9. GLOBAL ENVIRONMENTAL CONCERNS

Syllabus
Global Environmental Concerns: United Nations Framework Convention on Climate Change (UNFCC), Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), Prototype Carbon Fund (PCF), Sustainable Development,

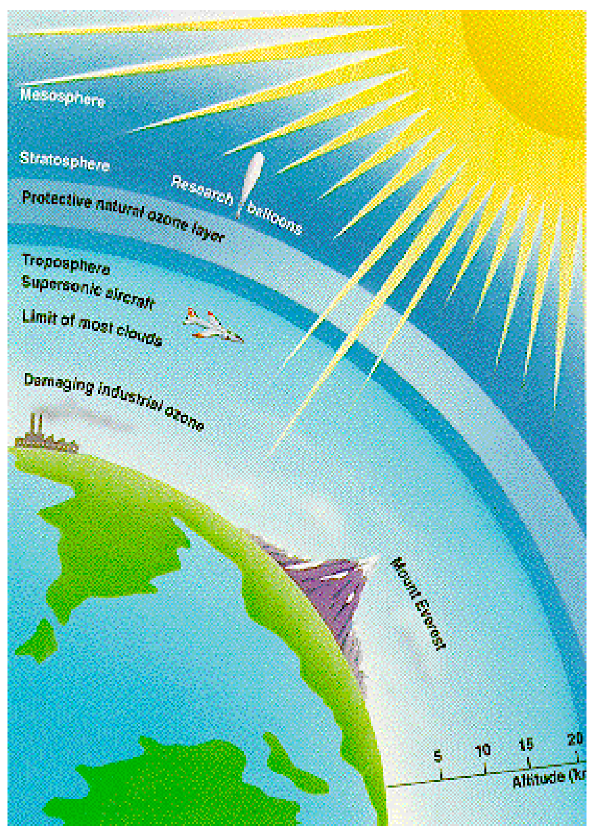
9.1 Global Environmental Issues

As early as 1896, the Swedish scientist Svante Arrhenius had predicted that human activities would interfere with the way the sun interacts with the earth, resulting in global warming and climate change. His prediction has become true and climate change is now disrupting global environmental stability. The last few decades have seen many treaties, conventions, and protocols for the cause of global environmental protection.

Few examples of environmental issues of global significance are:

- Ozone layer depletion
- Global warming
- Loss of biodiversity

One of the most important characteristics of this environmental degradation is that it affects all mankind on a global scale without regard to any particular country, region, or race. The whole world is a stakeholder and this raises issues on who should do what to combat environmental degradation.



9.2 Ozone Layer Depletion

Earth's atmosphere is divided into three regions, namely troposphere, stratosphere and mesosphere (see Figure 9.1). The stratosphere extends from 10 to 50 kms from the Earth's surface. This region is concentrated with slightly pungent smelling, light bluish ozone gas. The ozone gas is made up of molecules each containing three atoms of oxygen; its chemical formula is O_3. The ozone layer, in the stratosphere acts as an efficient filter for harmful solar Ultraviolet B (UV-B) rays

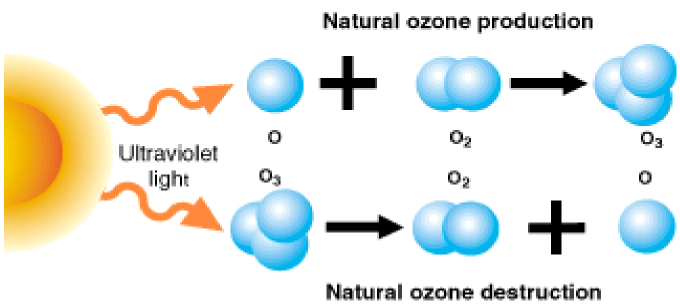


Figure 9.2 Ozone Production and Destruction Process

Ozone is produced and destroyed naturally in the atmosphere and until recently, this resulted in a well-balanced equilibrium (see Figure 9.2). Ozone is formed when oxygen molecules absorb ultraviolet radiation with wavelengths less than 240 nanometres and is destroyed when it absorbs ultraviolet radiation with wavelengths greater than 290 nanometres. In recent years, scientists have measured a seasonal thinning of the ozone layer primarily at the South Pole. This phenomenon is being called the ozone hole.

9.2.1 Ozone Depletion Process

Ozone is highly reactive and easily broken down by man-made chlorine and bromine compounds. These compounds are found to be most responsible for most of ozone layer depletion.

The ozone depletion process begins when CFCs (used in refrigerator and air conditioners) and other ozone-depleting substances (ODS) are emitted into the atmosphere. Winds efficiently mix and evenly distribute the ODS in the troposphere. These ODS compounds do not dissolve in rain, are extremely stable, and have a long life span. After several years, they reach the stratosphere by diffusion.

Strong UV light breaks apart the ODS molecules. CFCs, HCFCs, carbon tetrachloride, methyl chloroform release chlorine atoms, and halons and methyl bromide release bromine atoms. It is the chlorine and bromine atom that actually destroys ozone, not the intact ODS molecule. It is estimated that one chlorine atom can destroy from 10,000 to 100,000 ozone molecules before it is finally removed from the stratosphere.

