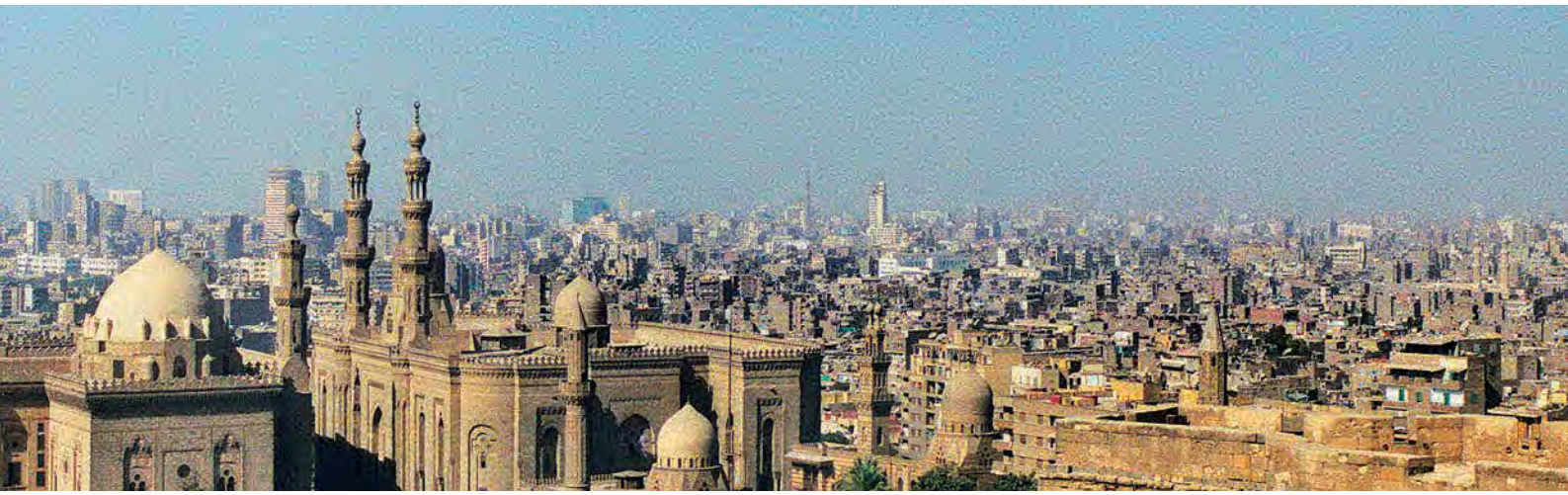
Chapter 7

Greenhouse gas emissions



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Cairo, Egypt.
This megalopolis suffers from air pollution that is sometimes difficult to bear.

It is clear that human activities affect the climate. Present world concentrations of greenhouse gases (GHGs) are considerably greater than pre-industrial levels determined by using core borings of ice covering several thousand years. The carbon dioxide (CO_2) concentration has increased by 40% since the end of the 18th century. Although carbon dioxide is the main gas emitted (76% of emissions), it is not the only one. Methane (CH_4), nitrous oxide (N_2O) and fluorinated gases also have considerable warming potential, with 16%, 6% and 2% respectively. The increase in the amounts of these gases in the atmosphere disturbs the natural carbon cycle and causes an additional greenhouse effect: the GHGs allow solar radiation to reach the Earth but trap the infrared radiation emitted at the surface and thus increase the warming of the atmosphere.

