Chapter 1 Climate Change – Short Version

1. Air Emission Overview

As the boom in industrialisation has taken place in the last few decades, the use of fossil fuel or hydrocarbon has also increased drastically. The fossil fuel consists of hydrogen, carbon and sulphur which, when burnt, produce water vapour, CO_2 and CO, various kinds of sulphur oxides (SO_x), and during the burning process with air it produces nitrogen oxides (NO_x).

Except for the water vapour, the other flue products are mainly toxic and some of them contribute to reduction of the oxygen level in the air.

These emissions have severe impact on human health and natural eco systems including the sea and land.

Air emissions affect public health; the environment, sea, land, agriculture, etc. which has been documented and observed by international authorities and the scientific community.

Air pollution, in the long run, is responsible for damaging the eco system and the formation of biological pathogens.

There are other kinds of emissions which are known as Greenhouse Gases (GHGs) and Ozone Depleting Substances (ODS). The GHGs increase the earth's temperature resulting in climate change and the ODS ruptures the ozone layers which are very important barriers in filtering out the cancer causing ultra violet rays from the Sun.

The GHG and ODS are considered to be key substances with global adverse impacts on the environment as a whole while the other pollutants are mostly, but not entirely, responsible for local or regional undesired impacts.

1.1 Origins of Air Emissions

It is well established that the air contains a large variety of gas or vaporous components. Despite the overwhelming presence of oxygen and nitrogen, the atmosphere contains various gases, vapours and aerosols. Such substances originate from natural processes or as a result of human activities.

- Naturogenic Emissions: Natural chemical and biochemical processes release particulate matters and gaseous substances into the atmosphere e.g. volcanic gas eruptions, forest fires, decaying dead animals, humans or plants, etc.
- Anthropogenic Emissions: Marine and industrial activities, produce large amounts of gases and chemicals which are released into the atmosphere. These emissions are increasing day by day as industrialisation and shipping trade increases. Some emitted gases and particulates are inert and play no significant role to harm the atmosphere and living organisms, while others are toxic and harmful to the environment.

1.2 Air Pollutants and Humans

Clean air is of important for humans and other creatures to breathe. Human lungs breathe in about 13,000 litres of air a day at a normal pace. Therefore, air quality is a very important factor for the human body oxygen in the air is mixed with blood in the lungs.

Therefore, contaminated air containing harmful substances can damage the respiratory system and eventually, the whole body.

The negative impacts on the human body were first observed in the highly dense industrialised cities where the first effort to manage the air quality was initiated.

1.3 Justification of Action

Global industrialisation, and subsequent marine transportation system growth, has been solely based on energy from fossil fuels. The huge increase in exploration and the combustion of fossil fuels, due to global trade demand, is causing increased contamination of the air, which in turn is causing global warming and climate change.

The amount of pollutant emitted to air is so large that it cannot be ignored any further. Some 100,000,000,000 kg of CO_2 is emitted into the atmosphere from transportation sector alone every year. The overall CO_2 emission is reported to be 10 Gigatonnes. Consider that similar amount of NO_2 and other pollutants are also emitted the total is by far too great to ignore when considering the known adverse impact on our planet by these toxins.

Warming of the climate system is now evident from the observation of increases in global ocean and air temperatures, widespread melting of ice and rising global average sea level. Increase in carbonic acid in our ocean is an indication of problems the planet is trying to adjust but as carbonic acid is unstable the carbon is often returned back into atmosphere through the saturation process in the oceans.

Taking such impacts into account, it would be prudent to keep the rate of increase of air pollution under control by utilising the available energy resources in a very efficient manner and minimising the emission of ODS.

2. Climate System and Global Warming

2.1 Overview

The climate is usually defined as the average weather over long term periods. In a more scientifically accurate way, the climate can be defined as “the statistical description in terms of the mean and variability of relevant quantities over a period of time”. So, the climate differs from the weather which is of chaotic nature and barely predictable, except over a short time scale. The climate thus refers to an average image of the weather over a longer time scale within which extreme short-term events are invisible.

The climate is a whole system which combines numerous interactions and retroactions between various complex subsystems: the atmosphere, oceans, land, ice and snow, living creatures including human beings and their activities (IPCC, 2007).

The dynamics of the Earth’s climate are impacted by the alteration of each of the following system:

- The lithosphere (i.e. solid layer of the Earth)
- the hydrosphere (i.e. the waters)
- the cryosphere (i.e. frozen waters)
- the biosphere (i.e. the living)
- the atmosphere (i.e. gases).

The Lithosphere

The lithosphere contains all of the cold, hard solid land of the planet's crust (surface), the semi-solid land underneath the crust, and the liquid land near the centre of the planet. The surface of the lithosphere is very uneven (see Fig. 1). There are high mountain ranges like the Rockies and Andes (shown in red), huge plains or flat areas like those in Texas, Iowa, and Brazil (shown in green), and deep valleys along the ocean floor (shown in blue).

The solid, semi-solid, and liquid land of the lithosphere form layers that are physically and chemically different. If someone were to cut through Earth to its centre, these layers would be revealed like the layers of an onion (see Fig. 1). The outermost layer of the lithosphere consists of loose soil rich in nutrients, oxygen, and silicon. Beneath that layer lies a very thin, solid crust of oxygen and silicon. Next is a thick, semi-solid mantle of oxygen, silicon, iron, and magnesium. Below that is a liquid outer core of nickel and iron. At the centre of the Earth is a solid inner core of nickel and iron.

