An Early Attempt at an
Easy-to-Use, Hypertext Knowledge Base on Climate Change

Part I

GREENHOUSE GASSES

Nordeco, Denmark. **August 2007**

Introduction: *This is an attempt to create an easy-to use knowledge base on Global Warming for Nordeco and its clients and collaborators. It consist of two files, the presents one on 'Greenhouse Gasses and a second on 'Global Warming – What to do?' The MindMap at the bottom of each file attempts to help with the overview, while the associated text generally provides first a 'key quote' or a description what an issue is about, and then goes on to refer to additional sources of information. If we have been able to identify sources that provide solid data, these are also listed, with some actual data. The present version is 1.3. Comments from users have been incorporated, as has recent developments and information. Later versions may be sent by email, on request to sj@nordeco.dk. Comments may be submitted at the same mail adress.*

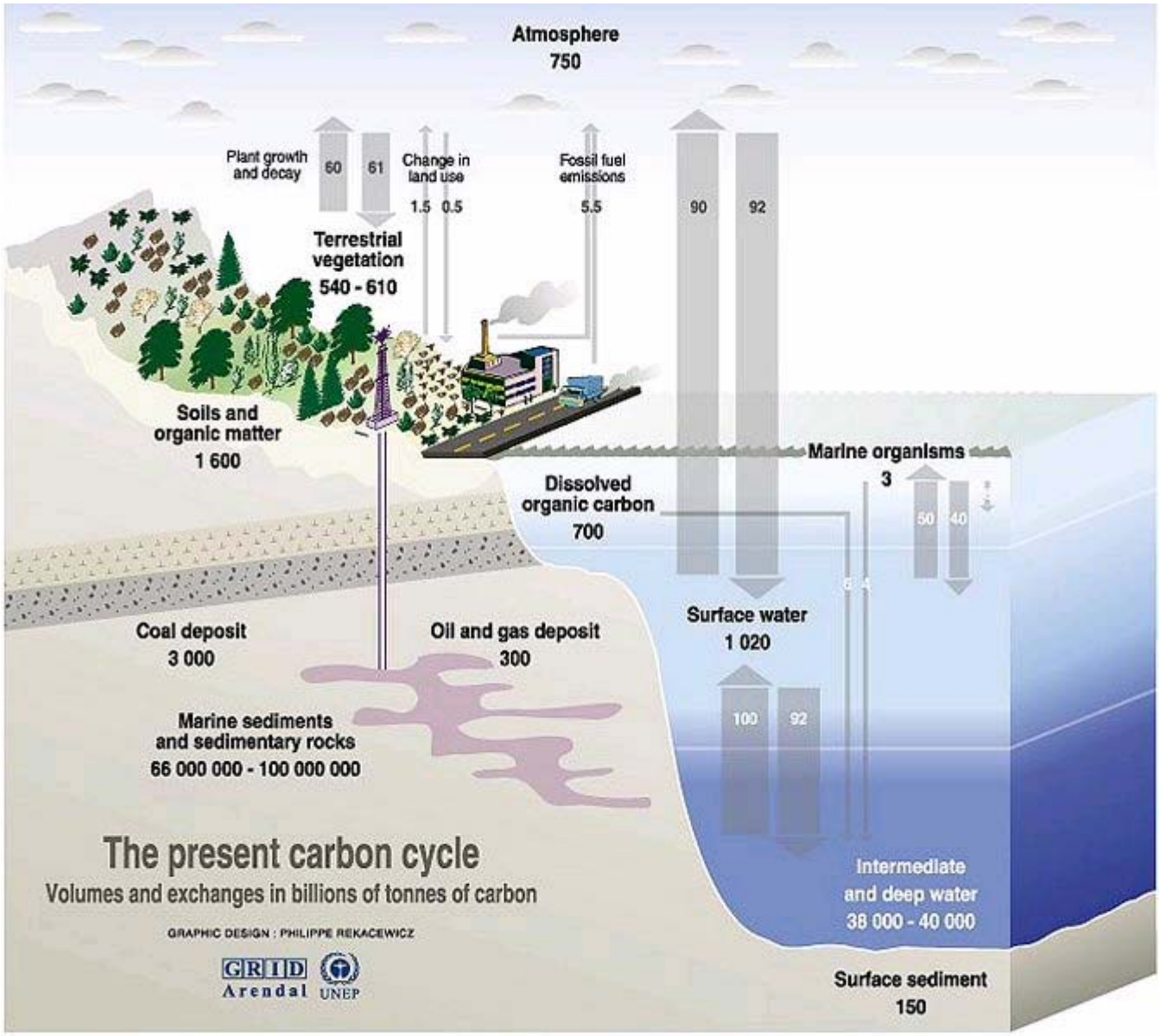
GREENHOUSE GASSES

Key quote:

Greenhouse gases (GHGs) control energy flows in the atmosphere by absorbing infra-red radiation emitted by the earth. They act like a blanket to keep the earth's surface some 20 degrees C warmer than it would be, if the atmosphere contained only oxygen and nitrogen. The trace gases that cause this natural greenhouse effect comprise less than 1% of the atmosphere. Their levels are determined by a balance between "sources" and "sinks". Apart from industrial chemicals like CFCs and HFCs, greenhouse gases have been present naturally in the atmosphere for millions of years. Humans however, are affecting greenhouse gas levels by introducing new sources or by interfering with natural sinks. (*from UNPCC*)

Data on emissions can be found at WRI.

An illustration of the global carbon cycle: (from CRed):



Sources: Center for climatic research, Institute for environmental studies, university of Wisconsin at Madison; Okanagan university college in Canada, Department of geography; World Watch, November-December 1996; Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge press university, 1996.

1 CO2 - Carbon Dioxide

Key quote:

Carbon dioxide is currently responsible for over 60% of the "enhanced" greenhouse effect. This gas occurs naturally in the atmosphere, but burning coal, oil, and natural gas is releasing the carbon stored in these "fossil fuels" at an unprecedented rate. Likewise, deforestation releases carbon stored in trees. Current annual emissions amount to over 23 billion metric tons of carbon dioxide, or almost 1% of the total mass of carbon dioxide in the atmosphere. (*from* UNPCC)

