Chapter 9
Impact on Climate and Environment

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9.1 Climate, Global Warming and CCS

If we go back 50–70 years, the great question was about food supply and the risk for nuclear war that would destroy all humans. The Nobel Prize laureate Svante Arrhenius, 120 years ago, worried about a new ice age, and recommended that we should burn all known fossil fuel resources, as the CO_2 would increase the temperature through the green house effect. During the 1960s the concern for green house effects started and since then has increased, but the emphasis has not been on too high a temperature increase that will negatively affect living conditions globally. Allen et al. (2009) and Andres et al. (1999) discuss the cumulative effect due to carbon dioxide emissions from burning fossil fuels during the last 100 years. In Searchinger et al. (2008) the effects on release of CO_2 from changed farming methods are discussed. Möllersten and Yan (2001) and Möllersten et al. (2003) discuss the possibility to remove CO_2 from exhaust gas from power plants using fossil fuels as well as the possibility to store the separated CO_2 underground. In Möllersten et al. (2004) the possibility to remove CO_2 through CCS in the pulp and paper industry is also discussed, although biomass is used there. This is because CO_2 streams can be higher in concentration, and thus more economic to remove.

Ernfors et al. (2008) also studied NOx emissions, which do not directly or primarily affect the atmosphere through green house effect, but increase growth of, e.g. algae in lakes and seas, affecting local climates. This is also something to consider, as it will significantly affect biodiversity.

The cement industry affects CO_2 emissions very strongly since new buildings are built using concrete. Figures about this are given in Cembureau (2010). The emissions come from heating $CaCO_3$, using mostly fossil fuels, and the calcination when $CaCO_3$ is converted to CaO at high temperatures (above 1000 °C).

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The climatic and environmental development are covered in many different sources, two of particular interest are Earth Trends: Environmental Information (2010) and World Bank development indicators (2016).

9.2 Biologic Diversity

Although, biological diversity is not a focus point in this book, we will just emphasise that the number of species on earth today is in the range of several billions, while we only recognize approximately 1.7 million or thereabout (nwf 2016).

Plants have high values as food, but also half of all synthetic drugs actually have an origin from crops; 40% of the most sold in the US are among these. Many plants (50%) only grow in one country and 42% of all terrestrial vertebrates are also only found in local areas or regions (nwf 2016).

Definitions about biodiversity and more discussions around this are found in, e.g. Greenfacts (2016). There are predictions that around 20% of the species known are on their way to extinction and some researchers say that we are right in the middle of the fifth or sixth major extinction seen historically since earth became populated by living species billions of years ago. The speed of species extinction is very high right now, mostly due to the new farming and living methods used over the last 50 years.

9.3 Environmental Issues and Waste Water Treatment

The major environmental concern today is the global warming issue; 30 years ago it was primarily sulphur emissions and 20 years ago mostly nitrous gases. Water concerns have focused on phosphorus and nitrous compounds, which both give eutrophication. Thus, the main demands on waste water treatment plants are on limitation of these two elements.

Phosphorus is normally removed by precipitation with iron or alumina salts, while nitrous compounds normally come as proteins and ammonium type of compounds. These are normally first oxidized and then nitrate is reduced in a second process to elemental N_2.

The metal phosphate precipitate usually also contains other metals, and thus to avoid polluting the soil it is not normally recycled to farmland. The phosphate is also strongly bound, and thus difficult to get back to crops. The problem with removal of phosphorus from the natural cycle has been studied by Vaccari (2009), who points out that a deficiency of phosphorus for fertilization may be a fact soon; especially clean phosphorus without cadmium pollutant in it, like the one often taken up in Northern and Western Africa.

Nitrogen removal is a very energy intensive process consuming a lot of electricity for aeration. The aeration electricity consumption can be reduced to half using

the anammox method. With a combination of algae (which produce oxygen) and microorganisms (which decompose organic matter), we can achieve lowered electricity consumption and at the same time build phosphate or nitrous compounds directly into algae. This has been studied at several places, such as Malardalen University and the waste water treatment plant in Vasteras, Sweden (Thorin et al. 2014).

Another important issue is spreading sludge on farmland if there are other types of toxins. Heavy metals are one thing, especially cadmium, nickel and similar, but lately also medicines, non-ionic tensides and micro plastics have been noticed as possible threats to humans, if some is taken up by crops. Odlare et al. (2011) studied uptake of metals and organics in crops at a test center outside Vasteras over 15 years, where waste water treatment sludge as well as residues from biogas production from household waste has been studied with respect to uptake into cereals. So far, no alarming levels have been seen.

Hydrocarbon emissions from firing wood in inefficient stoves or open fire is a strongly unhealthy atmosphere for humans, and have been studied by a number of researchers like Ludwig et al. (2003) and Melillo et al. (2009).

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