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Dangerous Interference with the Climate System: Implications of the IPCC Third Assessment Report for Article 2 of the Climate Convention

Greenpeace Briefing Paper

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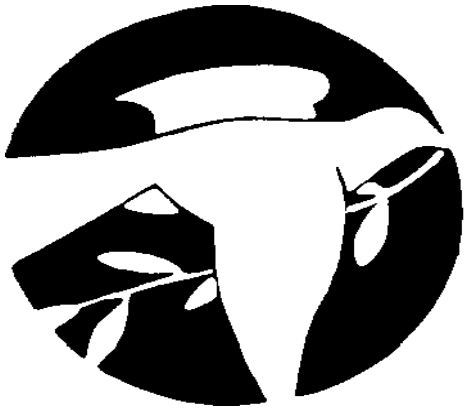

Greenpeace International

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Executive Summary

Introduction

COP6 (Part Two) is to receive the findings the three working group reports of the IPCC Third Assessment Report at a time when the very principle of international action on climate change is being challenged by the USA. Yet the report shows more clearly and strongly than ever before that the scale of the risks posed by climate change are enormous and that we are already seeing the first signs of the impacts of climate change. It has also found that international, co-ordinated action is critical to the efforts to reduce emissions.

Perhaps of most importance to the current context of the US rejection of the Kyoto Protocol and the US Administrations fossil fuel intensive National Energy Plan are the findings of IPCC Working Group III on mitigations options. This has found that the choice of energy investments made over the coming decade will determine whether and at what level atmospheric CO_2 levels can be stabilized. If the choice is made towards fossil fuel intensive technologies then atmospheric stabilization may not be possible.

Article 2 of the UNFCCC to which the USA (and its allies in the rejection of the Kyoto Protocol) such as Australia are Parties, requires that atmospheric CO_2 levels be stabilized at a level and within a timeframe that prevents dangerous climate change. It is clear that US energy policy at present is in clear violation of this objective as it would not lead to or contribute to global efforts at stabilization of CO_2 at any level. Furthermore, US energy policy is on track to contribute substantially to triggering the meltdown of the Greenland ice sheet which could begin as a result of a local warming of some 3^{o}C (or a global mean warming of 1-3^{o}C). This could happen within the next 3-5 decades and if sustained would lead to a 3 metre sea level rise over the next millennium.

At the end of this Executive Summary we have summarized many of the impacts which the IPCC Third Assessment Report has identified by level of future projected warming. We would invite any delegates to look at this table and tell us what level of warming is dangerous. We have a feeling that many will find even 1^{o}C dangerous and that nearly all will find much to fear in a 1-2^{o}C warming. Perhaps the most chilling part of this table is what is not there: warming of more than a few degrees have not been examined by the impacts community. Yet the IPCC is projecting a warming range of 1.4-5.8^{o}C by 2100. This range of temperature increases <u>does not</u> include the effect of climate feedbacks on the terrestrial biosphere. Climate induced forest dieback and release of carbon from warming soils could add, according to the IPCC WG I report nearly 300 ppmv CO_2 to the atmosphere above

the 970 ppmv which would be achieved from the most fossil fuel intensive scenarios (such as the US National Energy Plan). This would add a few degrees to the high end of the warming range.

Interestingly, the high end of the warming range comes from future emissions scenarios premised on fossil fuel intensive energy development patterns, whose archetypal form is to be found in the US National Energy Plan.

Science Assessment

The IPCC's Third Assessment Report comes to much stronger and clearer conclusions on the science and impacts of climate change, as well as on the economics of combating climate change than either of it's two predecessors in 1990 and 1995. The TAR depicts an increasingly dramatic situation that humanity and the earth's natural ecosystems are facing due to climate change predictions, unless actions to mitigate climate change are adopted and successfully implemented
Key findings of IPCC Working Group I on the scientific aspects of the climate system and climate change are:

> *There is new and stronger evidence that most of the observed warming over the last 50 years is attributable to human activities. …*
>
> *"[M]ost of the observed warming over the last 50 years is likely to have been due to the increase in greenhouse gas concentrations. …*
>
> *"[I]t is very likely that the 20th century warming has contributed significantly to the observed sea level rise…*
>
> *"About three quarters of the anthropogenic emissions of CO_2 to the atmosphere during the past 20 years are due to fossil fuel burning".*

Not only has the IPCC considerably strengthened its opinion that the recent warming is mostly due to human activities, it links this increase principally to the burning of fossil fuels.

The IPCC has projected a higher rate of temperature increase than in the Second Assessment Report:

> *"The anticipated increase in temperature over the next century has increased from a range of 1 – 3.5° C in the IPCC's Second Assessment Report, to 1.4 – 5.8°C;"*

This report has also found that:

> *"The projected rate of warming is much larger than the observed changes during the 20th century and is very likely without precedent during at least the last 10,000 years…"*

The report finds that there is a risk of large positive feedbacks from the response of the biosphere to climate which would significantly enhance climate change. Human induced climate

change could cause forest dieback releasing huge volumes of carbon to the atmosphere, substantially increasing CO_2 concentrations in the coming century.

Impacts Assessment

IPCC Working Group II addresses the vulnerability of socio-economic and natural systems to climate change, negative and positive consequences of climate change, and options for adapting. This working group has found that warming in the last few decades is already having an effect on natural systems:

> *"Thus, from the collective evidence there is high confidence that recent regional changes in temperature have had discernible impacts on many physical and biological systems"*

Some of the most immediate threats identified by the IPCC come from extreme weather events. The greatest dangers-those that would result in global catastrophe-are posed by the potential for large scale and irreversible impacts.

Among Working Group II's main conclusions are that projected human-induced climate change:

- Risks large scale and irreversible impacts, such as the melting of the Greenland and Antarctic ice sheets, the slowing down or shutting down of the Gulf Stream, and massive releases of greenhouse gases from melting permafrost and dying forests;

- Will have severe impacts on a regional level. For instance, in Europe, river flooding will increase over much of the continent; and in coastal areas, the risk of flooding, erosion and wetland loss will increase substantially;

- Will have the greatest impacts on those least able to protect themselves from rising sea levels, increase in disease and decrease in agricultural production in the developing countries in Africa and Asia. At all scales of climate change, developing countries will suffer the most. More people will be harmed than benefited, even for small amounts of warming.

Mitigation Assessment

IPCC Working Group III has found that the cost of fulfilling the Kyoto commitments and further reducing emissions are relatively low.