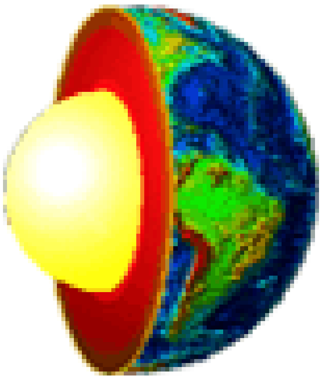


Fig. 1: The Lithosphere

The Hydrosphere

The hydrosphere contains all the solid, liquid, and gaseous water of the planet. It ranges from 10 to 20 kilometres in thickness. The hydrosphere extends from the Earth's surface downward several kilometres into the lithosphere and upward about 12 kilometres into the atmosphere.

A small portion of the water in the hydrosphere is fresh (non-salty). This water flows as precipitation from the atmosphere down to Earth's surface, as rivers and streams along Earth's surface, and as groundwater beneath Earth's surface. Most of Earth's fresh water, however, is frozen.

Ninety-seven percent of Earth's water is salty. The salty water collects in deep valleys along Earth's surface. These large collections of salty water are referred to as oceans. Figure 2 depicts the different temperatures one would find on oceans' surfaces. Water near the poles is very cold (shown in dark purple), while water near the Equator is very warm (shown in light blue). The differences in temperature cause water to change physical states. Extremely low temperatures like those found at the poles cause water to freeze into a solid state such as a polar icecap, a glacier, or an iceberg. Extremely high temperatures like those found at the equator cause water to evaporate.

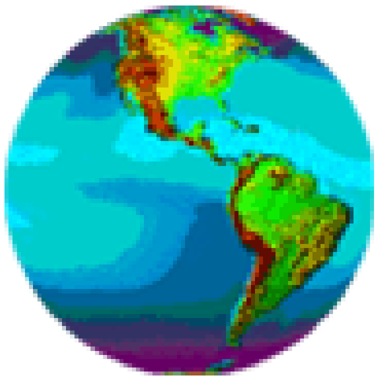


Fig. 2: The Hydrosphere

The Cryosphere

Some scientists place frozen water (glaciers, icecaps, and icebergs) in its own sphere called the "cryosphere." For the purpose of this module, however, frozen water will be included as part of the hydrosphere. The word "hydrosphere" will be used in reference to water in all forms in Earth's system.

The Biosphere

The biosphere contains all the planet's living things (micro organisms, plants, and animals).

Within the biosphere, living things form ecological communities based on the physical surroundings of an area. These communities are referred to as **biomes**. Deserts, grasslands, and tropical rainforests are three of the many types of biomes that exist within the biosphere.

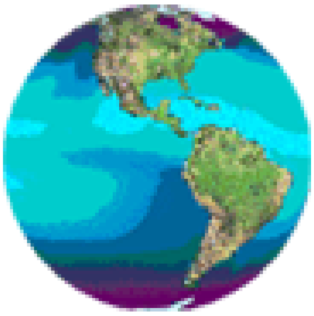


Fig. 3: The Biosphere.

It is impossible to detect from space each individual organism within the biosphere. However, biomes can be seen from space. For example, figure 3 distinguishes between lands covered with plants (shown in shades of green) and those that are not (shown in brown).

Humans are placed in their own sphere called the '**Anthrosphere**'. It is also known as the '**Technosphere**'. For the purpose of this article, however, humans will be included as part of the biosphere. The word "biosphere" will be used in reference to all living creatures in Earth's system.

Fig. 4: The Anthrosphere

The Atmosphere

The atmosphere contains all the air in Earth's system. It extends from less than 1 m below the planet's surface to more than 10,000 km above the planet's surface. The upper portion of the atmosphere protects the organisms of the biosphere from the Sun's ultraviolet radiation by means of the protecting layer of ozone gas. It also absorbs and emits heat energy. When air temperature in the lower portion of this sphere changes, weather changes occur. As air in the lower atmosphere is heated or cooled, it moves around the planet as a result of density change. The result can be as simple as a breeze or as complex as a tornado.

The main reason for of this assignment is ultimately to make young people aware of harmful emissions and find ways to reduce these and achieve energy efficiency. The atmosphere is made up of many layers that differ in chemical composition and temperature that play a significant role in protecting the Earth in various ways. Each layer, when subjected to air pollution eventually fails in different ways to protect the Earth according to the type of pollution.