Chemistry of Ozone Depletion

When ultraviolet light waves (UV) strike CFC* ($CFCl_3$) molecules in the upper atmosphere, a carbon-chlorine bond breaks, producing a chlorine (Cl) atom. The chlorine atom then reacts with an ozone (O_3) molecule breaking it apart and so destroying the ozone. This forms an ordinary oxygen molecule (O_2) and a chlorine monoxide (ClO) molecule. Then a free oxygen** atom breaks up the chlorine monoxide. The chlorine is free to repeat the process of destroying more ozone molecules. A single CFC molecule can destroy 100,000 ozone molecules. The chemistry of ozone depletion process is shown in Figure 9.3.

* CFC - chlorofluorocarbon: it contains chlorine, fluorine and carbon atoms.
** UV radiation breaks oxygen molecules (O_2) into single oxygen atoms.

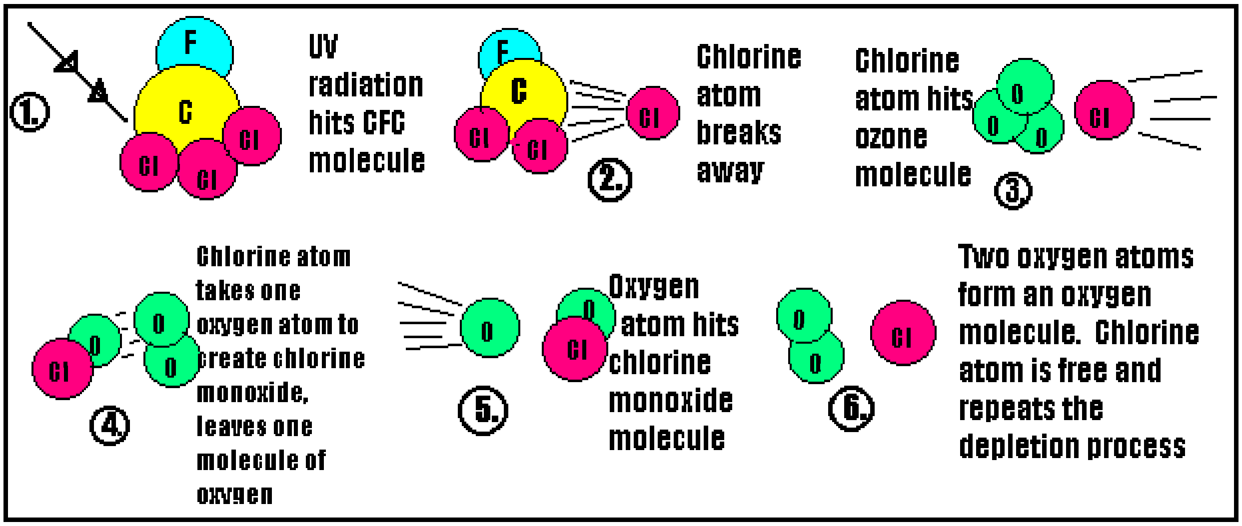


Figure 9.3 Chemistry of Ozone Depletion Process

Chemical equation is

$$CFCl_3 + \text{UV Light} \Rightarrow CFCl_2 + Cl$$
$$Cl + O_3 \Rightarrow ClO + O_2$$
$$ClO + O \Rightarrow Cl + O_2$$

The free chlorine atom is then free to attack another ozone molecule

$$Cl + O_3 \Rightarrow ClO + O_2$$
$$ClO + O \Rightarrow Cl + O_2$$

and again ...

$$Cl + O_3 \Rightarrow ClO + O_2$$
$$ClO + O \Rightarrow Cl + O_2$$

and again... for thousands of times.

Scientist measure ozone layer thickness by measuring how much ultraviolet radiation reaches the ground, using a Dobson ozone spectrophotometer. Ozone layer thickness is measured in Dobson units. The higher the number, the thicker the ozone layer. Since the 1970s, gases produced for commercial purposes have been destroying the ozone layer, upsetting the natural equilibrium that existed. It is planned that by 2005 in developed countries and by 2015 in developing countries, the use of ozone depleting gases, such as CFCs, will be phased out.

9.2.2 Effects of Ozone Layer Depletion

Effects on Human and Animal Health: Increased penetration of solar UV-B radiation is likely to have high impact on human health with potential risks of eye diseases, skin cancer and infectious diseases.

Effects on Terrestrial Plants: In forests and grasslands, increased radiation is likely to change species composition thus altering the bio-diversity in different ecosystems. It could also affect the plant community indirectly resulting in changes in plant form, secondary metabolism, etc.

Effects on Aquatic Ecosystems: High levels of radiation exposure in tropics and subtropics may affect the distribution of phytoplanktons, which form the foundation of aquatic food webs. It can also cause damage to early development stages of fish, shrimp, crab, amphibians and other animals, the most severe effects being decreased reproductive capacity and impaired larval development.

Effects on Bio-geo-chemical Cycles: Increased solar UV radiation could affect terrestrial and aquatic bio-geo-chemical cycles thus altering both sources and sinks of greenhouse and important trace gases, e.g. carbon dioxide (CO_2), carbon monoxide (CO), carbonyl sulfide (COS), etc. These changes would contribute to biosphere-atmosphere feedbacks responsible for the atmosphere build-up of these greenhouse gases.

