



# **CLIMATE CHANGE**

## **PROBLEMS AND SOLUTIONS**

***SPARE***

**SCHOOL PROJECT FOR APPLICATION OF RESOURCES AND ENERGY**

# CLIMATE CHANGE - PROBLEMS AND SOLUTIONS

## Oslo 2009

SPARE (School Project for Application of Energy and Resources) is the largest international school project on energy, climate and environment. 4500 schools and 175.000 pupils in so far 16 countries participate annually in the SPARE educational program. The SPARE program was created in 1996, by the Norwegian Society for the Conservation of Nature (Norges Naturvernforbund).

Through SPARE pupils learn how to use energy and resources efficiently. Active SPARE schools conduct education on sustainable use of energy and resources, implement practical measures on energy efficiency or renewable energy, and finally inform the neighborhood about their achievements. SPARE educational activities in each country are coordinated by national NGOs who also promote education on energy and environment into the national educational plans as well as simple technologies for energy efficiency and use of renewable energy sources.

A large number of serious ecological problems of world scale are connected with the production and use of energy. The idea of the SPARE program is to go from a discussion of global problems to practical actions of schoolchildren, to receive an answer to the question: How can we satisfy our need for energy (heating, light, transport) without dangerous and devastating consequences for nature?

18 pages.

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SPARE - THE LARGEST INTERNATIONAL SCHOOL PROJECT  
ON ENERGY, CLIMATE AND ENVIRONMENT

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# THE CLIMATE

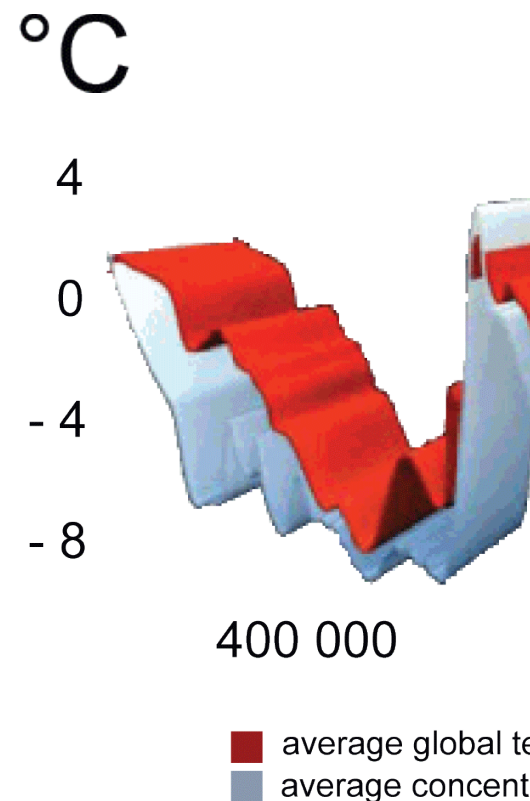
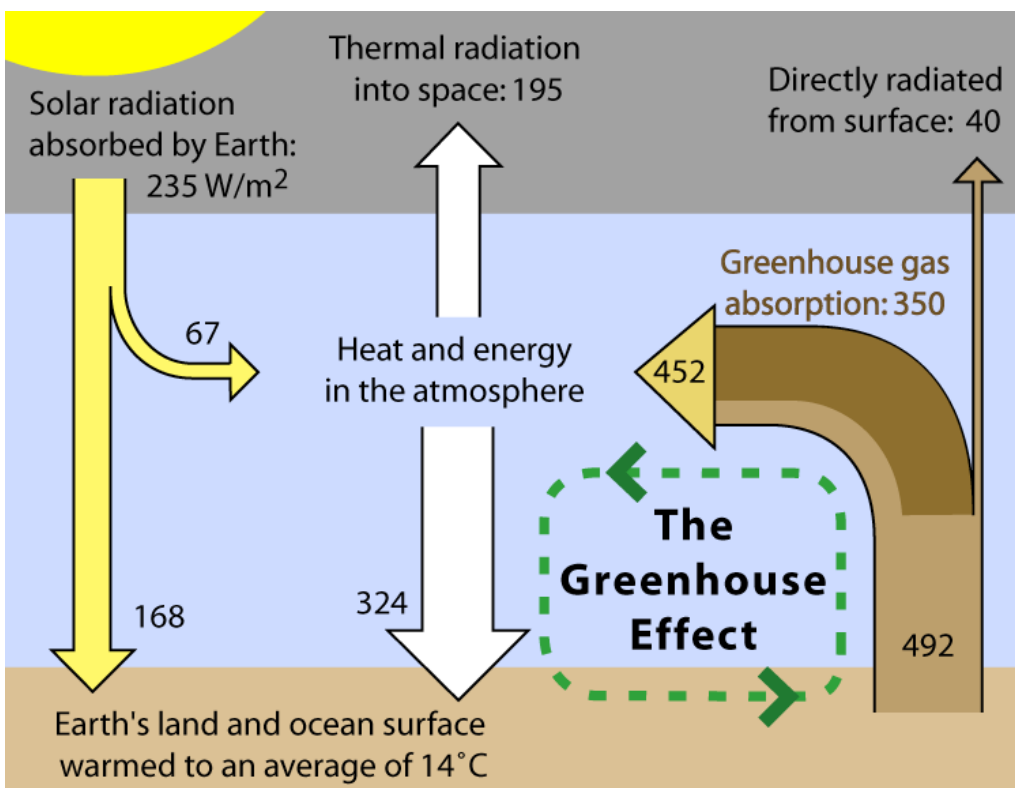
Carbon dioxide (CO<sub>2</sub>) along with other greenhouse gases (GHG) warm the surface of the planet naturally by trapping solar heat in the atmosphere. This is a good thing because it keeps our planet habitable. However, by burning fossil fuels such as coal, gas and oil and clearing forests we have dramatically increased the amount of carbon dioxide in the Earth's atmosphere and temperatures are rising.