1.1 Burning of fossil fuels

1.1.1 What is it?:

Fossil fuels generally mean hydrocarbons or carbon derived from fossilised biological material (mainly algae (oil) or higher plants (coal)).

Data:

A lot of data, including data on fossil fuel reserves can be found at 'Oildrum'

1.1.2 Decomposition or burning of organic matter

Key quote: Deforestation is responsible for more emissions than the transport sector. *Stern review*

Another quote:

Land use changes from forest or grassland to arable agriculture have been and still are a significant source for the release of former plant and soil carbon into the atmosphere. The reasons for decreasing soil carbon contents are a reduced input of plant biomass into cropland on the one hand, and an accelerated decomposition of the existing organic matter in agricultural soils on the other. The combined losses from the earth's native biomass and from soils due to cultivation between the year 1700 and today amount to about 170 Gt carbon, which is now largely in the atmosphere. A further CO2 emission in the range of 1.2 Gt C per year is still going on due to additional land clearing for agriculture in the tropics. The only way to escape from this forest conversion is a more sustainable use and improved productivity of the already existing farmland.

From a Journal Article by Sauerbeck

1.1.3 Land use changes (forest or grassland to agriculture)

Key quote:

Land use changes from forest or grassland to arable agriculture have been and still are a significant source for the release of former plant and soil carbon into the atmosphere. The reasons for decreasing soil carbon contents are a reduced input of plant biomass into cropland on the one hand, and an accelerated decomposition of the existing organic matter in agricultural soils on the other. The combined losses from the earth's native biomass and from soils due to cultivation between the year 1700 and today amount to about 170 Gt carbon, which is now largely in the atmosphere.

A further CO2 emission in the range of 1.2 Gt C per year is still going on due to additional land clearing for agriculture in the tropics. (From an overview paper)

1.2 Respiration

What is it:

Any breakdown of organic matter, such as happens in the metabolism (the part called respiration) of any living organism, releases some of the 'building blocks' of the organic matter. Among these are carbon, which may be relased as CO2 - Carbondioxide - or in some cases (when no oxygen is available) as CH4 - methane.