The report finds that it is possible to stabilize carbon dioxide concentrations in the atmosphere at well below doubling of CO_2 above pre-industrial levels (at or below 450 ppmv). This is based on a conservative assessment with no new technological breakthroughs. However, it finds that government policies to put in place energy efficient technologies and to introduce more rapidly low, or no-carbon energy supply technologies are needed if this is to be achieved. Stabilization of CO_2 will require, in addition to emission reduction action in the developed countries, technology transfer to developing countries.

Working Group III warns that the choice of energy investments in the future will determine whether or not, and at what level and cost CO_2 concentrations can be stabilized. At present the report finds that investment is directed towards

discovering and developing more conventional and unconventional fossil resources.

The limited scale of conventional oil and gas resources means there will have to be a change in the mixture of fossil fuels used in the next century. In replacing oil and gas there is a choice between either unconventional fossil fuels (tar sands, oil shales, methane hydrates or using coal to make liquid fuels) or non-fossil alternatives. The carbon contained in unconventional oil and gas deposits and coal contain more than enough carbon, which if released to the atmosphere, would increase CO_2 to very high levels.

Finally, the report confirms the finding of the 1995 IPCC report that early action to reduce emissions is needed. The report notes that a gradual transition in the near term of the world energy system towards lower carbon emissions will minimize the costs arising from the premature retirement of capital stock (eg closing down coal fired power stations).

However, more rapid short term action to reduce emissions would decrease the risk of human and environmental damages from climate change and stimulate the deployment of low carbon technologies and help to avoid locking in carbon intensive technologies.

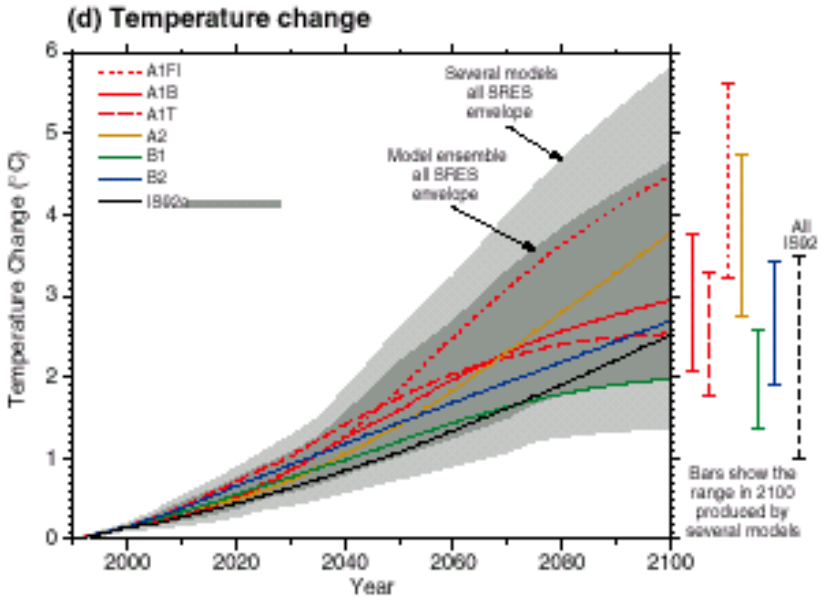

Figure 5(d) from IPCC WGI Summary for Policy Makers

Summary of Impacts by Temperature Band

Human Health Impacts:

Expected temperature increases will strain health services currently struggling to cope with infectious diseases and infrastructure deficiencies.

Increase of temperature up to 2ºC:

Direct - more heat-related deaths especially among vulnerable populations;

Indirect - more illness and death resulting from increased frequency and intensity of extreme weather events.

Increased risks to human life, risk of infectious disease epidemics, and many other health risks where floods, droughts or storms increase in frequency and/or intensity. Increased heat related deaths and illness, affecting particularly the elderly, sick, and those without access to air conditioning

Increase of temperature between 2-3ºC:

Indirect - greater exposure to infectious diseases such as malaria and dengue. Expansion of the areas of potential transmission of malaria and dengue fever with roughly 300 million more people at risk of malaria.

(Decrease in cold weather-related deaths will occur in counties that are already more resilient to the impacts of climate change.)

Ecosystem Impacts:

Minimal temperature increases are already destroying sensitive ecosystems while species die off is underway—a portent for the next few decades.

Increase of temperature up to 1ºC:

Shrinking ice and snow cover disrupts hydroelectric capacity and systems dependent on spring thaw timing.

Changes in growing seasons, shifts in population ranges, and premature reproduction in plants, insects, and birds threaten the integrity of complex systems dependent on timing of seed dispersal, pollination, availability of food, etc.

Extinction of some critically endangered and endangered species. Species immediately threatened by rising sea levels and shrinking ranges include the Bengal tiger (Ganges delta), the mountain gorilla (Central Africa), the spectacled bear (Andes mountains), resplendent Quetzal (Central America).

Increase of temperature between 1-2ºC:

Wildfires and insect infestations will disrupt relationships in complex ecosystems already undergoing stress from direct effects of heat. Increased disturbances of ecosystems by fire and insect pests-

Coral bleaching events will increase in frequency and duration, leading to destruction of brain corals and loss of related reef ecosystems.

Loss of up to 10% of coastal wetlands globally from sea level rise will eliminate habitat of major migratory bird populations.

Increases of temperature between 2-3ºC:

Reduction of ice cover during Arctic summer will eliminate habitat of seals, walruses, and polar bears.

Some unique biodiversity hotspots already pressed to latitude or altitude limits will be lost, such South Africa's Cape Fynbos region and Costa Rica's cloud forests.

Increases of temperature between 3-4ºC:

Elimination of tropical glaciers and significant reduction in ice cap and temperate glacier volume will alter hydrology and dependent ecosystems.

Coral death from sea temperature increases lasting for 6 months or more will eliminate whole reef ecosystems.

Other ecosystems under threat include atolls, mangroves, boreal and tropical forests, alpine meadows, prairie wetlands, and remnant native grasslands.

Summary of Impacts by Temperature Band

Agricultural Impacts:

Nations, regions, and communities already struggling to feed themselves will face further difficulties due to the effects of higher temperatures, altered hydrology, and extreme weather events on agriculture.

Increase of temperature between 1-2ºC:

Heat waves will damage crops (rice unable to form grains, fruit unable to set) and livestock will suffer from heat stress (reductions of milk production and conception difficulties in dairy cows).

Decreased cereal crop yields in tropical and subtropical regions would reverse agricultural self-sufficiency progress in many developing nations.

Increased cereal crop yields in many mid- and high latitude regions providing adaptation opportunities are available and water stress does not outweigh CO2 fertilization effect.

Increases of temperature between 2-3ºC:

Food prices will increase throughout the global economy.