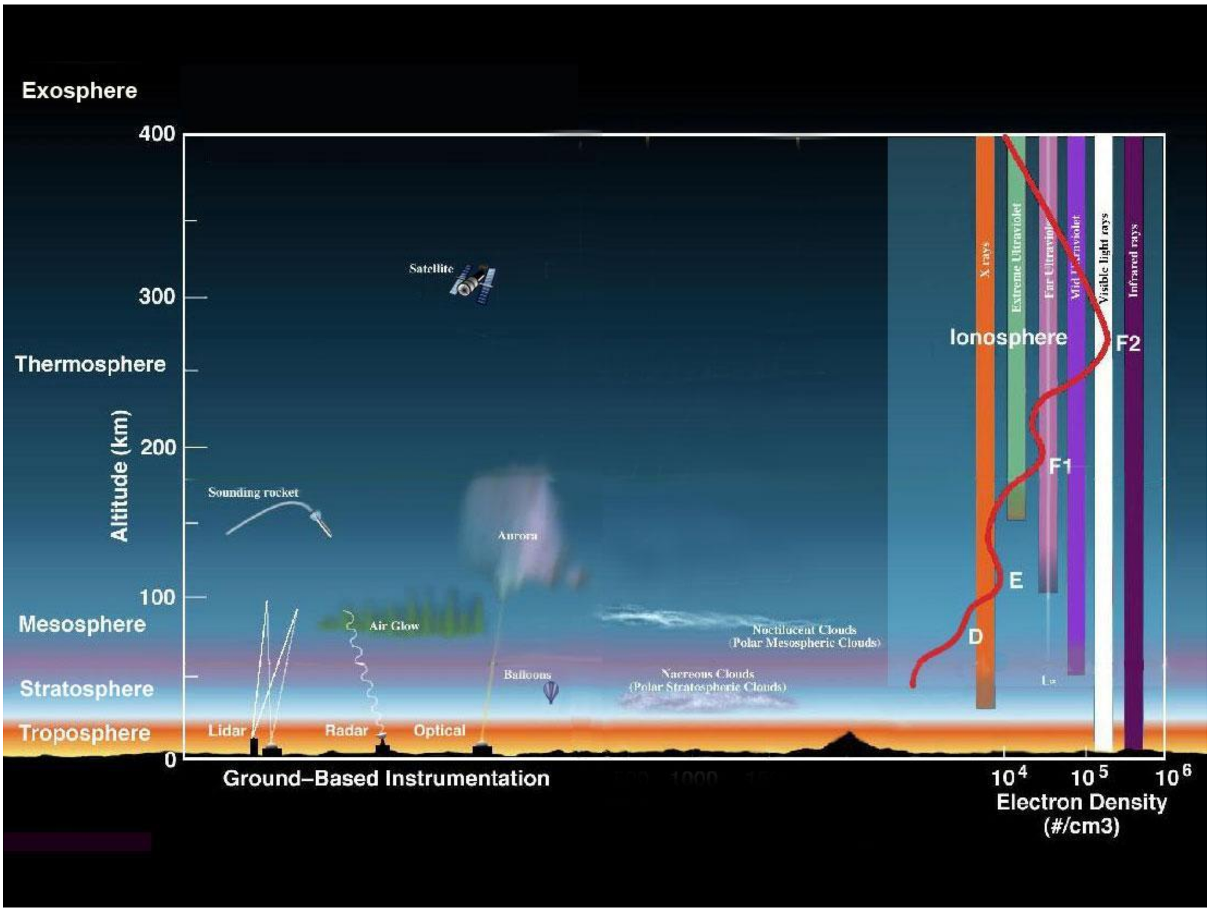


Fig. 5: Diagram of the layers within Earth's atmosphere.

These layers are:

Troposphere - The troposphere starts at the Earth's surface and extends 8 to 14.5 kilometres high. This part of the atmosphere is the densest. Almost all weather is in this region.

Stratosphere - The stratosphere starts just above the troposphere and extends to 50 kilometres high. The ozone layer, which absorbs and scatters the solar ultraviolet radiation, is in this layer.

Mesosphere - The mesosphere starts just above the stratosphere and extends to 85 kilometres (53 miles) high. Meteors burn up in this layer.

Thermosphere - The thermosphere starts just above the mesosphere and extends to 600 kilometres (372 miles) high. Aurora and satellites occur in this layer.

Ionosphere - The ionosphere is an abundant layer of electrons and ionized atoms and molecules that stretches from about 48 kilometres above the surface to the edge of space at about 965 km, overlapping into the mesosphere and thermosphere. This dynamic region grows and shrinks based on solar conditions and divides further into the sub-regions: D, E and F; based on what wavelength of solar radiation is absorbed. The ionosphere is a critical link in the chain of Sun-Earth interactions. This region is what makes radio communications possible.

Exosphere - This is the upper limit of our atmosphere; it extends from the top of the thermosphere up to 10,000 km.

These intertwined elements form and influence the climate system which in return influences them. A permanent retroactive feedback connects the whole and the parts of the climate. In such a complex and dynamic system of interactions, there is no permanent stability. Fig. 6 shows such a complex interaction schematically.

