Este artículo presenta las investigaciones más recientes sobre el papel de los bosques en el cambio climático. Comenzamos con una revisión de los recursos forestales mundiales. A continuación se discute el carbono almacenado en los bosques y la dinámica global, que muestra que América del Sur representa el 28,76% del total de carbono almacenado en el mundo, con un total de 187.653 millones de toneladas (Mt). Entren 1990 y 2010, 20.201 millones de toneladas de carbono se han perdido, lo que reduce el carbono almacenado de 672.571 a 652.371 millones de toneladas. América del Sur sufrió la mayor pérdida neta de superficie forestal en 4.213 millones de hectáreas (Mha) por año entre 1990 y 2000, y 3.997 millones de hectáreas anuales entre 2000 y 2010 y, en consecuencia, elevaciones significativas de las emisiones de CO$_2$. Estos resultados demuestran el importante papel de los bosques en el contexto del cambio climático, ya sea como vectores o víctimas del problema. Como vectores, los bosques contribuyen al calentamiento global debido a la deforestación, la quema, la descomposición y las emisiones de los suelos. Como víctimas, los bosques tienen que adaptarse a un mundo de cambio climático agraviado por el calentamiento global. Sin embargo, los bosques pueden ser la mejor solución para enfrentar el calentamiento global. La conservación de los bosques evita las emisiones de gases de efecto invernadero. La reforestación permite la eliminación de CO$_2$ de la atmósfera mediante la fotosíntesis. El uso de madera como un sustituto de otras materias primas reduce las emisiones y el carbono en los productos finales. Concluimos con una reseña de las negociaciones internacionales sobre el cambio climático mundial y la inclusión de los bosques en este contexto.

**Palabras clave**: Secuestro carbono; Emisión carbono; Almacenaje y almacenamiento de carbono.

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1. INTRODUCCION

The phenomenon known as climate change is now recognized by most people as a significant threat to planet Earth and to human existence. Until recently, this concern was merely a scientific hypothesis and few believed it would become one of the main challenges for governments, for the scientific community and for society in general.

Scientific studies show that the planet is undergoing a heating process. Since the first International Conference on Climate in 1979, several international discussions on the subject have concurred, reaching the same conclusion that global warming has been accelerated by human activities. In 1988 the Intergovernmental Panel on Climate Change (IPCC) was created, a body whose aim is to study and disseminate technical findings on climate change.

After several international meetings among world nations in 1997, the Kyoto Protocol was signed, and signatory nations agreed to a target of 5.2% overall reduction in emissions below 1990 levels, during the period between 2008 and 2012. The latest report released by the IPCC (2007) warns of an increase in average global temperatures between 1.8°C and 4.0 °C by 2100. This increase may be even greater (6.4 °C) if the population and economy continue their rapid growth and current levels of intensive fossil fuel consumption are maintained. However, the most reliable estimate predicts an average increase of 3 °C, assuming that carbon dioxide levels will stabilize at 45% above the current level. It further points out, with more than 90% reliability, that most of the temperature increase observed in the last 50 years has been caused by human activities (Ávila, 2007).

The second largest source of emissions of greenhouse gases according to the IPCC (2007) is derived from land use changes, second only to the use of fossil fuels. Also according to the fourth report of the IPCC (2007), carbon emissions associated with land use change were 1.6 Gt/yr during the 1990's. The section of land use change of the same report states that deforestation contributes 20% of total global greenhouse gas emissions.

2. FORESTOS OF THE WORLD

The loss of global forests, though it has slowed since the last publication of the FAO/FRA (2010), with observations since 1946, is still of great concern for many countries. According to FAO (2011), in the year 2010 there were 4,032 million hectares of natural forests in the world, or about 30% of the total land area and 264 million hectares of planted forests.

2.1. Natural Forests

According to the FAO (2011), Europe has 24.4% of the world’s natural forests (1,005 million hectares), and of these, 80.5% are located in the Russian Federation (809.09 million hectares).

