



Research Matters – Climate Change Governance

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1 SCIENTIFIC BASIS OF CLIMATE CHANGE

"Climate change in IPCC usage refers to any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the Framework Convention on Climate Change, where climate change refers to a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods". In figure 1 is shown the anthropogenic drivers, impacts of and responses to climate change, and their linkages (Source: IPCC, 2007).

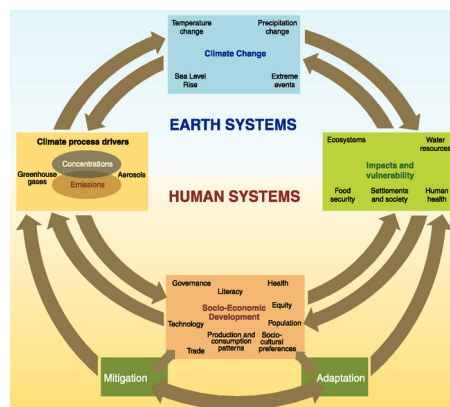


Figure 1. (Source: IPCC, 2007) The anthropogenic drivers, impacts of and responses to climate change, and their linkages.

1.1 Observations of climate change

As a result of human activities, since 18th century, the concentrations of carbon dioxide, methane and nitrous oxide increased gradually. These evidences were obtained studying ice cores. The main causes of global increase of carbon dioxide concentration were fossil fuel and land-use change. On the other hand, agriculture was the main source of concentration increase for methane and nitrous oxide. This increase of concentration for the mentioned gases created a greenhouse effect with climate warming consequences.

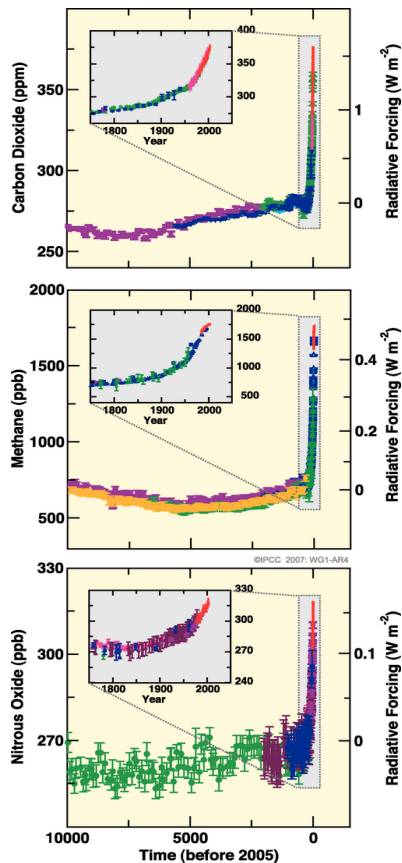


Figure 2. (Source: IPCC, 2007) The trend of carbon dioxide, methane and nitrous oxide concentrations over the last 10,000 years [Red lines – based on atmospheric samples; other colors – based on ice cores (different for each study)]

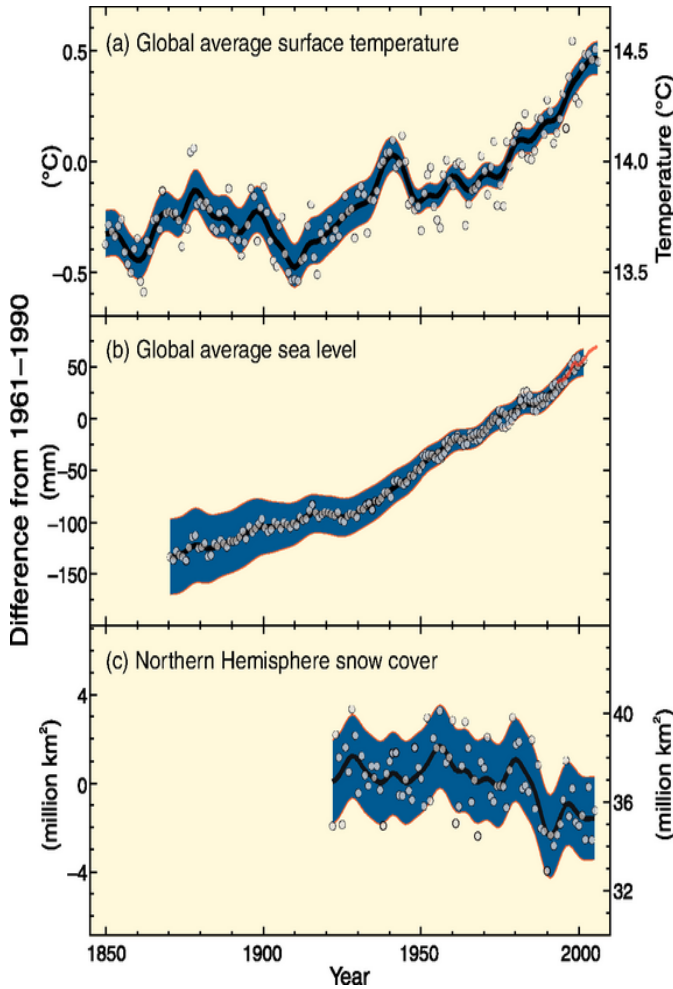


Figure 3. (source: IPCC, 2007) The changes in global average surface temperature (a), global average sea level (b) and Northern Hemisphere snow cover (c), between 1961 and 1990.

Carbon dioxide is the most important greenhouse gas. The concentration of carbon dioxide into the atmosphere increased from 280 ppm in the pre-industrial times to 379 ppm in 2005 (figure 2). Therefore the concentration of carbon dioxide increased about 35% by human activities especially industrialization. The global atmospheric concentration of methane has increased from 715 ppb in pre-industrial times to about

1774 ppb in 2005, which means an increase of 148%. Also, the global atmospheric nitrous oxide concentration increased from 270 ppb in pre-industrial times to 319 ppb in 2005. The growth rate remained constant since 1980. Many halocarbons (including hydrofluorocarbons) have increased from a near-zero pre-industrial background concentration, primarily due to human activities.

Warming of the climate is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, rising of sea level and melting of snow and ice. Moreover, eleven of the last twelve years (1995–2006) rank among the 12 warmest years in the last 150 years. The warming trend over the last 50 years is about 0.13°C per decade. The temperature increased from 1850 to 2005 by about 0.76°C.

Considering all observations made until this moment, it is extremely unlikely that global climate change over the last 50 years can be put on the basis of natural causes alone. It is very likely that there has been significant anthropogenic warming over the past 50 years. The observed patterns of warming, including greater warming over land than over the ocean, and their changes over time, are only simulated by models that include anthropogenic forcing. Also, the temperatures of the most extreme hot nights, cold nights and cold days are likely to have increased due to anthropogenic forcing.

The observed patterns of warming, including greater warming over land than over the ocean, and their changes over time, are simulated only by models that include anthropogenic forcing. No coupled global climate model that has used natural forcing only has reproduced the continental mean warming trends in individual continents (except Antarctica) over the second half of the 20th century (figure 4).