Crop yields will drop in regions affected by more drought conditions.

General decrease in cereal crop yields extend to mid-latitude, temperate regions.

Water Resource Impacts:

The effects of climate changes on water scarcity, water quality, and the frequency and intensity of floods and droughts, will intensify demands on water and flood management.

Increase of temperature between 1-2ºC:

Decreased water supply will be available in regions already suffering from water scarcity such as the Mediterranean, southern Africa, and arid parts of central and south Asia affecting half a billion people.

Increases of temperature between 2-3ºC:

More flood damage will result from intense storms, especially in areas affected by deforestation, wildfires, insect infestations, and ecosystem degradation.

Areas of increasing drought will suffer from decreases in water quantity and quality.

Market Impacts:

The effects of climate change will have market sector effects by changing the abundance, quality, and prices of food, fibre, water, and other goods and services.

Less than 1ºC warming:

Net negative market sector impacts in developing countries and net market sector gains in developed countries. Applying more weight to impacts on poor countries indicates negative aggregate impacts globally.

Increase of temperature between 1-2ºC:

Many developing countries will suffer from net market losses in important sectors.

Energy demands for air conditioning will increase.

Increasing frequency and intensity of extreme weather events will result in increased insurance costs and decreased insurance availability (coastal areas, floodplains).

Increases of temperature between 2-3ºC:

Most regions will suffer net market losses in important sectors that will affect global aggregates.

Introduction

This Greenpeace International briefing paper is designed to present the salient points emerging from the recently completed Third Assessment Report (TAR) of the Intergovernmental Panel on Climate Change (IPCC).

The TAR contains a very large amount of information that has been interpreted and compiled into Summaries for Policymakers and Technical Summaries that are available at the IPCC website: http://www.ipcc.ch. This document represents a selective summary of the WG I, II, and III Summary for Policy Makers. Items in quotation marks are taken from the Summary(s) for Policy Makers.

Background: The IPCC

Recognizing the problem of potential global climate change, the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) established the Intergovernmental Panel on Climate Change (IPCC) in 1988. It is open to all members of the UNEP and WMO. The role of the IPCC is to assess the scientific, technical and socio-economic information relevant for the understanding of the risk of human-induced climate change. It does not carry out new research nor does it monitor climate related data. It bases its assessment mainly on published and peer reviewed scientific technical literature.

The IPCC has three working groups:

- Working Group I assesses the scientific aspects of the climate system and climate change.

- Working Group II addresses the vulnerability of socio-economic and natural systems to climate change, negative and positive consequences of climate change, and options for adapting to it.

- Working Group III assesses options for limiting greenhouse gas emissions and otherwise *mitigating* climate change (not the impacts and of climate change).

The IPCC completed its First Assessment Report in 1990. This report played an important role in establishing the Intergovernmental Negotiating Committee for a UN Framework Convention on Climate Change (UNFCCC) by the UN General Assembly. The UNFCCC was adopted in 1992 and entered into force in 1994. It provides the overall policy framework for addressing the climate change issue.

The IPCC continues to provide scientific, technical and socio-economic advice to the world community. In particular, it advises the 170-plus Parties to the UNFCCC through its periodic assessment reports on the state of knowledge of causes of climate change, its potential impacts and options for response strategies. Its Second

Assessment Report, Climate Change 1995, provided key input to the negotiations, which lead to the adoption of the Kyoto Protocol to the UNFCCC in 1997.

The most recent Third Assessment Report is a comprehensive and up-to-date assessment of the policy-relevant scientific, technical, and socio-economic dimensions of climate change. It concentrates on new findings since 1995, pays greater attention to the regional (in addition to the global) scale, and includes non-English literature to the extent possible.

Working Group I Findings

In January 2001 government representatives met in Shanghai to negotiate and approve the Summary for Policymakers of the IPCC Working Group I contribution to the Third Assessment Report on Climate Change 2001: The Scientific Basis.

Warming of the last 50 years is mostly due to human activities, principally burning of fossil fuels.

"There is new and stronger evidence that most of the observed warming over the last 50 years is attributable to human activities".

- "…[M]ost of the observed warming over the last 50 years is likely to have been due to the increase in greenhouse gas concentrations".
- "…[I]t is very likely that the 20th century warming has contributed significantly to the observed sea level rise…" (10 –20 cm over the last century).
- "About three quarters of the anthropogenic emissions of CO_2 to the atmosphere during the past 20 years are due to fossil fuel burning".

Risks of warming are increasing and we are already seeing the first signs of this.

- "Globally it is very likely that the 1990s were the warmest decade and 1998 the warmest year in the instrumental record since 1861."
- "The anticipated increase in temperature over the next century has increased from a range of 1 – 3.5° C in the IPCC's Second Assessment Report, to 1.4 – 5.8°C;
- "The projected rate of warming is much larger than the observed changes during the 20th century and is very likely without precedent during at least the last 10,000 years…";
- There is very likely to be an increase in extreme weather events such as heat waves, increased precipitation leading to floods, and higher

minimum temperatures and fewer cold days;

- There is likely to be an increase in the risk of drought in the mid-latitudes interiors of continents;

- There is likely to be an increase in some areas in the peak wind and precipitation intensities of tropical cyclones;

- 20th century trends of increasing temperature, sea-level rise, and increased precipitation will continue and intensify in the 21st century unless emissions are reduced;

- The anticipated range of global sea level rise over the next century is now between 9 and 88 cm, compared to 13-94 centimeters in the IPCC's Second Assessment Report;

- Glaciers and polar ice will continue to melt and there will be a continued decrease in Northern Hemisphere snow and ice cover;

- "[G]lobal warming is likely to lead to greater extremes of drying and heavy rainfall and increase rainfall and increase the risk of droughts and floods that occur with El Nino events in many different regions."

- "It is likely that warming associated with increasing greenhouse gas concentrations will cause an increase of Asian summer monsoon precipitation variability";

- Climate change will persist for many centuries, due to the long life of greenhouse gases in the atmosphere however "…the lower the level at which CO_2 concentrations are stabilised, the smaller the total temperature change".

Unless emissions are reduced, there is a major risk that the warming expected during the next five decades would trigger meltdown of the Greenland ice sheet.

- "Ice sheets will continue to react to climate warming and contribute to sea level rise for thousands of years after climate has been stabilised."

- Warming around Greenland is likely to be from 1-3 times the global average warming, which as noted above is projected to be in the range 1.4-5.8ºC, hence a 3ºC warming around Greenland appears likely within the next century and probably within the next 50 years unless action is taken to reduce emissions.

