Forests and Climate Change

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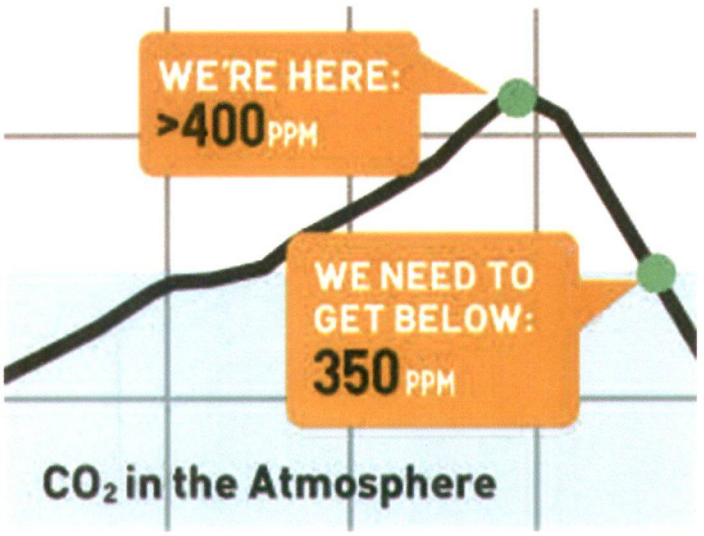
Climate Change

Ever since the dawn of life, our climate has been changing. However, the recent changes in the climate, documented unequivocally by scientists across the world, are due to human action. This is the phenomenon of Global Warming, brought about by an increase in the concentration of the so-called greenhouse gases, carbon dioxide, methane and nitrous oxides, in our atmosphere. This increase began around the 1750's with the Industrial Revolution in the West, which required extraction and burning of fossil fuels – coal, oil and gas – hitherto locked up 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 land for agriculture.

Carbon and Climate Change

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, it has now increased to 380 ppm and continues to increase at the 1 – 2 ppm every year. 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 carbon dioxide, 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 Greenhouse effect

The chemical composition of our atmosphere provides ideal conditions for life on Earth. The atmosphere is composed of 78% nitrogen and 2% oxygen, accounting for 99% of the atmospheric gases. However, the comfortable temperature we experience on earth is due to 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. The 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 is similar to green houses (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 -18° C. Even an atmosphere of only nitrogen and oxygen would have still produced a desert of ice and life would have been impossible. However, thanks to the greenhouse effect, the Earth has an average temperature of +15° C. This is the natural greenhouse effect.

Table 1

	Carbon dioxide	Methane	Nitrous oxide	CFC	HFC	TFM
Pre industrial	280 ppm	700 ppb	270 ppb	0	0	40 ppt
1998 concentration	365 ppm	745 ppb	314 ppb	268 ppt	4 ppt	80 ppt
	1.5 ppm	7.0 ppb	0.8 ppb	-1.4 ppt	0.55 ppt	1 ppt
Atmospheric lifetime in years	ca. 100	12	114	45	260	>50,000

Forest and carbon storage

Forests store more carbon than any other ecosystem on this planet and are considered as "sinks" for carbon. When forests are cleared or burnt, the stored carbon is released into the atmosphere as carbon dioxide. It would take many years for this carbon dioxide to be fixed again if and when a new forest is planted. While the industrialised countries release carbon dioxide stored mostly in the fossil fuels, the developing countries, which are mostly in the tropics do so by clearing forests. Thus deforestation in the tropics destroys these important carbon sinks. A newly planted young forest grows rapidly and would absorb and store carbon more rapidly. A mature forest would release as much carbon as it stores through new growth. Such a forest in a steady-state or equilibrium can be considered as a store house of carbon, until it is disturbed through human activity (deforestation) or natural calamities (forest fires, landslides etc.), which would disturb the equilibrium.

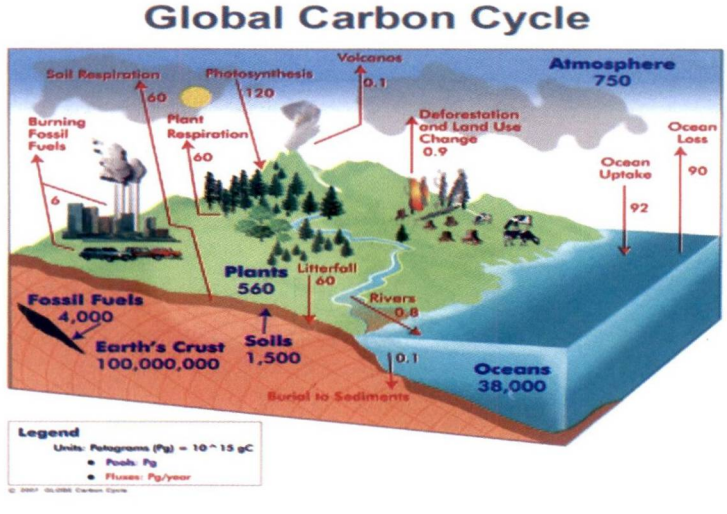
The carbon stored in the forests depends on the type of the forest. The major forest types in Sri Lanka are the Dry monsoon forests in the dry zone, and the Moist monsoon and Lowland forests in the wet zone. The extent of dry forests in the dry zone is nearly 53% of the total forest cover in Sri Lanka. These typically have a canopy layer with trees rarely exceeding 20 m in height and a shrub layer. The composition of the forest is dominated by a few species, most of which are valuable timber trees, such as *Diospyrosebenum, Manilkarahexandra, Chloroxylonswietinia*(Sinh. burutha) and *Drypetessepiaria* (Sinh. Wira). The moist forests such as Sinharaja and the montane forests, have up to five layers with a dense canopy, tall emergent trees and a sub-canopy with an under-storey and a ground layer. The moist forests have a higher biomass than dry forests and this can be attributed to the annual rainfall. The dry zone forests receive moisture from a single monsoon, where as the wet forests receive rainfall from the two monsoons and the inter-monsoons.