1.2 Observed effects of climate change

There is high confidence that natural systems related to snow, ice and frozen ground (including permafrost) are affected. Examples are:

- enlargement and increased numbers of glacial lakes
- increasing ground instability in permafrost regions and rock avalanches in mountain regions
- changes in some Arctic and Antarctic ecosystems, including those in sea-ice biomes, and predators at high levels of the food web.

Based on growing evidence, there is high confidence that the following effects on hydrological systems are occurring: increased runoff and earlier spring peak discharge in many glacier- and snow-fed rivers, and warming of lakes and rivers in many regions, with effects on thermal structure and water quality.

There is very high confidence, based on more evidence from a wider range of species, that recent warming is strongly affecting terrestrial biological systems, including such changes as earlier timing of spring events, such as leaf-unfolding, bird migration and egg-laying; and pole ward and upward shifts in ranges in plant and animal species. Based on satellite observations since the early 1980s, there is high confidence that there has been a trend in many regions towards earlier 'greening' of vegetation in the spring linked to longer thermal growing seasons due to recent warming.

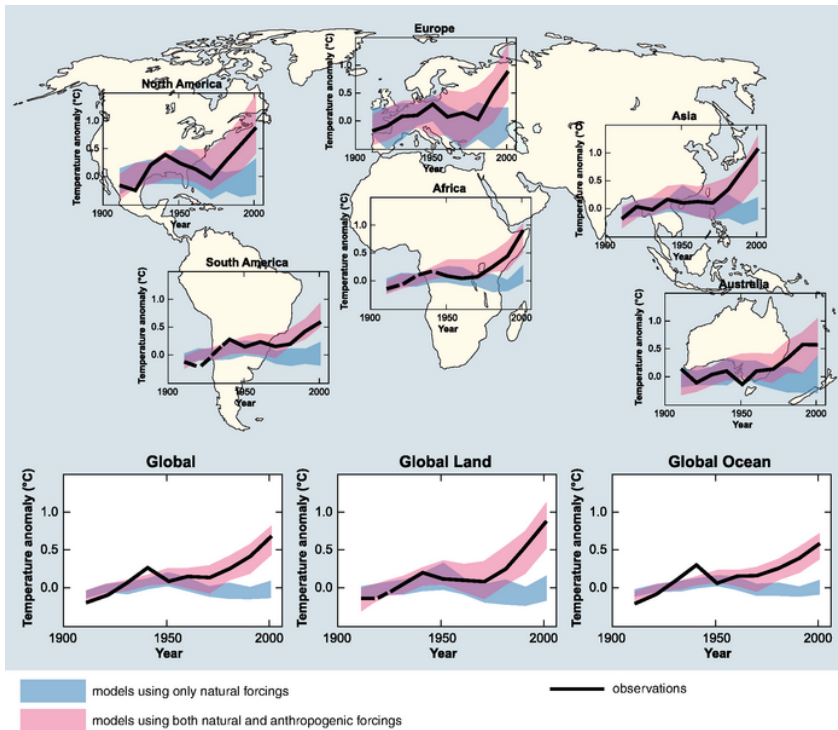


Figure 4. (Source: IPCC, 2007) Climate model predictions using only natural forcing (blue) and both natural and anthropogenic forcing (red), with the decadal averages of observations (black line, dashed lines where spatial coverage is less than 50%)

There is high confidence, based on substantial new evidence, that observed changes in marine and freshwater biological systems are associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels and circulation. These include: shifts in ranges and changes in algal, plankton and fish abundance in high-latitude oceans; increases in algal and zooplankton abundance in high-latitude and high-altitude lakes; and range changes and earlier fish migrations in rivers. While there is increasing evidence of climate change impacts on coral reefs, separating the impacts of climate-related stresses from other stresses (e.g. over-fishing and pollution) is difficult.

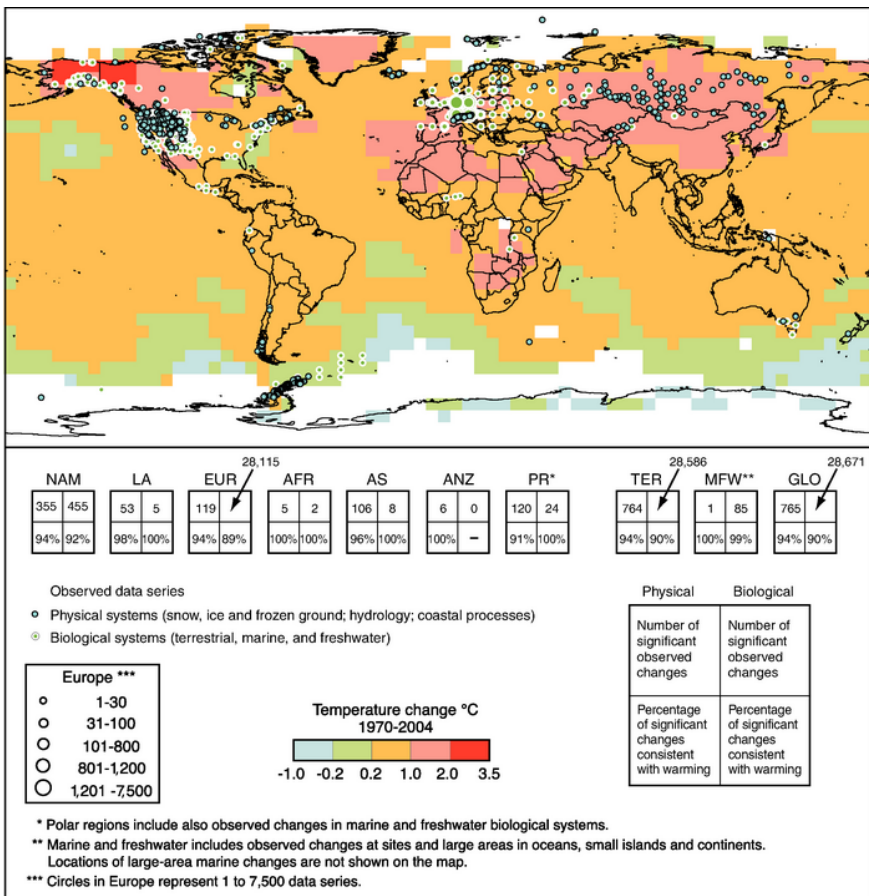


Figure 5. (Source: IPCC, 2007) Changes in physical and biological systems and surface temperature 1970-2004

1.3 Emission scenarios

For the next 20 years, the temperature is about to increase of about 0.2°C per decade. Even if the concentrations of all greenhouse gases and aerosols had been kept constant at year 2000 levels, a further warming of about 0.1°C per decade would be expected. Continued greenhouse gas emissions at or above current rates are going to cause further warming and induce many and more severe changes in the global climate system.

The IPCC Special Report on Emissions Scenarios (SRES, 2000) projects an increase of global GHG emissions by 25 to 90% (CO₂-eq) between 2000 and 2030 (Figure 6), with fossil fuels maintaining their dominant position in the global energy mix to 2030 and beyond. More recent scenarios without additional emissions mitigation are comparable in range.

