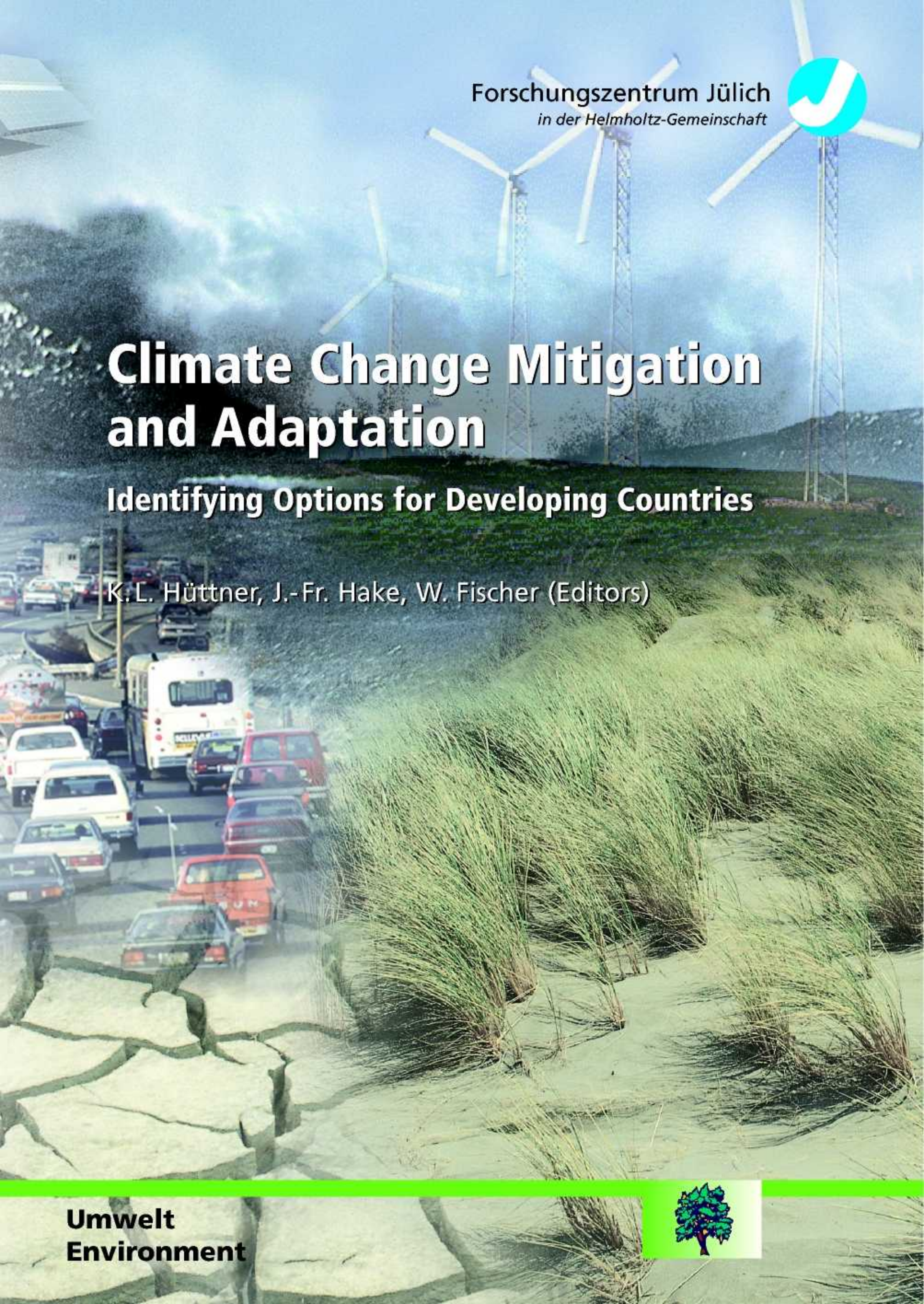

Forschungszentrum Jülich
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Climate Change Mitigation and Adaptation

Identifying Options for Developing Countries

K. L. Hüttner, J.-Fr. Hake, W. Fischer (Editors)

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Technologische Entwicklung

Climate Change Mitigation and Adaptation

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Karl Ludwig Hüttner, Jürgen-Friedrich Hake,
Wolfgang Fischer (Editors)

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Foreword

Mid-September 2003, the German Ministry of Education and Research (Bundesministerium für Bildung und Forschung) invited 27 young researchers, scientists and administrators from African, Asian and Latin American countries to participate in a summer-school on "Climate Change – Mitigation and Adaptation: Identifying Options for the Developing Countries". Organized by the Forschungszentrum Jülich and its "Programme Group Systems Analysis and Technology Evaluation" under the leadership of Wolfgang Fischer and Karl-Ludwig Hüttner, the meeting took place in Bad Münstereifel, a medieval small resort town, not too far from neither Bonn nor Cologne, as an almost ideal setting for very engaged and stimulating discussions and encounters on a both international and interdisciplinary level. In my capacity as the scientific coordinator of this meeting I would like to extend my gratitude and thanks to all who have contributed not only to the success of the meeting, but also to the fast publication of its results.

In the introductory remarks to the summer-school I described the intention of this experiment that it should fulfil three main functions:

- It should be focussed on strategic aspects of mitigation and adaptation to climate change from a distinctly Southern perspective.
- It should serve as a discussion forum for experts of different backgrounds from the developing world to exchange their specific experiences, priorities and strategies towards the consequences of climate change.
- It should enhance the dialogue between the North and the South in this specific field of global environmental change and formulate – if possible – jointly supported and advocated expectations and political positions of a Southern perspective towards the North.

We all are aware of the fact that human interference into the climate system is becoming an increasingly serious problem. While the second report of the Intergovernmental Panel of Climate Change (IPCC) in 1997 declared somewhat ambiguously that "the balance of evidence suggests discernable human influence on global climate", the same report four years later (2001) came to the following conclusion: "There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities". As a result the authors conclude that not only "human influences will continue to change atmospheric composition throughout the 21st century" and that "anthropogenic climate change will persist for many centuries" (IPCC 2001).

It is before this background that I presented in the opening session of the summer-school the by now well-known diagram by R.E. Kates, which – in a very comprehensive way – reflects the obvious dichotomies and attitudes of North and South in regard to climate and environmental changes.

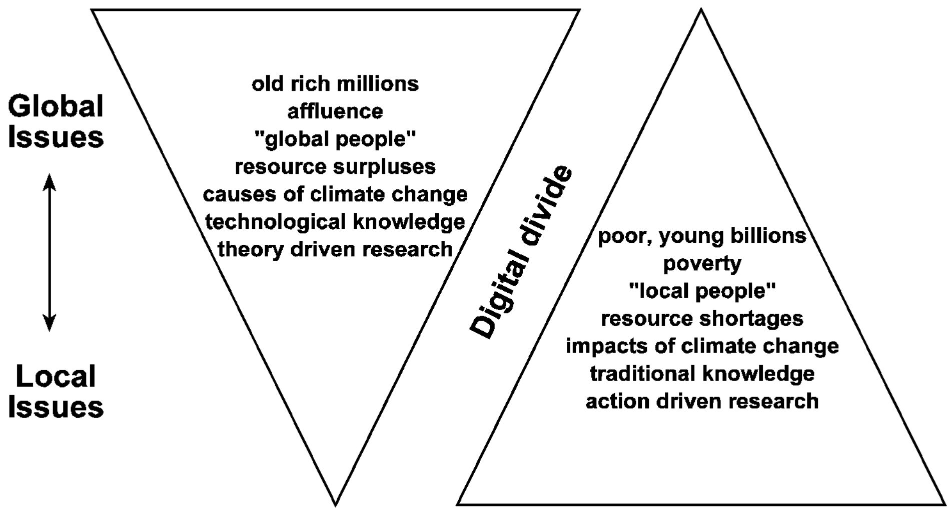

Figure 1: Sustainability Science within a Divided World. A cartoon-like view of the sharp contrast in both perceptions and realities of resource distribution between countries of the "North" and the "South". The research of the "North" is global in orientation, theory-driven, and draws upon technological knowledge. The much smaller research effort of the "South" is local in orientation, action-driven, and draws upon traditional knowledge. The socio-economic, environmental, and knowledge dichotomies are exacerbated by the deepening "digital divide".

Source: Kates, R.W. et al.: Environment and Development : Sustainability Science. In : Science 292, 2001, pp. 641-642.

When, in the final session of the summer-school, held in the Federal Ministry of Science and Technology in Bonn on September 16th, 2003, the participants presented the main results of the their preceding deliberations and discussions, it became clear that the main objectives of this experiment had been reached. It became obvious that the exchange and discussion of

- southern versus northern perspectives,
- scientific versus political approaches and
- theoretical versus practical problems

in regard to climate and environmental changes helped to identify and clarify options for developing countries in the fields of adaptation and mitigation strategies. While it may not be surprising that North and South have and tend to maintain different views on their implementation, it became equally clear that dialogue and open and frank discussions help to overcome obvious conflicts of interests in the pursuit of common aims and goals. The present volume is testimony to the fact that lectures, submitted papers by the participants, working group reports and/or summaries of specific sessions combine towards an extremely diversified, yet focussed and problem-oriented outcome of the meeting.

It is a great pleasure for me to introduce the readers to this volume in which the results of the summer-school on "Climate Change – Mitigation and Adaptation: Identifying Options for the Developing Countries" are presented. The highly stimulating mix of very practical and problem-loaded case studies from the South, of political positions and international perceptions of the Kyoto-process, of industrial solutions to cope with climate change: all this makes the present volume not only an interesting reader, but also – and hopefully – a welcome document of a memorable international and interdisciplinary symposium on a topic that is of relevance to all of us. The very fact that this volume is being published only a few months after the end of this event is highly commendable. Therefore once again: thanks to all and everybody who contributed to the success of the summer-school on "Climate Change – Mitigation and Adaptation: Identifying Options for the Developing Countries".

Eckart Ehlers

Introduction

There is a broad consensus among climate scientists that scientific evidence points to a man made climate change, and that global greenhouse gas emissions have to be reduced up to 80 percent in this century in order to avoid a “dangerous” human interference with the climate system. Whereas national and international politics agree more or less with that assessment in general, there is a discernible and growing dissent about how to cope with that challenge. The cornerstone of international climate policy, the Kyoto Protocol, is not in force, and there are indications that only a handful of states are prepared to implement their emission reduction or limitation targets. Even if it is too early for accusing the international diplomatic process to enter a dead end road, a crisis of the international climate change diplomacy seems to be impending, suggesting research about new or additional approaches to the Kyoto Architecture.[1] There are different reasons for the shortcomings and pitfalls of the national and international climate policies, which have been analysed from different perspectives: Obviously there is a lack of adequate implementation of mitigation measures and policies, indicating that climate change is not taken as serious as declaratory policies suggest; in many countries there is a perception of high mitigation costs and resistance from societal agents; another reason is a general but different threat for states stemming from climate change and doubts about the effectiveness of the agreed mitigation policies, therefore directing (at least implicit) attention more to adaptation policies - whatever adaptation may be and look like. One main problem (and a political reason for at least the USA not to ratify the protocol) is the integration of the Non-Annex I Countries, the developing and threshold-countries, into a future climate protection regime in a substantial manner - that is limiting their future emissions too. There is no foreseeable consensus about the “ifs”, “whens” and “hows” of such an integration. But at least informal political discussions have started and a growing body of scientific literature deals with that issue.

Even the Summer School on Climate Change Mitigation and Adaptation, organized by the Office for Climate Protection Research of the Programme Group Systems Analysis and Technology Evaluation on behalf of the Federal Ministry of Education and Research, has addressed that problem. Interdisciplinary in its focus, from different professional areas (science, business and decision-making), the participants from developing and threshold countries have drawn their own conclusions on how climate change should be dealt with in the „South“ and be

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[1] W. Fischer / P. Holtrup, Klimaschutz und Klimapolitik: Chancen und Herausforderungen. In: Klimaschutz und Klimapolitik. Chancen und Herausforderungen. Beiträge aus der Forschung. Jürgen-Friedrich Hake / Karl Ludwig Hüttner (Eds). Forschungszentrum Jülich GmbH, Jülich 2003, S. 25-54; B. Buchner / C. Carraro, China and the Evolution of the Present Climate Regime. FEEM Working Papers 103, 2003, Milan. AVL: www.feem.it (Status of 4th December, 2003).

integrated into the world wide climate protection policy. To stimulate their discussions, experienced scientist and practitioners have presented overviews of the state of climate change science, political negotiations, concepts and options to address climate change both with respect to mitigation and adaptation policies. The conclusions, agreed among the 27 participants and printed in this volume, are reflecting more or less an "ideal" southern perspective as it could be sifted out from the official negotiation strategy of the "South". No one should be surprised by it. The points made by the participants are a minimal consensus among these countries, reflecting a common "objective" and legitimate interest in avoiding obligations as far as possible and getting the maximum reward in making concessions. The Annex I Countries, bearing "responsibility" for a lion's share of "historic" greenhouse gas emissions, in particular those states (as Germany) interested in forging a sustainable global climate protection strategy, have to deal with these negotiation positions to find common ground. Even if climate protection policies impetus has been weakened both in most countries and internationally today, there is still hope that the dynamics of the 1990s could return. The issue climate change is on many agendas, there are discussions about a Kyoto II Agreement, which tightens GHG - emissions in Annex I Countries further, paves the way to get the USA "on board" again and makes a first move to limit GHG - emissions of some "southern" countries. Science is making headway in understanding the climate system; there are technological developments contributing to higher efficiency, to energy systems with reduced carbon emissions, and concepts of carbon sequestration are coming under scrutiny, and societal forces are engaged in "grass root" GHG - emission reductions and limitation activities worldwide, often in cooperation with local or regional authorities or industry. But the real challenge is still ahead: Reducing worldwide GHG - emissions in the next 100 years to a level that minimizes the risk of a dangerous interference with the climate system. It is not yet clear whether and how it could be done. What is obvious is the tremendous challenge to develop and implement a global cooperation model for such a mitigation strategy, which success seems to be a precondition for promising adaptation strategies, which are necessary anyway.

Against this background the proceedings of the summer school are intended as a contribution to the ongoing dialogue between "southern" developing and threshold countries and "northern" highly industrialised countries. The proceedings contain the lectures given by experts and practitioners both from developing and threshold and industrialised countries (part one). They include contributions about Science and Policy of Climate Change, Mitigation, Adaptation, South-North Cooperation, Business and Integrating the "South" in a global climate protection regime. Part two contains the short papers of the participants, which provide a brief and general overview of the importance of climate change in their countries. Bearing in mind the diverse backgrounds of the participants from three continents, these papers are to be considered as extraordinary compendium. Part three of the proceedings contains the summary reports of rapporteurs designated to the sessions on Science and Climate

Change, Policy of Climate Change, Mega Cities and Emissions Limitation in the South as well as Adaptation. Furthermore, part three consists of the written conclusions of working group discussions thus representing the discursive core of the summer school and the proceedings.

The consolidation of the working group discussions finally led to a Set of Conclusions by the participants. This set was presented to representatives from Government, Business and Non-Governmental Organizations on the final day of the summer school at the Federal Ministry of Education and Research (BMBF) in Bonn. This part four also contains two welcome addresses by MinDir Junker (BMBF) and Board Member Eisenbeiß (Research Centre Jülich).

The editors wish to thank the lecturers for their excellent presentations and contributions. The participants deserve substantial credit for their inspiring discussions and extensive efforts in completing the short papers, the session summaries and the set of conclusions. The summer school highly benefited from the excellent talent of Prof. Ehlers of both stimulating and structuring the discussions. His dedication has been highly appreciated by all participants and we wish to express our gratitude for his engagement.

Our special thanks are dedicated to Dr. Norbert Binder and Dr. Ulrich Katenkamp of the Global Change Department of the Federal Ministry of Education and Research. Only the continuous support and interest of the Ministry in organizing such an event, particularly its financing within the activities of the Office for Climate Protection Research, allowed both for the realization of the Summer School and the participation of candidates from developing and threshold countries.

Jülich, December 2003

Karl Ludwig Hüttner Jürgen-Friedrich Hake Wolfgang Fischer

Welcome Address by Dr. Ulrich Katenkamp

(Federal Ministry of Education and Research)

on the occasion of

the opening of the Summer School

Good morning to everybody!

Salaam alejkum - Bom dia - Tschau ahn - O la - Xin Chau - Selamat pagi - Sdrastwyite - Magan-dangtang - Jambo ......

But, to simplify matters – I just say: Hello!

Ladies and Gentlemen,

I would like to welcome you cordially on behalf of the German Federal Ministry of Education and Research to this charming German town of Bad Münstereifel. My name is Ulrich Katenkamp, and I am responsible for Climate Research and Research for Climate Protection in the ministry's Division on Global Change.

You have travelled a long way to attend this Summer School, but we too had to travel a long way, as it were, to initiate and organize this event. More than two years ago, we developed the first concepts for organizing the Summer School as a visible contribution to increasing support of my ministry for activities in the field of global climate protection.

Surprisingly, it turned out to be time-consuming to bring information on the Summer School to your countries and to find suitable contacts. In the end, however, all problems could be mastered successfully, even though the planned "Spring School" eventually became a "Summer School".

Mr. Fischer and Mr. Hüttner of the Jülich Research Centre shouldered the chief burden of all the work, and I would like to thank them warmly for all their efforts and their commitment, and also for organizing the meeting here in Bad Münstereifel. In February 2003, we were very pleased to receive more than 170 applications for registration from a total of 37 countries.

Meanwhile our team had been greatly enriched by Prof. Ehlers of the University of Bonn. I was very happy about Prof. Ehlers' willingness to chair this Summer School in Bad Münstereifel. I am certain that, at the end of the meeting, you will share this feeling with me. Prof. Ehlers brought to our team his international experience – he is a widely-travelled geographer and has many colleagues and friends all over the world: he was chairman of the International Human Dimensions Programme, one of the four major programmes on global change, and he was also chairman of the National Committee for Global Change Research in Germany. But, last but not least: he is quite simply a very nice person!

We wanted to have a small, a closed meeting and that's why we had to limit the number of participants in this event - so, we had to select 30 candidates from the large number of interested people. We did not find this easy, in view of the many highly qualified applicants. At the same time, the selection of countries had to be balanced:

it was to be representative,

there was to be a clear relation to the topic of climate change in the respective country (both in terms of being affected and in terms of possible management measures), and

the selection of countries was to fit to some extent into the network of countries with which we already had good relations.

I hope that we eventually made the right choice and would like to say once more that I am very happy that you are with us here today.

Ladies and Gentlemen,

A look at the programme before us promises an exciting week. Speakers from different countries will guide us through various fields, from the climate system, its man-made changes and impacts, to climate policy issues, possibilities of reducing emissions and of adapting to inevitable climate variations, to technology transfer and questions of bilateral cooperation. This will be also considered from the point of view of industry.

These topics are to be dealt with and discussed from various standpoints – both from the point of view of the industrialized countries and from the point of view of the countries of the South. We very much hope that you will actively engage in this discussion – because an interactive dialogue also means for us that we can learn from you and your point of view.

Therefore, the programme schedule was arranged in such a way as to leave sufficient time for personal exchanges, either here in the conference centre or within the framework of the planned joint excursions.

The Summer School is the first of its kind also for us, and its success will essentially depend on you and your active participation.

Perhaps, when preparing your trip to Germany, you had the opportunity to also obtain some information on our research system.

The German research system is highly diverse and complex. We have many different research centres and funding programmes in the field of climate research. An ongoing programme of my ministry is the German climate research programme DEKLIM, for example, which you can find on the web under www.deklim.de.

There are many other activities, both at the institutional level, e.g. by the national research centres (HGF) or the Max-Planck-institutes, and in the field of project funding, also by other organizations.

But In our view, the approaches that aim at the application of knowledge and at management options for mastering current problems must be developed much more strongly in the future.

This is the reason why research funding by the BMBF will focus on these questions to a greater extent than in the past, and why questions of global climate protection and other aspects of global change must be investigated more intensively. But ultimately, it is also the reason why the Summer School has been organized.

I trust that this Summer School will provide you with new ideas for your work back in your home countries, and that new contacts will be forged and consolidated, which can form the basis for cooperation between our countries later on.

Ladies and Gentlemen,

I very much hope that the coming days will be interesting and successful for you and also for us. I wish you – the speakers and the participants in the discussions – and all of us, a good and exciting week and every success.

Thank you for your attention.

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I Lectures

Lectures

Science of Climate Change

Anthropogenic Greenhouse Gas Emissions: Sources and Trends

Rüdiger Schaldach
Centre for Environmental Systems Research
University of Kassel
Kurt-Wolters-Straße 3
34109 Kassel
Germany
E-mail: rschaldac@usf.uni-kassel.de

1 Introduction

The lecture gives an overview of anthropogenic sources and sinks of greenhouse gases. It is divided into three main parts: first the chemical and physical basics for understanding the natural and anthropogenic greenhouse effect are given. The second part focuses on the sources and sinks of the three main greenhouse gases carbon dioxide, nitrous oxide and methane. Here the central point is a short outline of the global carbon cycle and its perturbation by human activity. Last, relevant driving forces are discussed and Intergovernmental Panel on Climate Change (IPCC) emission scenarios for exploring future emission trends are introduced.

2 The Climate System

The climate system consists of five major components: atmosphere, hydrosphere, cryosphere, land surface and biosphere [1]. Most important external driver to the system's dynamics is the sun, supporting the climate system with radiation energy. In this lecture we concentrate on the atmosphere keeping in mind that the components are strongly inter-connected with one another by flows of energy and matter. Main chemical component of the atmosphere is nitrogen (78,08 Vol. %), followed by oxygen with a share of 20,95 % and argon (0,93 %). The rest is formed by a number of trace gases. Some of these trace gases adsorb and re-emit infrared radiation causing what is known the natural greenhouse effect which rises the medium earth surface temperature from far below zero (-19°C) to about 15°C. Incoming short wave solar radiation is partly absorbed or reflected on its way through the atmosphere (Figure 1). A certain ratio reaches the earth's surface and heats it up. This causes the emission of long wave radiation (infrared spectrum), which in turn is adsorbed by atmospheric trace gases (greenhouse gases) and saved as warming energy. Later this energy is re-radiated (infrared spectrum again) in all directions causing the additional temperature effect.

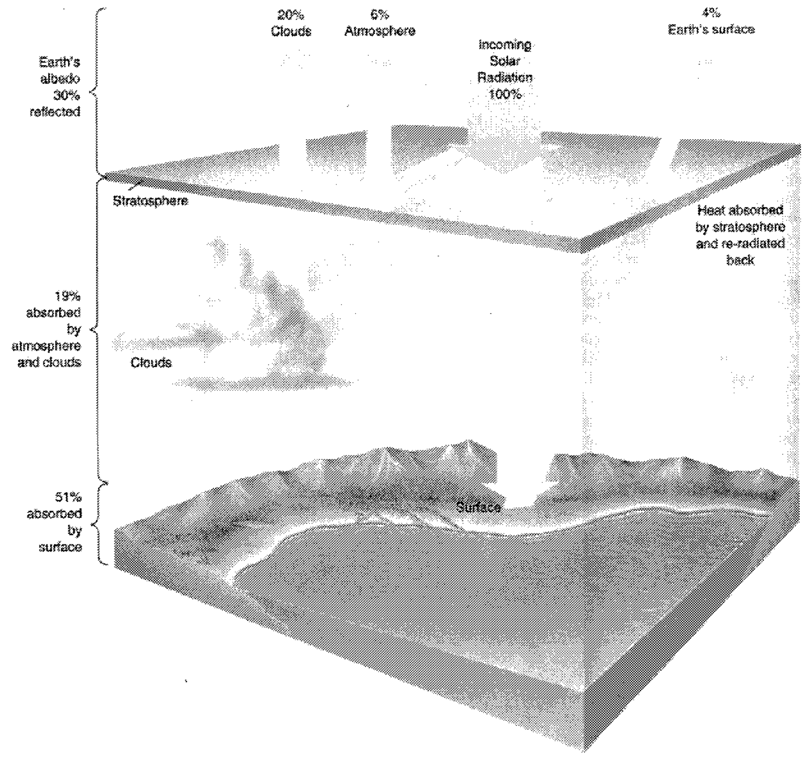

Figure 1: The partitioning of incoming solar radiation in the Earth's atmosphere

Atmospheric greenhouse gases are:

- Water vapour, additional indirect effect due to formation of clouds;
- Carbon dioxide (CO_2), complex atmosphere-biosphere-hydrosphere cycle (see chapter 3);
- Methane (CH_4), few sinks, relatively long-lived;Halocarbons, deplete stratospheric ozone; non-reactive; long-lived in atmosphere;
- Ozone (O_3), increase of tropospheric ozone increases the greenhouse effect;
- Nitrous Oxide (N_2O), non-reactive, long-lived.

The "undisturbed" atmospheric system can be assumed being in a dynamic balance. Natural perturbations come for example from variations of solar radiation over long time, changes in ocean circulation patterns and volcano eruptions.

By introducing human industrialized societies into the system, we find a range of man-made disturbances of the atmosphere's balance. First to mention is the change of land cover (deforestation, urbanization) resulting in a change of albedo altering land-atmosphere heat fluxes. The most interesting perturbation for this lecture are the growing industrial activities and energy consumption patterns that, together with agricultural management intensification leads to additional greenhouse gas emissions and therefore to a change of the trace-gaseous composition of the atmosphere. This results in an anthropogenic greenhouse effect that will most likely cause changes of temperature and precipitation patterns affecting human life as well as ecosystem stability – i.e. the climate system moves towards a new level of balance with a certain time lag.

The most important anthropogenic greenhouse gas is carbon dioxide (CO_2) with its amount in the atmosphere increased by about 30% since pre-industrial era, followed by methane (CH_4) and nitrous oxide (N_2O). These gases have very different effects in the atmosphere.

A tool to evaluate the relative climate impacts of these trace gases are the concepts of “Radiative Forcing” and “Global Warming Potential (GWP)”. According to IPCC “Radiative Forcing” is defined as the net radiative flux change, induced at tropopause by perturbation of concentration of an atmospheric species (gas or aerosol) keeping all other species constant” [1]. The GWP is “the time-integrated change in radiative forcing due to instantaneous release of 1 kg trace gas expressed relative to release of 1 kg CO_2”. Using these measures 1 t of methane has the same climate effect as 23 t of CO_2. The GWP of N_2O is even higher with 296 (both for a time period of 100 years). The explanation can be found in their chemical characteristics as well as in their lifetime in atmosphere.

3 Greenhouse Gases: Sources and Sinks

3.1 Carbon Dioxide

Carbon dioxide is the main contributor to the anthropogenic greenhouse effect. Figure 2 shows a very simplified view of the global carbon cycle. Apart from the atmosphere three major carbon pools can be identified: the hydrosphere (oceans), biosphere and lithosphere. Exchange between atmosphere and hydrosphere takes place in the upper layer of the oceans. Primary production (photosynthesis) is the major flux to the biosphere. Decomposition processes and biomass burning again release carbon. In an undisturbed system, the lithosphere is a prominent carbon sink. Carbon is fixed in carbonaceous rocks as well as in organic compounds (natural gas, coal, crude oil). Dominant anthropogenic disturbance of the carbon cycle is the burning of fossil fuels, releasing the carbon dioxide that is fixed in the lithosphere. Here, the industrial, energy and transportation sectors are main emitters. Worldwide the use of primary energy rose from 250 EJ to more than 400 EJ between 1971 and 1998 while CO_2 emissions were rising from 4500 Mt/C to 7500 Mt/C. Another contribution to this trend can be found in the change of fluxes between atmosphere and biosphere. Forests can serve either as a carbon source or carbon sink.

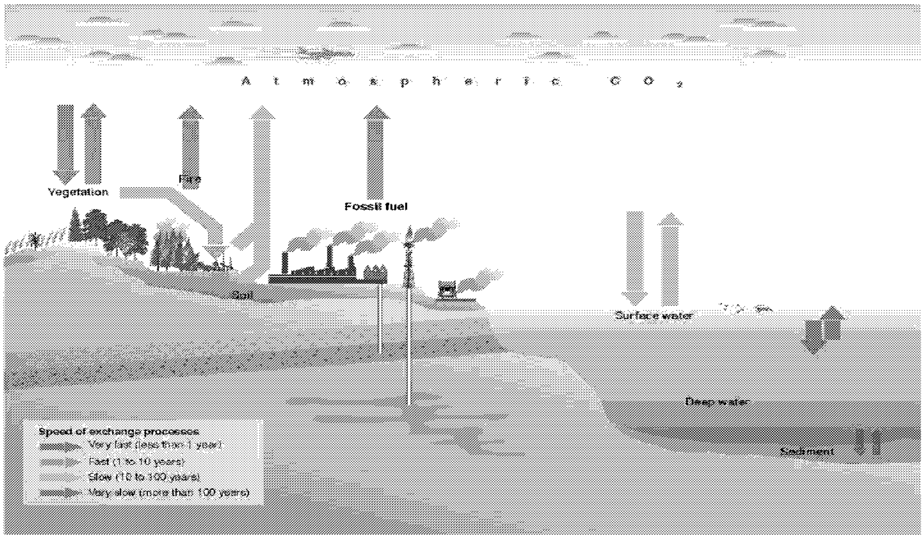

Figure 2: Overview of the global carbon cycle [2].

On the one hand the burning of biomass due to deforestation contributes with 130 Mt/C [3] to the overall emissions in 1990, on the other hand a responsible forest management or afforestation for example of marginal agriculture land can form a considerable carbon sink [4]. Also soil can either be a carbon source or sink depending on agricultural management and change between different land use types (grassland, natural vegetation).

Questions of quantifying agro- and forest-ecosystems' capacities, as carbon sinks are a major point in the climate negotiations started in Kyoto. Since these systems are also affected by natural disturbances (fires, hurricanes etc.) their sink capacities are highly variable making it a very demanding task to make them part of emission trading systems.

3.2 Methane

In contrast to CO_2, the main source of methane and nitrous oxide emissions is the land use sector with a share of 74 % and 77 % [3]. As major land-use related sources of methane landfills, rice cultivation and livestock are to be mentioned.

In landfills (or waste disposal sites), organic material is decomposed under anaerobic conditions and landfill gas with a share of about 50-60 % of methane is released. This amount adds to 20-79 Mt CH_4 emissions per year.

Rice cultivation area is about 10 % of the world's total cultivated area. Global methane emissions related to rice cultivation are about 60 Mt per year. Since it is produced through anaerobic decomposition of organic material on flooded rice fields, main contributors are irrigated (50 % of the total cultivated rice area) and rain fed wetland rice (30 %). The remaining upland rice fields do not produce significant amounts of methane [5].

Livestock produce methane in their digestive tract by the process of enteric fermentation. Main sources are cattle and buffalo. Emission quantities are about 80 Mt per year.

Methane emissions are also part of the carbon cycle with a strong coupling to primary production by anaerobic decomposition of residues (chemical reduction) in contrast to the coupling of CO_2 by oxidation processes.

3.3 Nitrous Oxide

The major source of N_2O emissions is cultivated agricultural soils through nitrification and de-nitrification of nitrogen. Emissions strongly depend on the amount of applied organic and mineral fertilizer as well as management practise, soil and climate conditions. Further sources include wastewater treatment and livestock (storage of manure).

3.4 Uncertainties

Estimations of emissions and sinks of greenhouse gases have a high degree of uncertainty and so do national emission inventories have. While we understand how much CO_2 is produced by burning a certain amount of fossil fuel, the relevant processes in the land use sector are highly dependent on environmental conditions (microbial activity for example highly depends on ambient temperature) and management factors (forest sinks). One way to reduce uncertainties is intensive measurement of fluxes between the observed system (soil, waste disposal site etc.) and the atmosphere over a wide range of environmental conditions, which is a very complex and time-consuming task.

Additionally, simulation techniques as a means of assessing the complex interactions between the socio-economic system and the climate system using models that represent our best understanding of the underlying processes have to be improved.

4 Emission Trends

4.1 Emission Trends of the Past – Identifying Driving Forces

Figure 3 shows the levels of the atmospheric concentration of the three major greenhouse gases from pre-industrial times to the year 2000. In order to estimate future emission trends, the first step is to identify and understand the underlying causes of the obviously radical development since the beginning of the 20th century. The future trajectories of these driving forces will at least partly determine future greenhouse gas emissions. On a very abstract level, IPCC lists demographic change, social and economic development and technological change as the most important driving forces [6].

For a more detailed view we pick the processes of paddy rice cultivation and energy production as examples to show, in a very simplified way, the interconnection between these factors and greenhouse gas emissions.

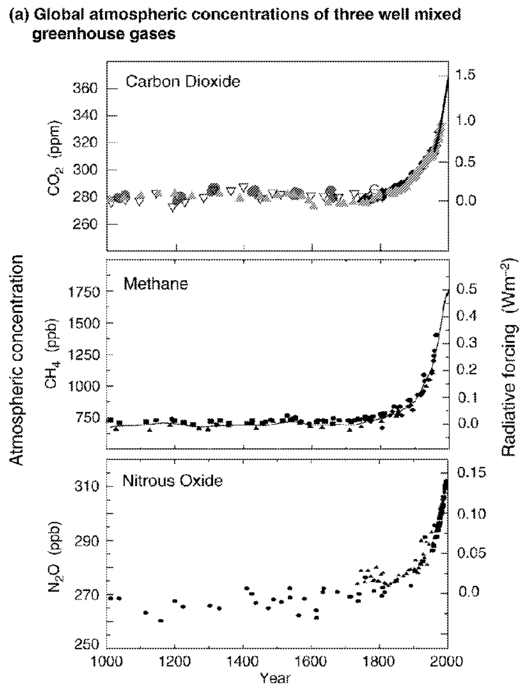

Figure 3: Development of atmospheric concentrations of the major greenhouse gases CO_2, N_2O and CH_4 during the last 1000 years [1].

Methane emissions from paddy rice directly depend on the amount of cultivated area, which showed a steady increase in the last decades. This at least can partly be explained by higher needs of food production for a growing population in Asian countries.

In the 20th century energy production was strongly correlated to economic growth (development of Gross Domestic Product (GDP)) leading to high carbon dioxide emissions from industrial countries. Use of more energy efficient technology leads to a decoupling of GDP from these emissions. Here we have to question how to make these technologies available to development countries and support a more sustainable growth of economy and welfare.

4.2 Future Emission Trends

Since there is no determined future, one way of describing and analysing a range of imaginable future development paths are scenarios. One can define scenarios as "alternative images of how the future might unfold" and as "an appropriate tool with which to analyse how driving forces may influence future emission outcomes and to assess the associated uncertainties"[6].

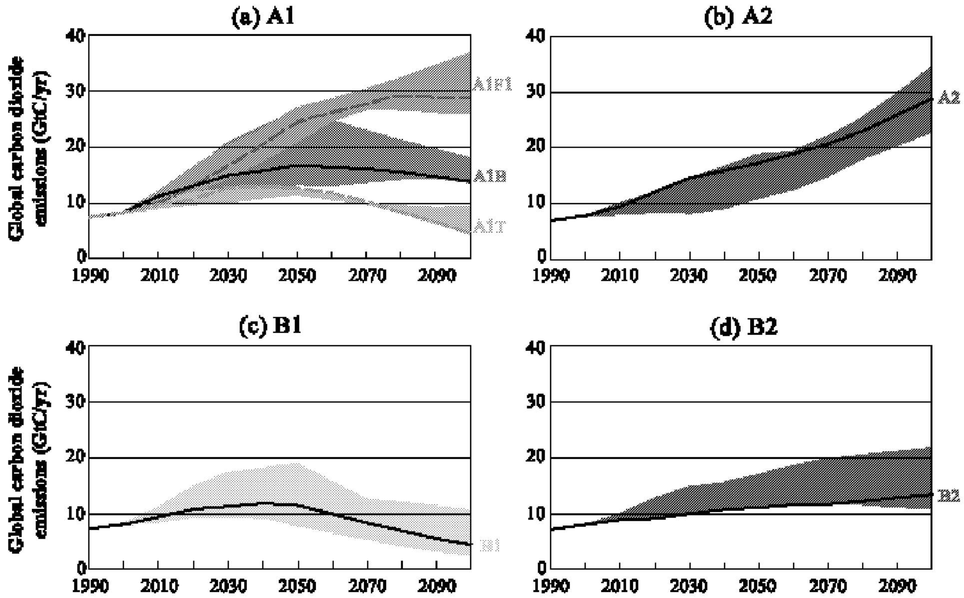

Figure 4: Carbon dioxide emissions according to the SRES scenario families [4]

In an open process the IPCC developed four scenario families covering a wide range of future developments until 2100 (altogether 40 scenarios) [6].

The A1 scenario family describes a globalised world with intensive market forces. It is characterized by very rapid economic growth and the introduction of new and efficient technologies (rapid technological change). Global population reaches its peak in the middle of the next century, declining thereafter. Regional disparities are becoming smaller and there is an increasing cultural and social exchange. The A2 world is more heterogeneous but also relies on globalised market forces. But here priorities lie on regional development leading to a slower convergence between regions but also to slower technological development. Population is continuously increasing.

The B1 family is sharing the same assumptions for conversion and population development with A1. But in contrast sustainability as a major goal is introduced. Economy is changing towards service and information orientation. B2 also focuses on environmental protection and social equity but these aims are achieved on local and regional levels (less globalised world).

One result of a model based scenario analysis is presented in Figure 4. We can see very impressively how different development paths influence global carbon dioxide emissions and therefore future life conditions on earth.

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CLIMATE CHANGE: THE IMPACTS

Chris B. Sear
serial_interface
31 The Landway, Bearsted
Maidstone, Kent ME14 4BE
United Kingdom
E-mail: chris_sear@btinternet.com

1 Introduction

According to Grove (1994) [1], our very first notions that human activities might cause climate change on regional scales came from British and French island colonies. The administrations of Tobago, St Vincent, St Helena and Mauritius were persuaded in the 18th and early 19th centuries that deforestation was linked to subsequent declines in rainfall. This led to protection of crucial island forest resources. With this in mind, I choose to consider the impacts of climate change on small island communities to evince the issues we face today and over the coming decades. Many of the potential impacts on and risks to these communities are shared by non-island and non-coastal communities and I touch on these issues also in this paper.

Table 1: The human toll of natural disasters by disaster type (1972 to 1996) and by region (1987 to 1996). Adapted from AFRC World Disaster Report 1998.

Natural Disaster	Deaths	Millions of people affected
Drought and Famine	73,600	59.3
Storms and Winds	16,000	11.7
Floods	12,700	65.9
Landslides	800	0.1
Volcanoes	1,000	0.1
Earthquakes	18,700	1.7
Region	Number of Disasters	Millions of people affected
Asia	107	185.8
Africa	43	12.7
Americas	73	3.0
Oceania	16	2.5
Europe	33	1.7

Two hundred years after a few people protected the environment on a few small islands, most people now agree that humanity causes global climate change. Global climate change is already occurring that may be ascribed to human activity and these are having a “widespread and discernible impact” according to the Intergovernmental Panel on Climate Change Third Assessment Report [2]. The report goes on to state: “The most widespread direct risk to human settlements is flooding and landslides, driven by rainfall, sea-level rise and tropical storms." Taking life itself, drought and its all too often devastating consequences is the predominant weather risk in the world today and this will not change as climates change through the 21st century (see Table 1).

2 Today's Risks First – The Example of ENSO

My first point then is that today's climate is a major influence on the lives and well being of people all over the world. In 1998 the World Bank estimated that the total cost of the damage caused worldwide by the 1997-1998 El Niño would be well over $20 billion. That one weather-related phenomenon could be so expensive is perhaps surprising at first sight but the El Niño Southern Oscillation (ENSO) phenomenon is undoubtedly the largest and potentially the most destructive of all weather and climate variations.

A short list of just some of the impacts of the 1997-1998 El Niño (extreme warm phase of the Pacific Ocean ENSO cycle) and their effects on people is included as Box 1 and only goes to demonstrate its potential for harm and its often devastating impact on peoples' lives and livelihoods. The most devastating and life-threatening effects of the 1997-1998 El Niño were closest to the phenomenon's centre of action, in and around the tropical Pacific but climates around the world are known to be affected by ENSO and the 1997-1998 El Niño was clearly responsible for some extreme weather, crop failures and other notable effects in parts of every continent.

The 1997-1998 El Niño was presaged – by May 1997; sea surface temperatures were rising rapidly in the eastern Pacific and by July the temperatures in key areas were higher that ever previously recorded. This led to predictions of a very severe event with extreme weather in many regions of the world through the rest of 1997 and in 1998. As we know, in many places these dire predictions were fulfilled (Box 1) but what of Africa? Most El Niño events peak in southern summer and ENSO is known to have a significant impact on weather conditions in most of sub-Saharan Africa, especially across southern Africa. Between June and September 1997 pundits in the media and many climate scientists were predicting dire consequences for southern Africa in the 1997-1998 rainy season. Later, in September, the consensus amongst forecasters from the region and outside at a regional seasonal forecasting meeting was that (probably) many parts of the region south of 15°S would suffer drought. In view of the size of the event in the Pacific, it was thought that it would be severe in places, to rival or exceed those in previous El Niño seasons in 1982-1983 and in the early 1990s.

In the event most of southern Africa had good or more than normal rainfall whereas down the eastern side of the continent the El Niño brought heavy rains to Kenya, Ethiopia, Tanzania, Mozambique and elsewhere with consequential crop losses, disease outbreaks and loss of property and lives. The worst food shortages associated with the strongest El Niño of the 20th century were in Africa but not in the south as predicted but in Sudan, Somalia, which experienced drought and in Ethiopia and Kenya owing to excessive rainfall.

The reasons that the African continent experienced different weather patterns during the 1997-1998 rainy season than were expected in an El Niño season are complex. Part of the reason for this was that a large and persistent sea surface temperature anomaly pattern developed in the Indian Ocean, which swamped the normal El Niño signal. This illustrates perhaps the most important fact about global climate and climate change – that we cannot take anything for granted when forecasting or considering what future world climatic conditions might be. Our climate system is chaotic and no matter how good our models are, or how knowledgeable are forecasters and climate research scientists, or how good are local, national and international decision-making processes, our weather will continue to confound and surprise us, as it always has.

ENSO affects many regions of the world and in some it is the most important factor determining the nature of seasonal weather, year on year. It is most important that we are able to predict ENSO effects better but the point made above evinces that climate variability and inherent unpredictability is and will remain the single most important constraint on formulating effective response strategies to future climate change. When the expected droughts did not materialise in southern Africa in 1997-1998 it was not the press that got the blame but climate science. This perceived failure to understand the climate system well enough to make reliable forecasts for a few weeks and months ahead risks the longer-term credibility of climate scientists and the decision-makers who might use their recommendations.

A sensible solution is to formulate effective response strategies that anticipate and factor into decision-making both the extremes of today's weather and an appreciation of how conditions might change, so as to provide a large enough 'climate envelope' to act as a baseline for formulating livelihood or economic strategies and within which to plan for the future. *Only when we can cope with today can we hope to cope with tomorrow.*

3 Recent and Future Climate Change

3.1 Climate: A Complex System

The Earth's climate is a complex and chaotic system that comprises *components* (the ocean, atmosphere, cryosphere, lithosphere and land and ocean biospheres); internal and external *forcing* (such as ENSO, volcanic eruptions, solar fluctuations and now, human beings); and *processes* and *feedback mechanisms* (that damp, amplify or otherwise modify components and forcing within the system). Weather and climate variations occur on all meaningful time scales up to hundreds of millions of years and spatially from local to global. How we measure and model current and future climates are covered elsewhere. This paper concentrates on the impacts of climate change on human activities using examples from around the world and stressing the interconnectivity of the system (i.e. that impacts that may be attributable to climate change caused by human activities can't be separated or divorced from the natural climate system and fluctuations and changes that occur naturally). Whether we live in Europe, Latin America, Africa, Asia or Washington DC, we are all part of the Earth's climate system, not apart from it.

3.2 Recent Climate Change

The consensus amongst climate scientists is that global climate change over the past century is mainly the result of human activities. This was confirmed in the IPCC Third Assessment Report (TAR) [2]:

- Atmospheric CO_2 has gone up by 31% since 1750 due to human activities;
- Methane concentration has increased by 151% since 1759;
- Nitrous oxide concentration has increased by 17% since 1750;
- Global surface temperature has increased 0.6°C ± 0.2°C since 1861 (see Fig. 1);
- The 1990s was the warmest decade since 1861 (Fig. 1);
- ENSO warm episodes have been longer, more frequent and intense since the 1970s;
- Global sea level rose by 0.1 to 0.2m during the 20th century at a rate of about 1.5cm / decade;
- There have been notable changes in flood and drought frequencies in several regions, especially in the last 30 years;
- Rapid global climate in the past two decades is primarily the fault of Man;
- Earlier 20th century changes had as much to do with external forces including solar variations and volcanic eruptions and were also partly damped by human activity (industrial pollution with sulphate aerosols).

3.3 The 21st Century

The likely range of global climate change during the 21st century according to the current consensus amongst climate scientists was reported to governments in 2001 through the IPCC TAR [2]:

Global climate change over the next century is likely to be dominated by human –induced change and some of this is already unstoppable:

- Human CO_2 emissions are almost certain to be the dominant influence on the trends in atmospheric CO_2 during this century;
- Current emissions scenarios show that humans will cause a doubling of atmospheric CO_2 from pre-industrial levels by as soon as 2045 and almost certainly by 2120;

- Significant reductions in greenhouse gas emissions are vital to stabilise radiative forcing - 'business as usual' is not a sustainable option;
- Globally averaged surface temperature is expected to increase by between 1.4 to 5.8°C over the period 1990 to 2100 (see Fig. 1) (we have already seen a 0.2°C warming during the 1980s and 1990s – Fig. 1);
- The projected rate of warming during the 21st century is much larger than the observed changes and is likely to be unprecedented in 10,000 years;
- By the year 2015 the range of additional warming predicted is between 0.2 and 0.9^{0}C;
- Current and future sea level changes are mainly the result of global ocean temperature changes as warmer water expands in volume, together with direct results of ice sheet and glacier melt;
- Global sea level is predicted to rise at a rate of between 0.9 and 9cm / decade and be between 0.1 and 1m higher by 2100;
- Ocean expansion takes centuries to adjust to temperature change;
- Even if 21st century efforts to mitigate climate change are successful and temperature stabilises later this century, future generations will see continued increases in sea level for at least another 1,000 years and
- Sea-level rise over the next millennium could be 3m to over 10m.

3.4 Uncertain Futures

The future is, of course, uncertain. It is worth reinforcing that there are two generic sources of uncertainty in climate prediction [3]:

- Uncertainty concerning future world development affecting how greenhouse gas emissions will change;
- Uncertainty associated with modelling of the Earth's climate system and the accuracy of climate models.

The first source of uncertainty will not be resolved by improvements in 'climate science'. The second source of uncertainty is, in principle, partly resolvable given adequate investment in the science base and continued expansion of computing power [4]. However, it is generally accepted that complexity and chaotic nature of the climate system will always preclude forecasting perfection.

The range of predicted global warming: *1.4°Cto 5.8°C by 2100*; is a function of both sources of uncertainty and:

- Between 25 and 40% of the range is due to unknown future emissions;
- 60 to 75% is due to imperfect modelling.

So, as much more than half the uncertainty is tractable, we expect intensive climate system-oriented research to make significant inroads into the overall prediction uncertainty over the next decades [3].

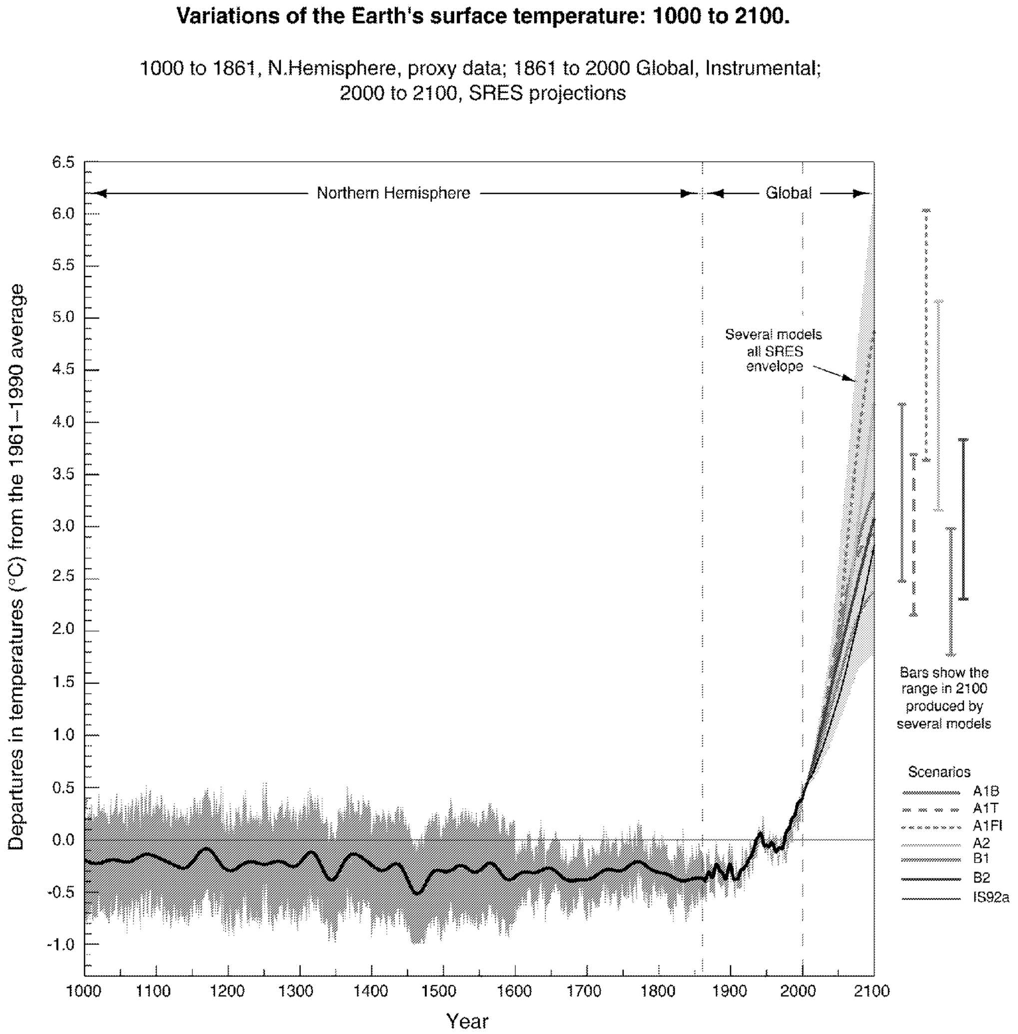

Figure 1: A synthesis of current projections of global surface air temperatures from the IPCC, including current best estimates and error bars for global temperature during the past millennium [2]. Note that even the most conservative estimate of 21st century temperature change far exceeds any variations during the past 1000 years.

However, given the current state of our understanding, it is useful to summarise relative levels of confidence we have in the components of future global change predictions. These are summarised in Table 2.

Table 2: Confidence levels for changes associated with global warming. (Adapted from [2]).

Prediction Statement	Confidence Level
Atmospheric CO_2 concentration increase	Very High
Global sea-level rise	Very High
Global temperature increase	High
Regional temperature increase	Moderate
Increase in hurricane intensity	Moderate / Low
Increased amplitude of ENSO events	Moderate / Low
Regional precipitation change	Low

Notwithstanding these different levels of confidence, it is safe to conclude that the ***least likely*** future for most populations around the world is that they will experience the same weather characteristics as they have seen over the past 50 years.

4 21st Century Climate Change Impacts

4.1 Introduction

Having provided some background on the current consensus, we can now take a closer look at climate change impacts. An appropriate starting point is the IPCC TAR Working Group 2 report of 2001 [5], from which come the following points and implications:

- Recent climate change has already affected physical and biological systems;
- Some societies have been affected by recent increases in flood and drought frequency and severity;
- Many natural systems are vulnerable to climate change and some may be irreversibly damaged in coming decades with as yet uncertain 'knock-on' effects on societies (*All human activity is ultimately predicated on environmental sustainability*[1]);
- Many societies are especially sensitive to climate change - some are more vulnerable than others (*and it is accepted that in general the poor are the most vulnerable*[2]);

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[1] Author's supplementary comment in brackets

[2] Author's supplementary comment in brackets

- Projected changes in climate extremes could have major consequences on many societies and billions of people (*for example, half the world's population live within 50km of the coast*[3]);
- Large-scale and possibly irreversible impacts pose risks that have not yet been reliably quantified;
- Adaptation is a necessary strategy at all scales to complement climate change mitigation efforts (*following the precautionary principle – see 4.2 below*[4]);
- Adaptation, sustainable development and increasing equity can be mutually reinforcing:

" we can all sink or we all float, 'cause

we're all in the same big boat"

(Sting, 1981; One World (not Three).

From: Police; Ghost in the Machine).

I take as the starting point for consideration of the prospects for and impacts of climate change a *Pressure-State-Impact-Response* framework (see, for example [6]). We can apply the PSIR concept to the interaction between climate change (*pressure)*, environmental *state*, *impacts* on environmental services and through these to *impacts* on livelihoods and their sustainability; leading to *responses* of policy- and local decision-making. This provides a simplified, yet systematic view of a most complex web of interactivity between climate change and society. Furthermore we can use this simple model to help us answer some of the key questions, such as those posed for the summer school.

4.2 Responses to Climate Change

The issue of global climate change is unusual. It is global and long-term and yet local and immediate (as anyone who has suffered a tropical storm or flood knows). It involves complex interactions between environmental, economic, political, institutional, social and technological processes. Alternative development paths may result in very different emissions and low emission paths will require major socio-economic, agro-forestry and energy policy changes and difficult decisions with respect to equity and development. Some emissions sources might be reduced with positive net social benefit or no regrets exploitation opportunities. These are being sought but economic costs and benefits are distributed unevenly between sectors and societies. The costs of mitigation and adaptation could be reduced by appropriate policies but in the end,

[3] Author's supplementary comment in brackets

[4] Author's supplementary comment in brackets

who will bear the brunt? Will the burden be distributed evenly or equitably between societies in the North and South?

Successful implementation of greenhouse gas mitigation options will have to overcome many technical, economic, political, cultural, social, behavioural and institutional barriers, which prevent the full exploitation of the technological, economic and social opportunities of these mitigation options. National responses to climate change will be more effective if delivered as policy integrated with non-climate related objectives, to achieve the long-term social and technological change needed for sustainable development. Coordinated actions among countries and sectors may help to reduce mitigation cost, address competitiveness concerns and resolve potential conflicts with, for example, trade regulations. Research is needed to make scientific assessment more robust, more locally specific and tractable and to minimize uncertainties so that useful information on impacts and responses is available for policy making at national level.

4.3 The Precautionary Principle

It seems that with a few notable exceptions most countries and international groupings now accept that for such an environmentally based concern, a soft formulation of the precautionary principle as expressed by the Rio declaration and by the Commission of the EU in 2000 is appropriate when considering human-induced climate change.

When an issue is shrouded in scientific uncertainty and yet it is suspected that harm may result from human activity, precautionary action is advisable [7, 8]. Climate change fits the bill, as I have already shown:

- The issue is clouded by ignorance and indeterminacy (the climate system is complex and chaotic and there are also statistical and modelling uncertainties;
- It is serious - potentially as serious as it gets (global, long term and affecting billions of people and most ecosystems);
- It is cumulative and partly irreversible.

Precautionary action anticipates and is based on prevention. It does not guarantee or even aim at providing zero risk solutions. The ethos is - take precautionary action, don't wait for scientific 'certainty' - investigate, understand, monitor, inform and act.

How does it work? In essence we should take precautionary action before scientific certainty of cause and effect exists, seek, consider and evaluate alternatives to potentially harmful practices and use good governance, developing more democratic decision-making criteria and methods. Measures should be proportional to the desired level of protection, consistent with measures used in similar circumstances and *non-discriminatory*.

4.4 Impacts Summaries

There are several ways by which we can categorise expected, likely or possible climate change impacts: perhaps by region; or by sector; or by ecosystem; etc. (see Box 2 and Box 3 which summarise many projected impacts based on the IPCC driven scientific consensus. Note that only a selection of sectors is included in Box 3 and it does not include, for example: fisheries, transport, housing and infrastructure, energy and tourism, to name but a few).

Such list making is not very satisfactory as it produces generic predictions of vague risk and consequence, which have little to say to national and especially to local, community-level or individual decision-making. Nor does generating generic predictions facilitate the development of adaptation strategies for vulnerable communities, nor does it take on board the need for precautionary action. Indeed it may be more appropriate to consider climate change, impacts and adaptation in a different way from a traditional top-down approach. Such a 'people-first' approach, based on livelihoods and vulnerability is gaining acceptance.

5 An alternative Approach to assessing Impact

5.1 Conventional Scenario Generation

A conventional top-down approach to analysing climate change impacts is shown schematically in Fig. 2. First greenhouse gas emission scenarios are generated and from them, through radiative physics, climate change scenarios are generated and modelled and projections made of rates of change of temperature. Climate models are then used to map changed climates (including temperature, pressure patterns, rainfall patterns, soil moisture, sea-ice extents and other parameters of the climate system), comparing today's climates (generally using a 1990 baseline) with conditions some undefined time in the future when CO_2 levels are approximately twice pre-industrial levels (possibly by around 2050 or soon after). I have already noted the uncertainty inherent in this process, the outcomes of which are various generic scenarios or 'climate futures'.

The next steps are to consider what effects these changes to climates around the world might have on physical and biological systems, adding further levels of uncertainty and dramatically increasing the complexity of the systems and interactions that need to be studied. Then consideration is made of the impacts of preferred scenarios on human activities. Apart from the complexity of the branching pathways, this approach is problematic for another reason – that the original global warming estimates are *ranges* (for example, currently a 1.4 to 5.8°C rise by 2100) and all derived climate scenarios are similarly broad.