The increase in atmospheric carbon dioxide, since the industrial revolution, is a good indicator that the global carbon cycle is not in equilibrium: in other words the 'sinks' do not have the capacity to absorb the excess carbon dioxide. The vast stocks of carbon below the earth's surface as fossil fuels, are being continuously released at an alarmingly and increasing rate. The carbon reservoirs on the earth's surface – the forests – are also subject to deforestation. Along with the oceans the forests ecosystems are a critical link in the global carbon budget. They are the only means of capturing carbon dioxide from the atmosphere and storing them in their wood and in the soil as biomass and organic matter. The forests therefore offer a means of offsetting the carbon released from fossil fuels.

Our planet is the result of many cycles in equilibrium: the water-cycle, carbon-cycle, nitrogen and other nutrient cycles (bio-geochemical cycles), whose interaction and feed-backs keeps the planet in equilibrium supporting the many forms of life. The forest and the vegetation on the earth's surface are an important component in this entire system.The forests playa critical role in the water- and carbon-cycle and the radiation balance on this planet.

The carbon cycle

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: C-cycle). 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 (Table 1). 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 balance by the plants and trees which take up carbon dioxide to synthesize organic food and release oxygen into the atmosphere.



About half of the carbon dioxide emitted by human action is absorbed by the oceans and land vegetation, while the rest stays in the atmosphere. Until the industrial revolution the exchange of carbon dioxide between the land and atmosphere and the ocean and atmosphere, was in equilibrium to give a relatively constant value of 280 ppm. However, the massive emissions from fossil fuel burning and deforestation since then have disturbed this balance resulting in a rapid increase in atmospheric carbon dioxide (Table).

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 discussed 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.

The Kyoto protocol has developed unique mechanisms to implement reduction of GHG's. These are through (i) Carbon trading, (ii) Joint implementation (eg. carrying out a reforestation project in another country), and (iii) Clean Development Mechanism (eg. transferring environmentally friendly technologies to developing countries. The forests, which are mostly in the developing countries, have a significant role in the politics of the Kyoto protocol, since they offer a means of trading the carbon stored in their biomass, with the industrialized countries.

Deforestation and Climate Change

Nearly one-third of the world's land area is covered by natural forests of which 47% are in the tropics, which is around 15% of the Earth's land surface. The demand for agricultural land, fuel-wood and timber in the tropics has led to a loss of forest cover in the tropics estimated to be 13 million hectares per year. This makes deforestation the second largest contributor to global warming after the burning of fossil fuels. Forests are thus an important driver of climate change.

The causes of deforestation vary from country to country. Initially deforestation in developing countries was state driven to meet the demands of expanding population, development projects, and to meet the demands for food from land for agriculture. In South America large scale farming enterprises are the cause for massive deforestation to meet the demands for soya bean and livestock for the export market, whereas in Africa it is from small-scale subsistence farmers. In South Asian countries such as Indonesia and Malaysia with vast tracts of rain forests, the primary reason is the expansion of palm oil plantations by the state and private enterprises, and the demand for timber. Thus addressing deforestation requires an analysis of country specific issues.

At the Conference of Parties in Montreal in 2005, Papua New Guinea and Costa Rica proposed a mechanism for reducing emissions from deforestation in developing countries. This received

support from other countries and saw the birth of the REDD initiative (Reduction of Emission from Deforestation and forest Degradation). This has now being modified to include the ecosystems and renamed REDD+.

Climate change is associated with extreme climate events: prolonged drought periods and heavy incidence of rainfall, which has an indirect impact on natural forests. Long periods of dry weather and high ambient temperatures create conditions (such as dry leaf litter and drier forests), which can initiate forest fires. While forest fires in Sri Lanka are rare, the USA and Australia have experienced forest fires on a massive scale, causing untold damage to life and property and the obvious release of carbon dioxide stored in these forests. Deforestation in montane regions in Sri Lanka exposes the soil surface. Extreme rainfall causes heavy run-off, since all the rain water cannot infiltrate into the soil, washing away the valuable top soil into the rivers. The heavily soaked soil is further vulnerable to earth-slips and landslides again causing damage to life and property.

Forests are in a unique position with regard to climate change. They have the ability to decrease the amount of carbon dioxide in the atmosphere and thereby mitigate climate change, and ironically, also increase the atmospheric carbon dioxide through deforestation. The forest is thus not a passive climate indicator for this planet but an important contributor, through its active participation in the different biogeochemical and biophysical cycles on this planet. It is our responsibility to take care of this ecosystem.

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 a sine quo non 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 by technology transfer of Clean Development Mechanisms from developed countries.

On the eve India's independence, Mahatma Gandhi was asked whether he thought India could follow the British model industrial development. His response underlines the prevalent inequities of natural resource utilization then as well as now: "It took Britain half the resources of this planet to achieve its prosperity. How many planets will India require for development?"