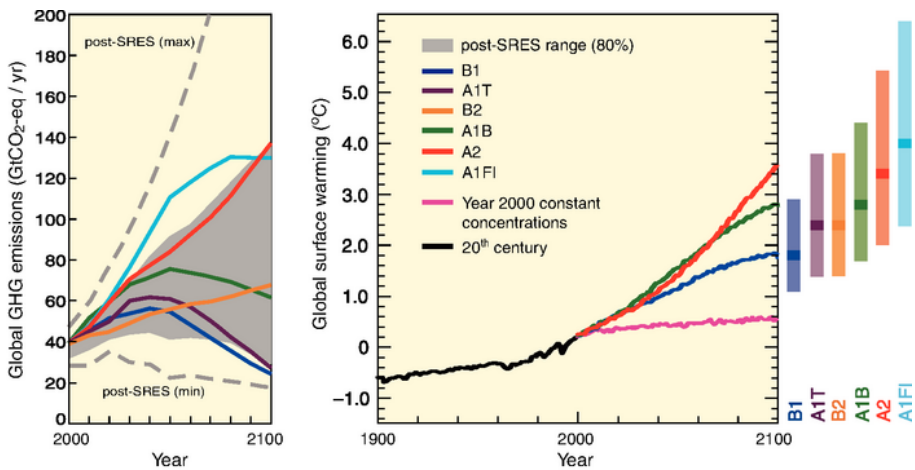


Figure 6. Source: (IPCC, 2007) Left chart: Global GHG emissions (in GtCO₂-eq) in the absence of climate policies; Right chart: Multi-model global averages of surface warming for different scenarios

The key uncertainties of the drivers and projections of future climate changes and their impacts as presented in Climate Change 2007 - Synthesis report are:

- Uncertainty in the equilibrium climate sensitivity creates uncertainty in the expected warming for a given CO₂-eq stabilization scenario. Uncertainty in the carbon cycle feedback creates uncertainty in the emissions trajectory required to achieve a particular stabilization level.
- Models differ considerably in their estimates of the strength of different feedbacks in the climate system, particularly cloud feedbacks, oceanic heat uptake and carbon cycle feedbacks, although progress has been made in these areas. Also, the confidence in projections is higher for some variables (e.g. temperature) than for others (e.g. precipitation), and it is higher for larger spatial scales and longer time averaging periods.
- Aerosol impacts on the magnitude of the temperature response, on clouds and on precipitation remain uncertain.
- Future changes in the Greenland and Antarctic ice sheet mass, particularly due to changes in ice flow, are a major source of uncertainty that could increase sea level rise projections. The uncertainty in the penetration of the heat into the oceans also contributes to the future sea level rise uncertainty.
- Large-scale ocean circulation changes beyond the 21st century cannot be reliably assessed because of uncertainties in the melt water supply from the Greenland ice sheet and model response to the warming.
- Projections of climate change and its impacts beyond about 2050 are strongly scenario and model-dependent, and improved projections would require improved understanding of sources of uncertainty and enhancements in systematic observation networks.
- Impacts research is hampered by uncertainties surrounding regional projections of climate change, particularly precipitation.
- Understanding of low-probability/high-impact events and the cumulative impacts of sequences of smaller events, which is required for risk-based approaches to decision-making, is generally limited.

2 THE INTERNATIONAL RESPONSE TO CLIMATE CHANGE

Climate change was internationally recognized as a serious problem in February 1979 in Geneva when the First World Climate Conference sponsored by the WMO took place (Robledo & Masera, 2007). In response to this issue, an international environmental treaty named United Nations Framework Convention on Climate Change was adopted by the United Nations Conference on Environment and Development (UNCED) at the “Rio Earth Summit” in 1992. After five years, within this convention was adopted Kyoto Protocol, that established legally binding emissions targets for industrialized countries, and created innovative mechanisms to assist these countries in meeting these targets. Recognizing the needs of policymakers for authoritative and up-to-date scientific information, the World Meteorological Organization (WMO) and the UN Environmental Programme (UNEP) established the Intergovernmental Panel on Climate Change (IPCC) in 1988 (Robledo & Masera, 2007).

2.1 Intergovernmental Panel on Climate Change (IPCC)

(Source: www.ipcc.org)

The Intergovernmental Panel on Climate Change was created in 1988. It was set up by the World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP) as an effort by the United Nations to provide the governments of the world with a clear scientific view of what is happening to the world’s climate. The initial task for the IPCC as outlined in the UN General Assembly Resolution 43/53 of 6 December 1988 was to prepare a comprehensive review and recommendations with respect to the state of knowledge of the science of climate change; social and economic impact of climate change, possible response strategies and elements for inclusion in a possible future international convention on climate. Today the IPCC’s role is also, as defined in Principles Governing IPCC Work, “...to assess on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation. IPCC reports should be neutral with respect to policy, although they may need to deal objectively with scientific, technical and socio-economic factors relevant to the application of particular policies.”

The scientific evidence brought up by the first IPCC Assessment Report of 1990 unveiled the importance of climate change as a topic deserving a political platform among countries to tackle its consequences. It therefore played a decisive role in leading to the creation of the United Nations Framework Convention on Climate Change (UNFCCC), the key international treaty to reduce global warming and cope with the consequences of climate change.

Since then the IPCC has delivered on a regular basis the most comprehensive scientific reports about climate change produced worldwide, the Assessment Reports. It also continued to respond to the need of the UNFCCC for information on scientific technical matters through Special Reports, Technical Papers and Methodology Reports. Methodologies and guidelines were prepared to help Parties under the UNFCCC in preparing their national greenhouse gas inventories.

The IPCC Second Assessment Report of 1995 provided key input in the way to the adoption of the Kyoto Protocol in 1997. The Third Assessment Report came out in 2001, and the Fourth in the course of 2007. "Climate Change 2007", clearly brought to the attention of the world the scientific understanding of the present changes in our climate and led the organization to be honored with the Nobel Peace Prize at the end of that same year.

Along with Comprehensive Assessment Reports, the IPCC has produced several Special Reports on various topics of growing interest, and many other papers and contributions to the advancements of the climate change science.

The participation of the scientific community in the work of the IPCC has been growing greatly, both in terms of authors and contributors involved in the writing and the reviewing of the reports and of geographic distribution and topics covered by the reports.

The IPCC is an intergovernmental body. It is open to all member countries of the United Nations (UN) and WMO. Currently 195 countries are members of the IPCC. Governments participate in the review process and the plenary Sessions, where main decisions about the IPCC work programme are taken and reports are accepted, adopted and approved. The IPCC Bureau Members, including the Chair, are also elected during the plenary Sessions.

Because of its scientific and intergovernmental nature, the IPCC embodies a unique opportunity to provide rigorous and balanced scientific information to decision makers. By endorsing the IPCC reports, governments acknowledge the authority of their scientific content. The work of the organization is therefore policy-relevant and yet policy-neutral, never policy-prescriptive.