Thus, as climate conditions change, it is neither clear how to draw thresholds of effect on either biophysical systems or on any human activities, nor indeed properly to consider transient responses. For example, it may never be possible to state that a sea temperature increase of say 2^0 will allow a certain coral reef system to be sustained whilst one of 2.5^o will cause its decline. Also it is likely that we will never be confident in a given situation that a rise of 2^0 in 50 years will be sustainable but 2^0 in 40 years will not. Finally, who will be able to draw lines around the sustainability of say a pastoralist society in southern Africa if the risk of drought rises from one year in five to one year in three over the next 25 years.

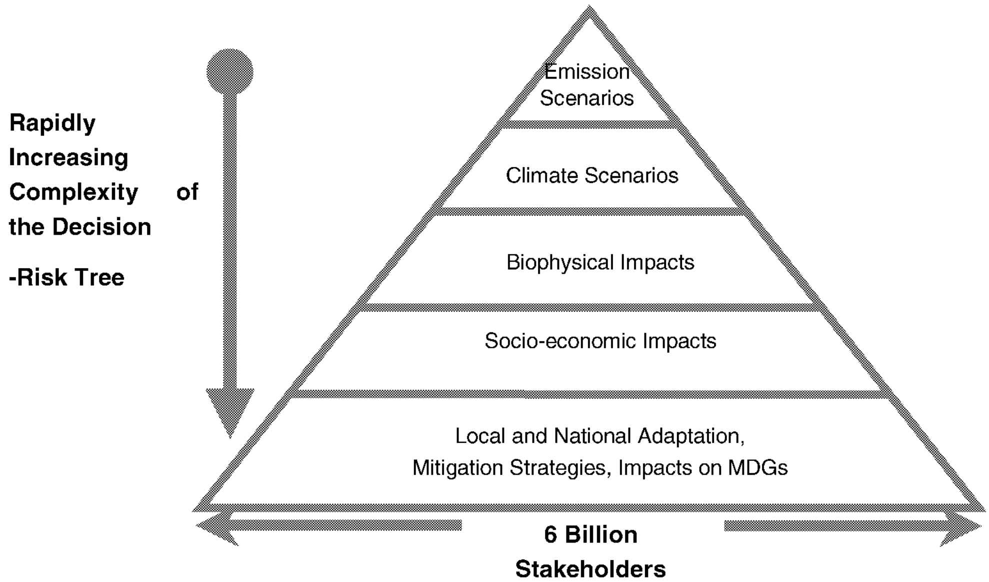

Figure 2: The increasing complexity of the decision-risk tree for conventional scenario-based approaches to assessing climate change impacts on people.

5.2 A Livelihood-Vulnerabiltiy Based Alternative

Seeking a way to minimise the complexity of the decision-risk tree an alternative approach is possible which can better integrate climate science with local concerns and real livelihood choices, and provide improved policy support. In this approach we start at a local level by considering today's livelihoods and how they can be sustained in the light of today's risks (including climate and weather-related hazards amongst others) and vulnerabilities. We also consider how improved knowledge of possible changes in the climate risk mix because of projected global warming might affect communities and impact on they options and livelihood choices in the context of sustaining development. Fig. 3 is a schematic of this revised model.

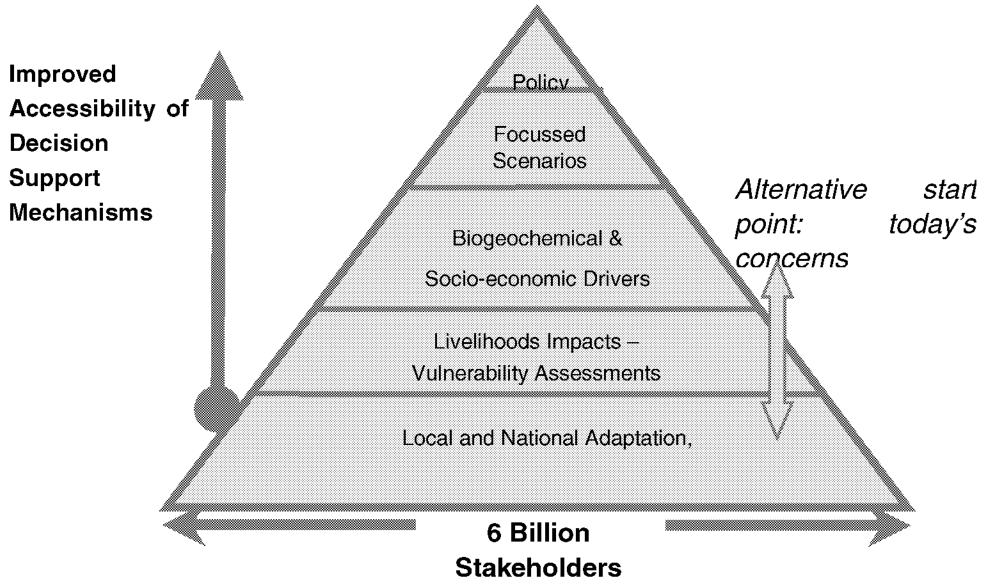

Figure 3: The policy support pyramid - an improved model starting with livelihoods and vulnerability assessment within communities today.

This approach would enable responses to climate change to be fully integrated in development. Then, improving our understanding of the likelihood of change and knowledge of impacts can help to overcome ignorance and (although uncertainty will always exist) can provide development opportunities in all societies [9].

To provide the linkage from vulnerable livelihoods to bio-physical drivers (for example environmental services) and climate scenarios, a methodology can be envisaged which would cluster typical or archetypal communities, livelihoods, stakeholder groups and multi-sector interactions according to the opportunities and threats they face in today's world, in the face of variable climate. Analysing the vulnerability of these livelihoods provides a powerful knowledge base from which to consider climate change impacts, avoiding the extreme complexities of the decision-tree generated by starting at the top with global temperature projections.

Many developing country communities may be in the position of ignorance about climate change science and likelihood and directions of change and yet are especially well-adapted to sustaining livelihoods, having traditional adaptive capacity in an uncertain present, and have relevant knowledge of extremes that can inform their decision-making now and as future climate change occur.

5.3 Impacts-Adaptation and Development Opportunities

Thus, by focussing on vulnerable livelihood archetypes (which may be as few as a dozen in most developing country situations – and indeed world-wide - many similar situations are repeated in Boxes 2 and 3) most of those people most at risk and vulnerable to projected climate change can be represented by a relatively few situations. Questions can then be posed about the processes by which these archetypal vulnerable livelihoods are exposed to climate change, how they may be impacted by them and how they can or will adapt or can be supported. Fig. 4 shows these communities schematically as represented in the top left box. By generating adaptive strategies, often based on traditional coping strategies or those associated with highly adaptive livelihoods (bottom right box), many of these most vulnerable will be 'moved' into the top right box and development opportunities can be derived from the challenge of projected climate change.

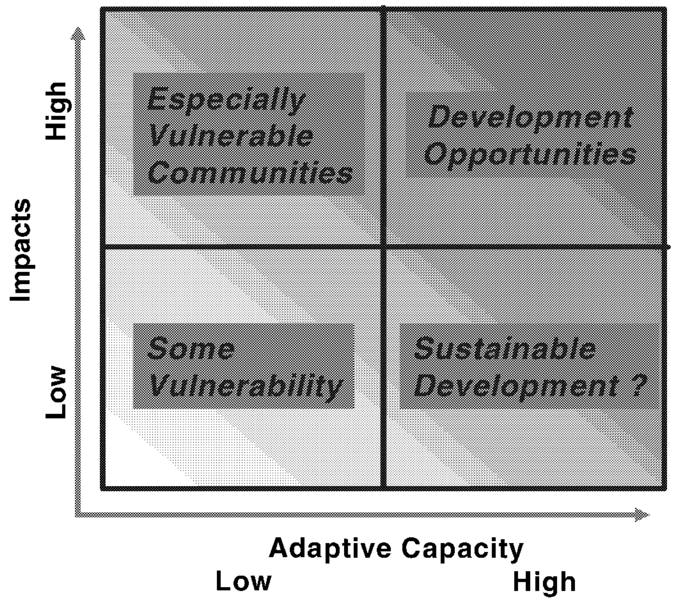

Figure 4: Climate Change Impacts-Adaptation Matrix [9].

This methodology should also enable analyses to understand the relative importance of climate change in the early part of this century, by comparison with other risks and threats to livelihood sustainability. Politically important questions such as the following may then become tractable:

- What minimum impacts can be expected by 2015, 2020, 2050 etc.?
- Are there livelihoods and communities where *near-future* projected climate change poses particular or significant threats?
- Are there 'threshold dates' by which time certain livelihood strategies may become untenable given projected rates of climate change?

6 Small Island States – An Example

6.1 Introduction

The aim of a livelihoods approach is to link impacts and adaptive capacity in critical situations, in order to identify development opportunities and thus to improve the sustainability of vulnerable communities. As an example, I consider small islands. A list of possible bio-physical climate change impacts for small island and for many coastal zones would include higher sea surface temperatures, higher storm-surge flooding and more intense storms, damage to coastal ecosystems, increased coastal erosion, inhibition of primary production, landward intrusion of seawater in estuaries and aquifers, changes in surface water quality and groundwater characteristics, and changes in the distribution of pathogens.

These might lead to socio-economic impacts such as loss of property and loss of coastal habitats, increased risk to life, property and livelihoods from flooding, damage to coastal protection works and other infrastructure, an increased risk of disease, loss of tourism and recreation income, and damage to water resources, leading to detrimental impacts on agriculture and aquaculture.

The lists above are non-specific and of little practical use to coastal and island communities seeking to understand how their lives and livelihoods might be affected by, or at risk from uncertain future climate change. The natural response of many people might be "life is a struggle today, why should I think about the long term future?"

6.2 Small Island Communities - Today's Concerns

In a study for DFID of the impacts of global change on the UK Overseas Territories [10], livelihoods and economies of small island states including specified UK Overseas Territories in the Caribbean, Atlantic and Pacific were analysed to identify the possible effects of projected 21st century climate change. From our livelihood-based analysis and stakeholder survey we concluded that climate change will put additional stress on key environmental systems and services on which local livelihoods depend. The key resources at risk were found to be coastal natural resources, coastal protection and island water resources. Damage to fragile coral reefs, mangroves and sea grasses would have the most far-reaching impacts. More intense storms will demand revised approaches to coastal protection and infrastructure development and risks to water supply from drought and flood will increase, with possible severe knock-on effects to livelihoods and health.

6.3 Key Sectors

We considered a sample of island communities, their socio-economic drivers and how they operate today. The sectors needing investment and planning to enable sustainable development and thus best manage and adapt to projected climate change were identified and are listed below. Naturally, the order of importance of the sectors varies by communities and between islands.

Tourism:

- The increasing size of the tourism industry makes it a critical sector for several small island states;
- Tourism is dependent on marine and coastal resources particularly sensitive to weather and climate.

Tourism is the most important source of revenue and employment for many small island states, especially in the Wider Caribbean (for example, tourism now accounts for one third of total economic activity in Anguilla and an even higher proportion for some other islands). It is expected to increase further in importance, especially 'eco-tourism' that requires pristine and bio-diverse environments. Anguilla and the Turks and Caicos Islands are examples of islands in which tourism is centred on beach and shoreline. Sea level rise will disrupt the sector through loss of beaches, inundation, degradation of coastal ecosystems, saline intrusion, loss of wetlands and damage to critical infrastructure.

Disruption to these natural ecosystems and implications for infrastructure, construction and for property insurance will impact on livelihoods. The experience of island societies following disaster (for example, Montserrat's experience after recent eruptions and Anguilla's, following Hurricane Lenny) demonstrates that tourist demand and tourist-based livelihoods are sensitive both to natural disasters and to perceptions of damage to resources and environmental services. Some islands rely heavily on cruise-ship tourism. Sustaining or growing this sector depends on port infrastructure, potentially at risk from sea level rise, weather and sea state changes.

The importance of tourism to many societies today can't be over-estimated and is expected to increase further (and not just on small islands and in coastal zones). It is vital that we consider today's tourism-based livelihoods and how they can be sustained in the light of current environmental risks and hazards before factoring in climate change risks.

Fisheries:

- Fisheries are extremely important for many small island states. Commercial and subsistence fishing are crucial to the livelihoods of many inhabitants;
- The impact of climate change on fisheries will be complex and will interact with many non-climate related stresses;
- Fisheries are dependent on marine and coastal resources, potentially at risk from sea temperature and sea level rises, ENSO variability and more intense storms.

Fish are a source of income but also a significant proportion of protein intake. Fisheries in Small Island developing states are made up of both artisanal and small-scale commercial fisheries and can be a major export good. Small-scale sustainable fisheries not only provide important dietary components to islanders but also may be responsible for long-term returns. The impact of climate change on fisheries is likely to be complex and interact with other socio-economic stresses, and is not yet properly studied. Inshore fisheries are dependent on sustained coastal ecosystems, dominated by reefs and sea grasses. The likely negative impacts of sea-level rise and sea surface temperature increases and consequent loss of live coral cover represents a real and serious threat to near-shore fisheries of many small islands.

For many deep-sea fisheries, the interaction between ENSO phenomena and fisheries production is a crucial area, particularly if increased frequency or severity of El Niño events are linked to global warming. For example, Pacific skipjack tuna stocks seem to be controlled largely by the periodicity of ENSO events [11].

The South Atlantic has supported a large-scale pelagic fishery since the 1940s associated with the Benguela Current but is subject to interannual variations known as Benguela Niños. The fishery occasionally suffers marked declines in productivity and crashes in pilchard and anchovy stocks and these are linked to anomalous sea surface temperatures and often occur about a year after Pacific El Niños. Also, there is increasing evidence that sea surface temperature anomalies in this area are linked to 'red tide' events that are deleterious effects to the Namibian fisheries sector, including to stock recruitment [12]. The influence on fisheries of ENSO and similar regional scale ocean phenomena and changes to their frequency, extent and severity as global warming occurs, is a significant and growing cause for concern and is especially relevant to sustaining fishery-based livelihoods, crucial for many islands.

Insurance and Migration:

- Migration is an important coping strategy for small island societies;
- Climate change and extreme weather events may limit insurance opportunities and constrain development;
- Some projected changes (for example drought and salination) may provide pushes to migration by direct and indirect impacts on livelihoods;
- The implications of climate change for population movement are not understood.

Many small islands already suffer the costs of remoteness (for example, through high freight insurance). Insurance premiums are sensitive to the magnitude and frequency of hazards, including tropical storms. Insurance costs have increased significantly in the Caribbean during the last decade and some re-insurers temporarily withdrew from the market because of high claims related to natural disasters. Increasingly severe events would trigger increases in premiums or further withdrawal. Such actions would present a serious impediment to development planning and have significant consequences for livelihoods, directly through increased costs for individuals and businesses and indirectly by acting as disincentives to investment and trade. Strategies to moderate the effects of rising insurance costs due to climate change are urgently needed.

Many Caribbean and other island societies have traditionally depended on migration and remittances to enhance sustainability of local livelihoods. Migration and remittances add to the flexibility of livelihood options and returning migrants enrich the human, social and cultural capital of small islands, bringing with them links to trans-national networks. Natural disasters also act as a significant 'push' factor for migration. The possibility of increased reliance on migration and remittances as climates change and the risk of population instability, pose profound questions for the islands and the international community.

Infrastructure:

- Heavier rain and more intense storms will have significant impacts on island infrastructure;
- Governments need to factor in climate change projections when planning and controlling building and other development;
- Investment in physical infrastructure requires up-dated design criteria to account for new extremes;
- Increased investment in soft engineering practices and will be beneficial now and in the future.

Heavier rains and more intense tropical storms (with up to 20% higher wind speeds) are projected for this century. Resulting floods, landslides and high winds may be especially damaging to water systems, road, rail, power lines, housing and industrial plants. Damage to ports and harbours, caused by more intense storms or sea level rise could result in a few small islands being cut off completely. Thus, climate change has significant implications for the design and building costs of public and private structures. For example, in September 1989, Hurricane Hugo (when still young) damaged over 90% and destroyed 20% of houses in Montserrat before making landfall in northern Florida and South Carolina. Hugo was the strongest storm to hit Florida since 1954. The impact of Hurricane Mitch in late October 1998 on the coasts, and hinterland of Honduras, Nicaragua and Guatemala is well documented. This was perhaps the most devastating Atlantic storm of the 20^{th} century (and possibly the worst since 1780) and the strongest late-season event ever recorded. These are typical of strong 'today's climate' storms.

It is no surprise then, that when asked, stakeholders on many islands in the Wider Caribbean cite the hurricane season as the only time of the year when they are at all interested in the weather. Similarly, the risk of devastation from hurricane dominates many lives and livelihoods, risking their sustainability, and people are generally very concerned with these risks and few others, now or in the future. But if storm intensity goes up, an average storm will cause more damage to property and transport infrastructure, as well as to crops and livelihoods. Possible increases in storm intensity and rainfall should be factored into island planning by ensuring adequate precautions are taken to prevent landslides and severe slope erosion and beach erosion based on today's climate, and by designing to account for increased wind speeds and flood risk.

Legislative and planning systems should take climate change into account when applying development controls, especially near the coast. Controls will include regulating excavations and vegetation clearance (for example, of mangroves and sea grasses), designing appropriate coastal defences, and regulating deforestation and agricultural practices that encourage soil erosion and gullying.

Agriculture:

- A vital sector in many island states but in some (especially small ones) it involves small populations, can be very specialised or is less important;
- Impacts on island agriculture will be mainly through seasonal rainfall variation and coastal salinisation;
- Most local stakeholders didn't highlight impacts on agriculture as a major concern.

Many small island states do not rely heavily on agriculture and forestry, though most have small agriculture sectors and on some, forest resources are significant. Stakeholder responses from UK Overseas Territories tended not to highlight local concerns over the impact of climate change on agriculture. Exceptionally, the very survival of Pitcairn Island's small community relies on reliable rainfall, as was demonstrated when a lack of rain in the past led to wholesale emigration. Recent increases in run-off and soil loss have led to islanders' concern for the future [13].

Health:

- There may be some increased risk from vector-borne diseases and heat stress - currently, these are the only currently identifiable health risks;
- Other risks are most likely to be associated with water supply problems and increases in water-borne disease;
- More research is needed into the impacts of climate change on island health.

Human health consequences of climate change could be significant, affecting livelihoods; but possible futures are currently unclear. There is evidence that some insect-borne and water-borne diseases may become more prevalent as temperatures increase and rainfall patterns change. The incidence and range of dengue fever may increase, as may those of malaria and other mosquito-vectored disease, if thresholds of critical weather variables, temperature and rainfall, are breached more frequently in future. Other possible health impacts come from impaired water supplies. Further research into the risks to human and animal health of projected climate change in small island states is needed.

In summary, many small island states have un-diversified economies with limited human resources and are especially vulnerable to external shocks. They are amongst the most fragile economies of all developing countries. Also, remittances from family members in other countries are an important source of income in many island societies and migration in times of hardship is a traditional coping mechanism. These factors make small islands potentially especially vulnerable to risks associated with climate change and the smallest, such as the UK Overseas Territories, are especially at risk from climate-related disaster [3, 10]. This makes island societies important cases for understanding interlinked risk and vulnerability for today's livelihoods as a pre-requisite for future climate change.

Generally, the sectors most at risk are tourism and fisheries. Employment opportunities are often severely limited and concentrated on these sectors. Climate change will also impact on agriculture, infrastructure, insurance and migration, and health, which are major components of island community livelihoods. Livelihoods dependent on fisheries, tourism, agriculture and remittances are at risk from projected climate change and require planned adaptation to complement traditional and spontaneous coping mechanisms in order to sustain development for vulnerable communities.

6.4 Implications and Opportunities for Development

Starting from communities, livelihoods and vulnerability provides a clear choice to look for opportunities for development in societies often considered on the edge of disaster in today's climate. These opportunities include:

- Planning to adapt to projected climate change via assessment of livelihoods and vulnerability at community and national level to provide added value, enhancing the chance of sustaining development under today's conditions;
- Systems-oriented approaches, including, for example, integrated coastal zone management;
- Better local information about sustainable utilisation of natural resources;
- Facilitation of community participation and local ownership of local initiatives.

The key feature of small island livelihoods is not just that they rely more heavily on fragile natural resources than many societies but rather that they rely on a very limited set of natural resources in coastal and marine resource systems. A similar analysis could made, for example of the reliance of pastoral and rural farming communities in continental sub-Saharan Africa on highly variable seasonal rainfall. The same can be said using a similar vulnerability-based, community level start point [14, 15][5] and of course for many other vulnerable groups.

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[5] These contain several relevant papers on traditional coping strategies in drought prone African communities and on sustaining development of vulnerable societies.

The fact that small island communities often rely on a very limited set of natural resources affects the ability of residents and communities to withstand shocks and variability and compromises their ability to recover. The likely significant impacts of climate change require planned adaptation. Caribbean populations are vulnerable to extreme weather events at present and make adjustments to their livelihood strategies to cope with these threats. Planning for expected climate change and improving defences against future disasters would improve island-planning systems and thus add value to existing interventions and development efforts. A more systems-oriented approach is needed through integrated coastal zone management because natural resources and the environmental services they provide are intimately interconnected with island coastal ecosystems and social systems at local, national and regional scales.

There appears to be scant evidence of strong local understanding of links between environmental change and sustainable use of natural resources [10]. The complex relationships between environmental services and livelihoods on small islands are unclear and need further research. The ecological importance of small niche populations and the determinants of variability of natural populations of importance to island communities are not well enough understood to assess how they might be affected by climate change.

The St Helena Millennium Forest Project is a good example of a national scale attempt to raise awareness of the importance of biodiversity and conservation and aims to foster national pride in the island's endemic species. Other national and community natural resource management capacity needs strengthening, following the example of local collective action, based on traditional, informal social structures (for example in Western Samoa, Tobago, Honduras and coastal Vietnam – see Box 4 and references [16 – 23]). The need for more support is further justified by the growing importance of bio-diverse environments to tourism. Local benefits would accrue in today's climate by strengthening cost effective natural resource management at local level, engendering a significant increase in local, social participation in helping to alleviate a global problem [16 – 23]. This work could be undertaken in conjunction with regional associations and strengthened local NGOs.

The main message that comes from using small islands states as an example of ways of adapting to climate change impacts is that people are concerned with today and today's risks, extremes and disasters, only some of which are weather and climate-related hazards. By coping with today's shocks and sustaining livelihoods, communities will be better able to sustain development into an uncertain future.

6.5 Knowledge Gaps and Actions for Island Communities

I round off this analysis of climate impacts by considering where there are still significant gaps in local knowledge that might impede the development of adaptation strategies. Projected climate change poses a significant challenge to the livelihoods of billions of people across the world, not least in small island states. A stakeholder survey of UK Overseas Territories in 2001 showed that there was then little concern in those islands about the risks from and potential opportunities in adapting to climate change [3]. There was little evidence of any understanding of who might be 'winners' and who 'losers'. The scientific community expressed great concern over the threat of climate change but those polled did not stress the importance of adaptation.

Identifying knowledge gaps is a priority when considering climate change impacts, mitigation, adaptation and sustainable development, for all vulnerable communities and societies, not only for small island states. Listed below are the gaps we identified in 2001 for the UK Overseas Territories, which also apply to many other small island states. Some may apply in other societies as well.

Uncertainty, we identified some overarching issues and concerns that need research:

- Magnitudes of changes, particularly of extreme events and regionally in the Atlantic and Pacific;
- The relationship between ENSO and global warming;
- Methods for integrated and community-focussed planning for current and future weather extremes;
- The impacts of changing climate on critical natural resources and environmental services;
- The relationships between livelihoods and natural resources and consideration of alternative coping strategies;
- The possible winners and losers, as climate change affect small island societies.

Needs, we identified island-specific requirements:

- Some island societies still need basic information about possible regional climate change over coming decades and how these might impact on critical services and sectors (for example, St Helena's water supply);
- Many islands dependent on deep sea or inshore fishing need information about impacts on fish stocks and fisheries;
- Many island states need to understand better about climate-tourism relationships (Turks and Caicos and Anguilla in the 2001 sample);
- All Caribbean societies need better information about projected future storm climates and extremes because of the importance of storms to island disaster management and development;
- Many societies need to know more about the relationship between climate change, livelihoods and migration and remittance strategies.

Actions, we identified priority interventions for integrating climate change into planning, to:

- Fill gaps in knowledge of regional climate futures[6];
- Study the interaction between ENSO and global warming;
- Improve further the influence of current and future investment in regional and global initiatives and their national and local community level impact;
- Understand better the relationship between key environments and the livelihoods they serve, using a systems-oriented approach;
- Review weather-related design criteria for planned developments;
- Support public awareness and information campaigns through media and NGOs;
- Provide training at government and at community level on climate trends and uncertainties, to inform the development of appropriate adaptation strategies;
- Kick-start development of action plans to adapt to climate change, through targeted strengthening of ministries responsible for environment and planning;
- Provide community-focused interventions with the support of strengthened local NGOs, to facilitate local planning adaptation to climate change and informed by and building on traditional strategies for coping with weather-related disasters;
- Examine how the resilience of current livelihood strategies can be strengthened and diversified to enhance sustainability in the light of current extreme weather and climate and projected changes;
- Facilitate improved regional awareness, informal institutional arrangements and information exchange for regional, national and local decision-support;
- Develop strategies to moderate the effects of rising insurance costs in increasingly risky environments.

These proposed actions are certainly not island specific, or even relevant only to small island states. They may be transferable to any and all developing countries and transitional economies. Indeed, they are necessary actions in all societies worldwide at risk from climate-related hazards and that seek to manage occasional natural disasters and sustain development into the future.

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[6] The term ‘climate futures’ represents the set of scenarios generated by the climate science community and characterising likely global, regional and local climates as they change through the 21st century.

7 *The International Context and Developing Country Obligations*

7.1 Working Together

Whatever actions are advisable to adapt to and sustain development in the light of projected climate change; there are certain political realities that developing countries must take into account.

With respect to the third question posed for this summer school, it is clear that for most communities, it is today's issues, concerns and risks that dominate and only when climate change related 'forecasts' can be seen in the context of today's risks and traditional coping strategies will it be possible to factor them in to national and local development planning.

With respect to the last question concerning solutions, the livelihood vulnerability-based model I presented earlier can effectively address local solutions, but co-operation between North and South can be built effectively only if each party understands their own local needs. There are several ways that developing countries can get more involved.

7.2 The Clean Development Mechanism

The overall *Kyoto Protocol* target for Annex 1 (industrialised) countries is to reduce emissions by 5.2% percent below 1990 levels by between 2008 and 2012. The Clean Development Mechanism (CDM) [Article 12 of the Kyoto Protocol] was devised to help Annex 1 countries achieve this goal of reducing their emissions and it involves developing countries. Its principles are that:

- Climate change mitigation activities are equally effective no matter where in the world they are occur;
- Mitigation activities may be less expensive in some developing countries than in Annex 1 countries.

The CDM allows for Annex 1 countries establishing mitigation activities in non-Annex 1 countries and then claim credit by way of emissions reductions, towards meeting their targets. Non-Annex 1 countries gain inward investment towards sustainable development.

7.3 Adaptation strategies

In 1992, the United Nations Framework Convention on Climate Change (UNFCCC) promised assistance to countries vulnerable to climate change to help them adapt:

> "The developed country Parties and other developed Parties included in Annex II shall also assist the developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation to those adverse effects."

Of course this commitment presupposes that vulnerability to climate change can be measured or at least that 'vulnerable countries' can be identified or singled out from others. As is now clear, vulnerability is complex, is not synonymous with risk and often operates at community or household level, being dependent on livelihood strategies. Thus communities in all countries can be shown to be vulnerable, though some countries (generally the poorest) clearly can have higher proportions of their populations vulnerable to climate-related extremes and climate change than do others.

It is possible, however to make crude comparisons. For example, Uganda and Zimbabwe are both poor countries and setting aside governance, both would be expected to have similar levels of vulnerability. Intuitively, however, Zimbabwe is the more vulnerable overall (with a higher proportion of its people at risk from and vulnerable to severe climate hazard (drought) than has Uganda - not as prone to drought, situated in a more 'forgiving' climate zone, etc.

7.4 Developing Country Obligations

Under Article 12 of the UNFCCC, Parties must submit National Communications containing a national inventory of anthropogenic emissions of greenhouse gases, a description of steps taken or envisaged to implement the Convention, and other information relevant to the UNFCCC objectives. Developing countries can propose projects for financing, including specific technologies, materials, equipment, techniques and practices needed to implement appropriate projects. By mid-2002 around 35 Annex 1 countries had submitted National Communications as had over 50 Non-Annex 1 (developing) Countries.

7.5 Priorities for Developing Countries

To conclude, I briefly outline just two priorities for developing countries, to enable them to overcome obstacles to take equal part in international co-operation for better understanding, decision-making and promotion of climate change issues as a component of sustainable development.

Capacity Building:
Developing countries need to develop the expertise to initiate and manage adaptation programmes. This requires a significant building of capacity in the South. As we have seen, there is still a lack of awareness of climate change issues and local expertise and technology is often minimal. Unless capacity can be developed locally, the developing world will continue to rely heavily on the North for expertise to help it adapt to climate change and build a sustainable future.

Resilience:

Many communities in many developing countries are seen to be especially susceptible and vulnerable to potential damage from projected climate change, primarily because of existing conditions and poverty. Much of sub-Saharan Africa and southern Asia appear to be particularly vulnerable. The need now is to build livelihood resilience to overcome today's shocks, whilst anticipating perhaps more extreme shocks to come. Critically this requires an emphasis on adaptation strategies, which need minimal external inputs (i.e. emphasising self-help). However, until more communities, societies and nations of the South recognise that things are likely to get worse because of climate change and that dealing with today's climate and weather-related risks is the first step towards coping with the future, little real progress will be made.

In conclusion, all countries, especially those in the developing world, should appreciate that climate change is not just an environmental problem but also a global development issue of the utmost importance.

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9 Boxes

Box 1

Impacts of The 1997-1998 El Niño

Latin America

In Peru and northern Chile, close the El Niño source region, there was excessive rain, with storms and mudslides, leading to exacerbated pest attacks on crops, harvests failing, roads being washed away, canals and drainage systems silting up, fishery catches being reduced and an increasingly difficult credit situation for small farmers. One Peruvian farmer is quoted as saying "I'm waiting for the earth to open up and swallow Peru. It's the only thing that hasn't happened yet this year." Farther north, Guatemala had drought and some of the worst fires in living memory and a state of emergency was issued. Parts of Brazil, Argentina, Paraguay and Uruguay had abnormal rains and flooding, though generally this was not as bad as in the 1982-1983 event.

South Asia

Across the Pacific in New Guinea the 1997-1998 El Niño event brought drought, an economic slump, currency devaluation and the country received food donations from Australia and New Zealand. In Australia itself the event brought drought and wild fire, with poor revenues for sheep and cattle stations. Infamously, in Indonesia drought was severe and fires spread plumes of smoke over huge portions of that country and its neighbours. Food shortages, economic crisis and political instability followed - 860 people died through famine and 159 were killed in ethnic unrest. The UN World Food Programme launched an appeal for emergency aid and delivered $88 million to cover the food shortages and prevent a major food crisis in the country. In the Philippines this famous El Niño brought drought and some food shortages and about one million people were at risk as rice and cereal crops withered. Parts of Viet Nam also experienced drought with some provinces having a 70% loss of cash crops. In Viet Nam 1998 was seen as a year of natural disaster and disease – at least 600 died and 4 million people were affected. And this followed closely on the November 1997 typhoon that killed 778 people and badly affected ½ million.

Northeast Asia

Parts of China had drought and a reduced cereal harvest. Dramatically, in North Korea drought followed two years of heavy rains and resulted in desperate food shortages across the country, which continued until recently and may well have precipitated a significant political dynamic with increased political contact with South Korea.

North America and Eurasia

During the 1997-1998 winter much of North America, Europe and north east Asia had warmer and wetter conditions than usual and as usual in warm phase ENSO events, California had excessive rainfall and in the High Sierras, snowfall, storms, floods, mudslides, extreme seas, flood and coastal erosion.

…. Continued .

Box 1 continued

Africa

Even before the southern African rainy season began, most scientists and the media were forecasting possible disaster as the strongest El Niño of the 20^{th} century was expected to generate severe drought with the usual consequences of water shortage, failed harvests, poor food security and famine, relief provision and the risk of a dependence culture, refugees and migration, failure of energy supply and industrial production, economic disruption, and possible political instability and civil disturbance. But it didn't happen. Most of southern Africa had good or more than normal rainfall with only parts of Namibia and small areas of Zimbabwe and northern South Africa having poor rains and poor livestock production. Farther north, however, El Niño brought heavy rains to Kenya with flooding affecting 20,000 people in the north of the country in November 1997 (and an outbreak of Rift Valley Fever). In early 1998 in Kenya, floods and ethnic violence killed 200.

Overall and not surprisingly the worst food shortages associated with the strongest El Niño of the 20^{th} century were in Africa but not in the south as predicted. In the Sudan political instability and war plus a drought brought poor food security, with 350,000 persons displaced or in dire need of famine relief, including food, seed grain and tools for planting. In Somalia, as in Ethiopia and Kenya severe flooding followed excessive rainfall with poor harvests, which set back attempts to improve national food security.

Box 2

Projected Climate Change Impacts by Region

Africa

Forecast 21st century climate changes are expected to have significant and generally detrimental impacts in Africa, most notably:

- On water resources: especially in international shared basins where there is a potential for conflict - reinforcing the need for regional coordination in managing shared resources;
- On food security: at risk from reduced agricultural production caused by an increased risk of drought in many parts of the continent;
- As a threat to environmental services and biodiversity;
- Risking increase in vector- and water-borne diseases, especially amongst vulnerable populations with poor health infrastructure;
- As a threat to coastal populations at risk from sea-level rise and vulnerable to the consequences of extreme storms;
- On semi-arid environments and pastoral societies – possibly increasing desertification.

Southern Asia

In southern Asia the following primary issues and threats have been noted:

- Possible changes in rainfall and evapotranspiration, affecting the distribution and health of rainforests and drier monsoon forest and reducing the viability of wetlands;
- Sea-level rise and sea surface temperature increases will generate stresses on coastal ecosystems (for example coral reef systems, sea grasses, tidal wetlands and mangroves) and affect human coastal populations;
- Higher evaporation (coming with global warming) and decreases in soil moisture may increase soil degradation and affect cropping patterns;
- Increased flooding and monsoon rainfall may increase the incidence of water-borne diseases and the incidence of some vector-borne diseases, whilst higher temperatures could increase heat-related deaths;
- Water stress in arid and semi-arid areas may be exacerbated by higher temperatures and increased evapotranspiration but water resources in some areas (for example Bangladesh) may increase with increases in monsoon rainfall;
- Coastal areas are under threat from sea level rise which might result in the displacement of people and disruption of coastal economies;
- Climate change is likely to increase the frequency and intensity of extreme events, such as floods, droughts and tropical cyclones.

… Continued

Box 2 continued (2)

North and Central Asia

Similar threats have been identified farther north in Asia:

- Tropical cyclones could become more intense and combined with sea-level rise, this would bring enhanced risk to life and livelihood in low-lying coastal areas in cyclone-prone regions;
- Increasing intensity of rainfall, especially during the summer monsoon could increase the area prone to flooding and yet there is potential for drier conditions in arid and semi-arid Asia during summer leading to more severe droughts;
- Freshwater availability may be at risk from anticipated climate change;
- Crop production and aquaculture would be threatened by thermal and water stresses, sea-level rise, increased flooding and more intense tropical cyclones;
- Warmer and wetter conditions would increase the potential for heat-related and infectious diseases;
- Climate change could exacerbate threats to biodiversity resulting from land-use cover change and population pressure;
- Farther north, warmer conditions risk permafrost degradation, affecting many sectors and economies in boreal Asia;
- Surface runoff increases during spring and summer periods would be pronounced in boreal Asia;
- The frequency of forest fires is expected to increase in boreal Asia as summers may be warmer and drier than today.

Latin America

- Stronger ENSOs could cause more frequent flooding and drought in some areas;
- Warming in the Andes would reduce snow and ice cover and affect tourism;
- Climate change could exacerbate threats to biodiversity;
- Sea level rise and flooding could affect water availability and agricultural production;
- Subsistence farming and forestry could be threatened in some parts of Latin America;
- Projected changes in climate would increase the impacts of already serious chronic malnutrition and diseases affecting large populations;
- Vector-borne diseases would spread to higher elevations and higher urban temperatures and pollution levels could deleteriously affect city populations;
- Many island communities are at risk from climate extremes such as tropical storms and many are especially vulnerable. Projected increases in storm intensities will put significant extra burden on them.

... Continued

Box 2 continued (3)

Small Island States

Island economies are often vulnerable economies even in today's climate, projected climate changes could have devastating effects (Sear *et al.*, 2001). The IPCC process found that:

- Sea level rise will have serious consequences for the sustainable social and economic development of many small island states
- Climate change will increase the stresses already on coastal zones beaches because of shoreline development and tourism, reducing natural resilience and increasing adaptation costs
- Inshore protective ecosystems, including coral reefs and mangroves may become less sustainable and further degrade in many areas and reef fish populations will also be at risk
- Climate change and sea-level rise could cause land loss and soil salination and threaten the sustainability of subsistence and commercial agriculture
- Many island communities are at risk from climate extremes such as tropical storms and many are especially vulnerable. Projected increases in storm intensities will put significant extra burden on them.

In other regions the following impacts have been identified:

In **Polar Regions** reductions in sea ice and ice extents and degradation of permafrost will accompany global warming. As yet unclear changes in Arctic ecosystems will occur and the impacts of these on animal and human populations are uncertain but surely will affect traditional livelihoods based on hunting. The massively important Antarctic Ocean ecosystems will be significantly affected by global warming, again as yet with recondite results.

Australia and New Zealand are expected to experience increased evaporation and possible decreases of rainfall in many areas, adversely affecting water supply, agriculture and ranching. Threatened ecosystems again include coral reef systems and freshwater wetlands and increases in tropical cyclone intensity and sea level rise risk increased storm and flooding hazard. Drought and fire – ever-present facets of the Australian experience - may become even more serious during the next century.

In **Europe**, existing stresses in water resources are likely to be exacerbated by projected reductions in summer rainfall and increased rainfall and flooding in winter. A range of risks has been postulated for human health through increased exposure to heat waves, some vector-borne diseases and coastal and river flooding. The implications for planning (for example for housing, industry and natural resource management) are already emerging as key issue in Europe, following recent severe flooding events and heat waves.

In **North America**, possible changes in the frequency and intensity heavy precipitation events will impact on land-use and infrastructure. Forestry is likely to be significantly affected by increased fire risk and pest outbreaks. Valuable coastal real estate is a high risk from fiercer storms and sea level rise over the next decades. Food production is predicted to benefit from a warmer climate but projected changes are expected to have negative effects on health by increasing deaths and illness related to heat waves. Asthma cases related to thunderstorms; injuries and infectious diseases related to extreme events and increases in vector- and water-borne diseases are also likely, as are more respiratory trouble caused by air pollution.

Box 3

Projected Climate Change Impacts by Selected Sector

Water Resources

- Projected changes will challenge water resources management policies by adding additional uncertainty - adaptive capacity is distributed unevenly across the globe
- Widespread accelerated glacial retreat and maximum river flow moving from spring to winter in many temperate and polar areas
- Increased seasonality of river flow and groundwater recharge
- Water quality may be degraded by higher water temperatures and further by lower river flows in some areas but in other areas higher river flows may improve quality
- Flood severity and frequency are likely to increase in most regions and low flows are likely to decrease in many regions except in hotter, drier summer seasons
- Demand for water is generally increasing and meeting that demand may be increasingly difficult as the century proceeds, especially where there is potential for conflict and regional coordination in managing shared resources is needed
- Unmanaged systems are likely to be most vulnerable to climate change.

Agriculture and Food Security

- Higher CO_2 levels have been shown experimentally to enhance crop growth as temperatures rise but not unequivocally and especially not when growing conditions are sub-optimal – more research is needed on this issue
- Projected lower soil moisture in summer in many regions would have detrimental effects on crop production in key areas
- Less reliable water supply and increasing risk of drought would have significant and probably detrimental impacts on the viability of pastoralist societies in several regions
- Soil erosion and degradation are likely to be more common as global warming proceeds, reducing yields.

Forestry

- Industrial timber harvests are predicted to increase by over 1% each year as warming proceeds and CO_2 levels continue to increase
- The area of industrial timber plantations is likely to expand and management in second-growth forests (especially in temperate zones) is likely to be geared to local, temporary and / or long term CO_2 sequestration, though much research on the science of carbon budgets
- The largest and earliest impacts induced by climate change are likely to occur in boreal forests, where weather (length of the summer growing season) and nutrient cycling tend to control growth rates productivity.

… Continued

Box 3 continued

Health

- An increase in the frequency or intensity of heat waves would increase the risk of mortality and morbidity
- Increases in climatic extremes (storms, floods, cyclones, etc.) would cause damage to natural and man-made environments and infrastructure, food producing systems, freshwater availability and quality; would cause population displacement and migration; and would increase the risk of infectious disease epidemics, especially in developing countries
- Warming will cause some air quality to become poorer, especially in large cities unless industrial and vehicular emissions can be curtailed
- The ranges of several key vector-borne diseases are expected to increase significantly (for example, malaria, Rift Valley Fever, Australian encephalitis and dengue fever – all transmitted by mosquitoes).

Box 4

Examples of Local Adaptations to Climate Risk on Small Islands

Western Samoa

The agricultural economy of Western Samoa is dependent on cash crops such as pineapple anc coconuts. These crops are susceptible to extreme weather events. Consideration has been made o local coping strategies and post-disaster recovery after a major tropical storm hit the island [16, 17] Despite a long-term decline in the cultivation of some storm resistant crops and ‘famine food crops’ non-monetary informal arrangements for social security persist in Western Samoa and the mora economy seems to be resilient to increased state and market involvement [16]. In this example, botl reciprocal collective action and migrant remittances enabled recovery and facilitated reconstruction.

Tobago

Large-scale tourism often brings fewer benefits to local employment and income than locally owned and controlled development. Local partnerships for capturing the benefits of tourism are an important element to the sustainable management of coastal and marine resources in Caribbean islands such as Tobago [18] where local community stakeholders are heavily involved in managing multiple use, complex systems as the Buccoo Reef Marine Park protected area, in view of the need for income generating tourism development and complementary environmental management.

Honduras

Reference [19] provides a useful example of successful community-based conservation efforts ir Honduras. In an effort to accommodate a surge in nature tourism and *un-supported by governmen* local communities there created and managed marine protected areas.

St Helena

The St Helena Millennium Forest Project is an excellent example of successful local and national scal conservation, based on attempts to raise awareness of the importance of biodiversity anc conservation. It aims to foster national pride in the island’s endemic species [20, 21]. Again, tourisn would be first sector affected and the most seriously so. This conclusion stems from an appreciation o the increasing importance of ‘eco-tourism’ to tourism industries world-wide and the growing publi perception that in a world of dwindling natural resources, bio-diverse natural environments are ‘mus visit before it’s too late’ places. These are powerful incentives in conjunction with the ‘paradise requirement of modern eco-tourists.

Viet Nam

References [22] and [23] discuss coping strategies to extreme weather events in the context o sustainable development in coastal Viet Nam, making a strong economic case for a precautionar approach to climate impact mitigation through actions to rehabilitate the local coastal ‘soft’ defences o mangrove ecosystems. This may be an optimal strategy in the face of uncertain changes and th increasing build and maintenance costs of ‘hard’ protection measures (such as sea walls and dikes that are already difficult to justify. The aim is to generate a ‘win-win’ benefit in “improving the livelihood of local resources users as well as enhancing sea defences.” [22].

CLIMATE CHANGE:
MODELS, SCENARIOS AND OBSERVATIONS

Ulrich Cubasch
Meteorologisches Institut der Freien Universität Berlin
Carl-Heinrich-Becker-Weg 6-10
12165 Berlin
Germany
E-Mail: cubasch@zedat.fu-berlin.de

1 The Climate System

Climate models simulate Earth's climate system with physically based mathematical equations, which are solved numerically in a supercomputer. These equations reflect the interaction of the different components of the climate system and their internal variability.

The computer calculates from these equations the climate for a region or the globe, i.e. the characteristic distribution of the mean state and extremes of the weather.

The main component of the climate system is the atmosphere. It interacts with the oceans (hydrosphere), the ice and snow cover (cryosphere), vegetation (biosphere), the land surfaces (pedosphere) as well as the lithosphere (figure 1).

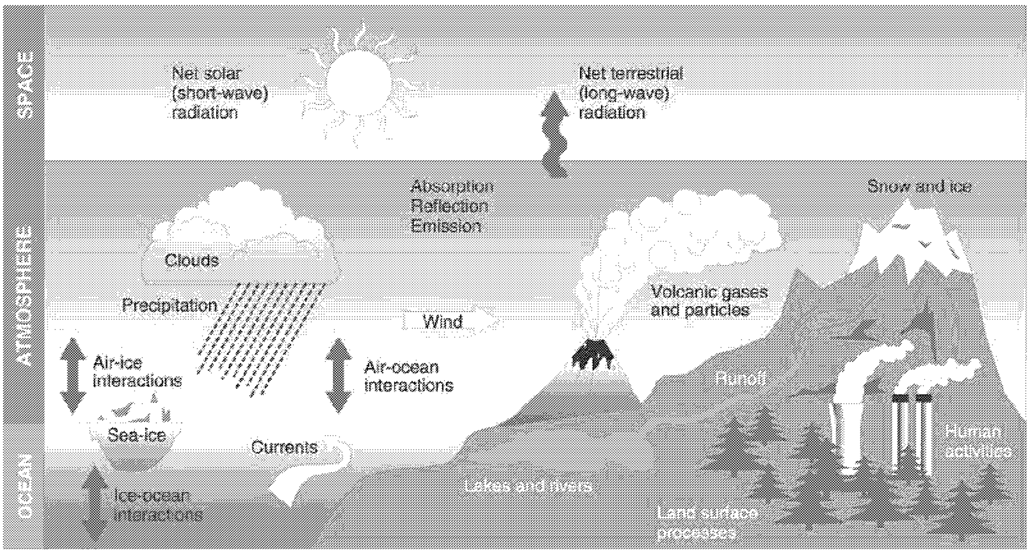

Figure 1: The climate system and its components [1].

The different climate sub-systems fluctuate at different time-scales. These different time-scales determine the time-dependent behaviour and represent therefore the dynamics of the climate system. Fluctuations in the climate system component atmosphere, commonly called “weather”, vary at timescales from hours to days, deep sea currents and ice shields vary in time scales from centuries to millennia. In the climate system small internal variations can be amplified by non-linear processes and can potentially have large impacts. Additionally, external forcings have to be considered like changes in the insolation. These might be caused by changes of the orbit of the earth around the sun. Also the solar radiation, which drives the whole climate system, is not constant with time, but undergoes periodic variations. Volcanism is also considered as an internal forcing. Mankind influences the climate system via the emission of greenhouse gases, pollutants and land use.

State-of-the-art climate models consist of comprehensive models for the climate sub-systems atmosphere and ocean, while the other climate sub-systems are represented only in a simplified form. The equations of the complex model are solved in the computer on grid-cells with a resolution of typically 250 to 500 km, and 9 to 20 levels in the vertical. Physical and chemical processes, which are smaller than a grid cell (for example clouds and convection), are not explicitly calculated, but parameterised, i. e. they are derived via statistical-dynamical relationships from the values available at the corner of each grid cell.

The current climate models have been developed from weather forecasting models. This has the advantage that they have been operationally tested. The climate models are calibrated by calculating the climate of the recent decades and by comparing the simulations with observations

2 Simulating historic Climates

Over the recent years the computing power has increased so substantially that models can be employed for simulations of the climate during the last centuries. It is therefore possible to validate the models with historic climate events.

In a study recently carried out by the Max Planck Institute for Meteorology in Hamburg and the GKSS Research Centre in Geesthacht the last 450 years have been calculated. At the beginning of this simulation period man’s influence is considered to be negligible. As external forcing the solar variability, volcanism and greenhouse gases (at the beginning of the simulation mainly from natural sources) are prescribed.

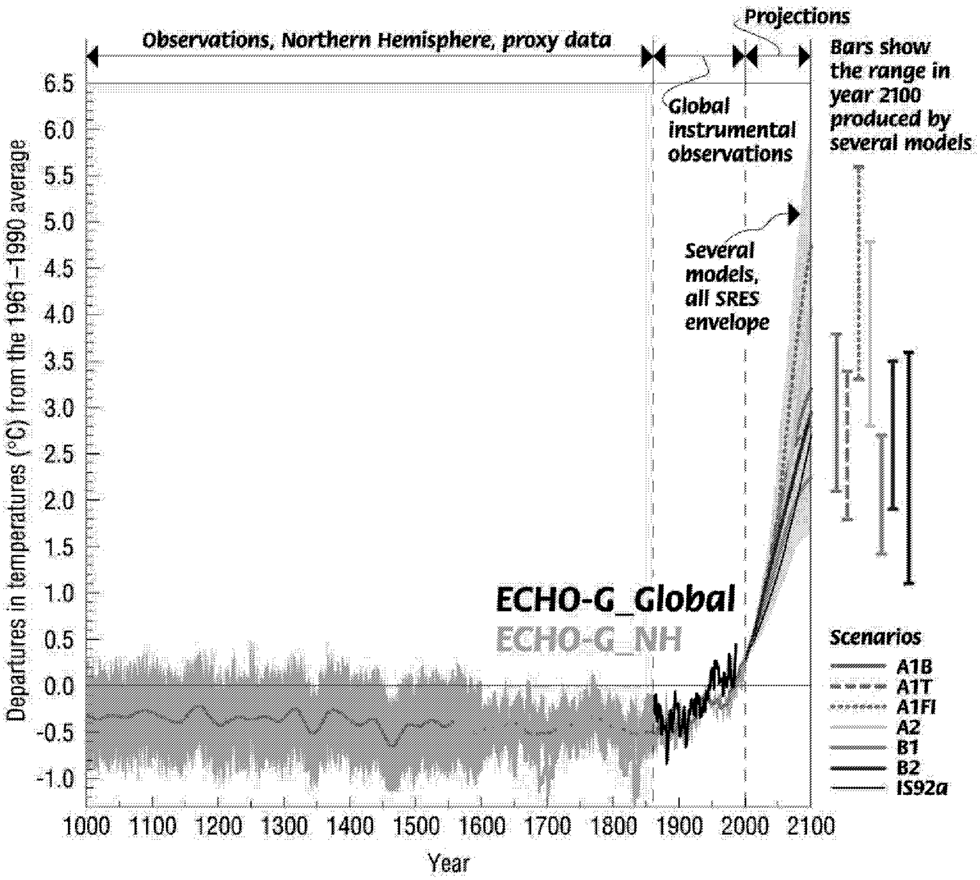

Figure 2: The evolution of the mean temperature from the year 1000 to the year 2100 with the year 1990 as reference.

From the year 1000 to 1990 only the Northern hemisphere has been averaged due to a lack of data on the Southern hemisphere. During this time the data have been reconstructed from tree ring data, bore hole temperatures, corals and ice cores. After 1860, instrumental data have been used. The line which begins at the point of 0.3 in the year 1000 and is continued until the prognosis for 2100 shows the 50 years average, the grey band below and above of this line indicates the 95 % confidence interval. From the year 1990 to 2100 the temperature projections for the scenarios are shown. The band “several models, all SRES envelope” indicates the uncertainty in the projections if all models and all scenarios are taken into account. Additionally, the simulation of the last 450 years can be found in this diagram (ECHO-G). One can clearly identify the “Late Maunder Minimum” (ca. 1675-1715) as well as the “Dalton Minimum” (ca. 1810-1830) [2].

The amount and temporal evolution of these forcing agents are derived from proxy data, since they could not directly be measured in those days. Proxy data like tree ring densities and width, sediment records as well as a multitude of written reports (for example repair cost of dikes, harvest yields, travelling time of sailing ships) the climate of the past can be reconstructed. The numerical experiment simulates the historic climate data (figure 2). Particularly the “Late Maunder Minimum” is a dominant feature during the late 17th century, which is simulated realistically.

The climate calculation clearly indicates that during the Late Maunder Minimum (ca. 1675-1715), at which time no sunspots had been observed and the solar activity was at a minimum, was a period with colder climate conditions than today. This cold spell has been documented in a number of historic records and is reflected in the increased number of snowy and icy landscapes in contemporary Dutch paintings. A comparison between modelled and reconstructed climate shows a good agreement for central Europe (figure 3), while one can detect a number of differences in Northern Europe. These differences might also be caused by the poor proxy-data basis for these regions. The simulation clearly shows that the interaction between reduced solar radiation and volcanism on the one hand and the atmosphere-ocean-ice coupling on the other hand leads to cold conditions over Europe and North America.

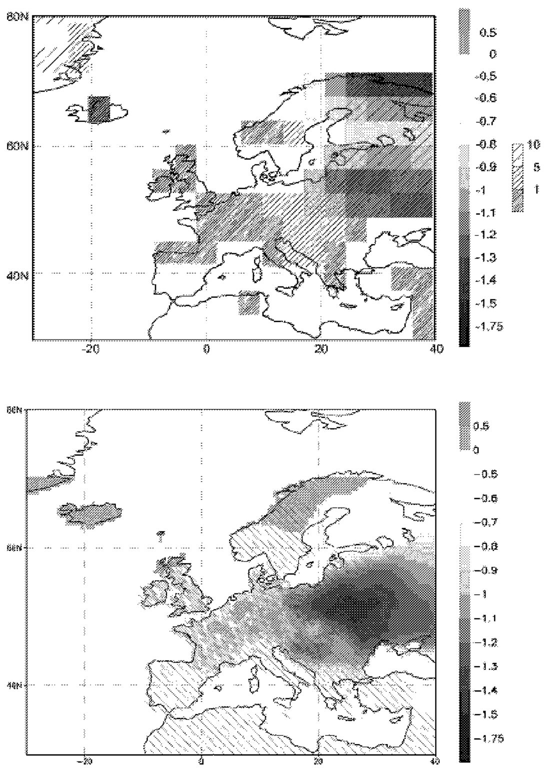

Figure 3: The temperature anomaly during the “Late Maunder Minimum” (ca. 1675-1715). Top: model simulation, bottom: reconstruction from historic documents. The hatching is an indicator of the statistical significance. The denser the hatching, the higher the significance [3].

3 The Climate at the Time of Industrialization

A question frequently raised is to what extend solar variability and volcanism are the cause of the observed climate change during the last 150 years, or if mankind has been the cause by the emission of greenhouse gases. Climate models can help to answer this question.

A suite of experiments has been carried out to investigate this issue: In a first experiment the model was driven only by natural forcings (solar, volcanism), in a second by only the anthropogenic effects, and in a third the natural as well as anthropogenic effects have been included. As can be seen in figure 4, both, natural and anthropogenic forcings have to be taken into account to obtain an optimal match between observations and simulations.

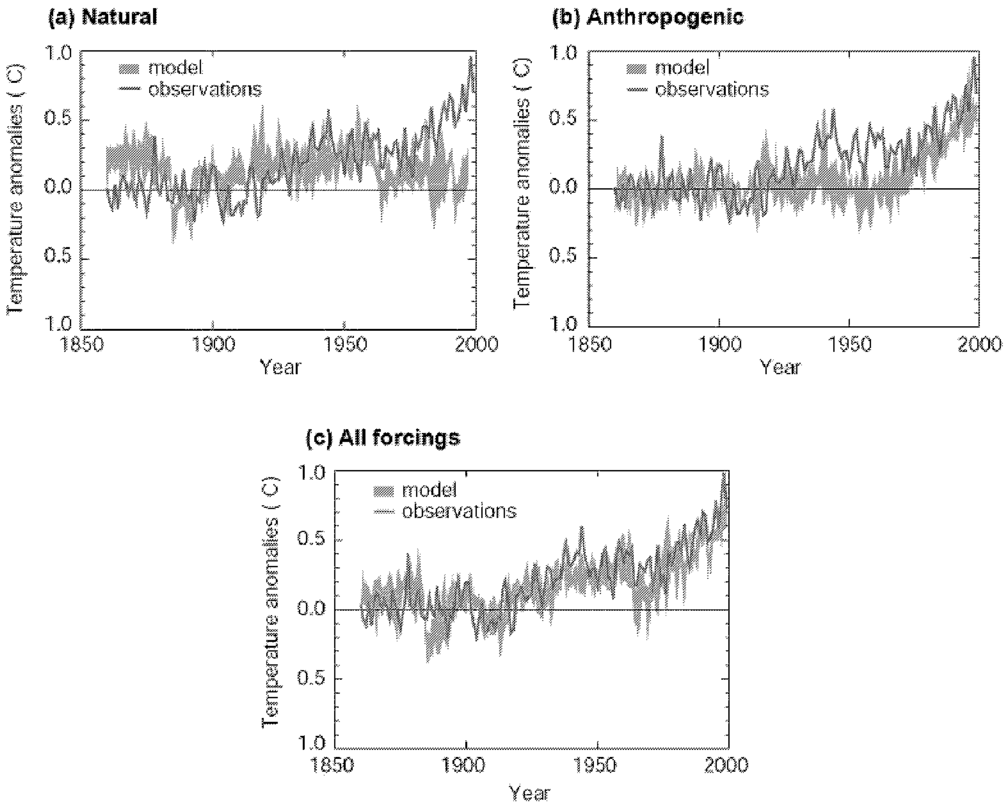

Figure 4: Climate models are used to identify the causes of the temperature change. a) Only natural (solar, volcanic) forcings have been used to drive the model, in b) only anthropogenic forcings, and in c) a combination of a) and b). The grey bands show the model simulations with its uncertainties, the red curve the observations. The observations are matched optimally when both types of forcing are considered [4].