The climate is an average stage of weather conditions over a long period of time. This means that even though the weather can be rainy, or sunny, windy or calm, we would add

up the weather conditions over a longer period of time, and see if days are mainly rainy, calm or sunny. Then we also need to know average temperatures, to see what type of temperature regime is prevailing, that is if days are mostly mild, very warm or cold. That is how we will get the main climatic characteristic. Hence, the weather is a current stage of atmospheric conditions, over a rather short period of time. Climate is a stable parameter and characterizes particular regions, while weather is unstable and changeable, and the same weather can appear in different regions of the world, and different climate zones. The weather can also change from day to

day, but the climate changes very slowly, over decades or centuries.

The climate has continuously changed ever since the origin of our planet. It has been depending on the different geological and astronomical changes such as volcanic activity, solar activity and the Earth's orbit variations. Also, the development of life on earth has been depending on the climate as well. These changes in climate regime have taken place over millions of years.



# THE NATURAL CLIMATE CHANGE

The climate on earth has colder and warmer periods. Scientists use different methods to determine how the climate has been changing in the past geological eras, and it is known today that it has been varying significantly over the time.

Different average temperatures create the main distinction between different climate periods, which has a consequence in change of life forms (both plants and animals).

Colder and warmer periods have been succeeding one another, and scientists have named these periods glacial and interglacial, respectively.

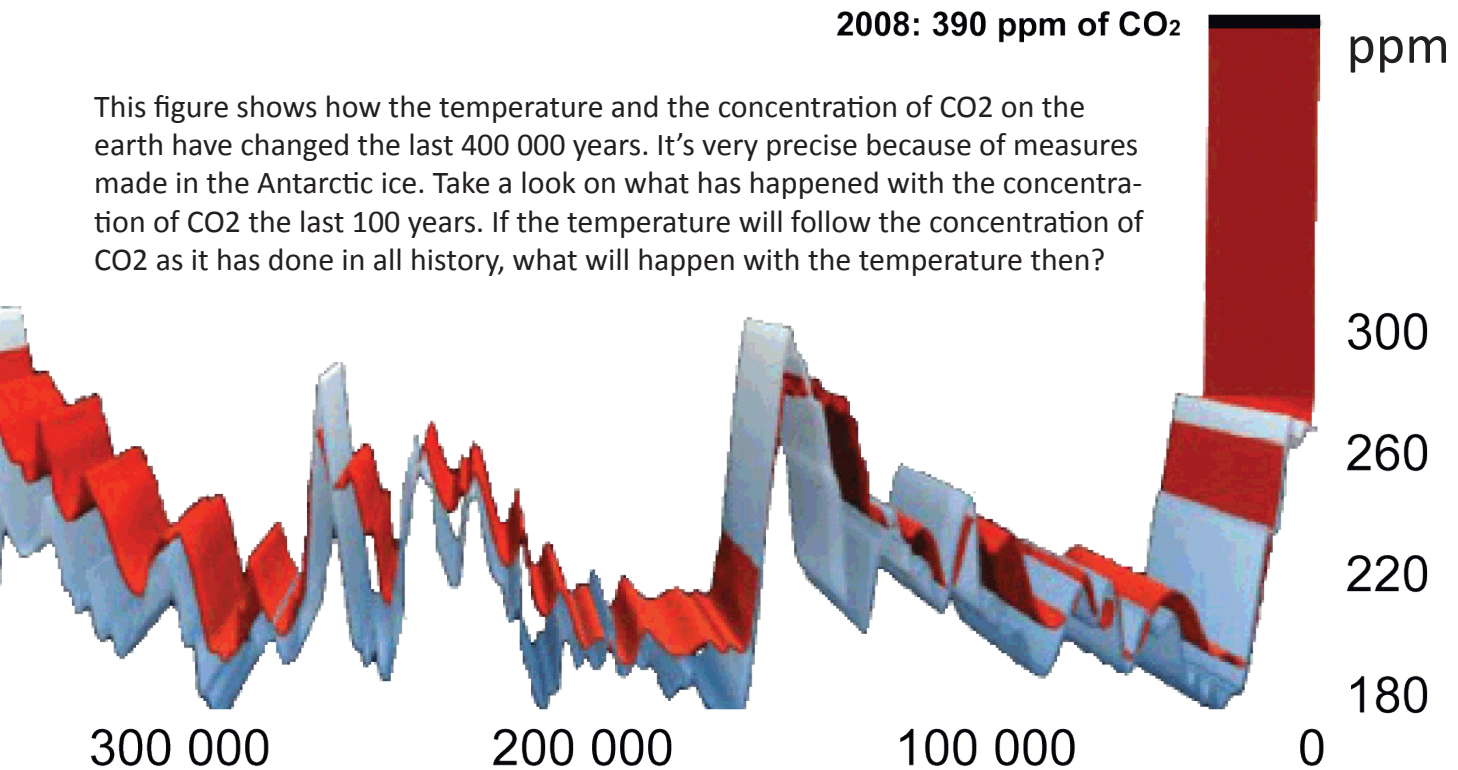
Today, the planet is in the interglacial period, which started some 10 000 years ago. Accordingly, the next glacial period will peak in about 80 000 years, but it is uncertain exactly when it will start.