2.1.1 The structure of IPCC

(Source: www.ipcc.org)

The IPCC is currently organized in 3 Working Groups and a Task Force. They are assisted by Technical Support Units (TSU), which are hosted and financially supported by the Government of the developed country co-chair of that Working Group/Task Force:

- Working Group I - *The Physical Science Basis of Climate Change* - Assesses the physical scientific aspects of the climate system and climate change. The main topics assessed by WG I include: changes in greenhouse gases and aerosols in the atmosphere; observed changes in air, land and ocean temperatures, rainfall, glaciers and ice sheets, oceans and sea level; historical and paleoclimatic perspective on climate change; biogeochemistry, carbon cycle, gases and aerosols; satellite data and other data; climate models; climate projections, causes and attribution of climate change.
- Working Group II - *Climate Change Impacts, Adaptation and Vulnerability* - Assesses the vulnerability of socio-economic and natural systems to climate change, negative and positive consequences of climate change, and options for adapting to it. It also takes into consideration the inter-relationship between vulnerability, adaptation and sustainable development. The assessed information is considered by sectors (water resources; ecosystems; food & forests; coastal systems; industry; human health) and regions (Africa; Asia; Australia & New Zealand; Europe; Latin America; North America; Polar Regions; Small Islands).
- Working Group III - *Mitigation of Climate Change* - Assesses options for mitigating climate change through limiting or preventing greenhouse gas emissions and enhancing activities that remove them from the atmosphere. The main economic sectors are taken into account, both in a near-term and in a long-term perspective. The sectors include energy, transport, buildings,

industry, agriculture, forestry, waste management. The WG analyses the costs and benefits of the different approaches to mitigation, considering also the available instruments and policy measures. The approach is more and more solution-oriented.

Working Groups also meet at the Plenary at the level of Representatives of Governments. The main objective of the Task Force on National Greenhouse Gas Inventories is to develop and refine a methodology for the calculation and reporting of national GHG emissions and removals. In addition to the Working Groups and Task Force, further Task Groups and Steering Groups may be established for a limited or longer duration to consider a specific topic or question.

2.1.2 Task Force on National Greenhouse Gas Inventories (TFI)

The TFI was established by the IPCC, at its 14th session (October 1998), to oversee the IPCC National Greenhouse Gas Inventories Programme (IPCC-NGGIP). This programme had been undertaken since 1991 by the IPCC WG I in close collaboration with the Organization for Economic Co-operation and Development (OECD) and the International Energy Agency (IEA). In 1999, the Technical Support Unit (TSU) set up at the Institute for Global Environmental Strategies (IGES) in Japan took over this programme in accordance with a decision taken by the IPCC at its 14th session.

The objectives of the TFI are:

- to develop and refine an internationally-agreed methodology and software for the calculation and reporting of national GHG emissions and removals, and
- to encourage the widespread use of this methodology by countries participating in the IPCC and by signatories of the United Nations Framework Convention on Climate Change (UNFCCC).

2.1.3 Assessment reports

The IPCC has published four comprehensive assessment reports reviewing the latest climate science, as well as a number of special reports on particular topics. These reports are prepared by teams of relevant researchers selected by the Bureau from government nominations.

The IPCC reports were published:

- 1990 - the first assessment report, with a supplementary report in 1992,
- 1995 - the second assessment report (SAR)
- 2001 - the third assessment report (TAR)
- 2007 - fourth assessment report (AR₄)

The fifth assessment report is due to be issued in 2014.

Each assessment report is in three volumes, corresponding to Working Groups I, II and III. Unqualified, “the IPCC report” is often used to mean the Working Group I report, which covers the basic science of climate change.

2.2 United Nations Framework Convention on Climate Change (UNFCCC)

(Source: www.unfccc.int)

In 1992, countries joined an international treaty, the United Nations Framework Convention on Climate Change, to cooperatively consider what they could do to limit average global temperature increases and the resulting climate change, and to cope with whatever impacts were, by then, inevitable.

By 1995, countries realized that emission reductions provisions in the Convention were inadequate. They launched negotiations to strengthen the global response to climate change, and, two years later, adopted the Kyoto Protocol. The Kyoto Protocol legally binds developed countries to emission reduction targets. The Protocol’s first commitment period started in 2008 and ends in 2012. At COP₁₇ in Durban, governments of the Parties to the Kyoto Protocol decided that a second commitment period, from 2013 onwards, would seamlessly follow the end of the first commitment period. The length of the second commitment period is to be determined: it will be either five or eight years long.

There are now 195 Parties to the Convention. The UNFCCC secretariat supports all institutions involved in the international climate change negotiations, particularly the Conference of the Parties (COP), the subsidiary bodies (which advise the COP), and the COP Bureau (which deals mainly with procedural and organizational issues arising from the COP and also has technical functions).

At the very heart of the response to climate change, however, lies the need to reduce emissions. In 2010, governments agreed that emissions need to be reduced so that global temperature increases are limited to below 2 degrees Celsius.

No mandatory limits on greenhouse gas emissions were drawn up. Instead, the treaty provides for updates (called “protocols”) that would set mandatory emission limits. The principal update is the Kyoto Protocol, which has become much better known than the UNFCCC itself. The UNFCCC entered into force on 21 March 1994. Today, it has near-universal membership. The 195 countries that have ratified the Convention are called Parties to the Convention.

The ultimate objective of the Convention is to stabilize greenhouse gas concentrations “at a level that would prevent dangerous anthropogenic (human induced) interference with the climate system.” It states that “such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner.”

The first important task of UNFCCC was to establish national greenhouse gas inventories of greenhouse gas (GHG) emissions and removals. These levels were used to create the 1990 benchmark levels for accession of Annex I countries to the Kyoto Protocol. Also, these levels were used for the commitment of those countries to GHG reductions.

The parties to the convention have met annually from 1995 in Conferences of the Parties (COP) to assess progress in dealing with climate change. In 1997, the Kyoto Protocol was concluded and established legally binding obligations for developed countries to reduce their greenhouse gas emissions.

Parties to UNFCCC are classified as:

- Annex I countries: industrialized countries and economies in transition
- Annex II countries: developed countries which pay for costs of developing countries
- Non Annex I countries: Developing countries.

Annex I countries which have ratified the Protocol have committed to reduce their emission levels of greenhouse gasses to targets that are mainly set below their 1990 levels. They may do this by allocating reduced annual allowances to the major operators within their borders. These operators can only exceed their allocations if they buy emission allowances, or offset their excesses through a mechanism that is agreed by all the parties to UNFCCC.

Annex II countries are a sub-group of the Annex I countries. They comprise the OECD members, excluding those that were economies in transition in 1992.

Developing countries are not required to reduce emission levels unless developed countries supply enough funding and technology. Setting no immediate restrictions under UNFCCC serves three purposes:

- it avoids restrictions on their development, because emissions are strongly linked to industrial capacity
- they can sell emissions credits to nations whose operators have difficulty meeting their emissions targets
- they get money and technologies for low-carbon investments from Annex II countries.

Developing countries may volunteer to become Annex I countries when they are sufficiently developed.