These are followed by Latin America and the Caribbean, with 21.66% of the global natural forests or 890.78 million hectares. Of these, 97% are located in South America. The FAO (2009) points out that 57.48% of the total area of Latin America and the Caribbean is located in Brazil (512.104 million hectares), which places Brazil with a global percentage of 12.69%, making it the country with the largest area of tropical forests (FAO, 2011). The five countries with the largest area of natural forests from this region are: Brazil, Peru, Colombia, Bolivia and Venezuela, accounting for 84% of total forest area of the region.
The Asia Pacific region has 18.01% of the native forest areas of the world (74.383 million hectares) (FAO, 2011). Of these, the largest area is in East Asia, with 255 million hectares; then in Southeast Asia with 214 million hectares; Oceania with 191 million hectares; and South Asia with 80 million hectares. One can highlight the countries: China, Australia, Indonesia, India and Myanmar with 74% of natural forests of this region, with China and Australia accounting for almost 50%.

North America had 16.51% of natural forest areas in 2010 (678.96 million hectares), with 45.7% of these areas in Canada (310.134 million hectares) and 44.8% in the United States of America (304.022 million hectares).

Africa has 16.40% of the world’s natural forests at 674.419 million hectares, of which 37.78% are in Central Africa, 28.81% in Southern Africa and just over 10% in each of North Africa, West Africa and East Africa. The five countries with the largest forest area in Africa are: The Democratic Republic of Congo, Sudan, Angola, Zambia and Mozambique, which together represent more than half the forest area of the continent (55%). The Middle East has the smallest representation of global natural forests, at 2.97%, or 122.327 million hectares.

2.2. Planted Forests

With respect to planted forests, 44.05% are in Asia and the Pacific (119.884 million hectares) a 61.65% increase in planted area compared to the year 1990 (FAO, 2011). Most of these plantations were established in China, India and Vietnam. Next is Europe, with 25.47% of global planted area (69.318 million hectares). Following Europe is North America with 13.79% of planted forest (37.529 million hectares), of which 67.58% are in the United States, 23.88% in Canada, and 8.53% in Mexico.

Africa has 5.66% of global planted forests (15.409 million hectares), located mostly in North Africa. Sudan has by far the largest area with over 6 million hectares planted through government, private and community programs and South Africa has nearly 2 million hectares of planted forests (FAO, 2011). The Middle East has 5.54% of the world’s planted forests, or 15.082 million hectares.

Although Latin America and the Caribbean have only 5.49% of the areas of planted forests (14.952 million hectares), planted forest areas grew 37.43% between 2000 and 2010, and several countries, Brazil, Chile, Argentina, Uruguay and Peru recorded the largest increases in planted forest area in this period (FAO, 2011).

3. STOCKS AND DYNAMICS OF CARBON IN GLOBAL FORESTS

3.1. Carbon Stocks

The role of forests in mitigating and adapting to climate change is essential. Within this context, the Kyoto Protocol, in one of its flexible elements known as CDMs (Clean Development Mechanisms) permits Afforestation and Reforestation (A/R) projects in order for countries to achieve their reduction targets. Moreover, the possibility of including Emissions Reductions from Deforestation and Forest Degradation (REDD) has been discussed in the context of the Kyoto Protocol, although there is still no consensus on the latter.

The Intergovernmental Panel on Climate Change’s fourth report (IPCC, 2007) points out that global forest vegetation has 283 Gt of carbon in biomass, 38 Gt of dead wood, and 317 Gt in
soil and litter up to a depth of 30 cm. Thus, it is estimated that there are a total of 638 Gt of carbon in the world’s forest ecosystems, which exceeds the amount of carbon in the atmosphere. Clearly forests play an important role in the carbon cycle.

The FAO’s (2010) estimates of total biomass were based on information from 180 countries that reported forest carbon values, representing 94% of the world’s forests. In this estimate, 289 Gt carbon are found in forests, 72 Gt are found in dead wood and litter, and 292 Gt carbon are found in the soil. Thus, the estimated total stored carbon is 653 Gt, corresponding to approximately 161.8 tons/hectare. Further, carbon in forests represents 44.27% of the total; 11.02% of carbon is stored as dead wood, and 44.71% is stored in the soil and leaf litter. (Ravindranath and Ostwald, 2008).