In terms of geology this is a rather short period of time, however in terms of human history, this period is indeed long.



2008: 390 ppm of CO<sub>2</sub>

This figure shows how the temperature and the concentration of CO<sub>2</sub> on the earth have changed the last 400 000 years. It's very precise because of measures made in the Antarctic ice. Take a look on what has happened with the concentration of CO<sub>2</sub> the last 100 years. If the temperature will follow the concentration of CO<sub>2</sub> as it has done in all history, what will happen with the temperature then?



temperature  
concentration of CO<sub>2</sub> parts per million (ppm) in the atmosphere

# HUMAN INFLUENCE ON CLIMATE

The climate change that's debated today is different. It has taken place within the period of a human life and is mainly caused by human activity. Our modern lifestyle has contributed to the increase of greenhouse gases in the atmosphere. Use of fossil fuels releases CO<sub>2</sub> that has been trapped in the ground for millions of years, and increases its concentrations in the atmosphere. Modern agriculture - crops growth, animal breeding and deforestation, also results in huge greenhouse gases (GHG) release.

Even though the greenhouse effect is a naturally occurring phenomenon, it has however been aggravated by human activities during the 20th century, and today we see devastating consequences of a human induced greenhouse effect. As we mentioned that carbon dioxide is a part of processes in nature, we must realize that the amount of this gas in the atmosphere exceeds by far the necessary amounts for natural cycles. Moreover, CO<sub>2</sub> is not the only gas that creates the greenhouse effect. Other gases released in the air due to human activities are part of the greenhouse effect, like nitrogen oxide, N<sub>2</sub>O, which is also toxic and methane, CH<sub>4</sub>, which is flammable. However they only make a small share of gas mixture in the atmosphere. Not to forget ozone, O<sub>3</sub>, a gas which is necessary in the higher layers of atmosphere since it protects life on earth from UV rays, but in the lower parts it contributes to the greenhouse effect. Therefore, this layer of greenhouse gases

keeps more heat on earth than before. The phenomenon, which appeared due to the greenhouse effect caused by human activity, is called global warming, since one of the major consequences of this effect is the global temperature rise.

It took a long time for effects of GHG accumulation to have a strong influence on the climate on earth; it will probably take even longer to diminish the effects of the amounts of these gases in the atmosphere today.

The increased greenhouse gases emission is a consequence of rapid development of the world after the industrial revolution, in the 19th century. Our industrialization has been developing on the massive use of fossil fuels such as coal, oil and gas. When burnt, these fuels release CO<sub>2</sub> into the atmosphere. This has been the main contribution to the man-made greenhouse effect. Over the decades, these changes gradually became more apparent and more harmful.

Today, the world average annual emission of CO<sub>2</sub> is 4 tons per capita. However, in the USA the average amount is about 25 tons per capita (2008), due to their massive use of fossil fuels. Other countries, particularly in less developed regions of the world, have CO<sub>2</sub> emissions way below average, in Mali the average is about 0,1 tons per capita (2002) .

## Suggestions for further reading:

Climate Change Science. UNFCCC website

[http://unfccc.int/essential\\_background/feeling\\_the\\_heat/items/2902.php](http://unfccc.int/essential_background/feeling_the_heat/items/2902.php)

Intergovernmental Panel on Climate Change report: "Climate Change – the physical science basis", Summary for Policy Makers.

<http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf> (english)



# MAJOR ANTHROPOGENIC SOURCES OF GREENHOUSE GASES

Today, we have every reason to believe that the human activities have started a chain of reactions resulting in changes in the atmosphere, water, soil and life on the planet, due to first and foremost extensive emission of the greenhouse gases.

## Power stations

Power stations generate electric power from different energy sources, traditionally from fossil fuels. These plants convert different forms of energy (such as chemical, or heat) into the usable form. Power plants that use fossil fuels, such as coal, oil or natural gas, are the biggest greenhouse gas source on earth, and carbon dioxide in particular. In a mixture of greenhouse gases, carbon dioxide comprises 72% of the greenhouse gases and it is therefore the most important contributor to the global warming.

## Industry

Production and material processing is also one of the greatest GHG emitters. Combustion of woods and fossil fuels, chemical industry, cement and lime production as well as iron and steel industry substantially contribute to the GHG emission, particularly to the CO<sub>2</sub> amounts in the atmosphere. The energy used by the industry sector has grown 61% from 1971 to 2004.

