to increased capacity to cope with the risks associated with climate change. For example, agroforestry activities are eligible under the CDM and offer an opportunity to develop synergies between efforts to mitigate climate change and efforts to help vulnerable populations adapt to the negative consequences of climate change [56].

In turn, adaptation projects need mitigation. If an adaptation project has a positive impact on ecosystems and carbon (e.g., EbA projects that include forest conservation in their portfolio of activities), it can integrate explicit mitigation objectives. This can help the project in overcoming financial barriers to adaptation as it can benefit from carbon funding (CDM, REDD+, voluntary carbon markets); such funding is an appealing reason to include mitigation into adaptation projects.

4.2. Policy Factors

National policies can either facilitate or hinder the integration of adaptation and mitigation in forestry projects, by providing incentives or imposing regulations on forest activities related to climate change. However, national policies in Latin America rarely link mitigation and adaptation, although in theory, national mitigation policies can benefit adaptation and vice versa. In many countries in the region, the focus remains on developing mitigation plans, although recently, tentative steps have been taken to address adaptation also. Most Latin American countries started developing climate change policies relatively early. For example, Mexico ratified the UNFCCC in 1993, and has since developed a National Climate Change Strategy [57], submitted four National Communications [58] and created a Special Climate Change Program [59]. Recently, Mexico’s National Commission for Protected Natural Areas defined a climate change strategy that clearly emphasizes the linkages between adaptation and mitigation: its stated objectives are to ‘increase the adaptive capacity of ecosystems and people […] and to contribute to GHG mitigation’ [60].

In Colombia, the views of adaptation and mitigation stakeholders differ with regard to the need for corresponding policies. For example, most adaptation project developers see opportunities in mitigation but believe that they do not need national policies to seize these opportunities. In contrast, most mitigation project developers believe that policies must support the integration of adaptation into their project (personal communications with project developers). One means of achieving such integration would be to include adaptation in national guidelines and approval procedures for mitigation projects. For example, Colombian national authorities assess CDM projects according to their contribution to sustainable development, but the criteria do not include aspects associated with adaptation. However, the government recognizes that including adaptation in the approval process for these types of project is a fundamental step in the development of the national climate change policy. Colombia does not yet have a national approval procedure for REDD+ projects, but the government has expressed interest in including biodiversity conservation and adaptation to climate change as selection criteria.

National policies regarding land tenure and rights, although not directly related to climate change, also influence mitigation and adaptation strategies. Many forest people's property rights are insecure or nonexistent, as the law does not formalize their customary resource rights and, in many tropical countries, the state owns much of the land and forests [41]. Insecure property rights are an indirect cause of deforestation [61]. For example, in some countries, forest clearing, which undermines mitigation projects, is carried out as a way to establish property rights as it helps demonstrate that the land is being used productively [62]. As rights and tenure also influence people's adaptive capacity [63], improving policies that are not related to climate change could benefit both adaptation and mitigation.

In Mexico, reforms following the Revolution resulted in the creation of agrarian communities and ejidos, leading in many areas to the clearance of forest areas for agriculture. However, the reforms also permitted the establishment of structures for community-based natural resource management, which have proved effective in protecting many forest areas from external and internal pressures. Structures (*comisariados*) exist at the community level to protect and administer communities' natural resources, and decisions on natural resource management and individuals' usufruct rights are made in community assemblies. In this context, communities in Mexico are a powerful force for both mitigation and adaptation activities. Central America has many similar examples: Community Forestry Concessions in Guatemala, Indigenous Territories in Panama and Costa Rica and the Mayangna Territories in Nicaragua. Consequently, it will be critical to design REDD+ and adaptation projects that take into account local property rights, socio-political dynamics and cultural perceptions of market-based instruments [64,65].

International policies also have the potential to influence the integration of adaptation and mitigation in forest projects, but this potential has not yet been realized. The architecture of international agreements (*i.e.*, setting emission targets under the Kyoto Protocol) reflects how mitigation activities have been the primary focus of international climate policies. Article 2 of the UNFCCC describes mitigation as the 'ultimate objective' ('stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system'). The CDM is the only mechanism under the UNFCCC that links mitigation and adaptation. A levy (share of the proceeds) of 2% of CDM carbon offsets is imposed to finance the Adaptation Fund (Kyoto Protocol Article 12.8), established to support adaptation to climate change in developing countries. As a result, the more effective mitigation is (*i.e.*, the CDM), the greater the amount of funds to be generated for adaptation. However, although a financing mechanism that feeds adaptation from mitigation is seen as progress, it does not link the approaches directly: CDM projects are not required to incorporate adaptation activities.