According to FAO estimates (2010), South America accounts for 28.76% of the total carbon stored in forests, with an estimated total of 187,653 million tons of carbon (54.46% in the forests, 5.32% in dead wood and 40.22% in litter and soil). Next is Europe with 24.92% of the total carbon stored in forests (162,582 million tons of carbon), (27.68% in the forests, 12.70% in dead wood and litter and 59.62% in soil.) In third place is North and Central America, with 16.52% or 107,748 million tons of stored carbon (36.75% in the forest, 25.02% in dead wood and litter and 38.24% in soil). Next is Africa with 15.06% of total stored carbon with 98,242 million tons, (56.86% in the forest, 8.06% in dead wood, and 35.08% in soils.) Asia and the Pacific account for 11.41% of total stored carbon with 74,453 million tons (47.93% in forest, 4.61% in dead wood and litter, and 47.45% in soils.) Finally, Oceania has 3.33% of stored carbon with 21,692 million tons (48.31% in forest, 13.54% in dead wood and litter, and 38.15% in soils.)

3.2. Dynamics of Carbon Stocks

The total net change in forest area during the period between 1990 and 2000 is estimated at 8.327 million hectares per year, while during the period 2000 and 2010 this loss was reduced to 5.211 million hectares per year. Regionally, South America suffered the largest net loss in forest area at 4.213 million hectares per year between 1990 and 2000 and 3.997 million hectares per year between 2000 and 2010. Next was Africa, with 4.067 million hectares lost per year between 1990 and 2000 and 3.414 million hectares per year lost between 2000 and 2010. Europe showed a 0.877 million hectares per year forest reduction between 1990 and 2000 and a reduction of 0.676 million hectares per year for 2000-2010. However these global areas showed opposing trends: Asia went from losing 0.595 million hectares per year (1990-2000) to losing 2.235 million hectares per year between 2000-2010, and Oceania’s losses increased as well going from 0.041 million hectares lost in the years (1990-2000) to 0.700 million hectares lost per year between 2000-2010 (FAO, 2010).

Of the average historical loss of global carbon (1,010 million tons of carbon per year), 520.15 million tons corresponded to carbon stored as biomass while 438.15 million tons were from soils, 58.2 million tons were from dead wood and 6.45 million tons were from litter (FAO, 2010).

In the period between 1990-2000, according to FAO (2010), the ten countries that had the highest annual net forest loss were: Brazil (2.89 million hectares per year), Indonesia (1.914 million hectares per year), Sudan (0.589 million hectares per year), Myanmar (0.435 million hectares per year), Nigeria (0.410 million hectares per year), Tanzania (0.403 million hectares per year), Mexico (0.354 million hectares per year), Zimbabwe (0.327 million hectares per year), Democratic Republic of Congo (0.311 million hectares per year), and Argentina (0.293 million hectares per year). As for the period between 2000 and 2010, according to FAO (2010), the top ten countries in terms of forest loss were: Brazil (2.642 million hectares per year), Australia (0.562 million hectares per year), Indonesia (0.498 million hectares per year), Nigeria (0.410 million hectares per year), Tanzania (0.403 million hectares per year), Zimbabwe (0.327
million hectares per year), Democratic Republic of Congo (0.311 million hectares per year), Myanmar (0.310 million hectares per year), Bolivia (0.290 million hectares per year), and Venezuela (0.288 million hectares per year).

Between the years 1990 and 2010, 20,201 tons of carbon were lost (FAO, 2010), reducing to 672,571 tons of stored carbon to 652,371 million tons. In other words, the average historical loss of global carbon was 1,010 million tons of carbon per year. Although numbers are high, when considering each period separately, we find that the losses continued to decline during each period, with 1,173 million tons of stored carbon per year between 1990 and 2000, 902 million tons of stored carbon per year between 2000 and 2005 and 790 million tons of stored carbon per year between 2005 and 2010. On average, the annual deforestation rate worldwide fell from 0.20% for the period between 1990 and 2000 to 0.13% between 2000 and 2010.

4. FORESTS AS DRIVERS OF CLIMATE CHANGE

4.1. Natural emissions

Although they have mechanisms to capture and store carbon in the atmosphere, forests are part of a cycle, which also includes carbon. Each time a tree dies, whether by disease, old age, competition with other species or by being brought down in a storm, the process of decomposition begins, with subsequent release of CO₂ and NH₄ into the atmosphere.

Another source of emissions of greenhouse gases is when forests are burned. Fire can occur naturally, caused, in general, by long periods of drought, though one should bear in mind that the release of CO₂ from burned wood is much faster than natural decomposition.

The soil is also part of the forest ecosystem and can be accounted for as a source of carbon emissions, not just as a stock. According Algelsen et al. (2010), the products of photosynthesis are distributed by the plant and move into the litter and soil when the branches and leaves fall and decompose. Conditions favoring the decomposition of soil organic matter contained in this release will provide the stock for the atmosphere, which is called soil respiration.