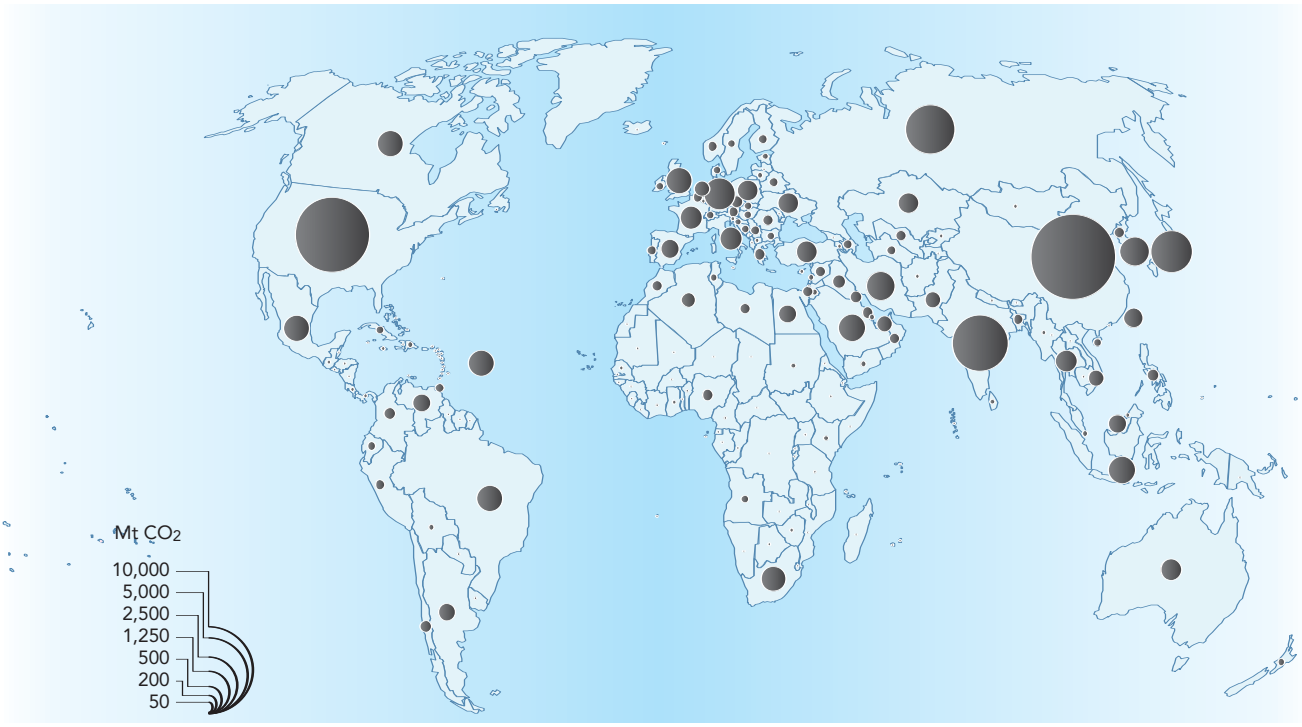
These emissions are linked directly to industrial development that has led to growing use of fossil energy (coal, oil and gas) by industry, agriculture, transport and dwellings and, to a smaller degree, change in land use (deforestation). Anthropic emissions of GHGs thus increased by 70% from 1970 to 2004.

Localised emissions

Although the greenhouse effect is a phenomenon at the scale of the planet, emissions are clearly localised. Emitted in a very heterogeneous pattern at the surface of the earth, greenhouse gases are then redistributed in the atmosphere at the scale of about one year. Thus even the regions with the smallest emissions or those that are furthest from sources of strong emissions—like Africa for example—have similar CO_2 concentrations to those of emission regions and are affected by climate warming.

Historically, emissions are largely from the western countries. Although their contribution is tending to decrease proportionally, their emissions continue to increase. Certain emerging countries like China, India and Brazil have now caught up with the rich countries. China has even overtaken the United States and is now the leader in terms of CO_2 emissions with 9,973 million tonnes (Mt) in 2013, nearly double that of the 5,233 Mt emitted by the USA. The poorest countries are far behind (Fig. 18). According to the 5th IPCC report, the difference in emissions per capita between the greatest and smallest emitters is a factor of 50.

Figure 18.
CO_2 emissions resulting from fossil fuels (2013).
Disproportionate emission levels for the planet as a whole.
Source : BODEN *et al.*, 2013



The accounting of emissions

Accounting world greenhouse gas emission is based on national inventories. Following IPCC guidelines, the methodology used today records the direct emissions related to activities (energy, industrial processes and product use; agriculture, forestry and other land use; waste) and households (motor cars and heating) in a country's territory. The most common methodological approach consists of combining data on human activities with coefficients that quantify emission or use by type of activity. However, the methodological choices, the calculation of coefficients and the estimating of uncertainties are the subject of scientific discussions within the actual work of the IPCC.

Furthermore, scientists have grouped the six greenhouse gases (CO_2, CH_4, N2O and three fluorinated gases) and a category called 'CO_2 equivalent'. The calculation of equivalents in terms of global warming potential is another source of uncertainty, especially as these greenhouse gases affect the climate in different ways, to different degrees and during distinct periods.

Benxi industrial centre. China is currently the world's leading emitter of greenhouse gases, ahead of the United States.

Imported emissions

In addition, national inventories do not always reflect all the emissions associated with consumption by the population. Indeed, accounting is performed on the basis of the national territory in which they are generated and not the territory in which they are consumed. For example, emissions per inhabitant in France total 8 t CO_2 equivalent according to national accounting. But when emissions involved in consumption are taken into account the figure increases by more than 50%. The difference results from imported products and foodstuffs whose greenhouse gas emissions are accounted for at their site of production—in other countries. Thus China has the largest CO_2 emissions in the world but nearly a third of these emissions concern exported products that are therefore consumed elsewhere. Finally, emerging or developing countries produce an increasing proportion of emissions linked to consumption by industrialised countries. These methodological points call into question the effectiveness of national policies for reducing emissions and certain estimates find that imported emissions form a quarter of global emissions.