However, international attention to adaptation is growing. Adaptation and mitigation were both major components of the roadmap for negotiations between COP 13 (Bali, 2007) and COP 15 (Copenhagen, 2009), and were highlighted in proposals to the UNFCCC's Ad Hoc Working Group on Long-term Cooperative Action prior to Copenhagen. In particular, the position paper by Guatemala, the Dominican Republic, Honduras, Panama and Nicaragua highlighted the need for exploring synergies between adaptation and mitigation ('adaptation measures should be developed considering […] the synergies between adaptation and mitigation, and within which REDD+ options are particularly relevant') [66].

At COP 16 (Cancún, 2010), the UNFCCC put its seal of approval on REDD+. While the building blocks of the Cancún agreements constitute an outline of what a potential REDD+ mechanism might look like, critical questions on how the scheme will be funded, operationalized and incentivized, and how both safeguards and deforestation will be monitored, remain unresolved. With regards to adaptation, COP 16 delivered the first global agreement on adaptation through the establishment of the Cancún Adaptation Framework, elevating adaptation to a significant level in the discourse on climate change and linking it to financial mechanisms. The Cancún Adaptation Framework includes both ecosystems and communities in the guiding principles and priorities. But although the framework recognizes and incorporates the need to build and maintain natural ecosystem resilience, there is no acknowledgment of the link between social and ecological resilience and of the potential of ecosystems such as forests to provide critical ecosystem services for the adaptation of people. The Cancún agreement text does not make any explicit reference to the links between adaptation and mitigation. For example, the word 'adaptation' does not appear in the section on mitigation, and vice-versa.

4.3. Project Certification

Forest projects may be encouraged to integrate adaptation and mitigation if the project partners and funders request it. Donors or carbon buyers may want adaptation to be included in mitigation projects to increase the acceptance of the project by the local population or international observers. Adaptation donors may have guidelines requiring that local adaptation projects contribute to the global environment, including through mitigation. In Latin America, several host countries, project developers, potential buyers and funding and technical support agencies have expressed strong interest both in maximizing the multiple benefits of adaptation and mitigation and in protecting the rights and interests of indigenous peoples and local communities. For example, a survey of actors involved in environmental service markets (including carbon credit buyers and forestry organizations) showed 'social benefits' was the most important criterion for actors to engage in a tropical forestry project providing environmental services [67]. Indigenous peoples and local communities have demanded recognition of the risks they face [68,69]. The result is clear public, political and economic interest in developing better standards to ensure that broader social and environmental risks are appropriately addressed.

Social and environmental standards are essential for the success of market- and/or fund-based approaches to REDD+ and represent an opportunity for integrating adaptation into mitigation projects. The Voluntary Carbon Standard considers the impacts of mitigation projects on local livelihoods, although not explicitly on adaptation. Only the CCB Standards require project developers to take climate change adaptation into account in their project planning. These standards include adaptation in their 'sustainable development' criteria and in their 'biodiversity and ecosystem services' criteria. The CCB Alliance has developed new social and environmental standards for national or subnational REDD+ and other forest carbon programs and policies. These standards were developed with the engagement of governments, NGOs and civil society organizations, indigenous peoples' organizations, the private sector, and research institutions from developing and developed countries; for example, consultation meetings were held in Ecuador in October 2009.

4.4. Knowledge

A factor that could increase the synergies between adaptation and mitigation is knowledge. Policy and practice communities in the forestry sector tend to be divided between adaptation and mitigation, with a mutual lack of knowledge between the two communities. As the examples presented in this paper demonstrate, most projects have the potential to harness the synergies between mitigation and adaptation but fail to realize it. For example, several adaptation projects contribute to conserving ecosystems but make no mention of these mitigation benefits even though, as noted above, highlighting such benefits could increase donor interest in the projects. The mitigation projects in Mexico and Brazil mention positive impacts on livelihoods but do not highlight any explicit connections to community adaptation. Very few mitigation projects explicitly integrate adaptation measures for forests.