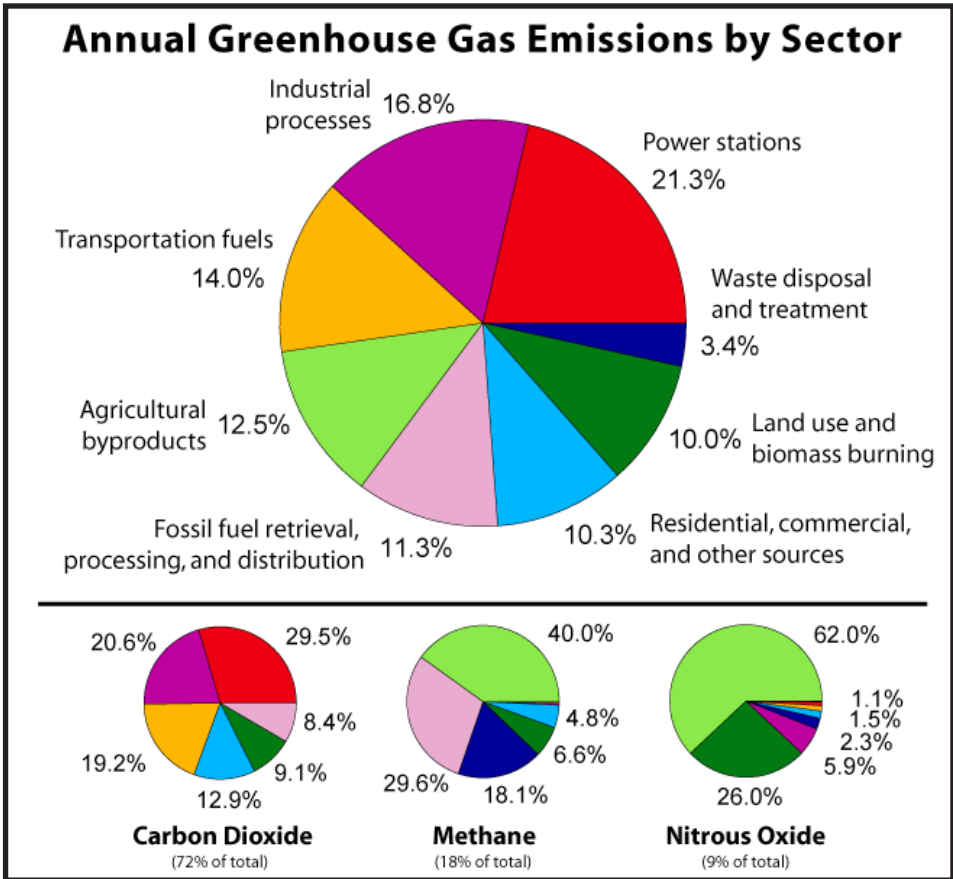
## Transport

Transport is the second biggest source of CO<sub>2</sub> emission, and it is constantly growing. In Europe one fifth of the CO<sub>2</sub> emission comes from traffic, while in the USA the transportation sector emits one third of the amount of CO<sub>2</sub> in the atmosphere. It is important to note that cars exhaust does not only contain CO<sub>2</sub> but also induce forming of ozone, due to the chemical reaction with the sunlight. Ozone in the lower layers of the atmosphere also acts like a greenhouse gas, capturing infrared sun rays reflected from the earth's surface.