Effects on Air Quality: Reduction of stratospheric ozone and increased penetration of UV-B radiation result in higher photo dissociation rates of key trace gases that control the chemical reactivity of the troposphere. This can increase both production and destruction of ozone and related oxidants such as hydrogen peroxide, which are known to have adverse effects on human health, terrestrial plants and outdoor materials.

The ozone layer, therefore, is highly beneficial to plant and animal life on earth filtering out the dangerous part of sun's radiation and allowing only the beneficial part to reach earth. Any disturbance or depletion of this layer would result in an increase of harmful radiation reaching the earth's surface leading to dangerous consequences.

9.2.3 Ozone Depletion Counter Measures

- International cooperation, agreement (Montreal Protocol) to phase out ozone depleting chemicals since 1974
- Tax imposed for ozone depleting substances
- Ozone friendly substitutes- HCFC (less ozone depleting potential and shorter life)
- Recycle of CFCs and Halons

9.3 Global Warming

Before the Industrial Revolution, human activities released very few gases into the atmosphere and all climate changes happened naturally. After the Industrial Revolution, through fossil fuel combustion, changing agricultural practices and deforestation, the natural composition of gases in the atmosphere is getting affected and climate and environment began to alter significantly.

Over the last 100 years, it was found out that the earth is getting warmer and warmer, unlike previous 8000 years when temperatures have been relatively constant. The present temperature is 0.3 - 0.6 ^oC warmer than it was 100 years ago.

The key greenhouse gases (GHG) causing global warming is carbon dioxide. CFC's, even though they exist in very small quantities, are significant contributors to global warming. Carbon dioxide, one of the most prevalent greenhouse gases in the atmosphere, has two major anthropogenic (human-caused) sources: the combustion of fossil fuels and changes in land use. Net releases of carbon dioxide from these two sources are believed to be contributing to the rapid rise in atmospheric concentrations since Industrial Revolution. Because estimates indicate that approximately 80 percent of all anthropogenic carbon dioxide emissions currently come from fossil fuel combustion, world energy use has emerged at the center of the climate change debate.

9.3.1 Sources of Greenhouse Gases

Some greenhouse gases occur naturally in the atmosphere, while others result from human activities. Naturally occurring greenhouse gases include water vapor, carbon dioxide, methane, nitrous oxide, and ozone (refer Figure 9.4). Certain human activities, however, add to the levels of most of these naturally occurring gases.

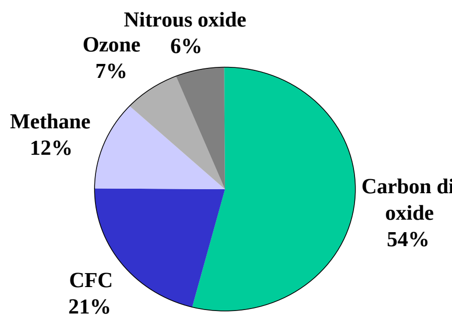


Figure 9.4 %Share of Greenhouse Gases

Carbon dioxide is released to the atmosphere when solid waste, fossil fuels (oil, natural gas, and coal), and wood and wood products are burned.

Methane is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from the decomposition of organic wastes in municipal solid waste landfills, and the raising of livestock. Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of solid waste and fossil fuels.

Very powerful greenhouse gases that are not naturally occurring include hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6), which are generated in a variety of industrial processes.

Often, estimates of greenhouse gas emissions are presented in units of millions of metric tons of carbon equivalents (MMTCE), which weights each gas by its Global Warming Potential or GWP value.

9.3.2 Global Warming Potentials

Although there are a number of ways of measuring the strength of different greenhouse gases in the atmosphere, the Global Warming Potential (GWP) is perhaps the most useful.

GWPs measure the influence greenhouse gases have on the natural greenhouse effect, including the ability of greenhouse gas molecules to absorb or trap heat and the length of time, greenhouse gas molecules remain in the atmosphere before being removed or broken down. In this way, the contribution that each greenhouse gas has towards global warming can be assessed.

Each greenhouse gas differs in its ability to absorb heat in the atmosphere. HFCs and PFCs are the most heat-absorbent. Methane traps over 21 times more heat per molecule than carbon dioxide, and nitrous oxide absorbs 270 times more heat per molecule than carbon dioxide. Conventionally, the GWP of carbon dioxide, measured across all time horizons, is 1. The GWPs of other greenhouse gases are then measured relative to the GWP of carbon dioxide. Thus GWP of methane is 21 while GWP of nitrous oxide is 270.

Other greenhouse gases have much higher GWPs than carbon dioxide, but because their concentration in the atmosphere is much lower, carbon dioxide is still the most important greenhouse gas, contributing about 60% to the enhancement of the greenhouse effect.

9.3.3 Global Warming (Climate Change) Implications

Rise in global temperature

Observations show that global temperatures have risen by about 0.6 °C over the 20th century. There is strong evidence now that most of the observed warming over the last 50 years is caused by human activities. Climate models predict that the global temperature will rise by about 6 °C by the year 2100.

Rise in sea level

In general, the faster the climate change, the greater will be the risk of damage. The mean sea level is expected to rise 9 - 88 cm by the year 2100, causing flooding of low lying areas and other damages.

Food shortages and hunger

Water resources will be affected as precipitation and evaporation patterns change around the world. This will affect agricultural output. Food security is likely to be threatened and some regions are likely to experience food shortages and hunger.