- Ice sheet models project that a local warming of larger than 3°C, if sustained for millennia, would lead to virtually a complete melting of the Greenland ice sheet

with a resulting sea level rise of about 7 metres.

- "Current ice dynamic models suggest that the West Antarctic Ice Sheet could contribute up to 3 meters to sea level rise over the next 1000 years…"

Risk of large positive feedbacks from the response of the biosphere to climate which would significantly enhance climate change.

The risk of large positive feedbacks from the biosphere is presented in the Summary for Policy Makers in the following way:

- "As the CO_2 concentration of the atmosphere increases, ocean and land will take up a decreasing fraction of anthropogenic CO_2 emissions. The net effect of land and ocean climate feedbacks as indicated by models is to further increase projected atmospheric CO_2 concentrations, by reducing both the ocean and land uptake of CO_2 . By 2100, carbon cycle models project atmospheric CO 2 concentrations of 540 to 970 ppm for the illustrative SRES scenarios (90 to 250% above the concentration of 280 ppm in the year 1750)... Uncertainties, especially about the magnitude of the climate feedback from the terrestrial biosphere, cause a variation of about 10 to 30% around each scenario. The total range is 490 to 1260 ppm (75 to 350% above the 1750 concentration)."

Decoding these paragraphs, the clear message is that there is a significant risk that feedbacks from the biosphere (forest decline, increased fires and losses of carbon from warming soils caused by climate change) could enhance CO_2 concentrations by nearly 300 ppmv CO_2 by 2100. In other words the magnitude of the potential positive feedback is equivalent, in CO_2 concentration terms, to a doubling of CO_2 above pre-industrial levels.

Main Conclusions

- **The warming of last 50 years is mostly due to human activities, principally the burning of fossil fuels.**

- **The risks of warming are increasing and we are already seeing the first signs of this.**

- **One of the major risks identified is that warming in the next five decades could be large enough to trigger meltdown of Greenland ice sheet, unless emissions are reduced.**

- **There is a high risk of more extreme events including flooding, drought and more intense storms.**

- **Positive feedbacks from the impacts of climate change on forests could substantially accelerate the warming.**

Working Group II Findings

In February 2001 government representatives met in Geneva to negotiate and approve the Summary for Policymakers of the IPCC Working Group II of the Third Assessment Report on Climate Change 2001: Impacts, Adaptation, and Vulnerability. The report emphasized the threats to nature and society posed by climate change.

Impacts of upper temperature projections not examined

As noted above the WG1 TAR projects to cause average global temperatures to warm 1.4 to 5.8ºC by 2100 relative to the 1990 temperature average, however the Working Group II assessment does not investigate the upper end of this temperature range. The available literature on climate impacts that in general *do not* investigate the impacts associated with the upper range of increased average temperatures. Therefore, impacts from the higher range of warming estimates are not represented in this report.

Threats to most natural and many human systems

The report finds that climate change presents are a threat to most natural systems. Those natural systems threatened include glaciers, coral reefs, mangroves, arctic ecosystems, alpine ecosystems, prairie wetlands, native grasslands, and biodiversity "hotspots". Climate change will increase existing risks of species extinction and biodiversity loss in ecosystems at every latitude and in each region. The level of damage will increase with the magnitude and rate of global warming.

Threats to human systems, beyond the loss of natural ecosystems, derive from threats to water resources, agriculture, forestry, health, settlements, energy, industry, and financial services. Vulnerability of particular human populations is determined by degree of the nature of the threat, sensitivity and ability to adapt--characteristics that depend on geographic location and development level of social, economic and environmental conditions. Tens of millions of people living in low lying coastal areas face the risk of having to move due to flooding.

Changes already underway

Observed 20th century climate changes have already affected physical systems. Examples include shrinkage of glaciers, thawing of permafrost, later freezing and earlier breakup of ice on rivers and lakes. Biological systems also appear to be responding through the lengthening of growing seasons, animal range shifts to higher altitudes and latitudes, declines of some animal populations, and earlier tree flowering, insect emergence, and bird egg laying.

- "there is emerging evidence that some social and economic systems have been effected by the recent increasing frequency of floods and droughts in some areas."

- "Thus, from the collective evidence there is high confidence that recent regional changes in temperature have had discernible impacts on many physical and biological systems".

Associations between these physical and biological phenomena and changes in regional climate have been documented in aquatic, terrestrial, and marine environments on all continents.

Threats from extreme whether events

While a change in average temperatures or precipitation can have significant impacts, the changes in extremes are most immediate and have great negative effects. The report outlines the following threats:

- Increased frequency of heat waves will increase crop and livestock losses, frequency of wildfires, wildlife mortality, energy demand for cooling, and human deaths and illness from heat stress and air pollution.

- Decreased frequency of cold waves and fewer frost days will extend the range of some pests and disease vectors while reducing losses due to cold.

- Increased frequency of high intensity rainfall will increase flood (and flash flood) risk, with consequent property damage, soil erosion, flushed pollutants, health threats, and deaths.

- More frequent drought in mid-latitude continental interiors will increase agricultural losses, threaten terrestrial and aquatic ecosystems, reduce quality and availability of water with consequent health effects, and promote land subsidence.

- Increased intensity and frequency of tropical cyclones will threaten property, coastal stability, ecosystems, health, and life.

- Any increase in intensity and frequency of extreme climate events will increase demands on already overburdened public and private financial mechanisms to cover weather related losses.

Potential for Large Scale and Irreversible Impacts

The most troubling research considers the possibility of irreversible, large scale, and abrupt effects triggered by human induced climate change. The report finds that that greenhouse gas increases over the next century could trigger large scale and irreversible impacts.

These events may not be likely to occur in the next century but there is a significant likelihood that they could be triggered by human activities in the next 100 years. Amongst these risks are:

- The slowing down or stopping of the North Atlantic's thermohaline circulation which could plunge Europe into the climate regime experienced by Labrador.

- Melting of the Greenland and West Antarctic Ice Sheets, which could lead to up to 3 metres of sea level rise *each* over the next 1000 years and "submerge many small islands and inundate extensive coastal areas."

- *Acceleration of global warming caused by releases of carbon to the atmosphere from forest disturbance which is itself caused by climate change.

- Releases of terrestrial carbon caused by the melting permafrost and releases of methane, a powerful greenhouse gas, from the decomposition of hydrates under coastal sediments on the sea bed "would further increase greenhouse gas concentrations and amplify climate change".

The timing of the triggering of these events are uncertain but their likelihood increases with the rate, magnitude and duration of climate change.