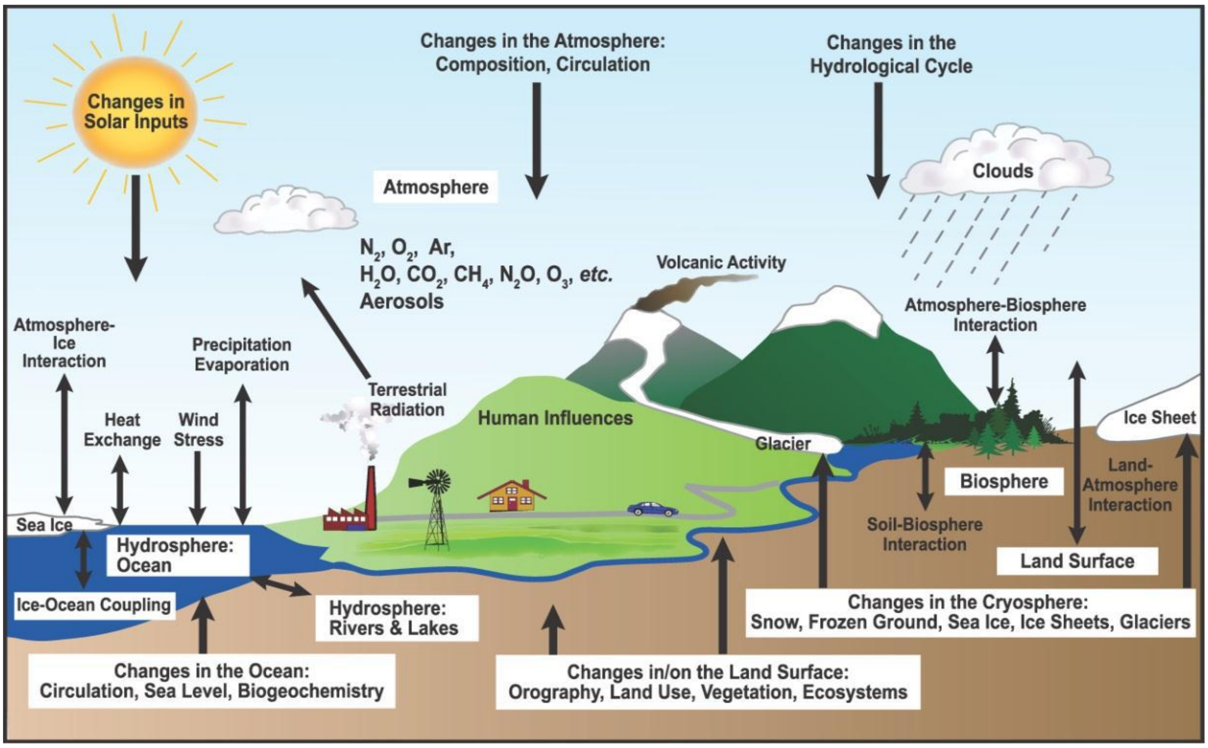


Fig. 6: Schematic view of the components of the climate system, their processes and interactions [IPCC Fourth Assessment Report, Climate Change 2007 (AR4) WG I]

In such a complex system of interactions, the alteration of one system would affect the whole set patterns. The modification of the atmospheric properties affects the other systems which by retroaction influence again the atmosphere. As an example, global warming increases ice melting which retroactively increases the warming effect by reducing radiation reflection from the Sun. This is a massive chain reaction with huge impact of global warming that gives so much prominence and urgency to the control of climate change.

2.2 Greenhouse Gas (GHG) emissions and Climate change

The GHGs act as a blanket for the Earth, leading to warming of the planet (see Fig. 7). The existence of GHGs in the stratosphere is highly valuable because they reflect back the energy of the infrared emitted by the Earth's surface. Without such an effect, the planet would be too cold. The GHGs represent a tiny fraction of the atmosphere, less than 1%. Except purely man-made chemicals like CFCs and HFCs, the GHG emissions naturally, and from natural sources, are present in the atmosphere.

The issue of GHGs is not their presence in the atmosphere but their quantity and concentrations which affects the level of temperature at the Earth's lower atmospheric layers. Ideally and to sustain human life on earth, not too much warming and not too much cooling is desirable.

Presently and with the support of scientific evidence, the man-made air emissions perturb the long-term established atmospheric general equilibrium and the mechanisms which increase the warming effect on the climate tend to overwhelm the others. With the rise of the anthropogenic sources of GHG and the perturbation of the natural sinks – e.g. forests, sea and land; the amount of GHG present in the atmosphere increases and, therefore, amplifies the GHG effect and the warming of the planet.

Global atmospheric concentrations of carbon dioxide, methane and nitrous oxide have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years (see Fig. 8).

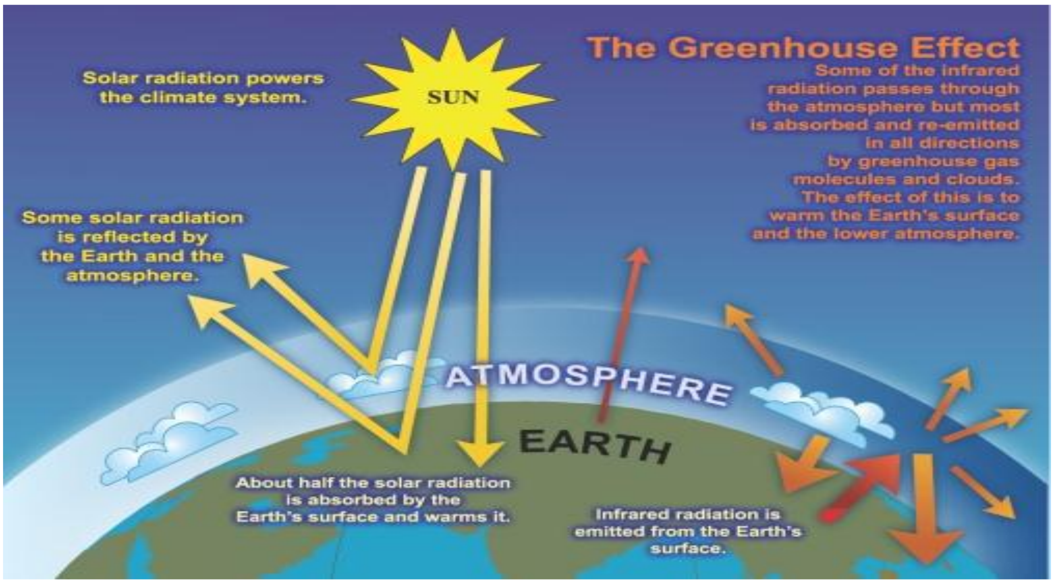
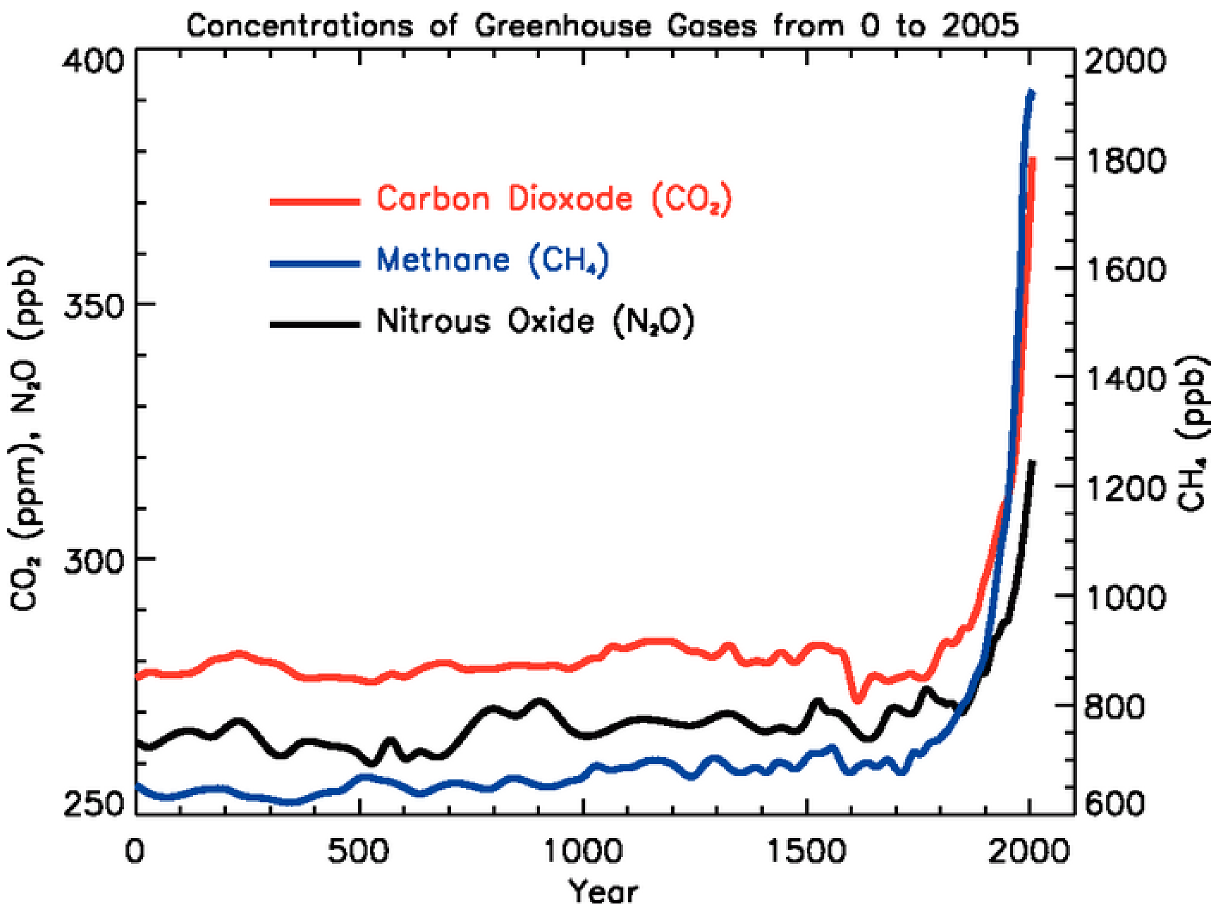