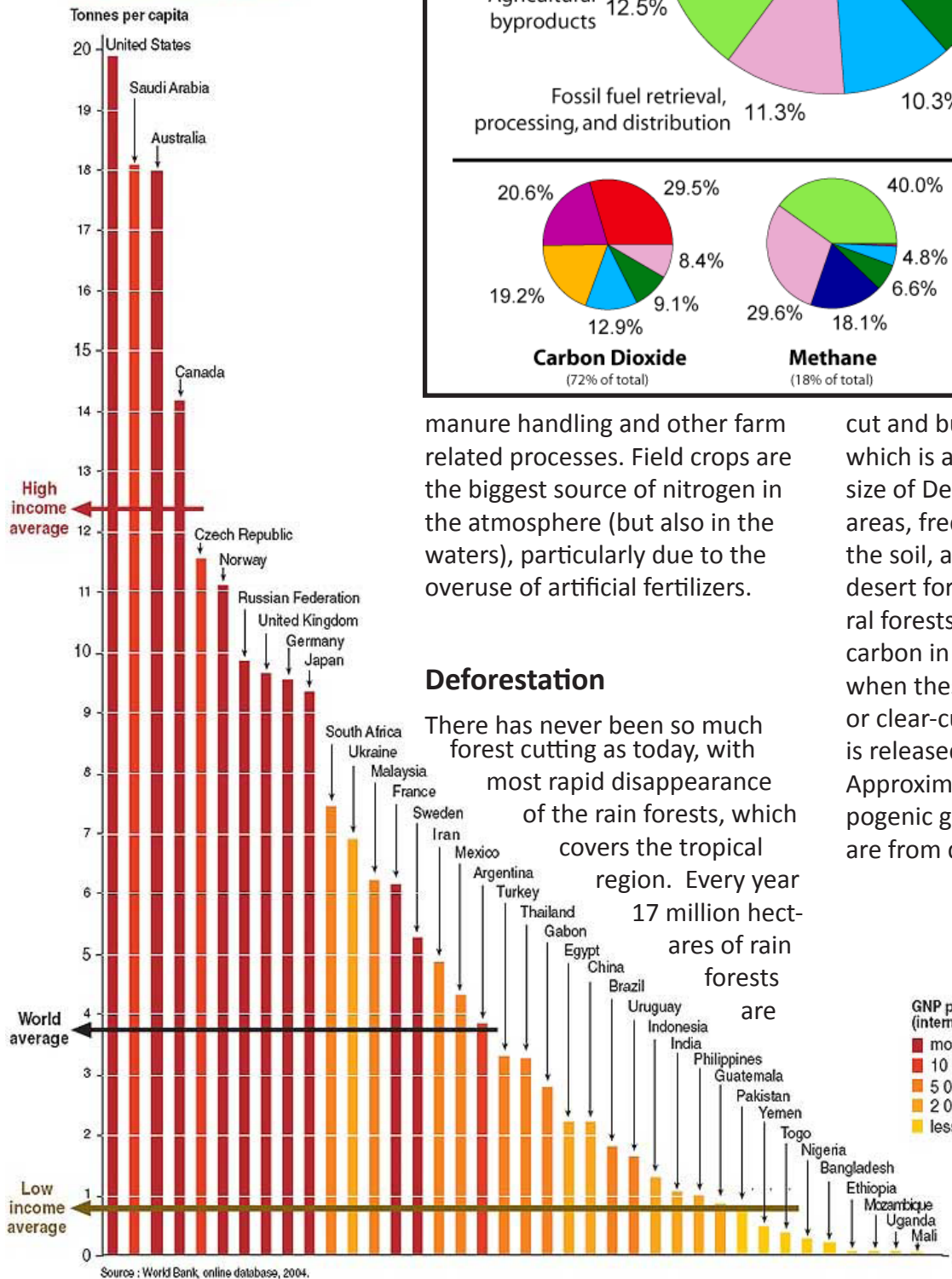


### Farming

Animal farming is one of the main sources of the greenhouse gas – methane. Cattle, chicken and pigs make up to 40% of man induced methane emission. Methane is emitted from the digestive process of the livestock, as well as from



### CO<sub>2</sub> Emissions in 2002



manure handling and other farm related processes. Field crops are the biggest source of nitrogen in the atmosphere (but also in the waters), particularly due to the overuse of artificial fertilizers.

### Deforestation

There has never been so much forest cutting as today, with most rapid disappearance of the rain forests, which covers the tropical region. Every year 17 million hectares of rain forests are

cut and burned in forest fires, which is approximately 4 times the size of Denmark. In the forest cut areas, frequent rains wash away the soil, and there is a danger of a desert forming. The world's natural forests store vast amounts of carbon in its soils and biomass, when these forests are burned or clear-cut, most of this carbon is released to the atmosphere. Approximately 1/5 of all anthropogenic greenhouse gas emissions are from deforestation.



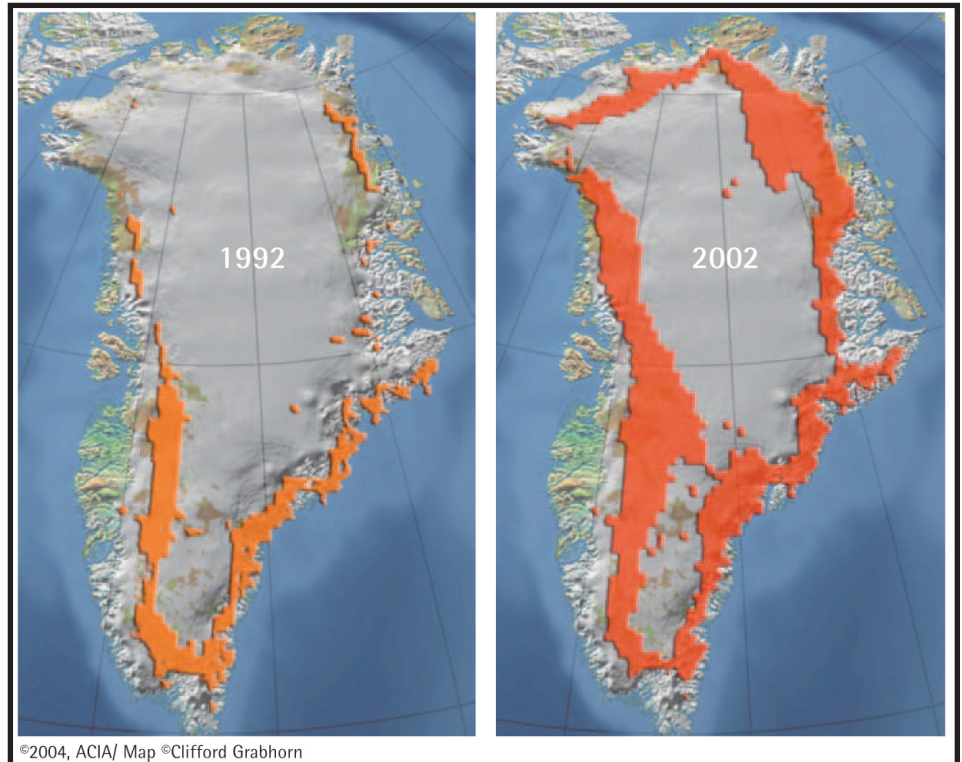


# EFFECTS OF CLIMATE CHANGE

## Effects on nature

Several decades ago, the climate of different regions in the world started to become less typical, i.e. it showed signs unusual for the season. Typhoons, floods, snowstorms and droughts started to appear in areas where they were not common and at times not expected. The average annual temperatures, particularly in boreal regions, showed signs of slow gradual rising. The glaciers at high mountain ranges such as European Alps or American cordilleras were melting more rapidly during warm seasons than earlier recorded, and were rebuilding their winter ice masses slower than before. The ice and snow of northern Europe and Greenland, as well as Northern Canada and Siberia were showing signs of disappearance. Birds started to change their migration patterns, and are slowly shifting their migration, mating and nesting seasons. Other animals are also showing changes in their annual schedule and plants are blossoming prior to their time.