4 The Climate of the Future

4.1 Scenarios

To obtain a realistic estimate of the possible climate evolution in future, one has not only to know the internal dynamics of the climate system, but also the future development of the forcings. To estimate the human induced forcing, so called scenarios have been developed, which are based on different plausible pathways for the future development of population growths, income, standard of living, energy consumption and energy sources. These scenarios correspond to different emissions of greenhouse gases (CO_2, CH_3, O_3, N_2O, NO_x, CFC's) and their concentration in the atmosphere.

These scenarios have been compiled by a group of experts of the International Panel on Climate Change (IPCC), which published 35 Emissions-scenarios based on different story lines, which are called „SRES-Scenarios". These scenarios can be categorized into four groups (figure 5) and are represented by four "marker" scenarios.

The A1 *scenarios* describe a world with a large economic growth. World population will have peaked by the middle of this century and gradually declined thereafter. New and efficient technologies will be introduced world wide, regional differences in income and living standard will even out. This group can be differentiated into three sub-groups according which technology is used to provide the energy: A1-FI places the main emphasis on fossil fuel, A1-T on non-fossil fuel, and A1-B on a mixture of different energy sources.

The *A2-scenarios* describe a heterogeneous world. The main assumption is regional independence and the continuation of regional differences. World population increases steadily during the next 100 years. The economical development, the living standard and the incomes are regionally quite different, and technological progress is proceeding only slowly.

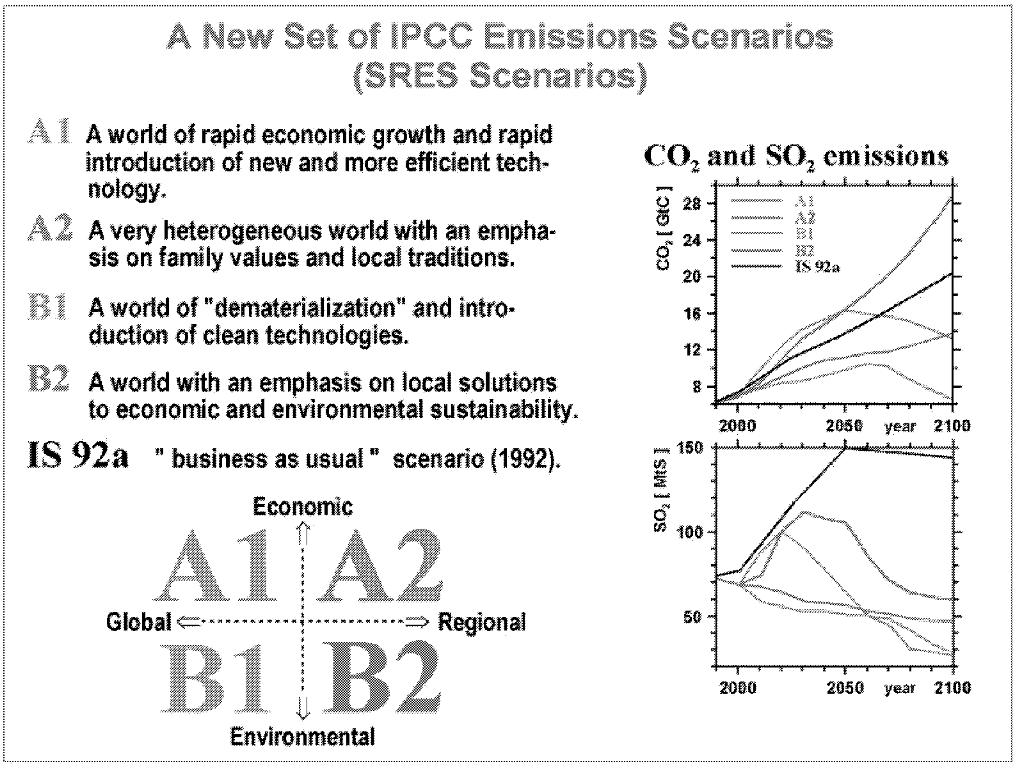

Figure 5: The four "marker" scenarios together with the older "business as usual" scenario IS92.

The *B1-scenarios* assume, similar to the A1-scenarios, a world population, which stabilizes during the next century. The economical development proceeds into the direction of a service oriented society with a reduced usage of natural resources and the introduction of clean and efficient technologies. The main emphasis lies on global and sustainable solutions.

The *B2-scenarios* anticipate a development, in which regionally different sustainable solutions of economical, ecological and social problems are found. World's population rises uncurbed, but slower than in the A2 scenario. The economical development is slower than in the other scenarios. As economical issues become less important, more diverse technological development emerges. The main emphasis is placed on environmental conservation and social justice, but on a regional scale.

4.2 Climate Projections

Based on the scenarios it is estimated that the global mean near-surface temperature will rise by 1,4 to 5,8 ^{0} C by the year 2100. This result is the summary of all 35 SRES scenarios and is based on several climate models (figure 2). The uncertainty in the temperature prognosis is caused by the uncertainty in the SRES-scenarios and by the uncertainties in the model prognosis.

The expected warming is larger than what has been observed during the 20th century and might be the highest during the last 10 000 years. The global water vapour concentration will increase; in the second half of this century also the precipitation in the middle and high latitudes of the Northern hemisphere. Here on has to expect also the largest fluctuations in the precipitation.

The snow and ice-coverage will decrease in the Northern hemisphere; glaciers and ice caps will vanish. The South polar ice shield will gain in mass due to higher precipitation, while the Greenland ice shield will decrease, because the increased precipitation does not compensate the accelerated ice-melt caused by the global warming. The sea level will rise during the next 100 years by about 10 to 88 cm mainly by thermal expansion and melt water from the glaciers.

Table 1 shows, which extreme events will be altered in future and for which quantities already now such a change can be identified. Many small-scale weather phenomena like tornadoes or thunderstorms cannot be resolved due to the coarse resolution of current climate models.

Confidence in observed changes (latter half of the 20th century)	Changes in Phenomenon	Confidence in projected changes (during the 21st century)
Likely	**Higher maximum temperatures and more hot days over nearly all land areas**	Very likely
Very likely	**Higher minimum temperatures, fewer cold days and frost days over nearly all land areas**	Very likely
Very likely	**Reduced diurnal temperature range over most land areas**	Very likely
Likely, over many areas	**Increase of heat index (Footnote 12) over land areas**	Very likely, over many areas
Likely, over many Northern Hemisphere mid- to high-latitude land areas	**More intense precipitation events***	Very likely, over many areas
Likely, in a few areas	**Increased summer continental drying and associated risk of drought**	Likely, over most mid-latitude continental interiors. (Lack of consistent projections in other areas)
Not observed in the few analyses available	**Increase in tropical cyclone peak wind intensities****	Likely, over some areas
Insufficient data for assessment	**Increase in tropical cyclone mean and peak precipitation intensities****	Likely, over some areas

Table 1: Estimates of confidence in observed and projected changes in extreme weather and climate events [4]. (: For other areas, there are either insufficient data or conflicting analyses; **: past and future changes in tropical cyclone location and frequency are uncertain)*

4.3 Future Developments in Climate Modelling

Present day climate models represent only a small part of the complete climate system, since they are calculating mainly atmospheric and oceanic dynamics. They have to be extended by the simulation of bio-geochemical cycles, the biosphere, and the chemistry and have to be extended into the higher atmosphere. The ultimate goal is the development of a comprehensive earth system model (figure 6).

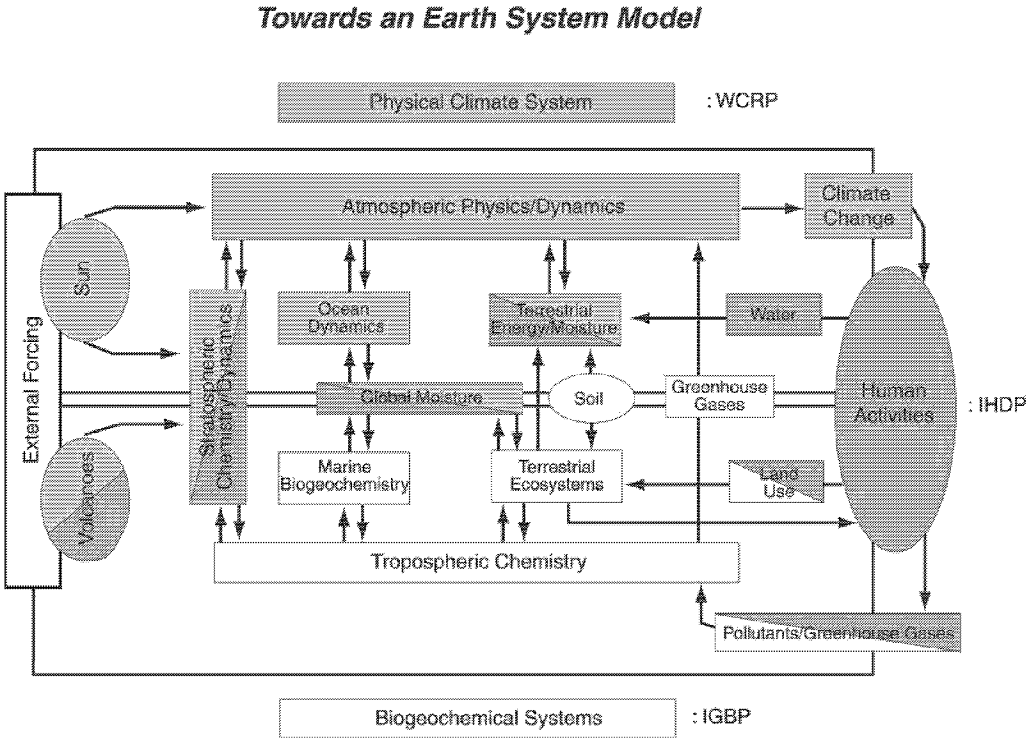

Figure 6: Schematic diagram of the "Earth-system" model and its components. Ideally a climate model should represent all these components.

In order to perform ideal model experiments, climate models have to be run several times to increase their statistical significance – similar, as multiple measurements are carried out in a laboratory. The extreme amount of computing resources needed for such experiment is currently only available in Japan, where an „Earth Simulator" has been set up, which at present is the most powerful computing facility for geosciences research applications.

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Policy of Climate Change

THE POLITICAL CONTEXT OF CLIMATE CHANGE: HISTORY & STATE OF NEGOTIATIONS

Karsten Sach, Enno Harders
Division of International Cooperation, Global Conventions,
International Climate Change
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
11055 Berlin
Germany
E-mail: Karsten.Sach@bmu.bund.de; Enno.Harders@bmu.bund.de

1 Introduction

Two years ago, the Secretary-General of the United Nations, Kofi Annan also had the pleasure to address students on the topic of climate change. Although the students' backgrounds might have been different from yours, it still holds true – or proves even truer today - what he alerted his audience of:

> "Time was once on our side in undertaking major environmental policy initiatives. Today, though we have the human and material resources to win the fight against climate change, the time for a well-planned transition to sustainable development is running out – unless, that is, you do your part."[1]

I am well aware of the fact, that many of you are already doing their part. Unfortunately though, there still lie important tasks to be completed ahead of us. The most pressing for the moment is the entry into force of the Kyoto Protocol. But before looking into the future, let me give you a brief account of the history of the international negotiations on climate change, which is the first part of the topic about which I have the privilege to talk to you who have come from all regions of the world.

2 History of the Negotiations

2.1 The Birth of the Regime and the first Experiences

Why it was more than vital to initiate negotiations on an international regime on climate change I do not need to tell you. Today you have listened to my distinguished fellow speakers on the scientific basis and the impacts of climate change. Therefore I will confine myself in this lecture to the political dimensions as the title indicates. Apart from theoretical knowledge I will hopefully be able to add some practical experience with the negotiating process, since I have been head of the German delegation for the past four years.

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[1] Commencement Address, Fletcher School, 20 May 2001, accessible via www.un.org/NewsPress/docs/2001/sgsm7811.doc.htm

The objective at the time of birth of international cooperation was to acquire basic knowledge of climate change, which is why the focus was on science rather than politics. Almost 25 years ago, the first World Climate Conference took place in 1979. As the following intergovernmental conferences it discussed results of scientific research, which first drew our attention to anthropogenic climate change and its impacts on humankind. The growing public concern over environmental issues certainly helped to push climate change onto the political agenda in the mid-1980s. An important step in the growing up of the regime in its early years was the foundation of the Intergovernmental Panel on Climate Change (IPCC) in 1988 by the United Nations Environment Programme (UNEP) and the World Meteorological Organisation (WMO). It consists of numerous scientists from all over the world, is divided into three working groups and most importantly provides scientific information in its assessment reports on which the formulation of climate change policies is to be based. In its first assessment report of 1990 the IPCC confirmed that climate change was a major threat and called for a global treaty.

Thus, at the second World Climate Conference in Geneva in 1990 the political phase of the process began. In the same year, the United Nations set up the Intergovernmental Negotiating Committee for a Framework Convention on Climate Change. The outcome of these negotiations was the United Nations Framework Convention on Climate Change (UNFCCC) which was signed by 154 States and the European Community at the Earth Summit in Rio in 1992 and which entered into force on the 21st of March 1994. Up to today a total of 186 countries and the European Community have become parties to the Convention.

The Convention marked a major breakthrough in so far as it was the first time that states acknowledged the need for global action for the protection of the climate. Its prominent Art. 2 states the ultimate objective of the convention, that is the stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. This objective is to be achieved guided by a number of principles, the best known of which is the principle of common but differentiated responsibilities and respective capabilities of the various parties. The industrialized states listed in Annex I to the Convention committed themselves in "soft" legal language to institute policies and measures that would reduce their greenhouse gas emissions to the level of 1990 by the year 2000. Not least due to the vague and sift wording of the provision, many states did not live up to their commitment. Apart from eastern European countries in which major industries broke down, only Germany, the UK, Luxemburg, Sweden and Switzerland, besides the EU as a whole, met their target. None of the non-European industrialised countries that are assembled in the so-called Umbrella group (US, Japan, Russia, Canada, Australia, New Zealand, Iceland and Norway) reached the target.

Thus, it soon became obvious that in the absence of a specific, legally binding instrument also allowing for sanctions in case of non-compliance, a viable climate protection would not be realised. However, the Convention is still considered to be a major step because it created the institutional base on which further efforts to protect the climate could build. The Convention provides for regular sessions of the Conference of the Parties (COP), held once a year, and sessions of the two subsidiary bodies. The subsidiary body for scientific and technical advice (SBSTA) and the subsidiary body for implementation (SBI) meet twice a year. The permanent Secretariat further facilitates the work under the Convention. This institutionalisation paved the way for the continuation of the negotiating process, which culminated in the conclusion of the Kyoto Protocol.

2.2 The Formative Years and the Adolescence of the Climate Regime

2.2.1 The Genesis of the Kyoto Protocol

At the first COP in Berlin in April 1995 the EU and a majority of the developing countries led by India (the so-called Green Group) came to the common understanding that further steps were required. They hence overcame opposition by the US, Russia, China and the OPEC countries to adopt a COP decision that the obligations under the Convention did not suffice to reach the objective of the Convention. Thus, the COP mandated an *ad hoc* working group to elaborate an agreement with quantified targets for greenhouse gas limitations and reductions in industrialized countries and with policies and measures to implement those obligations. This mandate came to be known as the Berlin Mandate. Already at that time it was understood that no new obligations for developing countries would be subject of this first negotiating round.

As could be easily predicted, the major contentious issue in the negotiations was the extent to which the different parties should limit or reduce their greenhouse gas emissions. While the negotiations took place, a welcome incentive came from COP 2 where a vast majority of state parties accepted the idea of compulsory reductions and fixed time lines. The working group was able to present a draft protocol at COP 3 in Kyoto/Japan, which, after protracted negotiations, was adopted on the 11th of December 1997 and came to be known as the Kyoto Protocol. For the first time in the history of the international co-operation on climate change, the Kyoto Protocol entails legally binding obligations for individual industrialized states to limit or reduce their greenhouse gas emissions.

However, agreement could only be reached at the cost of leaving open essential questions of implementation. Therefore, the Protocol could not be implemented without further defining provisions and its effect and effectiveness depended very much on this concretion. Many of the signatory states made their ratification dependent upon such a concretion. At COP 4 in Buenos Aires in 1998 a Plan of Action was then agreed which provided for a work programme for elaborating the Protocol's implementing provisions and clarifying the open implementation issues. COP 6 was set as the deadline for completing this work programme.

The open questions of implementation thus had to be settled before the Kyoto Protocol would be ratified by industrialized countries and could enter into force. It was in particular highly controversial in how far so-called sinks should be allowed to be taken into account in determining the emissions of a country. Sinks are forests and other natural systems, which remove CO_2 from the atmosphere. In that respect they provide a potentially attractive way to balance emissions. Yet the sequestration or "storage" of CO_2 is difficult to measure and, even more importantly, sinks may not be permanent. When e.g. a forest burns down, it will not only cease to "store" carbon dioxide, but all the CO_2 stored before will also be released. Logging raises similar problems. Several countries belonging to the Umbrella group demanded the inclusion of sinks so as to reduce their burden of national reduction measures. They faced opposition by the EU that held that inclusion of sinks would jeopardize the effectiveness and integrity of the protocol since it does not reduce the amount of anthropogenic GHG emissions. COP 6 in The Hague in 2000 could not decide on the matter and postponed it until COP 6 was resumed in Bonn in July 2001. There, a political decision on the implementation was taken which came to be known as the Bonn-Agreement. The Bonn Agreement laid out the general terms of a compromise but left many controversial detailed issues to be settled in the concrete legal decisions still to be elaborated. These decisions were then adopted later that year at COP 7 in the form of the so-called Marrakech Accords.

2.2.2 The Withdrawal of the US and its Consequences

Shortly before COP 6 in Bonn US-President Bush announced the US withdrawal from the participation in the Kyoto Protocol. The world's largest emitter accounting for 25 % of global greenhouse gas emissions is thus not subject to compulsory reductions besides the one spelled out in the UNFCCC.

Of course, the US withdrawal was not without effect on the process as a whole. Most importantly, it made the entry into force of the protocol much more difficult. According to its Art. 25 the protocol will enter into force when 55 states have ratified the protocol including a sufficient number of Annex I parties accounting for 55% of that group's greenhouse gas emissions in 1990. With the US withdrawal 36% of the industrialized countries' emissions were "withdrawn". Thus it became ever more vital to get Russia and Japan on board, because without them 55% of the Annex I emissions in 1990 could never be achieved. Being aware of this fact, those parties were in a good position to push their own interests which was primarily the inclusion of sinks Therefore, the implementation rules agreed upon at the continued COP 6 in Bonn and COP 7 in Marrakech reflect compromises that lagged behind the initial hopes of the EU and other key players in climate protection. However, the fact that a compromise was reached at all must be considered a major achievement.

The heading I chose for this subsection was that of "formative years and adolescence of the climate regime"; The time up to the Marrakech Accords constituted formative years because at COP 6 and 7 it was decided which way the regime would go, what it would look like. This time resembled the time of adolescence because these were very difficult years for the regime that had to decide on its future. The coming of age of the regime will be reached once the protocol has entered into force, not least because it then constitutes hard international law, which all parties are obliged to comply with. Before turning to the question what the adulthood of the regime might possibly look like, let me turn to a description of the characteristics and the shape of the Kyoto Protocol as it stands today.

3 Today's Shape of the Protocol

3.1 Overview

The most prominent characteristic of the Kyoto Protocol after the Marrakech Accords is that it provides for legally binding emission targets for greenhouse gases. Annex I parties have to reduce their combined anthropogenic greenhouse gas emissions in the first commitment period between 2008 and 2012 by 5% compared to the level of 1990. Annex B to the protocol breaks down the overall target of 5% into individual national targets which vary widely. For example, the EU has an overall reduction target of 8%, while Australia is only obliged to limit its increase to 8%. Russia and New Zealand are required to stabilize their emissions. These varied obligations reflect the different geographic, climatic, economic and social backgrounds of the states parties. In pursuing the fulfilment of their obligations states have to prove demonstrable progress by 2005 on which they have to report.

Another feature of the protocol worth mentioning is that Annex I countries are allowed to fulfil their emission targets jointly. This means that a group of states can share the burden by redistributing the targets set out in Annex B for them as long as they do not exceed their combined emission target. This system, commonly known as the "bubble", was included at the demand of the EU, but can be used by other groups of states, too. The EU member states agreed on a burden sharing in 1998, which e.g. provides for 28% reductions for Luxemburg and 21% for Germany, and at the other end of the spectrum a 27% increase allowance for Portugal.

Furthermore, a reliable and correct collection of emissions data in national registries and inventories needed to be ensured, because otherwise there could not be an effective control of the fulfilment of obligations. Methodologies used to collect the necessary data shall be those developed by the IPCC. In addition, the Kyoto Protocol provides for compulsory reporting and submission of inventories, which are regularly assessed by so-called expert review teams. The latter thus play an important role in assessing compliance with the protocol, which I will come back to shortly.

With respect to the hotly debated accounting of sinks activities, the Kyoto Protocol had already permitted inclusion of afforestation and reforestation. In the Marrakech Accords, Parties furthermore agreed to allow for the accounting of forest management to a limited extent, as well as of some other management activities.

While every party is free to choose its own policies and measures to reach its targets, Art. 2 of the protocol provides for a non-exhaustive catalogue of possible measures such as energy efficiency and the reduction of counteracting subsidies. Apart from those there are the so-called “flexible mechanisms”, which allow for industrialized countries to meet their obligations by reducing emissions in other industrialized (Joint Implementation – JI) or developing countries (Clean Development Mechanism – CDM) or to trade with emission rights and reduction units. These measures have been incorporated at the pressure of the Umbrella group in order to reduce the economic costs of climate protection and to employ the economic means there, where they bear the greatest effect. Yet these mechanisms cannot make up for a lack of viable national policies and measures to reduce emissions, they are merely supplementary. Overall, greenhouse gas emissions have first and foremost to be de-connected from economic growth.

3.2 The Flexible Mechanisms and Compliance

Since other speakers will address the different mechanisms in more detail in the course of this summer school, I only want to give you a brief insight into what they entail.

Firstly, in order to be able to participate in the flexible mechanisms at all, a state has to ratify the Kyoto Protocol, to establish a national emissions data system, to report timely and correctly on its yearly greenhouse gas emissions, to produce an inventory for sinks and to report correctly on the carbon sequestration by sinks.

The underlying idea of emissions trading is that Annex I Parties may acquire emission rights and units from other Annex I Parties who find it easier, relatively speaking, to reduce emissions and meet their emission targets. These units traded may stem from national allowed emissions (so-called “assigned amounts”), but also – subject to certain limitations - from CDM or JI projects and sink activities. In order to distinguish these different origins, the emission units are labelled differently (AAU, CER, ERU or RMU). In order to prevent countries from “overselling” each Annex I Party is required to hold a minimum overall level of emission units. As in other areas, certain monitoring and reporting measures are foreseen for emissions trading.

The Clean Development Mechanism allows Annex I Parties to implement projects that reduce emissions in the territories of non-Annex I Parties. This Mechanism serves two purposes. First, the emission reductions generated by such projects can be used by Annex I Parties to help meet their emission targets. Secondly, the CDM helps non-Annex I countries to achieve sustainable development and to contribute to the ultimate objective of the Convention. It is expected that CDM projects will levy investment in developing countries, especially from the private sector. Once set up designated national authorities will be able to approve CDM projects. A so-called Executive Board composed of ten members from parties provides oversight to the operation of the CDM and elaborates further rules.

An issue under discussion also in the context of the CDM is the inclusion of sinks. Sinks activities under the CDM are limited to afforestation and reforestation and Annex I countries may only use the resulting credits to balance up to one percent of their overall allowed emissions. The details of the relevant provisions are still subject to further negotiations. Hopefully, by the time COP 9 in Milan is in session in December this year rules on sinks in the CDM will be ready for adoption. As co-chair of the contact group on sinks in the negotiating process I can only tell you that it still is a very difficult and controversial topic.

Joint Implementation schemes are the counterpart to CDM projects in industrialized countries, i.e. they allow Annex I Parties to implement emissions reducing projects in the territories of other Annex I Parties. In practice, joint implementation projects are most likely to take place in the so-called "countries with economies in transition" of Eastern Europe and the former Soviet Union where there tends to be more scope for cutting emissions at low cost. Projects involving the use of nuclear power are excluded from both the CDM and JI.

A major characteristic of the protocol is its teeth, i.e. the compliance system. In charge of this system is the Compliance Committee made up of two branches, namely the facilitative branch and the enforcement branch, each being composed of ten members. As suggested by its name, the facilitative branch has the task of providing assistance to the Parties to meet their obligations, it is, so to speak the helping hand. The enforcement branch on the other hand has the task to subject non-complying Parties to certain consequences, such as restoring any excess emissions plus an interest or penalty of 30% in the second commitment period. Attention to a potential case of non-compliance can be brought to the committee by the Party itself or by other parties or by the expert review teams reviewing the emission inventories and other reports of parties. An elaborate procedure including opportunities for written statements and hearings has been agreed on.

3.3 Developing Countries Issues

No matter whether we switch on international news on TV, open newspapers or surf the internet, we are every day reminded of the facts that who suffers the most from climate change are developing countries. Dwellings of the poor are destroyed by hurricanes; lifesaving harvests drown in floods; traditional crops cease to grow due to temperature increases etc. While the Convention already paid attention to this fact through provisions on technology transfer and capacity building, the Kyoto, Bonn and Marrakech negotiations have come up with some specific schemes and mechanisms, which are also still further elaborated.

Three financial mechanisms are being put in place to support developing countries in their efforts to adapt to climate change, to combat climate change and to meet the needs of least developed countries. These mechanisms are the Adaptation Fund, the Special Climate Change Fund and the Least Developed Countries Fund. The latter will also be used to assess the vulnerability of individual states and to implement national adaptation programmes. The EU and other industrialized countries declared that they would annually contribute US$ 450 million by 2005. In addition, Annex I parties are to achieve their emission targets through policies which will minimize adverse impacts on developing countries.

3.4 The legal Bodies

The Kyoto Protocol is, as you all know, a protocol to the Framework Convention, so, to a certain extent, they are legally interlinked. However, since some states are parties to the Convention but not to the Protocol, it was necessary to find an institutional and legally sound answer to the question of who governs what. For the large majority of countries who are or will become parties to both, the answer was relatively simple: let us use the Convention bodies for the Protocol as well. Yet the states not being party to the Protocol, most notably the US, requested an institutional separation since they wanted to prevent becoming torn into the Protocol process through the backdoor. Although this appears to be a merely technical point it proved to be highly controversial.

A workable compromise was reached at the 18^{th} session of the Subsidiary Bodies in June this year, elaborated by a contact group, which I had the honour of chairing myself. The Conference of the Parties to the Convention will in principle consider its agenda separately from the Meeting of the Parties to the Protocol. Yet if both bodies agree to do so, common agenda items can be dealt with and negotiated together. The two subsidiary bodies, SBTSA and SBI serve both agreements, which guarantees a certain efficiency of the international climate change regime. These arrangements are to be reviewed and possibly further developed after the first Conference of the Parties also serving as the Meeting of the Parties of the Protocol, i.e. after the entry into force of the Kyoto Protocol.

4 The Years to come

Although the title of my lecture does not necessarily call for this, please allow me to briefly glimpse into the future of the regime.

The most important step in the nearest future is what I have earlier described as the coming of age that is the entry into force of the Kyoto Protocol. We all hope that the Russian government and the Russian parliament, the Duma, will proceed with the Russian ratification soon. This is the necessary step for the Kyoto Protocol's entry into force. While awaiting the Protocol's entry into force, we cannot afford to lose valuable time for advancing climate protection and implementing the Protocol. Climate change does not wait for Russian ratification and the commitment period 2008-2012 comes closer day by day. The European Union, for one, has already started implementing an emissions trading regime, which will come into operation in less than two years. Many European countries, including Germany, have elaborated climate protection plans and have begun to implement them in order to meet their Kyoto targets. Progress is also reportedly made in Canada and Japan.

While implementing Kyoto might seem sufficient to fill our political agendas, discussions about further measures beyond Kyoto cannot wait. The Kyoto Protocol determines a 5% reduction of greenhouse gas emissions in industrialized countries, yet to stabilize the global climate requires us to more than halve our emissions – worldwide! We therefore have to begin to develop ideas about the time beyond 2012 already today. We are best advised to agree on further reduction obligations for the second commitment period soon in order for states to have sufficient time to implement the necessary measures. As a first contribution to a debate about further action, Germany has offered to reduce its emissions by 40% by 2020 if the EU is willing to commit itself to 30% reductions.

In addition, we have to investigate what other, complementary measures might be required to mitigate global climate change and adapt to its consequences. Enhanced technology development and cooperation might be one relevant area. The EU has already started to advance international cooperation on a core element of any strategy to come to grips with climate change by, together with a large number of like-minded countries, launching a Renewable Energy Initiative at the Johannesburg Summit last year. Germany will host a major conference on renewable energies next year, which we hope will inject further political momentum to the development and spreading of renewable energy technologies.

Such initiatives can only be supplemental to legally binding quantified targets. Only quantified targets can give the certainty that required emissions reductions will indeed be pursued and achieved. In the long run, however, we will hardly achieve the required emission reductions without the largest emitter, the United States. For an effective long-term climate protection it will therefore be paramount to get the US back on board the international process - accepting the need for real reductions of their emissions. There are some developments within the US that give reason for hope that political support for effective action on climate change may be growing and may eventually lead to a full reengagement of the US position in the international process. California, for example, has decided to regulate carbon emissions from cars and to increase the amount of energy generated from renewable sources to 20 percent of electricity sold into the State by 2010. Six New England governors committed themselves to reduce greenhouse gas emissions between 70 to 80 percent over the long term and are now working together and individually to put in place concrete policies and measures. Moreover there has been a bipartisan initiative by Senators Mc Cain and Lieberman to install a cap and trade system. But these are just some positive examples - there is still a long way to go.

Finally, I am fully convinced that the industrialized countries have to make the greatest effort to protect our common climate – for a lot of reasons, including our historical and ethical responsibility as well as our larger capabilities. Yet, I cannot talk about the future of the international climate regime without pointing to the need for further action beyond 2012 also by developing countries. The objective of stabilizing atmospheric concentrations of greenhouse gases makes limitations of emissions in the South inevitable. Especially some developing countries by their sheer size contribute substantially to the worldwide emissions. Every effort therefore can make a substantial contribution. However, I am aware that their per capita emissions are still very low compared to the USA, the EU or other industrialized countries. The principle of common but differentiated responsibilities therefore needs to be taken into account when deciding on the type and the level of commitment. We all know that many developing countries do not have the capabilities to implement substantial obligations without assistance by industrialized countries, and we all know that we will have to be creative in elaborating a workable international scheme for future action. But we all have to contribute our share – and here I come back to my initial quote of Kofi Annan and ask you with all due respect “to do your part” - as well as I will strive to do mine.

THE RELEVANCE OF CLIMATE CHANGE NEGOTIATIONS FOR DEVELOPING COUNTRIES

Chandrashekar Dasgupta
Distinguished Fellow, TERI
Habitat Place, Lodhi Road
110003 New Delhi
India
E-mail: dasgupta@teri.res.in

1 Introduction

The climate change negotiations reflect a deep North-South divide but they are also affected by divisions within the North as well as within the South. The Kyoto Protocol has been emasculated by the deep rift in the North between the United States and most other industrialized countries. Differences within the South do not run so deep but are nevertheless significant.

The following account analyses the common positions of the developing countries in the climate change negotiations as well as points of divergence within the group. It thus outlines the areas of consensus in the G-77 / China group, indicating at the same time the outer limits of the consensus.

2 Common Interests and Areas of Consensus in G- 77 / China Group:

The G-77 / China group comprises countries that share certain common characteristics of basic importance. However, since they account for a large majority of the parties to the UN Framework Convention on Climate Change (UNFCCC), it is not surprising that their circumstances also differ in certain respects. It is necessary to identify the common as well as the differing circumstances in order to understand the positions taken by the group in the climate change negotiations.

Generally speaking, the common circumstances of the group include the following features:

- Developing countries have low per capita greenhouse gas (GHG) emissions (with the exception of some oil exporting countries);
- Developing countries have low per capita incomes (with the exception of some OPEC countries and new OECD members);
- Most developing countries are particularly vulnerable to Climate Change because of the regions in which they are located, accentuated in many cases, by other geographical features (e.g., low-lying deltaic areas and islands).

These common circumstances help to explain the group's positions on the response to climate change through mitigation and adaptation. Since developing countries have low per capita GHG emissions, they can justifiably maintain that they are not *responsible* for inducing climate change. The *responsibility* lies with industrialized countries whose historic and current per capita emission levels exceeds a sustainable range, thus precipitating climate change.

India, for example, has pointed out that climate change is not caused by GHG emissions per se but by *excessive* levels of anthropogenic GHG emissions. The *responsibility* for causing climate change thus lies exclusively with those countries whose historical and current GHG emissions levels are excessively high. These countries have, in effect, appropriated more than their fair share of atmospheric resources.

2.1 Mitigation

It follows from this premise that there is no justification in terms of equity for requiring countries with low per capita GHG emissions to shoulder any part of the mitigation burden that should be borne by those countries that are responsible for precipitating climate change through their excessively high emissions levels. Most developing countries share the view that, on grounds of equity, mitigation targets should be based on long-term convergence of per capita emissions. Even if historical emissions are ignored, developing countries cannot be required to accept binding mitigation commitments until such time as their per capita emission levels converge with the per capita emission levels of the industrialized countries. Until then, binding commitments can apply only to the latter countries since it is they who are responsible for precipitating climate change. Developing countries do not share this responsibility and are only victims of the phenomenon.

This reasoning is sometimes reinforced by the secondary argument that developing countries also lack the financial and technological *capability* for shouldering mitigation burdens. UNFCCC incorporates the principle that countries should take actions to respond to climate change in accordance with their "differentiated responsibilities and differing capabilities"(art. 3.1). It would be inequitable in terms of both their "*differentiated responsibilities*" as well as their *"differing capabilities"* to impose binding mitigation commitments on developing countries. Any binding commitments would be detrimental to the attainment of the primary goals of developing countries, namely, economic and social development and poverty eradication.

While rejecting binding commitments, developing countries are prepared to enter into *contractual and conditional* commitments to implement specific mitigation measures provided that the full incremental costs are met by developed countries. This is an equitable basis for North-South cooperation on mitigation. It must be emphasized that developing countries do NOT view provision of incremental costs for mitigation measures as constituting economic aid. The financial provisions merely compensate them for the costs incurred in implementing mitigation measures. They are not primarily intended for stimulating economic or social development.

Consistently with the position they have taken since the inception of the climate change negotiations in the 1980s, the G-77/ China group have strongly opposed suggestions that a debate should be initiated on the question of new mitigation commitments for developing countries after 2012 – the year that the Kyoto Protocol completes its first term.

In light of these positions, the G-77/ China group have always attached the greatest importance to the following mitigation provisions in the two multilateral climate change treaties – the UNFCCC and the Kyoto Protocol:

- Annex II Parties "shall also provide such financial resources, including for the transfer of technology, needed by the developing country Parties to meet the agreed full incremental costs of implementing measures...that are agreed between a developing country Party and the international entity..." (UNFCCC art.4.3);
- Annex II Parties "shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties..." (UNFCCC art. 4.5);
- "The extent to which developing country Parties will effectively implement their commitments under the Convention will depend on the effective implementation by developed country Parties of their commitments under the Convention related to financial resources and transfer of technology and will take fully into account that economic and social development and poverty eradication are the first and overriding priorities of the developing country Parties." (UNFCCC art. 4.7);
- Annex II Parties shall "provide such financial resources, including for the transfer of technology, needed by the developing country Parties to meet the agreed full incremental costs of advancing the implementation of existing commitments... that are agreed between a developing country Party and the international entity..." (Kyoto Protocol, art. 11);
- "Annex II Parties "may also provide, and developing countries avail themselves of, financial resources...through bilateral, regional and other multilateral channels." (Kyoto Protocol, art. 11.3).

2.2 Adaptation

On the basis of the same principle of action in accordance with "differentiated responsibilities and differing capabilities", developing countries maintain that the industrialized countries should assist them combating the adverse effects of climate change. As a rule, developing countries have refrained from specifically interpreting "responsibility" for precipitating climate change as involving a legal "liability" for payment of compensation, no doubt because this would be rejected out of hand by the industrialized countries. However, even if the legal liability argument is not pursued, there is a clear moral obligation on those responsible for causing climate change to assist its victims to cope with the adverse effects through adaptation measures.

There are two kinds of "adverse effects" related to climate change. First, there are the adverse effects or physical damage resulting from the phenomenon of climate change itself (e.g., inundation of low-lying islands and coastal areas, agricultural losses due to disturbances in temperature and rainfall patterns, etc.) Secondly, there is the damage caused particularly to oil-exporting economies by measures to mitigate carbon dioxide emissions by controlling consumption of hydrocarbon fuels. Developing countries are agreed that sufferers from both these phenomena should be assisted by the Annex II countries in coping with the "adverse effects" but, as we shall see later, there are major differences within the G-77/ China group on the links and relative weights to be attached to the two phenomena.

UNFCCC addresses the interests of both groups of adversely affected developing countries. Art.4.4 exclusively addresses the concerns of the first group, providing that the Annex II countries "shall...assist the developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation to those adverse effects". Art.4.8, on the other hand, covers both groups, requiring that "full consideration" be given to "what actions are necessary...including actions related to funding, insurance and the transfer of technology, to meet the specific needs and concerns of developing country Parties arising from the adverse effects of climate change and/or the impact of the implementation of response measures..."

3 Divergent Interests and Positions within the South

Given the size and diversity of the G-77/ China group, it is not surprising that its members are divided on some issues. The most important of these differences are those that exist between two sub-groups – the Alliance of Small Island States (AOSIS) and a group of countries whose economies are primarily dependent upon their oil exports. The Pacific island states are leading members of AOSIS, while Saudi Arabia and some of the other Gulf countries play a prominent role in the second group (for convenience, we shall refer to the latter group somewhat loosely as the "oil exporters").

3.1 Mitigation

Sea-level rise resulting from climate change threatens to submerge many of the AOSIS countries partially or even fully. With their geographical survival at stake, the

AOSIS countries tend to press for the strongest possible mitigation measures in order to minimize the extent of climate change. The "oil-exporters", on the other hand, are concerned that ambitious mitigation commitments would lead to a sharp contraction of the global petroleum market, which would have an adverse impact on their economies. These countries, therefore, tend to have serious reservations concerning strong mitigation proposals.

In shaping a consensus position on mitigation, the G-77/ China group have had to accommodate these divergent interests. The consensus within the group is limited to two elements, viz, (a) that the industrialized countries should adopt binding emission limitation commitments and (b) that developing countries should be exempt from such commitments though they may take on contractual commitments if they are provided the finance and technology needed to cover the full incremental costs of the project.

The G-77/ China group have never proposed specific targets for emission reductions by industrialized countries. This is mainly because of conflicting views of the AOSIS and oil-exporter sub-groups though it also reflects a disinclination on the part of many developing countries to add to the complications of negotiations on this question between the industrialized countries.

3.2 Vulnerability and Adaptation

There is a corresponding divide between interests of the AOSIS and the "oil exporters", respectively, concerning questions of vulnerability and adaptation. While AOSIS countries are vulnerable to the *effects* of climate change (in particular, sea-level rise), the "oil exporters" are economically vulnerable to measures to *mitigate* climate change, to the extent that these result in reduced demand for petroleum. Since their economies are largely dependent on revenues from petroleum exports, the countries belonging to the latter sub- group are apprehensive about the impact of a possible fall in the global demand for petroleum.

Both sub-groups pressed their case vigorously from the outset of the climate change negotiations and were able to incorporate their concerns in UNFCCC. Thus, AOSIS' concerns are reflected in article 4.4, which provides that the Annex II Parties "shall... assist the developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation to those adverse effects." Article 4.8 addresses the concerns of both sub-groups, together with a variety of other disadvantaged countries. It calls for giving "full consideration" to the "specific needs and concerns of developing country Parties arising from the adverse effects of climate change and/or the impact of the implementation of response measures, especially on: (a) Small island countries...(h) Countries whose economies are highly dependent on income generated from the production, processing and export... of fossil fuels..." Finally, article 4.10 dwells exclusively on "developing country Parties, with economies that are vulnerable to the adverse effects of the implementation of measures to respond to climate change". The article, however, merely enjoins on Parties to "take into consideration" the situation of these developing countries.

It will be seen that the concerns of AOSIS evoked a relatively greater response in UNFCCC than those of the "oil exporters." The latter were only promised "full consideration' or merely "consideration" of their concerns, while Annex II Parties accepted a commitment to assist small islands states and other developing countries that are particularly vulnerable to climate change.

The Kyoto Protocol incorporated provisions similar to article 4.8 of the UNFCCC. Articles 2.3 and 2.14 of the Protocol are essentially a reiteration of this UNFCCC article. However, the protocol lacks a broad provision corresponding to article 4.4 of UNFCCC, which committed Annex II Parties to assist AOSIS countries in meeting costs of adaptation. Instead of a general but not quantified commitment, the protocol offers a specific – but very limited – commitment by requiring that "a share of the proceeds" from CDM activities should be used to "assist developing country Parties that are particularly vulnerable to the adverse effects of climate change to meet the costs of adaptation". The share of CDM proceeds was subsequently fixed at 2 per cent. The "oil exporters" are excluded from this benefit but developing countries with low-lying coastal areas or other features that make them "particularly vulnerable to the adverse effects of climate change" are included among the beneficiaries.

Adaptation was brought into sharper focus at COP 8, without detracting from the primary emphasis on mitigation. Informal discussions since then have brought to light the difficulties in striking an appropriate balance between the interests of the low-lying, small island states and the countries which are primarily dependent on their oil revenues. The search for a G-77/ China consensus position will test the negotiating skills and statesmanship of both these sub-groups.

4 Conclusions

From the perspective of the developing countries, climate change is a phenomenon of which they will be the worst sufferers, even though they themselves have little or no *responsibility* for causing it. Moreover, their *capability* for responding to climate change is relatively limited as they lack financial and technological resources.

The G-77/ China group has, therefore, consistently maintained that the burden of mitigation measures should be borne by those Parties – namely, the industrialized countries – that are in the first place responsible for precipitating climate change. The developing countries oppose, on grounds of fairness and equity, all efforts to shift part of the mitigation burden to their own shoulders. Thus at COP 8, when some industrialized countries sought to initiate discussions on possible future commitments for developing countries, they ran into strong opposition from the G-77/ China group.

While they are agreed that only industrialized countries should take on binding mitigation commitments, the G-77/ China group has never taken a position on the *extent* of these emission reductions. This is explained mainly by differences within the group – in particular, between those favouring deep reductions and the sub-group of "oil exporters", who want to minimize the impact on the petroleum market. Many developing countries are also loath to add to the complexities of the negotiations between the industrialized countries on mitigation burden-sharing. In this sense, it may be said that the role of the developing countries in the climate change negotiations is largely of a *defensive* nature. The group's primary concern is to reject efforts by the industrialized countries to shift part of the mitigation burden to their shoulders.

While rejecting binding emission commitments, the developing countries are prepared to implement conditional or contractual measures in which they are compensated for the full incremental costs incurred by them. Similarly, they welcome international cooperation through the Clean Development Mechanism (CDM) established under the Kyoto Protocol.

Developing countries have consistently called upon the industrialized countries, particularly the Annex II Parties, to provide finance and technology for adaptation. As we saw, however, there is a wide divergence within two sub-groups, the AOSIS and the "oil exporters" on the relative weight to be attached to adaptation to climate change and adaptation to measures to address climate change. These differences will have to dealt with appropriately for progress to made on international cooperation on adaptation.

Mitigation

EMISSION REDUCTION: OPTIONS AND STRATEGIES IN EUROPE

Jürgen-Friedrich Hake, Regina Eich
Forschungszentrum Jülich GmbH
Programme Group Systems Analysis and Technology Evaluation (STE)
52425 Jülich
Germany
E-mail: jfh@fz-juelich.de; r.eich@fz-juelich.de

1 The UNFCCC and its Implications on the Policy of the European Union

The United Nations Conference on Environment and Development (UNCED) was held in Rio de Janeiro in 1992. The 'Earth Summit', attended by over 100 national leaders, was concerned with a range of environmental issues. Amongst other initiatives, the conference established the United Nations Framework Convention on Climate Change (UNFCCC). The UNFCCC was opened for signature in June 1992 at the Rio 'Earth Summit' and entered into force in March 1994.In doing so, they took the first step in adressing one of the most urgent environmental problems facing humankind.

The UNFCCC aims to stabilize atmospheric levels of greenhouse gases to prevent detrimental man-made interference with the climate - this is accomplished through a list of commitments for signatory nations, including:

- Annual reporting of national greenhouse gas inventories;
- Regular disclosure and review of progress on regional greenhouse gas abatement programs;
- Technological assistance to developing countries that are especially vulnerable to climate change;
- Participation in the meetings of the Conference of Parties (COP) to the Convention.

The Convention further adopted a list of industrialized nations (Annex I) for which domestic greenhouse gas reduction measures were recommended and developing nations (Non-Annex I) which are exempted from immediate emission reduction measures, but may participate on a voluntary basis.

The first 'Conference of Parties' (COP), held in Berlin in 1995 initiated a new round of talks that sought to achieve stronger and more specific emissions reduction commitments. This recognised that the voluntary commitments made at the 1992 Rio 'Earth Summit' were insufficient to result in concrete GHG emission reductions. The subsequent agreement negotiated at 'COP3', the Kyoto Protocol, bound industrialised nations to reduce GHG emissions by an average of 5.2% below 1990 levels by the first commitment period of 2008 to 2012. Six specific greenhouse gases are regulated under the Kyoto Protocol: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6).

Most industrialised ('Annex B') countries have committed themselves to reduce their collective emissions of greenhouse gases by an average of 5.2% by the commitment period of 2008 to 2012, while developing nations ('Non-Annex B') are not subject to emissions reduction caps. The Kyoto Protocol shall enter into force when a minimum of 55 parties that account for at least 55 % of the Annex I carbon dioxide emissions in 1990 have ratified.

The emission reduction targets for 2008 - 2012 (with respect to 1990 levels) taken on by industrialised countries under the Kyoto Protocol are set out below:

- Switzerland, Central & East European states, European Union: - 8%;
- United States: -7%;
- Canada, Hungary, Japan, Poland : -6%;
- New Zealand, Russia, Ukraine: 0%;
- Norway: +1%;
- Australia: +8;,
- Iceland: +10%.

The European Union has agreed to an internal burden sharing arrangement that allows the distribution of a single Kyoto Protocol commitment between its fifteen member states (Joint Fulfilment).

2 Climate Change Policy of the European Union

The latest monitoring data indicates the progress the European Union has delivered on its long-standing commitment to stabilise emissions of carbon dioxide (CO_2) - the main greenhouse gas responsible for man-made global climate change. In March 2000 the Commission launched the European Climate Change Programme (ECCP) to prepare additional policies and measures, as well as an emissions trading scheme, to ensure that the EU achieves the 8% cut in emissions by 2008-2012 to which it is committed under the Kyoto Protocol.

The ECCP's initial work to develop further policies and measures focused on the energy, transport and industry sectors. Therefore, a number of working groups have been set up to consider and give recommendations on the most important options for reducing greenhouse gas emissions cost-effectively. The initial working groups, set up in summer 2000, were:

- Flexible Mechanisms (Emission Trading, Joint Implementation and Clean Development Mechanisms);
- Energy Supply;
- Energy Consumption;
- Transport;
- Industry (including a working group on fluorinated gases) and
- Research.

Each of these working groups reported to the European Commission on the potential initiatives it had considered for reducing GHG emissions. As a result, in June 2001, the Commission published an ECCP Report on the findings of the working groups. The report identified 42 possible measures, which could lead to some 664-765 $MtCO_2$ equivalent emissions reductions that could be achieved against a cost lower than 20€/tonne CO_2eq. This is about twice the emissions reduction required for the EU in the first commitment period of the Kyoto Protocol with respect to 1990. The identified emission reduction potentials are estimates and cannot always be relied on, as the real gains depend on the concrete implementation and the interplay of the various measures.

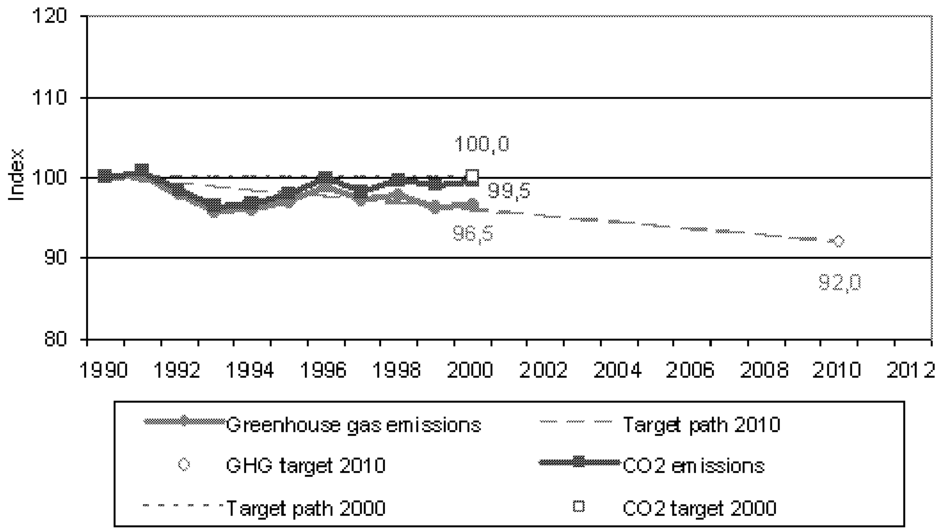

Figure 1: Total EU greenhouse gas emissions in relation to the Kyoto target [3].

The total EU emissions of the six Kyoto greenhouse gases are estimated to have been 1.0% higher in 2001 than a year before. Despite the increase from 2000, the EU's greenhouse gas emissions in 2001 were 2.3% below their level of 1990. However, this was less of a drop than in the two previous years. In 2002, the emission inventory of the European Union has increased for a second consecutive year. The European Environment Commissioner Margot Wallström said: "The European Union is moving further away from meeting its commitment to achieve a substantial emissions cut under the Kyoto Protocol. The progress we have made already needs to be backed up by additional measures. Especially the Member States that are not on track in reaching their targets urgently need to take additional action."

The second ECCP progress report gives an overview of the latest results of the ECCP, including the status of implementation of the range of measures investigated since the start of the Programme [4]. It forms the basis for the Commission to prepare further actions in those areas that are most promising and it keeps the focus on cost effective measures. The policies and measures included in the ECCP report have a total emission reduction potential of 578-696 million tonnes of CO_2-eq. This is about twice the EU-15's 8% emission reduction required under the first commitment period of the Kyoto Protocol, confirming the EU's ability to meet its target if the appropriate measures are put in place.

The legislative measures currently in force or already proposed by the Commission represent a potential 276-316 Mt CO_2eq., including measures such as :

- Directive on the promotion of electricity from renewable energy sources;
- Directive on the energy performance of buildings;
- Landfill Directive;
- Proposals for a Directive on emissions trading;
- Proposals for the promotion of bio-fuels and
- Proposal for a Directive on the promotion of CHP.

A number of other key measures are in an advanced stage of preparation and could increase the potential identified above by 25%:

- Implementing a framework for energy services;
- Implementing a framework for the eco-design of energy using products;
- Forcing the reduction of fluorinated gases;
- Implementing an public awareness campaign on energy efficiency and
- Public procurement.

Other measures are also under consideration by the Commission Services, such as integrating climate change into structural funds, further steps to stimulate the use of renewable energy sources for heating applications, the integration of energy efficiency in the Eco-Management and Audit Scheme (EMAS), and measures to reduce greenhouse emissions of air conditioners in cars [4].

Commissioner Wallström commented on the sectoral findings of the report: "The report shows that the improvement of energy efficiency is the area that has the largest potential for greenhouse gas reductions, usually combined with good cost-efficiency due to lower energy costs. Rising emissions in the transport sector remain a big challenge - urgent action is needed here to make our transport system more climate-friendly. Above all, our findings demonstrate that the Kyoto targets can be met without imposing unacceptable costs on society. Meeting them is a question of political will and full and effective implementation of the measures agreed. The Commission is committed to closely monitoring the progress and will act accordingly." The EU has to reduce its greenhouse gas emissions by 336 Mt CO_2eq. in order to reach its target of reducing its emissions by 8% by 2010 according to the Kyoto Protocol [6]. The reduction potential of the measures currently in force or already proposed by the Commission is 276 Mt CO_2eq, the measures in an advanced stage of preparation amount to 83 Mt CO_2eq. All measures together mentioned in the report of the European Climate Change Programme amount to 578 Mt CO_2eq.

It must be emphasised that ECCP estimations are subject to considerable uncertainties. Uncertainty is related to the extent of real implementation, while it takes considerable time before emission reductions are put in place. Therefore, caution in the interpretation of the estimated reduction potentials is required.

3 Burden Sharing Agreement

The Member States have agreed to redistribute their targets under the Kyoto Protocol in accordance with the Burden Sharing Agreement as contained in the Council Conclusions of 16 June 1998. If installations trade allowances with other installations within the same Member State, there would be no change to the number of tonnes that a Member State can emit under the Burden Sharing Agreement. However, if an installation buys allowances from an installation in another Member State, then there will be need for a corresponding adjustment, recorded by the national registries, to the number of tonnes that each Member State can emit under the Burden Sharing Agreement. Selling an allowance to an installation in another Member State would mean that the "originating" Member State loses its entitlement under the Burden Sharing Agreement to emit a tonne of carbon dioxide equivalent. Buying an allowance from another Member State, on the other hand, entitles an extra tonne of carbon dioxide equivalent to be emitted within the Member State in which the buying installation is located ('EU Internal Joint Implementation').

Overall, the Community will emit the same number of tonnes as were foreseen under the Kyoto Protocol. But the precise entitlements of each Member State will be adjusted to correspond with trades that its installations undertake. There should be no danger of non-compliance arising from this scheme by any Member State as long as installations individually have enough allowances to cover their actual emissions. If installations sell, they must actually reduce their emissions correspondingly. That is why there needs to be strong national non-compliance provisions for participating installations.

The latest Member States emission data shows that 10 of the 15 Member States are a long way off track for their agreed share of the EU greenhouse gas emissions target. This is the case for Austria, Belgium, Denmark, Finland, Greece, Ireland, Italy, the Netherlands, Portugal and Spain. Marked increases in emissions from 2000 to 2001 occurred in Austria (+ 5%) and Finland (+7.3%). Initial analysis indicates these were partly due to the cold winter but also to lower rainfall which cut hydropower production in both countries and reduced Finland's imports through the Nordic electricity market. Consequently Austria and Finland had to increase their use of fossil fuels for power and heat production. Ireland, Spain and Portugal are the furthest away from keeping to their share of the EU target. Ireland's emissions in 2001 were 31.1% higher than in 1990, more than doubling the 13% increase it has been allowed between 1990 and 2008-2012. For the first time in five years, Spain's emissions decreased by 1% compared with its figures for 2000. This was the result of a greater production of hydropower which reduced the need to use fossil fuels for power and heat generation. Luxembourg shows the biggest reduction in greenhouse gas emissions of any Member State, cutting its emissions down by 44% since 1990. Germany, the largest EU emitter, has achieved the most marked reduction among the big Member States, with an 18% cut since 1990. However, between 2000 and 2001 Germany's emissions rose by 1%.

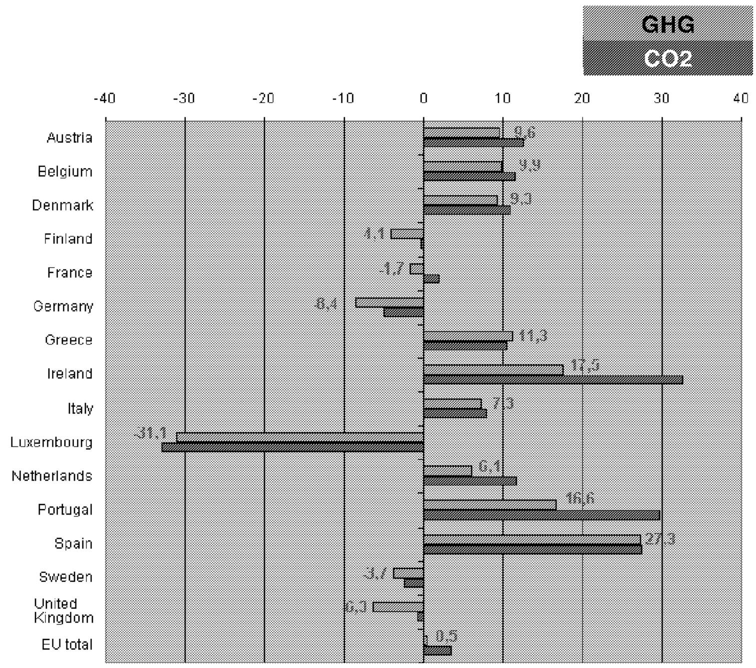

Figure 2: Deviations from the linear process of the conversions of the Kyoto obligations of the individual European Union states in 2000 (Data Base: August 2002) [3].

4 Emissions Trading in the European Union

In March 2000, the Commission adopted a Green Paper on greenhouse gas emissions trading within the EU [6] that launched a debate across Europe on the suitability and possible functioning of emissions trading. The responses received were overwhelmingly in favour of emissions trading. Within the multi-stakeholder European Climate Change Programme, emissions trading has been the subject of extensive discussions and analysis that have added to the understanding both of the instrument and the points of view of different actors. Further consultation meetings with stakeholders, Member States and Accession Countries in September 2001 demonstrated strong support for emissions trading. The present proposal draws on all those discussions.