Sharing information on the synergies between adaptation and mitigation could benefit both types of project. For example, adaptation project managers may need to know more about the opportunities and risks of carbon funding, the technical aspects of mitigation (e.g., quantifying carbon, setting a baseline) and the institutional and economic aspects (e.g., marketing opportunities, carbon trading agreement, transaction costs). Mitigation project managers may need to know more about adaptation needs and the methods available for addressing adaptation (e.g., how to assess the vulnerability of local communities and design community-based and ecosystem-based adaptation, how to assess the impacts of climate change on forests and design adaptation measures for forests).

Research is also needed to improve understanding of the synergies between adaptation and mitigation. Most scientific literature on the linkages between adaptation and mitigation provides theoretical analysis of the possible synergies and trade-offs at the global scale. However, for the forestry sector, empirical studies are lacking and more research is needed to explore these linkages in forests, at the levels of landscapes, projects, countries and international agreements. There is a need for more research on the role of ecosystem services in reducing societal vulnerability to climate change. Also necessary are methods for assessing the magnitude of the ecosystem services generated through forest conservation and reforestation and for measuring the synergies between these services. The trade-offs or synergies between carbon and local ecosystem services useful for local adaptation require further investigation [70]. For example, in Costa Rica, ecosystem service mapping enabled researchers to identify areas with clear synergies between carbon and hydrological services and areas where trade-offs required further analysis [52].

More research is needed to establish the conditions under which the process of integrating adaptation and mitigation can be effective [15]. Some scholars highlight the need for incorporating adaptive measures into natural resource management and mitigation projects—and vice versa—and for studying the risks associated with projects that do not incorporate these measures [2]. However, very little research has been conducted in this area, especially in developing countries. Comparative case studies (e.g., on the impacts of carbon projects on local communities and their adaptive capacity) are needed to grasp the necessary lessons and develop best practices for mainstreaming adaptation and mitigation.

In early 2011, the Consortium Research Program 6 (part of the Consultative Group on International Agricultural Research) developed a proposal for 10 years of research on ‘Forests, Trees and Agroforestry: Livelihoods, Landscapes and Governance’. In this proposal, the component on climate change explicitly addresses the linkages between adaptation and mitigation and proposes research questions and methods [71]. Examples of broad research questions are: What are the opportunities and modalities for linking mitigation and adaptation in international and national policies? What governance mechanisms are most effective in fostering the synergies between mitigation and adaptation? How to increase the synergies between mitigation and adaptation in subnational and local initiatives? The research program also proposes to assess the political economy of mitigation and adaptation trade-offs (e.g., mitigation as a global issue driven by developed countries *vs.* adaptation driven by local and national needs in developing countries) and to analyze how institutional and financial mechanisms can foster synergies between mitigation and adaptation (e.g., pro-poor payments for multiple ecosystem services). The program will develop methods and tools for mapping ecosystem services and analyzing their trade-offs or synergies (carbon *vs.* services relevant for adaptation), for analyzing livelihoods and governance issues in mitigation and adaptation, for modeling the coupled dynamics of social and ecological systems, and for integrating knowledge from different disciplines and stakeholders in the definition and analysis of future scenarios and pathways for mitigation and adaptation.

5. Conclusions

To date, adaptation and mitigation have been treated as two distinct approaches to climate change, with global negotiations and policies focusing more on mitigation than adaptation. Adaptation and mitigation measures have the potential to be mainstreamed into forestry activities in Latin America. Such mainstreaming can occur at the project scale, as mitigation projects need adaptation for increasing the sustainability and legitimacy of carbon projects and adaptation projects need mitigation for harnessing more funding opportunities from carbon mechanisms.

Mainstreaming adaptation and mitigation into forest projects can be facilitated by national and international policies, and by the development of climate change standards for forest projects. Given the range of actors involved in mitigation and adaptation, the implementation of synergistic measures may encounter institutional complexity, both nationally and internationally. A ‘forced marriage’ strategy may be counterproductive and this integration may need time to materialize. Better understanding and knowledge sharing on the synergies between adaptation and mitigation are needed.

