THE PLANET IS WARMING

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Introduction

A common opening remark when strangers meet is to comment on the weather: it was unusually warm last night, the rains have not come at their usual time, and heavy rains caused landslides. These are observations or effects obvious to anybody. Scientists have been looking for 'causes' for these 'effects'. The causes, scientists tell us, are anthropogenic – that is, we humans are responsible for the change in our climate, through Global Warming. The phenomenon of Global Warming is brought about by an increase in the concentration of the so-called greenhouse gases, carbon dioxide, methane, nitrous oxides, and others in our atmosphere (Table 1). This increase began around the 1750's with the Industrial Revolution in the West, which required the extraction and burning of fossil fuels – coal, oil and gas – hitherto locked up safely beneath the earth's surface, to power the steam engine and later the internal combustion engines. The climate problem should also be seen within the framework of population increase and the demand for food and energy. This caused widespread deforestation to accommodate the population increase and clearing of land for agriculture.

	Carbon dioxide	Methane	Nitrous oxide	[1]CFC	[2]HFC	Trifluoromethane
Before 1750	280 ppm	700 ppb	270 ppb	0	0	40 ppt
Present concentrations	379 ppm[3]	1,774 ppb[3]	319 ppb[3]	268 ppt[4]	14 ppt[4]	80 ppt[2]
Atmospheric lifetime in years	ca. 100	12	114	45	260	>50,000

Table 1. The important anthropogenic greenhouse gases in our atmosphere (ppm – parts per million, ppb – parts per billion)

[1]Chlorofluorocarbons, [2]Hydrofluorocarbons,
[3]2005 values, [4]1998 values. Source: IPCC 2007 and 2001, respectively.

CO_2 in the atmosphere

Compared to other gases in our atmosphere, the amount of carbon dioxide (CO_2) is extremely low (Table 1). However, it is this tiny fraction that is responsible for keeping our planet warm. The carbon in this planet is locked up in various forms. A large fraction is found in the terrestrial vegetation. Nearly 50% of plant matter is carbon and the biggest reservoirs are our forests and vegetation. Cutting down the trees and burning them releases their carbon as CO_2 into the atmosphere. Below the earth's surface there are vast reservoirs of fossil fuel, whose origin was from vegetation buried million years ago. Fossil fuels are hydrocarbons and their burning to produce energy releases CO_2 and water vapour into the atmosphere. Another large reservoir of carbon is the oceans. Carbon dioxide is dissolved as carbonic acid and also found in the corals and sediments as carbonates. Of course we also produce CO_2, along with other living organisms when we respire: the 'burning' of food in our bodies to produce energy.

The increase in atmospheric CO_2 is measured in many laboratories around the world. The measurements at the Mauna Loa observatory in Hawaii are the longest records of direct measurements of CO_2 in the atmosphere, began by Dr. David Keeling in 1958 (Fig. 1), which clearly shows the yearly increase in our atmospheric CO_2. The present record of CO_2 at this laboratory for October 2012 is 390.01 ppm compared to 388.92 in October 2011.

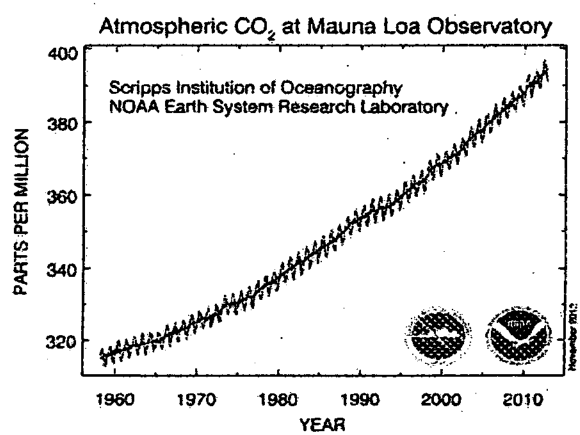

Fig.1. The increase in atmospheric carbon dioxide measured at the Mauna Loa Observatory in Hawaii. *(Source:Dr. Pieter Tans, NOAA/ESRL (www.esrl.noaa.gov/gmd/ccgg/trends/) and Dr. Ralph Keeling, Scripps Institution of Oceanography (scrippsco2.ucsd.edu/).*

The Greenhouse effect

The chemical composition of our atmosphere provides ideal conditions for life on Earth. The atmosphere is composed of 78% nitrogen and 21% oxygen, accounting for 99% of the atmospheric gases. However, the comfortable temperature we experience on earth is due to the greenhouse gases, which occur in trace amounts, in the remaining 1% of the atmosphere. The important trace gases determining our climate are carbon-dioxide, methane and water vapour. These gases have a unique property: they allow the high energy visible solar radiation to pass through the atmosphere, but partly absorb the invisible heat radiation that is re-radiated from the warm Earth's surface. This trapping of the heat energy is called the 'greenhouse effect', and the responsible gases the Greenhouse gases (GHG). This effect is similar to the greenhouses (made out of glass) in temperate regions (a similar effect is experienced inside a vehicle with the shutters up on a sunny day – the glass acting like GHG preventing the heat from escaping). If not for this Greenhouse effect, the Earth's temperature would be a rather uncomfortable -18º C. Even an atmosphere of only nitrogen and oxygen would have still produced a desert of ice on Earth and life would have been impossible. However, thanks to the greenhouse effect, the Earth has an average temperature of +15º C. This is the natural greenhouse effect.