Different sources of emission according to the country

A variety of emission activities is added to this global disparity. Since 1970, more than three-quarters of the increase of greenhouse gas emissions is attributed to CO_2 released by the combustion of fossil fuels (in industry, for heating, transport, etc.). The rest is mainly related to changes in land use and particularly deforestation. Agriculture is also the main source of two other greenhouse gases: methane emitted by ruminants, animal faeces and rice fields and nitrous oxide (N_2O) resulting from nitrogen fertilisers.

The different sources of emissions vary strongly according to the country (Fig. 19). In the 84 poorest countries—corresponding to the groups of 'low-income economies' and 'lower-middle-income economies' according to World Bank nomenclature—agriculture and deforestation are the main sources of greenhouse gases (90% of total emissions). The emissions profile of countries with economies in transition in the upper-middle-income economy category, including Brazil and China, are similar to those of the richest countries but with more emission from industry at the expense of transport and construction. These emission profiles show clearly that the political response cannot be the same for all countries, whether in terms of responsibility or priorities to be addressed according to the sector. The same observation can sometimes be applied at the national level when regions are very different from each other.

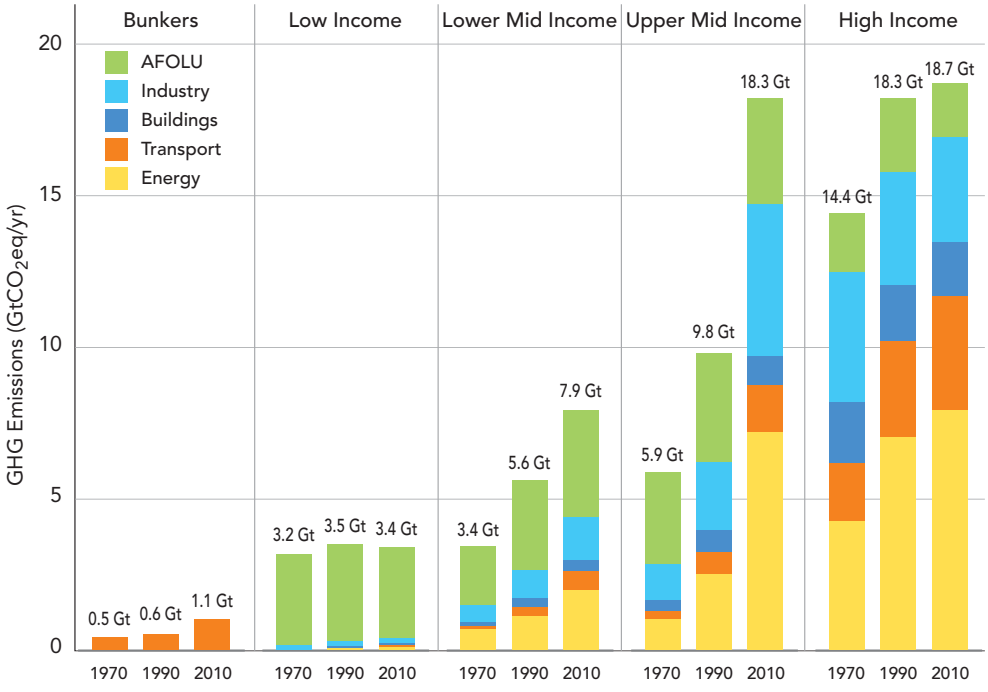


Figure 19.
Distribution of greenhouse gas emissions according to emission activities by group of countries (using World Bank nomenclature and in Gt CO_2-equivalent).
Source: IPCC Fifth Assessment Report, 2013

The clearing of tropical forests

According to the IPCC Fifth Assessment Report, the felling of several million hectares of tropical forest in Amazonia and South-East Asia accounts for the greater part of CO_2 emissions linked with changes in land use since the 1980s. However, the share of agriculture and forestry in global emissions is tending to decrease, forming a quarter of emissions in 2010 in comparison with a third 20 years previously. But it should be noted that this trend is linked with a comparatively faster increase in other sources of emissions.

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Amazonian pioneer front in the State of Para, Brazil. The clearing of tropical forest is a substantial source of carbon dioxide emissions.

Tropical forests also play a role of natural carbon sinks and can thus reduce the CO_2 concentration in the atmosphere. Much research is thus addressing the measurement of the **biomass** in these forests in order to gain a closer view of the contribution of deforestation to global emissions and also to assess the carbon storage capacity of forests and soils (see page 147).

Box 13

The singular profile of the African continent

Africa accounts for only 3.4% of world emissions, making it a marginal contributor to global climate change.
Another singular feature is that over half of emissions are related to agriculture and changes in land use. Nevertheless, the deforestation of African tropical forest accounts for a comparatively small proportion of the footprint of world deforestation—in comparison with that in South America and South-East Asia.