2.2.1 Mitigation of climate change

(Source: www.unfccc.int)

Reducing Emissions from Deforestation and forest Degradation (REDD)

The agenda item on “Reducing emissions from deforestation in developing countries and approaches to stimulate action” was first introduced into the COP agenda at its eleventh session in Montreal (December 2005).

The IPCC (2007) estimated emissions from deforestation in the 1990s to be at 5.8 GtCO₂/year. It also noted that reducing and/or preventing deforestation and preventing the release of carbon emissions into the atmosphere is the mitigation option with the largest and most immediate carbon stock impact in the short term per hectare and per year globally.

Parties to the UNFCCC process recognized the contribution of greenhouse gas emissions from deforestation in developing countries to climate change and the need to take action to reduce such emissions. After a two-year process, the COP adopted a decision on “Reducing emissions from deforestation in developing countries: approaches to stimulate action” (Decision 2/CP.13). The decision provides a mandate for several elements and actions by Parties relating to reducing emissions from deforestation and forest degradation in developing countries:

- Further strengthening and supporting ongoing efforts;
- Support for and facilitate capacity-building, technical assistance and transfer of technology relating to methodological and technical needs and institutional needs of developing countries;
- Explore a range of actions, identify options and undertake demonstration activities to address drivers of deforestation and enhance forest carbon stocks due to sustainable management of forests; and
- Mobilize resources to support the efforts mentioned above.

The decision also provides a set of indicative guidance for the implementation and evaluation of demonstration activities. Parties are also encouraged to apply the IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry for estimating and reporting of emissions and removals.

In 2008 and 2009, policy approaches and positive incentives relating to reducing emissions from deforestation and forest degradation in developing countries and the role of conservation, sustainable management of forests, and enhancement of forest carbon stocks in developing countries have been considered under the process of the Bali Action Plan.

UN REDD Programme

(Source: www.un-redd.org/)

The UN-REDD Programme is the United Nations Collaborative initiative on Reducing Emissions from Deforestation and forest Degradation (REDD) in developing countries. The Programme was launched in September 2008 to assist developing countries prepare and implement national REDD+ strategies, and builds on the convening power and expertise of the Food and Agriculture Organization of the United Nations

(FAO), the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP).

The Programme currently supports 44 partner countries spanning Africa, Asia-Pacific and Latin America, of which 16 are receiving support to National Programme activities. These 16 countries are: Bolivia, Cambodia, Democratic Republic of the Congo (DRC), Ecuador, Indonesia, Nigeria, Panama, Papua New Guinea, Paraguay, the Philippines, Republic of Congo, Solomon Islands, Sri Lanka, Tanzania, Viet Nam and Zambia. To-date, the UN-REDD Programme's Policy Board has approved a total of US\$67.3 million for National Programmes in these 16 partner countries. These funds help to support the development and implementation of national REDD+ strategies.

UN-REDD Programme countries not receiving direct support to national programmes engage with the Programme in a number of ways, including as observers to the Programme's Policy Board, and through participation in regional workshops and knowledge sharing, facilitated by the Programme's interactive online workspace. These countries are: Argentina, Bangladesh, Benin, Bhutan, Cameroon, Central African Republic, Chile, Colombia, Costa Rica, Ethiopia, Gabon, Ghana, Guatemala, Guyana, Honduras, Ivory Coast, Kenya, Malaysia, Mexico, Mongolia, Myanmar, Nepal, Pakistan, Peru, South Sudan, Sudan, Suriname and Uganda.

Land Use, Land-Use Change and Forestry

(Source: www.unfccc.int)

Forests, through growth of trees and an increase in soil carbon, contain a large part of the carbon stored on land. Forests present a significant global carbon stock. Global forest vegetation stores 283 Gt of carbon in its biomass, 38 Gt in dead wood and 317 Gt in soils (top 30 cm) and litter. The total carbon content of forest ecosystems has been estimated at 638 Gt for 2005, which is more than the amount of carbon in the entire atmosphere. This standing carbon is combined with a gross terrestrial uptake of carbon, which was estimated at 2.4 Gt a year, a good deal of which is sequestration by forests. Approximately half of the total carbon in forest ecosystems is found in forest biomass and dead wood.

Other terrestrial systems also play an important role. Most of the carbon stocks of croplands and grasslands are found in the below-ground plant organic matter and soil.

Human activities, through land use, land-use change and forestry (LULUCF) activities, affect changes in carbon stocks between the carbon pools of the terrestrial ecosystem and between the terrestrial ecosystem and the atmosphere.

Management and/or conversion of land uses (e.g. forests, croplands and grazing lands) affects sources and sinks of CO₂, CH₄ and N₂O. During the decade of the 1990s, deforestation in the tropics and forest re-growth in temperate and boreal zones remained the major factors contributing to emissions and removals of greenhouse gases (GHG) respectively. Estimated CO₂ emissions associated with land-use change, averaged over the 1990s, were 0.5 to 2.7 GtC yr⁻¹, with a central estimate of 1.6 GtCyr⁻¹.

The role of LULUCF activities in the mitigation of climate change has long been recognized. Mitigation achieved through activities in the LULUCF sector, either by increasing the removals of GHGs from the atmosphere or by reducing emissions by sources, can be relatively cost-effective.

General mitigation options could include forest-related activities such as reducing emissions from deforestation and degradation, enhancing the sequestration rate in new or existing forests, and using wood fuels and wood products as substitutes for fossil fuels and more energy-intensive materials. A variety of options for mitigation of GHG emissions also exists in other land systems. The most prominent example is agriculture, where options include improved crop and grazing land management (e.g., improved agronomic practices, nutrient use, tillage and residue management), restoration of organic soils that are drained for crop production, and restoration of degraded lands.

However, the main drawback of LULUCF activities is their potential reversibility and non-permanence of carbon stocks as a result of human activities, (with the release of GHG into the atmosphere), disturbances (e.g. forest fires or disease), or environmental change, including climate change.

According to the FAO (2005), deforestation, mainly conversion of forests to agricultural land, continues at an alarming rate of approximately 13 million hectares per year (for the period 1990–2005). Deforestation results in immediate release of the carbon originally stored in the trees as CO₂ emissions (with small amounts of CO and CH₄), particularly if the trees are burned and the slower release of emissions from the decay of organic matter. The IPCC WGIII (2007) estimated emissions from deforestation in the 1990s to be at 5.8 GtCO₂/yr. The IPCC also notes that reducing

and/or preventing deforestation is the mitigation option with the largest and most immediate carbon stock impact in the short term per hectare and per year globally as the release of carbon as emissions into the atmosphere is prevented.

LULUCF sector under the Convention

Under the Convention, the commitments by Parties to mitigate climate change are defined in Article 4. These commitments take into account Parties' common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances. Article 4 has references to commitments relating to the land use, land-use change and forestry sector:

- Article 4, paragraph 1(a): Develop, periodically update, publish and make available to the Conference of the Parties, in accordance with Article 12, national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases (GHGs)¹ not controlled by the Montreal Protocol, using comparable methodologies to be agreed upon by the Conference of the Parties.
- Article 4, paragraph 1(d): Promote sustainable management, and promote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs of all GHGs not controlled by the Montreal Protocol, including biomass, forests and oceans as well as other terrestrial, coastal and marine ecosystems.