4.2. Anthropogenic Emissions

According to the fourth IPCC report (2007), the concentration of carbon dioxide, methane and nitrous oxide in the global atmosphere has increased markedly as a result of human activities since 1750, and the overall concentration of carbon dioxide has increased since pre-industrial history, which was around 280 ppm but rose to 379 ppm by 2005.

The use of fossil fuel continues to be the main source of increase in the concentration of carbon dioxide in the atmosphere, according to the fourth IPCC report (2007). The second largest source is land use change. This report highlights that carbon emissions associated with the change of land use was 1.6 gigatons per year during the 1990s. Clearly one needs to take into account that not all of these emissions are due to deforestation, and the total includes, for example, decomposition of biomass resulting from logging and deforestation, decay of peat and peat burning. However, when considering some tropical countries such as Brazil, deforestation accounts for 75% of total emissions.

In the third IPCC report (2001), the global flow of CO₂ for change in land use was calculated based on a study carried out by Houghton (1999), which estimated emissions at 1.7 (0.6 to 2.5) GtC/yr for the 1980s, and in the fourth report of the studies used data from Houghton (2003).
Sanquetta, et al.: The role of forests in climate change.

Achard et al. (2004) and DeFries et al. (2002) to make estimates of emissions from changes in land use for the different regions. The results were GtC/yr, 0.7 in America, and Africa 0.3, and Asia 0.8.

Overall it was concluded in the fourth report that deforestation contributes 20% of total global emissions of greenhouse gases. However, Van der Werf et al. (2009) cited in FAO (2011) conducted another analysis using the same methods, but with updated estimates on carbon emissions. The results showed that the contribution of CO₂ emissions from deforestation and forest degradation was substantially lower, about 12%. The differing results occurred because the FAO reduced its estimate of the rates of deforestation and forest degradation after the IPCC report had already been written. In addition, an updated estimate of deforestation data by remote sensing, derived from changes in the density of trees covering the humid tropics during the period 2000-2005, suggested that the rates were similar to those of the previous decade, resulting in even lower estimates than those reported in the survey by FAO.

In 2010, Annex B Parties under the Kyoto Protocol submitted their data on the annual emission of greenhouse gases for the years 2008 to the UNFCCC. Of the countries reporting their emissions, Australia showed the highest emissions of CO₂ from deforestation (49,651 tons). Russia ranked second in emissions from deforestation (26,607 tons). However, their reforestation and forest management provide the highest uptake of carbon from the atmosphere (466,562 Gt CO₂ equivalent) of the countries included in the list, while France ranked second at 98,211 Gt of CO₂ in 2008 (FAO, 2011).

Countries such as Belgium, Bulgaria, Australia, Canada, Estonia, Denmark, Ireland and the Netherlands showed net positive emissions, with more carbon being emitted than absorbed, since the emissions from deforestation were higher than the uptake by reforestation and management (UNFCCC, 2010, cited in FAO, 2011).

Countries such as Austria, Czech Republic, Finland, France, Germany, Greece, Hungary, Iceland, Italy, Japan, Latvia, Liechtenstein, New Zealand, Norway, Poland, Portugal, Russia, Slovakia, Slovenia, Spain, Switzerland, Sweden, UK and Ukraine had a negative bottom line, with more carbon capture, indicating that their afforestation, reforestation and management absorb more carbon than was emitted by deforestation. Belarus, Croatia, Lithuania, Luxembourg, Romania and Turkey did not report their emissions for the LULUCF sector (UNFCCC, 2010, cited in FAO, 2011).

5. FORESTS AS VICTIMS OF CLIMATE CHANGE

One can cite numerous examples of the impacts suffered by forests due to changes in the global climate. The examples cited in this study are from the IPCC's fourth assessment of climate change on the planet. The IPCC has gathered and analyzed studies conducted worldwide on the responses of natural systems to these changes.

When considering forestry studies such as Nabuurs et al. (2002) cited in IPCC (2007) it appears there was an increase in atmospheric CO₂ many regions of the world. The increase the longest period of growth due to warming and nitrogen deposition resulted in an increase in storage capacity annual CO₂ in forests in recent decades, leading to greater net absorption of carbon.