The carbon cycle

Carbon is one of the most abundant chemical elements on earth found in animals and plants as organic matter. In the atmosphere, however, it occurs in trace amounts measured in parts per million (ppm). From a level of approximately 270 ppm just before the industrial revolution in the 1750's, it has now increased to 380 ppm and continues to increase at 1 – 2 ppm every year (Table 1). The carbon dioxide in the atmosphere is continuously in cycle through the vegetation – mostly forests – which absorb carbon dioxide in the atmosphere to synthesize carbohydrates, consumed by animals including humans, which is burnt or respired in our bodies to produce energy and release carbon dioxide back into the atmosphere. In addition to this, we are also adding carbon dioxide by burning fossil fuels and cutting down and burning the forests, particularly in the tropics. Part of the carbon dioxide in the atmosphere is dissolved in the oceans and absorbed by the vegetation on land and the rest remains in the atmosphere.

The carbon cycle is the movement of carbon between all life forms in this planet, through gaseous carbon dioxide, and the major reservoirs of carbon in the atmosphere, forests, oceans and the soil (Fig. 1). Carbon dioxide is the single most important gas in the atmosphere, responsible for global warming. This gas, although occurring in trace amounts in the atmosphere, is held in vast amounts in natural reservoirs: in the soil as organic matter, dissolved in the ocean as carbonic acid and on the land surface in the forests and vegetation as biomass. The land and ocean reservoirs are much larger than the carbon dioxide in the atmosphere. Thus small changes in these reservoirs would change the atmospheric concentration by large amounts. The release of 2% of the carbon stored in the oceans (e.g. through ocean warming) would double the amount of atmospheric carbon dioxide. All living forms take in oxygen from the atmosphere, to burn the carbon in our food to produce energy and the carbon dioxide is released back into the atmosphere. The decomposition of organic matter and the fires burning to cook and provide us warmth, similarly release carbon dioxide. This is balanced by the plants and trees which take up carbon dioxide to synthesize organic food and release oxygen into the atmosphere.

The politics of climate change

The carbon dioxide in the atmosphere knows no boundaries. Managing the atmospheric carbon dioxide is a global problem, requiring global understanding and measures. This however, is easier said than done, since a universal consensus to reduce carbon emissions, particularly among the major emitters of carbon dioxide, is yet to be reached.

In 1992, the United Nations held a conference on environment and development issues in Rio de Janeiro, popularly known as the Earth Summit. An important outcome was an international treaty, the United Nations Framework Convention on Climate Change (UNFCCC). The purpose of the treaty was to stabilize the GHG concentrations in the atmosphere to avoid a dangerous disturbance of the climate. Annual meetings are held of the parties to the convention (called Conference of Parties, or COP) who discuss strategies to combat Global Warming. In December 1997, the COP consisting of 159 nations, proposed the Kyoto protocol, which was unanimously adopted. The Kyoto protocol came up with legally binding mandatory emission limits for industrialized countries to reduce their GHG's by an average of 5.2% (based on emissions in 1996) by 2008 – 2012. The protocol came into effect in 2005, ratified by 141 countries including the major industrialized nations. However, one of the leading contributors to GHG's, the USA, is yet to ratify this convention. It is acknowledged that the cause of global warming, the increased carbon dioxide in the atmosphere, was caused by the now industrialized countries and they have an ethical obligation to rectify the problem. For this purpose the UNFCCC has identified these countries as Annexure I countries, who are required to limit their GHG emissions by the Kyoto protocol, while the Annexure II countries – the developing nations - are not required to abide as yet.

So, what can we do?

In the very long term, we need to reduce the source of carbon dioxide in the atmosphere by finding alternatives to fossil fuels – the "source" of carbon dioxide, and remove the excess in the atmosphere into a "sink". Forest trees are in a unique position to provide a solution to both these problems. Unlike fossil fuels, fuel-wood is a renewable source of energy, since the carbon dioxide released through burning can be captured again by planting new trees. Timber trees from plantations can be converted to permanent wood products such as furniture and building materials, which keep the carbon out of the atmosphere. Regulations to conserve existing forests should be enacted and implemented and reforestation with fast growing species undertaken. These are measures that can be undertaken at an individual and national level.

Energy is the key to the climate problem and therefore developing renewable sources of energy is absolutely necessary in the long term. In the short term, however, we need to take steps individually (how much Horse Power do we need to transport ourselves?) and collectively to save energy using energy efficient systems particularly in our industries.