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References

1. *Climate Change 2007: Synthesis Report*; Core Writing Team, Pachauri, R.K., Reisinger, A., Eds.; IPCC: Geneva, Switzerland, 2007; Available online: http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf (accessed on 18 March 2011).
2. Klein, R.J.T.; Schipper, E.L.F.; Dessai, S. Integrating mitigation and adaptation into climate and development policy: Three research questions. *Environ. Sci. Policy* **2005**, *8*, 579-588.
3. Tol, R.S.J. Adaptation and mitigation: Trade-offs in substance and methods. *Environ. Sci. Policy* **2005**, *8*, 572-578.
4. Kok, M.T.J.; de Coninck, H.C. Widening the scope of policies to address climate change: Directions for mainstreaming. *Environ. Sci. Policy* **2007**, *10*, 587-599.
5. Laukkonen, J.; Blanco, P.K.; Lenhart, J.; Keiner, M.; Cavric, B.; Kinuthia-Njenga, C. Combining climate change adaptation and mitigation measures at the local level. *Habitat Int.* **2009**, *33*, 287-292.
6. Srivastava, L. Climate protection for sustainable development or sustainable development for climate protection? A case study from India. *Glob. Environ. Change* **2006**, *16*, 120-122.
7. Locatelli, B. *Local, Global: Integrating Mitigation and Adaptation*; Perspective Forests/Climate Change No. 3; Cirad: Paris, France, 2010.
8. Stehr, N.; Storch, H.V. Introduction to papers on mitigation and adaptation strategies for climate change: Protecting nature from society or protecting society from nature? *Environ. Sci. Policy* **2005**, *8*, 537-540.
9. Pielke, R.J.; Prins, G.; Rayner, S.; Sarewitz, D. Lifting the taboo on adaptation. *Nature* **2007**, *445*, 597-598.
10. Dang, H.H.; Michaelowa, A.; Tuan, D.D. Synergy of adaptation and mitigation strategies in the context of sustainable development: The case of Vietnam. *Climate Policy* **2003**, *3*, S81-S96.
11. Ravindranath, N.H. Mitigation and adaptation synergy in forest sector. *Mitigat. Adapt. Strat. Global Change* **2007**, *12*, 843-853.
12. Parry, M.; Lowe, J.; Hanson, C. Overshoot, adapt and recover. *Nature* **2009**, *458*, 1102-1103.
13. Bernstein, L.; Bosch, P.; Canziani, O.; Chen, Z.; Christ, R.; Davidson, O.; Hare, W.; Huq, S.; Karoly, D.; Kattsov, V.; *et al. Synthesis Report*; Intergovernmental Panel on Climate Change: Cambridge, UK, 2007; p. 52.
14. McKibbin, W.J.; Wilcoxen, P.J. *Climate Policy and Uncertainty: The Roles of Adaptation* Versus *Mitigation*; Economics and Environment Network Working Paper EEN0306; The Brookings Institution: Washington, DC, USA, 2004.
15. Swart, R.; Raes, F. Making integration of adaptation and mitigation work: Mainstreaming into sustainable development policies? *Climate Policy* **2007**, *7*, 288-303.
16. Wilbanks, T.J. Issues in developing a capacity for integrated analysis of mitigation and adaptation. *Environ. Sci. Policy* **2005**, *8*, 541-547.
17. Watson, R.T.; Noble, I.R.; Bolin, B.; Ravindranath, N.H.; Verardo, D.J.; Dokken, D.J. *IPCC Special Report on Land-Use, Land-Use Change and Forestry*; Cambridge University Press: Cambridge, UK, 2000.