This proposal, based on Article 175(1) of the Treaty, places direct emissions of the greenhouse gases covered by the Kyoto Protocol within a regulatory framework. The total quantity of greenhouse gas emissions covered by this scheme would be limited. Furthermore, installations would have the possibility to engage in Community-wide emissions trading. This possibility constitutes the key element for harnessing the available cost-effective emissions reduction potential. Emissions reductions will then be made wherever in the Community it is cheapest to make them. The benefit of these cheaper reductions will be available to others elsewhere in the Community who may not themselves have as cheap reduction possibilities. This is why emissions trading is of benefit to those who buy as well as to those who sell. The economic case for a Community-wide scheme is supported by several recent studies demonstrating efficiency gains. A Community scheme would minimise distortions of competition and potential barriers to the internal market that might otherwise arise as a result of a number of disparate trading schemes (and hence prices for carbon) being established in the European Union.

The proposal is based on two ideas. The first of these is that of the greenhouse gas "permit", that will be required by all installations covered by the scheme. The second concept is that of greenhouse gas "allowances", denominated in metric tonnes of carbon dioxide equivalents, which entitles the holder to emit a corresponding quantity of greenhouse gases. Member States, or their relevant authorities, will grant a greenhouse gas permit that sets an obligation to hold allowances equal to the actual emissions. The permit also requires adequate monitoring and reporting of emissions. The allowances will be transferable, while the permit itself is attached to a specific installation or site. In addition to the permits, Member States, or their relevant authorities, will allocate allowances. These allowances can be traded between companies if they choose to do so. Each year, companies must submit for cancellation a number of allowances that corresponds to their actual emissions. If they do not have enough allowances, sanctions will be imposed. The holding and tracking of allowances will be done through an electronic register.

Table 1: Greenhouse gas emission trends and Kyoto Protocol targets for 2008-2012 [3].

MEMBER STATE	Change 1999–2000 (%)	Change 1990–2000 (%)	Targets 2008–12 under Kyoto Protocol and EU "burden sharing" (%)	Distance-to-target indicator (DTI) (index points)	Evaluation of progress in 2000
Austria	0,0%	2,7%	-13,0%	9,2	☹
Belgium	0,5%	6,3%	-7,5%	10,0	☹
Denmark	-6,0%	-1,7% (-9,8%)	-21,0%	8,8 (0,7)	☹ (☹)
Finland	-2,9%	-4,1%	0,0%	-4,1	☺
France	-1,1%	-1,7%	0,0%	-1,7	☺
Germany	-0,2%	-19,1%	-21,0%	-8,6	☺
Greece	4,8%	21,2%	25,0%	8,7	☹
Ireland	1,5%	24,0%	13,0%	17,5	☹
Italy	0,7%	3,9%	-6,5%	7,2	☹
Luxembourg	-0,6%	-45,1%	-28,0%	-31,1	☺
Netherlands	-0,4%	2,6%	-6,0%	5,6	☹
Portugal	-1,1%	30,1%	27,0%	16,6	☹
Spain	4,1%	33,7%	15,0%	26,2	☹
Sweden	-1,6%	-1,9%	4,0%	-3,9	☺
United Kingdom	0,4%	-12,6%	-12,5%	-6,3	☺
EU-15	0,3%	-3,5%	-8,0%	0,5	☹

The first phase of the scheme, between 2005 and the end of 2007, is a period that precedes the Kyoto Protocol's commitment period. In this preliminary phase, the Commission believes that the Community would greatly benefit from experience of greenhouse gas emissions trading, so that it is prepared for the commencement of international emissions trading under the Kyoto Protocol that will begin in 2008. The present proposal recognises, however, that during the preliminary phase from 2005 to the end of 2007, there are no legally binding targets limiting the emissions of greenhouse gases of Member States. In view of this, specific differences have been incorporated into the preliminary phase. These include that allowances should be allocated to participating installations free of charge and that there is a lower common level of penalty for non-compliance.

From 2008, the exchange of allowances between installations in two different Member States will give rise to the adjustment – through the national registries – by a corresponding number of tonnes of the total quantity of emissions allowed for each Member State as contained in the proposal for a Council Decision on the ratification of the Kyoto Protocol.

The first accessions are likely to have taken place by the commencement of this scheme and so would be covered by this proposal. However, for countries that are not part of the EU when this scheme comes into force, there exists the possibility to link the Community scheme with those of other Parties to the Kyoto Protocol by entering into agreements with those other Parties to mutually recognise each other's allowances.

4.1 Allocation and Issuance of Emission Trading

It is proposed that in the period from 2005 to 2007 all Member States allocate allowances to participating installations for free. This common approach is to protect the internal market. Without such harmonisation, it is feared that if allowances were allocated on the basis of auctioning in one Member State but allocated free in another, competition may be distorted. Requiring participants to pay for their initial allocation will present particular difficulties in the first period because the price of allowances will still be unknown.

By 30 June 2006 the Commission will review the experience gained during the allocation of allowances for the period 2005-2007 with a view to ascertaining which harmonised method would be most appropriate in future. There may be too little time for the Commission to make a proposal on the method of allocation for the period 2008-2012 that could be adopted and transposed in time to allow operators sufficient prior notice of how allocations would be made in that period. It is therefore proposed that pending adoption of such a proposal, the Commission, assisted by the Regulatory Committee, should be able to decide on the method of allocation in the period 2008-2012.

The total quantity of allowances issued under the proposal would be left essentially to the Member States. However, in order to ensure that the sectors concerned by the emissions trading scheme contribute appropriately to the overall reduction of greenhouse gas emissions made necessary by the Community's international commitments, and to ensure a level playing-field between companies competing within the internal market, the allocation of allowances must comply with a set of criteria to be applied across the EU. These criteria are elaborated in Annex III of the proposal. This Annex can be further amended in the light of experience of the implementation of the Directive.

Also, the quantities allocated should ensure that the overall emissions of all the participating installations collectively would not be higher than if the emissions were to be regulated under the IPPC Directive (Integrated Pollution Prevention and Control) [7], which should be the case if the criteria contained in Annex III are followed. Member States, in establishing their national allocation plan, should consider the technological potential of the installations concerned to reduce direct greenhouse gas emissions. Furthermore, all allocation decisions would have to comply with Community requirements concerning State aid. The proposal does not spell out what would be consistent or inconsistent forms of allocation with regards to State aid as each situation will have to be examined on its merits. Member States should also ensure that new entrants have adequate access to allowances, so as to be able to establish their operations within the Member State in accordance with Article 43 of the Treaty [8].

To ensure the transparency and fairness of allocations, Member States would be required to publish and to submit in advance to the Commission a national allocation plan that shall include objective and transparent criteria for allocation within that Member State. The national allocation plans would be examined within the framework of the Regulatory Committee. This proposal provides for the Commission to reflect a plan that is inconsistent with the criteria within 3 months. However, when a national allocation plan contains State aid within the meaning of Article 87 of the EC Treaty, the plan has to be notified to the Commission in accordance with the provisions of Article 88.

In Dezember 2002, a year after the Commission presented its proposal for an EU greenhouse gas emissions trading system, the Council unanimously reached political agreement on a common position on the Commission's proposal. This agreement confirms the EU's continued political leadership in the area of mitigation of climate change. "This is a landmark decision for the EU's strategy to fight climate change", Commissioner Wallström declared. "It proves that the EU is taking action on climate change and gets emissions down, and that we do so in a way that minimises the costs to the economy. The world's eyes have been upon us to see whether we will succeed in creating the biggest emissions trading scheme world-wide so far. We have succeeded. It will help all Member States, as well as the EU as a whole, to reach their Kyoto targets while cutting costs at the same time". She added: "As early movers on emissions trading we will gain valuable experience with this new instrument, and improve it over time. The EU will be well prepared to participate in the emissions trading system foreseen by the Kyoto Protocol from 2008".

Emissions trading will establish absolute limits on the emissions of carbon dioxide from the sectors covered, which is currently not the case. The trading of allowances will enable costs of cutting emissions to be substantially reduced while still achieving the same environmental benefit: operators that would incur high costs, were they to achieve additional emissions reductions can instead buy allowances from operators which have met their obligations at a lower cost and have excess allowances to offer for sale. An EU-wide emissions trading will cut cost to the economy by about 35%. Other greenhouse gases will eventually be included within the scheme upon a separate proposal from the Commission.

This is the first trans-national emissions trading scheme in the world covering potentially, with participation of the EEA countries and in view of the forthcoming EU enlargement, up to 30 countries in the period up to 2012. The CO_2 emissions expected to be covered by the scheme are estimated to account for about 46% of the EU 15's total CO_2 emissions in 2010, and about 4,000 to 5,000 installations across the existing EU Member States will be affected.

Elements agreed to include [8]:

- Opt-out: Although trading will start in 2005, individual installations or economic activities can be exempted from emission trading in the period 2005-2007. Opt-outs are however subject to approval by the Commission, on strict conditions.

These notably include fulfilling the same emission reduction requirements as companies and installations participating in the scheme;

- Opt-in: Member States can unilaterally include additional sectors and gases from 2008, subject to approval by the Commission;
- Pooling: The agreement also provides for the possibility for companies to pool their emission allocations until 2012;
- Allocation of emission rights: Allocations of emission permits will be free of charge. Member States can auction up to 10% of allowances from 2008;
- Penalties: The penalty rate foreseen for the period from 2005-2007 has been slightly reduced from 50 Euro per tonne of CO_2 equivalent emitted in excess of the allowance to 40 Euro. It will be 100 Euro thereafter.

Other greenhouse gases include the five other Kyoto Protocol greenhouse gases: methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). In addition, annual information on emissions of the following gases shall be provided: carbon monoxide (CO), nitrogen oxides (NO_x), non methane volatile organic compounds (NMVOCs) and sulphur oxides, in line with the reporting requirements under the UNFCCC.

4.2 Monitoring Mechanisms in the European Union

The system of linked national registries is central not only to the holding of allowances and the tracking of trades, but also for the adjustment of the Member States' commitments under the Burden Sharing Agreement. The linked national registries will be a crucial component of the Community Monitoring Mechanism established by Council Decision 93/389/EEC, in enabling the accurate tracking of what the entitlements of individual Member States are under the Burden Sharing Agreement. Furthermore, the national registries will provide accurate information on the emissions entitlement of the trading sectors in each Member State, and thereby serve as a check on the likelihood of Member States individually, and the European Community as a whole, living up to their commitments.

The current legal basis of the compilation of the EC inventory is Council Decision 99/296/EC amending Council Decision 93/389/EEC for a Monitoring Mechanism of Community CO_2 and other GHG ermissions. The purpose of this decision is to monitor all anthropogenic greenhouse gas emissions not controlled by the Montreal Protocol in the EC Member States and to evaluate progress towards meeting greenhouse gas reduction commitments under the UNFCCC and the Kyoto Protocol (KP).[1]

[1] It should be noted that the Commission has recently adopted a proposal (COM(2003)51 final) [9] to replace this Decision.

Under the provisions of Art 3.2 of Council Decision 99/296/EC, the Member States shall report to the Commission each year, not later than 31 December:

- Their anthropogenic CO_2 emissions by sources and removal by sinks for the previous calendar year;
- Final national inventory data on emissions by sources and removals by sinks for the other greenhouse gases for the previous year but one and provisional emission data (inventories) for the previous year.

The reporting requirements for the Member States under Council Decision 99/296/EC are elaborated in additional guidelines under this Decision. According to the Decision and these additional Guidelines the reporting requirements are exactly the same as for the UNFCCC, regarding content and format.

Based on the data provided by the Member States, the Commission establishes the Community greeenhouse gas inventory and circulates this to all Member States by 1 March each year. This procedure aims at achieving the best avaiable Member States' Data on greenhouse gas emission and removals for the compilation of the final annual EC greenhouse gas inventory (due to 15 April each year). This final inventory is required for two purposes:

- **The annual greenhouse gas inventory submission to UNFCCC:** The European Community, as the only regional economic integration organisation having joined the UNFCCC as a Party, has to report annually on greenhouse gas inventories within the area covered by its Member States. The EC greenhouse gas inventory including data of the EC as a whole (EU15) and of the individual Member States has to be submitted by the European Commission to the UNFCCC by 15 April each year.
- **The progress evaluation report under Decision 99/296/EC:** Under the Monitoring Mechanism, the European Commission has to assess, whether the actual and projected progress of Member States is sufficient to ensure fulfilment of the EC's commitments under the UNFCCC and the Kyoto Protocol. For this purpose, the Commission has to prepare a progress evaluation report, which has to be forwarded to the European Parliament and the Council by October each year.

The European Environment Agency (EEA) assists the Commission in the compilation of the annual EC inventory for both purposes, through the work of the European Topic Centre on Air and Climate Change (ETC/ACC). The activities of the EEA result in:

- Draft EC inventory by 1 March;
- Final EC inventory by 15 April (to be submitted by the European Commission to the UNFCCC Secretariat).

5 Strategies and Measures of the European Union for the final Conversion of the Reduction Defaults of the Kyoto Targets

At the beginning of July 2003 the European Parliament voted in favour of a compromise package on emissions trading, thereby finalising a Directive which will give carbon dioxide a market value across the Community from January 2005. "The agreement on this Directive signifies a breakthrough both for climate change and emissions trading"[10], Environment Commissioner Margot Wallström declared: "It means that the largest emissions trading scheme in the world to date will be a reality from 2005, and that the architecture foreseen under the Kyoto Protocol is coming to life. Companies across 25 countries must now start incorporating climate change into day-to-day commercial decisions, and begin assessing what innovative steps they can take to reduce emissions [10]".

Emissions trading will, for the first time, set limits on the emissions of carbon dioxide from energy intensive sectors. Companies reducing emissions to a level below their limit can sell this over-achievement to other companies above their limit; or "bank" it for future use. A company's strategy will largely depend on the price at which emission reductions are traded. In this way, the EU scheme will not only allow emission reductions to take place at minimum cost to the economy, but it will also bring climate change into the boardroom through giving carbon reductions a value. This in turn promotes innovation, which brings new opportunities to companies within the European Union.

Margot Wallström added: "When the European Union signed up to the Kyoto Protocol, we knew that this commitment would require solid action to follow. The EU emissions trading scheme demonstrates the Community's willingness to take such action which is not only ambitious in its scope but swiftly decided upon. I hope that other countries become inspired by our progress, in order that global action is taken to protect current and future generations from climate change [10]."

The EU scheme will be the first multi-national emissions trading scheme in the world covering all the Member States of an enlarged European Union. It is estimated that about 46% of the EU's total CO_2 emissions in 2010 will be brought under the scheme. The EU is encouraging other countries to adopt measures to tackle climate change such as emissions trading, and has indicated its willingness through specific text in the Directive to link the EU scheme to trading schemes in those countries that have ratified the Kyoto Protocol.

The final changes voted through in the compromise package today include:

- Method of allocating allowances: Auctioning has been extended to the first phase of the scheme. Member States now have the discretion to auction up to 5% of allowances in the first phase (2005-07), and up to 10% of allowances in the second phase of the scheme (2008-12). The remainder of the allowances will be allocated free-of-charge;

- Quantity of allowances allocated: Further safeguards protecting against the over-allocation of allowances have been added. Plus, the Directive now explicitly states that Member States must show that they are on a path to meeting their Kyoto Protocol obligations (2008-12) when proposing the quantity of allowances to be allocated to companies in the first phase (2005-07);
- Credits from the Kyoto Protocol project mechanisms (Joint Implementation and the Clean Development Mechanism): New text emphasises the importance of the Community undertaking domestic action to achieve greenhouse gas emission reductions, alongside using credits resulting from emission reductions made outside the Community;
- Future extension of the scheme to other sectors: The Commission will assess the coverage of the scheme in 2004 and 2006 with a view to the possible inclusion of other sectors, for example, the chemical, aluminium and transport sectors.

As a formality, the Council will adopt the Directive without discussion in one of its next meetings, and it will enter into force as soon as it bears the signatures of both the President of the Parliament, and the President of the Council.

The Commission shortly put forward a new proposal to link the Kyoto Protocol project mechanisms to the EU emissions trading scheme. The proposal provides details as to how project credits will enter into the EU market, the use of which will further lower the costs to companies with emission reduction obligations.

One of the core tasks in the run-up to the implementation of the EU-wide greenhouse gas allowance trading scheme is the elaboration of national allocation plans by Member States.

Allocation is governed by Articles 9 to 11 and Annex III of the Directive in the form of the common position. The first national allocation plans for the trading period 2005 to 2007 need to be finalised and submitted to the Commission by March 31, 2004. The Commission supports Member States in the allocation work. It has conducted two studies: "Evaluation of alternative initial allocation mechanisms in a European Union greenhouse gas emissions allowance trading scheme" and "Allowance allocation within the Community-wide emissions allowance trading scheme".

6 Interactions with Energy Taxes

Energy taxes aimed at tackling carbon dioxide emissions and emissions trading should be designed in such a way that they act as complementary instruments for covering the totality of emissions. While both instruments can be used at the same time in different sectors of the economy, this may give rise to adverse impacts on competitiveness if they are used at the same time within the same sector. The Commission recalls its proposal of 1997 [11] for an energy products tax, and continues to believe that the Community needs a general framework for the taxation of energy products. However, within this general framework, where activities are covered by the Community greenhouse gas emissions trading scheme, it would be appropriate to take into account the level of taxation that pursues the same objectives, without prejudicing to the application of Articles 87 and 88 of the Treaty.

The EU has debated for years the merits and drawbacks of setting minimum tax levels for electricity and gas, but has never agreed on the matter which requires unanimity among the 15 member states.

Environmentalists want an increase in energy tax as an essential policy to spur companies and individuals to use energy frugally and reduce the pollution caused by fossil fuels and nuclear power. EU diplomats said an agreement was possible, although there were many outstanding disagreements on the various exemptions from the tax required by member states. Another question is whether there should be a general exemption for agricultural energy use.

The draft under discussion would set a minimum tax rate of 50 cents per megawatt of electricity for companies and one euro per megawatt for households.For coal and natural gas, the proposed minimum rates are 15 cents per gigajoule for firms and 30 cents for private consumers.

Denmark, one of the EU's most environmentally-aware countries, has made the issue something of a priority. It is unlikely to receive the same attention from Greece and Italy which will chair the EU for the next 12 months. The most difficult issue is likely to be a request from France and Italy to maintain reduced tax rates for diesel used by hauliers. Germany, backed by the European Commission, is opposing such a concession

In 2004 the EU is due to let in up to 10 new member states, making unanimous decision-making even harder than at present.

In March 2003 European Union finance ministers signed up to common rules to tax energy products aimed at helping the environment after Austria lifted a reservation. More tax coordination and the removal of cross-border fiscal hurdles should ease the way that the 15-nation internal market works and are part of a 10-year agenda to boost competitiveness and growth that EU leaders are tackling at talks on March 2003. But the EU failed to find common ground on long-sought plans to tax income from billions of savings held abroad due to stiff resistance from Italy.

The common energy tax rules are aimed at deterring overuse of fossil fuels by introducing minimum tax rates on items such as gas and coal and raising tax rates on other products. Austria had held up a deal as it objected to a tax exemption for energy-intensive industries. The Internal Market Commissioner Frits Bolkesteing hailed the agreement as a major step in EU's quest for competitiveness.

But the proposed minimum energy tax rates are so low, and there are so many exceptions that they would result in few tax rises for EU citizens or firms.

Environmentalists see them, however, as an important first step toward higher energy taxation across the EU.

7 Contributions from other Sectors

Despite from the implementation of the so called "Flexible Mechanisms" following the Kyoto-Protocol it is also necessary to identify and develop the most important elements in the area of energy supply that are necessary for the implementation of the Kyoto Protocol. The following aspects were classified as relevant in the European Union:

- Further development of the internal electricity and gas market incorporating environmental considerations;
- Access to the grid for decentralized electricity production, increasing the share of renewable energies;
- Increased use of combined heat and power generation (CHP);
- Reduction of methane emissions in mining and extraction industries;
- CO_2 capture and disposal in underground reservoirs;
- Promotion of more efficient and cleaner fossil fuels conversion technology and
- Energy efficiency in the electricity and gas supply industry.

Apart from the range of the power supply the range of the energy consumption was identified as a further important topic. All energy end-use sectors are included in the activities of the European Union to reduce emissions, with special emphasis on energy consumption in buildings but including other aspects of the domestic and tertiary sectors and certain horizontal aspects of energy efficiency in industry. Specific instruments will include, e.g., best practices and benchmarking, audit schemes, technology procurement and heat performance certificates. Areas where there is a clear overlap between the Working Group on Energy Consumption and the Working Group on Industry will be referred to a Joint Sub-Working Group.

Special emphasis will be placed on the further development and refinement of ongoing and proposed Community policies and measures as outlined in the recently adopted "Action Plan to improve Energy Efficiency in the European Community".

Combined heat and power as a flexible and environmentally friendly and energy-efficient means of electricity and heat production is also included. Improvement of building and lighting performance are also priority areas. Building design and certain aspects of infrastructural planning are included. Public procurement initiatives will be given priority. Specifications for energy services for the domestic and tertiary sectors will be included, especially as outlined in the Action Plan for Energy Efficiency.

For the European Commission the transport objective requires to assess realistically the potential for a cost-effective approach for reduction of CO_2 emissions by the transport sector. Because after the present projections more than 90 % of the increase in CO_2 emissions, which can be expected up to the year 2010 will be caused by the transportation and traffic sector.

This means arriving at a least-cost package of compatible measures which realises the given objective of CO_2 reduction. This objective can be achieved by different combinations of levels of mobility, energy carriers, energy efficiency and fuel mix. The degree of interdependency of these three factors dictates the large margins of uncertainty that will surround any quantitive evaluation of policy measures affecting them. However, it is possible to indicate orders of magnitude of expected effects from various policy instruments and combinations of them, to obtain estimates of the potential CO_2 reduction impact of each measure. We should then see the effect on economic growth and on employment.

According to the Commission's Communication on Transport and CO_2 (COM(98) 204), the growth of about 260 Mt of CO_2 caused by Transport could be halved by implementing a number of cost-effective package of policy and measures, which were outlined in that document.

Up to the year 2010 the European Union wants at short notice to prevent an extreme increase of the CO_2 loads with the following measures in the freight and passenger sector:

- Revitalisation of rail;
- Promotion of multimodal transport, in particular road/rail and road/sea;
- Promotion of short-sea shipping;
- Improved logistics, including improved fuel efficiency of commercial vehicles.

Strategies to reduce CO_2 emissions from private cars, including fuel efficiency, fuel quality and non-product measures are:

- Promotion of public transport;
- Urban transport policy;
- Measures to enhance Air Traffic Management and
- "Economic" measures in aviation.

The objective in the area of industry is to identify and to assess the reduction potential of energy consumption in products and industrial processes and the assessment of rational use of energy and improvement of energy efficiency in various sectors. The assessment should be carried out and measures should be proposed in the following areas:

- Efficiency requirements for electrical and electronic equipment,

- Efficiency requirements for industrial processes and
- Improved energy service provision to industry, in particular to SMEs.

An outstanding position grants the European Commission in the connection of the future rushing direction to the aspect of intensified research activities. In this connection the attention is on the following aspects: Research and the stimulation, through the appropriate policies, of technological development and innovation should

become a structural element of the ECCP in parallel to good management and to regulatory and economic instruments.

As a matter of fact both the UNFCCC and the Kyoto Protocol include research among the policies and measures for emission limitation and reduction with a view to promoting sustainable development. The two instruments explicitly encourage the signatories to promote and co-operate in scientific, technological, technical, socio-economic and other research as well as systematic observations.

As identified in the Commission Communication one of the measures to be considered by the ECCP is the implementation of the framework programme, in particular in energy, environment and sustainable development.

The Kyoto commitments are considered as the starting point for emission mitigation. Further steps will require scientists to define, with accuracy and certainty the evolution of the phenomenon and its potential impacts on ecosystems, societies and economies. It is also important to invest on research for developing new methodologies and technologies for making mitigation more cost effective and socially acceptable.

Also the use of renewable energy and the more efficient production and consumption of all types of energy have a key role to play in the move towards creating a low intensive carbon economy.

Working to reduce the costs of renewable energy and more efficient energy systems in order to promote the take-up of low carbon technologies will be key to achieving a low carbon economy. But, in order to gain political support, we need to make clear that a low carbon economy is not just about the reduction of greenhouse gas emissions, there are other benefits too.

For example, developing renewable energy and energy efficient systems can have many positive environmental spin offs - from local air quality improvements to the reduction of deforestation which occurs in developing countries where the burning of wood for fuel is still a major problem.

The economy can also benefit. Renewable energy and energy efficiency can help ensure energy security. There are also growing commercial opportunities, as the Commissioner implies, as the global market for sustainable energy technologies continues to expand rapidly.

It is the aim to put the European Union on a path to a reduction in carbon dioxide emissions of some 60 % from current levels by the middle of the century. The goals for a new energy policy are:

- Primarily, to put the EU on a path to cut the carbon emissions with real progress marked out at 2010 and 2050;
- To maintain the reliability of energy supplies;
- To promote competitive markets in the EU and beyond and
- To ensure that every home is adequately and affordably heated.

These four objectives can be achieved together. It is this which makes a new energy policy a sustainable energy policy, and which further strengthens our commitment to sustainable development.

8 The Enlargement of the European Union and the Effects in balancing the EU Greenhouse Gas Emission Targets

Since 1998 the EU is negotiating accession with a large number of countries. Substantive negotiations on *accession* were set up with Cyprus, The Czech Republic, Estonia, Hungary, Poland and Slovenia, the so-called 'first wave' countries, plus Malta. The so-called 'second wave' countries (Bulgaria, Latvia, Lithuania, Malta, Romania, Slovakia) have not commenced substantive negotiations with the yet.

All accession countries are members of Annex B with the exception of Cyprus, Malta and Turkey (which has not even ratified the UNFCCC). It would be advisable for countries joining the EU to join Annex B upon EU accession. Since the negotiations on the next commitment targets shall start in 2005 (Art. 3.9 KP) a finalisation of the enlargement process (first wave and second wave) before this date would be desirable. Thus, these countries could be included in the negotiations on commitments for the second period. Among the countries listed in Table 2, only Cyprus has ratified the Kyoto Protocol so far. Within the first wave group, especially Poland and the Baltic states are unlikely to come near their Kyoto budget under business-as-usual. The volume of available permits of these countries under business-as-usual probably amounts to 130 million tons of CO_2, i.e. about 40% of the shortfall of the EU. In the case of Poland the GHG emissions decreased due to the economic decline. But in spite of a positive growth of GDP from 1992 further emission reduction could be observed because of lower energy consumption due to the structural change of the economy, e.g. substitution of coal by gas or fuel oil. In Estonia the economic depression resulted in a decrease of electricity generation. Moreover, increasing electricity prices have been the main reason for the considerable decline in GHG emissions. Hungary, Slovenia and the Czech Republic are less likely to produce sizeable surplus. They have been suffering from economic recession and the collapse of trade relations with the Former Soviet Union, which mainly resulted in reduced GHG emissions. However, the recoveries of energy-intensive industry and increases in the transport sector have changed the declining trend of the early years of transformation.

Table 2: GHG Emissions of the EU-15 and the EU-25

	1991	1992	1993	1994	1995	1996	1997	1998	1999
Belgium	104	103	102	105	107	109	105	108	106
Denmark	116	106	110	116	112	131	117	110	105
Germany	96	91	90	88	88	89	86	84	81
Greece	100	101	102	104	105	109	114	119	118
Spain	102	106	100	106	111	109	116	119	129
France	104	102	98	97	99	102	100	103	99
Ireland	101	102	102	105	107	110	115	119	122
Italy	100	99	97	96	101	100	101	103	103
Luxembourg	105	103	105	117	71	72	63	54	55
Netherlands	105	104	105	106	106	111	106	108	104
Austria	105	97	97	98	102	103	105	103	103
Portugal	103	108	106	106	113	110	113	119	131
Finland	97	93	93	101	98	104	103	100	99
Sweden	101	98	98	104	103	108	101	103	100
United Kingdom	100	97	94	94	92	95	92	92	87
Cyprus	100	100	100	120	120	120	120	120	140
Czech Republic	93.8	86.4	83.2	78.4	78.6	80.5	82.4	77.1	72.8
Estonia	93.3	68.8	54	56.3	51.2	53.9	54.4	49.4	45.2
Hungary	86.5	77.8	77.7	75.9	76.7	77.9	75.6	81.4	84.4
Lithuania	89.4	78.6	67.9	57.2	46.5	47.7	48.3	46.3	46.3
Latvia	80.2	65.9	54.2	49.4	43.2	40.9	38.5	39	36.5
Malta	108	115	118	121	122	123	120	122	126
Poland	77.5	77.9	76.1	77.8	73.8	77.4	75.5	71.3	70.9
Slovenia	88.9	88	91.1	91.6	95.3	99.3	99.3	99.3	99.3
Slovak Republic	88.1	81.7	76	72	74.5	74.2	74.3	72.6	70.7
EU15	100	98	96	96	97	99	97	98	96

Thus, it is estimated that the emission level in 2010 will be close to that of the base year. According to a World Bank Study, Hungary, Slovenia and the Czech Republic could offer 10 million tons CO2eq. per year within an emission trading regime if domestic policy instruments are implemented.

Two options are plausible. The first option would maintain the present EU target, but the targets of existing Member States would need to be renegotiated taking into account the situation in the new Member States. This option would mean that the lengthy negotiation process among existing Member States, similar to the one before the Kyoto conference, would be repeated each time a new CEE country accessed the Union. On the other side, this option would ensure the fulfilment of the EU pledge in Kyoto. The second option would simply add a new member into the present EU "bubble" without changing the existing Member State targets. In this case, a resource-intensive negotiation process could be largely avoided, but the EU target as a whole would change based on the performance of the new members.

Be it the first or the second option, it is in the interest of the European Union to assist their new potential members in achieving the best possible results in combating greenhouse gas emissions. And this might require the EU earmarking part of its assistance towards the CEE countries specifically for climate change-related projects.

A strategic EU climate policy should include accession countries. Thus, even in the case of early ratification of the Kyoto Protocol, it would be sensible to form a bubble with all countries that are certain to be EU members during the commitment period

2008–2012. Of course due to Art. 4,4 the EU-15 has to stick to its own bubble. However, nothing prevents it from forming an implicit bubble including all first wave countries by inducing them to form a bubble on their own and transfer the surplus to the EU-15. Similarly, second wave countries should form a bubble of their own to co-ordinate JI and permit transfers to the EU. This would reduce the gap between business-as-usual and the target by about 50%. If ratification is delayed to a point where it is clear which second wave countries will be members by 2008, the bubble should be extended by those countries. When in 2005 target negotiations start for the second commitment period, the EU should negotiate a bubble consisting of all states being certain to be members by that time.

Any creative bubbling by the EU might lead to replication of these efforts by other Annex B countries and considerably change the use of the project-related flexible instruments.

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HOW TO COPE WITH RISING EMISSIONS FROM DEVELOPING COUNTRIES

Chandrashekar Dasgupta
Distinguished Fellow, TERI
Habitat Place, Lodhi Road
110003 New Delhi
India
E-mail: dasgupta@teri.res.in

1 Introduction

Future historians will identify the eradication of mass poverty as one of the defining achievements of the 21st century. Despite the progress achieved in the latter half of the 20th century, hundreds of millions of people in Asia, Africa and Latin America still lack the most basic requirements in terms of nutrition, health, shelter and education. According to a World Bank study[1], 2.8 billion people – accounting for almost half of humanity- live on a daily income of less than 2 dollars. Among these, 1.2 billion – a fifth of humanity- struggle to eke out an existence on less than 1 dollar per day. At the World Summit on Sustainable Development, held in Johannesburg last year, global leaders resolved to halve by 2015 the proportion of the world's people whose income is less than 1 dollar per day, of those who have no access to safe drinking water, and of those lacking access to basic sanitation.

2 Energy Requirements for Poverty Eradication

The fulfilment of these goals will require a major increase in energy consumption and, therefore, of carbon emissions in the South. The International Energy Agency (IEA)[2] estimates that only 40.8 % of households in developing countries have access to electricity. The picture is even worse in rural areas, where the bulk of the people live. Here, only 30.1 % of households have electricity. The implications of these figures in terms of nutrition (food preservation), health services and educational facilities can easily be imagined. In societies deprived of hydrocarbon energy, economic activity continues to be heavily dependent on human and animal muscle power. Agriculture is based on hoe cultivation (based on human muscle power) or on ploughs drawn by draught animals. Transportation depends on porters or on carts drawn by human beings or animals. In the millions of villages that lack access to drinking water, womenfolk have to walk several kilometers to the nearest source in order to bring back head-loads of water for the domestic needs of their families.

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[1] World Bank: World Development Report 2000/2001 - Attacking Poverty
[2] International Energy Agency: World Energy Outlook 2002

Access to modern energy resources is an absolute requirement for freeing hundreds of millions of people from such brutish levels of poverty.

The IEA study gives the following sectoral break-up for projected increases in CO_2 emissions from the developing countries (in million tonnes of CO_2) in the periods 1990-2010 and 2000-2030:

Table 1: Sectoral break up of emissions increase of developing countries

	1990-2010	*2000-2030*
Power generation	*2,870*	*5,360*
Industry	*739*	*1,298*
Transportation	*1,040*	*2,313*
Other	*620*	*1,365*
TOTAL	*5,268*	*10,336*

IEA projections show that energy consumption in the industrialized countries will also increase, with rising levels of affluence. However, the bulk of the increase in emissions will originate in developing countries as they struggle to provide their populations with basic necessities. The developing countries, accounting for the bulk of the world's population, today account for a mere 30 % of global energy demand. This is projected to rise to over 40 % by 2030. Global CO_2 emissions are projected to increase from 22 billion tonnes in 2000 to 38 billion tones in 2030 – an increase of 70 %. Two-thirds of the increased emissions will originate in developing countries. By 2030, developing countries will account for 47 % of global CO_2 emissions.

To put this into proper perspective, it must be remembered that the bulk of the world's population is concentrated in the developing countries. Thus, in per capita terms, energy consumption and carbon emissions in the developing countries will still be very small compared the industrialized countries, even after three decades. For example, IEA forecasts that India's per capita emissions will increase from 0.9 tonnes in 2000 to 1.6 tonnes in 2030. The latter figure will remain a small fraction of the per capita OECD emissions, which will increase to 13 tonnes by 2030. Thus, even after three decades, per capita emissions in India will be only 12 % of the OECD figure.

Three salient facts emerge from these projections:

- Aggregate CO_2 emissions of developing countries will rise more rapidly than those of industrialized countries in order to meet the challenge of poverty eradication;
- Aggregate CO_2 emissions of the developed countries will continue to increase over the next three decades, despite their obligations under the UN Framework Convention on Climate Change (UNFCCC) and the Kyoto

Protocol. Even in 2030, emissions from the developed countries will constitute the larger part of global emissions;

- Per capita emissions from developing countries will remain far below the level of industrialized countries even 30 years from now.

3 The Debate about Developing Country Commitments

Industrialized countries point to the first of the facts listed above in order to urge the developing countries to take on new mitigation commitments. They argue that unless this is done, emission reductions in the industrialized countries would be more than offset by rising emissions in the developing countries. Thus, EU and Japan have proposed initiation of discussions on new emission obligations for developing countries in the second commitment period under the Kyoto Protocol, beginning from 2012.

Developing countries, on the other hand, point to the second and third of the facts listed above in order to press for greater mitigation efforts on the part of the industrialized countries and to reject as inequitable proposals to impose binding new commitments on developing countries. They maintain that it would be inequitable to require them to accept binding emission commitments before their per capita emissions – as well as per capita incomes - converge with those of the industrialized countries. They point to the huge disparities in these indicators and the negative impact that new emission obligations would have on economic and social development and, in particular, poverty eradication. They also point out that binding emission commitments would result in distortion of their environmental priorities. Climate change would, of course, have very serious long-term impacts on developing countries, but these countries also face other critical environmental problems of even greater urgency. Priority must be given to such problems as lack of access to clean drinking water, for example, that cause millions of deaths every year. At COP 9, held in New Delhi last year, the G-77/China group firmly rejected a proposal to initiate negotiations concerning new commitments for developing countries.

There is a certain lack of clarity in the current debate. The *real issue is NOT the desirability of moderating the increasing emissions from the developing countries*. Developing countries have always accepted the voluntary and contractual emission commitments envisaged in UNFCCC article 4.3, which provides that the full agreed incremental costs of such measures shall be met through contributions by developed (Annex II) countries. The Kyoto Protocol, likewise, provides for cooperation on a similar basis through a Clean Development Mechanism (article 12). *The real issue concerns the apportionment of the costs of emission moderation measures taken in developing countries*. Should the costs be borne by developing countries (as would be the case if non-contractual, binding commitments are imposed on these countries) or should the incremental costs be met by industrialized countries, which are mainly, if not exclusively, responsible for, precipitating climate change and which also possess the financial and technological resources needed to address the problem? This is the real issue between North and South in current negotiations.

4 Implementing UNFCCC

UNFCCC does not fail to take note of the fact that emissions from developing countries would inevitably increase, nor does it fail to provide for measures to moderate these increases. It specifically notes that " the share of global emissions originating in the developing countries will grow to meet their social and development needs." But it also observes that "the largest share of historical and current emissions of greenhouse gases has originated in developed countries, [and] that per capita emissions in developing countries are still relatively low." It recognizes that the participation of countries in an international response should be "in accordance with their common but differentiated responsibilities and their respective capabilities and their social and economic condition." In view of these and other relevant considerations, UNFCCC envisages binding emission limitation targets only for industrialized (Annex I) countries. Moreover, it requires Annex II countries (broadly corresponding to the OECD) to contribute financial and technological resources to enable developing countries to participate in an international response. These contributions are to be used to meet the "agreed full incremental costs" of measures implemented by developing countries. UNFCCC specifies that "the extent to which developing country Parties will effectively implement their commitments under the Convention will depend on the effective implementation by developed country Parties of their commitments under the Convention related to financial resources and the transfer of technology." It goes on to emphasize that "economic and social development are the first and overriding priorities of the developing country Parties."

It will be seen from the foregoing that proposals requiring developing countries to take on binding commitments without provision of financial resources to cover the full incremental costs involved, are inconsistent not only with the letter but also the logic of UNFCCC. *These would involve abandoning UNFCCC or, at the very least, amending it in a manner that would involve fundamental changes in its logic and framework.* The G-77/ China group, which accounts for a large majority of the Parties to UNFCCC have made it amply clear that they will reject attempts to impose new, binding commitments on developing countries and that they regard such proposals as inequitable. To insist on such proposals would effectively undo UNFCCC and such progress as has been achieved through international negotiations since 1989. The alternative approach is to proceed on the lines already agreed in UNFCCC and to bring into full operation the provisions of its article 4.3.

UNFCCC outlines two commitments for the industrialized countries: first, a commitment to limit their greenhouse gas emissions (article 4.2); and, second, a commitment to provide "new and additional" financial resources to developing countries to enable the latter to implement measures under the convention (article

4.3). It should be noted that the latter is a binding legal obligation ("the developed country Parties and other developed Parties included in Annex II *shall* provide new and additional financial resources…"). Moreover, the article points to the requirement that the flow of funds should be adequate and predictable ("The implementation of these commitments shall take into account the need for adequacy and predictability in the flow of funds and the importance of appropriate burden sharing among developed country Parties".). While laying down this framework, the convention left it to future protocols to translate these general commitments into specific, time-bound targets.

The Kyoto Protocol took the UNFCCC process a step further by laying down time-bound numerical *emission limitation* targets for Annex I Parties. It did not lay down similar targets for financial flows from Annex II countries to developing countries to enable the latter to implement measures under the convention. Logically, therefore, the next step should involve adoption of specific, time-bound *financial* commitments for Annex II countries. This alone would provide an equitable basis for implementing measures to moderate rising emissions from developing countries. Unless a post-2012 protocol includes such provisions, the process of translating the UNFCCC into action will not be completed.

5 Conclusions

We may now sum up our principal conclusions, as follows:

- UNFCCC requires that Annex II Parties provide financial resources to cover the "full agreed Incremental costs" of measures implemented in developing counties in agreement with the Global Environment Facility. It imposes no emission commitments on developing countries that are not of this conditional and contractual character;
- There is no real disagreement between the North and the South on the need to implement measures in developing countries with a view to moderating the rapidly increasing greenhouse gas emissions in these countries. The real in issue is: who will bear the incremental costs? The industrialized countries are pressing for binding commitments that would, in effect, transfer the incremental costs to the developing countries. The latter are not prepared to accept such proposals;
- The position taken by the industrialized countries is not in accord with UNFCCC. It implies abandoning UNFCCC or, at least, introducing fundamental changes in its provisions and in its underlying logic;
- Since developing countries are strongly opposed to the proposed new commitments, pursuing the current line further threatens to unravel UNFCCC and the progress in negotiations achieved since 1989;

- The only alternative is to implement in full the UNFCCC provisions relating to transfer of finance and technology. This would entail financial contribution targets for Annex II countries, in addition to emission reduction targets for all Annex I countries post-2012.

Strategies for Sectoral Emission Reduction in Germany

Manfred Kleemann
Forschungszentrum Jülich GmbH
Programme Group Systems Analysis and Technology Evaluation (STE)
52425 Jülich
Germany
E-Mail: m.kleemann@fz-juelich.de

1 National Carbon Dioxide Reduction Goals

The German Government declared in the past the national carbon dioxide reduction goal to be 25 % by the year 2005, relative to the internationally defined base year 1990. Since the initial emission in 1990 amounted to 1015 mill. tonnes, the rate of 25 % means a physical reduction of 254 mill. tonnes. Due to recent statements of the German Ministry for Environment (BMU), the 25 % reduction goal for 2005 is still politically effective. On the other hand, the Government and many experts have been aware of the difficulties of achieving such an ambitious reduction level. Present trends of carbon dioxide emissions show clearly that this goal cannot be reached. The policy has to be changed to a less ambitious reduction level.

The agreements of the Kyoto Protocol seem to be more realistic with regard to the reduction level and the available time span. This protocol obliges the European Community to reduce the emissions by 8 % until 2008/2012 in the whole community. In the framework of the European burden sharing agreement Germany took over a guiding role and declared its reduction goal to be 21 % by 2008/2012. The German Minister for Environment declared recently: Despite all predictions to the contrary we are well on the way to achieving our goal of 21 % reduction by 2010. Discussions and scientific investigations on long-term CO_2 reduction goals aim at mitigation levels of 40 % by 2030.

2 Development of overall Energy Use and Carbon Dioxide Emissions

2.1 Pattern of primary Energy Consumption

Figure 1 shows the development of the primary energy consumption from 1990 until 2001 in Germany. The effects of warm and cold winters have been eliminated. According to Figure 1 the primary energy consumption declined from 1990 to 1994. This is due to the utilization of more efficient technologies and the restructuring of the economy in East Germany after reunification in 1990. After 1994 economic growth slightly accelerated the consumption, but the total level in 2001 remained about 3 % below the 1990 level.

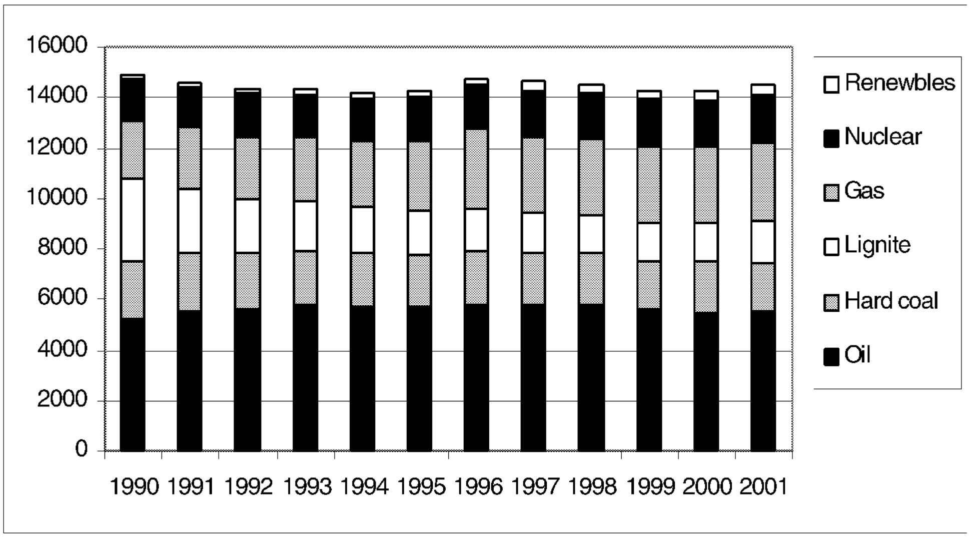

Figure 1: Development and pattern of primary energy consumption in PJ

But the individual development of the various fuels is quite different. The use of oil increased from 5238 PJ in 1990 to 5577 PJ in 2001, which is equal to a 6.5 % increase. This growing demand has been forced mainly by the increasing traffic sector. Hard coal use declined by 17.4 %. The extreme high production costs for German hard coal are responsible for this development. Lignite faced an extreme reduction. Its utilization came down from 3201 PJ to 1630 PJ, which is a reduction rate of nearly 50 %. The main reason for this decline is the restructuring of the East German economy, which was heavily dependent on lignite before the reunification. Natural gas is the winner in this competition. Its utilization increased by 35 %. This fuel is easy to handle, relatively cheap and environmentally compatible. These excellent properties guarantee an increasing demand. Nuclear power contributed a slightly growing share of about 12 %. This is caused by the increasing annual availability of the existing power plants. No new capacities have been installed during the last decades. The share of renewable energies increased from 1.2 to 2.7 %. Despite the extreme growth rate of 113 %, the overall contribution is still low.

These figures show clearly, that Germany's present primary energy consumption highly depends on fossil fuels. About 24.3 % are met by coal, about 38.5 % by oil und about 21.5 % by natural gas. The total fossil share amounts to 84,3 %. This results in a relatively high carbon dioxide emission level.

The present energy policy of the German Government aims in general at:

- A reduction of hard coal and lignite use;
- An increase of natural gas utilization;

- A strong preference of renewable energies;
- A phasing out of nuclear energy;
- A reduction of energy consumption.

2.2 Carbon Dioxide Emissions Decline

The reduction rate of carbon dioxide emissions is higher than the corresponding rate of primary energy consumption. The fuel switch from lignite, hard coal and fuel oil to natural gas has caused this additional mitigation. Additional but relatively low reduction effects are caused from the increasing use of renewable energies.

The carbon dioxide emissions of the various sectors show different developments from 1990 until 2001. A high reduction of 68 mill. tonnes or 16.5 % has been achieved in the electricity and district heat generation sector (see Table 1 and Figure 2). About 64 mill. tonnes have been reduced in the industrial sector. This means a reduction rate of 32.5 %, which is the highest of all sectors. The household and commercial sectors reduce together 25 mill. tonnes, which is equivalent to rate of 11.6 %. But it should be noticed that the trends in both sectors are completely different. The commercial sector strongly declines whereas the household sector slightly increases. The most unfavourable development happened in the traffic sector. Here the carbon dioxide emissions did not decrease but increase by 16 mill. tonnes or 9.9 %. The reduction of non-energy related production processes amounts to 4 mill. tonnes or 11.6 %.

Table 1: Development of energy related carbon dioxide emissions from 1990 to 2001 by sector

	1990	1995	2001	1990-1995	1995-2001	1990-2001
	Mill. tonnes			Changes in %		
Electricity and district heat generation	413	352	345	-14.8	-1.7	-16.5
Industry and construction	197	150	133	-23.9	-8.6	-32.5
Commercial	76	63	55	-17.1	-12.7	-27.6
Household	139	131	135	-5.7	3.1	-2.9
Traffic	162	177	178	9,3	0,6	9,9
Mineral and chemical industries	28	26	24	-4.7	-6.9	-11.6
Total	**1015**	**899**	**870**	**-11.4**	**-2.8**	**-14.2**

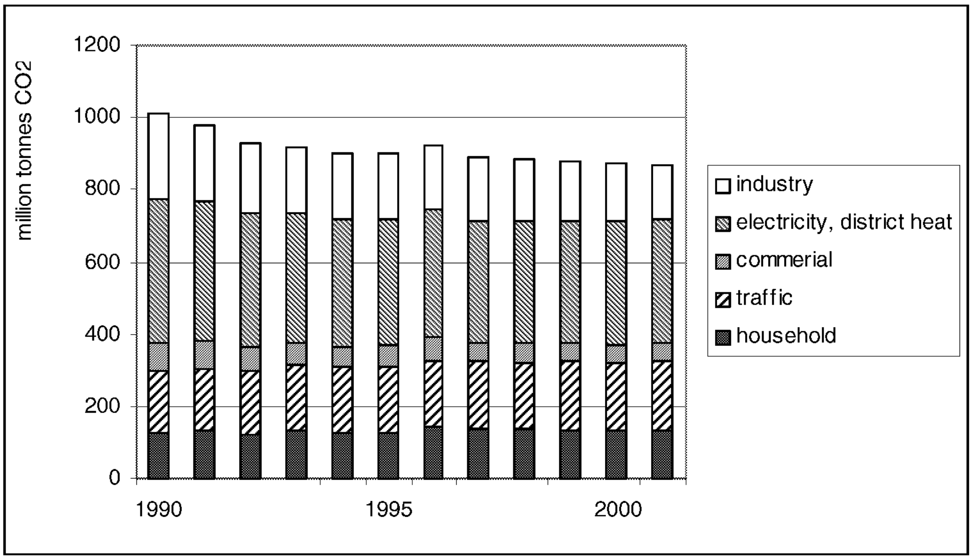

Figure 2: Development of carbon dioxide emission and reduction goals

The level of the total carbon dioxide emissions decreased from 1015 mill. tonnes in 1990 to 870 mill. tonnes in 2001. The 145 mill. tonnes correspond to an overall reduction rate of 14.2 %. The speed of reduction declined considerably. During the five years period from 1990 to 1995 the emissions were reduced by 116 mill. tonnes. But in the following six years from 1995 to 2001 the carbon dioxide reduction amounted to not more than 29 mill. tonnes. The high level from 1990 to 1995 was partly caused by the restructuring of the East German economy after reunification.

3 The residential Sector

3.1 Development of basic parameters

The most significant factors affecting energy consumption and CO_2 emissions are summarized in Table 2.

Table 2: Expected development of floor space and units of accommodation

		1990	2000	2010	2020
Resident population	10^6	80.6	82.7	83.4	81.2
Total units of accommodation (number of households)	10^6	34.4	36.9	38.0	38.1
Total floor space	$10^9 m^2$	2.86	3.14	3.33	3.40
Floor space per unit of accommodation	m^2	83	85	88	89
Floor space per capita	m^2	35	38	40	42

In the long-term it is expected that the resident population after a small, intermediate increase will decline and reach again the present level after 2020. But in contrast to this development the number of accommodation units and the floor space area will steadily increase, due to social changes and increasing income development. Both parameters are expected to grow in the long-range at an average rate of 0.6 % per annum. They will force the energy demand for space heating.

3.2 Structure of Energy Consumption

In 2000 the total final energy consumption of the residential sector amounted to 2550 PJ. About 2004 PJ or 78.6 % of this energy have been used for space heating. Only 9.5 % are consumed for warm water preparation. About 8.8 % are used for electric appliances and 1.0 % for lighting. The remaining 2.1 % served as cooking energy.

According to Table 3 space heating and warm water preparation are dominated by light fuel oil and natural gas. But the share of light fuel oil declines steadily whereas the share of natural gas increases. It is expected that these trends will continue in the future. Warm water preparation and especially cooking are based on electricity to a considerable share. Solid fuels are expected to disappear from the fuel market in the long run.

Table 3: Pattern of final energy consumption in the residential sector in 2000

	Space heating		Warm water		Cooking		Appliances and lighting
	PJ	%	PJ	%	PJ	%	PJ
District heat	133	7	20	8			
Light fuel oil	802	40	72	30			
Natural gas	869	43	95	39	16	29	
Coal and solid fuels	90	5	6	2	1	2	
Electricity	109	5	51	21	37	69	230
Total	**2004**	**100**	**243**	**100**	**54**	**100**	**250**

3.3 Emission Reduction Measures already taken

It is commonly agreed that the residential-building sector holds the greatest reduction potentials. Therefore the previous national report on climate protection in Germany mentioned already a considerable number of implemented political measures. Some important measures are considered in the following sections.

3.3.1 Amendment of the Thermal Insulation Ordinance

The new Energy Saving Ordinance for buildings (ESPVO) came into force in 2002. The ordinance is expected to reduce the heating demand for new buildings by up to 25 %, thus reducing CO_2 emissions by a similar amount. At the same time it is aimed at improving energy efficiency in existing buildings.

Figure 3 shows the development of the various ordinances during the last 30 years. In average the regulations have been tightened every five to six years. The allowable annual useful heat consumption has been reduced in average from 300 to 60 kWh per square meter ground floor.

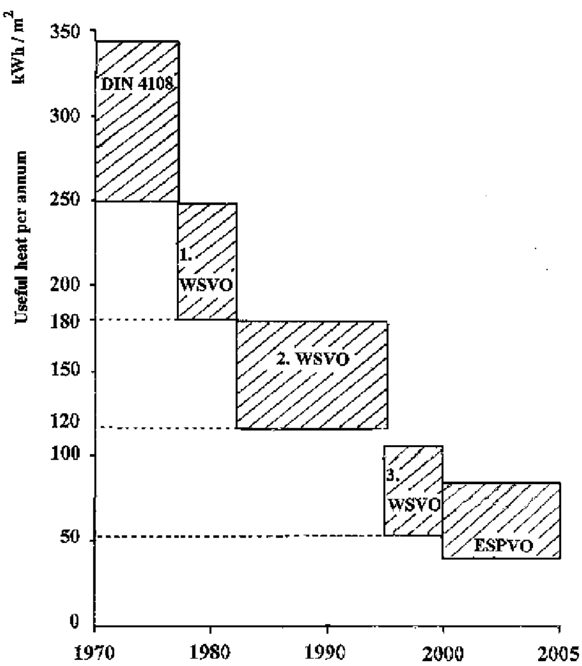

Figure 3: Development of ESPVOs

3.3.2 Housing Modernisation Programme in East Germany

This programme was established in 1990. It provides low-interest loans for renovation and modernisation of houses. This includes also energy-saving measures. Up to now about 4 mill. dwellings have been supported in East Germany. This figure amounts to about 50 % of the total number of apartments in this part of the country. Now the programme has been extended to total Germany.

3.3.3 Programme for CO_2 Reductions in existing Buildings

The programme finances especially measures in existing residential buildings to reduce energy consumption and CO_2 emissions. The support is provided in form of low-interest loans for improvement of thermal insulation, new efficient boilers and the use of renewable energies.

3.3.4 Information and Motivation Programmes

Various ministries, agencies, institutions and many other organisations provide guidance to the owners of buildings in selecting and executing appropriate modernisation and energy saving measures.

3.3.5 Ecological Energy Tax

This measure is in fact an intersectoral measure. In 1999 it increased fuel oil prices for residential heating by 2 Cents per litre and in the years 2000 until 2003 the tax has been increased in four steps by 3 Cents per litre each year. For comparison: The price of a litre fuel oil is in the range of 30 to 35 Cents.

3.4 Additional Reduction Measures

Table 1 shows that the overall CO_2 reduction in the household sector from 1990 until 2001 amounts to 2.9 %. This is by far not enough to reach the reduction goals. The main reasons for this insufficient development are:

- The floor space increased by 10 %, which causes a respective increase of additional energy demand and CO_2 emissions (see Table 2).
- The main problems are caused in the building stock (existing buildings). The modernisation took not place as expected. This has two reasons:
  - The running financial supporting programmes are considered not to be attractive enough for the investors.
  - Many of the owners who renovate their building do not follow the energy saving regulations. Sometimes for example, they don't install a sufficient thermal insulation, because the authorities do not inspect or control the executed renovation.
- The low annual renovation rate, due to the high lifetime of building components, creates another problem. According to the experience in Germany an average residential building is renovated once within 50 years. Therefore the average annual renovation rate reaches only 2 % of the building stock. Hence the total system changes very slowly. A quick CO_2 reduction cannot be expected in the residential building sector.

To overcome some of these constraints additional reduction measures are necessary. This requires a more stringent climate protection policy. Scientists and politicians discuss the following additional enforcement measures:

- A more effective control and inspection if the requirements of the building regulations are met;
- A further increase of the thermal insulation standards;
- More attractive financial incentives for the building owners;
- A more intense use of high efficient heat generation technologies;
- The further increase of renewable energy use.

4 The commercial Sector

4.1 Energy Use and CO_2 emissions

In the commercial sector final energy consumption declined from about 1570 PJ in 1990 to about 1450 PJ in 2000. This is equivalent to a reduction rate of 8 %. At the same time the CO_2 emission decreased from 76 mill. tonnes to 55 mill. tonnes. The reduction rate amounts to 27.6 %, which is considerably higher than the rate of energy use. This development is mainly due to the restructuring of the East German economy after reunification. During the modernisation process the high share of lignite utilization was replaced by natural gas, which has a considerably lower CO_2 emission coefficient. Moreover new and efficient technologies have replaced old technologies. Table 4 shows for what purposes final energy is used in the commercial sector.

Table 4: Final energy consumption in the commercial sector

	%
Space heat for buildings	49
Warm water preparation (low temperature)	11
Cooling, air conditioning	4
Process heat (high temperature)	7
Shaft power	16
Lighting	10
Electrical equipment	3
Total	**100**

4.2 Implemented Measures

About 60 % of the energy is used for space heating and warm water, therefore some of the measures for the residential sector are effective in the commercial sector too: The most important implemented measures are:

- Amendment of the thermal insulation ordinance

  This measure is described in chapter 3.2 above.