In West Africa, the dominance of agriculture as a source of emission (nearly 40%) reduces the scale of carbon dioxide emissions, replaced by other greenhouse gases strongly emitted by the sector. Thus methane and nitrogen alone account for 75% of GHG emissions in West Africa in comparison with 25% in the world as a whole.

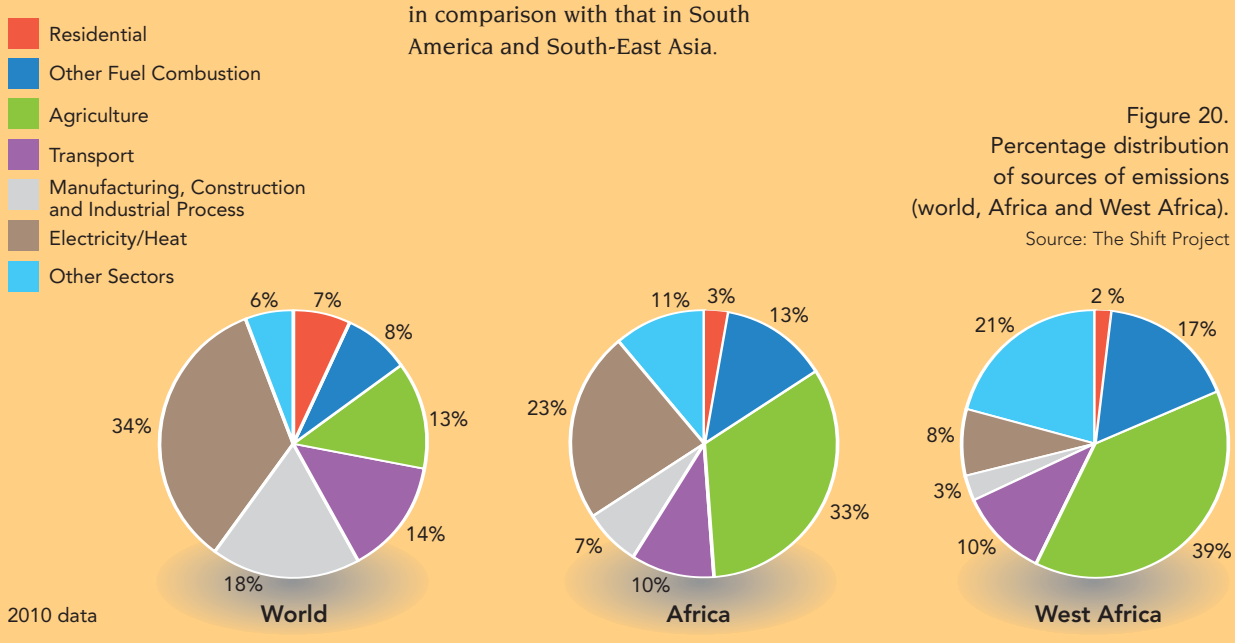

Figure 20.
Percentage distribution of sources of emissions (world, Africa and West Africa).
Source: The Shift Project

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In spite of a decade of rigorous measures to limit pollution, Mexico City—one of the most seriously polluted cities in the world—is enveloped by a misty halo almost every day.

Urban emissions

Greenhouses gases are produced mainly in cities and their peripheral areas that concentrate industrial emissions, emissions resulting from transport and heating/air conditioning. Although the northern countries are the main sources of urban emissions, urban development in the southern countries is now catching up. Of the ten cities with the highest emission levels in the world, six are in India, three in Pakistan and one in Iran. However, the contribution to global emissions is not always visible as they are 'diluted' in national average figures. For example, average emission in Thailand is 3.8 t CO_2 per person per year whereas the figure for Bangkok alone is 10.7 t per person per year.

Because of this growing urbanisation, scientists must assess the contribution of cities to climate change. In the northern countries, the drawing up of 'climate plans' has made it possible to set up watches and to model emissions on medium scales. However, in the countries in the South observation networks are still not very dense and there are very few systems for observing urban climates.

Reducing global emissions

All economic sectors—industry, agriculture, town planning, etc.—are therefore concerned by the effort to reduce emissions. According to IPCC scenarios, to have a chance of remaining at less than 2°C warming between now and 2100, world emissions must be reduced by 40% to 70% by 2050 in comparison with 2010 levels and reach practically zero at the end of the century. The decreasing of world emissions has thus become the hobbyhorse of international climate policies set up under the aegis of the United Nations. But this focus on a global volume of emissions is now reaching its limits insofar as it has not been able to provide a political response to the climate crisis (see page 177).

Bernoux Martial, Mazurek Hubert. (2015).

Greenhouse gas emissions.

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