Fig. 7: An idealised model of the natural greenhouse effect [Source: IPCC AR4 WG I]

The global increases in carbon dioxide concentration are due primarily to fossil fuel use and land use change, while those of methane and nitrous oxide are primarily due to agriculture.



Atmospheric concentrations of important long-lived greenhouse gases over the last 2,000 years. Increases since about 1750 are attributed to human activities in the industrial era. Concentration units are parts per million (ppm) or parts per billion (ppb), indicating the number of molecules of the greenhouse gas per million or billion air molecules, respectively, in an atmospheric sample.

Fig. 8: Evolution of atmospheric concentration of a number of GHG emissions [IPCC (2007a)]

The impact of the industrial era on the GHGs amount in the air shows an increase of around 35% for CO_2, 180% for CH_4 and 16% for N_2O (IPCC, 2007) as shown in **Fig. 8**.

2.3 Main GHG Emissions

The main GHGs heat-trapping gases are:

Carbon dioxide (CO_2**):** According to IPCC, this gas influences most the global warming (IPCC, 2001) because of the quantities released and its lifetime in the atmosphere. However, as a natural compound, carbon dioxide belongs to a large carbon circulation between land, atmosphere and oceans in which carbon sources (release) and carbon sinks (capture) co-exists (see **Fig. 9)**