- Ecological energy tax

  The ecological energy tax is an instrument by which the government tries to influence, through higher costs, the behaviour of consumers and to induce energy and CO_2 savings. This measure is effective in all sectors.

  The ecological tax increased energy prices in 1999 as follows: electricity by about 1.0 Cent per kWh and light fuel oil for heating by 2 Cents per litre and natural gas by 0.16 Cents per kWh. In the years 2000 until 2003 the tax has been increased in four steps by 3 Cent per litre of fuel oil and by 0.25 Cents per kWh electricity.

For comparison: Electricity for private households costs between 15 and 20 Cents per kWh and for natural gas households pay between 3 and 4 Cents per kWh.

- German industries voluntary commitment on climate protection

  This measure is described in chapter 5.2 (see below).

- Measures to support cogeneration of heat and electricity

  Several legal measures support combined heat and electricity generation in industries. This makes industrial cogeneration economically more attractive.

4.3 Supplementary Measures

For the year 2030 a reduction rate of 40 % relative to 1990 is envisaged. This requires a stricter climate protection policy and additional measures such as:

- Use of more effective multiple purpose technologies

  This includes electricity reduction measures for applications, which are used in the commercial sector, such as; compressed air, pumps, blowers, electrical motors, air conditioning, electrical process heat, lighting and office machines.

- Reduction of space heating demand (Described in chapter 3.4.)
- Efforts for a more effective energy use

  Comprehensive concepts and measures need to be developed to overcome constraints for a more efficient use of energy in various branches of the commercial sector.

5 The industrial Sector

5.1 Energy Use and CO_2 Emissions

The total final energy consumption declined from 2977 PJ in 1990 down to 2430 PJ in 1993. This development is due to the restructuring and modernisation of the East German industry after reunification. Modern technologies have replaced old and inefficient technologies. From 1994 until 2001 the industrial consumption level remained nearly constant and reached 2430 PJ in 2001. An increase did not happen during the last years due to the low economic growth in Germany as well as to the taken reduction measures. The total reduction rate from 1990 to 2001 amounts to 18.4 %. According to Table 1 the CO_2 emissions decreased from 197 mill. tonnes in 1990 to 133 mill. tonnes in 2001. This results in a mitigation rate of 32.5 %. Compared to the other sectors, industry has reached the highest reduction rate.

5.2 Implemented Measures

Although restructuring and modernisation of East German Industries has caused the strongest effect, several political measures have been taken. The most important ones are listed below.

- Amendment of the thermal insulation ordinance

  This measure reduces the heat demand in new and old industrial buildings. It is described in chapter 3.2 above.

- Ecological energy tax

  Already described in chapter 4.2 above.

- German industries voluntary commitment on climate protection

  The German industries have stated in 1996 their willingness to make special efforts to reduce their specific CO_2 emissions and their specific[1] energy consumption. Some of the industrial associations also made a commitment regarding absolute CO_2 reductions. The voluntary commitment of the industries covers most of the industrial final energy consumption and of the public power supply. The commitment has been improved in 2000. Compliance with the commitments will be monitored by an independent agency.

- Measures to support coupled heat and electricity production

  Explained in chapter 4.2 above.

5.3 Additional Measures for the Future

Scenarios for the industrial sector aim at a reduction rate of 40 % for the year 2030. To reach this goal, the total final energy consumption of the sector has at least to remain on the level of the year 2000. Moreover CO_2 intensive energy carriers like coal and oil have to be replaced by natural gas to a large extend.

- Efforts for a more effective energy use

Further measures need to be developed and implemented for a more efficient use of energy in the following fields of industrial energy consumption:

  - Process heat use;
  - Electricity use and
  - Coupled heat and electricity generation.

[1] per unit of production

6 The Traffic Sector

6.1 The increasing Demand of the Traffic Sector

In comparison to other sectors, the traffic sector exhibits most unfavourable trends in energy consumption and CO_2 emission. The final energy consumed in 1990 amounted to 2379 PJ. Until 2000 the consumption increased by a growth rate of 15.4 % and reached about 2745 PJ. The corresponding CO_2 emissions of the transport sector as a whole grew by 10 %. The reason for this development is that the mileages for all modes of transport increased tremendously. The demand for passenger miles grew from 730 billion pkm (passenger-kilometre) to 926 billion pkm (increase 27 %). The growth of the demand for tonnes-kilometre (tkm) was even higher. The level increased from 300 billion tkm in 1990 to 505 billion tkm in 2000, which is equal to an increase of 68 %.

6.1 Implemented Measures

The CO_2 reduction policy for the traffic sector has to deal with greater challenges, compared to other sectors. Beside ecological concerns it has to be ensured that the transport system remains effective for industry and commerce and that the individual demand for mobility can be met in a reasonable manner. The German climate protection policy has taken several measures up to now. The most important ones are presented in the following sections.

- Ecological energy tax

  The aim of this measure is to reduce the demand for individual mobility and to make public transport more attractive. The ecological tax increased in 1999 the price for motor fuels by 3 Cent per litre and in the years 2000 until 2003 the tax has been increased in four steps by 3 Cent per litre each year. For comparison: The price of motor fuel is in the range of 110 to 120 Cents per litre.

- Introduction of sulphur-free motor fuel

  Fuels free of sulphur make it possible to use engine technologies, which have a lower fuel consumption than conventional engine technologies.

- Introduction of toll on motorways

  Money should be paid for the use of motorways by lorries. The purpose of this measure is to shift road transportation to railway transportation.

- Emission related tax for motor vehicles

  For passenger cars with low consumption and low emission levels less tax has to be paid. The idea of these incentives is to make low-emission cars attractive for producers and owners. The overall number of heavily polluting vehicles has already been reduced.

6.2 Need for further Measures

All measures implemented were not able to reduce the traffic emissions; they only prevented an even stronger increase of the emissions. Additional and more effective measures are needed in the future.

- Campaign for climate protection in the traffic sector

  An intensive and comprehensive campaign for bicycle use, fuel saving car driving and extended use of public transport is necessary.

- Introduction of low emission and zero emission fuels

  This includes motor technologies based on LPG, bio fuels and hydrogen.

- A comprehensive concept for sustainable traffic

  Such a concept must include transport infrastructure, transport management, legal aspects, economic considerations, technological aspects, community planning, public relations work and education and training.

7 The Electricity Sector

7.1 Development of Generation

Electricity use increased slightly from 570 TWh in 1990 to 610 TWh in 2000. The growth rate amounts to about 7 %. But according to Table 1 declined the CO_2 emissions by 16.5 %. About 14.8 % have been reduced in the period from 1990 to 1995. This high reduction is due to the restructuring and modernisation of the East German power industry. New units, partly based on other fuels than coal, have replaced all the old, lignite-fired power stations.

Germany has completely liberalised the electricity market in 1998. This has caused lower electricity prices, especially for the industrial sector, as well as the development and provision of new electricity products such as “green electricity”. As a consequence of liberalisation suppliers have improved their efficiencies to protect their competitiveness. But on the other side lower prices can stimulate consumers to use more electricity. The impact of liberalisation on CO_2 emissions is not yet clear.

7.2 Taken Measures

- Enhancement of generation efficiencies

  Significant progress has been made in recent years in the case of lignite-fired plants and modern gas fired capacities. The efficiencies of new and existing plants have been increased significantly.

- Support of cogeneration

  German industry has committed itself to retaining, modernising and expanding cogeneration. Additionally a new act on heat and power cogeneration came into force in 2002.

- Expansion of renewable energy use

  The German government considers the expansion of renewable energies use as an important opportunity of achieving sustainable energy supply. The Renewable Energy Sources Act, established in 2000, obligates operators of electrical power networks to accept electricity generated with renewables and to pay certain minimum rates. The act has promoted the expansion of renewable energies distinctly.

- Phasing out of nuclear power

  The German Government and the electric power utilities agreed to phase out nuclear power plants. The current share of nuclear electricity in total generation amounts to 30 %. Depending on what types of power stations replace the nuclear capacities, tremendous amounts of additional CO_2 emissions will be generated. With the present non-nuclear power plant mix, the CO_2 emissions would increase by 145 mill. tonnes if the nuclear plants were switched off suddenly.

7.3 Supplementary Measures

The additional measures, which are necessary in the future, aim mainly at:

- Reduction of electricity demand in the end use sectors;
- Further expansion of electricity generation from renewables and
- Increase of gas utilization.

8 Conclusions

Up to now the German climate protection policy has achieved a good progress with an overall reduction level of 14.2 % (CO_2). But with the already implemented measures in all sectors the CO_2 emissions will reach a level of about 850 mill. tonnes within the next years. This is equal to a reduction rate of about 15 % (see Figure 4). It's unlikely that the 25 % goal can be managed with the up to now implemented measures. Therefore additional measures, as discussed above, have to be introduced to reach 40 % reduction in 2030.

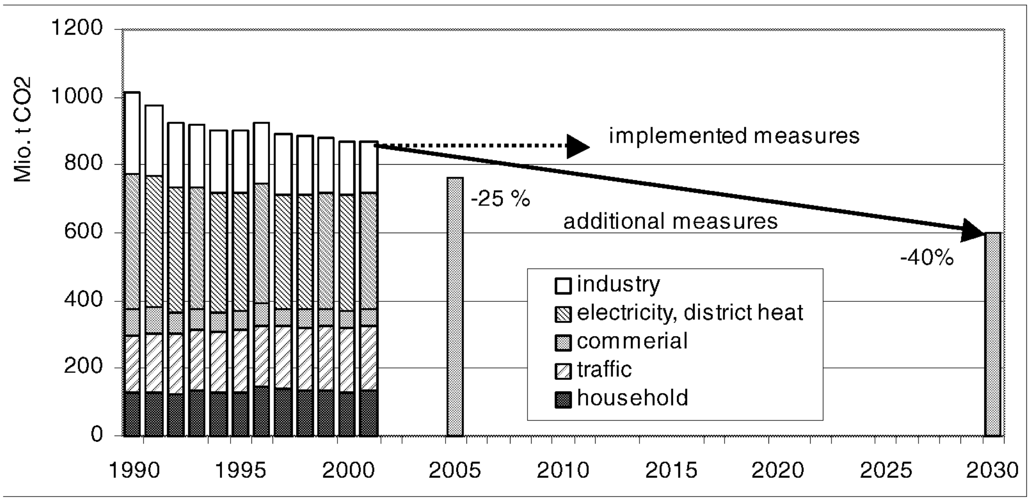

Figure 4: Overall long-term development of carbon dioxide emissions in mill. tonnes

In the long run a stricter climate protection policy is urgently necessary. The general efforts of the recent energy policy have to be intensified strongly. An appropriate mix of supplementary regulatory, information and funding concepts and measures are needed for the future.

URBANISATION AND GLOBAL ENVIRONMENTAL CHANGE

Pauline M. Midgley
Institute of Energy Economics and the Rational Use of Energy (IER)
University of Stuttgart
70565 Stuttgart, Germany
E-mail: pm@ier.uni-stuttgart.de

1 Introduction

The trend towards urbanisation and the proliferation of metropolises (cities with over one million inhabitants) and megacities (cities with over ten million inhabitants) is a striking example of global change that does not just concern individual countries or regions but the world as a whole. It is of particular significance however in developing countries and emerging economies. In 1975 only 38% of the world's population were city dwellers. It is estimated that, in the year 2007, for the first time more than half of humanity will live in cities, rising to two thirds by 2030 at the latest. China and India in particular stand on the threshold of an urban transition. It has been projected that, by 2030, in each of these countries 350 million people will have moved into urban centres; and approximately 1.2 billion people in Asia as a whole.

There is a two-way interaction between urbanisation and global environmental change that may increase the rate, intensity and scale of both urban and environmental change. The extent of the potential negative changes challenges the functioning, stability and sustainability of urban areas. These changes are taking place in all regions of the world but pose a greater threat to already vulnerable countries and economies in the countries of the South.

2 Urbanisation: Problems and Opportunities

The so-called megacities, each with more than ten million inhabitants, are at the forefront of this development. Their number grew from only 5 in the year 1975 to around 15 today and is expected to reach 26 in the year 2015. In addition there are another 20 cities that are growing at around 3-4% annually which is twice as fast as the average for all cities. If this rate continues, these will approach the threshold size of a megacity by 2015. These "megacities of tomorrow" are politically of particular interest because they offer the chance for precautionary intervention and directed urban development.

Megacities are critical points in global sustainable development because the merging and compression of population, resources, goods and capital there frequently give rise to cumulative problems of sustainability. These include social distortions such as crowded, unhealthy living conditions and very unequally distributed incomes;

economic restrictions such as mass unemployment and congested infrastructure; together with ecological problems like air pollution, overloading the capacity of drinking water and sewage systems and tremendous problems of waste disposal. Moreover urbanisation and megacities are of global importance because of their close and reciprocal connection to other aspects of global change such as population growth and migration, overuse of agricultural resources and soil degradation.

On the other hand the high population density of these cities provides opportunities to promote efficient, compact and sustainable forms for businesses and life-styles, which not only improve the living conditions in the city itself but can also have a positive effect on surrounding regions, national economies and even on globally connected chains of supply and distribution. In this sense metropolises and megacities represent key elements for global sustainable development.

The economic, social and ecological effects of megacities, whether negative or positive, can have global consequences because these cities draw on resources from a wide area, not only broadly from their surrounding countryside but from all over the world, bringing them together in regional and global networks.

3 Conclusions

The many fast-growing cities with over one million inhabitants stand precisely at the crossroads of different development paths. Choosing the direction that leads to the goal of sustainability poses a special challenge for policymakers and requires a solid foundation of knowledge based on research. However research results can contribute to solving the problems - and to maximising the opportunities - that result from the expansion and rapid population of urban areas. Moreover these megacities of tomorrow provide “laboratories for change”. Research that prepares the decision-makers and citizens of these cities as far as possible for the dynamics of urbanisation and that extends and supports their scope for organisation and design can have a wider application and great influence if the right policies are developed.

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M. Akhtar-Schüster, University of Hamburg
P. Bergweiler, Project Management Group, DLR, Bonn
C. Best, Project Management Group, DLR, Bonn
N. Binder, BMBF, Bonn
G. Hahn, BMBF, Bonn
C. Krück, VDI Technology Centre, Düsseldorf
P. M. Midgley, University of Stuttgart
B. Rothstein, VDI Technology Centre, Düsseldorf

Adaptation

ADAPTATION: A CHALLENGE FOR THE "NORTH" AND THE "SOUTH"?

Claudio Forner
Methods, Inventories and Science Programme
UNFCCC secretariat
53175 Bonn
Germany
E-mail: cforner@unfccc.int

1 Introduction

For some years now, scientists from several disciplines have devoted important amount of efforts to study the changes of the earth's climate system as a consequence of human activities. These results are compiled in the third assessment report (TAR) of the Intergovernmental Panel on Climate Change.

According to the TAR, there is evidence that human activities have contributed to the observed changes in the variables of the climate system[1] [1]. The TAR shows that the average surface temperatures of the globe increased by about 0.6 °C during the 20^{th} century. In addition, climate models compiled by the TAR predict that average temperatures on the earth can rose up to 5.8°C by 2100 in comparison to 1990 [2]. Direct impacts of the rising temperatures include drastic changes in rain patterns and rain distribution, increases in frequency and intensity of extreme climatic phenomena such as hurricanes, shrinkage of glaciers, and sea level rise. Likewise, these changes will consequently affect natural and human systems, hindering future development.

The predicted impacts of climate change on natural and social systems calls for an institutional framework to address this problem. In an effort to join global efforts to combat climate change, the United Nations Convention on Climate Change (UNFCCC) was adopted in 1992 as a framework for action. Two main roads of action are recognized by the convention. Firstly, mitigation, which tackles directly the source of the problem by reducing emissions and enhancing the sinks of greenhouse gases (GHGs); and secondly, adaptation, which refers to any action aiming at reducing the impacts of climate change as well as the vulnerability of the systems.

The present paper is an overview of adaptation in the context of the UNFCCC. It starts with a brief summary of terms related to adaptation, followed by an overview of the impacts of climate change and the determinants of the adaptive capacity of

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1 The raising temperatures are attributed to the increase in the concentration of the so-called greenhouse gases (GHG) in the atmosphere. Emissions of CO_2 from fossil fuel burning is the most important source of GHG; other important greenhouse gases include methane and nitrous oxide.

society. The fourth chapter summarizes the most important elements of the UNFCCC in relation to adaptation. The paper finishes by pointing out some challenges and tasks for the future.

2 Conceptual Framework

As stated in the introduction, there are two main roadmaps for action within the UNFCCC (see Figure 1). Mitigation is defined by the IPCC as "an anthropogenic intervention to reduce the sources and enhance the sinks of GHG"; adaptation as "any adjustment in natural or human systems in response to actual or expected climate stimuli or their effects, which moderates harm or exploits beneficial opportunities" [1].

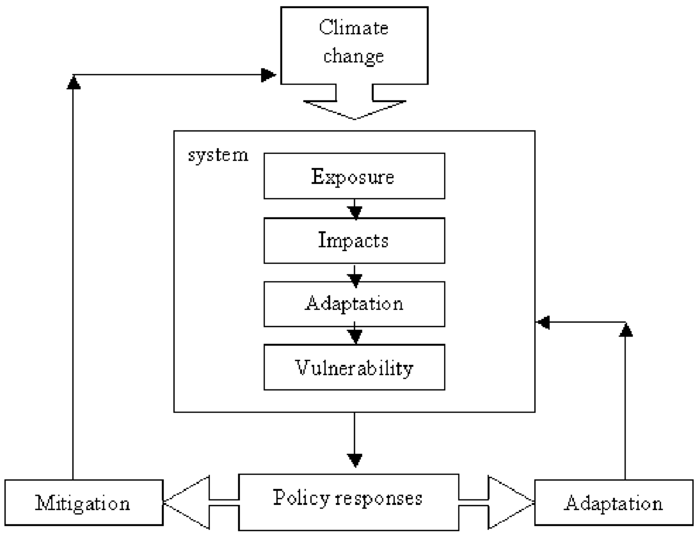

Figure 1: Mitigation and adaptation in the UNFCCC (Source: [1])

Adaptation is an adjustment executed by a system (natural or human), which can be either conscious or unconscious. **Autonomous adaptation** refers to that adaptation that is mechanized or unconscious. On the other hand, conscious adjustments, which include, programmed actions, plans and/or policies, receive the name of **planned adaptation**. Autonomous adaptation is important to assess the vulnerability of the system (see below) while planned adaptation is intended to reduce it.

Adaptability or adaptive capacity is the ability of a system to adapt to climate change. Adaptive capacity refers to how likely is a system to experience those adjustments necessary to be able to outlast the new climatic conditions and its impacts.

Impacts refer to the negative or positive consequences of climate change on natural and human systems (see Box 1). The degree to which a system is susceptible to the impacts of climate change is known as **vulnerability** (see Figure 1). The vulnerability of a system is determined by the impact itself and its adaptive capacity. If the impacts of climate change are high and the system has a low adaptive capacity, then its vulnerability is high. The relation between vulnerability, impacts and adaptation is described in the relation below:

Vulnerability = Impacts - adaptive capacity - planned adaptation

Box 1: Summary of the impacts of Climate change

Hydrology and water resources: Increasing demand for water added to the changes in the patterns and distribution of rain can severely affect the availability of this resource in the planet, in particular, in regions already affected by drought. In contrast, floods are also expected to increase in frequency and magnitude.

Agriculture and food security: Agriculture is the human activity, which is expected to be most affected by climate change, given its dependency on water availability and temperature. Although higher temperatures and higher CO_2 concentrations may lead to higher yields in some parts of the world, tropical and subtropical production is expected to decrease, thus endangering future human development.

Natural ecosystems: Natural ecosystems are likely to be affected by changes in the distribution and quantity of species, reproductive behaviours and others. Drought will affect several terrestrial ecosystems. Impacts on coastal and marine ecosystems will occur primarily as a consequence of temperature rise and sea level rise.

Human health: Impacts on human health can be directly caused by the increasing temperatures, exacerbating pulmonary and other disorders, and by the expansion of vectors of diseases. In addition, flooding and changes in rain patterns represent also risks for human health

Settlements: Main impacts over settlement include affection of cities by either flooding or sea level rise. According to the TAR, by 2080, around 200 million people will be affected by settlements. To these events, damages to infrastructure are expected as a consequence of extreme weather events. The increase in global population in particular urban population will exacerbate this problem.

Industry and energy: As for human settlements, possible impacts on industry can be summarized in damages to infrastructure. With regards to energy production, affection to hydropower energy as a consequence of the changes in rain is expected.

3 Adaptation and Climate Change

The main objective of adaptation is to reduce vulnerability to climate change. Although, in comparison to mitigation, adaptation has been given less attention, it has experienced important developments since the last decade [3]. Initial work on adaptation was mainly focused on predicting, measuring and analysing regional impacts, and on developing punctual actions to address these impacts. For this purposes, climatic scenarios and models were developed with the main objective of predicting the behaviour of the climate in the future. These predictions were used to assess the impacts of climate change on natural and human systems, taking into account their intrinsic variables, such as complexity, structure, population growth, level of economic activity and others.

Smit and Skinner [4] illustrate the enormous amount of actions and measures that could be undertaken for adapting to climate change and argue that developing a list of them would be impracticable. Types of actions include (a) technological developments, (b) government programmes and insurance, (c) changes in practices and (d) financial management. Box 2 summarizes a classification of measures and actions proposed by Smit and Skinner.

Box 2: Classification of adaptation actions and measures

Actions and measures can be divided according to their:

Purpose and objectives: Actions can be undertaken to bare and/or share the costs, to modify the circumstances, to prevent impacts, to change the location of the impacts or the affected system, and to research and educate.

Time: Actions can be anticipatory (before the impact), incidental (during the impact) or reactive (after the impact).

Duration: Tactical (or short term) or strategic (long term)

Scale: Punctual, local, regional and/or national

Latest trends suggest that adaptation should concentrate on strengthening the system rather than on predicting the impacts. This is due to the fact that models usually produce outputs subject to high degrees of uncertainty. From a country perspective, this is traduced into understanding adaptation as development process, where general policies are put in place, covering sectoral policies, adaptation plans and programs, all together constituting a national framework where actions for adaptation are implemented in a harmonized and efficient way (see Figure 2).

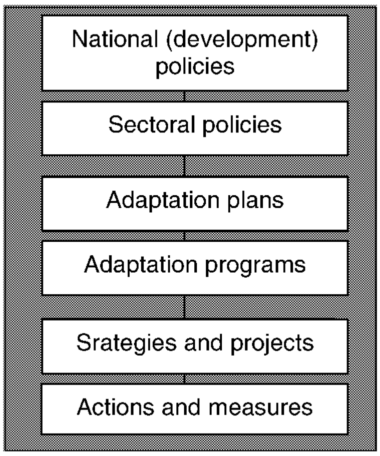

Figure 2: Hierarchy of components for adaptation

The adaptive capacity of society is given by its social and economic conditions. Efforts to increase the adaptive capacity of a country should take into account the following determinants of adaptive capacity (note their relation to development indicators):

- <u>Level of economic activity/equity</u>: Economic activity is important to the extent that it generates resources for climate change adaptation. Capital is needed for institutions, education, technological development and infrastructure, and thus, constitutes the basis for a high adaptive capacity. A diversified and equitable economy, on the other hand, is less vulnerable;

- <u>Technology</u>: The level of technological development as well as the attention given to research and development of technology also determines the adaptive capacity. Technology brings cost effective solutions to problems, for example, the development of new crops, architectural and engineering developments and others, can help in addressing specific expected impacts;

- <u>Technical and human capacity</u>: People are in charge of planning and implementing actions to reduce the impacts of climate change. Climate change calls for the action of an interdisciplinary group of individuals. Capacity building and education also determines the adaptive capacity of a country;

- <u>Infrastructure:</u> The development and implementation of adaptation projects and actions is supported by infrastructure. Roads, communications, networks and others facilitate the process of adaptation;

- <u>Institutional framework:</u> The role of institutions is to join societal efforts and to determine a common framework for social action. They also create the setting for technical, scientific, financial and political support for adaptation. National policies where priorities are set increase the overall efficiency of individual actions of adaptation.

4 Adaptation in the UNFCCC

The UNFCCC is a framework for global action as a response to the negative impacts of climate change. Under the objective of stabilizing greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system, the convention gathers actions in the fields of capacity building, research and systematic observation, technology transfer, finance and others. Adaptation is also an important part of the convention's objective, which stipulates that the pace of stabilization should allow ecosystems to adapt naturally to climate change, to ensure that food security and to economic development to proceed in a sustainable manner. As part of the principles of the convention, Article 3.3 states that Parties should take precautionary measures to mitigate the adverse effects of climate change.

The basis for adaptation in the convention is found as part of the commitments in Article 4.1(b), which states that all parties shall formulate and implement measures to facilitate adequate adaptation to climate change. Financial resources for this purpose are mentioned in Article 4.4, which states that developed Parties shall assist those developing Parties particularly vulnerable to the negative impacts of climate change in meeting costs of adaptation. Article 4.8 mentions specific actions necessary under the convention to address impacts of climate change, highlighting activities such as funding, insurance and technology transfer.

The UNFCCC is regulated by a set of decisions of the COP. These decisions provide specific guidance on issues of implementation of the convention, which, for the case of adaptation, are essentially financial matters and issues relating to national communications, technology transfer and capacity building. Additional provisions appear scattered in these decisions, referring to some specific guidance on the type of activities for adaptation, the special consideration of vulnerable regions in the world and others (see Appendix I).

Financial support in relation to adaptation was firstly adopted by the first session of the COP, which decided that funding for developing countries will follow three phases: (a) planning, including impact assessment, (b) measures, directed at increasing technical capacity, and (c) measures, including the implementation of specific activities. The seventh session of the COP, better known as the Marrakech Accords, finalize the structure of the funding mechanism. Three funds were created. First, the Special Climate Change Fund will fund specific activities on adaptation, as stipulated by decision 7/CP.7 and 10/CP.7 (see Annex I); second, the Least Developed Countries Fund which, as it names suggests, is intended to fund activities for the poorest countries; and finally, the Adaptation Fund, which works under the protocol and will strictly fund adaptation activities for those parties who have ratified the Kyoto Protocol.

Regarding adaptation and the least developed countries, the Marrakech Accords established a working programme, which included a simplified channel for these countries to inform the convention about their needs relating to adaptation. The preparation of National Adaptation Programmes of Action (NAPAs) will be funded through the Least Developed Countries Fund.

Additional activities within the convention also include the compilation of methods and tools to evaluate strategies for adaptation to climate change[2]. Aside from general tools such as models for developing scenarios and screening adaptation options, information on specific tools for assessing impacts and adaptation strategies on water resources, coastal areas and others have also been compiled.

5 Concluding Remarks: North and South Challenges

Setting a global agenda for adaptation. To date, most of the actions and efforts in the context of climate change have been devoted to mitigation. There is still a need for strengthening the global agenda for addressing directly the impacts of adaptation. Aside from the understanding of the impacts (work which has largely served as a reason for pursuing adaptation), further efforts will be needed to reduce the vulnerability of natural and human systems. Even with mitigation policies in place, impacts of climate change will still be borne by society. The following paragraphs summarize outstanding issues in these regards.

Equity considerations: Findings summarized in the TAR and supported by the report "Poverty and Climate Change" [5] indicates that the poorest people in the world are the most vulnerable to the impacts of climate change. These reports highlight the economic and social conditions of regions Africa, Asia, Latin America, and the small island states, which may exacerbate the consequences of climate change in food security, health, infrastructure water resources and others. Equity becomes an issue when the costs of climate change has been put over poor communities that have not received any benefits from industrialization.

Cooperating for adaptation: As stated above, technological development and human capacity is a determinant of adaptive capacity. According to the TAR, these determinants are weak in most developing regions of the world. This calls for actions both at the international level to increase cooperation in capacity building, particularly for the assessment of vulnerability and the design of strategies for adaptation. At the national level, governments need to consider adaptation to climate change as part of the national development policy and assign resources for adaptation.

2 All submitted methodologies and tools can be found at:
http://unfccc.int/program/mis/meth/view.html

Funding issues: Discussions at the international level have faced difficult political disagreements on the way funding under the convention and the Kyoto Protocol may work in practice. This, apart from the delay in the general implementation of projects, has lessen the focus on the actual actions and strategies for adaptation to climate change. On the other hand, technical and financial cooperation, including bilateral agreements, could be strengthen to overcome the obstacles from the international side.

Actors: More actors need to be engaged in the process of adaptation. Aside from the general policy frameworks, where national governments play an important role, actions implemented at the local level call for the participation of a broader set of actors including scientists, local governments and communities and others.

Measuring vulnerability and setting priorities: Rather than trying to measure and assess impacts, the understanding of the impacted system and its vulnerability should be pursued. Countries have been engaged in several studies related to adaptation with the support of the Global Environment Facility (GEF). Further funding for implementation will be made available on the basis of this analysis.

Policy frameworks for adaptation: Latest literature of policy for adaptation has identified several problems in the approach by which expected impacts are addressed with specific actions [see 3, 6]. As stated above, an alternative option is the strengthening of society and the determinants of its adaptive capacity. Adaptation in this way could be seen as an important part of the process of development of a country. In other words, rather than focusing on the results of models subject to uncertainty, policies and actions should consider first the system subject to the impacts of climate change and increase its adaptive capacity.

To this end, national governments should take consideration of the importance of adaptation, by committing resources and increasing political will both to address adaptation locally and to make the international funding and other schemes ready for implementation.

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7 Annex: Main Decisions of the COP in relation to Adaptation

- **11/CP.1:** Guidance to GEF, where the stages of funding for adaptation are defined;
- **3/CP.3:** Relating to the implementation of Articles 34.8 and 4.9 of the convention;
- **2/CP.4:** Guidance to GEF, with special reference to adaptation in the national communications. The financial mechanism is established to cover 100% of the costs of national communications for developing countries;
- **2/CP.7:** Capacity building. The decision identifies areas for capacity building in adaptation, in particular, for fragile ecosystems, soil degradation and others. This decision calls for developing parties to identify their own adaptation needs;
- **5/CP.7:** This decision mentions specific activities to be funded through GEF;
- **6/CP.7:** Guidance to GEF, where adaptation activities are mentioned in a very general way. GEF is called to finance pilot projects;
- **7/CP.7:** Financial mechanism under the convention. With this decisions, two funds are created: the Special Climate Change Fund and the Least Developed Countries Fund;
- **10/CP.7:** Financial mechanism under the Kyoto Protocol;
- **28/CP.7:** Includes the guidelines for the preparation of NAPAs.

ADAPTATION: CASE STUDIES IN THE „NORTH"
- SEMINAR PROMPTS -

Chris B. Sear
serial_interface
31 The Landway, Bearsted
Maidstone, Kent ME14 4BE
United Kingdom
E-mail: chris_sear@btinternet.com

1 Introduction

There are essentially three ways to respond to climate change given the risk and uncertainty of change and cost of precautionary and remedial actions and taking into account sophistications such as insurance. These are:

Do nothing (except perhaps increase insurance premiums); Mitigate: Actions taken to reduce global warming and related weather and climate impacts by reducing greenhouse gas emissions and / or increasing global carbon sinks; Adapt: Actions driven by policy and taken to reduce risk and vulnerability of climate change impacts at all levels in society from individual and community to national and international

Taking precautionary actions that reduce vulnerability to weather and climate events and adapting to climate change impacts can lessen vulnerability to uncertain climate change. Human societies will be more secure and sustainable, infrastructure and ecosystems protected and resources saved.

Often, it is difficult to separate adaptation actions from mitigation actions. This is especially true in many societies in the North, where the reality and risk of climate change have been accepted and where the need for precautionary actions has been accepted widely and been incorporated into policy. For example, encouraging

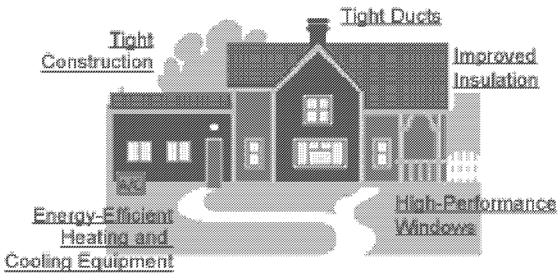
2 Energy Saving Houses

Energy savings gained through established technologies and building practices.

Tight Construction (Reduced Air Infiltration); Tight Ducts; Improved Insulation; High Performance Windows; Energy Efficient Heating & Cooling Equipment

3 Sustainable Urban Drainage Systems (SUDS)

SUDS are designed to manage surface water runoff in a more sustainable way than traditional drainage systems. They are designed to provide more natural approaches to runoff management and help to prevent increases in flood or water pollution risk downstream of the development. They can also provide direct improvements to local amenity and biodiversity.



SUDS can save money, improve surface water drainage, infiltrate water back into the ground locally, reduce the risk of flooding, reduce pollution and provide an environmentally friendly leisure resource. SUDS work by using porous pavements for roads and car parks, infiltration trenches beside roads and car parks, swales (wide, shallow ditches) to slow surface water flow, Infiltration basins and permeable conveyance systems to store water and slow down its drainage to rivers and passive treatment systems such as filter strips, retention ponds and wetlands. SUDS reduce the risk of flood and other environmental impacts of surface water drainage, leading to improvement of the water quality in rivers (especially urban rivers) and provide a more varied and attractive built environment. They are designed to mirror the natural drainage sites and sustainably manage water flow. They are easy to maintain and create natural wildlife habitat areas, which can be used for leisure and education.

Example Components:

Swales. Swales are grassland depressions that take water overland to storage or a discharge system. Wider and shallower than traditional ditches, swales provide temporary storage for storm water and reduce peak flows. They slow and balance surface water flow, Increase the loss of surface water through infiltration, evaporation and transpiration, filter and improve the quality of water, reduce the need for expensive roadside drainage and gullies and reduce the risk to local populations of amphibians.

Balancing Ponds

As the name suggests, balancing ponds are used to balance surface water and that infiltrating and draining away from developed surfaces in different weather conditions. Balancing Ponds are designed to retain flood events and reduce peak water flows to reduce significantly the risk of local flooding. The initial pond is often a Detention Basin, designed to hold back storm runoff for a short while and allow solids to settle out and to remove some nutrients and metals from the water. Detention basins are dry except during storms. Detention basins can incorporate small permanent ponds or wetland to enhance their appearance and provide wildlife habitats. Other, larger Balancing Ponds retain some water at all times to enhance attractiveness, remove nutrients and trace metals and provide pond and wetland habitats.

Wetlands incorporate shallow areas planted with marsh or wetland vegetation. These provide a much greater degree of filtering and removal of nutrients by algae. Specially constructed wetlands can be used to treat surface water and provide moderate to high levels of pollutant removal in all weather conditions.

Porous Pavements

Making hard standing areas, car parks, motorway service areas, hypermarket car parking and similar large areas of run off using porous blocks can allow infiltration of rainfall and runoff form neighbouring roadways. Surface water is held in reservoir structures under the paving for subsequent infiltration or delayed discharge and this significantly reduces the likelihood of local flooding. Porous pavements also slow the arrival of water into drainage systems and river systems smoothing out flows. Porous Paving can be materials such as gravel, porous concrete blocks or porous asphalt. Pollutant removal rates are high and occurs via infiltration through the pavement and absorption and filtering within the subsoil. Removal of up to 80% of sediment, 60% of phosphorus and 80% of nitrogen has been measured, as well as high removal rates for trace metals and organic matter.

4 Human Health - Adapting to Heat and Cold

Direct effects of exposure to heat and cold contribute to seasonal fluctuations in health and it is well documented that in the northern populations, the elderly are most affected by both heat and cold and most vulnerable to trauma and death associated with temperature extremes.

Global warming is expected to increase the frequency and the severity of heatwaves (and if the recent past [and especially this summer in Europe] is anything to go by, it’s already happening. In recent years, as average temperatures have increased there has been an increase in the frequency of hot days in most European countries. Societies in Mediterranean states and Balkans are particularly at risk from excessive and long-lasting heatwaves and numbers of the most vulnerable (the elderly, those with respiratory conditions or cardiovascular disease, the poor, living in poor housing and without access to adequate clean water) die each time a notable heat wave occurs. In 1987: a heat wave in Greece is estimated to have caused 2000 extra deaths, mainly in Athens. In 1995 a heat wave in the UK was associated with 180 excess deaths, compared to a ‘normal’ week in summer.

Since, in Europe mortality is much higher in winter than in summer (probably from respiratory infections, such as influenza and bronchitis), it is expected that milder winters in the future might reduce mortality overall but it is not yet clear whether or by how much, wetter weather might counter the effect of extra warmth.

Some current adaptive measures with respect to heat and cold are listed below.

Legislative (Governance)

Building Codes and Guidelines; Educational Programmes – especially about water intake; Weather Watches and Warnings.

Technical

Improved Insulation, Air Flow and Air Conditioning; Urban Planning for 'Cooler Cities'.

Behavioural

Hydration and Sensible Drinking; Work Breaks (and Siestas) in Hot Weather; Sensible Clothing; Air Conditioning in Homes and Vehicles.

5 Flooding

The most serious impacts of predicted climate change on human health are likely to be changes in the magnitude and frequency of extreme events (not gradual trends in averages). Extreme weather events can trigger disasters. In Europe, floods are the most devastating of natural disasters. In the last fifteen years, floods in Europe have caused over 2000 deaths and made nearly half a million people temporarily homeless. It's clear that a major impact can be the trauma of having been flooded. Since it is expected that global change will result further increase in the risk of both river and coastal flooding, it is vital that adaptation strategies are devised.

Physical and disease risks from flooding can be greatly reduced by well-maintained flood control and sanitation infrastructure and by disaster early warning. Perhaps prompted by recent increases in the severity and frequency of flood events throughout Europe, many governments and responsible agencies are now investing significant resources into these. Also important are public health measures including activities to detect and control outbreaks of infectious diseases. Current adaptation measures include land use planning which includes provision for reducing flash floods, legislation for housing and industrial development away from flood-risk areas, incentivised sustainable building programmes and public awareness and disaster preparedness programmes and early warning systems.

6 Vector-borne diseases

Vector-borne diseases, including malaria, tick borne encephalitis, Lyme disease, Leishmaniasis, Hanta virus infections and West Nile Fever, are maintained in complex transmission cycles and usually reservoir hosts that depend on specific ecological conditions for survival. These diseases are all sensitive to climatic conditions, although response patterns vary between diseases. It is unclear how the ranges of vector borne diseases will change with global warming as temperature changes are by no means the only determinants of disease range and severity. However, higher temperatures, in combination with favourable patterns of rainfall and humidity might prolong transmission seasons in some endemic locations. Elsewhere transmission may reduce as rainfall of temperatures become unfavourable. The health impacts of changes in disease transmission will be strongly determined by the effectiveness of public health systems. Adaptation measures will need to include strengthening of public health surveillance and vector control.

Adaptation measures to vector-borne disease can be categorised as before.

Legislative (Governance)

Surveillance; Education campaigns; (Enforced) vaccination programmes.

Technical

Window and door screens; Biological control (e.g. releasing sterile male vectors); Vector habitat control.

Behavioural

Use insect repellents; Use pyrethroid-impregnated bed nets; Improved water storage and gardening practices; Install window and door screens; Self inspection (e.g. for Lyme disease and other tic-borne infections).

7 Water- and food-borne diseases

A seasonal pattern is often observed in the disease epidemiology of water- and food-borne diseases, with caseload peaks in food poisoning during the summer months, when temperatures are higher, bacteria colony growth fast and food can spoil very quickly. Cases of salmonella, often caused by poor food storage on warm days, increase when temperatures exceed 7°C (at least in the UK). The most significant water-borne disease associated with the public water supply in Western Europe is cryptosporidiosis. When contamination occurs, it has the potential to infect very large numbers of people. Some notable outbreaks of cryptosporidiosis have been associated with heavy rainfall events.

Adaptation measures for water- and food-borne disease include:

Legislative (Governance)

Education campaigns for safe food storage; Enforcement of hygiene standards in hotels and restaurants etc.; Watershed protection legislation; Water quality regulation; Better coastal outfalls and 'clean beach' campaigns; Public alerts (e.g. to boil drinking water).

Technical

Improved cleaning materials; Improved food preparation techniques; Genetic/molecular screening for pathogens; Improved sanitation in public toilets; Improved sewerage cleanup.

Behavioural

Improved food preparation hygiene; Boil untreated water

The following is advice to individual householders in the UK about how they can help to mitigate and adapt to predicted climate change (from a BBC Weather Centre web page).

Life At Home

It's not just policies and industries that need to be more climate-friendly, each individual has an impact on his or her environment. Choices that we make in our day-to-day lives can affect the climate.

If you could start again, would you make the same decisions as you have made in your life given the knowledge that you have now about how people are affecting the environment and now the climate too? Try our 'I'm alright Jack' game to see how simple choices you make during Jack's life impact on the climate.

For tips on environmentally friendly transport, shopping and saving water, see 'other ways to help'.

Things you can do today at no cost:

Turn off lights when you leave a room

Only boil the amount of water you need in your kettle

Turn off televisions, videos, stereos and computers when they are not in use - they can use between 10 and 60% of the power they use when on

Don't leave fridge doors open for longer than necessary, let food cool down fully before putting in the fridge or freezer, defrost regularly and keep at the right temperature

Close curtains at dusk to keep in heat

Let your clothes dry naturally rather than using a tumble drier

Turning down the thermostat for your heating by 1 degree could cut your heating bill by 10%

Set your water thermostat for 60 degrees - this is plenty warm enough for bathing and washing and will save money too

Use economy programmes on dishwashers or washing machines

Where possible don't stand cookers and fridges/freezers next to each other

Things you can do in the future or with an initial cost:

Put foil behind radiators fitted on external walls

Use energy saving light bulbs - they use a quarter of the electricity and last much longer

Insulate your hot water tank and pipes

Speak to your energy provider about their 'green tariff' - they may be able to match your energy consumption with an equivalent amount of energy from renewable sources

Fit seals to externals doors, skirting boards and floor boards to reduce heat loss - 15% of heat is lost through draughts and 15% through the floor

Make your windows draught proof or fit double glazing - this cuts heat loss in half - up to 10% of heat is lost through un-insulated windows

(NB ventilation is essential in rooms with gas, oil or solid fuel appliances so don't block of ventilation in rooms with these types of appliances.)

Fit loft insulation - which should be at least 200mm thick to be most effective - 25% of heat is lost through an un-insulated roof

Fit wall insulation - up to 33% of heat is lost through un-insulated walls

Replace old inefficient boilers

Fit solar panels or solar tiles to your roof

For tips on environmentally friendly transport, shopping and saving water, see 'other ways to help'.

South-North Cooperation

CARBON-SINKS: ENHANCEMENT & MANAGEMENT

Reinhard Leithner
Institut für Wärme- und Brennstofftechnik
Technische Universität Braunschweig
38106 Braunschweig
Germany
E-mail: r.leithner@tu-bs.de

1 Introduction

The need or wish to sequestrate CO_2 is based on the assumption of the International Panel of Climate Change (IPCC) that CO_2 may be a major driver in climatic changes, i.e. especially the anthropogenic CO_2 emissions due to the combustion of fossil fuels like coal, oil and natural gas will increase the atmospheric CO_2-content, which will lead to higher temperatures in the atmosphere. The 0,03% CO_2 in the atmosphere have a 22% share of the natural greenhouse gas effect of 33 K necessary for life on earth. The main share of 62% has the water vapour in the atmosphere. Only if one concentrates on the greenhouse gas effect of the gases beside water vapour, CO_2 becomes important with 58% influence.

In addition there are other influences on the climate like:

- Eccentricity of earth's orbit, precession of orbital plane, obliquity and precession of earth's rotation axis (Milankovitch's theory);
- Sunspots and magnetic field of the sun;
- Changing streams in the ocean;
- Volcanic activities;
- Distribution of continents on the surface of the earth;
- Impact of meteorites;
- Change of insolation by interplanetary dust [1] etc.

Figure 1 shows the mean temperature of the atmosphere and the atmospheric CO_2-content time histories 1 billion years back; no correlation can be found between them.

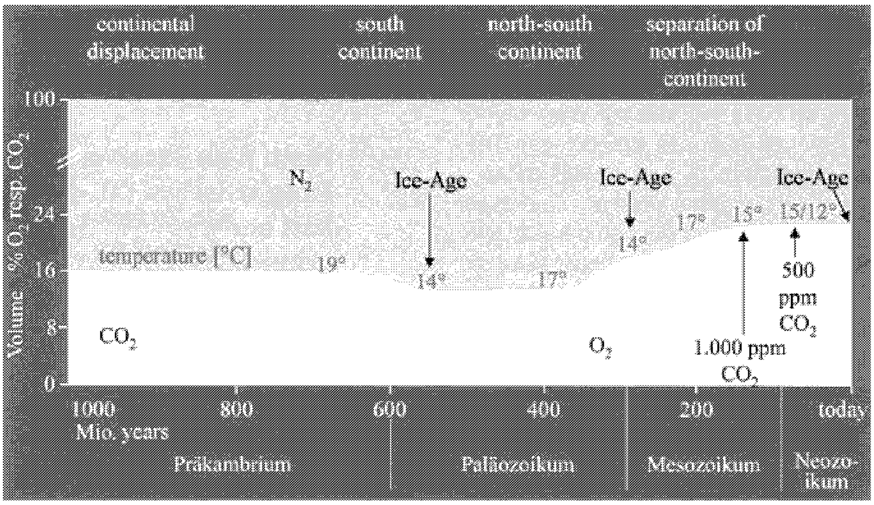


Figure 1: Temperatures, O_2- and CO_2- contents in atmosphere 1 billion years back. [2]

Figures 2 and 3 show the worldwide CO_2-emissions and balance. It is not easy to trace the anthropogenic greenhouse gas emissions, because of the still small amount compared with the natural cycles.

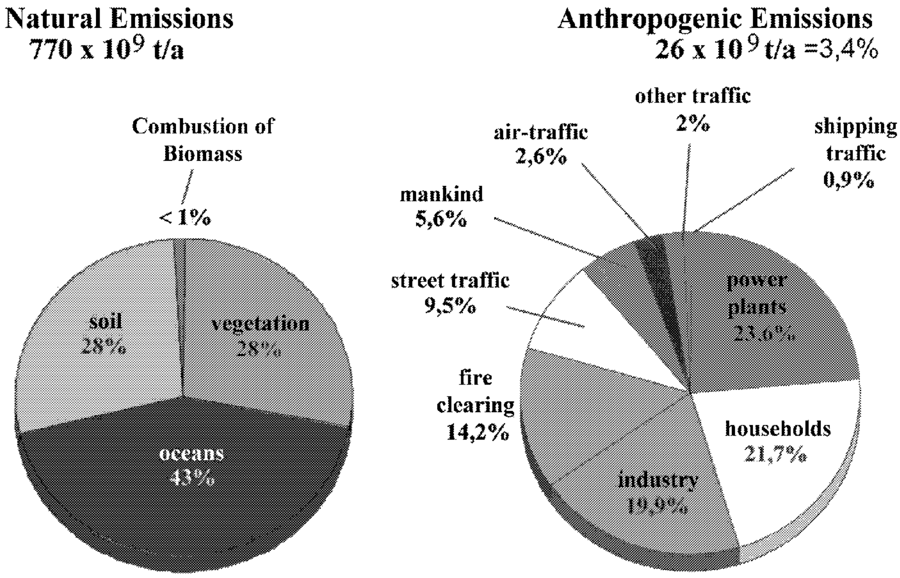


Figure 2: Global anthropogenic CO_2-emission per year [3]

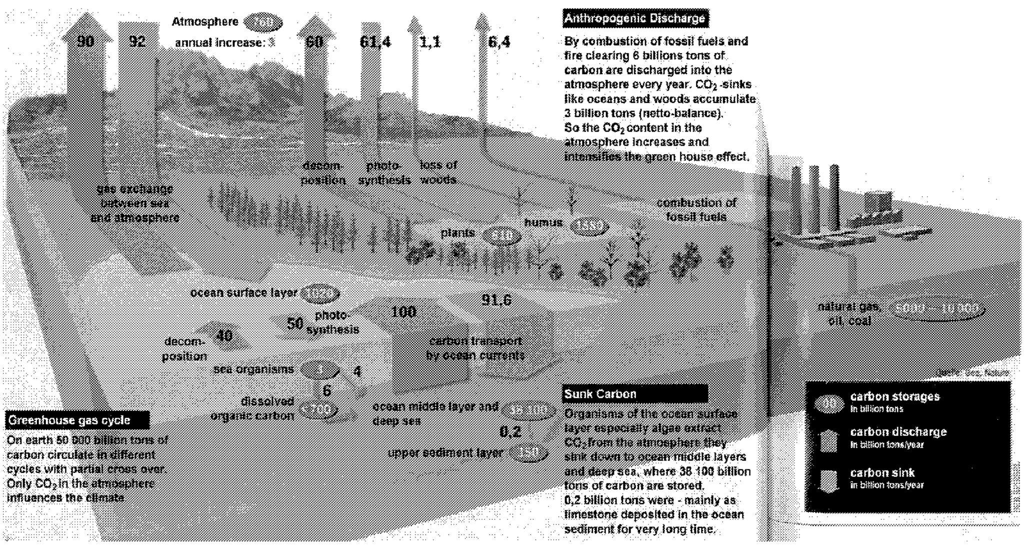


Figure 3: Global CO_2-emissions and captures

Beside the C-cycle comprising atmospheric CO_2-production of biomass combustion of fossil fuels etc., there is also another one comprising atmospheric CO_2-carbonation of Ca/Mg-Silicates (e.g. olivine and serpentine)-immersion of continental plates (heated up to more than 800°C) and CO_2 discharge to atmosphere by volcanoes.

Figure 4 shows the storage of CO_2 (given in billion t of C).

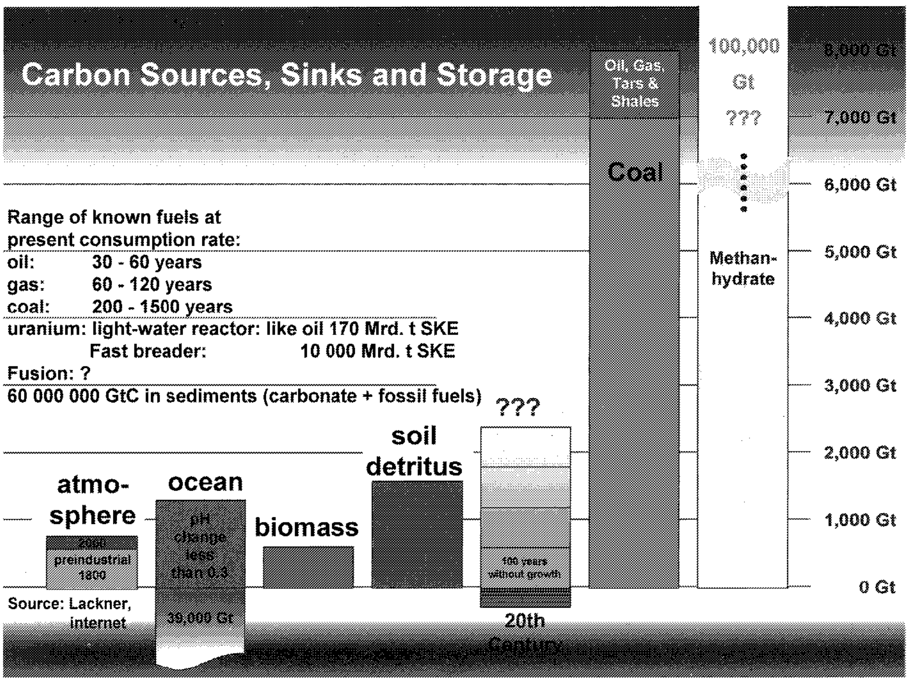


Figure 4: Carbon sources and sinks [4]

2 How can CO_2 be captured, if believed necessary

There are concentrated sources of CO_2 emissions like power plants, iron blast furnaces or cement industries etc. and distributed sources like cars, households etc. The CO_2 emitted during calcination of $CaCO_3 \rightarrow CaO + CO_2$ is captured, when the CaO is used for buildings as $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$. In Germany about 50 % of the CO_2-emissions come from concentrated sources, the CO_2-concentration of which depends on the air surplus of the combustion and can reach about 15%.

Of course it is useful to capture the CO_2 first at the concentrated sources, but it can be also feasible and advantageous to capture the CO_2 out of the atmosphere like plants do.

There are three main options to capture (concentrate to more than 90 %) the CO_2 of concentrated sources:

- Pre combustion;
- Post combustion with oxygen after an air separation or
- Post combustion with air (no changes of the used technology).

Figure 5 shows a general description of the numerous options without becoming too detailed and loosing overview.

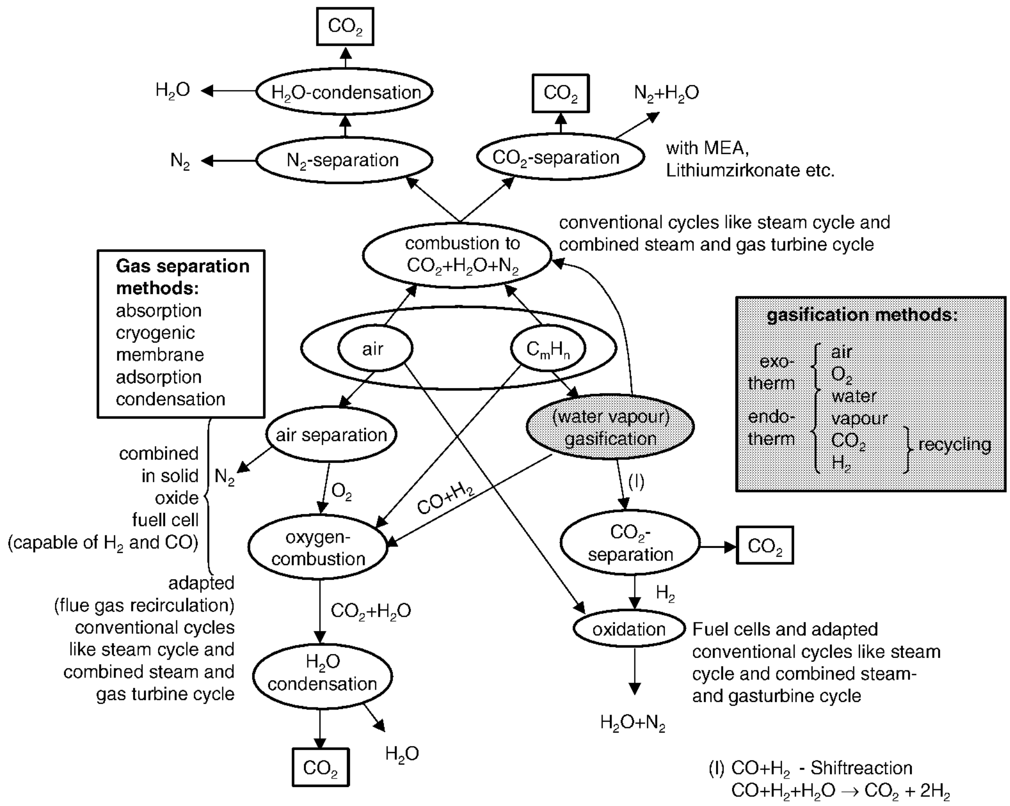


Figure 5: Energy-conversion cycles and CO_2-capture methods

These three options can be characterized as follows:

- Pre combustion capture of CO_2 leads to hydrogen as fuel, from which CO_2 was separated. For solid or liquid fossil fuels a gasification process is necessary and the most useful one is the water gasification using waste heat of the process;
- Post combustion with air separation capture leads to flue gases consisting mainly of CO_2 and water vapour, because oxygen was used for combustion. Flue gas recirculation could be/has to be used to reduce combustion temperatures to usual values. After condensing the water vapour CO_2 is left in high concentration. The most effective way is to use an SOFC as air separation membrane and the waste heat of the SOFC for water vapour gasification, because this implicitly provides a chemical heat pump, increasing efficiency probably up to 70%, whereas the efficiency of the SOFC is 50%;
- Post combustion with air capture is, what would have to/could be made at usual power plants like pulverized coal fired units or combined gas- and steam turbine units, i.e. separate the CO_2 from the other flue gas components like N_2, water vapour etc.

There are also options to capture the CO_2 out of the atmosphere, e.g.:

- By using e.g. adsorption by $CaO+CO_2 \rightarrow CaCO_3$. Calcinating $CaCO_3 \rightarrow CaO+CO_2$ delivers CO_2 in high concentration and CaO for reuse;
- By capturing the CO_2 out of the flue gases of combusted biomass. This method could be especially useful in developing countries.

3 CO_2-Separation Technologies[1]

3.1 Solvent scrubbing [5]

Amine scrubbing technology was established over 60 years ago in the oil and chemical industries, for removal of hydrogen sulphide and CO_2 from gas streams. Commercially, it is the best established of the techniques available for CO_2 capture although practical experience is mainly in gas streams which are chemically reducing, the opposite of the oxidising environment of a flue gas stream. There are several facilities in which amines are used to capture CO_2 from flue gas streams today, one example being the Warrior Run coal fired power station in the USA, shown in Fig. 6, where 150 t/d of CO_2 are captured. Mono-ethanolamine (MEA) is a widely used type of amine for CO_2 capture. CO_2 recovery rates of 98% and product purity in excess of 99% can be achieved. There are, however, questions about its rate of degradation in the oxidising environment of a flue gas and the amount of energy required for regeneration.

