Global Climate Change Alliance Support Facility

Training workshops on mainstreaming climate change in national development planning and budgeting

HANDOUT FOR PARTICIPANTS

MODULE 3

Understanding the basics of climate change science

The GCCA is funded
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MODULE 3 – Understanding the basics of climate change science

TOPICS COVERED BY THE MODULE:

- Observed trends and changes.
- Causes of change: greenhouse gas emissions and the greenhouse effect.
- Main consequences.

KEY CONCEPTS AND MESSAGES:

Observed trends and changes

1. *There is no doubt that the earth's climate is getting warmer.* Observed trends are clear and all point in the same direction. Manifestations of this change notably include increased average air temperatures, increased average ocean temperatures, widespread melting of snow and ice, and rising sea levels. As a result, changes are observed in *physical systems* (e.g. melting of the permafrost, alterations in hydrological patterns and flows) and in *biological systems* (e.g. shifts in the range of some terrestrial species, shifts in the range and abundance of plankton and fish). Many documented changes in ecosystems that are attributable at least in part to other causes are also likely to be exacerbated by climate change (e.g. losses of coastal wetlands, mangroves and coral reefs) (IPCC 2007a2007b & IPCC 2007c, World Bank 2010a).

Causes of change: greenhouse gas emissions and the greenhouse effect

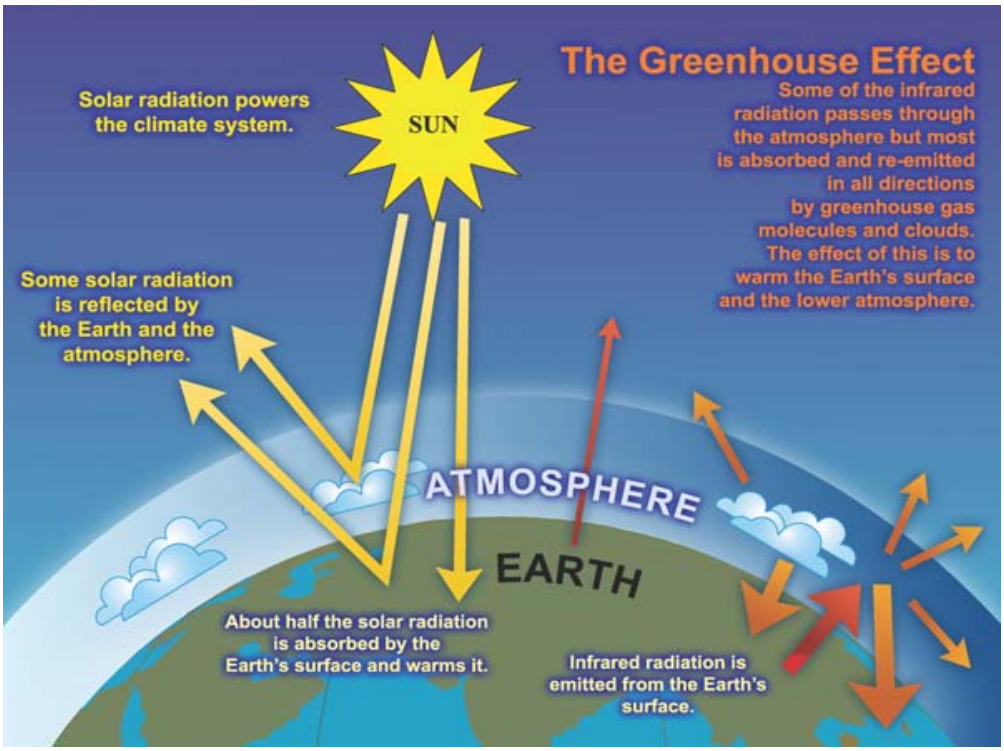
2. Natural variability is an inherent feature of the climate, but there is no longer any reasonable doubt that *the changes we are observing today are to a large extent driven by anthropogenic emissions of long-lived greenhouse gases* (GHGs). Indeed, human activities cause unprecedented emissions of such GHGs, and they have accumulated in the atmosphere at levels not observed over the past 650,000 years (IPCC 2007a & 2007b, World Bank 2010a).