Either of these events may not be alarming on their own, but added



up these create a clearer image. We have every reason to believe that the climate on our planet is changing.

On a more global scale, it is likely that the ocean currents will change their directions at least slightly, as the temperature of the currents may change, since there is a great inflow of fresh cold water from ice and snow melting. The level of the sea is likely to rise significantly in the



next decades. All of these events will have a strong influence on both ocean life and coastal ecosystems.



Scientists have so far identified only one viable mechanism to induce large, global, abrupt climate changes: a swift reorganization of the ocean currents circulating around the earth. These currents, collectively known as the Ocean Conveyor, distribute vast quantities of heat around our planet, and thus play a fundamental role in governing Earth's climate.

With a temperature regime change, many terrestrial and aquatic habitats are already disappearing. Plants and animals used to certain conditions are often not able to adapt to a changed environment in such a short notice, which leads to a great biodiversity loss. One example is the Polar Bear, which is the first animal that the U.S. government has listed as threatened under the Endangered Species Act (ESA), because of climate change. Climate change is destroying vital polar bear habitat, putting the species at risk of extinction. This decision clearly indicates that climate change im-

pacts are already threatening the survivability of animals and habitats, and illustrates the urgency of preparing for and adapting to a rapidly changing climate.

## Effects on humans

### Water

Within the last 10 years, 7 have been the warmest recorded years in history; when the planet is warming, drought accure more frequently in some vulnerable regions and after drought come the lack of water. In general terms, even though some countries have enough water to waste, the world is already facing a "water crisis". Up to 25% of the world population lack water and 40% do not have basic sanitary conditions.

Communities worldwide depend on the fresh water that flows in their rivers from melting glaciers. All this melting water is constantly replaced by fresh snow that compresses into ice over time and subsequently melts into water. This cycle goes on and on maintaining a perfect balance in the generation of fresh water and size of the glacier.

Because of global warming, the average global temperature keeps on increasing and ice from glaciers keep melting much faster. This can cause catastrophes of unimaginable proportions. The reduced ice cover over earth will cause temperatures to rise further. Ice glaciers deflect almost 80% of the heat from the sun and absorb





about 20% of the heat. When an ice glacier vanishes and exposes the earth below, 80% of the heat from the sun is absorbed by the earth, and only about 20% of this heat is deflected back.

This increases the temperature of the earth, which increases the temperature of sea water. Sea water expands with an increase in water temperature and causes sea levels to rise. Melting water from glaciers will finally empty into the sea, causing a further increase in sea levels.

There are many more effects that rapidly melting glaciers cause. While some areas will witness unprecedented floods, other areas will witness severe draught. Whether witnessing floods or draught, agriculture will be severely hit, causing scarcity of food grains. Nations depending on hydroelectricity will have to switch over to other sources to generate their electricity, in effect further polluting the atmosphere. Forest fires will happen more frequently (they already are in Australia and the US) causing great stress to humans living in the vicinity. The bad effects of rapidly melting ice glaciers are limitless.

### Food

The global temperature rise may cause climate belts shift, with warmer areas expanding further

to the north. This may have numerous consequences. Regions with fertile soil and mild climate may experience frequent droughts and floods, which will affect the agriculture. However, northern regions with soil unsuitable for most crops will enter the mild zone, with temperature regime suitable for food production. In most northern regions, permanently frozen ground would release great amounts of methane, as it starts to melt. The climate belt shift creates excellent conditions for many parasite species to expand, which agricultural plants are not adapted to.

Changes in the global climate pattern lead to a food production decline. Temperature regimes, droughts and floods have a strong influence on yield, and with the yield drop, the prices of food will start to grow rapidly.



### Diseases and migrations

With lack of water and food, humans are more susceptible to diseases. With the temperature rise, tropical diseases may expand via insects into areas where they previously did not exist. Other disease carriers, such as mice also expand their ranges where temperatures

are becoming more suitable for rodents, hence bacteria and viruses arrive to new areas, with people unprepared for the diseases. Malaria, cholera and Lyme disease are reaching higher up in mountain areas as well as further north on the planet. Changes in climate already cause great evacuations and migrations of people due to destructive weather conditions and destroyed crops, and it is expected that the rate of human migrations, in order to escape floods, droughts and famines, will increase in the future.

but also to all the other species living in coastal areas.

These and many other consequences of the global warming are yet ahead of us. Perhaps we cannot even foresee a lot, and only guess for many. Moreover, it is rather difficult to predict exactly how and to which degree many of the consequences will occur and how exactly these would affect different areas of the world.