2 CH4 - Methane

Key quote, #1:While carbon dioxide is the principal greenhouse gas, methane is second most important. According to the IPCC, Methane is more than 20 times as effective as CO2 at trapping heat in the atmosphere. US Emissions Inventory 2004 states that levels of atmospheric methane have risen 145% in the last 100 years. Methane is derived from sources such as rice paddies, bovine flatulence, bacteria in bogs and fossil fuel production. Most of the world's rice is grown on flooded fields. When fields are flooded, anaerobic conditions develop and the organic matter in the soil decomposes, releasing CH4 to the atmosphere, primarily through the rice plants. (Source)

Key quote, #2:' Methane (CH4) is a greenhouse gas that remains in the atmosphere for approximately 9- 15 years. Methane is over 20 times more effective in trapping heat in the atmosphere than carbon dioxide (CO2) over a 100- year period and is emitted from a variety of natural and human- influenced sources. Human- influenced sources include landfills, natural gas and petroleum systems, agricultural activities, coal mining, stationary and mobile combustion, wastewater treatment, and certain industrial process.

Methane is also a primary constituent of natural gas and an important energy source. As a result, efforts to prevent or utilize methane emissions can provide significant energy, economic and environmental benefits.

Methane is emitted from a variety of both human-related (anthropogenic) and natural sources. Human-related activities include fossil fuel production, animal husbandry (enteric fermentation in livestock and manure management), rice cultivation, biomass burning, and waste management. These activities release significant quantities of methane to the atmosphere. It is estimated that 60% of global methane emissions are related to human-related activities (IPCC, 2001c). Natural sources of methane include wetlands, gas hydrates, permafrost, termites, oceans, freshwater bodies, non-wetland soils, and other sources such as wildfires.

Methane emission levels from a source can vary significantly from one country or region to another, depending on many factors such as climate, industrial and agricultural production characteristics, energy types and usage, and waste management practices. For example, temperature and moisture have a significant effect on the anaerobic digestion process, which is one of the key biological processes that cause methane emissions in both human-related and natural sources. Also, the implementation of technologies to capture and utilize methane from sources such as landfills, coal mines, and manure management systems affects the emission levels from these sources. (Source)

Data:

An attempt to quantify methane releases from agricultural soils

2.1 From animal metabolism and excreta

Key quote # 1:

'the livestock sector generates more greenhouse gas emissions as measured in CO2 equivalent – 18 percent – than transport'.

(FAO is source)

Key quote # 2

'The (livestock) sector emits 37 percent anthropogenic methane (with 23 times the global warming potential of CO2), most of that from enteric fermentation by ruminants'

(From the full report - executive summary)

Data:

Ruminant livestock can produce 250 to 500 L of methane per day (From a scientific paper)

2.2 From chemical fertilizers

2.3 From flooded rice

Additional information:

An article about methane and global warming

'Defined aeration periods reduce methane emissions. Soil entrapped methane is released to the atmosphere as a result of soil disturbances/../ The methane release per m2 from different rice ecosystems follow the order: deepwater rice>irrigated rice>rainfed rice.' (Source, a paper from the Internationa Rice Research Institute)

Some primary data from articles (a list)

Data:

'Over the 100- day season, daily emissions averaged about 0.25 g CH4/sq m' - in California (Source)

2.4 From landfills

Data:

'Published estimates for worldwide landfull methane emissions range from 9 to 70 Tg yr[-1]. Field and laboratory studies suggest that maximum methane yields from landfilled refuse are about 0.06 to 0.09 m[3] (dry kg)[-1] refuse, depending on moisture content and other variables, such as organic loading, buffering capacity, and nutrients in landfill microenvironments. Methane yields may vary by more than an order of magnitude within a given site. Fates for landfill methane include (1) direct or delayed emission to the atmosphere through landfill cover materials or surface soils; (2) oxidation by methanotrophs in cover soils, with resulting emission of carbon dioxide; or (3) revocery of methane followed by combustion to produce carbon dioxide' (Source)

2.5 From fossil-fuel production

What is it?

Fossil fuel ciónsists of mixtures of hydrocarbons, one of them being methane – the simplest possible hydrocarbon. It is frequenly released at oil or gas production sites.