India could be more at risks than many other countries

Models predict an average increase in temperature in India of 2.3 to 4.8^{o}C for the benchmark doubling of Carbon-dioxide scenario. Temperature would rise more in Northern India than in Southern India. It is estimated that 7 million people would be displaced, 5700 km^2 of land and 4200 km of road would be lost, and wheat yields could decrease significantly.

9.4 Loss of Biodiversity

Biodiversity refers to the variety of life on earth, and its biological diversity. The number of species of plants, animals, micro organisms, the enormous diversity of genes in these species, the different ecosystems on the planet, such as deserts, rainforests and coral reefs are all a part of a biologically diverse earth. Biodiversity actually boosts ecosystem productivity where each species, no matter how small, all have an important role to play and that it is in this combination that enables the ecosystem to possess the ability to prevent and recover from a variety of disasters.

It is now believed that human activity is changing biodiversity and causing massive extinctions. The *World Resource Institute* reports that *there is a link between biodiversity* and *climate change*. Rapid global warming can affect ecosystems chances to adapt naturally. Over the past 150 years, deforestation has contributed an estimated 30 percent of the atmospheric build-up of CO_2. It is also a significant driving force behind the loss of genes, species, and critical ecosystem services.

Link between Biodiversity and Climate change

- Climate change is affecting species already threatened by multiple threats across the globe. Habitat fragmentation due to colonization, logging, agriculture and mining etc. are all contributing to further destruction of terrestrial habitats.
- Individual species may not be able to adapt. Species most threatened by climate change have small ranges, low population densities, restricted habitat requirements and patchy distribution.
- Ecosystems will generally shift northward or upward in altitude, but in some cases they will run out of space – as 1^0C change in temperature correspond to a 100 Km change in latitude, hence, average shift in habitat conditions by the year 2100 will be on the order of 140 to 580 Km.
- Coral reef mortality may increase and erosion may be accelerated. Increase level of carbon dioxide adversely impact the coral building process (calcification).
- Sea level may rise, engulfing low-lying areas causing disappearance of many islands, and extinctions of endemic island species.
- Invasive species may be aided by climate change. Exotic species can out-compete native wildlife for space, food, water and other resources, and may also prey on native wildlife.
- Droughts and wildfires may increase. An increased risk of wildfires due to warming and drying out of vegetation is likely.
- Sustained climate change may change the competitive balance among species and might lead to forests destruction

9.5 Climatic Change Problem and Response

9.5.1 The United Nations Framework Convention on Climate Change, UNFCCC

In June 1992, the "United Nations Framework Convention on Climate Change" (UNFCCC) was signed in Rio de Janeiro by over 150 nations. The climate convention is the base for international co-operation within the climate change area. In the convention the climate problem's seriousness is stressed. There is a concern that human activities are enhancing the natural greenhouse effect, which can have serious consequences on human settlements and ecosystems.

The convention's overall objective is the stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."

The principle commitment applying to parties of the convention is the adoption of policies and measures on the mitigation of climate change, by limiting anthropogenic emissions of greenhouse gases and protecting and enhancing greenhouse gas sinks and reservoirs. The commitment includes the preparation and communication of national inventories of greenhouse gases. The Climate convention does not have any quantitative targets or timetables for individual nations. However, the overall objective can be interpreted as stabilization of emissions of greenhouse gases by year 2000 at 1990 levels.

The deciding body of the climate convention is the Conference of Parties (COP). At the COP meetings, obligations made by the parties are examined and the objectives and implementation of the climate convention are further defined and developed. The first COP was held in Berlin, Germany in 1995 and the latest (COP 10) was held in December 2004, Buenos Aires, Argentina.

9.5.2 The Kyoto Protocol

There is a scientific consensus that human activities are causing global warming that could result in significant impacts such as sea level rise, changes in weather patterns and adverse health effects. As it became apparent that major nations such as the United States and Japan would not meet the voluntary stabilization target by 2000, Parties to the Convention decided in 1995 to enter into negotiations on a protocol to establish legally binding limitations or reductions in greenhouse gas emissions. It was decided by the Parties that this round of negotiations would establish limitations only for the developed countries, including the former Communist countries (called annex A countries).

Negotiations on the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) were completed December 11, 1997, committing the industrialized nations to specify, legally binding reductions in emissions of six greenhouse gases. The 6 major greenhouse gases covered by the protocol are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).

Emissions Reductions

The United States would be obligated under the Protocol to a cumulative reduction in its greenhouse gas emissions of 7% below 1990 levels for three greenhouse gases (including carbon dioxide), and below 1995 levels for the three man-made gases, averaged over the commitment period 2008 to 2012.

The Protocol states that developed countries are committed, individually or jointly, to ensuring that their aggregate anthropogenic carbon dioxide equivalent emissions of greenhouse gases do not exceed amounts assigned to each country with a view to reducing their overall emissions of such gases by at least 5% below 1990 levels in the commitment period 2008 to 2012.

The amounts for each country are listed as percentages of the base year, 1990 and range from 92% (a reduction of 8%) for most European countries--to 110% (an increase of 10%) for Iceland.