18. Stern, S.N. *The Economics of Climate Change*; Cambridge University: Cambridge, UK, 2006; p. 27.
19. UNFCCC. CDM Project Search. UNFCCC: Bonn, Germany, 2010; Available online: http://cdm.unfccc.int/Projects/projsearch.html (accessed on 28 February 2011).
20. Angelsen, A. *Moving Ahead with REDD: Issues, Options, and Implications*; CIFOR: Bogor, Indonesia, 2008; p. 172.
21. Turner, W.R.; Oppenheimer, M.; Wilcove, D.S. A force to fight global warming. *Nature* **2009**, *428*, 278-279.
22. Peskett, L.; Brown, D.; Luttrell, C. *Can Payments for Avoided Deforestation to Tackle Climate Change also Benefit the Poor?* Forestry Briefing 12; Overseas Development Institute: London, UK, 2006.
23. *Convenient Solutions to an Inconvenient Truth: Ecosystem-Based Approaches to Climate Change*; The World Bank: Washington, DC, USA, 2009; p. 91.
24. Phelps, J.; Guerrero, M.C.; Dalabajan, D.A.; Young, B.; Webb, E.L. What makes a 'REDD' country? *Global Environ. Change* **2010**, *20*, 322-332.
25. Angelsen, A.; Brockhaus, M.; Kanninen, M.; Sills, E.; Sunderlin, W.D.; Wertz-Kanounnikoff, S. *Realising REDD+: National Strategy and Policy Options*; Center for International Forestry Research (CIFOR): Bogor, Indonesia, 2009; p. 390.
26. *CIFOR REDD+ Database*; CIFOR: Bogor, Indonesia, 2010; Available online: http://www.forestsclimatechange.org (accessed on 30 October 2010).
27. CCB Projects. The Climate, Community & Biodiversity Alliance: Arlington, VA, USA, 2011; Available online: http://www.climate-standards.org/projects/ (accessed on 28 February 2011).
28. Locatelli, B.; Kanninen, M.; Brockhaus, M.; Colfer, C.J.P.; Murdiyarso, D.; Santoso, H. *Facing an Uncertain Future: How Forest and People can Adapt to Climate Change*; CIFOR: Bogor, Indonesia, 2008; p. 86.
29. Vignola, R.; Locatelli, B.; Martinez, C.; Imbach, P. Ecosystem-based adaptation to climate change: What role for policy-makers, society and scientists? *Mitigat. Adapt. Strat. Global Change* **2009**, *14*, 691-696.
30. Fisher, M.; Chaudhury, M.; McCusker, B. Do forests help rural households adapt to climate variability? Evidence from Southern Malawi. *World Dev.* **2010**, *38*, 1241-1250.
31. *CBD Connecting Biodiversity and Climate Change Mitigation and Adaptation: Report of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change*; Secretariat of the Convention on Biological Diversity: Montreal, Canada, 2009; p. 126.
32. Pramova, E.; Locatelli, B.; Brockhaus, M.; Fohlmeister, S. Ecosystem-based Adaptation in the National Adaptation Programmes of Action (NAPAs). Presented at the *National Climate Change Adaptation Research Facility (NCCARF) 2010 Climate Adaptation Futures Conference*, Gold Coast, Australia, 29 June–1 July 2010.
33. Colls, A.; Ash, N.; Ikkala, N. *Ecosystem-based Adaptation: A Natural Response to Climate Change*; IUCN: Gland, Switzerland, 2009; p. 16.
34. Adaptation fund proposal for honduras. In the *Proceedings of Adaptation Fund Board, Project and Programme Review Committee Second Meeting*, Bonn, Germany, 15 September 2010; p. 41.