2.6 From thawing permafrost

What is it?

There has been serious concern that thawing permafrost - mainly in Siberia - may release vast amounts of methane.

There seems, however, to be some controversy about this theory (?). The swamps in Siberia are growing in size and possibly capturing substantial amount of CO2 (see 'Peat Bogs' i text/MindMap about 'Global Warming - what to do')

2.7 In deep water

What is it?

Deep water bodies in oceans and in deep lakes contain enormous amounts of methane hydrate.

In a possible scenario, increasing temperatures, due to global waming, may lead to increased mobilisation (release) of methane from this source, in a 'positive feedback'.

(Source - a Paper in 'Chemical Engineering Science')

2.8 From plants?

What is it?:

It has been proposed that plants themslves release methane, possibly even in quantities, which make sequestration of carbon in living plants a net negative mitigation approach.

Recent research has debunked this claim

3 N2O - Nitrous Oxide

Key quote: Another greenhouse gas is Nitrous oxide (N2O), a colourless, non-flammable gas with a sweetish odour, commonly known as "laughing gas", and sometimes used as an anaesthetic. Nitrous oxide is naturally produced by oceans and rainforests. Man- made sources of nitrous oxide include nylon and nitric acid production, the use of fertilisers in agriculture, cars with catalytic converters and the burning of organic matter. Nitrous oxide is broken down in the atmosphere by chemical reactions that involve sunlight. (Source)

3.1 Denitrification

From agricultural land

Agricultural land may emit N2O especially during cold seasons (in temperate regions).

Use of chemical fertilizers increase the emission of N2O.

Data:

Calculated global annual N2O- N and NO-N emissions from fertilized agricultural fields amount to 2.8 and 1.6 Mtonne, respectively. The global mean fertilizer- induced emissions for N2O and NO amount to 0.9% and 0.7%, respectively, of the N applied.

Detailed data for northern conditions are given here.

An attempt to quantify N2O releases from agricultural soils

3.1.1 From freshwater

A lot of Nitrogen ends up in open waters or groundwater. Here some it is denitrified, releasing N2O to the atmosphere. A very important source of the Nitrogen is chemical fertilizers.

3.1.2 From marine waters

A very technical paper, here:

3.1.3 From livestock - manure

Key quote:

'It (The livestock sector) emits 65 percent of anthropogenic nitrous oxide (with 29 times the glogal warming potential of CO2), the great majority from manure' (FAO is source)

4 Water vapour

Key quote:

The largest contributor to the natural greenhouse effect is water vapour. Its presence in the atmosphere is not directly affected by human activity. Nevertheless, water vapour matters for climate change because of an important "positive feedback". Warmer air can hold more moisture, and models predict that a small global warming would lead to a rise in global water vapour levels, further adding to the enhanced greenhouse effect. On the other hand, it is possible that some regions may become drier. Because modeling climate processes involving clouds and rainfall is particularly difficult, the exact size of this crucial feedback remains unknown/uncertain.

(*from UNPCC*)

5 Others

A list of these chemicals can be found here

5.1 Halogen-containing compounds

5.2 CFC's

Key quote: CFCs (Chlorinated Fluoro- Carbons) - found in fridges, air conditioners, aerosols etc. are extremely effective greenhouse gases. Although there are lower concentrations of CFCs in the atmosphere than CO2 they trap more heat. A CFC molecule is 10,000 times more effective in trapping heat than a CO2 molecule. (Source)

CFC's are also a cause of depletion of the Earth's ozone layer. They have - with success - been restricted by the international agreement termed the Montreal Protocol.

Unfortunately, they have largely been replaced with Hydrogenated FluoroCabons (HFC's), which are strong Greenhouse Gasses.