3. Climate change is caused by the *greenhouse effect*, a phenomenon by which GHGs in the atmosphere trap part of the infrared radiation that the earth (heated by the sun's energy) radiates back to space (see **Figure 3.1**). The greenhouse effect is a natural phenomenon, which is most useful since it allows maintaining the average global temperature at 15°C (rather than –18°C in the absence of GHGs). However, fast increasing atmospheric concentrations of GHGs as a result of ever-increasing anthropogenic emissions are now causing a very fast (by geological time) and very significant increase in temperature at the surface of the earth (IPCC 2007a, http://wwf.panda.org).

4. With the exception of chlorofluorocarbons (CFCs) and other halogenated compounds, which are the product of industrial activity, other *major GHGs* (i.e. carbon dioxide, methane, nitrous oxide and ozone[1]) are naturally present in the atmosphere. However, human-driven emissions of these gases, as a result of fossil fuel burning, agriculture and land use change, have added significantly to their natural levels in the atmosphere (IPCC 2007a & 2007b).

[1] Water vapour is also a GHG. Its presence in the atmosphere results from natural processes (the hydrological cycle).

Figure 3.1 – The greenhouse effect



Source: WWF/IPCC (http://wwf.panda.org/about_our_earth/aboutcc/how_cc_works/)

5. There are various ways of accounting for the contribution of various GHGs to climate change. One of them is the *global warming potential* (GWP, expressed in tonnes of CO_2 equivalent or t CO_2e). This is a measure of how much a given mass of a GHG is estimated to contribute to global warming, compared with the same mass of CO_2 (by convention, GWP of CO_2 = 1). It is used (notably in the context of the Kyoto Protocol) to estimate the potential future impacts of emissions of different gases on the climate, in a relative manner. The GWP depends on the time span over which it is calculated, as shown in **Table 3.1**; for instance, over a 100-year period (the reference period used under the Kyoto Protocol), methane has a GWP of 25, nitrous oxide of 298, CFC-11 (an ozone-depleting substance phased out under the Montreal Protocol) of 4,750, and HFC-23 (a substance temporarily used as a substitute for chlorofluorocarbons) of 22,800; fortunately, these gases with a very high GWP are much less abundant than carbon dioxide (IPCC 2007b).

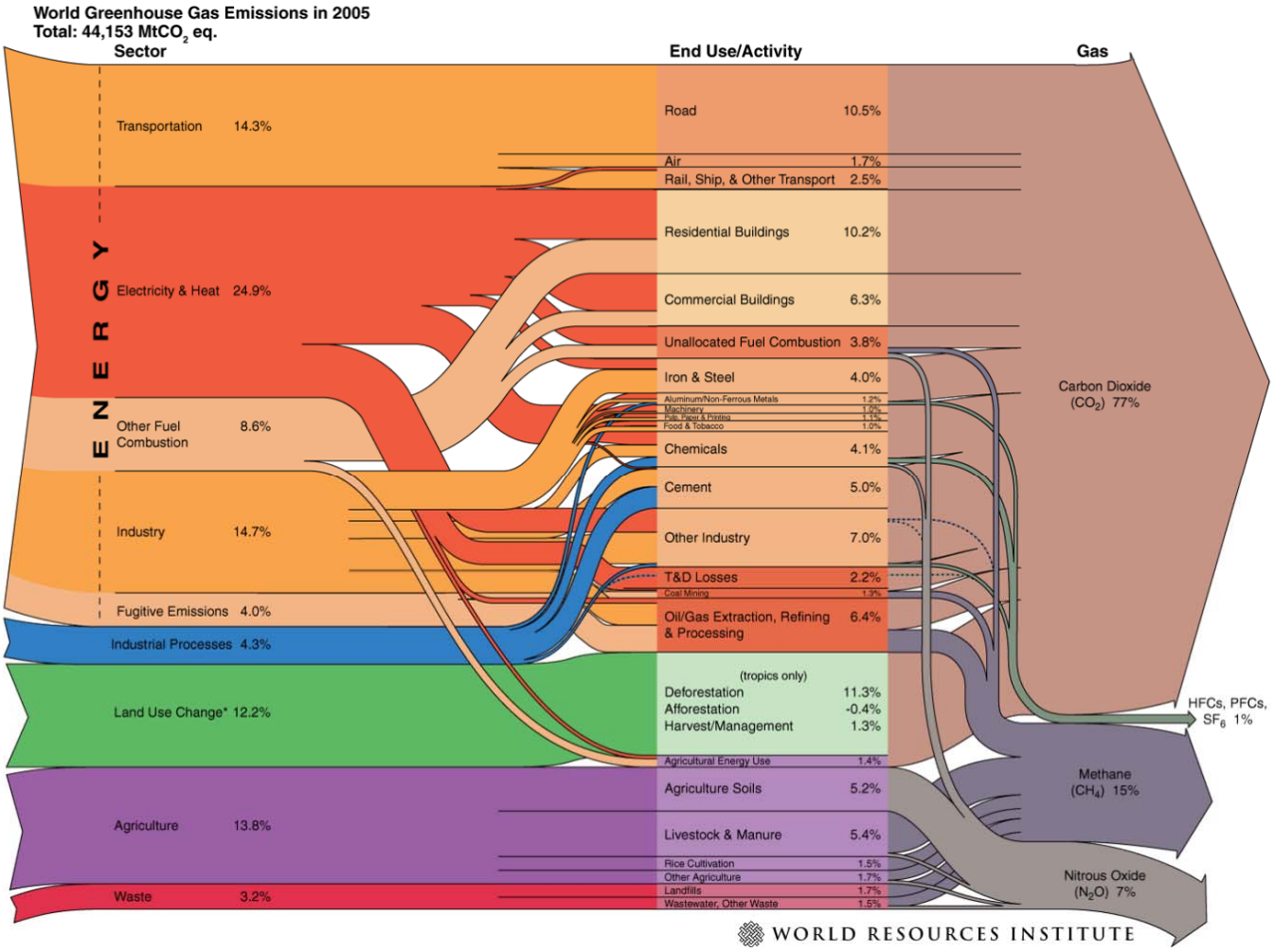
Table 3.1 – Global warming potential of some greenhouse gases

