



## Topic 10: Climate Change and Soils

### Introduction

There is increasing evidence that the climate is changing. The earth's climate has changed many times in its history and a land that has been desert at one time may have been a tropical rainforest at another time. So why should we be worried? Well, this time it appears that human activity is largely responsible for creating and accelerating the change. Humans inevitably affect our environment as they generate industry, as they grow in numbers, and as they need to occupy more and more of the land. There is now good evidence that human activity is accelerating the rate of climate change, so that we can expect to see significant changes in climate in the next 100 years. So where does soil come into this? Firstly, soil contains huge amount of carbon, as much as in all land based vegetation and the atmosphere combined, and carbon is one of the main factors in climate change. Secondly, soil has the capacity to store carbon, keeping it from contributing to climate change, but it also has the ability to release more carbon to the atmosphere thereby accelerating climate change. We therefore need to consider how best to manage the soil carbon so as to limit climate change.



### The Greenhouse Effect

You will know already that the earth's surface is warmed by the sun. The incoming solar radiation reaches the earth's surface as short-wave radiation. Some of this radiation is absorbed and some is reflected back into the atmosphere as longer-wave radiation. If energy-in balances energy-out then the earth maintains a constant temperature. Without this balance the Earth would become gradually hotter and would eventually be unable to support life.

However, in the past 250 years there has been a significant increase in the amounts of gases entering the atmosphere due mainly to global industrialisation. These gases, now often referred to as greenhouse gases, have particularly settled in the lower atmosphere. As a result this layer has increasingly become a barrier to radiation leaving the earth's surface. Long wave radiation from earth is intercepted by this barrier and is reflected back to earth where it causes increased warming at the earth's surface.

This so-called barrier has been likened to the effect of the greenhouse in which the sun's rays enter the greenhouse but their return from the greenhouse is reduced by the glass panes. Hence the term 'greenhouse effect' which is often mentioned with respect to climate change.



This is an important example of how humans can influence the planet on which they live. It has taken two decades for climate change to be taken seriously. Think what you might do to reduce the effect of climate change.



## The Greenhouse Gases

(i) The main greenhouse gases are carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxides (NO<sub>x</sub>) and a groups of gases termed called hydrofluorocarbons and perfluorocarbons.

Carbon dioxide is emitted by the burning of fossil fuels, such as coal and oil, by burning during deforestation, and also natural processes during the breakdown of organic matter in the soil. Methane is a product of decaying materials in waste disposal sites. It is also released by livestock excreta, and by wetlands including paddy fields producing rice. Nitrous oxides come from various industrial processes, from fossil fuel burning, and from the use of fertilisers in agriculture and horticulture. The fluorocarbons are associated with electrical goods and some manufacturing processes involving metals.

Some greenhouse gases are more potent than others. For instance, methane has 20 times more global warming potential than carbon dioxide, nitrous oxide about 300 times more and the fluorocarbons several thousand times more. However, this has to be weighed against how common the gases are and what quantities are involved. All these gases are thought to play a significant part in global warming.



Since the Industrial Revolution began about 250 years ago and intensive farming some fifty years ago, humans have produced many of the so-called greenhouse gases and they have been released to the atmosphere.

## The Likely Extent of Climate Change

The Intergovernmental Panel on Climate Change has reported that the earth surface temperature will increase by between 1.4 and 5.8°C over the period 1990 to 2100, but will be warmest over the land areas.

The rainfall predictions are much more variable. A decrease in rainfall is forecast for Australia, Central America and South Africa.

Global mean sea level is likely to rise by 0.09-0.88 m. This will impact greatly on coastal regions and lower lying parts could become inundated.