Developing Country Responsibilities

Another problematic area is that the treaty is ambiguous regarding the extent to which developing nations will participate in the effort to limit global emissions. The original 1992 climate treaty made it clear that, while the developed nations most responsible for the current buildup of greenhouse gases in the atmosphere should take the lead in combating climate change, developing nations also have a role to play in protecting the global climate. Per Capita CO_2 emissions are small in developing countries and developed nations have altered the atmosphere the most as shown in the Figure 9.5 & Figure 9.6.

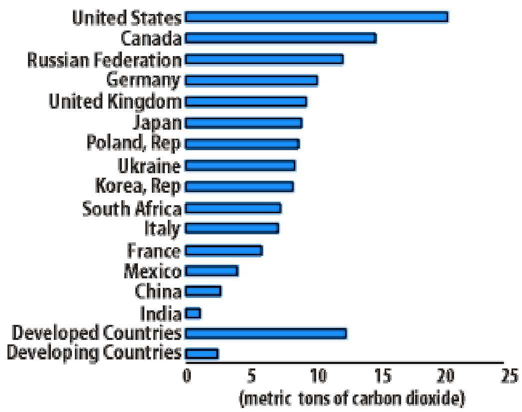


Figure 9.5 Per Capita CO_2 Emissions for the 15 Countries With the Highest Total Industrial Emissions, 1995

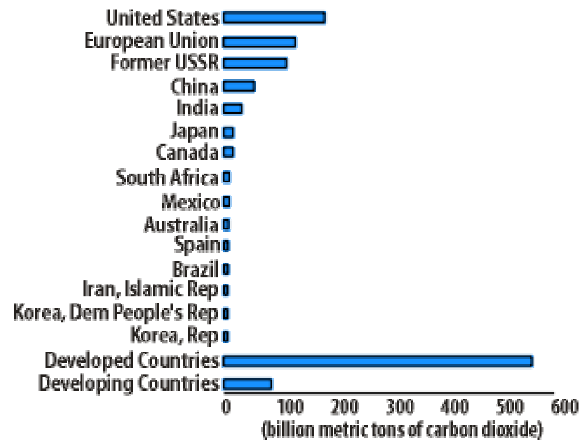


Figure 9.6 Cumulative Carbon-Dioxide Emissions, 1950-95

Developing countries, including India and China, do not have to commit to reductions in this first time period because their per-capita emissions are much lower than those of developed countries, and their economies are less able to absorb the initial costs of changing to cleaner fuels. They have not contributed significantly to today's levels of pollution that has been the product of the developed world's Industrial Revolution. The idea is that developing countries will be brought more actively into the agreement as new energy technologies develops and as they industrialize further.

Annex I and Annex II Parties

Annex I parties are countries which have commitments according to the Kyoto protocol. The entire Annex I parties are listed in the Table 9.1 below. Further Annex I parties shown in bold are also called Annex II parties. These Annex II parties have a special obligation to provide "new and additional financial sources" to developing countries (non Annex I) to help them tackle climate change, as well as to facilitate the transfer of climate friendly technologies to both developing countries and to economies in transition. Commitments are presented as percentage of base year emission levels to be achieved during between 2008 – 2012.

Table 9.1 Annex I and Annex II Parties

European Union	%	Economies in transition to a market economy	%
Austria	92	Bulgaria	92
Belgium	92	Croatia	95
Denmark	92	Czech Republic	92
Finland	92	Estonia	92
France	92	Hungary	94
Germany	92	Latvia	92
Greece	92	Lithuania	92
Ireland	92	Poland	94
Italy	92	Romania	92
Luxembourg	92	Russian Federation	100
Netherlands	92	Slovakia	92
Portugal	92	Slovenia	92
Spain	92	Ukraine	100
Sweden	92		
United Kingdom	92		
Other Europe		Other Annex I	
Iceland	110	**Australia**	108
Liechtenstein	92	**Canada**	94
Monaco	92	**Japan**	94
Norway	101	**New Zealand**	100
Switzerland	92	**United States of America**	93

Base year is 1990 for all countries except those economies in transition, who may chose an alternative base year or multi-year period.

Actions required from developed and developing Nations

The Kyoto Protocol does call on all Parties (developed and developing) to take a number of steps to formulate national and regional programs to improve "local emission factors," activity data, models, and national inventories of greenhouse gas emissions and sinks that remove these gases from the atmosphere. All Parties are also committed to formulate, publish, and update climate change mitigation and adaptation measures, and to cooperate in promotion and transfer of environmentally sound technologies and in scientific and technical research on the climate system.

Who is bound by the Kyoto Protocol?

The Kyoto Protocol has to be signed and ratified by 55 countries (including those responsible for at least 55% of the developed world's 1990 carbon dioxide emissions) before it can enter into force. Now that Russia has ratified, this been achieved and the Protocol will enter into force on 16 February 2005.

9.5.3 India's Greenhouse Gas Emissions

India has experienced a dramatic growth in fossil fuel CO_2 emissions, and the data compiled by various agencies shows an increase of nearly 5.9 % since 1950. At present India is rated as the 6th largest contributor of CO_2 emissions behind China, the 2nd largest contributor. However, our per capita CO_2 of 0.93 tons per annum is well below the world average of 3.87 tons per annum. Fossil fuel emissions in India continue to result largely from coal burning. India is highly vulnerable to climate change as its economy is heavily reliant on climate sensitive sectors like agriculture and forestry. The vast low-lying and densely populated coastline is susceptible to rise in sea level.