LULUCF under the Kyoto Protocol

Several Articles of the Kyoto Protocol make provisions for the inclusion of land use, land-use change and forestry activities by Parties as part of their efforts to implement the Kyoto Protocol and contribute to the mitigation of climate change.

In Article 2, sub-paragraphs 1(a) (ii) and (iii), Annex I Parties, in meeting their emission reduction commitments under Article 3, shall implement and/or further elaborate policies and measures to protect and enhance sinks and reservoirs of greenhouse gases (GHGs) not controlled by the Montreal Protocol, promote sustainable forest management, afforestation and reforestation and sustainable forms of agriculture.

¹ Including inventories of GHG emissions and removals from the LULUCF sector

Annex I Parties must report emissions by sources and removals by sinks of GHGs resulting from LULUCF activities, in accordance with Article 3, paragraphs 3 and 4. Under Article 3.3 of the Kyoto Protocol, Parties decided that net changes in GHG emissions by sources and removals by sinks through direct human-induced LULUCF activities, limited to afforestation, reforestation and deforestation that occurred since 1990, can be used to meet Parties' emission reduction commitments. Under Article 3.4 of the Kyoto Protocol, Parties may elect additional human-induced activities related to LULUCF specifically, forest management, cropland management, grazing land management and revegetation, to be included in their accounting of anthropogenic GHG emissions and removals for the first commitment period. Upon election, this decision by a Party is fixed for the first commitment period. The changes in carbon stock and GHG emissions relating to LULUCF activities under Article 3, paragraphs 3 and 4 must be reported for each year of the commitment period, beginning with the start of the commitment period, or with the start of the activity, whichever is later. When LULUCF activities under Articles 3.3 and 3.4 result in a net removal of GHGs, an Annex I Party can issue removal units (RMUs) on the basis of these activities as part of meeting its commitment under Article 3.1.

In addition, under Article 3, paragraph 7, for the purpose of calculating the assigned amount, an Annex I Party for which land-use change and forestry constituted a net source of GHG emissions in 1990 shall include in their 1990 emissions base year or period the aggregate anthropogenic carbon dioxide equivalent emissions by sources minus removals by sinks in 1990 from land-use change [according to paragraph 5(b) in the annex to 13/CMP.1, this refers to: all emissions by sources minus removals by sinks reported in relation to the conversion of forests (deforestation)].

Two of the flexible mechanisms of the Kyoto Protocol make provisions for the implementation of LULUCF project activities by Parties. The clean development mechanism (CDM) under the Kyoto Protocol (Article 12) allows for the implementation of LULUCF project activities, limited to afforestation and reforestation, in non-Annex I countries. These project activities assist Annex I Parties in achieving compliance with their emission reduction commitments under Article 3, while simultaneously assisting non-Annex I Parties to achieve sustainable development.

Under joint implementation (Article 6), an Annex I Party may implement projects that increase removals by sinks in another Annex I country. The emissions reduction units (ERUs) generated from such a project can be used by the former to meet its emission reduction target. Any project under Article 6 aimed at enhancing anthropogenic

removals by sinks shall conform to definitions, accounting rules, modalities and guidelines under Article 3, paragraphs 3 and 4, of the Kyoto Protocol.

2.2.2 Reporting GHG inventories

(Source: www.unfccc.int)

The quality and credibility of GHG inventories rely on the integrity of the methodologies used, the completeness of reporting, and the procedures for compilation of data. To promote the provision of credible and consistent GHG information, the Conference of Parties (COP) has developed standardized requirements for reporting national inventories.

The UNFCCC reporting guidelines on annual inventories require Parties included in Annex I to the Convention (Annex I Parties), by 15 April each year, to provide annual national GHG inventories covering emissions and removals of direct GHGs (CO₂, CH₄, N₂O, HFCs, PFCs and SF₆) from six sectors (Energy, Industrial processes, Solvents, Agriculture, LULUCF, Waste), and for all years from the base year or period to the most recent year.

Under the UNFCCC reporting guidelines for Annex I Parties, inventory submissions are in two parts:

- Common reporting format (CRF) – a series of standardized data tables containing mainly numerical information and submitted electronically
- National Inventory Report (NIR) – a comprehensive description of the methodologies used in compiling the inventory, the data sources, the institutional structures and quality assurance and control procedures

Well-constructed annual inventories should include sufficient documentation and data to enable the reader to understand the underlying assumptions and calculations of the reported emission estimates.

The NIR as established by decision 18/CP.8 is one element of the annual greenhouse gas (GHG) inventory that is required to be submitted to the UNFCCC by Annex I Parties to the Convention. The other elements of this submission include the reporting of GHG emissions by sources and removals by sinks and any other additional information in support of this submission.

Annex I Parties that are also Parties to the Kyoto Protocol are also required to report supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol, with the inventory submission due under the Convention, in accordance with paragraph 3(a) of decision 15/CMP.1.

The review of GHG inventories comprises three stages. Each stage complements the previous one, and ensures that the process as a whole provides a thorough and technical assessment of the inventory and of conformity with the UNFCCC and IPCC guidelines.

- Initial check: immediate quality assurance check to verify that the inventory submission is complete and in the correct format. The result is a status report whose main purpose is to provide a brief check of completeness of the inventory submission, mainly based on the CRF.
- Synthesis and assessment: Part I compile and compare basic inventory information, such as emission trends, activity data and implied emission factors, across Parties and over time. Part II provides a 'preliminary assessment' of the inventory of individual Parties. The identification of potential problems in this assessment is an important input to the individual review stage.
- Individual review: international teams of sectoral inventory experts examine the data, methodologies and procedures used in preparing the national inventory. Reviews are conducted as a centralized review, where 5–8 inventories are reviewed by an expert review team (ERT) convened at the secretariat; a desk review, where 3–5 inventories are reviewed by experts based in their home countries; or an in-country review, where a single inventory is reviewed by an ERT in the Party under review. This is the most important and detailed review stage.

2.3 Kyoto Protocol (KP)

(Source: www.unfccc.int)

The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change, adopted in Kyoto, Japan, on 11 December 1997. The major feature of the Kyoto Protocol is that it sets binding targets for 37 industrialized countries and the European community for reducing greenhouse gas (GHG) emissions. These amount to an average of five per cent against 1990 levels over the five-year period 2008-2012. The major distinction between the Protocol and

the Convention is that while the Convention encouraged industrialized countries to stabilize GHG emissions, the Protocol commits them to do so.

Recognizing that developed countries are principally responsible for the current high levels of GHG emissions in the atmosphere as a result of more than 150 years of industrial activity, the Protocol places a heavier burden on developed nations under the principle of “common but differentiated responsibilities.”

Pursuant to Article 22, the Protocol is subject to ratification, acceptance, approval or accession by Parties to the UNFCCC. Parties to the UNFCCC that have not signed the Protocol may accede to it at any time.