5.3 Carbon tetrachloride

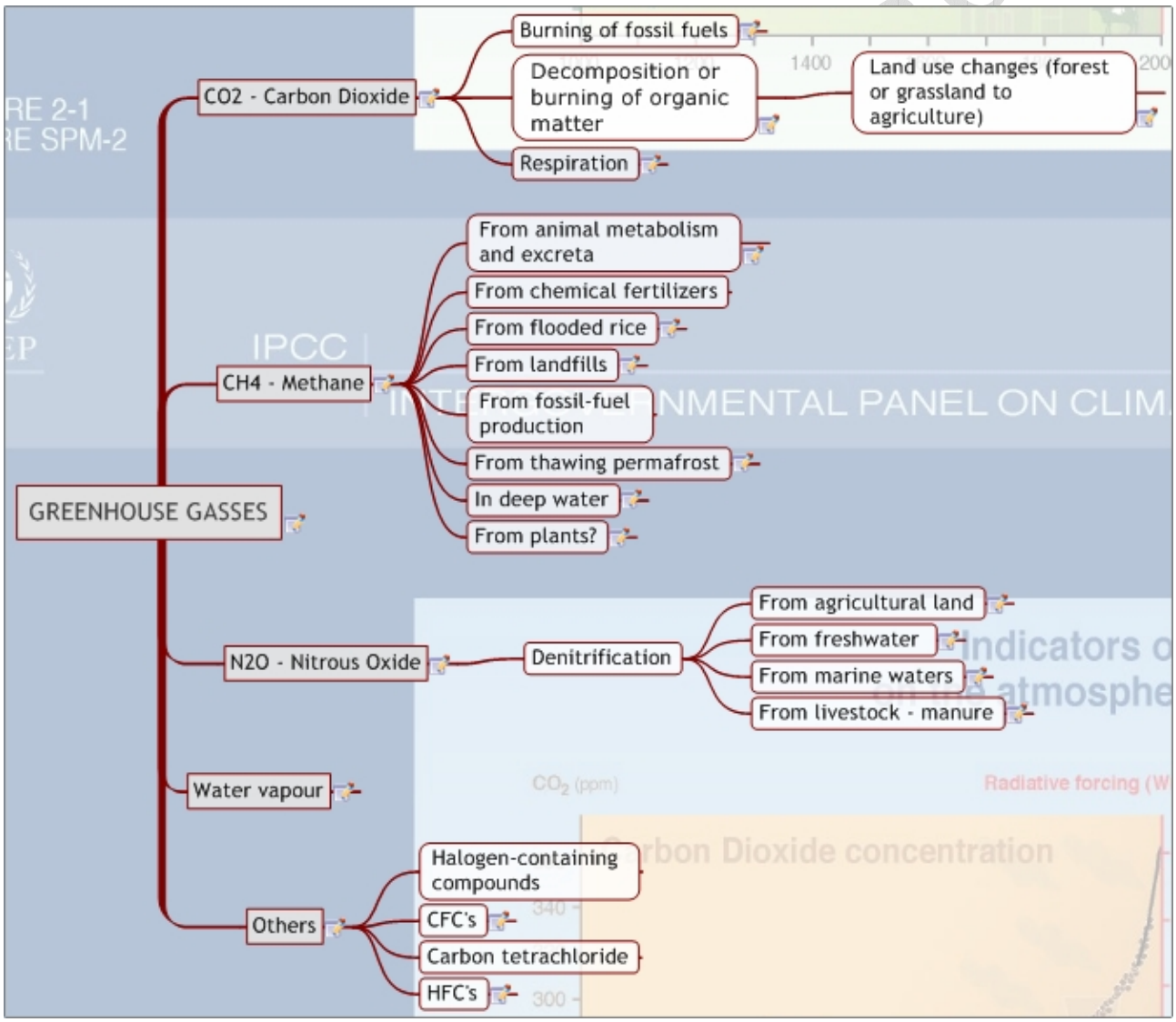
5.4 HFC's

Key quote:

Hydrofluorocarbons or 'HFCs' have been increasingly used in the last decade or so as an alternative to ozone damaging CFCs in refrigeration systems. Unfortunately, though they provide an effective alternative to CFCs, they can also be powerful greenhouse gases with long atmospheric lifetimes.

The three main HFCs are HFC-23, HFC-134a and HFC152a, with HFC- 134a being the most widely used refrigerant. Since 1990, when it was almost undetectable, concentrations of HFC-134a have risen massively.

(source)



The entire Word file above is produced from a more detailed version of this Mindmap. The Mindmap may be obtained from sj@nordeco.dk, together with a free reader for the software