Developing Countries most at risk

The report finds that developing countries are most at risk from climate change. Global increases in temperature would produce net economic losses in many developing countries for all magnitudes of warming and these losses would be greater the higher the warming. Those with the least resources have the least ability to adapt, and will be most damaged by climate change. Increase in global mean temperatures will produce net economic losses in many developing countries for all magnitudes of warming, and the condition is most extreme among the poorest people in these countries

- "The effects of climate change are expected to be greatest in developing countries in terms of loss of life and relative effects on investment and the economy. For example, the relative percentage damages to GDP from climate extremes have been substantially greater in developing countries than in developed countries."

- "The projected distribution of economic impacts is such that it would increase the disparity in well-being between developed countries and developing countries, with disparity growing for higher projected temperature increases."

- "…[I]ncreases in global mean temperatures would produce net economic losses in many developing countries for all magnitudes of warming studied, and losses would be greater in magnitude the higher the level of warming.

- "In contrast an increase in global mean temperature of up to a few degrees C would produce a mixture of economic gains and losses in developed countries, with economic losses for larger temperature increases."

More people projected to be harmed than benefited even for small warming

- "More people are projected to be harmed than benefited by climate change, even for global mean temperature increases of less than a few degrees"

Extensive Regional Impacts Identified

Africa

The impacts of climate change threaten large populations of Africa already struggling for sustainable development.

> "Grain yields are projected to decrease for many scenarios, diminishing food security, particularly in small food-importing countries."

In a region already facing the effects of AIDS and malnutrition, climate change will foster the expansion of a host of infectious diseases.

> "Extension of ranges of infectious disease vectors would adversely affect human health in Africa."

Floods, famine, and refugee migrations are very likely as climate change tips the balance in overburdened regions of the African continent.

> "Increases in droughts, floods, and other extreme events would add to stresses on water resources, food security, human health, and infrastructures, and would constrain development in Africa."

As climate change grips Africa and vital ecosystems wither, some of the richest biodiversity on Earth is likely to disappear.

> "Significant extinctions of plant and animal species are projected and would impact rural livelihoods, tourism, and genetic resources."

Asia

Climate change is already being experienced across the Asian continent.

> "Extreme events have increased in temperate and tropical Asia,

including floods, droughts, forest fires, and tropical cyclones."

Climate change is likely to bring disruption and instability to millions of people in Asia.

"Decreases in agricultural productivity and aquaculture due to thermal and water stress, sea level-rise, floods and droughts, and tropical cyclones would diminish food security in many countries of arid, tropical, and temperate Asia; agriculture would expand and increase in productivity in northern areas.

In the most densely populated regions of the world, climate change is likely to intensify threats from infectious disease.

"Human health would be threatened by possible increased exposure to vector- borne infectious diseases and heat stress in parts of Asia."

Mega-cities and densely populated areas along the Pacific and Indian Ocean coastlines are caught between the threats of sea level rise and river flooding from increased upstream precipitation.

"Sea level rise and an increase in intensity of tropical cyclones would displace tens of millions of people in low-lying coastal areas of temperate and tropical Asia; increased intensity of rainfall would increase flood risks in temperate and tropical Asia".

The combined effects of accelerating climate change and land-use pressures are fragmenting and likely to significantly damage Asian ecosystems that comprise some of the richest biodiversity on Earth.

- "Climate change would exacerbate threats to biodiversity due to land-use and land-cover change and population pressure in Asia. Sea level rise would put ecological security at risk, including mangroves and coral reefs."

"Many species of mammals and birds could be exterminated as a result of the synergistic effects of climate change and habitat fragmentation."

Australia and New Zealand

Despite the hopes that climate change will be a help for some crops in Australia and New Zealand, any short-term gains for some crops in some regions are likely to be overwhelmed by other regional losses and long term damage.

"The net impact on some temperate crops of climate and CO_2 changes may initially be beneficial, but this balance is expected to become negative for some areas and crops with further climate change."

Droughts and fires will be even more common and water more valuable as great portions of Australia dry up.

> "Water is likely to be a key issue due to projected drying trends over much of the region and change to a more El Nino-like average state."

Threats from extreme events are likely to change the lives of many Australians.

> "Increases in the intensity of heavy rains and tropical cyclones, and region-specific changes in the frequency of tropical cyclones, would alter the risks to life, property, and ecosystems from flooding, storm surges, and wind damage."

The unique biological evolutionary line that has evolved in Australia and New Zealand over millions of years, as well as some of the richest biodiversity on Earth could be devastated by climate change.

> "Some species with restricted climatic niches and which are unable to migrate due to fragmentation of the landscape, soil differences, or topography could become endangered or extinct.

> "Australian ecosystems that are particularly vulnerable to climate change include coral reefs, arid and semi-arid habitats in southwest and inland Australia and Australian alpine systems."

> "Freshwater wetlands in coastal zones in both Australia and New Zealand are vulnerable, and some New Zealand ecosystems are vulnerable to accelerated invasion by weeds."

Europe

Glaciers and distribution of permafrost are sensitive indicators of climate change. In Europe they are both shrinking at an unprecedented rate.

> "Half of alpine glaciers and large permafrost areas could disappear by the end of the 21st century."

Expected flood patterns will place large portions of Europe at high risk.

> "River flood hazard will increase across much of Europe; in coastal areas, the risk of flooding, erosion, and wetland loss will increase substantially with implications for human settlement, industry, tourism, agriculture, and coastal natural habitats."

Many Alpine ecosystems are very likely to disappear, along with vast tracts of precious wildlife habitat.

> "Upward and northward shift of biotic zones will take place. Loss of important habitats (wetlands, tundra, isolated habitats) would threaten some species."

Latin America

Glaciers are shrinking in Latin America also, where they supply the water necessary for agriculture and energy production as well as residential and industrial use.

> "Loss and retreat of glaciers would adversely impact runoff and water supply in areas where glacier melt is an important water source."

In parts of Latin America, there will be increasing frequency of damaging extreme events.

> "Floods and droughts would become more frequent with floods increasing sediment loads and degrade water supply in some areas."

In Central and equatorial America, the devastation of tropical cyclones could get worse.

> "Increases in intensity of tropical cyclones would alter the risks to life, property, and ecosystems from heavy rain, flooding, storm surges, and wind damages. "

Food security could become a serious problem for many countries in Latin America.

> "Yields of important crops are projected to decrease in many locations in Latin America even when the effects of CO_2 are taken into account; subsistence farming in some regions of Latin America could be threatened."

Latin American problems with infectious diseases that thrive in a warming world could be exacerbated.