The Kyoto Protocol sets binding emission reduction targets for 37 industrialized countries and the European community in its first commitment period. Overall, these targets add up to an average five per cent emissions reduction compared to 1990 levels over the five-year period 2008 to 2012. KP was structured on the principles of the Convention. It only binds developed countries because it recognizes that they are largely responsible for the current high levels of GHG emissions in the atmosphere, which are the result of more than 150 years of industrial activity. KP places a heavier burden on developed nations under its central principle: that of “common but differentiated responsibility”.

The Protocol entered into force on 16 February 2005 in accordance with Article 23, that is the ninetieth day after the date on which not less than 55 Parties to the UNFCCC, incorporating Parties included in Annex I which accounted in total for at least 55% of the total carbon dioxide emissions for 1990 of the Parties included in Annex I, have deposited their instruments of ratification, acceptance, approval or accession.

Currently, there are 192 Parties (191 States and 1 regional economic integration organization) to the Kyoto Protocol to the UNFCCC. The total percentage of Annex I Parties emissions is 63.7%.

2.3.1 Mechanisms of Kyoto Protocol

(Source: www.unfccc.int)

Countries with commitments under the Kyoto Protocol to limit or reduce greenhouse gas emissions must meet their targets primarily through national measures. As an additional means of meeting these targets, the Kyoto Protocol introduced three

market-based mechanisms, thereby creating what is now known as the “carbon market.”

The Kyoto mechanisms are:

- Emissions Trading
- The Clean Development Mechanism (CDM)
- Joint Implementation (JI)

Emissions Trading

Parties with commitments under the Kyoto Protocol (Annex B Parties) have accepted targets for limiting or reducing emissions. These targets are expressed as levels of allowed emissions, or “assigned amounts,” over the 2008-2012 commitment period. The allowed emissions are divided into “assigned amount units” (AAUs). Emissions trading, as set out in Article 17 of the Kyoto Protocol, allows countries that have emission units to spare - emissions permitted them but not “used” - to sell this excess capacity to countries that are over their targets. Thus, a new commodity was created in the form of emission reductions or removals. Since carbon dioxide is the principal greenhouse gas, people speak simply of trading in carbon. Carbon is now tracked and traded like any other commodity. This is known as the “carbon market.”

Clean Development Mechanism (CDM)

The Clean Development Mechanism (CDM), defined in Article 12 of the Protocol, allows a country with an emission-reduction or emission-limitation commitment under the Kyoto Protocol (Annex B Party) to implement an emission-reduction project in developing countries. Such projects can earn saleable certified emission reduction (CER) credits, each equivalent to one tonne of CO₂, which can be counted towards meeting Kyoto targets. The mechanism is seen by many as a trailblazer. It is the first global, environmental investment and credit scheme of its kind, providing a standardized emission offset instrument, CERs. A CDM project activity might involve, for example, a rural electrification project using solar panels or the installation of more energy-efficient boilers. The mechanism stimulates sustainable development and emission reductions, while giving industrialized countries some flexibility in how they meet their emission reduction or limitation targets.

Joint Implementation (JI)

The mechanism known as “joint implementation,” defined in Article 6 of the Kyoto Protocol, allows a country with an emission reduction or limitation commitment under the Kyoto Protocol (Annex B Party) to earn emission reduction units (ERUs) from an emission-reduction or emission removal project in another Annex B Party, each equivalent to one tonne of CO₂, which can be counted towards meeting its Kyoto target. Joint implementation offers Parties a flexible and cost-efficient means of fulfilling a part of their Kyoto commitments, while the host Party benefits from foreign investment and technology transfer.

The Kyoto mechanisms:

- Stimulate sustainable development through technology transfer and investment
- Help countries with Kyoto commitments to meet their targets by reducing emissions or removing carbon from the atmosphere in other countries in a cost-effective way
- Encourage the private sector and developing countries to contribute to emission reduction efforts

Accounting, Reporting & Review under the Kyoto Protocol

The Kyoto Protocol’s effectiveness will depend upon two critical factors: whether Parties follow the Protocol’s rulebook and comply with their commitments; and whether the emissions data used to assess compliance is reliable. Recognizing this, the Kyoto Protocol and Marrakesh Accords, adopted by CMP 1 in Montreal, Canada, in December 2005, include a set of monitoring and compliance procedures to enforce the Protocol’s rules, address any compliance problems, and avoid any error in calculating emissions data and accounting for transactions under the three Kyoto mechanisms (emissions trading, clean development mechanism and joint implementation) and activities related to land use, land use change and forestry (LULUCF).

The Protocol’s monitoring procedures are based on existing reporting and review procedures under the Convention, building on experience gained in the climate change process over the past decade. They also involve additional accounting procedures that are needed to track and record Parties’ holdings and transactions of

Kyoto Protocol units - assigned amount units (AAUs), certified emission reductions (CERs) and emission reduction units (ERUs) - and removal units (RMUs) generated by LULUCF activities.

Articles 5, 7 and 8 of the Kyoto Protocol address reporting and review of information by Annex I Parties under the Protocol, as well as national systems and methodologies for the preparation of greenhouse gas inventories.

- Article 5 commits Annex I Parties to having in place, no later than 2007, national systems for the estimation of greenhouse gas emissions by sources and removals by sinks (Article 5.1). It also states that, where agreed methodologies (that is, the revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories) are not used to estimate emissions and removals, appropriate “adjustments” should be applied (Article 5.2).
- Article 7 requires Annex I Parties to submit annual greenhouse gas inventories, as well as national communications, at regular intervals, both including supplementary information to demonstrate compliance with the Protocol. In addition, Article 7 states that the Conference of the Parties serving as the meeting of the Parties to the Protocol (CMP) shall decide upon modalities for the accounting of assigned amounts prior to the first commitment period.
- Article 8 establishes that expert review teams will review the inventories, and national communications submitted by Annex I Parties.

The Protocol states that guidelines for national systems, adjustments, the preparation of inventories and national communications, as well as for the conduct of expert reviews, should be adopted by the CMP at its first session (CMP 1), and regularly reviewed thereafter.

2.4 European Commission – DG Clima

(Source: <http://ec.europa.eu/dgs/clima>)

The Directorate-General for Climate Action (“DG CLIMA”) was established in February 2010, climate change being previously included in the remit of DG Environment of the European Commission. It leads international negotiations on climate, helps the EU to deal with the consequences of climate change and to meet its targets for 2020, as well as develops and implements the EU Emissions Trading System.

2.5 Combating climate change within and outside the EU

Given the necessity to keep global average temperature increase below 2 degrees Celsius compared to pre-industrial levels, DG CLIMA develops and implements cost effective international and domestic climate change policies and strategies in order for the EU to meet its targets for 2020 and beyond, especially with regard to reducing its greenhouse gas emissions. Its policies also aim at protecting the ozone layer and at ensuring that the climate dimension is appropriately present in all Community policies and that adaptation measures will reduce the European Union's vulnerability to the impacts of climate change.