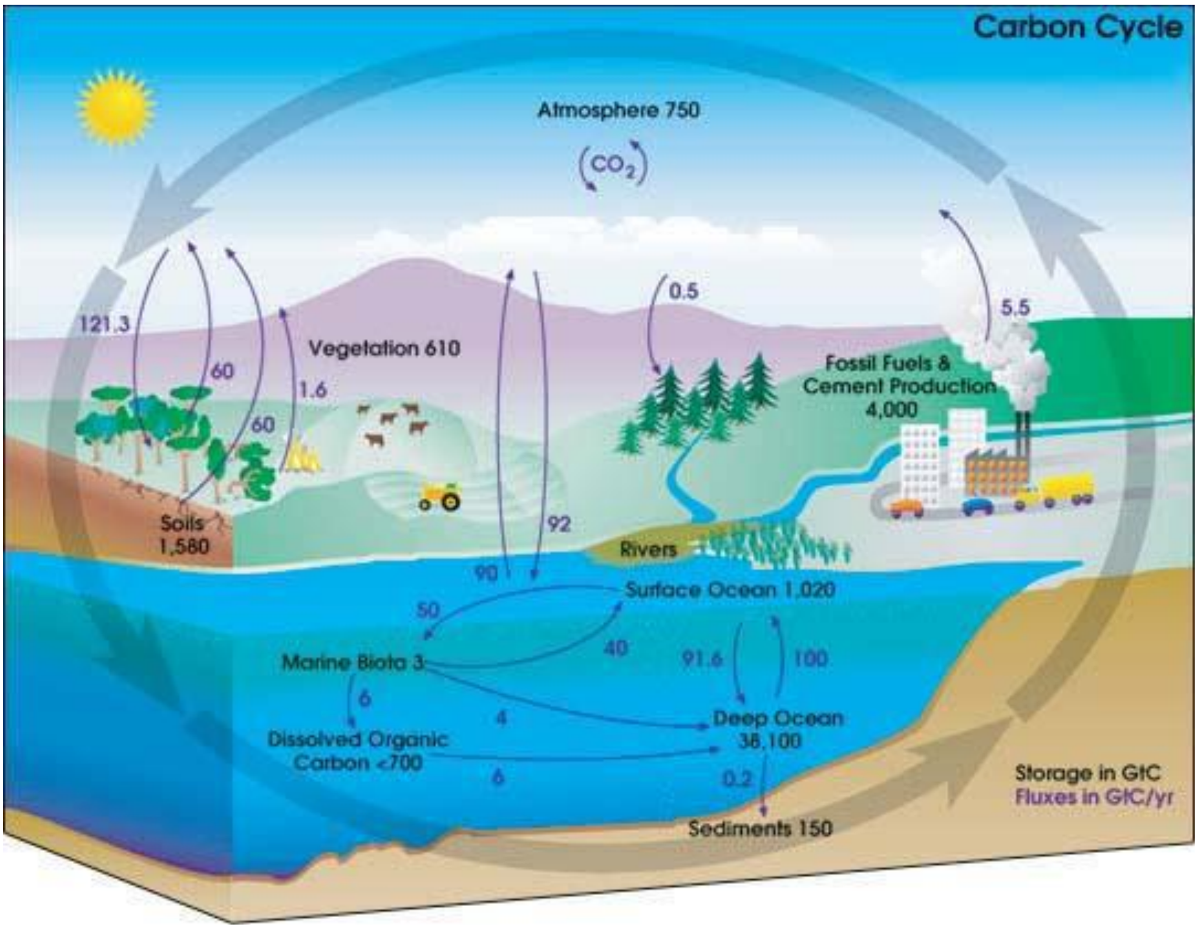


Fig. 9: Major Carbon pools and fluxes of the global carbon balance

Main sources of human-related CO_2 emissions are fossil fuels burned for electricity generation, transportation, industrial and household uses, by-products during the manufacturing of cement, and deforestation.

Globally, over the past several decades, about 80 percent of human-induced carbon dioxide emissions came from the burning of fossil fuels, while about 20 percent resulted from deforestation and associated agricultural practices. The concentration of carbon dioxide in the atmosphere has increased by roughly 35 percent since the start of the industrial revolution.

The fuel used releases CO_2 into the atmosphere supplementing the existing carbon cycle and the CO_2 present in the air. In addition, deforestation, land-use change and soil degradation are affected by human activities which reduce their abilities to capture carbon as sinks. Moreover, there are serious uncertainties in the capacity of the ocean to retain increasing amount of CO_2.

Methane (CH_4): Main sources of human-related CH_4 emissions are: agriculture and livestock, mining, transportation, use of certain fossil fuels, sewage, oil and gas production and processing, and decomposing garbage in landfills. Methane quantities in the air are far less than CO_2 but its warming capacity is very high despite its short lifetime.

Nitrous oxide (N_2O): Industrial farming using large quantities of fertilizers accounts for the majority of the nitrous oxide release. The second position is taken by the combustion of fossil fuels.

Halocarbon (CFCs, HCFCs,): They are mainly man made but some natural halocarbons are produced from forest fires and volcanoes non-natural but manufactured compounds. They are extensively used as refrigerants but may be found in other industrial processes. Despite their very low concentration in the air, their radioactive forcing effect is important and they may remain active for a very long time:

Therefore, these compounds, even with relatively small emissions, have the potential to influence climate far into the future. For example, carbon tetrafluoride (CF_4) resides in the atmosphere for at least 50,000 years.

Their quantities seemed to have peaked in 1994, and are now declining slowly. The regulations on ozone (O_3) Depleting Substances (ODS) contribute to this decay.

Other gases like ozone or water vapour have GHG properties. In addition, the particulate matters emitted in the atmosphere may have varying properties and depending on their type, aerosols can either mask or increase the warming caused by increased levels of GHGs.

2.4 Climate Change Impacts on Oceans

The global warming and substances in the air absorbed by the oceans deeply affect their health. Ecosystems and habitats are disturbed by the modification of the ocean properties by the absorption of pollutants such as CO_2 which are responsible for global warming. Another consequence of the warming is the ocean dilatation and sea-level rise which endangers the coastal ecosystems and accelerates erosion.

In addition, carbon dioxide, combined with other atmospheric compounds, possesses another important impact: ocean acidification. As part of the natural carbon cycle, oceans absorb $CO_2$and when the CO_2 increases in the air the amount dissolved in the oceans increases. In sea water, the CO_2 reacts with H_2O and forms carbonic acid and the overall acidification process of the ocean begins.

$CO_2 + H_2O = H_2CO_3$

The acidification of the surface ocean by anthropogenic carbon dioxide (CO2) absorbed from the atmosphere is now well-recognized and is considered to have lowered surface ocean pH by 0.1 units (corresponding to an approximately 25% increase in the acidity of the surface oceans) since the mid-18th century.
The present rate of increase in ocean acidification has no precedent for the last 30 million years. The high speed acidification may impair the ability of many organisms to cope with changing oceanic properties.

Ocean acidification is known to have significant impacts on ocean areas, including reduced ability of many key marine organisms, including calcareous phytoplankton, the base of much of the marine food chain, to build their shell and skeletal structures; increased physiological stress, reduced growth and survival of early life stages of some species.