Estimates of global net primary production from satellite data of vegetation indexes showed an increase of 6% between 1982 and 1999, with large increases seen in tropical ecosystems (NEMAN et al., 2003 cited in IPCC, 2007). The study by Zhou et al. (2003), also reported in the IPCC report, using satellite data, has confirmed that the Northern Hemisphere vegetation activity increased by 12% in Eurasia and 8% in North America between 1981 and 1999.
Analyses in China attribute the increase in net primary productivity, in part, to a longer growing season in China. Similarly, other studies have shown a decrease of 10 days in the period of frost in northern China (Chen and Schwartz, 2002; Dingbo and Fang, 2003 cited in IPCC, 2007).

But in southern Europe, a declining trend in biomass production was discovered due to a reduction in precipitation (Maselli, 2004 cited in IPCC, 2007), especially after the severe drought of 2003 (Gobronet et al. 2005, Wolf and Maisongrande, 2006 cited in IPCC, 2007).

For North America, recent observations from satellite imagery (1982 to 2003) document a decline in production of a substantial portion of the forest, possibly related to hotter summers and longer winters. (Goetz et al., 2005 cited in IPCC, 2007).

Global warming may also increase the area of occurrence of some harmful insects, as observed during the last 20 years for beetles in the USA (Williams and Liebhold, 2002 cited in IPCC, 2007) and pine moths in Europe (Battisti et al. 2005 cited in IPCC, 2007).

Another important impact on the forests caused by global climate change is the risk of fire. The increase in fires in England and Wales between 1965 and 1998, according to Cannell et al. (1999), cited in the IPCC report (2007), can be attributed to warmer and drier summers. Large forest fires have become more numerous during the hot season in recent years in the Mediterranean and North Africa, as well as California, and have also been linked to episodes of drought.

The reproduction of plants can also be altered by changes in weather patterns. Network studies show that the production of leaves and flowering in the spring and summer have advanced an average of 1-3 days per decade in Europe, North America and Japan in the last 50 years. The early flowering implies an earlier onset of the pollen season, which has great influence on reproduction (IPCC, 2007).

In addition, Parmesan and Yohe (2003), also cited in the fourth IPCC report (2007), claim that there were changes in species distribution in a wide range of taxonomic groups and geographical locations during the 20th century. The authors also point out that there was an increase in the area of occurrence of various species, and that this fact was probably due to increased temperature.

In northwestern Europe, for example, the Netherlands' and Norway's central thermophilic species were significantly more prevalent compared with 30 years ago. In contrast, there was a slight decrease in the presence of traditionally cold-tolerant species (Tamis et al. 2001; EEA, 2004 cited in IPCC, 2007).

In many mountainous regions in the Northern Hemisphere, displacement of tree species to higher elevations has occurred during the 20th century, such as in Bulgaria, in the mountains of Scandinavia and in Alaska (Meshinev et al., 2000, Kullman, 2002; Sturm et al., 2001 cited in IPCC, 2007).

The dispersion of exotic plants in Spain, Ireland and Switzerland has also been observed (Pilcher and Hall, 2001; Sobrino et al., 2001). The rise in CO₂ concentration can also contribute to the spread of weeds (Hattenschwiler and Korner, 2003 cited in IPCC, 2007).

The direct effects of CO₂ on photosynthesis, as well as faster cycling rates (forest turnover rates) in the Amazon rainforest, may have resulted in a substantial increase in the density of lianas in the forest over the past two decades (Phillips et al., 2004 cited in IPCC, 2007).
6. FORESTS AS SOLUTION TO CLIMATE CHANGE

In the process of photosynthesis, trees absorb CO₂ from the air and in the presence of light, water and nutrients, produce carbohydrates that are used in metabolism and growth of plant organs above and below ground (Malmsheimer et al., 2008).

The concept of carbon sequestration has been enshrined in the Kyoto Conference in 1997 in order to contain and reverse the buildup of CO₂ in the atmosphere and thereby reduce the greenhouse effect. In principle, carbon sequestration applies to the preservation of forest areas at risk of being destroyed, the recovery of degraded forests, and the establishment of new forest plantations, agroforestry systems of native or exotic species (Yu, 2002). Thus, forests represent a solution to the problem of global warming, the only proven way to remove carbon dioxide from the atmosphere. The effects are real, measurable and long-term, within the principles advocated by the Framework Convention and the Kyoto Protocol.