The energy sector is the largest contributor of carbon dioxide emissions in India. The national inventory of greenhouse gases indicates that 55% of the total national emissions come from energy sector. These include emissions from road transport, burning of traditional bio-mass fuels, coal mining, and fugitive emissions from oil and natural gas.

Agriculture sector constitutes the next major contributor, accounting for nearly 34%. The emissions under this sector include those from enteric fermentation in domestic animals, manure management, rice cultivation, and burning of agriculture residues. Emissions from Industrial sector mainly came from cement production.

Indian Response to Climatic Change

Under the UNFCCC, developing countries such as India do not have binding GHG mitigation commitments in recognition of their small contribution to the greenhouse problem as well as low financial and technical capacities. The Ministry of Environment and Forests is the nodal agency for climate change issues in India. It has constituted Working Groups on the UNFCCC and Kyoto Protocol. Work is currently in progress on India's initial National Communication (NATCOM) to the UNFCCC. India ratified the Kyoto Protocol in 2002

9.6 The Conference of the Parties (COP)

The Conference of the Parties is the supreme body of the Climate Change Convention. The vast majority of the world's countries are members (185 as of July 2001). The Convention enters into force for a country 90 days after that country ratifies it. The COP held its first session in 1995 and will continue to meet annually unless decided otherwise. However, various subsidiary bodies that advise and support the COP meet more frequently.

The Convention states that the COP must periodically examine the obligations of the Parties and the institutional arrangements under the Convention. It should do this in light of the Convention's objective, the experience gained in its implementation, and the current state of scientific knowledge.

Exchange of Information

The COP assesses information about policies and emissions that the Parties share with each other through their national communications. It also promotes and guides the development and periodic refinement of comparable methodologies, which are needed for quantifying net greenhouse gas emissions and evaluating the effectiveness of measures to limit them. Based on the information available, the COP assesses the Parties efforts to meet their treaty commitments and adopts and publishes regular reports on the Convention's implementation.

Support for Developing countries

Developing countries need support so that they can submit their national communications, adapt to the adverse effects of climate change, and obtain environmentally sound technologies. The COP therefore oversees the provision of new and additional resources by developed countries.

The third session of the Conference of the Parties adopted the Kyoto Protocol.

9.6.1 The Flexible Mechanisms

The Kyoto protocol gives the Annex I countries the option to fulfill a part of their commitments through three "flexible mechanisms". Through these mechanisms, a country can fulfill a part of their emissions reductions in another country or buy emission allowances from another country. There are three flexible mechanisms:

i. Emissions trading
ii. Joint implementation
iii. Clean development mechanism

i) Emissions trading

Article 17 of the Kyoto protocol opens up for emissions trading between countries that have made commitments to reduce greenhouse gas emissions. The countries have the option to delegate this right of emissions trading to companies or other organisations.

In a system for emissions trading, the total amount of emissions permitted is pre-defined. The corresponding emissions allowances are then issued to the emitting installations through auction or issued freely. Through trading, installations with low costs for reductions are stimulated to make reductions and sell their surplus of emissions allowances to organisations where reductions are more expensive. Both the selling and buying company wins on this flexibility that trade offers with positive effects on economy, resource efficiency and climate. The environmental advantage is that one knows, in advance, the amount of greenhouse gases that will be emitted. The economical advantage is that the reductions are done where the reduction costs are the lowest. The system allows for a cost effective way to reach a pre-defined target and stimulates environmental technology development.

ii) Joint Implementation, JI

Under article 6 of the Kyoto protocol an Annex I country that has made a commitment for reducing greenhouse gases, can offer to, or obtain from another Annex I country greenhouse gas emissions reductions. These emissions reductions shall come from projects with the objectives to reduce anthropogenic emissions from sources or increase the anthropogenic uptake in sinks. In order to be accepted as JI-projects, the projects have to be accepted by both parties in advance. It also has to be proven that the projects will lead to emissions reductions that are higher than what otherwise would have been obtained. JI-projects are an instrument for one industrial country to invest in another industrial country and in return obtain emissions reductions. These reductions can be used to help fulfill their own reduction commitments at a lower cost than if they had to do the reductions in their own country.

iii) Clean Development Mechanism (CDM)

Article 12 of the Kyoto protocol defines the Clean Development Mechanism, CDM. The purpose of CDM is to:

a) contribute to sustainable development in developing countries;
b) help Annex I-countries under the Kyoto Protocol to meet their target.

With the help of CDM, countries which have set themselves an emission reduction target under the Kyoto Protocol (Annex I countries) can contribute to the financing of projects in developing countries (non-Annex I countries) which do not have a reduction target. These projects should reduce the emission of greenhouse gases while contributing to the sustainable development of the host country involved. The achieved emission reductions can be purchased by the Annex I country in order to meet its reduction target.

In order to be accepted as CDM-projects, the projects have to be accepted by both parties in advance. It also has to be proven that the projects will lead to emissions reductions that are higher than what otherwise would have been obtained. The difference between JI-projects and CDM-projects is that JI-projects are done between countries that both have commitments, while the CDM-projects is between one country that has commitments and another country that does not have commitments. Emissions reductions that have been done through CDM-projects during the period 2000 to 2007, can be used for fulfilling commitments in Annex I countries for the period 2008-2012.