### Sea level rise

From 3 000 years ago until the 19th century the sea level has been more or less constant, with a minor rise of max 0.2 mm per year. However, over the 20th century the average annual rise rate has been 1-2 mm, and since the 1990s this rate reached over 3 mm. The rise of the sea level has been linked to global warming, and it is likely the consequence of melting snow and ice from northern regions and high mountain ranges. Presently almost 50% of the world's population lives in coastal areas and sea level rise poses a great threat, not only to humans,

Note that due to the increase of temperature, warmer weather is not the only consequence of the climate change, even though the global warming is occurring. In some places of the world due to the global disturbance of the climate, the temperature may drop as well as other unusual weather conditions may occur, such as blizzards, tornadoes, excessive precipitations or droughts, all as consequences of changing climate patterns.



# GLOBAL WARMING ALERTS

We're already seeing changes. Glaciers are melting, plants and animals are being forced from their natural habitat, and the number of severe storms and droughts is increasing.

## Today we can see that...

- The number of Category 4 and 5 hurricanes, which can wipe out cities, has almost doubled in the last 30 year.
- malaria has spread to higher altitudes in places like the Colombian Andes, 7,000 feet above sea level
- The flow of ice from glaciers in Greenland has more than doubled over the past decade
- at least 279 species of plants and animals are already responding to global warming, moving closer to the poles

If the global warming continues with the present rate, we can expect catastrophic consequences:

- global sea levels could rise by more than 10 meters with the loss of shelf ice in Greenland and Antarctica, devastating coastal areas worldwide
- the Arctic Ocean could be ice free in summer by 2050
- heat waves will be more frequent and more intense
- droughts and wildfires will occur more often
- deaths from global warming will double in just 20 years to 300,000 people a year

-more than a million species worldwide could be driven to extinction by 2050

All of these phenomena have indicated the same frightening fact – this time humans have gone too far. Global changes in yearly cycles of nature and temperatures have all pointed in the same direction – something has to be done before our planet hits the point of no return. There is reason to believe, and increasing amount of evidence, that the climate changes are indeed caused mainly by human activities, and more specifically – greenhouse gas releases.



## Suggestions for further reading:

Intergovernmental Panel on Climate Change report: "Climate Change – Impacts, adaptation and vulnerability", Summary for Policy Makers.

<http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-spm.pdf> (English)



# HOW DO WE SOLVE CLIMATE CHANGE?

Climate change is a global issue that will affect all of us. If we work together and take immediate action we can stop dangerous climate change.



Insulate your windows!

A team of international environmental researchers warned in 2009 that many effects of climate change are irreversible. The scientists show how changes in surface temperature, rainfall, and sea level are largely irreversible for more than 1,000 years even if carbon emissions can be halted. The team warned that if carbon levels in the atmosphere continued to rise, there would be less rainfall in already dry areas of southern Europe, North America, parts of Africa and Australia.

The scientists said that the oceans are currently slowing down global warming by absorbing heat, but they will eventually release that heat back into the air. When this happens, it will already be too late.

Humanity must face the uncomfortable fact that industrial civilization itself has become the principal driver of global climate. If we stay on our present course, using fossil fuels to feed our grow-

## The key ways to avoid dangerous climate change are:

- Use energy extremely efficient and reduce demand for it radically.
- Stop all burning of fossil fuel (especially coal and oil) and add a cost on all carbon use.
- Globally boost renewable energy generation (wind, solar, tidal, micro hydro, and bio-energy).
- Stop all broad-scale land clearing.
- Set legally binding targets to reduce our climate change pollution
- Shift from private cars to public transport.
- Develop a just transition for employees and communities affected by the move to a new, cleaner economy.
- Contribute to the international effort to combat global warming by ratifying Kyoto.
- Engage and educate your local community.





ing energy-intensive life styles, we risk returning the planet to conditions when it was largely ice free, when sea levels were higher by 70 meters.

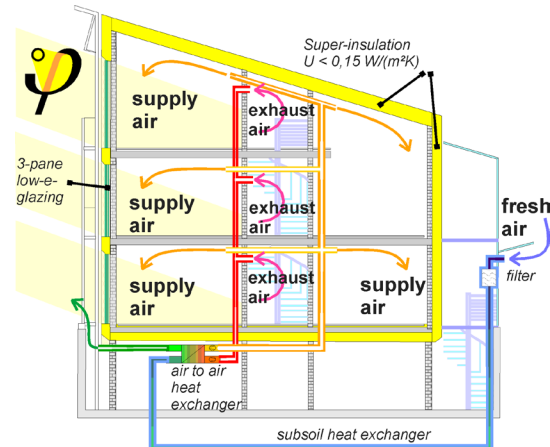
To keep our planet as it is today we need to dramatically cut our carbon emissions. The European Union recently adopted the 2°C above pre-industrial global temperature as a goal to limit human-made warming. This 2°C limit implies a maximum CO2 level of 450 ppm according to the Intergovernmental Panel on Climate Change. But some scientists believe that if we wish to preserve a planet similar to the one we have today, CO2 will need to be reduced from its current 390 ppm to at most 350 ppm.

To reach a goal of 350 ppm we need to reduce our emissions globally by 50 % within 2020 and 100 % by 2050.

We have the technology to reduce our greenhouse pollution. Our government needs to ratify the Kyoto Protocol and legislate targets to reduce our greenhouse pollution for this potential to become reality.



Travel by train!



New building standards.



More efficient energy use.



# INTERNATIONAL AGREEMENTS

Changes in the climate became very apparent in the past 15 - 20 years, even though the emission of greenhouse gases from fossil fuels burning processes started over 100 years ago.