The role of forests in climate change may play out in different ways, among which we can highlight: the conservation of carbon stocks and the consequent avoidance of emissions from deforestation and forest fires; forest management, which calls for rational use of forest and continuous carbon fixation stimulated by interventions that open living space; the reforestation of degraded areas that have lost their carbon; the use of wood instead of other non-renewable materials; and more intense emission of carbon and energy use of wood in replacing fossil fuels.

Thus there are different strategies to conserve and manage forest resources and to draw carbon into ecosystems, thus avoiding emissions and also removing the same carbon from the atmosphere, which contributes to combating global warming. The use of solid wood or wood in the form of processed and raw energy avoids the release of more carbon into the atmosphere by using sustainable materials.

According to Nutto et al. (2002), timber is a form of CO₂ storage in long-lasting products. For example, a house built using 50 m³ of timber, stores 12.5 t C, a value that corresponds to 45 tons of CO₂, which will be stored for hundreds of years.

Wood can replace the pattern of fossil fuel use, thus avoiding CO₂ emissions into the atmosphere without the subsequent sequestration. The wood being burned in the form of charcoal, pellets, briquettes, wood chips and other residues causes emissions of carbon dioxide, but because the forest is replanted, restored and managed, the sequestered carbon is returned, setting up a closed cycle for the element carbon.

The use of wood products to replace concrete, aluminum, steel and plastic can reduce the energy intensity of production, besides storing carbon in wood products themselves, although no CDM methodology currently exists to cover these possibilities of substitution of materials. Bio-energy is of particular interest in developing countries, where energy demand continues to grow and biomass is already a common source of fuel (UNDP, 2009).

Wood products from sustainably managed forests can be replenished continuously, providing a reliable supply of trees and wood products, and supporting ecosystem services such as clean water, clean air, habitat for wildlife and recreation (Malmsheimer, 2008).

In the fourth IPCC report, the agency recognizes the substitution of fossil fuels for biomass and the use of wood products in place of other materials as options for mitigating climate change (IPCC, 2007).

In 2007, the National Council for Air and Stream Improvement (NCASI) examined the global profile of the carbon from the forest product industry. The net sequestration in forest products in use and in landfills was estimated at the equivalent of 600 million tons of CO₂ equivalent per year. This sequestration is in approximate equilibrium with the direct and indirect emissions from forest products industries (775 million metric tons of CO₂ per year). In addition, 270 million tons of CO₂ equivalent per year are avoided through the use of biomass fuels, the
use of combined heating systems and energy, recycling paper and the effects of product substitution.

With regard to economic issues, according to Malmsheimer (2008), the use of biomass fuels and bio-based products can reduce imports of oil and gas. Biomass can replace fossil fuels like coal, natural gas, gasoline, diesel and fuel oil. At the same time, its use can improve the domestic economy by supporting the rural economy and fostering new bio-based industries.

The World Resources Institute published a document to help members of the forest products industry find new market opportunities created by climate change. According to the document, if the effects on existing business models are included, climate change may create new markets and products for industry, since forest resources can provide raw materials for forest products, credits for carbon sequestration, and raw materials to produce fuels and electricity. Thus, some plants can become forest biorefineries producing fuels, chemicals and electricity as well as wood products and paper (Ausili, Sauer and Wellington, 2008). The forest floor is another component that can store carbon that one day was present in the atmosphere. The existence of soil organic carbon, according to Caldeira et al. (2002), depends on the input of organic material through the senescence of certain components of biomass above and below ground, falling leaves and dead animals. Once deposited these residues initially undergo partial decomposition by mesofauna and later decaying action by microorganisms. Part of the carbon present in the residue is released into the atmosphere as carbon dioxide and the remainder becomes part of organic matter, as a component of the soil.

7. NEGOTIATIONS ON FORESTS UNDER CLIMATE CHANGE

7.1. Forests Under the Kyoto Protocol

According to Campos (2001), the gradual realization of the need to develop policies and international legal instruments on the issue of climate change led the UN General Assembly to establish, in its sessions of 1990, the Intergovernmental Negotiating Committee for Framework Convention on Climate Change (INC/FCCC). According to the Climate Convention (1995), more than 150 countries sent their representatives, who met for five meetings between February 1991 and May 1992. On May 9, 1992 the United Nations Framework Convention on Climate Change was adopted at the UN Headquarters - UNFCCC. In 1994 the Convention went into effect.