35. Malhi, Y.; Roberts, J.T.; Betts, R.A.; Killeen, T.J.; Li, W.; Nobre, C.A. Climate change, deforestation, and the fate of the Amazon. *Science* **2008**, *319*, 169-172.
36. Noss, R.F. Beyond Kyoto: Forest management in a time of rapid climate change. *Conserv. Boil.* **2001**, *15*, 578-590.
37. Guariguata, M.R.; Cornelius, J.P.; Locatelli, B.; Forner, C.; Sánchez-Azofeifa, G.A. Mitigation needs adaptation: Tropical forestry and climate change. *Mitigat. Adapt. Strat. Global Change* **2008**, *13*, 793-808.
38. Reyer, C.; Guericke, M.; Ibisch, P.L. Climate change mitigation via afforestation, reforestation and deforestation avoidance: And what about adaptation to environmental change? *New Forests* **2009**, *38*, 15-34.
39. Goulden, M.; Naess, L.O.; Vincent, K.; Adger, W.N. Accessing diversification, networks and traditional resource management as adaptations to climate extremes. In *Adapting to Climate Change: Thresholds, Values, Governance*; Adger, W.N., Lorenzoni, I., O'Brien, K.L., Eds.; University of Cambridge: Cambridge, UK, 2009; pp. 448-463.
40. Chhatre, A.; Agrawal, A. Trade-offs and synergies between carbon storage and livelihood benefits from forest commons. *Proc. Natl. Acad. Sci. USA* **2009**, *106*, 17667-17670.
41. Cowie, A.; Schneider, U.A.; Montanarella, L. Potential synergies between existing multilateral environmental agreements in the implementation of land use, land-use change and forestry activities. *Environ. Sci. Policy* **2007**, *10*, 335-352.
42. Zomer, R.; Trabucco, A.; van Straaten, O.; Bossio, D. *Carbon, Land and Water: A Global Analysis of the Hydrologic Dimensions of Climate Change Mitigation through Afforestation/Reforestation*; IWMI Research Report 101; International Water Management Institute: Colombo, Sri Lanka, 2006; p. 44.
43. Murdiyarso, D.; Robledo, C.; Brown, S.; Coto, O.; Drexhage, J.; Forner, C.; Kanninen, M.; Lipper, L.; North, N.; Rondón, M. Linkages between mitigation and adaptation in land-use change and forestry activities. In *Tropical Forests and Adaptation to Climate Change: in Search of Synergies*; Robledo, C., Kanninen, M., Pedroni, L., Eds.; CIFOR: Bogor, Indonesia, 2005; pp. 122-153.
44. Lawlor, K.; Olander, L.P.; Weinthal, E. *Sustaining Livelihoods While Reducing Emissions from Deforestation: Options for Policy Makers*; Working Paper NI WP 09-02; Nicholas Institute for Environmental Policy Solutions, Duke University: Durham, NC, USA, 2009.
45. May, P.H.; Boyd, E.; Veiga, F.; Chang, M. *Local Sustainable Development Effects of Forest Carbon Projects in Brazil and Bolivia: A View from the Field*; IIED: London, UK, 2004.
46. Nelson, K.C.; de Jong, B.H.J. Making global initiatives local realities: Carbon mitigation projects in Chiapas, Mexico. *Global Environ. Change* **2003**, *13*, 19-30.
47. Tipper, R. Helping Indigenous farmers to participate in the international market for carbon services: The case of Scolel Te. In *Selling Forest Environmental Services: Market based Mechanisms for Conservation and Development*; Pagiola, S., Bishop, J., Landell-Mills, N., Eds.; Earthscan: London, UK, 2002; pp. 223-234.
48. Smith, J.; Scherr, S.J. Capturing the value of forest carbon for local livelihoods. *World Dev.* **2003**, *31*, 2143-2160.

49. Viana, V.M. *Sustainable Development in Practice: Lessons Learned from Amazonas*; Environmental Governance No. 3; International Institute for Environment and Development: London, UK, 2010; p. 60.
50. *The Juma REDD Project*; Amazonas Sustainable Foundation: Manaus, Brazil, 2008; Available online: http://www.fas-amazonas.org/en/secao/juma-redd-project/juma-redd-project (accessed on 9 March 2011).
51. Viana, V.M. Bolsa Floresta: Um instrumento inovador para a promoção da saúde em comunidades tradicionais na Amazônia. *Estudos Avançados* **2008**, *22*, 143-153.
52. Locatelli, B.; Imbach, P. Synergies and trade-offs between local and global ecosystem services in Costa Rica. In the *Proceedings of the Second DIVERSITAS Open Science Conference*, Cape Town, South Africa, 13–16 October 2009.
53. República de Colombia. *Segunda Comunicación Nacional ante la Convención Marco de las Naciones Unidas sobre Cambio Climático*; Sistema de Información Ambiental de Colombia, Ideam: Bogotá, Colombia, 2010.
54. Andrade Pérez, Á.; Medina Muñoz, M.M.; Shutze Páez, K.; Triana, J.V. Ecosystem-based adaptation: Lessons from the Chingaza Massif in the high mountain ecosystem of Colombia. In *Building Resilience to Climate Change: Ecosystem-based Adaptation and Lessons from the Field*; Andrade Pérez, Á., Herrera Fernández, B., Cazzolla Gatti, R., Eds.; IUCN: Gland, Switzerland, 2010; pp. 20-31.
55. Halpin, P.N.; Secrett, C.M. Potential impacts of climate change on forest protection in the humid tropics: A case study in Costa Rica. In *Impacts of Climate Change on Ecosystems and Species: Terrestrial Ecosystems*; Pernetta, J.C., Leemans, R., Elder, D., Humphrey, S., Eds.; IUCN: Gland, Switzerland, 1995; pp. 1-21.
56. Verchot, L.V.; Mackensen, J.; Kandji, S.; Noordwijk, M.V.; Tomich, T.; Ong, C.; Albrecht, A.; Bantilan, C.; Anupama, K.V.; Palm, C. Opportunities for linking adaptation and mitigation in agroforestry systems. In *Tropical Forests and Adaptation to Climate Change: In Search of Synergies*; Robledo, C., Kanninen, M., Pedroni, L., Eds.; CIFOR: Bogor, Indonesia, 2005; pp. 103-121.
57. Government of Mexico (GOM). *National Climate Change Strategy (Estrategia Nacional de Cambio Climático, ENACC)*; Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT): Mexico D.F., Mexico, 2007.
58. Government of Mexico (GOM). *Mexico's Fourth National Communication to the UNFCCC*; Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT): Mexico D.F., Mexico, 2009.
59. Government of Mexico (GOM). *Special Climate Change Program 2009–2012 (PECC)*; Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT): Mexico D.F., Mexico, 2009.
60. SEMARNAT; CONANP *Estrategia de cambio climático para áreas protegidas (ECCAP)*; SEMARNAT (Secretaria de Medio Ambiente y Recursos Naturales), CONANP (Comisión Nacional de Areas Naturales Protegidas): Mexico D.F., Mexico, 2010; p. 41.
61. Angelsen, A.; Kaimowitz, D. Rethinking the causes of deforestation: Lessons from economic models. *World Bank Res. Obs.* **1999**, *14*, 73-98.