The Directorate-General for Climate Action is at the forefront of international efforts to combat climate change. It leads the respective Commission task forces on the international negotiations in the areas of climate change and ozone depleting substances and coordinates bi-lateral and multi-lateral partnerships on climate change and energy with third countries.

DG CLIMA develops and implements the EU Emissions Trading System ("EU ETS") and promotes its links with other carbon trading systems with the ultimate aim of building an international carbon trading market. Furthermore, it monitors the implementation of Member States' emission reduction targets in the sectors outside the EU ETS ("Effort Sharing Decision").

It also promotes the development and demonstration of low carbon and adaptation technologies, especially through the development and implementation of cost effective regulatory frameworks for their deployment (e.g. carbon capture and storage, fluorinated gases, ozone depleting substances, vehicle efficiency standards, fuel quality standards) as well as through the development of appropriate financial support schemes.

Combating climate change is a top priority for the EU. Europe is working hard to cut its greenhouse gas emissions substantially while encouraging other nations and regions to do likewise. At the same time, the EU is developing a strategy for adapting to the impacts of climate change that can no longer be prevented. Reining in climate change carries a cost, but doing nothing will be far more expensive in the long run. Moreover, investing in the green technologies that cut emissions will also create jobs and boost the economy.

The European Union has long been a driving force in international negotiations that led to agreement on the two United Nations climate treaties, the UN Framework Convention on Climate Change (UNFCCC) in 1992 and the Kyoto Protocol in 1997.

The Kyoto Protocol requires the 15 countries that were EU members at the time ('EU-15') to reduce their collective emissions in the 2008-2012 period to 8% below 1990 levels. Emissions monitoring and projections show that the EU-15 is well on track to meet this target.

In 2007 EU leaders endorsed an integrated approach to climate and energy policy and committed to transforming Europe into a highly energy-efficient, low carbon economy. They made a unilateral commitment that Europe would cut its emissions by at least 20% of 1990 levels by 2020. This commitment is being implemented through a package of binding legislation.

The EU has also offered to increase its emissions reduction to 30% by 2020, on condition that other major emitting countries in the developed and developing worlds commit to do their fair share under a future global climate agreement. This agreement should take effect at the start of 2013 when the Kyoto Protocol's first commitment period will have expired.

The Cancún Agreement, a balanced and substantive package of decisions adopted at the end of the UN Climate Conference in Mexico (December 2010), represents an important step on the road to building a comprehensive and legally binding framework for climate action for the period after 2012.

The UNFCCC commits the EU and its Member States to develop, periodically update, publish and report to the Conference of the Parties national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol on substances that deplete the ozone layer (greenhouse gases), using comparable methodologies agreed upon by the Conference of the Parties.

The UNFCCC commits all Parties to formulate, implement, publish and regularly update national, and where appropriate, regional programmes containing measures to mitigate climate change by addressing anthropogenic emissions by sources and removals by sinks of all greenhouse gases.

2.6 Adoption of the Kyoto Protocol

The Conference of the Parties to the Convention, at its first session, concluded that the commitment by developed countries to aim at returning, individually or jointly, their emissions of carbon dioxide and other greenhouse gases not controlled by the Montreal Protocol to the Convention for the Protection of the Ozone Layer to 1990 levels by the year 2000 was inadequate for achieving the Convention's long-term objective of preventing dangerous anthropogenic interference with the climate system.

The Conference further agreed to begin a process to enable appropriate action to be taken for the period beyond 2000, through the adoption of a protocol or another legal instrument. This process resulted in the adoption on 11 December 1997 of the Kyoto Protocol to the United Nations Framework Convention on Climate Change.

2.7 EU and Member States jointly responsible for the quantified emission reduction commitment

The Kyoto Protocol provides for Parties to fulfill their commitments jointly, acting in the framework of and together with a regional economic integration organization. When the Protocol was signed in New York on 29 April 1998, the EU declared that it and its Member States would fulfill their respective commitments of the Protocol jointly.

In deciding to fulfill their commitments, the EU and the Member States are jointly responsible for the fulfillment by the EU of its quantified emission reduction commitment. Consequently, Member States individually and collectively have the obligation to take all appropriate measures, whether general or particular, to ensure fulfillment of the obligations resulting from action taken by the institutions of the EU, including the EU's quantified emission reduction commitment under the Protocol, to facilitate the achievement of this commitment and to abstain from any measure that could jeopardize the attainment of this commitment.

The Kyoto Protocol requires the EU to reduce greenhouse gas emissions by 8% below 1990 levels by 2008-2012. Most of the Member States that joined the EU in 2004 have the same target. The target for Hungary and Poland is -6% while Cyprus is no Annex-I Party to the UNFCCC and thus has no target.

2.8 EU monitoring and reporting of greenhouse gas emissions under the UNFCCC and the Kyoto Protocol

Given the UNFCCC and the Kyoto Protocol requirements, there is a need for thorough monitoring and regular assessment of EU greenhouse gas emissions and the measures taken by the EU and its Member States in the field of climate change policy need to be analyzed in good time. Therefore, it is appropriate for the European Commission to provide for effective cooperation and coordination in relation to the compilation of the EU greenhouse gas inventory, the evaluation of progress, the preparation of reports, as well as review and compliance procedures enabling the EU to comply with its reporting obligations under the Kyoto Protocol, as laid down in the political agreements and legal decisions taken at the seventh Conference of the Parties to the UNFCCC in Marrakech (“the Marrakech Accords”).

The European Environment Agency assists the Commission, as appropriate, with monitoring activities, especially in the scope of the EU inventory system, and in the analysis by the Commission of progress towards the fulfillment of the commitments under the UNFCCC and the Kyoto Protocol.

Since the objectives of complying with the EU’s commitments under the Kyoto Protocol, in particular the monitoring and reporting requirements laid down therein, cannot, by their very nature, be sufficiently achieved by the Member States and can therefore be better achieved at EU level, the EU may also adopt measures.

2.9 European Climate Change Programme

The European Commission has taken many climate-related initiatives since 1991, when it issued the first Community strategy to limit carbon dioxide (CO₂) emissions and improve energy efficiency. These include: a directive to promote electricity from renewable energy, voluntary commitments by car makers to reduce CO₂ emissions by 25% and proposals on the taxation of energy products.

However, it is clear that action by both Member States and the European Community needs to be reinforced if the EU is to succeed in cutting its greenhouse gas emissions to 8% below 1990 levels by 2008-2012, as required by the Kyoto protocol.

The EU Council of Environment Ministers acknowledged the importance of taking further steps at Community level by asking the Commission to put forward a list of priority actions and policy measures.

The Commission responded in June 2000 by launching the European Climate Change Programme (ECCP). The goal of the ECCP is to identify and develop all the necessary elements of an EU strategy to implement the Kyoto Protocol.

The development of the first ECCP (2000-2004) involved all the relevant groups of stakeholders working together, including representatives from the Commission's different departments (DGs), the Member States, industry and environmental groups. The second European Climate Change Programme (ECCP II) was launched in October 2005.

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