Since 1995, the parties have met to discuss the issue of climate change in the so-called Conference of Parties (COP), which are annual meetings whose purpose is to advance the negotiations on the issue of climate change and reducing emissions from the greenhouse effect. Table 1 shows the chronology of the COPs.

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<th>Table 1. Chronology of the Conference of Parties (COPs)</th>
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During COP 3, held in Kyoto in 1997, the Kyoto Protocol was created. This protocol stipulates that during the first commitment period (2008-2012) the countries belonging to Annex B should reduce their emissions at a level of at least 5.2% compared to emissions in the year 1990. The Kyoto Protocol went into effect on February 16, 2005, after achieving a minimum ratification in a political process with negotiations full of give and take.

In the Kyoto Protocol (COP-3), forests are treated in different ways. The first part of the process is reducing emissions of greenhouse gases from Annex B countries (mostly developed) while the second part of the process concerns the countries' development - called Non-Annex B – which is a proposition for afforestation and reforestation projects that can be implemented in these countries through a CDM (Clean Development Mechanism).

The subject of land use, land-use change and forestry (LULUCF) has always been the subject of intense debate during the negotiations of the Kyoto Protocol. Though it has always been included in the negotiations, LULUCF was only formally treated after the 2001 Marrakech Accords, at COP-7.

### 7.2. The COPs and Progress on Forests During Global Climate Negotiations

According to Rocha (2003), the Marrakesh Agreement (COP-7) defines the operational rules for the LULUCF flexibility mechanisms in the Kyoto Protocol. In this agreement, rules were established to limit the use of credits derived from forests and agriculture in the "carbon market".

According Corte (2005), it was decided during the Marrakech Accords that forest conservation activities would not be eligible in the carbon market. A meeting held in Bonn in 2001 established that only afforestation and reforestation (A/R) activities (the planting of trees and not the maintenance of native forests) would be eligible under CDM.

At COP-9 Milan, it was decided that the term “forest” refers to an area of at least 0.05 to 1.0 hectare, with canopy cover (or equivalent stocking level) of at least 10-30 percent, whose trees are capable of reaching a minimum height of 2-5 meters at maturity in situ. A forest may consist either of closed forest formations where trees of various strata and undergrowth cover most of the ground, or open woodlands. Young natural stands and all plantations that have yet to reach a crown density of 10-30 per cent or tree height of 2-5 meters are considered forests as well as areas that are typically part of a forest area that are temporarily destocked as a result of human intervention, thinning or natural causes but which are expected to revert back to forest. Additionally the term “afforestation” was adopted to describe human-induced conversion of an area unforested during a period of at least 50 years to a forested area through planting, seeding and/or human-induced promotion of natural sources of seed. Meanwhile the term reforestation concerns direct human-induced conversion of non-forested area to forested area through planting, seeding and/or promotion of natural seed sources induced by man, in an area that was forested but that was not converted to forested. For the first commitment period, reforestation activities will be limited to reforestation occurring on those areas that did not contain forest on 31 December 1989, as previously mentioned.

Another important issue discussed at COP-9 in Milan concerned the use of exotic species and genetically modified organisms in carbon projects. According to Krug (2004), the initial negotiations document on this point proposed to veto the use of these species or organisms in CDM. However, after heated debate this proposition was rejected, leaving that decision to the countries and their national laws.
7.3. REDD - Reduction of Emissions from Deforestation and Degradation

According to Angelsen (2008), although emissions of greenhouse gases from deforestation have not been considered in the Kyoto Protocol, there is currently a debate within the Convention of the UN Climate Change (UNFCCC - United Nations Framework Convention on Climate Change) about how to treat them in a post-2012 framework. REDD stands for Reducing Emissions from Deforestation and Forest Degradation. According to the concept adopted by the UN Climate Convention, the term refers to a mechanism enabling compensation of those parties who keep their forests standing, thus preventing emissions of greenhouse gases associated with deforestation and forest degradation. Since the advent of the acronym REDD, in COP13, initiatives (projects, programs and funds) and REDD preparation activities have accumulated. However, these initiatives and activities should be differentiated from REDD policy still under construction at the UN. After the drafting of this REDD concept, the Convention also included in its definition conservation activities, sustainable management of forests and increasing stocks in developing countries. These components gave rise to REDD+.

