Plants and climate change: which future?

Chapter 1: An overview of current climate change

Chapter summary

There is unequivocal evidence that the earth's climate is warming at an unprecedented rate. Temperature increases are geographically inequitable. Some regions, particularly at high altitudes and latitudes, are warming more than other areas. Other climatic effects, including prolonged droughts in arid and semi-arid regions, increased flooding in mid to high latitudes, and more extreme weather events are also increasing. Sea levels are rising. Climates are changing more rapidly than species can adapt and there is a high risk of mass extictions of biodiversity as the planet warms. There is very good evidence that human activities that increase the concentration of greenhouse gases (GHGs) in the atmosphere are driving the climate change.

The Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) stated that: "continued GHG emissions at or above current rates would cause further warming and induce changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century. For the next two decades a warming of about 0.2°C per decade is projected for a range of emission scenarios. Afterwards, temperature projections increasingly depend on specific emission scenarios."

In other words, the future world climate depends on us and our ability to curb GHG emissions.

Key points of this chapter:

- CO_2 is one of the principle GHGs driving climate change.
- Global atmospheric CO_2 is increasing due to human activity, particularly the burning of fossil fuels, deforestation and agriculture.
- Uptake by plants is the major pathway by which CO_2 is removed from the atmosphere. Approximately 50% of our emissions are currently removed this way, but the ability of vegetation to act as a sink is decreasing and in some areas, vegetation may switch to become a source of CO_2.
- Plants convert CO_2 to complex carbohydrates (such as glucose) through the process of photosynthesis.
- The photosynthetic pathway is the major route by which carbon, the principle element within our bodies, is made available to animals and humans.
- Plants therefore form the basis of the carbon cycle. They are major regulators of the global climate and underpin all life on our planet.

Boxes from this chapter:

Box 1.1 – Climate change definitions

Climate is defined as the average 30 year weather patterns of a region (World Meteorological Association, no date). We do not need to be able to predict exact weather conditions to be able to understand average climatic trends.

Climate *change* constitutes three main variables; elevated CO_2, altered rainfall patterns and temperature ranges.

Dangerous **climate change** was legally introduced as a term in 1992, when the United Nations Framework Convention on Climate Change (UNFCCC) called for stabilisation of GHGs to prevent dangerous anthropogenic interference with the climate system. The Convention suggested that such a level should be achieved within time frames sufficient to allow ecosystems to adapt naturally to climate change; to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

Though scientific knowledge is insufficient to point to a single 'safe' GHG concentration, it has been suggested that the most serious consequences of climate change (i.e. dangerous climate change) might be avoided if global average temperatures rise by no more than 2°C above pre-industrial levels. Any temperature rise above this would significantly increase risks of irreversible feedback mechanisms that could produce runaway climate change. GHG emissions of 550 parts per million (ppm) would very likely raise temperatures above that level, and so an appropriate precautionary approach would aim to stabilise emissions as far below 550ppm as possible (Schellnhuber *et al.,* 2006). A 2006 study by Lowe *et al.* (2006) showed that even with stabilisation at 450ppm, 5% of modeled scenarios led to a complete and irreversible melting of the Greenland ice sheet.

In 2006, the Stern Review calculated a 77 - 99% chance of a 2°C rise before 2035 and at least a 50% chance of exceeding 5°C during the following decades. We are thus rapidly approaching this mark.

Box 1.2 – Feedback mechanisms

Different parts of the climate system interact with each other. Positive feedbacks tend to amplify the variability of climate whereas negative feedbacks provide stability. For example, warmer water stores less dissolved CO_2, which then remains in the atmosphere and is hence a positive feedback. In some interactions, the effect is reduced (a negative feedback), such as increased cloud cover due to increased ocean evaporation.

Though the global climate system is generally stable, it is a balance that is dynamic and constantly adjusting to forced perturbations. A change in any one part of the climate system will have much wider consequences as the initial effect cascades through the coupled components of the system. For example, the destruction of a forest will affect the balance of local surface energy, which in turn may modify local atmospheric circulation, effecting further climatic changes some distance away (Lovejoy & Hannah, 2005). Likewise, ice on the ocean has a huge effect on the local air temperature, as air over ice or land can be much colder than air over water. Sea ice changes might therefore influence fast, extreme climate change.

Box 1.3 – Inequitable climate change

Geographically, climate change will impact the people of the world in very different ways. Though an all pervasive issue, it will largely cause the most harm, soonest, in developing countries, where people are least responsible for it and least able to cope. Greatest attention should be given to helping these countries to mitigate and adapt to current and future climate change impacts (Lane *et al.,* 2005).

Climate change adaptation is increasingly seen as an issue of both human welfare (in the face of inevitably unfair distribution of these burdens (Müller, 2002)) and of security. It has been addressed as such by the UN Security Council, forecasting conflicts over scarce food, water and land as well as unprecedented rates of human migration (Purvis & Busby, 2004).

Since CO_2 emissions are linked to Gross Domestic Product (GDP), developing countries will also play a significant role in determining the success of multilateral climate change response regimes. There is therefore a discrepancy between responsibility for, and the sharing of, climate impact burdens.