The conditions for CO_2 separation in pre-combustion capture processes will be quite different from those in post-combustion capture. For example, in a coal IGCC process, modified for capture, the CO_2 concentration would be about 35-40% at a pressure of 20 bar or more. In that case, physical solvents, such as Selexol®, could be used for pre-combustion capture of CO_2, with the advantage that the CO_2 can be released mainly by depressurisation, thereby avoiding the high heat consumption of amine scrubbing processes. However, depressurisation of the solvent still results in a significant energy penalty. Physical solvent scrubbing of CO_2 is well established, e.g. in ammonia production.

[1] The description of separation, transporting, storage technologies and costs is mainly based upon the International Energy Agency [5].

Figure 6: CO_2 capture plant at Warrior Run power station, Cumberland, USA

3.2 Cryogenics

CO_2 can be separated from other gases by cooling and condensation. Cryogenic separation is widely used commercially for streams that already have high CO_2 concentrations (typically >90%) but it is not used for more dilute CO_2 streams. A major disadvantage of cryogenic separation of CO_2 is the amount of energy required to provide the refrigeration necessary for the process, particularly for dilute gas streams. Another disadvantage is that some components, such as water, have to be removed before the gas stream is cooled, to avoid blockages. Cryogenic separation has the advantage that it enables direct production of liquid CO_2, which is needed for certain transport options, such as transport by ship. Cryogenics would normally only be applied to high concentration, high pressure gases, such as in pre combustion capture processes or oxygen fired combustion.

3.3 Membranes

Gas separation membranes allow one component in a gas stream to pass through faster than the others. There are many different types of gas separation membrane, including porous inorganic membranes, palladium membranes, polymeric membranes and zeolites. Membranes cannot usually achieve high degrees of separation, so multiple stages and/or recycle of one of the streams is necessary. This leads to increased complexity, energy consumption and costs. Several membranes with different characteristics may be required to separate high-purity CO_2. Solvent assisted membranes are being developed to combine the best features of membranes and solvent scrubbing. Much development is required before membranes could be used on a large scale for capture in power stations.

3.4 Adsorption

Solid adsorbents, such as zeolites and activated carbon, can be used to separate CO_2 from gas mixtures. In pressure swing adsorption (PSA), the gas mixture flows through a packed bed of adsorbent at elevated pressure until the concentration of the desired gas approaches equilibrium. The bed is regenerated by reducing the pressure. In temperature swing adsorption (TSA), the adsorbent is regenerated by raising its temperature. PSA and TSA are commercially practiced methods of gas separation and are used to some extent in hydrogen production and in removal of CO_2 from natural gas. Adsorption is not yet considered attractive for large-scale separation of CO_2 from flue gas because the capacity and CO_2 selectivity of available adsorbents is low. However, it may be successful in combination with another capture technology.

But there is a new technology developed not mentioned by IEA [5]: The CO_2-wheel, which captures CO_2 by lithiumzirkonate at temperatures of 500°C. CO_2 is desorbed at temperatures above 700°C. Lithiumzirkonate adsorbs 20 time more CO_2 than MEA.

4 Transport of CO_2

After capture, CO_2 would be transported to the storage site. CO_2 is largely inert and easily handled and it is already transported in high-pressure pipelines. About 30 million tonnes/year of CO_2 is currently transported by pipeline in the USA. The longest pipeline at present is the Sheep Mountain pipeline, which is 656 km long. If CO_2 capture and storage became widely used, pipeline grids such as those used for natural gas distribution would probably be built, to improve operating flexibility and provide economies of scale. Ships would be used for long distance transport of CO_2. Although CO_2 is not transported by ship at present, tankers similar to those currently used for liquefied petroleum gas (LPG), could be used.

5 Use and Storage of CO_2: Options, Capacities, Safety and Costs

Most of the options are shown in Figure 7.

5.1 Use of CO_2

Only a small amount of CO_2 can be used for food/beverage -industry, as solvents in the chemical industry etc. and for the transport of H_2 in form of usual fuels. But all this CO_2 is again emitted to atmosphere sooner or later.

5.2 Oil and natural Gas Fields

CO_2 is already injected into oil fields to enhance oil recovery by typically 10 to 15 %. 33 million t CO_2/a are used for this purpose already today in the USA. Of course depleted oil fields could also be used and filled up with CO_2. Also depleted natural gas fields can be used as storage for CO_2.

Depleted oil and gas fields have a number of attractive features as CO_2 storage reservoirs:

- Exploration costs would be small;
- The reservoirs are proven traps, known to have held liquids and gases for millions of years;
- The reservoirs have well known geology;
- There is potential to re-use some parts of the hydrocarbon production equipment to transport and inject the CO_2;
- Last but not least oil and gas companies would earn money for the CO_2-sequestration.

5.3 Deep saline Reservoirs

There are many underground, water-filled strata (aquifers) that could potentially be used to store CO_2. The aquifers that would be used for CO_2 storage are deep underground, contain saline water and are unsuitable for supplying potable water. CO_2 would partially dissolve in the water in the aquifer and in some formations it would slowly react with minerals to form carbonates, which would lock up the CO_2 essentially permanently. Suitable aquifers would have a cap rock of low permeability to minimise CO_2 leakage. Injection of CO_2 into deep saline reservoirs would use techniques similar to those for disused oil and gas fields. Nearly a million tonnes per year of CO_2 is already being injected into a deep saline reservoir under the Norwegian sector of the North Sea in conjunction with gas production from the Sleipner Vest gas field. When this injection began in 1996 it marked the first instance of CO_2 being stored in a geological formation because of climate change considerations. CO_2 removed from a natural gas stream, which would normally be discharged to the atmosphere, is being stored underground. The storage reservoir is the Utsira formation, which is a sand formation extending under a large area of the North Sea at a depth of about 800m. The flows of CO_2 injected at Sleipner are being monitored and modelled as part of an international project established by Statoil with the IEA Greenhouse Gas

R&D Programme. This work should help in the design and operation of future CO_2 injection projects.

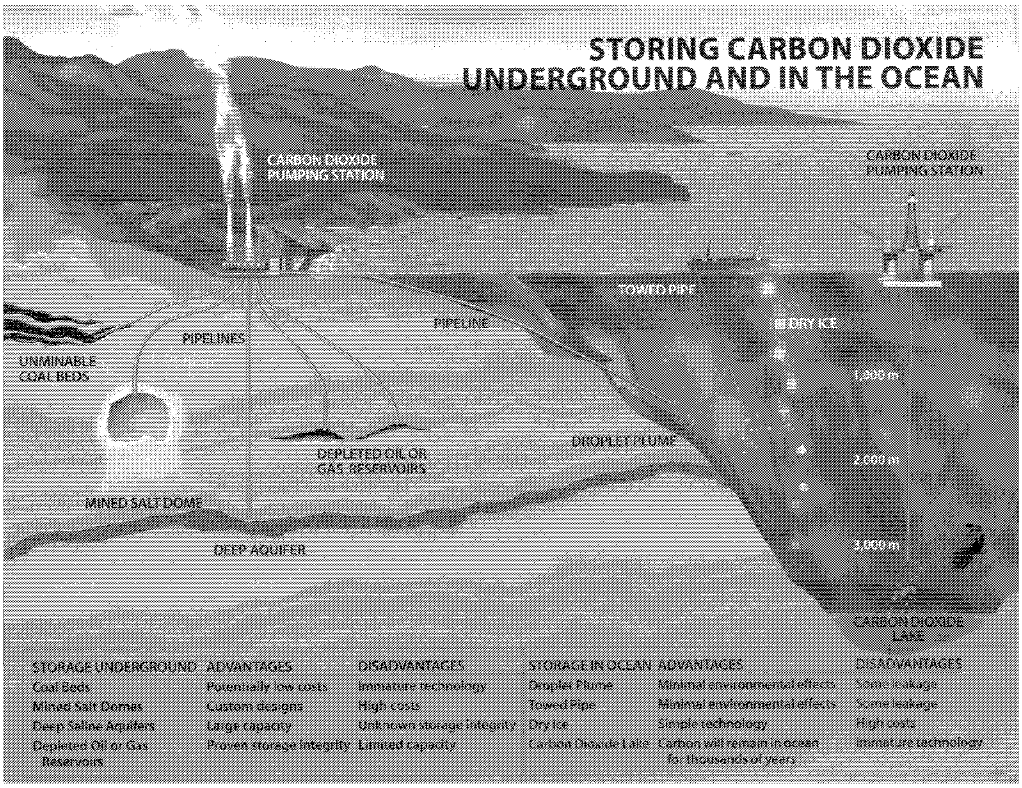


Figure 7: Storage sites for carbon dioxide [6]

5.4 Salt Domes and artificially insulated Repositories for dry Ice

There are various other ways of potentially storing CO_2 but none has been found to be economically competitive against the options described above. Underground caverns, such as mined salt domes, could be created to store CO_2. Such caverns are used for short-term storage of natural gas and certain industrial gases but the quantities of CO_2 that would need to be stored are very much larger.

In addition, such storage is very unsafe, because CO_2 can escape very fast, much faster than from a porous formation.

Solid CO_2 (dry ice) could also be stored in a repository, surrounded by thermal insulation to minimise heat transfer and loss of CO_2 gas.

5.5 Deep Ocean

CO_2 can also be stored in the ocean deeper than about 3000m. It can be transported to these sites by pipelines, ships or swimming drilling rigs with vertical pipes or as blocks of dry ice. The expected retention time is about 500 years. Ocean streams could bring up CO_2 to the surface and atmosphere in a catastrophic event like it happened in lake Nios in Cameroon, Africa. Also the detrimental effect on the fauna present in the deep ocean is a matter of concern.

5.6 Mineral Deposition

Another option is to react CO_2 with naturally occurring minerals, such as magnesium silicates e.g. olivine and serpentine (enough available to store the CO_2 of all fossil fuel), to produce carbonates that could be stored permanently. However, the mass of minerals that would need to be quarried and stored would be substantially more than the mass of CO_2 and costs would be much higher than for storage in oil and gas reservoirs, aquifers and coal seams. The advantage of this option is that the CO_2 would be locked safely up for extremely long time scale, because the carbonates would have to be heated up to more than 800°C to decompose them and expel the CO_2. However, a better way to achieve this end may be to inject CO_2 into underground reservoirs that contain minerals that will react with CO_2, what happens continuously in nature but very slowly. May be developing countries can offer the use of such geologic formations to industrialised countries. Capacities, storage times and costs are given in Table 1 and 2.

Table 1: Storage options for carbon dioxide – global capacity, duration and costs [7]

Natural storage	Global storage in Gt. CO_2		
Atmosphere	2631	(By 348 ppm volume CO_2)	
Ocean	154	(Hydrogencarbonate, Carbonate	
Possible sinks for CO_2	Global storage capacity in Gt. CO_2	Storage time in years	Costs of storage in DM/t CO_2
Ocean	> 3664	> 500	1,9 (500 m depth) 9,8 (1200 – 3000 m depth)
Aquifer		$10^3 - 10^6$	2,2
Depleted Oil- and gas-fields	> 366	10^6	3,8
Enhanced oil production	238	10^6	
Reafforestation	4,4 /a	10^2	>0,5
Reafforestation of whole agricultural land of Germany	0,023 /a (<10% of CO_2-emissions of Germany)		
Chemical industry (actual market volume)	< 0,33 /a 0,006 /a	10	
Dry ice repository		800 at 50% CO_2-losses	230
CO_2-pipelines			Ocean: 1,0/100 km Land: 1,4/100 km

In general a rough estimate is, that the CO_2 capture costs about 5 to 10 % (points) efficiency of the usual energy conversion processes with only few exemptions like SOFC (because of the implicit air separation). This reduction of efficiency can also be used to calculate the costs e.g. for electricity production. CO_2 transport and storage costs have in this case to be added.

Table 2: Natural reservoirs suitable for storage of CO_2 [5]

Storage option	Global capacity	
	Gt CO_2	% of emissions to 2050
Depleted oil and gas fields	920	45
Deep saline reservoirs	400 - 10 000	20-500
Unminable coal seams	>15	>1

6 Political Influences on CO_2- Emission Reduction

There are different options to urge people to reduce CO_2 – emissions e.g. self-commitment, certificates or taxes on CO_2-emissions or on fuels. Certificates can minimize the costs of the reduction-measurements, if the first allocation was very unreasonable or unfair. If the first allocation was reasonable, there is no necessity to deal with the certificates, but the costs of the administration and controlling remain and will exceed the advantages. There are also no generally acceptable solutions for first allocation, closing or opening plants and the whole system is very prone to fraud. As taxes also cause additional costs the best way is self-commitment.

7 Conclusions

- Most of the capture methods are not developed today and are very expensive;
- Most of the storage options are in my opinion not safe enough. May be in some developing countries interesting geological formations are available for CO_2 sequestration or biomass can be used;
- Scientifically spoken climate changes have always occurred and of course will also occur in the future. At the moment the models and the simulations of climate change are definitely much too simple to give reliable answers;
- The energy consumption per unit of a product has been reduced significantly in the past years and this is the way of no regret, i.e. research and development to increase efficiencies have to be supported everywhere. This could have the following synergies:
  - Reduction of other pollutant emissions;
  - Saving of fossil fuel reservoirs for following generations; increasing the time and lowering the necessary effort for transition to renewable energies;

- Giving necessary time to develop new technologies and reduce costs e.g. for photovoltaic, fuel cells, etc. and to change the equipment like power plants, when it is necessary anyway.
- To replace all fossil fuel fired power plants within a few years by renewable or CO_2 free energy-systems would not be possible also for industrialized countries without significant detrimental social and economic impacts.
- If till 2050 energy has to be "produced" CO_2 – free, for Germany instead of 4% of the GNP (gross national product) 6% have to be used. This seems to be a small amount, but in reality it is e.g. not possible to reach 0.70 % of GNP for ODA in Germany.

- The best measurements for developing countries (also „the South") which will develop a lot of social, economical and ecological positive synergies would be:
    - Information dissemination;
    - Investment in new infrastructure;
    - Education.
- A really fair solution for the allocation of CO_2-emission-certificates would be to allocate to every child an amount of CO_2 for its life, which it can use by himself or sell to others. Of course the bureaucracy would be enormous but it would transfer a lot of money to developing countries. But I suppose the influential people and countries will never agree to such an idea.
- A better basis of cooperation can be generated by a social and ecological amendment to the General Agreement on Tariffs and Trade, which should generate globally accepted social and ecological standards, e.g. minimum wages for labor, which enables working people to live and rise children in an acceptable way, and e.g. emission standards for pollutants. This would enable developing countries to place the necessary investments for infrastructures and CO_2 – reduction (If somebody has not enough money to buy food, he totally ignores climate changes.).
- There are a lot of opportunities also for local solutions especially concerning solar energy, biomass, wind etc.

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TECHNOLOGY TRANSFER: EXPERIENCES AND PERSPECTIVES

Holger Liptow
Climate Protection Programme
Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ)
65726 Eschborn
Germany
E-mail: holger.liptow@gtz.de

1 Technological Change: The Key to Climate Protection

1.1 Challenges

Technological change is at the heart of the UN Framework Convention on Climate Change (UNFCCC). We can only achieve a climate that does not have a negative impact on human life if we reduce the emissions caused by human activities. Since the living standard of most people in developing countries needs to be raised and people in developed countries want at least to maintain their standard, we need to change the technology we currently employ to generate electric power and other forms of energy, material products, mobility and services. The applied technologies have to become much more efficient or have to be changed so that for the same output far fewer or no greenhouse gases (GHG) are emitted.

The Kyoto Protocol (KP) obliges all industrial countries to limit their GHG emissions in the period 2008 to 2012. How this can be achieved and how the burden is to be shared among all major individual emitters is at the moment intensely debated – at least in Europe and other countries that accept their responsibility for climate protection. The EU directive on greenhouse gas emission allowance trading is just one example of how companies in the EU can be forced to carefully consider in which way they can meet their individual emissions reduction target: e.g. by increasing the energy efficiency of their processes, using less or no GHG-emitting fuels or buying carbon credits from others. Others may be other companies within the EU or in other developed countries, particular Eastern Europe, or in developing countries. The KP allows this flexibility through the instruments of Joint Implementation and Clean Development Mechanisms (CDM). Technological changes and technology transfer play a key role in the implementation and realisation of the KP. Without technological alternatives the Kyoto targets cannot be achieved, and without technology transfer developing countries cannot participate in CDM. More important, they cannot prepare themselves for the upcoming great challenges in climate protection.

1.2 Development and Transfer of Technologies under the UNFCCC [1]

Officially, under the UNFCCC the issue of “Development and Transfer of Technologies” is stipulated in Article 4.5. According to this article the developed country parties shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, *environmentally sound technologies* and know-how to other parties, particularly to developing countries. This should enable them to implement the Convention. The commitment of industrialised countries is echoed in similar provisions under the Kyoto Protocol. To address the implementation of technology transfer appropriately, the Conference of Parties has established an Expert Group on Technology Transfer (EGTT). A "Framework for meaningful and effective actions to enhance the implementation of Article 4.5 of the Convention" reveals the approach the parties to the convention intend to use to address technology transfer. The framework covers five key themes and areas for meaningful and effective action, namely:

- Technology needs and needs assessments;
- Technology information;
- Enabling environments;
- Capacity-building;
- Mechanisms for technology transfer.

The implementation of technology transfer requires, of course, financial resources. The official source of funding made under the convention is provided through the Global Environment Facility (GEF). For climate change the focus is on four technologically defined areas:

- Removal of barriers to energy efficiency and energy conservation;
- Promoting the adoption of renewable energy by removing barriers and reducing implementation costs;
- Reducing the long-term costs of low greenhouse-gas-emitting energy technologies;
- Promoting environmentally sustainable transport.

Besides the technology transfer promoted with particular allocated funds under the convention, environmentally sound technologies are also transferred through private sector activities and through official development assistance (ODA).

A conceptual approach is presented on how technological capabilities can be built to make the transfer of technologies successful. This is followed by examples on the practical experience existing in technology transfer, particularly in the energy sector.

2 A General Approach to Technology Transfer

2.1 Concept of Technology

There is no definition of the concept of technology, which is generally accepted. In principle, one could reduce the prevailing understandings of technology to two variants - a narrow and a broad definition.

2.1.1 Technology: A Narrow View

In a narrower sense, technology is the know-how required to develop and apply technical procedures. It exists embodied in machinery and equipment and unembodied in blueprints and technical instructions or manuals. Technology transfer is the process of passing on this know-how to others.

The term technology transfer is often used synonymously for the international transfer of technology between industrialised countries or from industrialised countries to developing countries.

The narrow definition of the concept has at first glance the benefit of being manageable. Its disadvantage is that it risks losing sight of the complementary factors involved, without which it makes little sense to deploy the technology in the first place. These complementary factors include above all qualification (training the persons who operate the technologies) and organisation (i.e. the integration of a given technology into social contexts and company-level operations).

The narrow definition, and the outlook and approaches it implies, is inappropriate for three reasons:

- Technology should be viewed neither in isolation from its context nor from the organisational structures in which it is used. Technology does not arise in a vacuum: it invariably emerges in determinate social contexts. It is never neutral: it is developed in connection with specific (economic, social, political) interests;
- Technology often involves organisational factors. A closed process in the chemical industry or a production line in the metal-working industry, for instance, not only implies technical knowledge of individual manufacturing steps, but also organisational knowledge of the possible arrangements of the connection between these manufacturing steps;
- A view unduly confined to technical procedures will often cause projects to fail - in DC no less than in many international high-tech firms, which have been known to founder due to one-sided technology-oriented rationalization projects. The diffusion of new technologies necessitates the development of complementary forms of organisation.

2.1.2 Technology: A Broad View

A broader definition of technology comprises four components:

- Technical hardware, i.e. a specific configuration of machinery and equipment designed to produce goods or provide a service (e.g., a coal-fired power plant);
- Know-how, i.e. scientific and technical knowledge, formal qualifications and experience-based knowledge;
- Organisation, i.e. the managerial methods used to link technical hardware to know-how;
- The product, i.e. the physical goods or service emerging from the production process (e.g., electrical energy).

The components of technology cover a broad spectrum:

- From the hardware of traditional tools and machinery to solar engineering and microelectronics;
- From the skills derived from traditional knowledge handed down through the generations to formal qualifications, e.g. computer skills;
- From the organisational patterns of traditional solidarity-based communities to highly specific Taylorist systems and teams of workers with polyvalent qualifications;
- From simple products of moderate quality to goods of world-class quality.

Depending on concrete situations, very different combinations of these factors are possible. Conversely, no single combination of these factors is the one and only best to be striven for under all circumstances; neither is high tech the magic word everywhere in manufacturing, nor do simple technologies necessarily constitute the best solution in poor countries. Instead, a core element of technological capability consists in organising open learning and search processes geared to finding the appropriate combination of technology components.

2.2. Building Technological Capabilities in Developing Countries

In order to find a consistent path towards sustainable development, including climate-friendly development, all developing countries should employ a broad range of technological options, be they low or high technologies. This path can only be followed if sufficiently developed technological capability exists. Such capacity should encompass:

- Knowledge of the technologies available;
- Ability to evaluate and select technologies;
- Ability to utilise, adapt, and improve technologies;

- Ability to develop technologies on an independent basis.

Achieving a technological capacity that meets a country's needs as determined by its chosen path towards sustainable development requires an extensive effort, one that is frequently beyond the means of, particularly, poor developing countries. Technology transfer can help in this process and development cooperation is one transfer mechanism. Technical cooperation, as part of development cooperation, can transfer know-how to partner countries with a view to upgrading their technological capabilities for addressing development challenges.

Technological capacity rests on four pillars:

- The capability of producers and firms to imitate and innovate;
- Framework conditions conducive to innovation;
- Technology-oriented institutions;
- An effective education and training system.

Technological capabilities can only be developed successfully if the four pillars are closely interlinked and networked. Here, too, technical cooperation focuses its contribution on developing networks and integrating its activities into existing structures. Technology-oriented cooperation must first and foremost aim to shape and reshape structures; but at the same time it must produce tangible results.

3 A successful Story

One brief example serves to demonstrate how a specific technology was successfully transferred using the general approach to technology transfer described in chapter 2. The case I would like to present from German technical cooperation is “Clean Coal Power Technology in China.”

At the beginning of this Chinese-German project, we observed in the coal-fired power plants of most Chinese utilities the following problems, listed below according to the four components of technology (2.1.2):

• Technical hardware:	Varying coal quality; Design errors in boilers of the power plants; Lack of (basic) measuring instruments; Limited availability of special materials (e.g., high-grade steel); ➔ Low efficiency in power plants; ➔ High GHG emissions per kWh.
• Know-how:	Deficiency in regard to power plant design; Insufficient knowledge of operating techniques.

- Organisation: Sub-optimal operation of power plants; Insufficient maintenance.
- Product: Costly and "dirty" power supply.

It was agreed that a project involving the Thermal Power Research Institute (TPRI) and GTZ would endeavour to improve the energy efficiency of boilers of coal-fired power plants through a low-investment approach. The main hardware investment was a measuring truck, a truck equipped with modern measuring instruments to check and adjust large boiler performance. The key to success was the networking of all components to create and sustain the technological capability required to improve boiler efficiency in many plants. In short, the Chinese government created framework conditions that were conducive to innovation in the power sector, including a policy to decrease specific coal consumption in old coal-fired power plants and more stringent emissions standards for SO_2 and NO_x. These framework conditions motivated the management of power plants to enhance combustion efficiency and reduce emissions. Management opened up to the idea of measurements as a basis for adjusting the operational parameters of coal-fired boilers. Furthermore, a demand was created for consultancy to improve efficiency, which led to the upgrading of technical and professional expertise at TPRI, the GTZ partner in the project, through on-the-job training. Capacity building was further supported through training and study tours in Germany of utilities manufacturers, research institutes and university departments for combustion technology and environmental protection for TPRI experts. Experts from a large German utility were involved in the capacity-building process, which included joint planning and design of technical solutions. The technology-oriented education and training courses addressed more than 400 TPRI engineers and power plant managers, engineers and specialists.

The physical and financial results at the power plants, which improved their efficiency, were also impressive. The optimisation of boilers in 32 coal-fired power plants (~ 10 000 MW) at a cost of US$ 7.5 million achieved:

- Coal savings of 270 000 t/a equiv. to US$ 8.2 million per annum;
- SO_2 reduction of 5000 t/a;
- Particulate reduction of 4000 t/a;
- US$ 1 technical assistance achieved US$ 20 in coal savings plus environmental benefits;
- 500 000 t/a of CO_2, reduction.

And finally: The Chinese Government decided to purchase through financial cooperation 15 new measuring trucks from Germany to improve the efficiency of 400 power plants with a capacity of 72 000 MW and a potential for reducing CO_2 by 3.6 million tons per year. GTZ technical cooperation is helping the Chinese partner to use the new measuring trucks with optimal effectiveness.

4 Outlook

The concrete example presented above is just one option for technology transfer to address GHG emissions reduction, one which focuses on the efficient utilisation of existing technologies but with opportunities for innovation and for their further development.

4.1 Technology Needs Assessments

Many other technologies are available for mitigating GHG, but it would be beyond the scope of this paper to list or even explain their potential for developing countries. Anyway, an appropriate choice of technology can only be made on the basis of a solid country-driven analysis and, finally, before investments are made, of a project-specific planning process. It was therefore recommended that countries assess their technology needs in a national study. Funds are available from the GEF. Some countries have already finalised their needs assessment process and presented results *(e.g. http://ttclear.unfccc.int/ttclear/html/WshpSeoulPresentations.html).*

Since technology needs assessments are frequently initiated by climate-change-oriented experts, institutions and government departments, it is decisive for the implementation of any recommendation that the stakeholders within the various sectors – foremost energy, industry, transport, waste management and also agriculture and forestry – be involved from the very outset of the study.

4.2 Clean Development Mechanism

Besides the needs assessment and follow-up, other mechanisms can be used to introduce environmentally sound technologies. One, which is currently heavily debated, is the "Clean Development Mechanism". This flexible mechanism of the KP offers opportunities for transferring new and innovative technologies to developing countries. Under the terms of this mechanism, national governments must decide right from the start what technology policy they wish to follow for CDM projects submitted to them for approval. Some countries have already made clear that they would prefer only innovative technologies in CDM projects in their country. But so far no country seems to have a concrete policy particularly favouring the transfer of specific and clearly defined technologies.

4.3 Other Initiatives

Of course, others initiatives are under way to advance technology transfer to developing countries. On technology information various data systems exists already in the Internet to inform von environmentally sound technologies. An extensive discussion takes place under the UNFCCC on enabling environment for technology transfer; a technical paper will be made available soon. On capacity building for technology transfer suggestions are prepared how best to address institutional and personal demand under the convention [2]

Under the KP a special climate change fund is set up to fund technology transfer activities. Currently suggestions are debated which activities and projects this fund should support.

4.4 Adaptation to the Adverse Effects of Climate Change.

This paper has purposely only touched on technology transfer for climate change mitigation. Technologies for adaptation is a wide field which need to be addressed in the future much more extensively once we are clear which technological challenges we have to face under adaptation.

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Business

INDUSTRY CONTRIBUTIONS: EMISSION REDUCTIONS AND SELF-COMMITMENTS

Joachim Hein
Department of Environmental Policy
Federation of German Industries (BDI)
10178 Berlin
Germany
E-mail: j.hein@bdi-online.de

1 Introduction and "History"

German industry supports a preventive climate policy and its actions are based on the precautionary principle: it is making major efforts to use resources as efficiently as possible and so minimise the impact on the environment. However, a sense of proportion must be retained at all times and measures must be commensurate. In addition any policy on climate can only succeed if the approach is global.
The challenges presented by potential climatic changes can no longer be adequately addressed by using the traditional instruments that have been used in the last decades to tackle the "common" environmental problems like air or water pollution. In many respects climate protection necessitates a fundamentally new approach because the phenomenon of potential climatic changes introduces new dimensions with respect to potential impacts on humans and, in general, on ecosystems. But it also introduces new dimensions with respect to possible starting points for developing response strategies. Problems like potential climatic changes are no longer only of an ecological nature but exert direct influence on other fields like economic policy and societal aspects. Sustainable development can thus not be achieved by simply limiting or reducing e.g. emissions. Sustainable development has to be viewed as an integrated optimisation problem whereby all three sustainability dimensions have to be taken into account.

1.1 Protection is coming from new Production Processes and Products

Decoupling of energy consumption and use of natural sources from economic growth continues. The fall in CO_2 emissions in Germany between 1990 and 2000 of 152 million tonnes (temperature adjusted) was the result of contrasting factors. The emission-increasing factors, i.e. rises in per capita GDP (+ 121 million tonnes) and population (+ 31 million tonnes) was more than offset by the emission-reducing factors triggered by major reductions in energy intensity, i.e. much higher energy efficiency both in production and the use of more energy-efficient products (- 194 million tonnes) plus reductions in carbon-dioxide content of the total consumption of primary sources (-112 million tonnes) (particularly in energy conversion).

1.2 The new Climate Protection Agreement now includes all "Kyoto Gases" – with even more ambitious Reduction Targets

The German Business in 1995 has presented a first Declaration on Global Warming Prevention to the Federal Government in the run-up to the first Conference of the Parties to the UN Framework Convention on Climate Change. This declaration has been extended and updated in 1996; in addition this extended declaration has been equipped with a so-called CO_2-monitoring system. This means that a neutral scientific institute, the Rheinisch-Westfälisches-Institut für Wirtschaftsforschung in Essen, has to check whether the emission reductions are on track, and it has to produce annual monitoring reports which are financed half-half by the government and by the industry. Applying this self-commitment as an instrument for climate protection has been seen from the beginning – by the industry and by the government – as a dynamic process, as a learning process with the intention to adapt the instrument to forthcoming changes in the general situation. A decisive change in the overall framework was the adoption of the Kyoto-protocol in 1997. After intensive negotiations the Agreement on Climate Protection between the Federal Government and the German Business could be signed on November 9, 2000. It was signed by Chancellor Schröder and Ministers Müller (economics) and Trittin (environment) as well as by the Presidents of BDI, VDEW (utilities), VIK (industrial power plants) and BGW (gas and water plants).

The core elements of the new agreement of 9 November 2000 are the agreements made by industry regarding the Kyoto Protocol reduction targets for specific greenhouse emissions (relating to all six Kyoto gases) of 35% by 2012. By 2005 further efforts are to be made to achieve a specific reduction of 28% in CO_2; in both cases the reductions are based on 1990. For its part the government declares it will not introduce a binding energy audit or initiatives for enforcing its climate policy targets by legislative measures. The decision on the use of the flexible instruments of the Kyoto Protocol will be made jointly with industry. The government will also try to ensure that those sectors of industry involved in the agreement will not suffer any competitive disadvantages internationally as a result of the future developments of the ecological tax reform. It is therefore becoming more likely that the special regulations for the producing sector can be retained within the framework of the ecological tax reform. In the national climate protection program of October 18, 2000 this agreement had already been incorporated as a central building block.

2 Present Situation

The national climate protection policy is lacking an overall concept; the traditional instruments of environmental policy are at their limit. The policy objectives (national and EU burden sharing) are not backed by a clear and comprehensive strategy on how to achieve them: Germany still lacks an integrated, reliable long-term policy that is sustainable for both the economy and society. The measures listed in reports published to date by an inter-ministerial working group on "CO_2 Reduction" fall a long way short of this requirement, rather they give an impression of ad-hoc non-integrated political intervention. To date policy has relied too heavily on traditional solutions such as domestic regulation and taxation rather than on international, better global co-operation.

To realise very ambitious Objectives requires an optimal Set of Instruments

The current set of instruments for climate protection can be compared to a patchwork blanket of uncoordinated measures and actions, created by continually adding new elements and without an adequate analysis of the possible inter-actions of the individual instruments and the effects on the overall situation: Federal Immissions Control Act ("BImSchG")/technology status ("Stand der Technik"), climate protection agreements, eco-tax, the Renewable Energies Sources Act, promotion of combined heat-and power production etc. Now, yet another instrument will have to be added to this "patchwork": emissions trading (ET). The German Business does not object to the instrument of ET as such. The German Business is however worried about competitive distortions that might arise from the ET-Directive as adopted in July 2003. The Directive stipulates an obligation for certain industrial installations to operate under absolute greenhouse gas emission ceilings. This air management system is feared to limit severely the flexibility indispensable for German Business. This is the more disturbing as German business is playing an active part in the realisation of national and Community-wide climate protection objectives. Measures taken as part of independent business initiatives have made a decisive contribution to the achievement of positive results for the climate in both the Federal Republic of Germany and the European Community as a whole. Within the Community (EU-15) greenhouse gas emissions decreased by 4% since 1990. Within the "EU-14" (all other Member States except Germany) emissions in the same time rose by about 1.3% or 57 million tons. Thus, Germany has already contributed substantial emissions reductions ("early actions").

These "early actions" must be honoured, and they cannot be booked as "wall-fall-profits". In Eastern Germany highly emitting installations have partly been shut down but most of all (energy-) inefficient productions have been brought up to the latest standards by massive private investments. This fundamental modernisation in Eastern Germany has not just fallen from heaven but has in spite of substantial financial transfers been paid for - and still is being paid for – with high unemployment rates. Analyses of the Fraunhofer Institute (ISI) and the DIW (German Institute for Economic Research) show moreover, that Germany was able to reduce its total greenhouse gas emissions by 9% (1990 till 2000), even without the "re-unification effect".

In 1990 Germany's share of the EU total emissions was only some 29%; till 1999 this share decreased even further to less than a quarter. The so-called EU Burden Sharing Agreement of June 1998 stipulates however that Germany has to deliver about 75% of the net reduction, which is necessary for the Community to achieve its Kyoto target. Competitive distortions will be the consequence of this Burden Sharing aggravated by the ET-Directive. In addition, each Member State has its individual mix of energy carriers. It is therefore easily understandable that France with a share of about 80% nuclear power (causing no CO_2 emissions) will have practically no problems with the proposal whereas Germany with a share of 60% coal-based electricity and simultaneously phasing out nuclear power takes a much more sorrowful look into the future. Because there is much more at stake than climate protection: if this proposal is thoroughly thought through its massive impact on industrial and structural policies becomes clear.

The national allocation plans to be drawn up by the Member States will have a decisive influence on the Member States' economic developments. Since the criteria for the drawing-up of such plans are rather "soft" and little concrete as laid down in an annex to the Directive this will unavoidably lead to competitive distortions. It is true that the commission has to be notified of the individual allocation plans but this is an argument cutting both ways: the Directorate General Competition will on the one hand try to safeguard competition, on the other hand the Directorate General Environment will be given a strong lever and an extremely far-reaching competence.

The competitiveness of German and European industries will however be especially battered in comparison with non-EU-countries: if a ton of cement or a ton of steel becomes even more expensive by adding the cost for allowances relocation of productions into non-European countries will be the only way to escape this extra cost. Even more cement will then be imported from Thailand, steel from China, in any case from countries that do not even have signed the Kyoto Protocol let alone have introduced drastic absolute emissions ceilings for their industries.

3 Greater Focus on Global Co-operation

Greater co-operation between industry and those responsible for development policy (public-private-partnerships) is essential in order to encourage the integration of developing and emerging countries into the global economy, something that will benefit the environment, defuse political and social conflicts and improve living standards. A major reason for the reluctance of many developing countries to accept the latest technology and energy-efficient systems is often the ongoing expense of the skilled employees and materials needed for the operation, maintenance and repairing of modern systems. In addition, the different objectives of development policy are competing for scarce resources and from the perspective of the developing countries climate protection is not normally a top priority. In terms of environmental policy, the international community is right to place its trust in the innovative drive existing within enterprises as a means of achieving global sustainability. *Agenda 21* calls for the strengthening of the forces of innovation within industry through more competition, environment management systems, the streamlining of administration and greater technology transfer. This is the only way to achieve significant advances, not only in Germany, but also beyond national borders on the road to energy-efficient, environmentally aware societies.

3.1 Global Effect of demanding German Targets is minimal

According to IEA forecasts (World Energy Outlook 2002) global CO_2 emissions will rise to an annual figure of 38 billion tonnes by 2030. Even if Germany were to achieve the – 21% reduction required under the EU burden sharing agreement this would represent a reduction of less than 1% in global emissions compared with the base year 1990. However, this relatively minor contribution by Germany will demand major sacrifices from the German economy because the cost of increasing what is already a high level of efficiency is disproportionately high. By the year 2010, around 80% of the world's population will be living in "young" countries. While energy consumption is expected to stagnate in the industrialized world, it will treble within these "young" countries, essentially due to increased use of fossil fuels. This could lead to nearly 60% of global CO_2 emissions originating from these nations.

Given the premise that these problems can only be solved by global networking, German industry could make an immediate contribution worldwide with its state-of-the-art technology. However, this does depend on investment capital being mobilized, with those efforts already made to modernize and extend the infrastructure being taken into account. The faster politicians see the process of globalisation in a positive light, the sooner and more effectively environmental protection can be improved.

3.2 Forcing Innovation

Everything points to the fact that innovation is the key for an energy-efficient, environmentally friendly society. Innovation is essential if society is to function economically, ecologically and socially. If the technological standards by which German industry operates were to be used worldwide today, CO_2 emissions would be reduced by around 3.8 billion tons (= 17%). Only further development of present day technology can provide the answers to the global challenges facing our energy and environmental policies. Rejecting technology is not the answer. Technical innovations present us with new options and choices, while rejection simply reduces our freedom of choice and ability to act, quite apart from its negative effect on the creation of jobs and income. Technological innovation needs to be approached with a sober, objective and open mind, instead of just emphasizing the potential risks that new technologies might harbour in a one-side fashion. Technophobia - the rejection of scientific and technological advances, or failing to act on them - must give way to a more receptive attitude towards new ideas and ventures. Negative and positive aspects must be carefully weighed up within the framework of sustainability, taking into account their intrinsic economic, ecological and social values.

Well-grounded, broad-based and open-minded general and university education is needed, as well as objective information and discussion. Only this way can people approach technology free of pre-conceived prejudices and hysteria. Sustainable development as an objective can only be achieved when a strategy can be developed which puts greater emphasis on technical progress and economic growth as a means of maintaining the natural basis of life. Technical progress demands investments, a fundamental condition in every dynamic economy, as well as its result. Stagnation is not only disadvantageous in the economic and social sense, it also has a detrimental effect on the environment. Technical progress and investment lead to economic growth and higher efficiency in the use of resources. As well as relieving the environment, they also create jobs and income. Environmental protection calls for innovation, which in turn needs the right "climate" for investment .

3.3 Stimulate worldwide Co-operation

The problems of the planet cannot be solved within just one region, or by just one nation. Sustainable development can only be achieved when the community of nations can agree on how to go forward. This involves agreements being reached between governments which can be implemented by all countries and communities. The international division of labour must also be applied to protect the environment. This means opening markets, reducing trade barriers and expanding the global exchange of goods on the principles of free trade, as formulated by the WTO. Even more importance must be attached to the transfer of private capital from the industrialized to the developing countries.

The principles of Joint Implementation and Clean Development Mechanism as new forms of co-operation and new opportunities for the transfer of technology and capital must be developed further. This will give the developing countries a chance to market their own existing environmental resources to the industrial countries. The focal point of this principle is the idea of implementing necessary environmental standards as efficiently as possible, i.e. to take cost-effective measures to ensure global benefits at the lowest possible cost. This would give considerable economic and ecological advantages to both the industrial and developing countries.

In the USA, despite improvements in energy efficiency, absolute emissions are still on the rise. Therefore, should the USA continue to reject the Kyoto Protocol, this cannot be counteracted by however ambitious a vanguard position of the European Union or even Germany. A Kyoto Protocol without the USA will have drastic consequences for the competitiveness of German and European industry, as especially in the USA climate protection policy is formulated within the context of a global redistribution of growth and development opportunities as part of global competition for markets and resources. Neither Europe nor Germany can ignore this any longer.

Within the framework of the climate agreement German industry contributes some 30% to the EU Kyoto target (i.e. 40% of the German contribution according to EU Burden Sharing) and stands by its commitments. Germany can only succeed in achieving its targets however, if – as stated in the agreement – the Federal Government does all it can to avoid competitive disadvantages for German industry globally as a result of the Kyoto commitments, the related instruments (Emissions Trading etc.) and the EU burden sharing. In view of the considerable emission reductions to which German companies are committed, other countries should be encouraged to undertake similar efforts. Effective and efficient climate protection necessitates the USA to be brought back to the path of international co-operation – under the Kyoto regime or within any other internationally acceptable scheme.

4 Outlook and BDI Theses

The idea of a "going it alone" environmental policy resulting in new, attractive export opportunities is an illusion. The very high standards of environmental protection in the Federal Republic of Germany can only be translated into export success when we reject the idea of trying to lead the world with a "lone ranger" policy, and start to place more emphasis on international cooperation. Close linkage between environmental and economic policy on the one hand, and the interests of commerce and foreign trade on the other, is highly relevant to the successful realization of the concept of sustainability within the context of more and more global competition. However, this does demand that these linkages be coherently integrated in all policy domains.

4.1 Climate Policy must not be reduced to Environmental Policy

Decisions taken with respect to climate protection affect directly and indirectly a great number of other policy areas, energy policy being the most important. Close linkage between environmental and economic policy on the one hand, and the interests of commerce and foreign trade on the other, is highly relevant to the successful realisation of the concept of sustainability within the context of more and more global competition. The geopolitical dimensions must be recognised: it is expected that energy security will be pushed up to the top of the energy policy agenda and governments will need to take a much more pro-active role in dealing with energy security risks. Climate protection targets might develop into means to steer the distribution and use of (particularly fossil) energy carriers. If climate changes occur the way they are predicted in model runs the distribution of the world's freshwater resources will be affected. The future might then see fighting for access to drinking water. If sea levels will rise huge migrations might result. These potential problems can only be solved if and when the community of nations can agree on how to go forward. The idea of "going it alone" is an illusion. The EU cannot combat climate change on its own. Much greater efforts must go into designing a truly global regime aiming at meaningful international cooperation to deal with global problems. Industry must be seen in this as part of the solution. Incentives must be created for investments that foster innovations that in turn lead to sustainable economic growth. A "fair" discussion must be started on the evolution of the Kyoto Protocol that includes participation by the US and developing countries

4.2 Criteria for the Instruments of Climate Protection Policy

Ambitious targets demand powerful tools. It is essential to examine and evaluate the suitability of any political instrument to be harnessed for climate protection purposes. This must be done by reference to an agreed set of criteria, which identify the impact of any instrument. The following criteria are particularly important:

- ecological efficiency: the environmental objectives must be achieved;
- economic efficiency: objectives must be achieved at the minimum possible cost;
- credibility and transparency: implementation of measures must be subject to transparent monitoring and the results verified by an independent body;
- flexibility: if flexibility is restricted "artificially" when measures are implemented, their effect is reduced;
- reliability: industry requires the maximum possible planning and investment security, in particular for plants with a long service life.

4.3 Developing and Emerging Countries must be incorporated into the Kyoto Process

As things stand at present, action restricted solely to industrialised nations (Annex B countries in the Kyoto Protocol) cannot offset the expected increases in emissions by non-annex B countries (developing and emerging countries). Climate protection will not succeed if two-thirds of the world's population make no special commitment in the long run to limit their – rising – greenhouse emissions. Consequently it is essential that the non-Annex B countries gradually join the Kyoto process, for example by accepting certain limits to their growth in emissions. This process could be encouraged by greater diplomatic and political efforts, appropriate drafting of the Kyoto mechanisms, functioning technology transfer etc.

4.4 Theses

- A strategy is needed that integrates preventive climate policy, economic growth and jobs by creating a framework and encourages investments;
- Climate policy is not only environmental policy but needs to be seen in a much broader context;
- Ecology must not be used as an excuse for increasing state revenues;
- Innovations must be vigorously promoted;
- Much greater emphasis must be placed on worldwide co-operation;
- Large developing countries should be willing in the future to make quantitative contributions to global warming prevention (e. g. China, Brazil, India);
- If global climate protection is to be effective countries with high growth rates and/or that use large amounts of fossil fuels and/or where energy carriers are used inefficiently should accept quantitative emission ceilings for greenhouse gases at least in the medium or long term.

OPTIONS FOR & EXPERIENCES OF THE PRIVATE SECTOR IN DEVELOPING COUNTRIES
ENERGY FOR THE FUTURE

Klaus Baumann
International Markets
RWE AG
Opernplatz 1
45128 Essen
Germany
E-mail: klaus.baumann@rwe.com

One focus of our business is continued development of energy services in the RWE Group. Energy services that meet future needs are not only the foundation for long-term company success, but are also the key to environmentally compatible development that creates worldwide prosperity. Since 1970, world energy consumption has almost doubled and, in the next few decades, global energy demand will continue to increase, above all in the Asia-Pacific region. According to the World Energy Council by 2020, world energy consumption, which is today 14 billion metric tons of coal units, will increase to 20 billion metric tons. This development will be driven by the continuous increase in the world's population from 6 billion to 7.5 billion people by the year 2020, and the steady growth of the global economy. One of the crucial challenges in the coming decades will be addressing, in particular, the justified desire of developing countries for access to a secure and affordable supply of energy and for economic development, prosperity, social security and equal opportunities for both countries and individuals. The central task will be to satisfy and secure the increasing demand for energy in line with environmental concerns.

1 Energy Consumption and Environmental Protection

Despite all efforts to promote renewable energy sources and efficient energy use, the majority of our future energy consumption will still rely primarily on fossil fuels and nuclear power. In all likelihood, renewable energy will not be able to make a significant contribution until the middle of this century in part because it is associated with comparatively high costs in the long term.

Using fossil fuels is, however, also inevitably connected to toxic emissions. It is true that the industrial countries were able to make a lot of progress in the last few years in "traditional" air pollution emissions such as sulphur dioxides, nitrous oxides, dust and volatile organic matter. However, air pollution, accompanied by an increase in energy consumption, is rising dramatically in large metropolitan areas and concentrated industrial centres in the newly industrialized countries as a result of emissions from cars, household heating and industry. Preventive technology is still frequently too expensive as a quick remedy to bring standards up to Western levels. Despite the public's resistance to the idea of nuclear power, the World Energy Council continues to believe that it is one of the best options for a secure, long-term and environmentally-safe energy supply.

2 Preventing Climate Change and Energy Efficiency

Preventing climate change is just as urgent as clean air. Greenhouse gases, the most important of which are CO_2, methane and nitrogen oxides have a global effect and have been on the agenda of international negotiations for years. It is true that the extent to which the increase in global temperatures has been caused by human beings has not been determined. Regardless of this fact, the Intergovernmental Panel on Climate change assumes that the increasing concentration of greenhouse gases in the atmosphere will result in a further increase in average global temperatures. This panel, made up of members of the international scientific community, anticipates a far-reaching climate change. The first measures taken to avert this change were discussed and adopted at the Climate Conferences in Kyoto (1997), Bonn (2001) and Marrakech (2001).

Germany, the frontrunner in efforts to prevent climate change, is responsible for 80 % of all EU reduction targets for greenhouse gas emissions. Between 1990 and 1999, energy productivity increased in Germany by about 15 %. CO_2 emissions decreased during the same period by approximately 16 %. Based on calculations provided by the "Fraunhofer Institut für Systemtechnik's" Division for Energy Technology and Energy Policy, only about half of these reductions were a result of German reunification. There was still a net reduction of nine %. The Federal Office of Statistics emphasized in its assessment of environmentally relevant economic factors for 2000 that "significant contributions had been made to the reduction of CO_2 emissions between 1991 and 1998" particularly in the areas of coal mining, energy supply, chemical industries as well as coking plants and mineral oil processing. In addition, German companies continued to do their part to increase energy efficiency. Between 2000 and 2020, economic growth and energy consumption will be able to continue to balance each other out as, according to scenario I of the energy report prepared by the German Federal Ministry of Economic Affairs, primary energy consumption will decrease in absolute terms by 3 % despite an increase in the real gross domestic product of about 45 %.

For the purpose of reducing CO_2 emissions, the associations of the German energy industry and the energy-intensive industries agreed to an "Action Programme on Climate Protection" with the Federal Government in the spring of 2001. This action programme supplemented the voluntary measures imposed in 2000. The objective of this programme is to reduce CO_2 emissions by 45 million metric tons per year by the year 2010 using a combination of voluntary measures and publicly promoted plans in a series of concrete and quantifiable steps.

3 Highlights: Prototype Carbon Fund

RWE is the only German industrial company participating in the Prototype Carbon Fund (PCF) set up in January 2000 to test the practical implementation of mechanisms established in the Kyoto Protocol. Backed by 180 million US dollars, the fund is a joint project of the World Bank, national governments and companies. The aim of the fund is to finance energy projects in both industrialized as well as newly industrialized and developing countries, which implement measures to prevent climate change. The resulting emission rights are credited to PCF participants depending on the amount of their capital interest. The first project financed converted landfill gas to electricity in Latvia. Implementation is underway for additional Clean Development and Joint Implementation projects. A PCF Fellowship Programme was set up to promote knowledge sharing among the participants. In the first half of 2002, RWE seconded an employee with first hand experience from the PCF in the implementation of some of the Kyoto mechanisms.

4 RWE is meeting Challenges head-on

As Europe's third-largest energy supplier, RWE wants to secure and expand its markets. To achieve this goal, RWE must have a supply of power and gas that is competitive, secure and environmentally compatible. In fact, RWE is still convinced of the environmental value of nuclear power because it is the only competitive type of energy, free of CO_2 emissions that will be available in Germany in the near future. RWE is, however, also aware of social realities and, as a result, decided to gradually phase out nuclear power on the basis of an agreement concluded in June 2001.

To continue expanding its core businesses and meet its sustainable development goals, the RWE Group relies on various types of electricity generation for the European market with a strong domestic production base. One of RWE's biggest advantages is having lignite as a long-term, competitive, domestic energy source in its portfolio because importing energy sources is associated with political risks and oil and gas prices are unpredictable. To meet climate protection standards, RWE will increase the energy efficiency of its power plant facilities through expansion and modernization. At the same time, current output will be expanded using renewable energy sources, innovative solutions such as fuel cells will be brought to market, and a distributed energy supply system will continue to be developed based on cogeneration. According to an optimistic prognosis, decentralized energy, which relies on renewable energies, cogeneration and fuel cells could reach 30 % of the overall power market in Germany by the year 2015.

5 Programmeme for Power Plant Modernization

By investing in modernization and expansion, the energy efficiency of our power plant facilities will increase an additional 15 to 20 % by 2010. Among the steps being taken are setting up lignite blocks with optimal facility technology (BoA) in Niederaussem in the Rhineland's lignite industry. This new power plant has an operating efficiency of over 43 % and replaces old facilities with efficiency levels of about 31 %. The continued development of this facility to BoA Plus is already being tested. Plus means that fluidised bed drying and mechanical-thermal lignite dewatering processes are used. These are pre-processing steps that further increase energy efficiency during combustion.

6 Expanding renewable Energy Capabilities

RWE intends to more than double its approximately 800 megawatts of current energy output from renewable energy sources to approximately 1,700 megawatts by the year 2010. For this reason, RWE is involved in testing large wind farm facilities in Germany. By the year 2020, this type of energy production will replace hydropower as the dominant renewable source since hydropower opportunities are limited and almost completely exhausted in Germany due to geographic factors. The %age of energy produced from biomass and garbage, sludge, organic and waste gases as well as photovoltaic energy will increase. Harpen and RWE Solar, both management companies of RWE, put RWE in a unique position to further expand its capabilities in the field of renewable energy sources. RWE Solar is one of the leading solar cell manufacturers in the world and it is adding a third production line to its current capacity in Alzenau. Harpen relies on wind energy and put a wind farm into operation ant the end of 2001 in Spain that will have a total capacity of 16.5 megawatts by the time it is finished.

7 Fuel Cells Potential

Fuel cells are ideal building blocks for distributed energy supply because they produce both power and heat at the same time. In addition, they can be flexibly integrated in systems of almost all sizes, have an extremely high operating efficiency regardless of their level of utilization, are quiet and almost completely maintenance free. On the basis of an optimistic prognosis, fuel cells could achieve a market share of up to 10 % in Germany by the year 2015. The associated reductions in CO_2 emissions of between 20 and 40 % mean that introducing fuel cell technology would make a contribution to achieving German climate protection targets. Since 1991, RWE has cooperated with manufacturers of fuel cells systems and has built up knowledge at an early stage. In the Fuel Cell Pavilion in Essen, the first units were tested for their day-to-day use potential. In addition, RWE equipped North Rhine-Westphalia's state representative office in Berlin with a fuel cell.

In the summer of 2002, the Ruhr region of Germany conducted the first field tests on 25 fuel cells in the five-kilowatt class. In the area of fuel cell plants, RWE is striving for the top ranking and will invest more than 100 million euros in this technology over the next few years. As part of its cooperations with other companies, essential elements required for series production will be supplied by German companies, thus creating additional jobs. Installation and maintenance of the units will be carried out by the local installation operations and offer new value-added opportunities.

8 Efficient and decentralized Energy Supply using Gas and Steam Turbines and Cogeneration

Combined cycle gas turbines (CCGT) and cogeneration (CHP) can pave the way for distributed, efficient energy supply, an area RWE has been active in, for some time. CCGT power plants connect gas and steam turbines to each other to increase efficiency levels. These plants are usually powered by natural gas. If the low-temperature steam is additionally utilized by cogeneration, high-energy efficiency levels of up to 87 % can be achieved.

Building and operating these types of facilities is particularly interesting for industrial customers who have an ongoing need for heating and process steam, and can also direct part of the electricity produced into their own networks or connected networks. In addition to the CCGT facilities operated by RWE at BASF, Bayer and Opel, the RWE operating management company, Harpen, has constructed several cogeneration facilities that work with different types of energy sources and generate both power and heat. This distributed supply strategy was enhanced by the law for the Maintenance, Modernization and Expansion of Cogeneration, which went into effect on April 1, 2002. This law provides compensation for electricity produced by particularly efficient cogeneration facilities that is then fed into the general power supply network.

9 Outlook

RWE will make considerable efforts in the future to reduce CO_2 emissions just like all German industrial companies. In spite of this, it is our opinion that some demands made by individual parliamentary groups and the Federal Sustainability Council that want to reduce CO_2 emissions by 40 % by the year 2020 are unrealistic. In light of the scheduled shutdown of some nuclear power plants, this objective will result in structural problems that jeopardize Germany as a business location and will endanger its workforce significantly. These types of goals can no longer be set within national borders but must instead be set within the European framework.

10 Highlights: RWE Position on Emissions Trading

The Kyoto Protocol uses the flexible instruments of Joint Implementation (JI), Clean Development Mechanism (CDM), and Emissions Trading (ET) for emissions trading rights. The inclusion of all climate gases, all regions and all emissions provides for the highest level of flexibility and the most cost-efficient reduction of climate gas emissions in line with global standards.

The draft guideline presented by the European Commission on October 23, 2001 for an EU-wide emissions trading system does not meet these requirements and should be rejected. This is the standpoint of German industry as a whole. The draft EU Directive only includes current EU member states, affects only a few sectors (electricity and heat production over 20 MW, iron and steel, glass, paper and cement), includes only CO_2 and ignores other green house gases - particularly methane and nitrous oxide. Moreover, it is not clear whether the EU draft is compatible with the existing mechanisms in Germany for preventing climate change (self-imposed measures, cogeneration law, renewable energies law, environmental tax, etc.) with which the national targets for reducing gas emissions by 2010 will most likely be reached. Rather, the fear is that the existing mechanisms will not be replaced and that an additional strain will be placed on companies and consumers leading to a loss of jobs and a decline in prosperity. As a result, the implementation of the emissions trading system should not be mandatory and should instead be optional if climate protection targets are reachable.

If the EU Commission sticks to its plan, a guarantee must be provided that the European economy is not put at a disadvantage because it is acting unilaterally. In addition, the burden of European climate change prevention policies must be distributed evenly among all affected sectors, the companies affected must have as much flexibility as possible and the cost of the system kept as low as possible. Some of the minimum requirements are:

- Inclusion of the other greenhouse gases mentioned in the Kyoto Protocol;
- Inclusion of the EU member candidates;
- Inclusion of project-related Kyoto mechanisms (Joint Implementation, Clean Development Mechanism).

The discussion is ongoing. A revised version of the Directive has been published in June 2003.

11 RWE promotes Sustainable Development worldwide

RWE is involved in the e7 initiative, an amalgamation if nine leading power-supply enterprises from the G7 countries drafting guidelines for a sustainable energy economy and the implementation of international climate-protection projects. The goal of this initiative is to forward the positions of the power economy in the global discussion and to foster innovation. To cite some examples, the e7 has acted within the scope of the UNFCCC to set up power supply systems in Indonesia, which operate independently. A project aimed at increasing efficiency and reducing emissions of fossil-fired power plants in Jordan has also been concluded on a successful note. Various Clean Development Mechanism (CDM) projects are being developed in Bhutan, Ecuador and Nicaragua. In order to promote the transfer of know-how, the e7 is holding workshops on climate change and electricity related issues and has even established a scholarship programme for students from developing countries.

Integrating the “South”: Options & Strategies for a Global Climate Protection Regime

EVOLUTION OF COMMITMENTS UNDER THE UNFCCC

Niklas Höhne
ECOFYS Energy & Environment
50933 Köln
Germany
E-mail: n.hoehne@ecofys.de

1 Introduction

International negotiations have lead to first steps in combating climate change within the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. Under the Protocol, industrialized countries have committed themselves to reduce their greenhouse gas emissions by around five per cent between 2008 and 2012 compared to 1990 levels. Although the USA has rejected the Protocol and it has yet to enter into force, it is broadly recognized that further steps are necessary to stabilize the climate in the long term.

This paper is summarising some major points of the study "Evolution of commitments under the UNFCCC: involving newly industrialized economies and developing countries" [1]. The paper describes and assesses four scenarios, how a future international climate regime could be shaped.

The emissions limits for all scenarios were calculated using common data and common assumptions [see 1] of individual countries based on the emission inventories of CO_2, CH_4 and N_2O as provided by the EGDAR database [2] and national communications of countries under the UNFCCC. Future emissions and future Gross Domestic Product (GDP) are based on the IPCC Special Report on Emission Scenarios [3].