> "The geographical distribution of vector-borne infectious diseases would expand poleward and to higher elevations, and exposures to diseases such as malaria, dengue fever, and cholera will increase."

In Latin America, valuable ecosystem resources will disappear, as already threatened biodiversity hotspots get hotter.

> "The rate of biodiversity loss would increase."

North America

Climate change is likely to destroy ecosystems that define the North American wilderness.

> "Unique natural ecosystems such as prairie wetlands, alpine tundra, and cold water ecosystems will be at risk and effective adaptation is unlikely."

Large expanses of the North American Atlantic coastal regions are very likely to be threatened.

> "Sea-level rise would result in enhanced coastal erosion, coastal flooding, loss of coastal wetlands, and increased risk from storm surges, particularly in Florida and much of the US Atlantic coast."

Insurance companies and government disaster relief agencies in North America are faced with increasing demands from victims of weather events and are unprepared for projected threats.

> "Weather-related insured losses and public sector disaster relief

payments in North America have been increasing; insurance sector planning has not yet systematically included climate change information, so there is potential for surprise."

As North America copes with threats from unusual weather, risk from climate change induced health problems is likely to increase.

> "Vector-borne diseases—including malaria, dengue fever, and Lyme disease—may expand their ranges in North America; exacerbated air quality and heat stress morbidity and mortality would occur socioeconomic factors and public health measures would play a large role in determining the incidence and extent of health effects."

Polar Regions

Rising temperatures in polar regions are already causing problems for traditional communities and priceless ecosystems.

> "Natural systems in polar regions are highly vulnerable to climate change and current ecosystems have low adaptive capacity; technologically developed communities are likely to adapt readily to climate change but some indigenous communities, in which traditional lifestyles are followed, have little capacity and few options for adaptation."

Polar regions are already warming at alarming rates and many of their ecosystems cannot survive the expected rates of further warming.

> "Climate change in polar regions is expected to be among the largest and most rapid of any region on the Earth, and will cause major physical, ecological, sociological, and economic impacts especially in the Arctic, Antarctic Peninsula, and Southern Ocean."

> "Changes in climate that have already taken place are manifested in the decrease in extent and thickness of Arctic sea ice, permafrost thawing, coastal erosion, changes in ice sheets and ice shelves, and altered distribution and abundance of species in the Polar regions."

Small Island States

The effects of sea level rise will be influencing, if not dominating, the socioeconomic reality in many small island states from now on.

> "The projected sea level rise of 5mm per year for the next 100 years will cause enhanced coastal erosion, loss of land and property, dislocation of people, increased risk from storm surges, reduced resilience of coastal ecosystems, saltwater intrusions into freshwater resources, and high resource costs to respond to and adapt to these changes".

Fresh water will become even more crucial to small islands with climate change.

> "Islands with very limited water supplies are highly vulnerable to the impacts of climate change on the water balance.

Current threats to the rich and unique coastal ecosystems of small islands are exacerbated by the increasing rates of climate change.

> "Coral reefs will be negatively affected by bleaching and by reduced calcification rates due to higher carbon dioxide levels, mangrove, sea grass beds, other coastal ecosystems and the associated biodiversity would be adversely affected by rising temperatures and accelerated sea level rise".

The reef fisheries that support populations on small island states are severely threatened by expected weakening and damage to coastal ecosystems.

> "Declines in coastal ecosystems would negatively impact reef fish and threaten reef fisheries, those who earn their livelihoods from reef fisheries, and those who rely on the fisheries as a significant food source".

Agricultural limitations on small islands will be worsened by the precipitation variability and sea level rise resulting from climate change.

> "Limited arable land and soil salinization makes agriculture of Small Island States, both for domestic food production and cash crop exports, highly vulnerable to climate change."

The socioeconomic repercussions of climate change threaten small islands' hopes of eco-tourism and sustainable development.

> "Tourism, an important source of income and foreign exchange for many islands, will face severe disruption from climate change and sea level rise."

Main Conclusions

From the findings of the 2nd TAR working group Greenpeace comes to the following main conclusions:

- **Expected changes are already underway.**
- **Both natural and human systems are under threat.**
- **Threats from extreme weather events are most immediate.**
- **The greatest dangers are posed by the potential for large scale and irreversible impacts.**
- **Developing countries will suffer the most.**
- **More people will be harmed than benefited, even for small amounts of warming.**

Working Group III Findings

In late February and early March 2001 government representatives met in Accra, Ghana to negotiate and approve the Summary for Policymakers of the IPCC Working Group III contribution to the Third Assessment Report on Climate Change 2001: Mitigation. The Report presents potential approaches to efficient and effective stabilization of GHG concentrations in the atmosphere**.**

Relatively low cost of greenhouse gas emission reductions

The report notes that the progress on technologies to reduce emissions has been faster in the last five years than previously anticipated, particularly in relation to wind turbines, fuel cell technology, and renewable biomass fuels:

> "Significant technical progress relevant to greenhouse gas emissions reduction has been made since the SAR in 1995 and has been faster than anticipated."

> "Technological options for emissions reduction include improved efficiency of end use devices and energy conversion technologies, shift to low-carbon and renewable biomass fuels, zero-emissions technologies, improved energy management, reduction of industrial by-product and process gas emissions and carbon removal and storage."

Using known and currently available technologies, global greenhouse emissions can be reduced below year 2000 levels in period 2010-2020 at zero net costs with at least half of this achievable at a profit (negative costs):

> "Half of these potential emissions reductions may be achieved by 2020 with direct benefits (energy saved) exceeding direct costs (net capital, operating, and maintenance costs), and the other half at a net direct cost of up to US$100/t$C_{eq}$ (at 1998 prices)".

Government action and policies removing both subsidies to fossil fuel production and use and barriers to market debut of emission reducing technologies are needed to harvest these gains in a most successful way:

> "Policies such as the removal of subsidies from fossil fuels may increase total societal benefits through gains in economic efficiency…"

> "Reduction of existing market or institutional failures and other barriers that impede adoption of cost-effective emission reduction measures can lower private costs compared to current practice".

Hundreds of technologies are currently available to improve energy efficiency:

> "Hundreds of technologies and practices for end-use energy efficiency in buildings, transport and manufacturing industries account for more than half of this potential."

Stabilization of CO_2 in the atmosphere at or below 450 ppmv is possible

Acknowledged conservative estimates considering no new technological breakthroughs indicate that it is possible to stabilize carbon dioxide concentrations in the atmosphere at or below 450 ppmv.

> "Most model results indicate that known technological options could achieve a broad range of atmospheric CO 2 stabilisation levels, such as 550ppmv, 450ppmv or below over the next 100 years or more, but implementation would require associated socio-economic and institutional changes."