Despite the worrying effects of global warming and atmospheric changes, there remain a large number of uncertainties because of the complexity of ecosystems and the social world.
For example, the impact of CO_2 is particularly difficult to predict because it belongs to the carbon cycle of the planet and the land and ocean feedback that increases the concentration of

CO_2. Future releases into the atmosphere are not completely predictable because they largely depend on the evolution of economic and social choices. However, the projected rapid increases in GHGs in recent decades has led to global warming on the scale that it is predicted to cause irreversible harm to all living beings including trees and plants on our planet.

3. Combating Air Pollution: The Role of International Bodies

3.1 Growth of Concern on Air Pollution

3.2 Historical Developments

The great 'smogs' in the UK and USA during the 1950s and 1960s, the groundings of Torrey Canyon (1967) and Amoco Cadiz (1978), damages related to acid rain in the 1970s, the release of poisonous chemicals in Bhopal (1982) and the nuclear accident of Chernobyl (1986), etc. demonstrate the rising "risk to society" of modern industrial activities. The existences of such risks, plus wider evidence of impacts of air emissions on human health, global temperature and ecosystem, have fully shifted the individual and social perceptions of risk, especially those affecting the environment.

In the global risks context, local and national regulations could be deemed ineffective and insufficient as this needs a global response. The progressive recognition of this context offered opportunities to the United Nations bodies to drive adequate international governance.

In the 1970s, the presence of acid rain led to realisation of the magnitude of air pollution and triggered the necessity to build a cooperative agreement. Acid rain is formed when large quantities of NOx and SOx released in the air react with water vapour or rain water and form acids. The inability to control when and where acid rain impacts the environment forced regulators to identify pollution sources contributing to the creation of acid rain. Once identified, those sources could be controlled through the regulatory process.

In 1972, the United Nations Conference on the Human Environment (UNCHE) adopted a body of principles which would later support international instruments. Examples of these principles are:

- Principle 2 recalls the importance of preserving the present "resources of the Earth" for the future.
- Principle 21 sets out that States should "ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction."

The latter principle 21 is also echoed in U.N. General Assembly Resolution 3281 which provides:

"States shall take all measures necessary to ensure that activities under their jurisdiction or control are so conducted as not to cause damage by pollution to other states and their environment, and that pollution arising from incidents or activities under their jurisdiction or control does not spread beyond the areas where they exercise sovereign rights in accordance with this Convention."

The climates of the countries of the world are interdependent. For this reason and in view of the increasing demand for resources by the growing world population that strives for improved living conditions, there is an urgent need for the development of a common global strategy for a greater understanding and a rational use of climate. There is serious concern that the continued expansion of man's activities on Earth may cause significant extended regional and even global changes of climate. This possibility adds further urgency to the need for global co-operation to explore the possible future course of global climate and to take this new understanding into account in planning for the future development of human society.

In the early 80s the development of ozone holes above the poles alerted the world to the global consequences of air emissions. Protection of the ozone layer is a framework Convention aimed to address the issue of the ozone depletion.

The adoption of the Montreal Protocol on Substances that Deplete the Ozone Layer in 1987 enabled binding implementation of the Convention's provisions. These instruments are considered the first action towards the control of substances impairing global atmosphere balance. The Protocol banned man-made compounds known as stratospheric Ozone Depleting Substances (ODSs). These substances increased ultraviolet radiation at Earth's surface as a result of damage to ozone layer; that was observed as an "ozone hole" above the Earth's Polar Regions. ODSs have also significant global warming effect; thus their control positively impacts the control of climate change.

The Montreal Protocol has had lasting impact in both protecting the ozone layer and reducing climate change.

Since most ODSs are also potent greenhouse gases, actions under the Montreal Protocol have had the very positive side effect of substantially reducing a main source of global warming.

Efforts during the 1970s and 1980 produced multiple international regulatory instruments to protect air quality. These instruments aimed to control identified substances but did not intend to holistically address the issue of climate change. In parallel with the creation of such instruments, several international conferences were organized on climate change but no internationally binding instrument was adopted.

3.3 The United Nations Environment Programme (UNEP)

Another important outcome of the UNCHE was the creation of the United Nations Environment Programme (UNEP), whose mandate is to coordinate the global response to established and emerging environmental challenges. The need for such an organization is clearly expressed in the UN Resolution 2997. The mission statement of UNEP is:

"To provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations."

UNEP activities cover the atmosphere, marine and terrestrial ecosystems, environment governance and green economy. After the Brundtland Report 'Our Common Future' and its validation during the 'Rio Summit' in 1992, the concept of sustainable development took centre stage in the UNEP's research and policy activities.

In the field of climate change, the UNEP supports countries and, in particular, developing nations by integrating the climate problem into their domestic development process. Four elements foster the achievement of this objective:

- Adapting to climate change: The purpose is to reduce vulnerability and improve resilience.
- Mitigating climate change: The UNEP supports technologies, policies and investments designed to reduce GHG emissions as well as energy efficiency and conservation programs.
- Reducing emissions from deforestation and forest degradation: The purpose is to valorize forests and sinks as well as to promote sustainable management of forest ecosystems.

Enhancing knowledge and communication: The UNEP support education and awareness programs.

3.4 Intergovernmental Panel on Climate Change (IPCC)

Created under the auspices of the UNEP and the WMO, the Intergovernmental Panel on Climate Change (IPCC) was endorsed by the UN in 1988. The objective was to build an internationally recognized structure capable to regularly monitor and diagnose the evolution on the climate system and its consequences. Its mission is to review:

- The state of knowledge of the science of climate and climatic change;
- Programmes and studies on the social and economic impact of climate change, including global warming;
- Possible response strategies to delay, limit or mitigate the impact of adverse climate change;
- Identification and possible strengthening of relevant existing international legal instruments having a bearing on climate; and
- Elements for inclusion in a possible future international convention on climate.

