THE GREENHOUSE EFFECT: GLOBAL WARMING AND ITS CONSEQUENCES

Osmund Jayaratne

Destruction by Humans

I do not wish to write about human beings self-destruction through wars and civil wars, which themselves are decimating the human race. I would like to draw the reader's attention to one aspect of human activities, industrial and otherwise, which is threatening the future of living beings, and may perhaps lead to our beautiful planet becoming an uninhabitable place at a time not so far away.

Over long-term periods the earth's climate has never been static. From time to time there have been changes in the composition, the temperature and the dynamics of our atmosphere. Today, the atmosphere consists of 75% nitrogen and about 23% oxygen. The balance 2% is made up of carbon dioxide, methane and water vapour. Today, a new factor has been added to the composition of the atmosphere. New man-made gases are being added to it. These are largely the consequences of human activity, mainly of industrial origin. The amounts of carbon dioxide and methane are fast increasing, as well as complex gases known as chlorofluorocarbons (CFCs), due to motor vehicles, leakage from refrigerators and air-conditioners, as well as insecticide and weedicide sprays. The absolute quantities of these gases may be small; but their effects on the atmosphere are significant.

Under normal conditions the temperature of the earth is determined by the balance between the rate at which the sun's rays reach the earth's surface and the rate at which the warmed earth sends heat radiation (infra-red radiation) back into space. The rate at which the composition of the atmosphere is being changed by human activities has accelerated in recent decades. This could very well destabilize the earth's climate and the natural systems we depend upon.

Material objects (including gases) that freely allow the passage of heat radiation are said to be *diathermanous*. Those that impede the passage of such radiation are called *adiathermanous*. In the presence of the naturally occurring trace gases (CO_2, CH_4, etc.) the average temperature of the planet was about 13°C. In the absence of these trace gases the average temperature would have dropped by 33°C to minus 20°C.

The Greenhouse Effect

The plant houses in highland parks situated in areas such as Nuwara Eliya and Hakgala would amply illustrate to my readers the nature and meaning of the Greenhouse Effect. These plant houses are enclosed by sheets of transparent glass or plastic. A feature of these materials is that the passage of radiation through them is dependent on the temperature of the radiation source. Heat radiation entering the plant houses is directly emitted from the sun, where the temperature of the outer corona is about 8,000°c. This heat radiation heats the plants and other objects within the plant house. Irrespective of the actual temperature, every material body tends to emit heat radiation to some degree. The heated entities within the plant house likewise emit heat radiation.

However, the temperature within the plant house can hardly be compared with the sun's outer temperature. The result is that *large* quantities of heat radiation enter the plant house but only a *miniscule* quantity leaves it. The result is a pronounced rise in temperature within the plant house. This is why even tropical plants can be found in the plant houses of Nuwara Eliya and Hakgala. This effect is known as the *Greenhouse Effect*.

The earth's atmosphere behaves very much like a green house relative to the sun and objects upon the earth. Layers of CO_2 and other trace gases easily allow the passage of heat radiation from the sun to our earth. But radiation from the earth, coming as it does from sources of a much lower temperature, find it extremely difficult to pass outwards through the spherical layers of CO_2 and trace gases which surround the earth about a hundred miles above its surface. This causes the phenomenon of the Greenhouse Effect, which is the theme of my present article.

Deforestation and Its Consequences

The world's forests store 450 Kgs of carbon, which is 20 to 100 times more carbon than stored by croplands. When forests are cleared, their ability to absorb carbon in the form of CO_2 from the atmosphere is lost. Once the trees are cut, their carbon content oxidizes and is released quickly if the trees are buried and slowly if they are left to decay.

Since pre-agricultural times, the world's forests have declined one fifth, from 5 to 4 billion hectares. Temperate forests have lost the highest percentage of their area about 32 to 35%. Subtropical and deciduous and savannas have lost 24 to 25%. Old tropical forests have declined by 15-20%.

Today, over one half of the world's forests are in developing countries. From 1850 to 1980 the greatest forest losses occurred in

the regions of North Africa, the Middle East, South Asia, and China. The highest rates of deforestation are now in South America, mainly due to the ruthless denudation of the Amazon forests. A word may be said here about our own country, Sri Lanka. Here, in the name of development, forests are being fast cleared not only for peasant agricultural use and industrial use, but also for illicit purposes. Schemes for protecting our forests have not met with any success so far. Around 1908, in the days when Leonard Woolf and John Still lived in our country and whose writings are part of our literature, about 70% of the land was covered by forests. Recent figures are alarming. The latest estimate places our forest cover at 20.7%. The area of tropical wet forests in the island is a mere 8.0%. These areas partially include the Sinharaja Forest, the Knuckles Range and the Peak Wilderness, and still the illicit felling of timber continues.

Brazil has the world's largest remaining tropical forest. The Amazon forest in Brazil extends over 337 million hectares. It covers six states and parts of three others. In 1987 Alberto Setzer of the National Space Research Institute of Brazil, using satellite images, found that 8 million hectares of virgin forest in the official Amazon had been cleared in that one year.

Deforestation is second only to the burning of fossil fuels (such as coal and petroleum) as a human source of atmospheric carbon dioxide. Today, almost all carbon releases from deforestation originate in the tropics. Of course, the massive deforestation of Europe and North America in the past contributed heavily to current global carbon levels.