The parameters of all scenarios (e.g. the reduction level) were chosen as to ensure that global emissions in 2020 are +27% above 1990 levels for the total of CO_2, CH_4 and N_2O emissions in CO_2 equivalents, which is consistent with a stabilization path to a CO_2 concentration of 450 ppmv.

2 Continuing original Kyoto

As a first scenario, it is assumed that the commitment regime is continued as under the Kyoto Protocol: binding absolute emissions limitation targets for a limited number of countries. We made selected the following parameters as to ensure that the total emissions in 2020 reach the goal of global emissions being 27% above 1990 levels:

The group of reducing countries (currently Annex I) reduces emissions by –20% below from 2010 to 2020. The reductions have to be shared among the countries possibly differentiated. A universal reduction is assumed here for the calculations.

Non-Annex I Parties emissions develop according to the business as usual path until 2010. After 2010, Non-Annex I countries move to the group of decreasing countries, if their GDP per capita in 2010 is above 7000 US$/person. If the GDP per capita is lower than this threshold, emissions are not limited and follow the business as usual path. Each 10-year step this is continued. The threshold for participation in the year 2010 of 7000 US$/person can be compared with the assumed Annex I average for 2010 of 23000 US$/person, the Non-Annex I average for 2010 of 4600 US$/person and the global average for 2010 of 8000 US$/person.

In order to reach the global environmental goal, the most advanced developing countries would participate in 2020, i.e. would be assigned an emission target. For the given assumptions these would include Argentina, Brazil, Mexico, South Africa, the Persian Gulf states, South Korea, Malaysia, Singapore and Thailand.

The results are very sensitive to the choice of the threshold when Non-Annex I countries would join Annex I. A decrease in the threshold for participation has a large effect, if it leads to the inclusion of a large country. The results are also very sensitive to the choice of the 'business as usual' scenario in terms of emissions and GDP growth.

Another line of reasoning could be based on the fact that some Annex I countries are granted an increase in emissions under the Kyoto Protocol. In this scenario, newly participating countries could therefore also receive growth targets. This interpretation would further increase the global total emissions in 2020 or would lead to further reductions by the current Annex I countries.

In conclusion, continuing the system of the Kyoto Protocol would be an obvious option for future commitments. Stringent environmental goals can, however, only be reached, if current Annex I countries decrease their emissions more than for the first commitment period (2008 to 2012) and if some developing countries receive emission targets at an early stage. A method to differentiate the targets for the participating countries is not included in this approach. Further, taking on absolute emission targets may be difficult for some developing countries due to the uncertainty in the development of the emissions.

3 Contraction and Convergence

The 'Contraction and Convergence' approach by the Global Commons Institute [4] assumes that a global emission path is agreed for each future year that leads to a long-term global stabilization level: 'contraction' (here 450 ppmv CO_2). In a second step, the global emission limit for each year is shared among all countries so that per-capita emissions converge: 'convergence' (here by 2050). Emissions trading would be allowed as to balance out shortages in supply and demand of emission allowances. It is important to note that to reach any stabilization level, global per capita emissions have to decrease below the current world average and even below the current Non-Annex I average.

Currently per capita emission levels differ considerably between countries ranging from 2 tCO_2eq. /person in India to 25 tCO_2eq. /person in the USA (based on the EDGAR database for 1995 including the three major greenhouse gases and including also emissions from deforestation). The Annex I average is 15 tCO_2eq. /person, Non-Annex I 4 tCO_2eq. /person and the global average is 6 tCO_2eq. /person.

Under the given assumptions, some Parties would be allowed to increase emissions from 2010 to 2020 (e.g. Egypt, India, China and Malaysia), but all major developing countries would have to reduce their emissions as of 2010 below the business as usual path. Only some smaller states in Africa and Asia would be allowed to increase the emissions above business as usual. The Philippines would be an example, where emissions would also be allowed to increase above business as usual mainly due to the assumed population growth. For most countries, the reductions would result in an abrupt change in the emission trend.

Due to the low per capita emission level required to reach the stringent global goal, the possible transfer of easily earned emission allowances could be relatively low. Only a few countries would receive more emission allowances than their business-as-usual path in 2020.

These results are sensitive to the fact that in this scenario the three major greenhouse gases from all sectors were included. For most developing countries, emissions from forestry as well as emissions of CH_4 and N_2O are more significant than for developed countries. Additional sensitivity is due to the choice of the business-as-usual path. Such a choice has an influence on the statement whether developing countries would need to reduce emissions below their respective business-as-usual path.

In conclusion, the contraction and convergence approach is intriguing due to the simplicity of the approach. It also is one of the few approaches that encourage early action by countries that are not yet part of the commitment regime. The simplicity of the approach is also the major disadvantage, as it does not account for the structural differences of countries and their ability to decrease their emissions. The long-term nature of the approach is also an obstacle as many governments may not be willing to agree on a process that is fixed for 100 years, but a stepwise review could address this problem. For stabilization levels of 450 or 550 ppmv CO_2, per-capita emissions have to decrease below the current world average and many developing countries would have to decrease emissions below their business as usual path. Only a few least developed countries could sell for a short period of time easily earned emission allowances to developed countries.

4 Global Triptych

The Triptych approach is one example of those approaches that derive national targets based on sectoral considerations (bottom-up). The Triptych approach is a method to share emission allowances among a group of countries. The approach as such does not define, which countries should participate. It was originally developed to share the emission allowances within the European Union. It has been extended here to the global scale, bearing in mind that it could be applied to any group or subgroup of countries.

In the Triptych approach, originally three broad categories of emissions are distinguished: The power sector, the sector of energy-intensive industries and the 'domestic' sectors. The selection of these categories is based on a number of differences in national circumstances raised in the negotiations that are relevant to emissions and emission reduction potentials: differences in standard of living, in fuel mix for the generation of electricity, in economic structure and the competitiveness of internationally-oriented industries.

The emissions of these three categories are treated differently: For each of the categories reasonable emission allowances are calculated, in the light of the relevant national circumstances. The allowances of the categories are added up to a national allowance for each country. Only one national target per country is proposed, no sectoral targets, to allow countries the flexibility to pursue any cost-effective emission reduction strategy.

Power sector: To calculate the emission allowance for the power sector of a country, assumptions about the future electricity generation are made and limits are set in how this electricity may be generated: Minimum requirements are set for the share of renewables and combined heat and power in total electricity production, a limit is set for the allowed shares of solid and liquid fossil fuels. Nuclear power in 2020 is allowed at the same share of as it occurred in 1990. The resulting emissions are the limits of that country.

Internationally-oriented energy-intensive industry: To calculate a country's emission allowance for this sector, physical production growth rates are used together with annual efficiency improvement rates for each country, taking into account potential newcomers. The resulting emissions are used as the sectoral allowance for the industry sector.

Domestic: The 'domestic' sectors comprise the residential sector, the commercial sector, transportation, light industry and agriculture. To calculate the emission allowance for the domestic sectors, it is assumed that in the long run emissions in the domestic sectors will converge (in 2030) due to a convergence of the standard of living (e.g. number of cars, number of appliances) and a reduction in existing differences in energy efficiency.

The original Triptych approach included only CO_2 emissions from energy and did not include emissions of CH_4 and N_2O as well as CO_2 emissions from forestry. For developing countries, however, these emissions are of higher relevance than for developed countries. We have therefore adapted the Triptych approach to also include these gases and sectors, along the same lines, either linked to production growth or converging [see 1 for details].

The emission allowances of the categories are added to obtain one national target. It is important to note that the targets are fixed before the commitment period based on assumptions about the production growth. Whether the assumed production growth really occurs is not relevant.

For the given assumptions, the Triptych approach leads to substantial reductions from 1990 levels for the OECD countries (excluding Mexico). Even larger reductions are needed from countries with carbon intensive industries such as the Eastern European states and former states of the Soviet Union. In contrast most developing countries would be able to increase their emissions substantially.

In conclusion, the Triptych approach is a method to differentiate emission reductions among countries based on technological considerations on the sector level. In its extended form, it accommodates the emission profiles of developed and developing countries to a better extent by including all major greenhouse gases and sectors. Major downside of the approach is still its complexity and the necessity of projections of production growth rates.

5 Multistage: First Sustainable Development then Emission Limits

In the current system there are two stages for countries: Annex I with quantified commitments and Non-Annex I with a general commitment but without quantified commitments. For this scenario of a staged approach, we assume the following four stages:

Stage 1- No commitments: Countries with low level of development do not have climate commitments. At least all least developed countries would be in this stage.

Stage 2 - Pledge for sustainable development: Countries with higher level of emissions per capita commit in a clear way to sustainable development. The environmental objectives should be built into the development policies. Requirements for such a sustainable pathway could be defined, e.g., that inefficient equipment is phased out and requirements and certain standards are met for any new equipment or a clear deviation from the current policies depending on the countries. The implementation of such a sustainable development pathway has to be monitored and verified. The additional cost could be born by the country itself or by the countries in stage 4.

Stage 3 - Moderate absolute target: In the next stage, countries may voluntarily commit to a moderate target for absolute emissions. The emission level may be increasing, but should be below a business as usual. An incentive to take on a voluntary target would be the possibility to participate in emissions trading. A 'safety valve' could allow a deviation from the target, if economic growth has been higher than expected. The additional cost could be born mainly by the country itself with limited contributions by the countries in stage 4.

Stage 4 - Absolute reduction: Countries in the highest stage have to reduce absolute emissions substantially until a sustainable per-capita level is reached. We assumed here that countries reduce emissions every 10 years by 20% based on the emissions at the beginning of that 10 year period until 2 tCO2/cap is reached.

Thresholds for graduating into different groups are defined in terms of greenhouse gas emissions per capita. The threshold defined as emissions per capita is an incentive to keep emissions low, in order not to move to the next stage. As alternative to rigid threshold levels, countries could be asked to position themselves in one of the stages and/or exceptions could be made.

Countries can only move to higher stages and not to lower ones, even if per-capita emissions fall below the threshold for the stage a country is in. This ensures, that a country that had very high emissions in one point in time, will have to reduce to the sustainable level of per capita emissions. Countries that never reached the stage 4 can continue to emit at a higher level, than those countries that reached stage 4.

Under this approach, some countries move to stage 3 and immediately to stage 4 (reduction) in 2020. For the described parameters these are Venezuela, South Africa, Persian Gulf states, Republic of Korea and Singapore. Immediately jumping on stage 3 are Argentina, Brazil, Mexico and Malaysia.

After the initial placement, only a few countries move to a higher stage. Most countries stay one stage from the start, e.g. India stays on stage 1 until 2090 and China on stage 2 until 2100: Once a country is on a sustainable path, emissions do not grow as fast and current per-capita emission levels of Annex I countries are not reached.

In conclusion, stringent long-term goals can be reached under this scenario, if industrialized countries decrease emissions significantly in the next 50 years and developing countries move very soon (best even as of 2010) to a sustainable emission pathway or a higher step. However, it remains uncertain whether the step of pursuing sustainable development is effective. As this scenario combines may concepts and ideas it may, on the one hand, be difficult to reach agreement upon in the negotiations but may, on the other hand, satisfy many countries as elements of their positions and important notions are included.

6 Conclusions

Significant reductions by industrialized countries are necessary: For all the approaches, significant emission reduction by industrialized countries (in the order of cutting emissions to around one third by 2050 and continuing to decrease) are necessary as soon as possible to leave some room for increasing developing country emissions and still to reach stringent environmental goals.

Early involvement of developing countries is needed: If per-capita emissions in developing countries reach current levels of industrialized countries, stringent stabilization goals would be out of reach. Even more, early deviation from current business-as-usual paths of developing countries is necessary. This can be achieved through emission limitation and reduction targets, but also through an enhanced sustainable development approach and through positive spill over of emission reductions from developed countries to developing countries. Not many of the existing approaches encourage early action by countries that are not yet participating. In fact, basing emission reductions on emission levels in the future is counterproductive to early action. A threshold for participation in emission limitation targets defined as per-capita emissions would encourage early action to stay beneath this threshold.

A mix as compromise: Every approach has advantages and disadvantages. Those approaches that mix several elements have a higher chance of being accepted since all constituencies find elements of their concern in the mixed approach. A good mix of approaches can be the key to finding a broadly acceptable solution.

Build upon existing system, but be creative: International negotiations are very time consuming and only five years after the Convention was agreed, the rules for the next step, the Kyoto Protocol, are set. Most approaches can be build upon the existing system that is already agreed by the international community: Legally binding emission targets for some countries, inclusion of all greenhouse gases in a basket, commitment periods, emissions trading, limited use of forestry activities, incentives for developing countries to participate e.g. through CDM. That does not mean that the system is rigid. The structure allows building in creative new approaches. E.g. emission intensity targets could be integrated in a further development of the Kyoto Protocol, if so desired. Another idea could be a separate Protocol for a special sector, e.g. a non-deforestation protocol. Such a new protocol could build upon the Kyoto Protocol or be based on the Convention. Links to the Conventions on biodiversity and desertification could be extended.

Allow diverse forms of targets: The concept of absolute emission targets may be appropriate for some countries, but less appropriate for others. Several forms of targets are available. In a diverse world possibly many different approaches need to be available to account for the diverse needs of all countries. One way to accomplish this would be the ‘menu approach’ to let (newly entering) groups of countries choose the appropriate form of their target from options such as absolute targets, GDP intensity, certain policies and measures. The *form* of the target is not significant as long as it is ensured that the targets are *stringent* enough. Many forms of targets (absolute emissions, intensity targets, policies and measures) can reach stringent environmental objectives, as long as they are set at the appropriate level. This, however, stresses the need to have the capability and data to be able to evaluate a variety of targets.

Focus on forms of targets allows developing country economic growth but limit emissions: Absolute targets are seen by developing countries as capping their economic growth. Several options are available to address this concern. Intensity targets are intending to provide such flexibility but may not do so, if they are set stringently or emission intensive activities increase that do not contribute much to the GDP. The Triptych approach could provide room for economic growth in activities but limit emissions per level of activity. Technology standards also do not limit activities but limit only the specific emissions. Also the pledge for sustainable development focuses on the development first and is therefore attractive.

To reach agreement on future commitments in the international climate negotiations will not be an easy task. There are however a large number of approaches available and it seems possible that a mix of several approaches can lead to a compromise. The most important at this moment seems to be to provide information and to stimulate a discussion on the scientific as well as on the policy level. The authors would welcome, if this paper would contribute to such a discussion.

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COMMITMENT TO HUMAN DEVELOPMENT GOALS WITH LOW EMISSIONS

- An alternative to emissions caps for post-Kyoto from a developing country perspective -

Jiahua Pan
Research Centre for Sustainable Development
Chinese Academy of Social Sciences
100732 Beijing
China
E-mail: Panjh@163bj.com

This scenario focuses on commitment issues from a developing country perspective. In this scenario, commitments by developing countries will be linked to human development goals as the first priority and ultimate goal and then translated to carbon goals. There are three steps to operationalize this idea. First, human development goals in terms of basic human needs satisfaction are identified and specified for a given period of time. In this process, neither luxurious nor wasteful development components should be included. Secondly, commitment of low carbon paths will be designed without compromising human development goals. Such commitments consist of three parts: voluntary, conditional and obligatory. Voluntary commitment is made for no-regret emission reductions based on autonomous energy efficiency improvement during the course of economic growth. Additional emission cuts mainly in developing countries will be committed conditional to transfer of technologies and financial assistance from developed countries. In case an economy-wide assessment is difficult, a sector approach can be adopted. The obligatory part is somewhat morally based, discouraging luxurious and wasteful emissions. Third step will be review and reporting of the goals and commitments. The commitments will be scrutinized with two criteria. The first one is to ensure that luxurious emissions are excluded from the path. The second one will make sure that development goals are not compromised for the sake of emissions reductions on the one hand and, on the other, no emissions reductions should be counted if no advancement of human development is achieved.

A progressive and international coordinated taxation on carbon is proposed here as an incentive mechanism under this approach. Such taxation will serve two purposes, to discourage luxurious (wasteful) emissions and to raise resources for low carbon practices. This scenario highlights two expectations. First, developing countries will be able to pursue human development goals, and they will welcome climate policy if it contributes to such goals. Secondly, assistance from developed countries will enable them to make additional emission reductions. However, there are a few issues requiring further examination, including specification of basic needs and the setting of progressive tax rates.

1 Introduction

A variety of approaches of commitment to climate change mitigation have been documented in the literature, targeting at either emissions or policies and measures (PAMS). Emissions targets are specified in terms of carbon and set either in absolute (Kyoto type) or in relevant (intensity) terms. Policies and measures are aimed at sustainable development including their impact on or implications for carbon emissions. Emissions reduction is therefore a co-benefit (in some occasions it can be negative) of policies and measures for sustainable development.

GHG emissions arise from human economic activities but serve an ultimate purpose of human development. What a human society can commit without any reservation is human development. For human development, some emissions are essential such as those for basic needs while others such as extravagant or wasteful emissions are not only unnecessary but also in conflict with human development.

Emissions should not be used solely to power economic growth or to generate dollar value. Instead, emissions should be designated to human development. It is against the above background that an alternative approach to commitment is proposed focusing on human development.

2 Re-consideration of Emissions Targets as a Goal

The target has to be set straightforward for stabilization of the atmospheric concentration level. But the experience since the Berlin Mandate has been rather confusing and frustrating. For climate change mitigation, it is necessary to limit emissions of greenhouse emissions, but GHG targets can be constrained by many others, even at higher priority level, goals. There is an urgency to revisit the goals of Article 2 of the UNFCCC and in the meantime, a reconsideration of how to treat carbon target as a goal for global community.

2.1 Kyoto Targets: from Berlin Mandate to Marrakech

With the UNFCCC coming into force in 1994, it was envisaged that a deep cut of the GHG emissions would be agreed. A political will is well expressed in the Berlin Mandate. The EU leaders suggested a 15% reduction relative to 1990 emissions levels at Group 8 meeting in June 1997, a few months before the birth of the Kyoto Protocol. The analyses in the literature consider a wide spectrum, from zero to 50% cuts of emissions, including developing countries.

However, the actual target in Kyoto Protocol is 5.2% reduction in aggregate by Annex I parties relevant to their 1990 levels, ranging from 10% increase to 8% decrease for different parties in the Annex I group. After the agreement of the Kyoto target in 1997, many of the Annex I parties have been able to excuse themselves from the implementation of the binding targets. First, some parties demanded the change of the base year in favour of a larger reference level of emissions. This agreement led to a decrease of the target level from 5.2% to 3.6%. Secondly, further compromise is made to accommodate the request for inclusion of sinks. As a result, the reduction level of GHG emissions is further shrunk. The US refusal to honour its commitment in early 2001 and the Russian unwillingness to ratify the Protocol have now effectively prevented the Protocol from coming into force, despite the ratification by 117 parties.

2.2 Emissions Targets as a Goal of Priority?

A few countries do not honour the commitment made in Kyoto and developing countries demand that developed countries take the lead. They must have their reasons. Clearly GHG mitigation does not seem to be their first priority target in decision-making. For both developed and developing countries, the order of goals might be as follows:

- First level: Political and/or social stability,Second level: Economic growth or development,Third level: Environmental pollution control/ natural conservation.Climate change is only a subset of goals likely at fourth level and

must be subject to the requirement of higher order goals. Even after a lower level goal is committed it may be disregarded simply because of its conflict with higher priority goals. This is one of the key reasons why the commitment should be made to human development rather than carbon.

2.3 Duality Nature of emissions

Carbon emissions have very distinct natures from other conventional pollutants. For carbon emissions, there are three duality implications. First, emission of carbon is both a commodity and a right. If it is linked to basic human needs, it falls into the category of human rights, which cannot be traded in the market. However, if it is a commodity, it should be tradable. Therefore part of it is transferable and part of it is not. Secondly, emission of carbon is not simply a good for household consumption like electricity and gasoline. More importantly it is also a commodity for collective consumption, for example, physical infrastructure like road and wastewater treatment systems. That is, emissions are used for both collective and household consumption. Thirdly, emissions are both a public good and a public bad. As a public good, they generate utility to individuals and society at large. As a public bad, they produce negative externalities such as global warming.

In summary, it is not surprising that Kyoto target does not work as agreed because of its intrinsic weakness. Carbon should not be made a target in its own right. Rather it can only be a side target and secondary or even tertiary level target subject to fulfilment of higher-level goals.

3 Emissions for Human Development

Carbon emissions are associated with industrial processes and can be attributed to individual sectors. Like any other products or services, however, carbon eventually enters into the basket of consumers, individually (household consumption) or collectively (public goods and services). Emissions cannot be the goal of a government, but serve the goals of political stability, economic development and environmental protection. Three types of emissions can be identified:

- Emissions for basic needs satisfaction,
- Collective consumption and
- Luxurious (wasteful) emissions. All these emissions are relevant to human development though themselves are not necessarily the goals.

3.1 Final Consumption of Carbon Emissions

For household consumption, two categories of goods and services can be distinguished: basic needs and luxuries. A decent living standard would require the consumption of necessary calories for survival, shelter, basic health care and education, and access to clean water and commercial energy. Luxurious consumption includes, for example, living space larger than necessary, large cars when smaller ones can accommodate travel purposes, excessive heating and cooling.

Infrastructure is a major category of public goods, such as roads, railways, undergrounds, public utilities, airport, water supply and treatment facilities, flood control and drainage systems. All these require energy intensive materials such as steel, cement and chemicals in addition to heavy machineries for their construction. Other examples include hospitals, schools and public office buildings.

If we look at carbon demands associated with these final consumptions, we may note that carbon for basic needs (Cbasic) is fixed at say, Cbasic but that for luxurious consumption (Clux) is unlimited; carbon for infrastructure (Cinfrast) can be substantial but once it is constructed (Cinfrast), its maintenance does not require much additional carbon. That means, total emissions in terms of final consumption (Ctotal) is:

$$C_{total} = C_{infrast} + C_{basic} + C_{lux}$$

As $C_{infrast} \leq C^{infrast}$; $C_{basic} \leq C^{basic}$; $C_{lux} \rightarrow \infty$, $C^{total} \leq C^{infrast} + C^{basic}$ if C_{lux} is excluded.

A party can make a commitment without any risk to emissions limitations at C^{total}, specifically designated to $C_{infrast}$ and C_{basic} for human development. These emissions can be then traced back to industrial sectors.

C^{total} can be treated as a right to leading a decent living standard but no ethical ground can be found to guarantee C_{lux} as a necessary right to emissions. Therefore, no commitment should be designated to C_{lux}. $C_{infrast}$ is for collective consumption not only by individuals of the current generation, but also for those in the future generations. Highways, railways, airports and many buildings can be used for generations. C_{basic} is necessary for human survival and decent standard of living. Achievement of human development potentials by current generation is beneficial to future generations.

3.2 Development with low Emissions

The above discussion on types of emissions can be useful for allocation and marketing of emissions credits. Emissions demand for basic needs can exceed available quantities of emissions of GHG prescribed for stabilization of atmospheric concentrations. The proposition here is not to compromise fulfilment of human development goals. As a result, there is a need to seek low emission paths to meet the same level of development goals. Figure 1 conceptualises such a possibility. Suppose that human development goal is set at a decent living standard without any luxurious (wasteful) emissions. As this goal is at a priority level and must be achieved, it does not consider the constraint by carbon emissions. For a developing country party, conventional carbon intensive technologies are likely to be used, as there is a general lack of capital and technologies (CUT curve as shown in figure 1). The emissions level can take a trajectory AA'. However, the trajectory can be lowered to AB' if more energy efficiency technologies (BAT as shown in figure 1) are made available and low/zero carbon energy possibilities are technically viable in developed countries. Therefore, low carbon emissions can be made possible without lowering human development goals. Low carbon possibilities may include:

- Structure of the economy: less carbon intensive,
- Structure of energy mix: zero carbon energy,
- Improvement of energy efficiency,
- Use of carbon sinks
- Social policies: family planning, poverty elimination.

In figure 1, excessive emissions are to be discouraged so that emissions from developed nations will be decreased. For many LDCs, their current level of emissions is at subsistence level, much lower than a decent living standard.

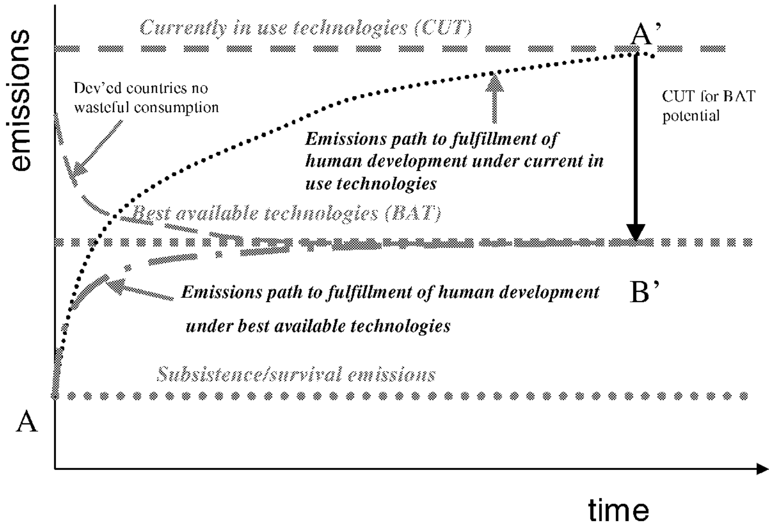

Figure 1: An overall framework for commitment

4 Commitment of low Emissions for Human Development

Three types of commitment can be identified here: voluntary, conditional and obligatory. For the voluntary part, it is also possible to be made obligatory if emissions reductions can be made with certainty. Conditional commitments can be granted to developing countries only while the obligation should be made to restrict excessive/wasteful emissions of greenhouse gases. A salient feature of this commitment is made to human development rather than to carbon emissions *per se.*

4.1 Voluntary Commitment

Two factors contribute to automatic reductions of emissions without any intentional intervention: technological progress and institutional innovation. For all the energy users, there is an internal drive to increase energy efficiency so as to reduce costs of production and consumption. For countries at a lower level of technology, spill over effects will further speed up diffusion of technologies in these countries. For instance, energy demand elasticities in the industrialisation process for developed nations were 1 (1% increase in GDP would require 1% increase in energy consumption) or higher. But in case of China, the figure has been only about 0.5 or so (1% increase in GDP is realized with 0.5% increase in energy consumption) for the past three decades or so. This is a natural/ automatic process. Before climate change was recognised as a problem, such trend had existed. This trend will continue and may accelerate as the depletion of fossil fuels come close to a reality.

Institutional factors are also important in automatic reductions of emissions. One reason may lie in the increase of awareness of climate change and consumer behaviour may be voluntarily adjusted towards more energy and carbon saving ways of life. For instance, the stand-by mode of television sets would consume 8 kWh per year more than simple turn-off. There are billions of television sets in use in the word and in aggregate, the saving of electricity would reach tens of billions of KWh. Institutional arrangements such as emissions standards and policy initiatives can also be made in favour of low emissions.

As this trend would continue automatically, a party can make a voluntary commitment in accordance with the rate of automatic energy efficiency improvement. For this part of commitment, no external support will be required and no strict obligation is implied. Energy efficiency improvement can be measured in both monetary and physical terms. Therefore voluntary commitment can be made with respect to intensity as measured by monetary unit or physical output. Physical terms are preferred as monetary measurement is subject to fluctuation of market prices.

For developed nations, this part of commitment can also be made obligatory as developed countries are in the lead in developing technologies for energy efficiency and low carbon energy sources. Also reduction in energy intensity per unit GDP can be used because the economies are more stable and no abrupt changes are expected to take place in these countries.

4.2 Conditional

Owing to technological inertia and lack of mitigation capability in the developing world, an external push may help developing country parties to make extra emissions reductions without compromising their development goals. This part of reductions will serve several purposes:

- Make extra emissions reductions so as to contribute to stabilisation of atmospheric GHG concentration;
- Reduce the costs of emissions in developed country parties and
- Achieve development goals in the developing country party.

Therefore this is a three wins solution: emissions reductions for a better environment – lower cost for developed country parties to meet their commitment – fulfilment of human development target in the developing country party.

The term conditional has three special meanings here, the extra reductions of emissions are ***conditional*** to transfer of technologies or financial assistance by the developed country parties to a developing country party, emissions reductions will not compromise human development goals nor encourage luxurious (wasteful) emissions in the recipient country and no credits of emissions reductions will be counted if no progress is made to fulfilment of human development goals so as to avoid the creation of "hot air". These conditions also imply that costs of emissions reductions in the developing country party are lower than that in the investment country party. Otherwise there would be no incentive for such transfer of resources from one party to another. It is also essential that the reductions of emissions be made consistent with human development goals. Assessment of emissions reductions will be made with respect to development goals. No progress in human development, no credits of emissions reductions even though technology is transferred or financial assistance made with "theoretical reductions".

These conditions are rather similar to those in position in the Montreal Protocol for the replacement of ODS (ozone depletion substances). The phase-out of ODS in developing countries is made conditional to technology transfer and financial assistance from the developed nations. With such assistance, China has now successfully phased out most of the production and consumption of CFCs and halons.

4.3 Obligatory

For human development and global environmental sustainability, basic needs satisfaction is part of human rights and should not be compromised but excessive consumption must be restricted. Therefore, the obligation here has to be made in two aspects:

Satisfaction of human basic needs and

Restrictions of excessive (wasteful) emissions.

No distinction should be made between developed or developing country parties in this regard. For all human beings and communities, emissions for basic needs must be granted and excessive /wasteful emissions must be discouraged in both developed and developing countries. When talking about basic needs, we are referring to not only developing nations but also developed countries. It would be wrong to say that developed nations should restrict their emissions below the level of basic needs. It should also be incorrect to say that luxurious and wasteful emissions should be encouraged because the overall emissions level is low in a developing country party. It might be the case that the handful rich people in poor countries can be more luxurious that many of the rich in the developed nations.

A practical problem arises when the precise definition of "luxurious (wasteful) emissions" is required for operational purposes. Despite the fact that circumstances differ greatly among nations and cultures, it would not be wise to use double or multiple standards to discriminate against any nation or culture. A simple criterion such as world average or 120% time world average might be used for some initial exercises. In case of physiological statistics such as nutritional requirements available, scientific figures can be employed such as those for nutrition, shelter and clothes.

It should also be noted that no suggestion is made to eliminate luxurious (wasteful) emissions. There are several reasons for toleration of luxurious emissions. First, it is against human nature to forbid luxurious consumptions, secondly as earning powers vary greatly among individual, a small handful group of consumers or even ordinary consumers at rare occasions may be able / willing to enjoy some degree of luxury; and thirdly, the pursuit of luxury is an incentive to creativity and innovation and in the same time a contribution to fiscal revenues for income redistribution.

5 Reporting and Implementation

Once the elements of commitments are agreeable, we need to make it operational. The tasks would include: (1) how the targets can be specified and calculated; (2) emissions reduction must be verifiable for acceptance; and (3) certain incentives must be adopted for effective implementation of the commitments.

5.1 Quantification of Emissions Targets

Emissions targets have to be linked to human development goals. One practical way is to assess and translate national development goals into energy demand and emissions requirement. In doing this, the following steps may be followed:

Step 1 Assessment of development goals

Many countries make comprehensive medium and long-term development plans. This does not have to be the practice under a planning economy. Medium and long-term economic projections are also made either by academic or governmental agencies in market economies. In China, for example, five-year plans have been made at national, sectoral and local levels. All these plans are country specific and somewhat reachable. The task here is to assess whether the development goals are consistent with human needs, if there are wasteful (luxurious) development projects and how the goals are linked to reinforce human development. The commitment period can be made consistent with duration of development planning, say 5 years.

Step 2 Specification of socio-economic and environmental targets

After assessment of development goals, socio-economic and environmental targets can be identified, which would include rate of economic growth, population features, welfare improvement, environmental protection, and the like. Such specification may be made at different levels (national, sectoral, regional and local) for calculation of low carbon targets.

Step 3 Identification of low carbon development paths taking into account availability of capitals and technologies.

The above goals are of higher priority targets and taken as the basis for low carbon paths. The calculation of quantitative targets will include the following components:

- ***Voluntary:*** The country or industrial sector will plan or assume energy efficiency improvement for the planned period, given the resources and technologies at its disposal. For the whole world the rate of automatic energy efficiency improvement has been over 1% annually and the figure is 2-3 times higher in developing countries due to technological spill over effect. This target can be set at either national level or sectoral/project level.
- ***Conditional:*** The technologies in use in a developing country must be less energy efficient than advanced technologies in developed nations. The difference of carbon saving can be made a target conditional to the provision of technologies and financial assistance.
- ***Obligatory:*** Obligation must be made to avoid or restrict all wasteful and luxurious consumption/emissions. This would require the rejection of some development projects / emissions.

5.2 Verification of Emissions Reductions

Such commitments will be subject to international scrutiny against resource endowments such as technologies, capital availability and energy supply. This will serve two purposes: Firstly, squeeze air and water out of the emissions commitment to make it close to reality and secondly, provide information on the scope for lower emissions to achieve the same level of human development and thereby the differences can be traded in the international market. The verification process can take the following steps:

- *Ex ante* information. The process must be transparent and information must be made available to the international community. As this is associated with development planning, relative information will cover the choice of development goals, the setting of socio-economic and environmental targets, and the specification of voluntary, conditional and obligatory commitments. In order to reduce transaction costs, no formal evaluation will be required and the final effects will be evaluated *ex post*.
- *Ex post* verification. Whether emissions reductions can be accepted and credits accrued to the host/investment country, the verification has to be dependent on the final outcome. That means, at the end of each commitment period, a comprehensive review will be conducted to validate the reductions, voluntary, conditional, and/or obligatory.
- Net reductions. The final acceptance will include only net reductions. All the luxurious (wasteful) emissions will be excluded though reductions are made in comparison with the production of luxurious (wasteful) products.

5.3 Incentives and Disincentives for Implementation

For implementation, both carrots and sticks are helpful. In most cases, sticks do not work well as a party has a choice to withdraw from commitments. Therefore, incentives play a more important and crucial role in implementation of the commitments.

Emissions trading. In principle, voluntary reductions are not eligible for trading, as this should be considered a baseline and the result of no-regret policies. The conditional part is additional reduction and should be tradable. For the obligatory part, there is a need to look at the directions of change. If the reduction is from restriction of luxurious emissions, credits should be awarded. However, if the reduction were relative to any increase in luxurious consumptions, there would be actual/absolute increase in emissions. This part should be deducted from reductions for trading. If voluntary commitment is not honoured, conditional and obligatory reductions will have to deduct the voluntary part before credits enter the market. Therefore, the incentives here for emissions trading, voluntary commitment is the pre-condition.

Conditionality requirement: Reductions must not lower any development goals. If the development/ socio-economic and environmental targets are lower than expected/planned, the emissions reductions should be re-assessed in accordance with the goals of human development. This requirement is designated to guarantee that development goals take priority and avoid over-estimate of emissions reductions.

Progressive taxation on emissions. A financial mechanism is essential to discourage excessive emissions. Similar to income taxation, a progressive taxation on emissions is proposed here. The tax rate will differentiate along with the levels of emissions. The more one consumes emissions space, the more he is asked to pay. For emissions lower than basic needs level, exemption may be granted or even a negative tax (that is, a subsidy) can be applied. If the emissions level is at basic needs level, a normal or basic rate can be employed. Afterwards, as emissions increase, higher and higher rates will be levied. For such a taxation mechanism, the following purposes are in mind, reduction of luxurious emissions and raising resources for low carbon development.

No exemption of luxurious emissions: No matter in a rich or poor country, the assessment of development goals and the use of progressive taxation on emissions should be fully applicable. This is particularly true in some developing countries where emissions per capita are in general low but wasteful (luxurious) emissions are hiding behind.

6 Evaluation of Effectiveness

When human development goals are in conflict with emissions targets, environmental goals give way to higher-level goals. At least in the short run, emissions targets may not be realizable if such a situation takes place. However, we need to look into the case before a conclusion is drawn.

6.1 Environmental Integrity

As commitment is made not directly to carbon emissions reductions, there is a reason for concern regarding environmental integrity. The goal of human development, however, is consistent with stabilization of GHG concentrations in the atmosphere.

First of all, there exists an upper limit (C^{total}) associated with basic human development if C_{lux} is excluded. Excessive consumption or emissions are not in the interest of not only current generation but also future generations.

Secondly, as emissions in many developing countries may be much lower than this upper limit, immediate realization of human development potentials may have a danger to overshoot. This is unlikely because development is a lengthy and gradual process. Industrialization in the developed world took over a century. Spill over effect would speed up the process but emissions would also be much lower. Many of the industrialized countries have already reached the upper level and started to decrease emissions because of technological progress.

Thirdly, wasteful (luxurious) emissions will be discouraged though not eliminated. This would have two effects, reduction of such emissions and promotion of low carbon or decarbonised development in developing countries for human development, using the resources levied from wasteful (luxurious) emissions.

Fourthly, there may be several scenarios for reaching the goals of human development. As the goals are set for human development, emission scenarios will be assessed and compared for selection of low instead of high emissions. As a result, actual emissions should be lower than the committed levels.

For different countries or human communities, $C_{infrast}$ can be in between 0 and $C^{infrast}$. For many developed countries, infrastructure has reached its upper bound. Under such cases, there is no need to produce carbon intensive materials such as steel and cement for bridges and roads. That is why in many EU countries, consumption of construction materials has been on the decline. Only maintenance is required. No further emissions should be allocated to infrastructure. On the other hand, such infrastructure in many developing countries is either not in existence or under construction. Emissions should be allowed for these countries to build an infrastructure essential for a decent life of their citizens.

Similarly, differentiation can also be made regarding emissions for basic needs between developed and developing nations. Most importantly, emissions for basic needs and luxuries should be separated and treated differently. Policies and measures should be directed to discourage wasteful and/or luxurious emissions. However, wasteful (luxurious) emissions should be treated the same no matter they are in a rich or a poor country. Low emission in a poor country is not a reason to cover or excuse wasteful (luxurious) emissions within the country.

6.2 Uncertainties

There exist great uncertainties for emissions in developing countries. This is simply because of the divergence between desired and actual achievement of human development. Voluntary targets may not be reached simply because development goals are set too high or political and social instability occurs. Conditional targets may give a higher level of reduction but socio-economic and environmental targets are compromised or lowered. This higher number of commitment does not provide any scope for creation of “hot air” as no selling of emissions rights are allowed. As a result, such uncertainty regarding excessive emissions will be avoided.

6.3 Comparison with Kyoto Protocol

There are a number of similarities and differences between the Kyoto type and a human development based commitment. The principle is the same, i.e. common but differentiated responsibilities. Both approaches are in the same direction with Article 2 of the Convention, making efforts to stabilization of atmospheric concentrations without harming the environment and development. Both are committed to emissions reductions directly or indirectly.

However, some of the differences between the two approaches are fundamental.

- The basis of commitment under Kyoto is direct and straightforward restriction of GHG emissions in terms of quotas allocated to individual Annex I parties. Under the human development approach, however, the basis is on human development goals, which take priority over environmental and GHG emissions targets. Human development goals are then translated to emissions implications and lower emissions approaches are assessed and commitments made to meet human development goals without lowering human development goals.
- Methodology: The Kyoto approach is basically a top-down framework. The global community agrees on a global target and allocates quota to a particular party. This way of thinking is still prevalent: Article 2 target of the Convention would suggest a concentration level and then be translated into emissions limit for allocation and commitment. Due to the fact that national circumstances differ, there are many bottom-up elements to accommodate the concerns of individual parties. For instance, the base year was allowed to adjust; the target for GHG reduction is not uniform across the parties; and flexibility mechanisms are introduced. By contract, the human development approach is country driven and country specific circumstances based. As levels of human development vary greatly, commitments are assessed and made in accordance with the specific conditions including growth of the economy, capital and technological availability, the levels of human development, etc. As a matter of fact, the reductions of emissions under all types of commitment do not follow any top down requirement but rather on the potentials at project, sector and then economy-wide levels.
- Separation of basic needs and luxurious (wasteful) emissions: The Kyoto commitment does not explicitly discourage luxurious (wasteful) emissions. Further more, it does not acknowledge essential emissions for basic needs satisfaction although implicitly developing countries are not required to take legally binding

reduction targets. The human development approach by contrast attempts to guarantee the requirement of emissions for basic human needs. No restriction should be placed on development goals that are directed to enhance the welfare of the poor at large. Development goals are not allowed to be lowered for reasons of emissions control. Luxurious (wasteful) emissions do not add welfare improvement and therefore should be discouraged if not totally eliminated.

- Incentive/financial mechanisms: Under Kyoto, incentives come from selling and/or buying emissions credits. The price of credits at market equilibrium is uniform and there is no price discrimination against excessive consumptions. No matter one is rich or poor; he has to pay the same price for emissions. With the human development framework, a progressive taxation system is suggested. The more one consumes, the more one has to pay. This is not only an incentive for discouraging excessive emissions, but also a fair and effective fundraising mechanism for low carbon technologies.
- Type of commitment: The Kyoto commitment is legally binding but the human development based commitment does allow the flexibility for both voluntary and conditional reductions. In addition, a third type of commitment is also proposed in the form of moral commitment to restriction of excessive emissions.
- Environmental integrity: The Kyoto type commitment can minimize uncertainty if the commitments are honoured. If parties withdraw from the agreement, environmental goals cannot be achieved. Human development goals are not directly linked to environmental targets and therefore environmental integrity can be problematic. As low carbon development paths can generate considerable reductions, parties would make all their best efforts to reach their goals to have a better image. Their actual effects can be even better as no party would withdraw from their commitments.
- Participation: So far, only developed country parties are required to participate in commitment to GHG reductions and developing country parties are exempted from any quantitative limitations. The Human development approach is primarily concerned with developing country participation, but developed nations can make their voluntary and conditional commitments legally binding. Therefore, there would be much wider participation under a low carbon development approach than under a Kyoto type commitment.
- Hot air: As a base year has to be selected for proportional or relative reductions, hot air can be created if there is a recession or economic downturn as in the case of Russia and eastern Europe. In case of low carbon development, the goals are

linked to human development. If no human development progress is made, emissions credits should not be counted no matter in theory or practice. All carbon reductions are assessed against planned goals of human development. Therefore, no hot air would be created.

- Implementation: Bottom-up approaches are based on self-assessment and self interest, there is an intrinsic drive to implement the development goals. Therefore, a human development approach creates win-win solutions rather than zero sum results under a Kyoto target.
- Flexibility/cost issues: Under Kyoto, three flexibility mechanisms are initiated for a cost-effective implementation of GHG reductions. This can reduce costs of carbon reductions greatly if market functions well. But the carbon market in many cases is complicated by political processes at least in a similar manner to the oil market. As a result, the scope for cost-effectiveness can be rather limited. Under human development goals, by contrast, incentives are intrinsic for voluntary and conditional part. Automatic energy efficiency improvement is a natural process and constitutes a no regret option. Without carbon policies, industries and enterprises together with consumers do their best for the increase in energy efficiency. The moral commitment is somewhat different as by human nature there is a tendency to show off or superiority. In this case, regulatory policies are necessary.

7 Discussions and Conclusions

Through the comparison with a Kyoto type commitment, major attractiveness of this approach is no regret participation as the basis of commitment is made to human development rather than carbon. In addition to this fundamental advantage, there are also a number of merits in practice, including full consideration of national circumstances, basic needs satisfaction, international cooperation, and incentive mechanisms for implementation.

On the other hand, there are a number of practical problems as well. First one is the difficulty for a clear and widely acceptable definition/ specification of basic needs satisfaction. Emissions for public goods and services can be relatively easy clarified, including major types of infrastructures such as roads, railways, airports, flood control and drainage systems, water supply and wastewater treatment facilities, and undergrounds. Once completed, there is no need to over construct such physical infrastructure. Emissions for basic needs can be calculated but more difficult, parameters including food production from the agricultural sector (fertilizers, irrigation, transport and storage), housing (20m^2 per person, construction materials and its maintenance), residential energy (lighting, cooking, heating, cooling, appliances-refrigerator, TV, etc – 500kWh per person per year of electricity, 200kg oe), and transport (100km per month per person – 7 litres per person per month).

Luxurious (wasteful) emissions are not eliminated but setting the rate of progressive taxation can be a political process. The use of the fund raised through such a tax system can be even more a difficult issue. Anyway, so long the principle is acceptable, actual figures are somewhat technical. These are actually interesting areas for further work.

8 Acknowledgements

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Short Papers of Participants

SHORT PAPER BY ANDREW I. AYENI

Federal Ministry of Environment
7th&9th Floor, Federal Secretariat, Shehu Shagari Way
P.M.B. 468, Garki, Abuja
Nigeria
E-mail: aiayeni@yahoo.com

1 NIGERIA & CLIMATE CHANGE ISSUES

Climatic data base is relatively poor in Nigeria as in other tropical countries and most models on climate change are severally limited in their ability to project regional climate change. Current evidences indicate that many human activities both agricultural and industrial, are causing the emission of increasing quantities of polyatomic molecules into the atmosphere. Most of these polyatomic molecules are radiactively active and can produce significant changes in climate with the time scale ranging from annual to longer duration.

Nigeria is one of the countries that identify with the Katogo agreement on limited global warming, which calls for reduction of emissions - Greenhouse gases (CFC, carbon dioxide, halogens, ethanes) This is to cure anthropogenic warming of the earth's climate and its consequence. Global warming has seriously affect farming in Nigeria leading to hunger and malnutrition, changing weather patterns could also bring migration from affected areas and Tropical disease will spread.

Prolong global warming will cause drought and desertification in northern part of Nigeria at Lat 12 degrees North. There will be strong winds, waves, currents, & sometimes heat waves.

There will be slow moving and creeping disaster and general poverty, soil degradation will be on the increase spelling undue hardship, political and social instability.

Nigeria's past efforts in drought management have largely been geared towards reactive rather than a proactive approach. It is well known that for a crisis management to be effective and efficient it has to be forecasted, anticipated with early warming system put in place. In Nigeria, sometimes, by the time it is confirmed that drought was around; it had operated for a year or two.

A forecast of the future climate of a region of the earth would have been easier in ordinary course of events. That is if nature follows its normal course. The problem of predicting the future climate change induced by man's activities has to be considered along with the problem of understanding natural variation which causes variations of the order of thousands of years.

Desertification in Nigeria is a scourge that is mainly made - due to unsustainable land use and over -exploitation of natural resources. Within the context of well- thought -

out policy framework, effective monitoring, evaluation and well-co-ordinated institutional arrangements, the government of Nigeria intends to:

- Assess the distribution of desertification with a view to evolve a holistic and integrated approach towards its management.
- Control further conversion of land to desertification and desert like condition.
- Reclamation of areas already desertificated to agriculturally productive areas
- Put in-place strategies to prevent future devastation of land due to desertification.

Before now, there was no comprehensive basis for planning, designing and implementing desertification management programmes. No scientific basis has been established for efficient preventive control and monitoring measures. The people were neither trained nor empowered to replicate and sustain the concept of desertification control. Efforts to combat desertification have been adversely affected by frequent shifts in the policy of the Governmen. due to leadership change. The department is put in place to address above highlighted issues as it pertains to drought and desertification.

SHORT PAPER BY SURUCHI BHADWAL

The Energy and Resources Institute
Darbari Seth Block Habitat Place, Lohdi Road
New Delhi
India
E-mail: suruchib@teri.res.in

1 Major concerns and challenges lying ahead

Climate change is a matter of grave concern to developing countries like India, which are highly vulnerable to its potential impacts. The third assessment of the IPCC has pointed out that the impacts of climate change will fall disproportionately upon developing countries. The risks of adverse impacts from climate change in the developing world is further aggravated due to their poor socio-economic conditions, lack of infrastructure, lack of access to technology and degraded natural resource base. Adverse impacts on critical sectors of their economy such as agriculture, forestry and fisheries have the potential to jeopardize development of the region. More frequent and intensified droughts can exacerbate land degradation. Thermal and water stress can affect the agricultural production. Increases in heavy precipitation events can increase flooding, landslides and mud slides, the destruction from which can set back development efforts by years in some instances. These events would also disproportionately impact the poorest in the society exacerbating inequities in access to adequate health, food, clean water etc. thus challenging the concept of sustainable development.

To be able to understand the implications of these changes at the local level, several studies that are regionally oriented are required to be conducted so that suitable adaptive measures can be adopted and mainstreamed into the planning process.

Despite other overriding problems of poverty, population and scarcity of resources, India is undertaking numerous initiatives to reduce emissions although it is not a significant contributor to global emissions. A major challenge is to provide sustainable energy to about 57 percent of its population that has still no access to electricity. Measures to mitigate greenhouse gas emissions by using cleaner fuels, shifting to renewable energy and using energy efficient technologies are being explored extensively within the country. The country's development plan also lays emphasis on conservation of energy and efficiency improvement. The country has a huge potential to use renewable energy to supplement conventional fossil-fuel-based power, provide electricity to remote areas and meet rural energy needs for a variety of applications. These improvements have been targeted through a mix of market based instruments and traditional measures.

2 Integration with other policies

Policy decisions on non-climate related reasons are required to be explored within the country as they might have significant implications for climate policy and climate change impacts apart from specifically addressing environmental issues. This in turn offers opportunities to capture synergies in developing response options, enhancing benefits and reducing costs. Reducing vulnerability to climate change can often reduce vulnerability to other environmental stresses and vice versa such as land use management. Addressing or avoiding land degradation also decreases vulnerability to climate change especially when response strategies consider the social and economic factors defining the land use practices together with the additional risks imposed by climate change. In regions where deforestation is progressing and leading to carbon loss and increased peak run off, restoring vegetation by reforestation and recultivation can help to combat desertification.

3 Current initiatives in India to improve understanding about climate change

Efforts are on to build the capacity of government organizations, independent institutions and the corporate sector to improve the scientific understanding about climate change. However, further development of domestic institutions to address climate change issues is required.

Public awareness towards these issues is also required to be built. Education and outreach programmes can be used to disseminate information. Also more studies that generate scientific information at the regional scale are required to study the implications of these changes at the local level.

4 Towards global cooperation to address the issue

The government has developed an interim criterion for approval of Clean Development Mechanism (CDM) project activities, which is now available to all stakeholders. India has been actively participating in the CDM and has endorsed six projects. Three biomass and three wind projects have been accepted under the Certified Emissions Reduction Unit Procurement Tender (CERUPT) – of the government of Netherlands for further development.

India signed the UNFCCC and ratified it in 1993. It is in the process of developing its first national communications to be submitted to the UNFCCC. The inventory is being prepared with 1994 as the base year covering five sectors in all 1) energy 2) agriculture 3) industrial processes 4) forestry and 5) waste. A few case studies on vulnerability and adaptation have also been included in the national communication report. India acceded to the Protocol in August 2002. The Ministry of Environment and Forests has also set up a nodal agency to deal with climate change and related issues.

By ratifying the Protocol, India reaffirms its faith in multilateral processes for addressing global environmental problems and looks forward towards other countries in ratifying the Kyoto Protocol.

SHORT PAPER BY MARCO TÚLIO CABRAL

Ministry of Foreign Relations
Division of Environmental Policy and Sustainable Development
Brasilia
Brazil
E-mail: mcabral@mre.gov.br

1 The Importance of the International Regime for Climate Change to Brazil

The awareness of the importance and complexity of global environmental problems has grown gradually, especially after the second half of the 20th century. This process is often sketched through some landmark events, such as the recognition of the contamination of Minamata Bay in 1956; the denunciation of the effects of DDT over wildlife in Rachel Carson's 1962 "The silent spring"; the emphasis on pollution and the limits to economic growth at the 1972 UN Conference on the Human Environment in Stockholm and the ensuing creation of UNEP; the release of the Brundtland Report in 1987 and the growing acceptance of the concept of sustainable development; the UN Conference on Environment and Development in Rio 1992 and its three main documents, Agenda 21, CBD, UNFCCC; the 2002 World Summit on Sustainable Development in Johannesburg, focusing on the establishment of new partnerships and the definition of means of implementation for Agenda 21.

Along this process, it has become clear that global environmental problems must be addressed both from a scientific and a political perspective. This question becomes especially clear in the international regime for climate change: on the one hand, there is a need to acquire in-depth knowledge of the problem, for which the Intergovernmental Panel on Climate Change (IPCC) was established in 1988; on the other hand, States need to agree on means to control the emission of greenhouse gasses and to manage the impacts of climate change, for which the UNFCCC and its Kyoto Protocol were signed, in 1992 and 1997, respectively.

As a large developing country, Brazil has an important role to play in this process, both from a political standpoint and as an important player in the world economy. In the field of energy generation, it stands out as one of the countries that uses the largest proportion of renewable energy sources: over ninety percent of its electric energy is generated by hydroelectric plants; the gasoline consumed in the country is mixed with ethanol in a proportion of one quarter –amounting to the largest biomass for energy program in the world.

Brazil has also been very active in multilateral climate change negotiations, both within the framework of the UNFCCC and in other for a. The Brazilian diplomatic service is faced with the task of negotiating global agreements bearing in mind the national interests. In the negotiating process leading to the Kyoto Protocol, Brazil has played a key role by suggesting more flexible mechanisms that eventually led to the establishment of the Clean Development Mechanism. At the Johannesburg Summit, the "Brazilian Energy Initiative" was presented, proposing the increase in the global use of renewable energy to at least 5% by 2010. At the same occasion, the Brazilian delegation has worked closely with European negotiators to try to include targets for the use of renewable energy in the Plan of Implementation. On a bilateral basis, Brazil and Germany are currently working on a cooperation scheme to foster the use of ethanol as a substitute to gasoline, within the framework of the Clean Development Mechanism.

From a domestic perspective, the question of climate change has deep implications for Brazilian national interests. Being a developing country with significant social demands to be met, the nation is faced with the challenge of ensuring economic growth without depleting the environment for future generations. In the field of energy, the country has experienced a power generation crisis in 2001, and the guidelines for future development of the sector are currently under consideration. Decision makers must find solutions to reduce the reliance on hydroelectric generation, which has made the system overly vulnerable to climatic factors, whilst assuring economically viable and environmentally responsible alternatives. One of the options currently being considered is the development of thermal power generation based on biomass –particularly sugarcane bagasse, a byproduct of the sugar and ethanol industry. Regardless of these alternatives, given the comparative advantages of hydroelectric generation in Brazil, both from an economic and environmental standpoint, the national power generation system will remain heavily reliant on aquatic sources in the foreseeable future, adding to the importance of climate change to the national interests.

Arguably, the most urging environmental problem facing the international community at present, climate change has huge implications for the development of the Brazilian society. Particularly vulnerable are local populations in rural areas, especially in the northeastern part of the country, one of the most densely populated semi-arid regions in the world. Regardless of the current controversy as to whether or not climate change is already taking place, these populations have experienced significant climatic stress in the last decade, hinting to the consequences such alterations could have for the everyday life of common people, in Brazil and elsewhere in the world.

SHORT PAPER BY CHAO QINGCHEN

National Climate Centre
No. 46, Zhongguancun Nandajie, Haidan District
Beijing10081
China
E-mail: chaoqc@cma.gov.cn

The Development of Studies and Operations on Climate Change in China

Climate change is a major concern facing the world as a whole. It involves many aspects including national economy and social development as well as ecological and environmental protection, energy and water resources, food security and human health. It also relates to sustainable development of human society.

China's vast expanse of territory covers many climate zones, from frigid temperate zone in the north to equatorial zone in the south. Frequent occurrence of disasters induced by extreme climate events, such as flood and drought have heavy impacts on social and economic development of China. The Chinese Government always attaches great importance to the issue of climate change. In 1992, the Chinese Government signed the United Nations Convention on Climate Change (UNFCCC), drew up China's Agenda 21 and developed sustainable development strategies. In 2002, the Chinese Government approved the Kyoto Protocol and the National Report on Sustainable Development. Over the past years, in order to facilitate the coordination of climate change-related activities at national level and the fulfilment of international commitments, the Chinese Government has set up the National Coordinating Group on Climate Change Policies and the National Climate Committee. In addition, China has been participating actively and playing an important and constructive role in the international efforts under the framework of IPCC and UNFCCC. The Government has also been supporting Chinese scientists' research on climate change, their development of climate system models and their preparation of national assessment reports on climate change.

In response to the social development and economic construction in China and the changing situation in global environment and development, the China National Climate Center (NCC) was founded in January 1995 with the approval of the State Council. Over the past eight years, the NCC has devoted to enhance its own capabilities on R&D, operations and services. It has now developed and operated a climate monitoring, prediction and validation system tailored to East Asia and a system of dynamic climate models including global atmospheric circulation model, marine circulation model, sea-air coupling model, East Asia regional climate model and high resolution Pacific-Indian ocean model. In 1997, it began to produce the modeled seasonal climate prediction on an experimental basis. In 2003, it began to produce seasonal climate prediction for spring, summer, autumn and winter using sea-air coupling model so that China is among a few countries that issues relevant prediction products using such a climate prediction model.

The NCC plays an important role in promoting the cooperation and coordination on regional climate prediction and climate information exchanges in East Asia. For years, it co-sponsors workshops on East Asia summer and winter monsoon jointly with climate-related operational units of meteorological services of Japan, Korea and other surrounding countries. It also facilitates the exchanges and sharing of regional climate information and products in East Asia. The NCC is in a position to offer training on the interpretation and application of East Asia climate prediction techniques and products.

At the same time, the NCC engages in the scientific research relating to the Intergovernmental Panel on Climate Change (IPCC) and the United Nations Framework Convention on Climate Change (UNFCCC). The NCC has contributed tremendous human and material resources to the paleoclimatic reconstruction, sequential analysis of proxy records and instrumental records, global and regional climate modeling, causality analysis and future climate change scenario analysis, achieving a number of research results and providing a lot of scientific evidence for the government to effectively participate in the international forums relating to climate and to make national decisions in response to the global climate change.