Energy Investments need to be changed if stabilization is to be possible

The report contains a warning that the choice of energy investments in the future will determine whether or not--and at what level and cost--CO_2 concentrations can be stabilized.

> "Developing a response to climate change is characterized by decision making under uncertainty and risk, including the possibility of non linear risk and/or irreversible changes."

> "The choice of energy mix and associated investments will determine, whether and if so at what level and cost greenhouse gas concentrations can be stabilized."

> "Currently such investment is directed towards discovering and developing more conventional and unconventional fossil resources."

To achieve this goal, government policies must encourage the adoption of energy efficient technologies and the rapid introduction of more low- or no-carbon energy supply technologies. It is very important to start this change now, as energy sector investments have a long life time and thus the choices of today will determine the opportunities for the future, especially in developing countries:

> "For the crucial energy sector, almost all greenhouse gas mitigation and concentration stabilisation scenarios are characterised by the introduction of efficient technologies for both energy use and supply, and of low- or no-carbon energy.

Stabilization of CO_2 will require, in addition to emission reduction action in the developed countries, technology transfer to developing countries:

> "Transfer of technologies between countries and regions will widen the choice of options at the regional level and economies of scale and learning will lower the costs of their adoption."

Current fossil fuel reserves if released to the atmosphere would lead to very high atmospheric CO2 levels.

Lower emissions and stabilization of CO2 concentration require different energy developments

The report contains several interlocking conclusions relating to the question of fossil fuel supply, oil and gas abundance and the question of stabilizing atmospheric CO2 concentrations.

> "there are abundant fossil fuel resources that will not limit carbon emissions during the 21.century".

Fossil fuel scarcity will not limit carbon dioxide emissions this century however the report points out that the supply of oil and gas is potentially limited:

> "different from the large coal and unconventional oil and gas deposits, the carbon in proven conventional oil and gas reserves, are much less than the cumulative carbon emissions associated with stabilization of carbon dioxide at 450 ppmv or higher"

Whilst this shows that proven conventional oil and gas reserves are less than the carbon emissions associated with stabilization of CO_2 at 450 ppmv or higher this begs the question as to whether this level is safe or not. Greenpeace believes that it is not safe. Resources of coal and unconventional oils are far larger than the amount of carbon that can possibly be emitted to the atmosphere without dramatic consequences. Currently, the share of coal in the global energy mix is above 30%, and expected to grow in the absence of efficient GHG policies.

The limited supply of oil and natural gas implies that there has to be a change from oil and perhaps gas to some other fuel sources at some point in the next century

> "These (fossil fuel) resource data may imply a change in the energy mix and introduction of new sources of energy during the 21st century."

The choice of this transition will determine whether nor not and if so at what level CO2 can be stabilized:

> "The choice of energy mix and associated investments will determine, whether and if so at what level and cost greenhouse gas concentrations can be stabilized."

In other words if the change is to coal and/or unconventional oil then it may not be possible to stabilize atmospheric CO_2 at low levels or at all. The change involves substantial investment over a long period either towards unconventional or towards non-fossil alternatives. The Draft Summary for Policy makers contained an important finding in this issue:

> "The transition to sources other than conventional oil and gas reserves involves substantial investment over a long period, either towards unconventional fossil resources or towards non-fossil alternatives."

This was removed in the final draft at the insistence of a number of countries led by the USA for essentially political reasons.

Nevertheless the report finds that:

> "Currently such investment is directed towards discovering and

> developing more conventional and unconventional fossil resources."

Choices have to be made in the energy system toward either fossil intensive investments or towards low carbon technologies. This choice will decide if CO2 stabilisation will be possible and at what level. Hence this choice has a direct bearing on Parties obligations under Article 2 of the UNFCCC to stabilise CO2 at levels that would prevent dangerous climate change. This, this is a clear warning, and that there is no such thing as business as usual in the long term.

On the timing of action to reduce emissions a transition in the near term of the world energy system towards lower carbon emissions will minimize the costs arising from the premature retirement of capital stock (e.g. closing down coal fired power stations) and from the damages of climate change.

> "This report confirms the finding in the SAR that earlier actions, including a portfolio of emissions mitigation, technology development, and reduction of scientific uncertainty increase flexibility in moving towards stabilisation of atmospheric concentrations of greenhouse gases".
>
> "On the other hand, more rapid near-term action would decrease environmental and human risks associated with rapid climatic changes."
>
> "It would also stimulate more rapid deployment of existing low-emission technologies, provide strong near-term incentives to future technological changes that may help to avoid lock-in to carbon-intensive technologies, and allow for later tightening of targets should that be deemed desirable in light of evolving scientific understanding."

Climate policies may have extensive additional benefits.

> "[R]educing carbon emissions in many cases will result in the simultaneous reduction in local and regional air pollution. It is likely that mitigation strategies will also affect transportation, agriculture, land-use practices and waste management and will have an impact on other issues of social concern, such as employment and energy security."
>
> "It is likely that mitigation strategies will also affect transportation, agriculture, land use practices and waste management and will have an impact on other issues of social concern, such as employment, and energy security.
>
> "Double dividend. Instruments (such as taxes or auctioned permits) provide revenues to the government. If used to finance reductions in existing distortionary taxes ("revenue recycling"), these revenues reduce the economic cost of achieving greenhouse gas reductions.

There will be winners and losers, but the damages can be minimised by responsible decision- making.

"Under mitigation policies, coal, possibly oil and gas, and certain energy intensive sectors such as steel production, are most likely to suffer an economic disadvantage."
"Other industries including renewable energy industries and services can be expected to benefit in the long term from price changes and the availability of financial and other resources that would otherwise have been devoted to carbon intensive sectors."

" [T]he cost of mitigation actions could be reduced by appropriate policies".

"Policies such as removal of subsidies from fossil fuels may increase total societal gains (...), while use of the KP mechanisms could be expected to reduce the net economic costs of meeting Annex B targets."

"With full emissions trading between Annex B countries, the estimated reductions in 2010 are between 0.1% and 1.1% of projected GDP. (…) 0.5% of GDP corresponds to an impact on economic growth rates over ten years of less than 0.1 percentage point."

"Induced technological change is an emerging field of inquiry. None of the literature reviewed in TAR on the relationship between the century-scale CO_2 concentrations and costs, reported results for models employing induced technological change."

Critical comments on the report

While generally satisfied with the quality of the work in the reports of Working Groups I and II, there are a number of points that must be raised about the assessment of some of the issues in the report of Working Group III.