How does deforestation contribute to the Greenhouse Effect and thus to global warning? There are many natural processes that contribute to the growth and eventual death of vegetation of trees and plants. I will refer only to two such processes relevant to the subject we are discussing.

(1) Photosynthesis

The leaves of plants generally contain a green colouring matter known as 'Chlorophyll.' In the presence of sunlight, leaves absorb carbon dioxide from the atmosphere. The resulting biochemical reaction produces carbohydrates, which constitute the food of plants and are necessary for their survival and growth. This is called photosynthesis.

(2) Respiration

Trees and plants, like animals, undergo breathing in the absence of sunlight, particularly during the night. They *absorb* oxygen from the atmosphere and release carbon dioxide. This is the process of *respiration.*

Before the large-scale felling of trees commenced over 150 years ago, a fine balance existed between these processes of photosynthesis and respiration. However, with the advent of deforestation and the large-scale depletion of the earth's forest cover, scientists have observed that the release of CO_2 into the atmosphere has begun to overtake the storage of CO_2 due to photosynthesis.

Role of Trace Gases in Global Warming

Tiny quantities of more than 30 trace gases (mostly man-made) threaten to warm the earth's atmosphere. Less and less heat is able to escape from the atmosphere. It is predicted that in the decades to come, the carbon equivalent in the atmosphere, due to the trace gases, will more than double the warming effect of CO_2. Dr Ralph J. Cicerone, director of atmospheric studies at the US National Centre for Atmospheric Research, says: "you may now have to think of a change two or three times bigger than we thought due to CO_2 alone. Recent US government studies of the Greenhouse Effect have concluded that the earth will see profound changes in the next two decades and changes in weather patterns are expected to cause serious disruptions in agriculture."

Possible Rise in Sea Levels

I quote from a statement made in 1989 by the late Prof. K.D. Arulpragasam (Professor of Zoology at Colombo University).
"It is expected that in the next half century or so, temperature will rise between 1.5°C and 4.5°C (due to the Greenhouse Effect). What effect will this have on marine eco-systems?

One of the first effects will be a rise in the sea level due to thermal expansion. Melting of ice and glaciers may increase sea level further."

Already mountain-sized chunks of ice have begun to dissolve and flow into the oceans from the Northern and Southern Polar regions. I am not referring here to the very rare Tsunami that on December 26th 2004 devastated the coastal regions of the south and northeast of Sri Lanka. This is a rare phenomenon which has no connection with Global Warming.

"The projected rise in temperature is expected to bring about an increase in sea level of 0.50 to 1.65mm over the next few decades. Low-lying islands in the Pacific and Maldives in the Indian Ocean are likely to disappear under the rising waters, requiring in the latter case, the re-location of the peoples of an entire nation. It is likely that Bangladesh will lose about one sixth of its land area, the home now of about 25 million people. The Nile delta may lose a fifth of its arable area, now used by about 10 million people. The great centers of commerce and civilization that have developed around the major port cities of the world are likely to be severely affected. These would include London, New York, Los Angeles, Buenos Aires, Calcutta and Tokyo among others. Many coastal areas of the world would gradually become uninhabitable. In Sri Lanka, we have been troubled in recent years over inroads into the land that the sea has been making by erosion of the south-west and other coasts."

A sea level rise, as envisaged above, would also hurt rice production in the river deltas and coastal plains in much of Asia through salt-water intrusion. Wetlands nourishing the world's fisheries would also suffer destruction.

I have already mentioned that the doubling of CO_2 emissions by 2050 AD may lead to an increase in the earth's average temperature by anything between 1-5 degrees C and 4 to 5 degrees C. If no positive action is taken to overcome this trend, the doubling of CO_2 may occur as early as 2030 AD.

Many of my readers may feel that an increase of 1.5^0 to 4.5^0 Celsius from the present average of 13^0C is insignificant. But it is worthwhile noting that the coldest average temperature during the last Ice Age was only about 5.5^0C below today's average. Yet the consequent climate and ecological changes in that period were spectacular.

A Word about the Future

International conferences have been held from time to time about environmental damage and what should be done to curtail or reduce it. I refer to the Rio de Janeiro Conference of 1992, where Sri Lanka also was represented. There has been much talk but very little action. Many NGOs are devoting their attention to these problems. But concerted global action is needed.

In recent months another important conference was held in the city of Kyoto in Japan, which was attended by over 100 countries of the world. Its purpose again was to find ways and means of reducing the emission of greenhouse gases in the world. It is a highly significant fact that at both conferences an important absentee was the USA, which is undoubtedly the greatest emitter of greenhouse gases into the atmosphere due to its industrial potential. It is clear that imperialism attempts to destroy the world not by military means alone, but by other methods such as we have outlined above. The short-term profit motive seems to be overtaking the dangers of the destruction of our human species. With the greenhouse effect, the depletion of the ozone layer, atmospheric pollution, along with the wars and civil wars sweeping through the world, one begins to wonder whether 'Homo Sapiens' is moving towards self-destruction. ■

Dr. Osmund Jayaratne is Emeritus Professor of Physics, formerly of the University of Colombo.