How CDM works?

An investor from a developed country, can invest in, or provide finance for a project in a developing country that reduces greenhouse gas emissions so that they are lower than they would have been without the extra investment – i.e. compared to what would have happened without the CDM under a business as usual outcome. The investor then gets credits – carbon credits - for the reductions and can use those credits to meet their Kyoto target. If the CDM works perfectly it will not result in more or less emission reductions being achieved than were agreed under the Kyoto Protocol, it will simply change the location in which some of the reductions will happen.

For example, a French company needs to reduce its emissions as part of its contribution to meeting France’s emission reduction target under the Kyoto Protocol. Instead of reducing emissions from its own activities in France, the company provides funding for the construction of a new biomass plant in India that would not have been able to go ahead without this investment. This, they argue, prevents the construction of new fossil-fueled plants in India, or displaces consumption of electricity from existing ones, leading to a reduction in greenhouse gas emissions in India. The French investor gets credit for those reductions and can use them to help meet their reduction target in France.

Requirements for Participating in CDM

Criteria

All Annex I and non-Annex I nations must meet three requirements for participation in CDM.

- Voluntary participation
- Establishment of National CDM Authority
- Ratification of Kyoto Protocol

In addition Annex I nations must establish:

- the assigned amount under Article 3 of the Protocol
- a national system for the estimation of GHG
- a national registry
- an annual inventory and
- an accounting system for the sale and purchase of emission reductions.

Eligible Projects

The CDM can include projects the following projects:

- End-use energy efficiency improvements
- Supply-side energy efficiency improvement
- Renewable energy
- Fuel switching
- Agriculture (reduction of CH_4 and N_2o emissions)
- Industrial processes (CO_2 from cement etc., HFCs, PFCs, SF_6
- Sinks projects (only afforestation and reforestation)

Note: Annex I nations must refrain from using CERs generated through nuclear energy to meet their targets

Project cycle for CDM

The project cycle for CDM is shown in Figure 9.7. There are seven basic stages; the first four stages are performed prior to the implementation of the project, while the last three stages are performed during the lifetime of the project.

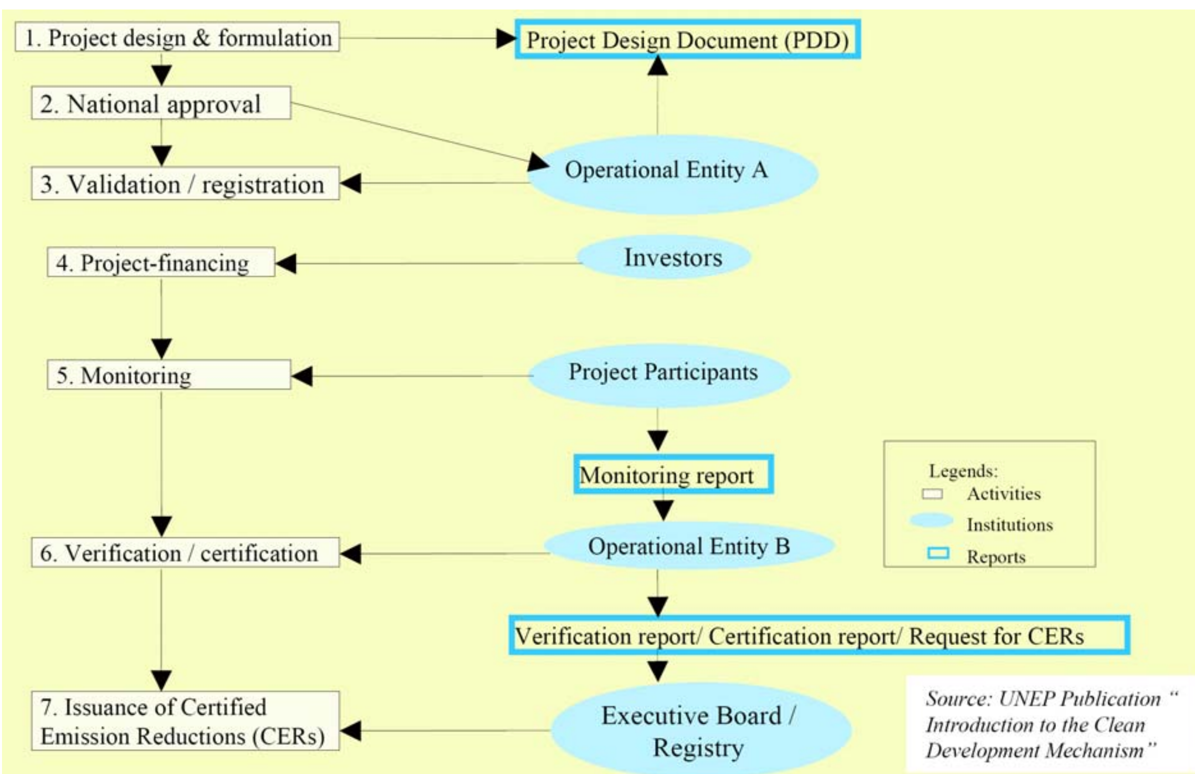


Figure 9.7 Project Cycle for CDM

While investors profit from CDM projects by obtaining reductions at costs lower than in their own countries, the gains to the developing country host parties are in the form of finance, technology, and sustainable development benefits.