62. Araujo, C.; Bonjean, C.A.; Combes, J.L.; Combes Motel, P.; Reis, E.J. Property rights and deforestation in the Brazilian Amazon. *Ecol. Econ.* **2009**, *68*, 2461-2468.
63. Adger, W.N. Vulnerability. *Global Environ. Change* **2006**, *16*, 268-281.
64. Corbera, E.; Brown, K. Building institutions to trade ecosystem services: Marketing forest carbon in Mexico. *World Dev.* **2008**, *36*, 1956-1979.
65. Corbera, E.; Gonzalez-Soberanis, C.; Brown, K. Institutional dimensions of payments for ecosystem services: An analysis of Mexico's carbon forestry programme. *Ecol. Econ.* **2009**, *68*, 743-761.
66. UNFCCC. Nicaragua on behalf of Guatemala, Dominican Republic, Honduras, Panama and Nicaragua. Adaptation—Proposal on the long-term agreement within the framework of the Bali Action Plan. In the *Proceedings of Ad hoc Working Group on Long-Term Cooperative Action under the Convention*, Sixth session, Bonn, Germany, 1–12 June 2009.
67. Sell, J.; Koellner, T.; Weber, O.; Pedroni, L.; Scholz, R.W. Decision criteria of European and Latin American market actors for tropical forestry projects providing environmental services. *Ecol. Econ.* **2006**, *58*, 17-36.
68. Cunningham Kain, M. Indigenous peoples and forests. Presented at the *International Expert Group Meeting*, New York, NY, USA, 12–14 January 2011.
69. Galloway McLean, K.; Ramos-Castillo, A.; Gross, T.; Johnston, S.; Vierros, M.; Noa, R. *Report of the Indigenous Peoples' Global Summit on Climate Change: 20–24 April 2009, Anchorage, Alaska*; United Nations University, Traditional Knowledge Initiative: Darwin, Australia, 2009.
70. Naidoo, R.; Balmford, A.; Costanza, R.; Fisher, B.; Green, R.E.; Lehner, B.; Malcolm, T.R.; Ricketts, T.H. Global mapping of ecosystem services and conservation priorities. *Proc. Natl. Acad. Sci. USA* **2008**, *105*, 9495-9500.
71. CGIAR *Forests, Trees and Agroforestry: Livelihoods, Landscapes and Governance. CGIAR Research Program 6 Proposal*; CIFOR, ICRAF, Bioversity, CIAT: Bogor, Indonesia, 2011; p. 338; Available online: http://www.cifor.cgiar.org/crp6/ (accessed on 9 March 2011).