In 1988, The Intergovernmental Panel on Climate Change (IPCC) was established by the World Meteorological Organization and UN Environmental Program. The task of IPCC is to assess the risks of human induced climate changes and to publish reports important for the implementation of the United Nations Framework Convention on Climate Change (UNFCCC).

UNFCCC is the treaty established at the Earth Summit in 1992 in Rio de Janeiro, Brazil. The conference, under its official title The United Nations Conference on Environment and Development (UNCED), set to combat the global warming, managed to achieve establishing of several protocols, from which the most famous one is the protocol established in Kyoto, in December 1997. The objective of this protocol is "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."

As of 2007, 175 states have ratified the Kyoto protocol. Out of these, 36 developed countries are required to reduce their greenhouse emission, while

developing countries have obliged to monitor and report their emissions.

The United Nations climate change conference in Bali in December 2007 was attended by 189 countries' representatives. The aim of the conference was to find further pathways in combating climate change, and to reach a new agreement, which will succeed the Kyoto protocol, expiring in 2012. In the future agreement, parties should set key areas that the new agreement would cover as well as the timeline for ratification of a new protocol, before the end of 2012.

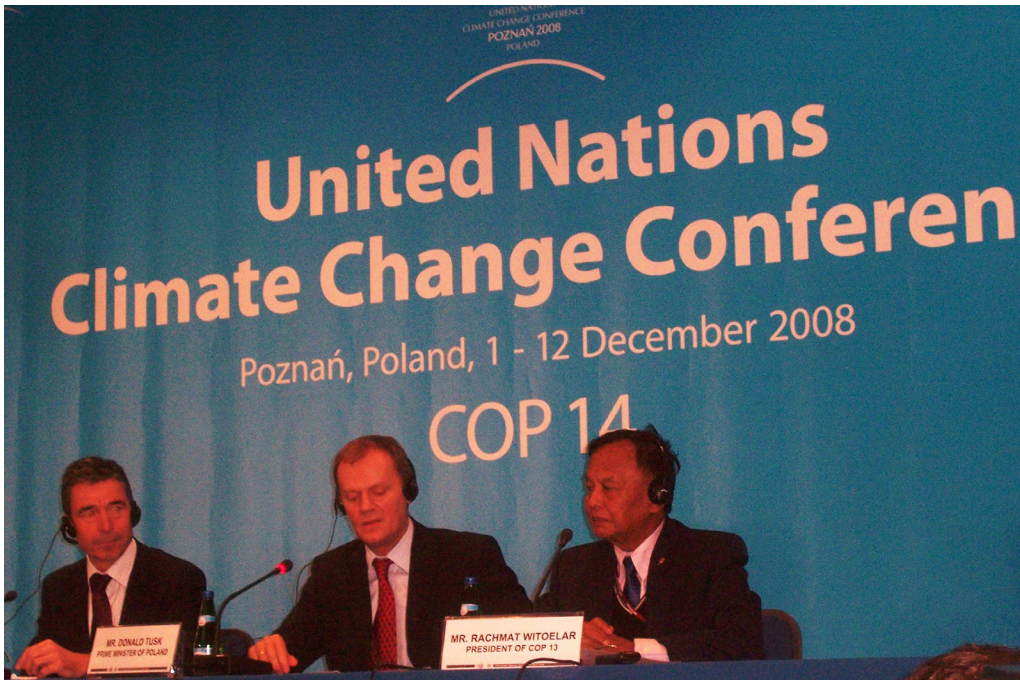
The USA is the country with the highest rate of GHG emission in the world. The second position belongs to China, the third to the EU and the fourth to Russia. Of European Union countries Germany has the highest GHG emission. The USA has declined to ratify the Kyoto protocol, while China has signed but is not obligated to reduce emissions, being a developing country which progress strongly depends on industrial expansion. Germany and Russia have ratified the protocol in May 2002 and November 2004, respectively.

From January 2007 several states of the USA have started their initiative, following California state ground breaking decision in 2006 to reduce GHG emissions, putting the pressure to the federal authorities, regarding the emission rates. These northeast US states that participate in the common





initiative have a total population of 46 million people. From December 4th 2007, 750 cities in 50 states of America have initiated nationwide efforts to meet the Kyoto protocol demands.



Many other countries, through their governments but also via civil society initiatives, have started to take measures to slow down the changes in climate regime. Through educational programs in schools as well as through media, people are today able to learn about the global situation, more than they have ever been before. Information we get through schooling, but also through radio and TV programs, as well as internet can provide us with enormous amounts of information on these issues.

What is very important for you to remember is that if we work together, we can fight the climate change and every, even very small environmentally friendly act you make, is a step forward to save our planet.

### Suggestions for further reading:

**Read more about the UNFCCC:**  
[http://unfccc.int/essential\\_background/feeling\\_the\\_heat/items/2913.php](http://unfccc.int/essential_background/feeling_the_heat/items/2913.php)

**Read more about the Kyoto protocol:**

[http://unfccc.int/kyoto\\_protocol/items/2830.php](http://unfccc.int/kyoto_protocol/items/2830.php)

**Climate Change information kit – English:**

[http://unfccc.int/resource/docs/publications/infokit\\_2002\\_en.pdf](http://unfccc.int/resource/docs/publications/infokit_2002_en.pdf)