Economic modeling and determination of costs insufficient

Mostly American global energy economic model results for estimating the costs to Annex 1 countries of implementing the Kyoto Protocol are used in the findings of the report. Although these model studies are limited because they do not take negative costs, ancillary benefits or targeted revenue recycling into account, they are heavily emphasised in the conclusions of the Working Group without substantial qualification.

Even with these shortcomings, the models show that with emission trading, which is built into the Protocol, "the estimated reductions in 2010 are between 0.1 and 1.1% of projected GDP." Footnote 15 of the Summary for Policy Makers puts this in perspective:

> "Many metrics can be used to present costs. For example, if the annual costs to developed countries associated with meeting Kyoto targets with full Annex B trading are in the order of 0.5% of GDP, this represents US$125 billion (1000 million) per year, or US$125 per person per year by 2010 in Annex II (SRES assumptions). This corresponds to an impact on economic growth

rates over ten years of less than 0.1 percentage point."

The following additional explanation was in the original report, but deleted at the insistence of the USA: "…while projected increase in GDP per capita is US$ 3000- 5000 per year above today's levels." Further, the now deleted elements of the footnote explained that the impact is "well within inherent uncertainties (of economic growth models), and the overall effect would be to defer economic growth by a few months".

Unequal treatment of technologies

The report of Working Group III should have dealt more positively with renewable energy. The bullet point on low carbon technologies ends with the general qualifier which is applied to all of the technologies – renewable biomass, wind, nuclear and CO2 disposal equally: "Environmental, safety, reliability and proliferation concerns may constrain the use of some of these technologies". In our view this is a serious distortion of the relative risk and problems facing the different classes of technologies.

Less certain future for nuclear power

The reference to nuclear power in the text is quite contentious and in Greenpeace's view represents a real distortion of the likely, realistic role of nuclear power relative to all of the other options.

"Low carbon energy supply systems can make an important contribution through biomass from forestry and agricultural by products municipal and industrial waste to energy, dedicated biomass plantations where suitable land and water is available, landfill methane, wind energy and hydro power, and through the use and lifetime extension of nuclear power plants."

In our view this results directly from the fact that the nuclear section of the report was written by an author from the International Atomic Energy Agency. The lifetime extension of nuclear plants is hardly mentioned in the main report and is so small relative to other option that it is not quantified. In addition the main report is extremely one-sided in its discussion of nuclear power with the relevant sections dominated by an author representing the International Atomic Energy Agency. The sections of this Chapter are quite unbalanced and do not describe the real state of nuclear power in the world today. A visitor from Mars reading this section could be excused for believing after reading this section that Nuclear power is expanding around the world and has unlimited possibilities. There is no place in IPCC assessments for such one-sided assessments. Whilst it is no secret that nuclear power is low carbon energy source it is also no secret that nuclear power is being phased out in a number of countries and that the market outlook for nuclear power is very poor owing to a range of well known problems.

Arguably all the factors indicate that the prospects for nuclear power are even worse than they were at the time of the Second Assessment Report. Since then Germany, Netherlands and Sweden have

set phase-out schedules for nuclear power plants, and there has been substantial erosion of public confidence in nuclear power in Japan, further delaying planned nuclear construction. Liberalisation of energy markets in Europe and the USA have also reduced or removed the prospects for new nuclear plants in France and the USA. Long-term waste disposal issues seem no closer to resolution and nuclear proliferation concerns have escalated as a consequence of bomb testing on the Indian Sub-continent and other developments.

The only difference appears to be that in the IPCC's 1995 assessment the IAEA was not involved in writing the report whereas its designated author more or less controlled the writing of the sections in the Third Assessment Report.

A better rendition of the real prospects for nuclear power might read:

> *Nuclear power is being phased out in several European countries and there have been no new plant ordered in the OECD Annex B countries since 1991 and economic, environmental, safety, nuclear waste disposal, public acceptability and proliferation concerns will constrain the use of this technology.*

The issue of sinks

A contentious finding in Greenpeace's view is that "After 2010, emissions from fossil and/or biomass- fuelled power plants could be reduced substantially through pre- or post- combustion carbon removal and storage."

This is not specifically qualified in any way by reference to environmental, economic or public acceptability issues. It is very unlikely for example that CO_2 disposal in the sea will be publicly acceptable and it is currently illegal under international law, although experiments are to be conducted. There are also likely to be significant environmental concerns in relation to CO_2 removal technologies as well as to storage in aquifers and underground etc. The economics of CO_2 removal and storage from power stations are still speculative although technically feasible. Finally the association of biomass fuelled power stations with CO2 storage seems to be wrong, as in principle biomass power stations should involved little or no net addition of CO2 to the atmosphere and should be renewable and sustainable if done well. Most of these issues have not yet been studied. Greenpeace feels that it is quite wrong to include this option without a specific qualification.

After much debate within WG III the compromise text on sinks reads:

> "Forests, agricultural lands, and other terrestrial ecosystems offer significant carbon mitigation potential. Although not necessarily permanent, conservation and sequestration of carbon may allow time for other options to be further developed and implemented."
>
> "Conservation of threatened carbon pools *may* help to avoid emissions, *if* leakage can be prevented, *and only* become sustainable if the socio-economic drivers for deforestation and other losses of carbon pools *can* be addressed."

> "the estimated global potential of biological mitigation options is in the order of 100 GtC (cumulative), although there are substantial uncertainties associated with this estimate, by 2050, equivalent to 10-20% of potential fossil fuel emissions during that period."

This text is clearly a compromise between those that advocate sinks and those with a critical stance toward them. Advocates see them as a low cost placeholder till emission reduction technologies fall into place in contrast to those criticising the uncertainty surrounding sinks and their temporary character as well as the very likely effect that they will only slow down the process of introducing emission reducing technologies.

Major Conclusions

From the findings of the Working Group III Greenpeace comes to the following major conclusions:

- **The costs of fulfilling the Kyoto commitments and further reducing emissions are relatively low.**

- **Stabilizing CO_2 at relatively low levels based on known technology is possible.**

- **Unless energy investment patterns are changed we may not be able to stabilize CO_2.**

- **Availability of fossil fuels will not limit future GHG emissions. As the energy mix needs to be changed as sources of oil and gas are running out, the choice is between coal and unconventional oil or new renewable energy sources.**

- **The more quickly we initiate short-term action to reduce emissions the more we minimize the risk of damaging human and natural systems.**

- **Rapid adoption of emission reducing actions will stimulate the deployment of low carbon technologies and insure avoidance of potential lock-in to carbon intensive technologies.**

FOR FURTHER INFORMATION
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