The proposal to compensate developing countries for Reducing Emissions of greenhouse gases from Deforestation and Forest Degradation or Reducing Emissions for Deforestation and Forest Degradation (REDD) was initially presented at COP-9 in 2003 by a group of entities (Santilli et al., 2005, Schwartzman and Moutinho, 2005 apud Nepstad, 2007). This proposal was formalized by Papua New Guinea, Costa Rica and other tropical nations during COP-11 held in Montreal in 2005 (and Silvachavez Petsonk, 2006; Schlamadinger et al. 2007; Skutsch et al. 2007; Sedjo Sohngen, 2007 apud Nepstad, 2007).

Finally, during COP-13 in Bali in December 2007 the so-called "Bali Road Map" was established, which includes determinations for a post-2012 climate agreement, the final year of the first commitment period of the Kyoto Protocol. This map also determines the beginning of a process of looking for mechanisms to address emissions from deforestation in developing countries. Brazil has endorsed reduction compensated (paid) emissions from deforestation by introducing positive incentives during the COP-12 held in Nairobi in 2006. Thus, a "tropical forest fund" would be created and maintained by voluntary contributions from developed countries. However, the Brazilian proposal did not include a market mechanism (trade in carbon credits from deforestation) to provide resources for the fund (Nepstad, 2007).

The REDD mechanism could create a dynamic world economy, regulated in a post-2012 international climate agreement, the year ending the first commitment period of Kyoto Protocol. The results obtained recently during the COP-15 and consolidated at the Copenhagen Accord point in this direction. Numerous financial funds aimed at enabling countries to monitor and control deforestation are being established and many are already in operation. Such funds will be fundamental to what initiatives are put into practice, and national REDD schemes could be set and regulated. The rapid advancement of discussions of REDD under the UNFCCC indicates that emissions from deforestation, not previously considered by the Kyoto Protocol, are now finding grounds for discussion by developed and developing nations and will be addressed especially in the next climate agreement. Apart from the UNFCCC, in developed countries like the U.S., policy discussions are rapidly evolving in the U.S. Congress to implement a national mechanism to limit emissions, and may find that REDD represents an opportunity to diminish the costs of reducing GHG emissions within their territories. Even so, alliances between states, such as the GCF, could create the means to remunerate parties for reducing emissions from deforestation (CGEE, IPAM, SAE, 2011).

In discussions at COP-16 in Cancun, Mexico, a few points about incentives for REDD+ were treated, but many definitions were left open. The Cancun agreement made clear the need to reduce, halt and reverse the loss of forest cover and carbon, according to national circumstances and dependent on the "adequate and predictable" support to developing countries.
Much of the framework of the REDD+ mechanism, which refers to reducing emissions from deforestation and degradation in developing countries and the role of conservation, sustainable management and enhancement of carbon stocks in forests, is described on pages 10 and 11 and in Annexes I and II of the draft text of the Ad Hoc Working Group on Long Term Cooperative Action.

Due to strong opposition from Bolivia, the text does not define whether the funding of REDD will be achieved through market mechanisms or not. The financing mechanisms, such as the carbon market, multilateral funds, and government will continue to be treated in future United Nations discussions.

Also mentioned in the text is another point that's been contentious over the course of negotiations regarding the mechanism of whether REDD+ should be accounted for on a national or subnational level.

The language calls for the establishment of national monitoring and reporting, arising from fears of leakage of emissions from individual projects to adjacent areas, but allows sub-national systems as an interim measure.

The text emphasizes the use of social and environmental safeguards, including the "full and effective participation of relevant stakeholders, inter alia, indigenous and local communities" and actions that are "consistent with the conservation of natural forests and biological diversity."

It is clear that developing countries should develop national strategies or action plans, which must include monitoring systems, security, a mechanism to deal with the drivers of deforestation and forest degradation, land issues, and governance, among others.

Developed countries have the responsibility to assist in the financing, training and technology development and demonstration activities in developing countries.

Overall, the text defines the framework of the REDD mechanism, but the details have yet to generate much discussion. In the future, we expect these issues to be treated more thoroughly both within the United Nations and in national strategies.

Countries around the world decided in 2010, during COP-16, held in Mexico, to create a "Green Climate Fund" in order to channel approximately U.S. $100 billion a year by 2020 to developing countries to help them cope with global climate change.

8. REFERENCES