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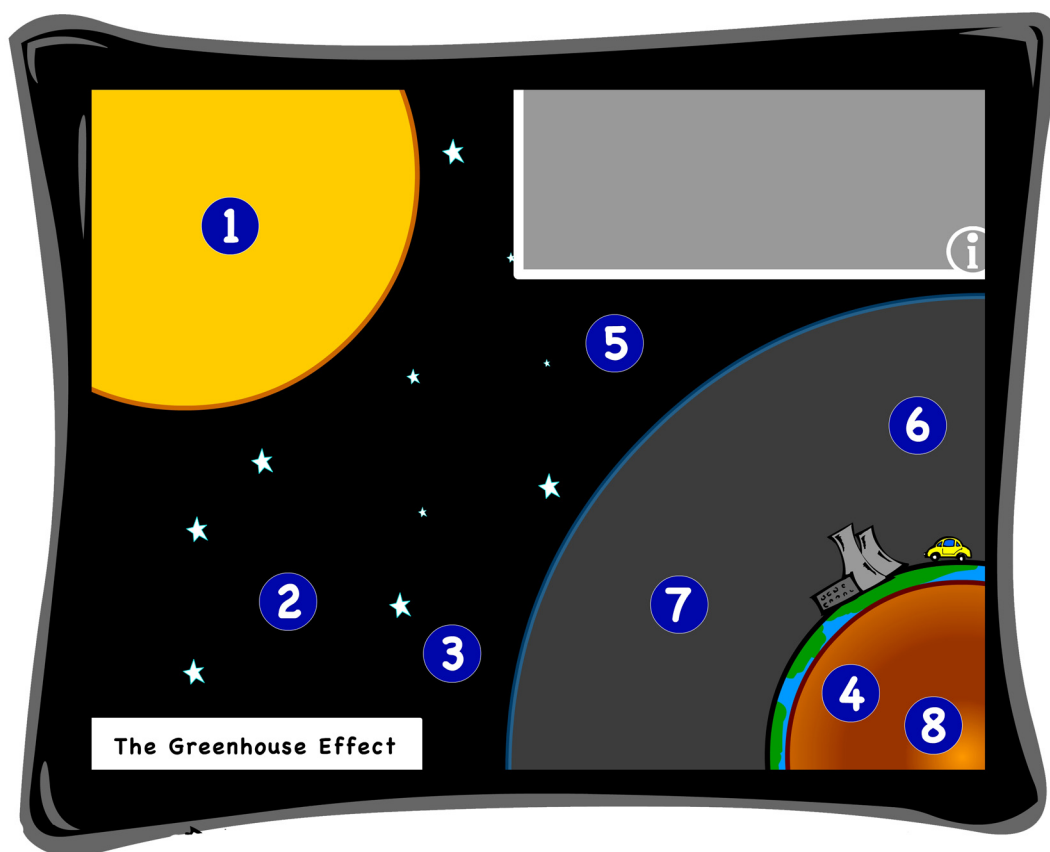


## Soils as a Sink for Greenhouse Gases

(i) Soil organic matter is one of the major pools of carbon in the biosphere. Growing plants take in CO from the atmosphere and use it in the process of photosynthesis. These plants eventually die and their remains enter the soil. This stock of carbon reaches the soil as leaf litter and dead branches, and in the soil dead roots and dead organisms also contribute. Thus increased plant growth in a warmer climate could lead to more CO leaving the atmosphere to help create vegetation, and eventually being bound up in soil organic matter.

Methane is formed by the anaerobic decomposition of organic matter in the soil. Oxidation of methane in the aerobic layers of soils restricts its release to the atmosphere. In some well aerated soils bacteria can oxidise methane as an energy source thus reducing its impact on climate change. It is also possible to adapt management of land to increase the soil methane sink.

Nitrogen is commonly added to the soil as inorganic fertiliser and organic manures. There are also inputs of nitrogen from the atmosphere via rainfall and as dust deposition. In the quest for increased food production increased amounts of nitrogen may be put into the soil.



Consider the tropics and imagine the amount of vegetative growth in this hot climate. It could be that as the temperature increases with climate change, there may be more prolific vegetation in many areas, more carbon stored within it, and more carbon returning to the soil.



## Soils as a Source of Greenhouse Gases

Increased temperatures that are forecast will also impact on rates of decomposition of soil organic matter. Plant remains as they fall to the soil undergo a cycle of decomposition which involves the release of CO<sub>2</sub>. The rate of decomposition of organic matter would increase as temperatures increase leading to more CO<sub>2</sub> being released to the atmosphere.

The soil already contains more carbon than the global vegetation and atmosphere combined. There is thus a significant amount of potential CO<sub>2</sub> in the soil, which if released to the atmosphere would increase the rate of global warming.

Nitrogen added to the soil as fertiliser or manures becomes a potential source of nitrous oxides to the atmosphere. Increasing temperature increases the rate at which the nitrogen in the soil is cycled and released back to the atmosphere. Natural and cultivated soils contribute more than half of the total NO<sub>x</sub> emitted to the atmosphere.



Organic matter in soils is a huge potential source of CO<sub>2</sub>. It is now recognised that we have to manage this source carefully. Indeed we have to examine carefully how we use the land and what steps we can take to reduce the levels of gases returning to the atmosphere.

## Climate Change and Threats to Soils

Climate is a key factor in soil erosion and desertification. It is likely that both of these will increase if the climate becomes warmer and drier.

Currently there are concerns about the increasing degree of salinisation of soils. Salinisation of soils is likely to increase with climate change, making more soils unable to produce crops.

Many of the functions that soils support, such as farming, forestry, growth of wild flowers and plants, and water storage, will change if the climate changes as predicted. In some cases, there will have to be much readjustment which may also be costly and not always beneficial.



We need to find ways of reducing the influence of the factors that lead to climate change. Can you make a list of them and think about how you can play your part in reducing their effect.