GHG	Over 20 years	Over 100 years	Lifetime (years)
Methane	72	25	12
Nitrous oxide	289	298	114
CFC-11 *(N.B. ozone depleting substance)*	6,730	4,750	45
HFC-23	12,000	14,800	270
SF-6	16,300	22,800	3,200

Source: Adapted from IPCC (2007b) *Climate Change 2007: The Physical Science Basis*. Table 2.14, p. 212.

6. Historically, the use of *energy* obtained from fossil fuels is the main contributor to anthropogenic emissions of GHGs. Over the past few decades, *agricultural practices* and *land use changes* have emerged as other significant sources of emissions. Today, the various uses of energy still account for about two-thirds of total GHG emissions. Land use changes (primarily deforestation) and agriculture contribute 13-15% each. Industrial processes (other than energy use) contribute another 4%, and the waste sector about 3%. The World Resources Institute's 'World Greenhouse Gas Emissions Flow Chart (2005)', shown in **Figure 3.2**, illustrates the contribution of various human activities to GHG emissions at the global level.

Figure 3.2 – *World Greenhouse Gas Emissions Flow Chart (2005)*

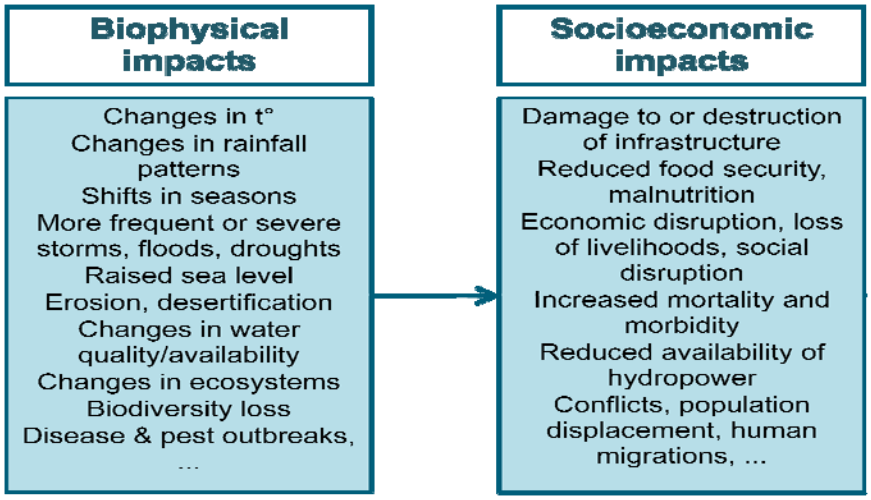


Copyright: World Resources Institute, Washington, DC
Source: Herzog (2005) *World Greenhouse Gas Emissions in 2005*, p. 2

Main consequences

7. Using a variety of scenarios for future GHG emissions, the IPCC has prepared *projections for the end of the 21st century*. Relative to the period 1980-1999 and depending on the chosen scenario, expected increases in global average temperature by the end of this century range between 1.1 and 6.4°C, while the range in sea level rise would be between 0.18 and 0.59 m. (These projections are now considered quite conservative by some experts, in particular with regard to sea level rise.) As already mentioned, changes in the climate system result in changes in physical and biological systems, which in turn lead to socio-economic impacts (EC 2009a). **Figure 3.3** provides a summary of the main biophysical and socio-economic impacts.