In other words, the purpose of the IPCC is to provide a clear scientific view on climate change and its potential environmental and socio-economic consequences as well as propose control measures and solutions. IPCC is thus the ultimate expert authority on environmental issues, in particular those related to climate change. The IPCC gathers the data published worldwide and produces assessments reports on the situation of climate change. Thousands of scientists participate in the IPCC in order to provide accurate, rigorous, and reliable data to policy makers.

In 1990, the IPCC published its First Assessment Report with subsequent Assessment Reports at planned intervals. Assessment Reports are part of a series of reports intended to assess scientific, technical and socio-economic information concerning climate change, its potential effects, and options for adaptation and mitigation. The report is the largest and most detailed summary of the climate change situation ever undertaken, produced by thousands of authors, editors, and reviewers from dozens of countries, citing over 6,000 peer-reviewed scientific studies.

The headline findings were:
"warming of the climate system is unequivocal", and "most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations."

3.5 The United Nations Framework Convention on Climate Change (UNFCCC)

After years of intensive negotiation through the Intergovernmental Negotiating Committee on Climate Change, the United Nations Framework Convention on Climate Change (UNFCCC) was adopted and opened for signature in 1992 in the Rio Summit (also known as Earth Summit). The UNFCCC entered into force in March 1994.

The UNFCCC was adopted on the following grounds:

- Climate change is a common concern of human kind requiring a global response;
- Human activities increase GHG emissions;
- Historically, developed countries played the first role in GHG release and should act immediately;
- Developing countries have a high degree of reliance on fossil fuels and may have difficulties addressing GHG issues. In addition, sustainable social and economic development of these countries may need additional energy consumption;
- Predictions have to deal with numerous uncertainties;
- States have the responsibility to make sure the activities under their jurisdiction do not harm other areas;
- The protection of the climate must encompass the environmental, social and economic impacts of the measures taken and be science-based.

The objective of the Convention is to prevent Climate System alteration by stabilizing GHG to a harmless level in order to avoid ecosystem disruption and economic disturbance. The requirements imposed on States are limited to commitments. In short, all Parties have to:

- Develop and communicate to the Conference of Parties a "national inventory of anthropogenic emissions by sources and removals by sinks".
- Commit to develop and communicate the measures related to GHG control.
- Promote "technology transfer and the sustainable management, conservation, and enhancement of greenhouse gas sinks and reservoirs (such as forests and oceans)."
- Consider climate change in social, economic and environmental policy development.
- Cooperate in sciences, techniques and education as well as exchange information related to climate change.
- Promote public awareness and education.
- Following the CBDR principle, the developed countries have to commit to additional requirements:
- They must play a leading role and demonstrate their commitment by developing measures and creating adequate strategies to reduce GHG emission.
- Their policies should aim at returning to their 1990's GHG emission level.
- Several countries may join to pursue a common target.
- The countries in transition to market economy benefit from certain flexibility in the implementation.
- The richest nations shall provide additional funding and facilitate technology transfer.

3.6 The Kyoto Protocol

The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change, which commits its Parties by setting internationally binding emission reduction targets.

The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997 and entered into force on 16 February 2005.

Recognising 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."

Under the Protocol, countries' actual emissions have to be monitored and precise records have to be kept of the trades carried out.

The Kyoto Protocol, like the Convention, is also designed to assist countries in adapting to the adverse effects of climate change. It facilitates the development and deployment of technologies that can help increase resilience to the impacts of climate change.

The Kyoto Protocol is seen as an important first step towards a truly global emission reduction regime that will stabilize GHG emissions, and can provide the architecture for the future international agreement on climate change.

The Kyoto Protocol set binding emission targets for the developed countries in order to pursue the ultimate objective of the UNFCCC: "with a view to reducing their overall emissions of such gases by at least 5 per cent below 1990 levels in the commitment period 2008 to 2012." In addition, the Annex B of the Kyoto Protocol under the "quantified emission limitation or reduction commitment" contains the targets to be reached by individual countries. The GHG emissions are categorised as six main items including CO_2, CH_4, N2O, HFCs, PFCs and SF6.

To reach their targets, countries can reduce their emission and/or offset their emissions by investing in carbon sinks which generate removal units. To facilitate this, the Kyoto Protocol introduces three innovative mechanisms:

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

These mechanisms were designed to limit the cost of mitigation measures by permitting the investment in other countries in which emission reduction can be achieved at cheaper costs. However, such offset strategies of emission reduction in other countries must supplement domestic actions and not being the main objective of the country.

International transportation (shipping and aviation) and Kyoto Protocol

The existence of specialised agencies in charge of air and sea transportation avoided the UNFCCC and the Kyoto Protocol to establish specific rules or targets for these sectors. Instead, the Kyoto Protocol clearly identifies the responsibility of relevant special agencies in dealing with the issue in its Article 2.2 by stating:

"The Parties included in Annex I shall pursue limitation or reduction of emissions of greenhouse gases not controlled by the Montreal Protocol from aviation and marine bunker fuels, working through the International Civil Aviation Organization and the International Maritime Organization, respectively."

Accordingly, the International Civil Aviation Organization (ICAO) and the International Maritime Organization (IMO) are required to pursue the objectives and intentions defined by the UNFCCC. Both ICAO and IMO have been heavily involved on issues relating to control of climate change and GHG emissions from aviation and maritime respectively.

NOTE: This is a shortened version of the Chapter 1. For full chapter see Project GreenShip website: https://www.green-ship.eu/. The full chapter also includes a section on International Energy Management Standards.