Projects starting in the year 2000 are eligible to earn Certified Emission Reductions (CERs) if they lead to "real, measurable, and long-term" GHG reductions, which are additional to any that would occur in the absence of the CDM project. This includes afforestation and reforestation projects, which lead to the sequestration of carbon dioxide.

At COP-7, it was decided that the following types of projects would qualify for fast-track approval procedures:

- Renewable energy projects with output capacity up to 15 MW
- Energy efficiency improvement projects which reduce energy consumption on the supply and/or demand side by up to 15 GWh annually
- Other project activities that both reduce emissions by sources and directly emit less than 15 kilotons CO_2 equivalent annually.

The CDM will be supervised by an executive board, and a share of the proceeds from project activities will be used to assist developing countries in meeting the costs of adaptation to climate change.

Indian Initiatives on CDM

Government of India has been willing to fulfill its responsibility under the CDM. It has developed an interim criterion for approval of CDM project activities, which is now available to stakeholders. It has undertaken various capacity building activities like holding of workshops, initiation of various studies, and briefing meeting with the stakeholders. India has been actively participating in the CDM regime and has already approved projects for further development.

Under CDM, projects such as energy efficient hydrocarbon refrigerators, modernization of small scale foundry units and renovation, modernization of thermal power stations etc. are being taken up.

Case Example

In a power plant renovation and modernization programme by replacing plant equipment which are prone to wear and tear over a period of time, such as boilers and auxiliaries, turbine blades, HP governor valves and station auxiliaries which include material handling equipment, water treatment, pulverisers, ash handling plant, ESP etc resulted in CO2 emission reduction from 1.20 kg/kWh to 1.11 kg/kWh. The details are shown in the Table 9.2:

Table 9.2 Efficiency Improvement And Emission Reduction in a Power Plant Modernisation Programme

Parameters	Before the programme	After the programme
Gross heat rate (kcal/KWh)	2700	2500
Net efficiency (%)	28	30
Specific coal consumption	0.77	0.71
Total CO_2 emissions (tones/year)	1435336	1329015
CO_2 emissions (kg/ kWh)	1.20	1.11

9.7 Prototype Carbon Fund (PCF)

Recognizing that global warming will have the most impact on its borrowing client countries, the World Bank approved the establishment of the Prototype Carbon Fund (PCF). The PCF is intended to invest in projects that will produce high quality greenhouse gas emission reductions that could be registered with the United Nations Framework Convention on Climate Change (UNFCCC) for the purposes of the Kyoto Protocol. To increase the likelihood that the reductions will be recognized by the Parties to the UNFCCC, independent experts will follow validation, verification and certification procedures that respond to UNFCCC rules as they develop.

The PCF will pilot production of emission reductions within the framework of Joint Implementation (JI) and the Clean Development Mechanism (CDM). The PCF will invest contributions made by companies and governments in projects designed to produce emission reductions fully consistent with the Kyoto Protocol and the emerging framework for JI and the CDM. Contributors, or "Participants" in the PCF, will receive a pro rata share of the emission reductions, verified and certified in accordance with agreements reached with the respective countries "hosting" the projects.

9.7.1 Size of Market for Emissions Reductions

- All estimates of market volume are speculative at this early stage in the market’s development.
- One way of looking at the potential size of the market is to assume that about one billion tonnes of carbon emissions must be reduced per year during the commitment period of 2008-2012 in order for the industrialized countries to meet their obligations of a 5% reduction in their 1990 levels of emissions.

Under Prototype carbon fund programme of the World Bank. Government of India has approved a municipal solid waste energy project for implementation in Chennai, which proposes to use the state of art technology for extracting energy from any solid waste irrespective of the energy content. Many industrial organisations in the private sector have also sought assistance under this fund.

9.8 Sustainable Development

9.8.1 What is Sustainable Development?

Sustainable development is often defined as 'development that meets the needs of the present, without compromising the ability of future generations to meet their own needs'.

Figure 9.8 Sustainable Development

Sustainable development encompasses three basic and inter-related objectives:

- Economic security and prosperity
- Social development and advancement
- Environmental sustainability

Sustainable development demands that we seek ways of living, working and being that enable all people of the world to lead healthy, fulfilling, and economically secure lives without destroying the environment and without endangering the future welfare of people and the planet.

Sustainable development as applied to energy and environment should consider the following:

- inputs - such as fuels and energy sources, land and raw materials - are non-renewable they should be used up only as far as they can be substituted in future
- where they are renewable they should be used up at a rate within which they can be renewed,
- outputs - in production and consumption - should not overstrain ecosystems or the assimilation capacity of the ecosphere.

QUESTIONS

1	Name and explain three effects of ozone layer depletion.
2	Explain ozone layer depletion problem?
3	Ozone is formed by combination of a) three oxygen atoms b) one oxygen atom c) four ozone atom d) five ozone atom.
4	Name at least three chemicals responsible for ozone depletion?
5	Name at least three greenhouse gases responsible for global warming?
6	Explain impacts of climatic change on earth?
7	What is the main role of UNFCCC?
8	What do you understand by term "COP" and explain its role?
9	What is Kyoto protocol, and what are its implications for developed and developing countries?
10	Explain CDM and its objectives.
11	What are the uses of prototype carbon fund?
12	Explain the concept of sustainable development.

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