Figure 3.3 – *Biophysical and socio-economic impacts of climate change*

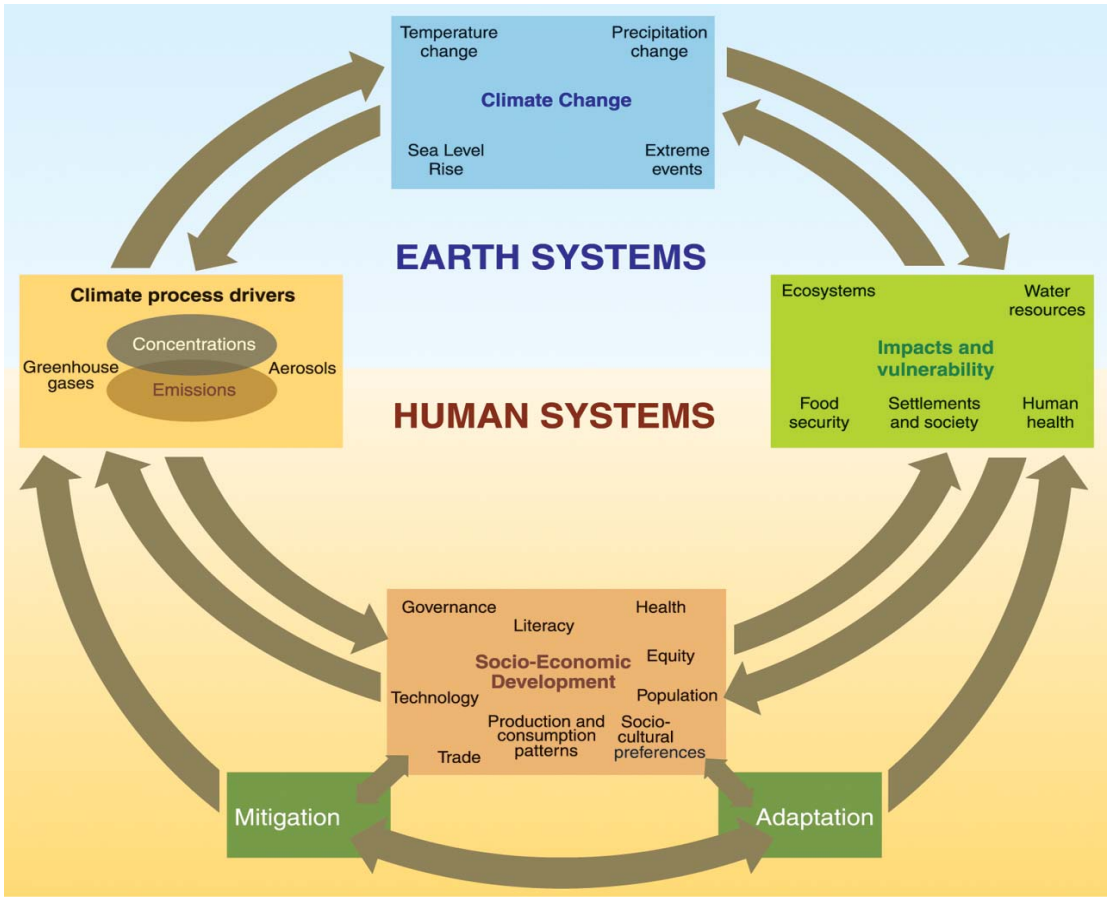


Source: EC (2009a)/GCCA Support Facility

Summary

8. **Figure 3.4** provides a schematic framework of anthropogenic drivers of climate change, how earth and human systems interact, and the role of adaptation and mitigation responses.

Figure 3.4 – Schematic framework of anthropogenic climate change drivers, impacts and responses



Source: IPCC (2007a) *Climate Change 2007: Synthesis Report*. Figure I.1, p. 26.

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USEFUL WEBSITE:

WWF – Climate change explained:
http://wwf.panda.org/about_our_earth/aboutcc/how_cc_works/