The National Climate Center is now in a position to deal with both operations and research on climate prediction, monitoring and diagnosis, impact assessments as well as climate change studies. Good planning and capacity building is necessary for enhance the development of NCC. We are doing what we can for the climate monitoring, prediction and services that are needed by the Asian countries for their socio-economic development.

CLIMATE CHANGE RESEARCH IN SOUTH AFRICA

Martin de Wit
CSIR, Environmentek
PO Box 395
Pretoria, 0001
South Africa
E-mail: MdeWit@csir.co.za

1 Introduction

South Africa is vulnerable to predicted climate change impacts, has an energy and carbon intensive economy and falls under the top twenty carbon dioxide emitters in the world. The South African government responded through signing the United Nations Framework Convention on Climate Change (UNFCCC) in 1993 and developed a position policy on global environmental change in 1993, although it did not really had an impact since then. In the events leading up to Kyoto, South Africa's position was described as being the *most ill-prepared country in the world*. South Africa narrowly avoided having only observer status at the Kyoto conference by being the last country that officially ratified the UFCCC in August 1997. Subsequently, a policy discussion document on climate change, and the first National Communications on climate change has been prepared, but not officially released yet.

Following the ratification of the UNFCCC, research on the implications of global climate change for South Africa has picked up steadily. Although most is in compliance with the FCCC itself, such as the South African Country Studies on Climate Change, there are some recent signs that more pro-active research is conducted on the threats and opportunities of climate change to South Africa, for example research activities on the Clean Development Mechanism and the impacts of global climate change on the South African economy.

One of the strategic questions for any country developing a position on climate change is whether the supply of research matches the demand for information on key issues pertaining to the debate on global climate change. Where are the research gaps? And subsequently – how can these gaps be closed as well as possible? The objective of this research paper is to identify climate change research needs in South Africa on the basis of existing research.

2 Methodology

Most work for this study has been done in September 2000. The following steps were employed:

- An Internet search was done to identify the attributes of research inventories in general;
- Key role-players in climate change research in South Africa were identified. This list was verified by a few experts in the field and included 71 people;
- An email message was sent to all identified people, and followed up by further emails, telephonic discussions, and physical meetings. A total of 31 people were successfully contacted – which is a 44% response rate. However, the respondents who were contacted identified most of the ongoing research activity in the country as the same institutions employed many individuals on the contact list;
- A general message was sent to all the members of the Forum for Economics and the Environment, estimated to reach around 450 people, predominantly in South(ern) Africa;
- A literature search on South African periodicals, publication lists from the National Research Foundation (NRF), and CSIR internal research reports has been done;
- Analysis of research information obtained has been carried out on the basis of key issues in the climate change debate;
- Research gaps are identified and suggestions for further climate change research made;
- Updates for the period October 2000 – August 2001 was done through a targeted email enquiry to institutions active in the field, and verification with a few key experts in the field.

3 What is climate change research?

In this work a more loosened definition of research is used, including "softer" activities such as policy advice, client reports, national communications and capacity building activities. The main reason for this is that the key issues emerging from the climate change debate do necessitate research in the strict sense, but at this stage much activity on the strategic and political level is required in developing countries.

The boundaries of climate change research are also not easy to define. The climate change debate has many facets and interlinkages with other research programmes, for example energy efficiency, biodiversity loss, economic performance and land use change. The complexity in the debate on global climate change has been emphasised in several publications. The ongoing research on integrated assessment and modelling on climate change bears testimony to these complexities. The following guiding questions were asked when evaluating whether research could be classified as climate change research or not:

- Is the *primary* motivation of the research related to climate change?;
- If the primary motivation of the research is not climate change *per se*, what realistic part of the research is directly related to climate change?

4 Key issues: What needs to be done?

The first challenge is to develop a framework wherein research can be reported. This framework should facilitate thinking on key research needs in the climate change debate relevant for South Africa. The approach taken here is to analyse international developments in the climate change debate, identify key issues pertaining to South Africa in the climate change debate, and international trends in future climate change research. This analysis serves as the major input in the development of a framework wherein research can be reported.[1]

5 Key issues for South Africa

The unique South African context would have to be taken into account when identifying the key issues for South Africa. The following issues are identified and motivated:

5.1 Adverse effects on ecosystems, human health and welfare

The potential negative impacts of global climate change on the southern African region has been brought forward on several occasions and has been recognised by the South African Government. A draft document on the SA Country Study on vulnerability & adaptation shows that South Africa has *significant sensitivity and vulnerability to climate change effects, but also has significant adaptive resources to address potential harmful effects.* An important facet of this vulnerability is expected impacts on human health, especially through the main vector-borne diseases of malaria and schistosomiasis.

5.2 Adverse effects on the economy

The adverse effects of global climate change come through at least three channels:

First, the international protocols and agreements on climate change could affect the demand for coal. Various studies are currently underway to assess the impacts of climate change in South Africa's energy and coal economies. South Africa is the fourth largest producer of and ranked under the top three largest exporters of coal in the world. Coal exports (35% of total production) totalled R9.3 billion in 1999. This is a significant 6.2% of total (seasonally adjusted and annualised) merchandise exports for 1999. In addition, Europe is the primary export market destination, followed by the

[1] Within the short paper the description of international developments is left out.

Pacific Rim (including Japan), where most trading partners have quantified emissions reductions under the Kyoto Protocol. However, alternative opportunities for South Africa's coal exports are expected in a rapid economically growing Asia.

Second, South Africa's energy and carbon intensive economy could be vulnerable to international agreements on addressing climate change. Investment, trade and aid patterns are expected to change, which could have both adverse effects and pose opportunities to the South African economy.

Third, it can be expected that South Africa's vulnerability to climate change, in terms of changing ecosystems and human health concerns, would have costs to the economy. For example, precipitation changes would impact an already marginal crop agriculture in various regions and spreading diseases would have an impact on the economic productivity of the population.

5.3 Kyoto Protocol mechanisms (CDM, JI, IET)

Some of these adverse effects can be addressed through mechanisms under the Protocol, most notably the Clean Development Mechanism (Art. 12 of the Kyoto Protocol). The CDM is an opportunity for developing countries that did not accept binding emissions reductions under the Kyoto Protocol. The economic rationale for CDM is that the marginal cost of reduction would differ considerably between industrialised and developing countries. Under a CDM industrialised countries could invest in developing country projects, in return "buy" the carbon credits which are then included in the calculation of domestic carbon reduction targets under the Kyoto Protocol. Developing countries would enjoy the environmental and local economic benefits of investments made to reduce greenhouse gases, for example the upgrading of electricity generation, investments to counter land degradation, or planting trees to trap some carbon dioxide.

Joint Implementation (as specified in Articles 3 and 4 of the Kyoto Protocol) is of little direct relevance to South Africa as it can only be undertaken between entities in Annex B (to the Kyoto Protocol) industrialised countries[2], which includes countries that are undergoing the transition to a market economy. Activities Implemented Jointly (AIJ) was established at the first Conference of the Parties (CoP1) as a pilot phase of Joint Implementation. The lessons learnt from AIJ are applicable both to JI and CDM projects.

International emissions trading (IET) (as referred to under Article 17 of the Kyoto Protocol) is also a mechanism for use among the Annex B countries. However, developing countries, including South Africa, could opt into the trading system by assuming national limits.

[2] Basically the OECD (minus South Korea and Mexico), plus the countries of the former Soviet Union and Eastern Europe.

Therefore, the CDM and IET could provide opportunities to South Africa that need to be further researched.

5.4 Technology transfer (TT)

Specific issues related to the transfer of technology cannot be separated from either the CDM or how developed countries will address adverse effects (under FCCC Art 4.8 and Protocol Articles 2.3 and 3.14). South Africa would have to determine its position on the key themes relating to technology: technology needs and needs assessment, technology information, enabling environments, capacity building and mechanisms for technology transfer.

5.5 Land use, land use change and forestry (LULUCF)

Based on 1990 figures, South Africa's uptake of carbon through LULUCF amounts only to an order of 4.5 – 5 per cent of the total CO2 equivalent emissions of CO_2, CH_4 and N_2O. However, some LULUCF projects would still have strategic importance for South Africa. Scholes *et al.* concluded: *Although the quantitative impact on national emissions of some of these land-use options is small, and they therefore do not in the long-term substitute for energy-, transport- or industrial-sector interventions, some may be very attractive as short-term options, especially when there are strong associated non-greenhouse gas benefits* [1].

5.6 Capacity building (CB)

The adverse effects of climate change on South Africa, as well as the opportunities which are presented under mechanisms such as CDM, would require adequate capacity to respond to these issues in a strategically manner. A research project on the climate change capacity building needs in South Africa has recently been started.

5.7 Policy development (PD)

South Africa has obligations and is presented with opportunities under the FCCC and the Kyoto Protocol[3]. To meet these obligations and capitalise on opportunities the right supportive policies should be in place.

[3] Obligations are most notably: under the FCCC, Articles 4.1 (all but (g)), 5(a) and (b) and 12, and under the Kyoto Protocol, Articles 10(b) and 18. Opportunities are most notably: under the FCCC, Articles 4.3, 4.4, 4.5, 4.7, 4.8, 4.10, 5(c), 11.2, 11.5, 12.4, and 12.7, and under the Kyoto Protocol, Articles 3.14, 10(c), 10(d), 10(g), 11(b), and 12. For a discussion see IEF (2000a).

6 Future research trends

Before a reporting framework for climate change research is developed, one question remains: *What are the predictable future tendencies in climate change research?* The answer to this question would leave space in the reporting framework for issues that might become important in future. However, an analysis of future research trends is a study in itself, and therefore a few key observations would have to suffice.

As reported in Hasselmann [2] the post-Kyoto climate change research agenda will be dominated by three aspects:

- Scientists' contribution to the public and policy makers through mainly IPCC publications;
- The continuous strive to increase on the reliability of scientific predictions. The increased computer power will have benefits especially on sub regional scales;
- Studying the complex link between pure research and policymaking. There is a clear need to transfer climate research into climate policy. To paraphrase Hasselmann: *The bottleneck in the development of effective climate change policy is not so much the uncertainty of climate predictions as our lack of understanding of the interactions of climate change, the environment and the global socio-economic system.* Integrated assessment models are increasingly being developed to guide negotiations, though *never able to replace the intricacies of international negotiations or modify the fundamental forces of divergent political interest*. These models, however, have an important role in guiding *negotiators towards an effective long-term strategy for climate mitigation* [2].

The first aspect relates to continuous work of IPCC Working Groups (WG) I, II and III. The science of global climate change, the vulnerability and adaptation to climate change impacts and the mitigation of adverse effects of global climate change would continue to dominate the research agenda in the years to come.

The second aspect relates to work done by, predominantly, IPCC WG I and II. Better model predictions would decrease scientific uncertainty on the impacts of global climate change on a regional and even local level. This aspect could also be included in existing research categories.

The third aspect is crosscutting to all IPCC Working Groups. The science-policy interaction is likely to become an increasingly important future research topic, and could be included under policy development issues.

7 Responding to key issues: the state of research

What is South Africa's readiness, especially in terms of research, in responding to these key issues and future research needs? Before this question can be answered a reporting framework is identified.

7.1 Types of research

Considering the approach followed in Climate Change Country Studies and in most National Communications the following categories apply:

- GHG inventory (Inv);
- Vulnerability and adaptation (V&A);
- Mitigation (M);
- Policies & Measures (P&M);
- Systematic observation and research (SOR);
- Education, training and awareness (ETA).

Considering the approach that ties directly to the key SA issues at international negotiations the following categories apply:

- Adverse effects on environment (Aenv);
- Adverse effects on economy (Aecon);
- Kyoto mechanisms, incl. CDM, AIJ/JI, IET (KM);
- Technology transfer (TT);
- Land use change & forestry (LULUCF);
- Capacity building (CB);
- Policy development (PD).

7.2 Value of research

The Rand value of research projects has been reported on. Where exact values were not available best estimates within certain orders of magnitude have been used. These orders of magnitude were specified in the survey itself (< R100 000; R100 000 – R250 000; > R250 000). Where orders of magnitudes were not available the most conservative value of comparative studies was used.

7.3 Analysing research information

7.3.1 Value of research

The research value in South Africa is estimated at around R30 million for current projects or projects planned in the near future. This compares to a conservative figure of R15 million in September 2000. Despite the fact that earlier figures were underestimated, the magnitude of the difference convincingly indicates that there is a trend towards intensification of research in the area of climate change.

7.3.2 The type of research

The results from the analysis are presented according to the breakdown in national communications and key issues to South Africa.

The bulk of research in South Africa is on *vulnerability and adaptation (V&A)*, which accounts for 46% of current research costs. The major studies in this category are the vulnerability and adaptation component of the SA Country Studies on Climate Change, an Eskom study on the local, regional and global impacts of climate change, SAFARI 2000 (assuming a 10% contribution of contract value to climate change research in South Africa), and several smaller studies, mainly commissioned by the NRF. The category *policies and measures (P&M)* accounts for 35% of research spending, with the major studies being a study on carbon sink potential in the Eastern Cape, an analysis of case studies on the CDM, South Africa's National Communications, policy support to DEAT on carbon allocations and a study on the impacts of the UNFCCC on the South African economy. *Mitigation (Mit)* studies account for 9% of the research value, including the mitigation component of the SA Country Studies on Climate Change and several smaller implementation studies. *Systematic observation and research (SOR)* includes only the SA Weather services station at Cape Town and accounts 7% of the costs. *Education, training and awareness (ETA)* accounts for 2% of costs, mainly on training programmes of climate change for government officials. The compilation of a greenhouse gas *inventory (Inv)* was a single project based on IPCC guidelines and accounts for 1% of research costs.

The *adverse effects on the environment (Aenv)* comprise 53% of research spending and include V&A and SOR components. The *adverse effects on the economy (Aecon)* draws 5% or research spending – including studies on the impacts of the UNFCCC on the SA economy, the linkages between CDM and EIA and the damage costs of global climate change. The category *policy development (PD)* draws 19% of the research costs and includes the National communications, the mitigation and policy development components of the SA Country Studies on Climate Change, and several smaller renewable energy implementation studies in the context of CDM. Some smaller corporate climate change strategies and research on approaching economic policymaking in complex and dynamic environmental problems are also included in this category. Research on the *Kyoto Mechanisms (KM)* accounts for 11% of research costs and include case studies on CDM, the national climate strategy and the South-South-North CDM project. 10% of research costs falls in the category of *land-use, land use change (LULUCF)* mainly through a carbon sinks potential study in the Eastern Cape. There were no clearly identifiable studies under the category *technology transfer (TT)*. Capacity building (CB) is the same as ETA accounting for 2% of the research value.

8 Conclusions

This paper does not claim to report on all climate change research in South Africa. Nevertheless, the interactive process followed with most of the major stakeholders in the research field leave an above average confidence in the list of research projects. However, the exact value of research was not available in all cases and estimates were made on the basis of known value categories and substantial deviation might occur on estimations on the costs of research. In cases where no information on research value was existent, it was excluded from analysis. The results on the value of research are therefore conservative. Despite these limitations, and with comparison to previous work in September 2000, a few important conclusions can be derived:

- There is an increase in the amount of research on the adverse impacts of global climate change on the South African economy. The absolute percentage is still small when compared to the total spending on climate change research. There is some evidence that some large businesses are determining the strategic implications of global climate change on their operations. The South African economy relies heavily on coal exports, is carbon and energy intensive, and is potentially vulnerable to the impacts of climate change. In this situation research into the estimated economic costs of climate change to the South African economy seems to be appropriate.
- The opportunities of the internal climate change developments through the *Kyoto Mechanisms*, notably CDM, is receiving increased research attention in South Africa. With a national strategy on CDM and several case studies in development, the need arises for a full-scale attraction of international investment funds to South Africa through this mechanism. There is a need, however, to developed research programmes in the area of *technology transfer*, as these are entrenched in both international actions on adverse effects and the CDM.
- *Policy development* studies are declining in relative terms to total research expenses. The national communications on climate change have been finalised and a new phase on appropriate policy design and response have not really started yet.
- Research in the category *land use, land use change and forestry* research has grown a lot in the last year. This fits in well with the principal inclusion of carbon sinks in the Bonn 2001 agreement.

- There still seems to be a need on *capacity building programmes*, specifically on global climate change. Although a key issue to South Africa, not many clearly defined projects could be identified. The strength of South Africa's international negotiations would depend largely on the breath and depth of expertise in the country on climate change issues.

The interaction between *science and policy*, identified as a key future research area in the international debate, is of importance to South Africa as well. The existing National Communications and National Strategy on CDM could be greatly enhanced through a science-policy platform on issues relating to global climate change. So far it appears as if the bulk of climate change research in South Africa is compliance-driven (to the UNFCCC). However, the research on the opportunities and threats of climate change on the South African economy and several corporate business strategies on climate change demonstrates a more pro-active stance on the issue.

In summary, South Africa has only recently started to examine the implications of global climate change on the country. This paper attempted to provide an overview of existing research, with the objective to identify the needs for further research. It was pointed out that the estimated R30m of current climate change research activities are illustrating an increased involvement of the country in climate change issues, but a lot of research remains.

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SHORT PAPER BY ELIEZER MARTINS DINIZ

Faculdade de Economia, Administracao e Contabilidade (FEA-RP-USP)
Universidade de Sao Paulo
Av. dos Bandeirantes, 3900
14040-900 Sao Paulo
Brazil
E-mail: elmdiniz@usp.br

1 CLIMATE CHANGE AND ECONOMICS IN BRAZIL

The economists currently experience an awakening of the importance of the environment in some questions posed by economics. A careful study in these cases may produce answers not obvious for the layperson. The attention of some researchers, including myself, was recently directed to a controversial topic: the evidence of climate change, the proposed measures to avoid the problem and their impact on economic variables. In order to evaluate these questions, we discuss in the following some empirical evidence relating pollution to aggregate output.

Empirical results in Grossman and Krueger [1], Grossman [2], de Bruyn [3] and Dasgupta et al [4] show that it is possible to find a relationship between economic output and emissions of pollutants called Environmental Kuznets Curve (EKC). According to them, economic development can be usually decomposed in two phases: a poor country develops and produces an increasing flow of emissions (phase I); a developed country increases its output and produces a decreasing flow of emissions (phase II). The turning point that separates both varies according to the pollutant considered. One may conjecture that the society itself creates the conditions to produce fewer emissions as the country experiences progress. In some cases, the level of output associated with the turning point is so high that the best to do is to negotiate an environmental agreement in order to force a lower flow of emissions.

Researchers may decompose the total flow of emissions in three components: the scale effect means a positive linear relationship between output and emissions; the composition effect relates changes in the composition of output to the flow of emissions as sectors do not have the same potential to pollute; the technique effect that associates technology to emissions as some ways to produce are cleaner than others. The first effect will not prevail only if the last two effects are negative and stronger than it. Then one can interpret phase I as the prevalence of the scale effect and phase II as the prevalence of the composition and technique effects. An environmental agreement is a way to design measures to enhance the composition and technique effects in order to force the occurrence of phase II.

Let us come back to the climate change problem and its relationship with economics. In order to tackle this problem one needs to address two questions. The first one is whether there exists an Environmental Kuznets Curve for the greenhouse gases that cause global warming. If the answer is positive, then any agreement or protocol to curb emissions is not necessary unless the turning point of output is too high. The data collected for the Brazilian case in Diniz [5] show that there is no evidence of this curve for carbon dioxide, the main greenhouse gas. According to the findings, an agreement like the Kyoto Protocol is necessary to ensure the desired combination of growth and sustainability.

The second question still deserves a clear answer: what is the impact of measures contained in the Kyoto Protocol on the economy? Previous results of simulations for the Brazilian case show a negative impact on output. One may consider a composition of policies in order to attain the desired goal of fewer emissions associated with higher output. For instance, measures promoting development associated with the policies recommended in the Kyoto Protocol may produce the desired result.

The panorama sketched above is imperfect as it points only to the whole of the economy. Panel studies may show the average of results for the whole world. Sectoral studies for a country may show, on the other hand, differentiated impacts of either the climate change or the measures to put the Kyoto Protocol into effect. For instance, if you consider agriculture, farm animals and pastures, climate change may not be harmful in some respects. For instance, higher temperature may result in larger crops. The implementation of meaningful policies needs to consider the sectoral contribution to greenhouse gas emissions. Brazilian data collected by the International Energy Agency point to the transportation sector as the main source of carbon dioxide emissions. A part of the solution may be the hybrid automobile adapted to use either a fossil or a renewable fuel, for instance. One needs to consider also differentiated regional impacts, for instance the Amazonia, its peculiarities and its importance for the world. Another aspect that deserves interest is the impact of climate change on health, as it may favour the spread of many tropical diseases.

Summing up, the study of climate change and its relationship with economic variables is still in progress. A fundamental piece in order to provide a foundation for an environmental agreement is in my opinion the Environmental Kuznets Curve. Empirical results for Brazil show that the Kyoto Protocol is necessary. A detailed sectoral study is still lacking. A complete study makes the analyses harder but may produce important results.

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SHORT PAPER BY SVETLANA DOLGIKH

Kazakh Research Institute for Environment Monitoring and Climate
Rozybakiev st., 291, app. 25
Almaty
Kazakhstan
E-mail: dolgikh@kniimosk.almaty.kz

1 The Importance of Climate Change in Kazakhstan

The Republic of Kazakhstan signed and ratified the United Nations Framework Convention on Climate Change (UNFCCC). Kazakhstan has declared its intention to ratify the Kyoto Protocol and bind itself with obligation of Annex I Parties, being in fact non-Annex I Party to the UNFCCC.

The climate change issues are very important for Kazakhstan due to several reasons.

Firstly, this is caused by its geographical location and national circumstances that make Kazakhstan vulnerable to climate change. Kazakhstan is located in Central Asia within the center of the Eurasian continent. The climate is highly continental, with wide variations throughout the territory.

Throughout the country, the temperature sums for the vegetative stage are sufficient for the cultivation of all species of cereals growing in a moderate temperature belt. However, there is a shortage of precipitation, and the cultivation of cereals is only possible in the north, northeast and in a narrow foothill area in the southeast of the country.

So, most of Kazakhstan territory is located in the natural landscape zones, ecological systems of that are considerably vulnerable to climate related stresses, and expected to be even more vulnerable to the expected climate change. The tendency of increase of seasonal and annual surface temperatures and the negative trend of annual rainfall were observed during the last centenary period in Kazakhstan. Such regime of rainfall combined with significant temperature rise is an evidence of increase in climate aridness over the most part of Kazakhstan within the last century. Besides that, the soils of the arable land are exposed to the degradation, which happens as the result of poor land management, and due to climate change. The studies showed that the desertification occurs not only in semi-desert zone, but also in the steppe zone, which is the main country's granary.

Impact studies in Kazakhstan showed that it is highly probable that humidity zone borders and according to this, the natural landscape zone borders as well, will shift in Kazakhstan under global warming. According to the different projected changes in temperature and precipitation, the humidity zones boundaries will shift by 100 to

400 km to the north. The climate zone, where in Kazakhstan the grain-crops are cultivated under the actual climate conditions, will be reduced by 6 % to 23%.

Such a nature of climate change will definitely affect other economic sectors and natural resources of the country. For example, combination of projected climate change and anthropogenic impacts can considerably accelerate the processes of degradation of soils. Kazakhstan is situated in water-scare areas. Climate change is projected to substantially reduce available water. Glaciers are projected to continue their widespread retreat during the 21st century in Kazakhstan. Most of Kazakhstan's rivers have glacier water supply. As result, a redistribution of an annual river run-off is expected. Redistribution of precipitation and increased frequency and intensity of droughts (as reflected by projected temperature and rainfall) will entail negative consequences, particularly in agriculture and water management of the country. The ability of livestock producers to adopt their herds to the physiological stresses associated with climate change is poorly known. For Kazakhstan, it was estimated that expected climate condition would have a negative impact on sheep-breeding productivity due to both grassland yield decrease and direct impact of increase in duration of stable hot weather periods on sheeps.

Thus, climate change issue is part of the larger challenge of sustainable development of Kazakhstan. Numerous possible adaptation options for responding to climate change have to be identified since they have the potential to reduce adverse and enhance beneficial impacts of climate change.

The other aspect of climate change problem - mitigation of GHG emission - is also very important for Kazakhstan. The GHG emissions in Kazakhstan amounted to over 10 tones per capita in 2001. Thus, it is obvious that Kazakhstan has a high potential for reducing GHG emissions by using more energy-saving and energy-efficient technologies. It is needed to identify priority sectors and measures in Kazakhstan on climate change mitigation. And it is necessary to facilitate the technology transfer to Kazakhstan through JI/CDM projects. The field of JI and CDM project development is still quite new, as demonstrated by the decision of the Framework Convention on Climate Change to extend the experimental phase of Joint Implementation for another several years.

Reduction of GHG emissions is one priority, while many environmental problems are competing for attention. The reason is that GHG emissions reduction is a case in which both environmental and economic needs are addressed. Since Kazakhstan is among the world's largest emitters of CO_2 per unit of GDP, there is great potential to improve its productivity by improving its efficiency. In addition, many cities in Central Asia have significant air quality problems. Measures that reduce GHG emissions also reduce emissions of pollutants that have local impacts. In order to improve its efficiency, Kazakhstan needs to attract investment in new, modernized equipment in both the industrial and energy sectors. Use of Joint Implementation or the Clean Development Mechanism offers an opportunity to attract these new investors, and to strengthen national ability to reduce and monitor GHG and other emissions. A successful climate change abatement regime is one in which we can more widely distribute the technologies needed for cleaner development, and thereby break the chain in which the poorest nations are also the most wasteful of their limited resources. Demand for cleaner development will, as we know from historical experience, create the right market conditions for continued breakthroughs in efficiency and new kinds of energy.

SHORT PAPER BY GAMAL EL-AZALY

National Research Centre
Solar Energy Department
El-Tahrir st., Dokki
Cairo
Egypt
E-mail: elazaly@hotmail.com

1 An Overview of The Climate Change in Egypt

1.1 Introduction

There is no doubt that everybody has the right to breathe clean air, drink clean water, and to live in a clean and safe environment. Greenhouse gases emissions such as carbon dioxide, chlorofluorocarbons, methane, and nitrous oxide cause a big problem for the environment. The emission of these gases in the atmosphere leads to the increase of the ambient temperature and consequently changes the climate all over the world. The mitigation of these gases needs coordination and co-operation between different sectors, international support, and stimulation of integrated management and sustainable development.

1.2 Global warming in Egypt

The increase of CO_2 emissions in the atmosphere is the most serious problem in Egypt, especially in Cairo and some industrial cities. These emissions mainly result from the large number of cars, trucks, automobiles, different industries, and from thermal power stations. These gases cause air pollution and lead to the anthropogenic greenhouse effect which contributes significantly to climate change.

Another main source for global warming in Egypt is the exhaust gases resulting from burning dried plants and straw in the fields by farmers after the harvest season.

1.3 Solving the problem of global warming in Egypt

To decrease the emission of greenhouse gases and to solve the problem of global warming in Egypt, the following points are very important:

- The use of new and renewable energy sources for power generation, such as solar energy and wind energy, where these energy sources are clean and locally available. The average yearly sunshine hours in Egypt exceeds 3600 hr/year and the average daily solar energy incident on horizontal surface exceeds 5.5 $kWh/m^2/day$. Also the average wind speed may exceed 10 m/s at some coastal regions in Egypt, which indicates that the use of wind energy and solar energy is very important to protect our environment.

- Using a suitable kind of lead-free petrol in cars and applying environmental laws and regulations on cars to decrease their emissions to the atmosphere.
- Controlling the amount of the exhaust gases of factories to decrease CO_2 emissions by increasing the machines efficiencies and improving the maintenance.
- Developing the human capabilities to understand the problems of global warming and their causes and results.
- Using modern test facilities for greenhouse gases assessment and monitoring to determine the real size of the pollution and global warming.
- Improving energy efficiencies of thermal power stations

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SHORT PAPER BY VIVIANA HORNA

Max Planck Institute for Biogeochemistry
Winzerlaer Str. 10
07745 Jena
Germany
E-mail: viviana.horna@bgc-jena.mpg.de

1 The Importance of Climate Change in Peru

In Peru, the national inventory of greenhouse gas (GHG) emissions reported for 1994 a value of 0.98 Pg. The Peruvian National Environmental Council (CONAM) has estimated that the level of greenhouse gases, if emissions continue at the current rate, will grow up to 2.6 times by the year 2025. Two main categories are recognized as sources of GHG emissions, the first category includes the industry, transport, and extractive activities like mining. The contribution of this category sums up to 32% of the total. The second category includes agriculture and other activities related to land use. However, the prediction from the CONAM forecasts a change in the composition of the emission sources with a large increase in GHG emissions coming from the industry and transport sectors, reaching a total of 55% by the year 2025.

Nowadays, there is lot of discussion in Peru about the implementation of new mechanisms and clean technologies that will allow the maintenance and improvement of the environmental quality by controlling the level of GHG emissions. The CONAM has proposed the application of alternative energy sources and the development of new transport systems within large cities as well as the use of more efficient and less polluting motors.

Regarding the agricultural and land use sector, overgrazing and deforestation are the main sources of species diversity losses and land use change. In the Andean part of the country, extensive areas are in danger of desertification due to the overgrazing. On the other hand, there is a slow downward tendency in the level of agricultural activities, due to the migration of the population to larger cities, leaving behind their abandoned fields. In the Amazon forest, slash and burnt agriculture is still a major problem and a source of natural forest destruction. The CONAM has proposed an extensive reforestation program for degraded and abandoned areas.

From the total amount of GHG emissions, 41 % is attributed to land use change and deforestation. Natural forests in Peru cover an area of 78.8 mill ha. The Amazon area of Peru covers 60.3 % (68.6 million ha) of its territory. Between 1985 and 1990, the Peruvian National Institute for Natural Resources (INRENA) estimated a deforestation rate of 261,158 ha per year. In 1990, 9.2 % of the original forested area was subject to deforestation as a consequence of selective logging and shifting agriculture. For the year 2025, the National Environmental Council estimates that 14 % of the original forest would have been perturbated. The INRENA has calculated that 10.5 mill ha are suitable for reforestation, however, only 0.06% of this area has been reforested so far.

Given the large extension of the forest area in Peru, there is a great potential to use this resource to improve the environmental quality of the country and to control the balance of greenhouse gas emissions. Some important points that should be integrated in a national strategy to monitor global change and the balance of GHG emissions coming from vegetation are the following:

Monitoring of forest plantations established in deforested regions and of areas suitable for management. There is a large expectation that vegetation and specially forests can serve as sinks of CO_2 emissions. During early growth, forest accumulate carbon in their above and belowground biomass production. In Peru, a reforestation plan or a forest management plan should take into account the diversity of the territory, and has to consider special conditions for each different natural region, here presented in a broad sense:

The dry forest along the Peruvian coast is an area subjected to high pressure from the dense population that inhabits it. However, in the north, natural vegetation seems to have a large regeneration potential especially during ENSO events, when precipitations are quite high in this area. During the occurrence of ENSO events, it has been observed that natural regeneration from common species became rapidly established in abandoned areas and that the natural vegetation showed an increase in annual growth due to the longer growing season or the shorter dry period. The vegetation covering these dry soils helps reducing desiccation levels by reducing evapotranspiration and actively capturing water from precipitation.

In the Andean region, several exotic species have been used for reforestation and different species of *Eucaliptus* are the most commonly spread. Only recently there is more interest in using native species for reforestation in the Andes. These species would be more suitable and adapted to the natural conditions of the environment. However, since *Eucaliptus* has a fast growth and has spread rapidly in the Andes, it would be very important to determine the actual role of plantations of this tree and the interactions with the environment.

For the Amazon region, the situation is quite complicated given the complexity of the forest structure and the diversity of plant species. A reforestation plan of this area usually tries to resemble the complex structure inside the forest with a reduced number of species occupying a canopy vertical level or through species enrichment of secondary vegetation. In all cases, there is not a comprehensive record of the characteristics of the silvicultural systems used and even much less about the biomass/carbon accumulation rates of these.

Conserving natural forested areas and monitoring their growth dynamics. Recent publications have suggested that tropical floodplain forests are growing at a larger rate, especially in the Neotropics. This means that tropical rainforests could be potential carbon sinks. However, the estimated values of forest productivity are subject to large error bars since current methodologies still struggle to provide accurate estimates of forest growth dynamics and total biomass over large areas. The use of remote sensing techniques in combination with inventory data from permanent plots of forest vegetation, provides a great help to develop algorithms to estimate forest biomass over large areas of difficult accessibility and during short periods of time. Actually, in Peru, during the Second National Forum about Protected Areas, carried out in Lima during March 2003, there was some discussion about the lack of a vegetation map for the whole country. For this purpose, a strategy would be the development and establishment of a remote sensing network in combination with ground data from forest inventories to map vegetation and its biomass stocks and to monitor vegetation dynamics.

This information, collected in a comprehensive and organized way would provide an invaluable basis to a successful reforestation plan that observes the different applications and potentials of the species to be used. This would also serve for the monitoring of land use change and the potential role of natural forest to act as carbon sinks or sources.

SHORT PAPER BY JIANGHUI

Yueyang environment protection bureau
Number 57, Road yuedong
Yueyang, Province Hunan
China
E-mail: yyjh3593@sina.com

1 Current Air Pollution and its Control in China

In recent years, air quality in some parts of China has been improving, but overall the air quality is not satisfactory. The air pollutants are mainly associated with soot from combustion of fossil fuels. The appearance of pollution of mobile vehicles in cities and the diversification of air pollution factors make it more difficult to improve urban air quality. The number of people affected by air pollution is increasing.

1.1 The dominance of coal in the energy mix will influence air pollution control for a long time.

China is rich in coal resource and is relatively in shortage of oil and gas. Though ratio of consumption of coal is declining year by year, coal is still dominant in energy consumption, being over 60%. 80 percent of coal consumption comes from direct combustion of raw coal, industrial and civil boilers with coal as fuel are the main source of SO_2 and soot. Currently, the main measures against air pollution are: to increase the ratio of clean fuel such as natural gas, low-sulfur coal and electricity, to strengthen the construction of foundation facilities that supply center-heating, or heat and electricity at the same time, to change the discharge patterns of air pollutants, to reduce low discharge sources etc.

1.2 Pollution by mobile vehicles in urban areas is becoming worse.

With rising living standards, the amount of automobiles in cities increases rapidly, resulting in more and more emissions. Emissions by car have become the major source of air pollution in the cities. Almost 50% of all emissions are NO_X, about 85% are CO. In large cities with more than 1 million population, air pollution characterized by soot is transforming into one featured by combined pollutants or mobile vehicles. Photochemistry smog and ozone pollution tend to develop and deteriorate in certain period of time. The most effective way to control car emissions in our country is to install an offgas purifier and electric gasoline injector.

3.1 Acid rain is yet to be brought uinder control in the southern parts of China

Acid rain in China is featured by low PH value, high ion density. The concentration of SO_4^{2-}, NH_4^- and Ca^{2+} is much higher that those in Europe and USA while that of NO_3^- is much lower. It belongs to vitriol acid rain, mainly caused by large amounts of SO_2 emitted to the air. The major reason of the formation of acid rain is the use of high sulphur coal in power plants. Recently, the ratio of NO_3^- in acid rain has increased, partly due to the leap of mobile vehicles partly due to no effective measures against fixed NO_X emissions at present. Now the main measure is to close and shut off small-scale thermal-power units and use low-sulfur coal as fuels in thermal power plants.

SHORT PAPER BY CHOU JIEMING

START Regional Research Centre for Temperate East Asia
Chinese Academy of Science, Qi Jia Huo Zi, De Sheng Men Wai Street
Beijing, 10029
China
E-mail: choujm@tea.ac.cn

The Importance of Climate Change

Climate change, especially the occurrence of climate variability and extremes, is an important part of global environmental problems, which has great effects on ecosystems, economies and social developments. The questions of adaptation and sustainable development, that is, how human beings adjust to their social and economic behaviours in order to get fit in the new environment as well as reduce vulnerabilities and promote benefits, must be answered. However, there is little attention paid to the relationship between climate change and sustainable development, which is mainly because the climate change studies have focused more on geosciences theoretically and researches of sustainable development have been directed more towards the socio-economic aspects so far.

In China the relation between the adaptations to the climate change impacts and sustainable development is widely recognized and becomes a hot spot of attention, due to the fact that China is the most populated country and experiencing a rapid economic development. The impact of climate change on the country's economic system, food supply and environment is of great importance to its future, which in turn will influence the global economy and environment changes. The practices of sustainable development help the country to meet the needs of its social and economic developments without sacrifying environmental integrity and resources of future generations.

SHORT PAPER BY VIVEK KUMAR

The Energy and Resources Institute
Darbari Seth Block Habitat Place, Lohdi Road
New Delhi
India
E-mail: kumarv@teri.res.in

1 GENERAL OVERVIEW OF THE IMPORTANCE OF CLIMATE CHANGE IN INDIA

1.1 General Overview of the Country

India is the seventh largest country in the world having a geographical area of 329 million hectares (mha). It has a land frontier of some 15,200 km and a coastline of about 7,500 km. Most of the Indian land mass is in the semiarid tropical belt and is characterized by seasonal rainfall mostly during the monsoon months lasting for about three months. The current population of the country is about 1.03 billion with a population density of 324 persons per square km.

About 70% of the Indian population lives in rural areas and is dependent mainly on agriculture and agro-based livelihoods. Out of this, about 40% live below poverty line and suffer from lack of basic amenities like safe drinking water, water for irrigation and energy. This results in low agricultural productivity, limited economic opportunities and thus poverty.

Out of the 500 million people in absolute poverty in South Asia, India alone has as many as 360 million people below poverty line (defined as per capita earning less than a dollar a day). Even those who have some income may not have access to basic facilities. Many people in India live not only without safe drinking water, sanitation, medical care, but also without homes. In 1995, 48% of the adult population in the country were illiterate. Lack of education in such a large percentage of population makes the situation still worse.

1.2 Climate Change and India

Climate change puts additional pressure on already stressed agriculture, water resources, and human health. The coastal areas and islands are particularly vulnerable to climate change. The 7500 Km long coastline and islands with a high density of population, the economic activities and recreation sites in the coastal areas and the fragile coastal ecosystems are under threat from global climate change. An all India coordinated study on the impact of one meter sea-level rise has brought out that such a sea level rise would place about seven million people at risk of displacement or severe disruptions. To develop an effective response strategy in the event of sea level rise of such a dimension, India needs to take up baseline studies of the vulnerable coastal areas in India on the different economic activities, livelihoods, shelters, agriculture, fisheries, and the different fragile ecosystems like the wetlands, mangroves etc.

Indian agriculture is heavily dependent on monsoon. Climate change will have an impact on agriculture and food production. Water resources are already scarce in many parts of India. Global warming and climate change may add additional stress to this scarce resource. India, however, utilises only a fraction of water from rain and melting of the Himalayan glaciers, the rest drains down to the sea. Global warming will result in earlier snowmelt leaving almost no water for the summer season. Human health is also predicted to be under stress due to global warming as the incidences of malaria, dengue fever, measles etc. will go up in a warmer climate. Climate change is predicted to affect adversely the vulnerable section of the society above average as it lacks technologies and financial resources to mitigate climate change or to implement measures for adaptation to adverse impacts of climate change.

1.3 India's Development Priorities

Poverty alleviation, economic and social development and environmental protection are the overriding sustainable development goals and priorities of India. To meet these goals, India needs rapid economic growth to fulfil the aspiration of the people. But this growth cannot come at the expense of India's environment as it so often happens.

The priority sectors for India's development are:

- Energy;
- Agriculture;
- Forestry;
- Building (construction sector).

While it is true that climate change is not a priority area for developing countries, but India has adopted a pro-active role in international climate change negotiations and is a signatory to the UNFCCC. The country has also pursued measures and options in its development strategy, which in turn also addresses mitigation of climate change.

For improving the quality of life of 1 billion people, the country must plan and implement rapid economic growth in all sectors of the economy. In doing so the availability of a reliable, efficient and adequate power infrastructure in the country is very crucial. The power sector in India relies primarily on the thermal generation of power using coal. Therefore, in the business-as-usual scenario, emissions of carbon dioxide (CO_2) and other greenhouse gases from fossil fuel uses in India is bound to increase.

India however emits a mere 2.4% of the world total. When measured on a per capita basis, its energy related CO_2 emissions are much lower, 0.2 metric tonnes of carbon against world average of 1.15 metric tonnes of carbon.

1.4 Indian Efforts in Climate Change Mitigation

India does not have any binding commitments to reduce greenhouse gas emissions yet it has initiated several coordinated climate research programmes to assess and understand the implications of climate change to enable the country to frame regulatory measures and policies as well as to identify GHG abatement options and opportunities in the energy, forestry and agriculture sectors. In the past, the country has taken up a few country studies on GHG emissions. At present the country is in the process of preparing the National Communication to the UNFCCC. The country has also started several voluntary initiatives for GHG emission reduction in selected sectors with support from multi/bi-lateral organizations.

The country has ratified the Kyoto Protocol and its activeness can be seen in the fact that it hosted the eighth Conference of the Parties to the UNFCCC in October 2002. Various research and development organizations as well as Indian industries are working on applied and procedural issues related to climate change mitigation and development of GHG mitigation projects. The country is in the process of setting up a National CDM Authority and setting up other rules and regulations. India thus offers great opportunities to Annex I countries for implementation of CDM projects.

The knowledge about climate change in India, however, remains confined to only a few organizations. State level institutions and other stakeholders are not aware of climate change debate. It thus becomes important to train them and raise awareness among them through various means.

SHORT PAPER BY LE ANH NGOC

National Office for Climate Change and Ozone Protection
International Cooperation Department
Ministry of Natural Resources and Environment of Viet Nam
Hanoi
Viet Nam
E-mail: vnccoffice@fpt.vn

1 Overview of the importance of climate change in Viet Nam

Viet Nam is located in the South East Asia, stretching, from $8^0 27$ to $23^0 23$N and from $102^0 08$ to $109^0 30$E. The land area occupies 330,990 km^2. Viet Nam has 1,400km of borderline to the North with China, 2067 km with Laos and Cambodia to the West. The coastal line of 3,260 km covers the East and the South. The seawater territory under sovereignty and jurisdiction is about 1 million km^2.

Mountains and hills cover three of four Viet Nam territories. The elevation is mostly from 100 to 100m. The plains concentrate in the down streams of two big rivers, the Red River and Mekong Rivers. The River network in Viet Nam is rather dense with 2360 rivers. The average density is 0.6km/km^2.

Viet Nam possesses a monsoon tropical climate with plentiful heat and humidity but due to lengthy territory stretching on many latitudes and diversified topography, the differentiation of climate between the regions is rather clear.

Viet Nam is located in the area affected by typhoon and tropical cyclones in the North West Pacific Ocean. In average, annually, there are 4-5 typhoons/tropical cyclones affecting Viet Nam.

Recent studies showed that climate change in Vietnam has the following main manifestations:

- Annual average temperature increases about 0.1^0C per decade. In some summer months, temperature increases about 0.1-0.3^0C per decade. In winter, temperature has decreasing tendency at early months and increasing tendency at late months;
- Variation tendencies of rainfall are not the same for different regions and periods;
- In the past 5 decades, ENSO has stronger and stronger effects on weather regime, climatic features in various areas of Vietnam;
- Basically, climate change in Viet Nam is in conformity with what isoccurring in the region as well as at global scale:
- By 2010, 2050 and2070, temperature in the coastal zone would likely increase of about 0.3, 1.1 and 1.5^0C correspondingly, meanwhile, in the inland regions the

value would be higher and equal to about 0.5, 1.8 and 2.5^{0}C. According to this scenario, sea level would rise 9 cm in 2010, 33 cm in 2050 and 45 cm in 2070.

If the sea level rises, the coastal zone would be affected severely. The inundated area in coastal zone would increase (If sea level rise should turn out to as much as 90 cm, 250 000 hectares of land would be lost to the sea), millions of hectares of the Mekong Delta and Red River Delta would be flooded, hundred thousands of hectares of mangrove forests would be lost. The living and constructions of the coastal people would also worsen.

Climate change would have directe negative impacts on human health. Extreme weather would lead to some dangers threatening old people, people suffering from cardiac disease and mental disorder. Warming climate would change seasonal structure; warming winter in North Viet Nam would result in changes of biological rhythm of the people.

Besides, climate change could have impacts on life and production. Agricultural areas would be reduced or dyke systems would have to be built to prevent cultivated fields from the sea level rise. Consequently, provision of food and foodstuff would be more difficult with higher prices due to increase of production expenditures. That significantly affects the income of the population in this sector.

To reduce/abate GHG emissions, Viet Nam has carried out many climate change activities including:

- Establishing a Climate Change Country Team and National Technical Expert Team to manage and implement projects regarding climate change issues;
- CC: Train (Phase 1) supported by UNDP/UNITAR/GEF;
- Asia Least Cost GHG Abatement Strategy (ALGAS) Project supported by UNDP/GEF/ADB;
- Economics of GHG Limitation supported by UNEP;
- Viet Nam National Strategy Study on Clean Development Mechanism (NSS) supported (NSS) by WB and Australia Government;
- Completed National GHG Inventories for 1990, 1993 and 1994;
- Preparation for 1998 National GHG Inventory (IPCC Method for GHG Inventory, version 1996).

Next climate change activities in Viet Nam are:

- To formulate National Action Plan to implement UNFCCC;
- To establish the CDM National Authority;
- To raise public awareness on climate change issues in general and CDM in particular;
- To prepare the Second National Communication to UNFCCC;

- To develop suitable GHG Mitigation Options and climate change adaptation measures;
- To develop capacity on CDM for policy makers, stakeholders related to CDM projects;
- To integrate CDM into national strategies, policies and plans.

With the policy on industrialization-modernization and on sustainable socio-economic development, the Government of Viet Nam supports CDM and allows its implementation in Viet Nam. This creates opportunities for Viet Nam to receive financial support from relevant international organizations and developed countries.

SHORT PAPER BY BATBAYAR LUVSANPUNTSAG

"Environment21"
Ulan Bator
Mongolia
E-mail: jemr@magicnet.mn

Climatic Change and Livestock Sector

Mongolia is a nation with an age-old history and culture. But as for development and progress it has been lagging behind many nations of the world for many years. Unique sustainable source of life in rural area of Mongolia is still pastoral animal husbandry wholly based on natural grasslands under direct influence of natural phenomenons, has a great risk, which has been increasing dramatically. Recent weather patterns following global warming of climate have had a very negative impact on the livestock sector. Resilience and adaptive capacity of the traditional livestock sector to cope with climate variability/extremes are weakening, while frequency and magnitude of climate variability intensifies. For example, the livestock sector of Mongolia was affected by severe drought, dzud disaster and epidemic disease in 1999-2002, and as a result, 11 million head of livestock an equivalent to 460 million US dollars had been lost. More than 10 thousands of households lost all their livestock, while over 13 thousand households were left with few animals. Livelihood for rural people rapidly plummeted contributing to an increase in unemployment and poverty.

GDP of the agricultural sector decreased by 16,8% in 2000 and 18% in 2001. These major declines dragged total GDP growth down to around 1% in both 2000 and 2001, well below the potential of the economy to grow. Head of livestock decreased dramatically from 33 million (in 1999) to 23.6 million (end of 2002).

Recent climate change country studies resulted with warming by 1.6°C in the last 60 years and the followings regarding to the impacts on natural zone, pasture and livestock:

Natural zone: The boundary of high mountain zone would shifts up, the forest area would decrease, the steppe would move forward the forest steppe and desert steppe and desert would extend to the north (Table 1). Desertification will be the most threatening issue in future.

Grassland: Climate change will cause significant impacts on pasture productivity. 10 and 3% decrease of carbon and nitrogen in soil organics, 23.5% reduction of peak standing biomass is projected. The most vulnerable regions in the country are the forest steppe, steppe and desert steppe. The negative balance of moisture capacity will definitely limit both the growing season and the pasture productivity.

Table :. Natural zone change projection in 2040 and 2070

Natural zone	Current area	Projected change in 2040		Projected change in 2070	
	mill. ha	%	mill. ha	%	mill. ha
High mountain	5,66	-2,5%	5,52	-8,5%	5,05
Forest steppe	28,71	-3,2%	27,89	-7,1%	25,91
Steppe	35,12	-0,5%	35,06	-2,9%	34,03
Desert Steppe	35,33	-7,2%	33,16	0,3%	33,25
Desert	20,36	13,3%	23,09	18,1%	27,28

Livestock: Climate change will affect the livestock sector. In general, temperature increases will have a negative impact on animal weight gain under unchanged management. For instance, the averaged ewe weight at the end of autumn will be 2.2 kg lower in the high mountains, 1.4 kg in the forest steppe, 0.8 kg in the Gobi region and, 0.2 kg in the steppe. Lower weight will negatively affect the production of milk, wool, etc.

Adaptation measures against negative impacts of climate change set in the National Action programme on Climate change addressed to government and consist from 12 paragraphs, as they follow in brief:

- Increase public awareness and educate herders;
- Develop rangeland and livestock management system;
- Restore natural hay making fields and improve forage production system;
- Improve water supply system;
- Relieve impacts of harsh winters, severe droughts and manage risk of extreme conditions;
- Strengthening of early warning system for extreme climate events;
- Develop insurance system for livestock;
- Improve marketing system;
- Improve income taxation system;
- Alternative revenue sources for rural people in case of unfavourable weather conditions;
- Improve health and veterinary service;
- Combat desertification.

Livestock sector development is on the agenda of government objectives even today. Seven of the measures mentioned above are among the priority tasks of rural development and livestock sector. The most actual task is to conduct an assessment with more detailed adaptation measures, addressing government, herders, local communities, NGOs, professional organizations and other stakeholders. The outputs and the country pressing issues and priority tasks can be highlighted as guidance in the further research agenda:

1. Extreme / Non-linear change of climate:
    a. Extremes, frequency, intensity;
    b. Hazard assessment: Frequency, intensity;
    c. Impacts on: Human health, households' livelihoods, animal bio-capacity, economy, environment, production, etc.;
    d. Vulnerability assessment: Present and future vulnerability;
    e. Risk assessment: Comparative and cost-benefit analyses.

2 Climate interactions with: Herders, animal, pasture biome, water resource, forage resource and soil:

    a) Adaptation Policy development process with and/or concern of: Development strategy, disaster management, poverty alleviation policy, pro-poor economic growth, pasture land management, equal rights, sustainability, efficiency and technology transfer;

    b) Uncertainty: in socio-economic development, adaptation options, risk and impacts.

SHORT PAPER BY SAMWEL O.O. MARIGI

Kenya Meteorological Department
P.O. Box 30259
Nairobi
Kenya
E-mail: marigi@lion.meteo.go.ke

1 Abstract

Weather and climate are sometimes very good servants and at other times ruthless masters venting their anger in extremes (droughts and floods) on their helpless victims. The scientific community is employing its knowledge to understand the causes of and to predict these extremes. In the light of the findings by scientists, humankind is formulating strategies to respond to weather/climatic extremes resulting from climate variability and change.

1 Introduction

Kenya is enacted within the theatre of natural disasters arising from a variety of natural processes. Over 70% of these disasters are related to extreme weather and climate events including droughts, floods, extreme temperatures, lightning strikes, hailstones, mudslides, thunderstorms, high oceanic and lake waves among others. Whenever they occur, they are often associated with many severe impacts such as destruction of property, displacement of people, loss of lives and disruption of many socio-economic activities. On the other hand, current scientific knowledge points towards a discernible change in the global climate with associated regional impacts. This is likely to upset any management methods based on the natural variability of climate with far reaching implications. This therefore underscores the importance of climate change with regard to Kenya, as virtually all its socio-economic activities are extremely sensitive to climate variability. Every effort is, however, being made in an endeavor to address the issue of the current climate variability as well as the perceived climate change.

2 Climate Change Concerns Relevant to Kenya

The concerns are numerous and include but are not limited to the following:

- *Extreme Climate Events:* These include floods, drought, hailstones, lightning strikes, strong winds, etc. A number of studies have suggested that there are significant changes in the frequency and intensity of these extreme events. In fact the country has not recovered from the impacts of the mid 1998/2001 drought, which happened to be the longest and severest drought since the 1950s;

- *Natural ecosystems:* Forests, pastures, wetlands and coastal ecosystems may have difficulties in adapting to the fast changing climate, thus it is possible to lose some of the flora and fauna;
- *Human health:* The impact on human health may be both direct and indirect including an increase in the transmission of diseases such as malaria, dengue and yellow fever;
- *Agriculture:* This is mainly rain dependent. The space-time distribution of rainfall is likely to be altered; thus affecting agricultural production as the seasons and amounts of rainfall may change. Much of the low lying agricultural lands may also be lost to the sea due to the projected sea level rise;
- *Human settlement:* Populations living in low-lying coastal areas and small islands will be displaced by the projected sea level rise and therefore have to be relocated.

3 Addressing the challenges

Global climate change is fundamentally different from the conventional environmental agenda where the practice has been to *react* and *correct.* The challenge now is to *anticipate* and *prevent.* Although the industrialized countries have historically contributed the most to the problem of climate change and have more resources to address it, the principals of *equity* and *common but differential responsibilities* call for developing countries to act together for this global issue. Kenya recognizes the fact that the question of how to adapt to the projected impacts of climate change is inevitable and needs its high priority. Adaptation strategies are needed early so that they can be integrated into long-term planning for sustainable development. Each action can also give advance warning of how climate change vulnerabilities and adaptation may affect various sectors of the economy. Following are highlights of efforts being carried out by the country in addressing the climate change issues:

3.1 Institutional set up

Establishment of a National Climate Change Activities Coordinating Committee (NCCACC). This has a multi-disciplinary/intersectoral membership derived from ministries of agriculture, environment, natural resources and wildlife, energy, national planning, finance, industry, research and technology as well as public universities, private sector and NGOs. The terms of reference of the NCCACC are:

- Ensuring the establishment of a properly networked database on climate change, impacts, response strategies and research activities;

- Advising the government on issues pertaining to the Global Environment Facility (GEF) or any other international financial mechanisms;
- Identification of climate related projects requiring regional and international cooperation;
- Identification of scientists who would be called upon to undertake specified research on climate change, impacts and response strategies and advising on human resources development;
- Advising the government on implications of commitment under the UNFCCC and other United Nations conventions related to climate change.

3.2 Formation of Climate Change Technical Working Groups (TWGs)

Four technical working groups have been formed and are marked by clearly identifiable activities namely:

- *National inventories of greenhouse gases:* This TWG is expected to evaluate the amount of GHGs that is emitted in Kenya;
- *Climate change mitigation options:* The group is expected to review existing and planned policies and measures to mitigate climate change;
- *Climate change vulnerability/impacts assessment and adaptation*: This group isolates 8 sectors (Energy, Terrestrial ecosystem, Coastal zone aquatic resources, Human settlement, Human health, Agriculture, Water resources, socio-economic assessment) and assess their vulnerability to climate change. The group is further to identify and develop policy options for adequate monitoring systems and response strategies for climate change impact assessments;
- *Education, training and public awareness raising:* The group is expected to create public awareness and understanding about trends and implications of global climate change and to sensitize the people on their obligations.

Outputs from these four groups will always form Kenya's national communication to the UNFCCC.

3.3 Climate monitoring and change detection activities

Kenya is one of a number of countries in the world, which are regularly making measurements of concentrations of greenhouse gases. It is doing so at its Global Atmospheric Watch (GAW) station on Mt. Kenya. The scientific community is factoring this information in monitoring global climate change. The Kenya Meteorological Department (KMD) is also making measurements of air temperature at synoptic, agrometeorological and radiosonde observatories. The data observed are used, among other things to detect trends in temperature.

4 Conclusion

Climate is life sustaining and life threatening. The human and economic losses as well as environmental damage due to extremes of climate are enormous. Climate change is likely to exacerbate the impacts of climate extremes on humanity and many developing countries such as Kenya are extremely vulnerable to such impacts. Effective early warning and preparedness schemes are therefore some of the best strategies to minimize the negative impacts of the perceived climate change. Despite its limited financial resources, Kenya is making efforts in an endeavour to address the challenges of the perceived climate change.

SHORT PAPER BY GABRIELA GONZÁLEZ-MERLA LAGUNA

Burguete, Celis Y Asociados, S.C.
Recreo #89-501 Del Valle c.p. 03100
México City
Mexico
E-mail: gabymerla@hotmail.com

1 Climate Change and Mexico

Scientific evidence and data has shown that the existence of gases in our atmosphere causing a greenhouse effect is one of the most important causes of climatic change and global warming that has been noted over the last few decades.

Because of the climatic change problem, in 1992 the United Nations Convention on Climatic Change ("The Convention") was signed being its principal objective the reduction of greenhouse gas emissions [1]. In 1997, 159 countries signed the Kyoto Protocol, by means of which the countries set out in Appendix-I of the Convention agreed to reduce their emissions during the period 2008-2012 by an average of 5.2% below the emission levels of 1990. In order to help the Appendix-I countries as well as their industries and companies to comply with the reduction commitments, the same Protocol establishes the possibility of using flexible mechanisms. One of the "flexible mechanisms" is the Clean Development Mechanism (CDM), which requires cooperation between developed and developing countries (Annex 1 and non-Annex 1 countries). Within the CDM, developed countries will invest in forestry and soil conservation projects as well as in cleaner energy technology.

Mexico is part of the Kyoto Protocol (non-Appendix-I country) and qualifies as a participant in projects that reduce emissions (as CDM projects). Mexico, as a host country of CDM projects, has great opportunities in several areas, as will be explained as follows.

Mexico and CDM

At the present time, Mexico is passing through an energy crisis, which will require substantial capital investment to deal with. At the same time Mexico needs to reduce its greenhouse gas emissions, part of which come from electricity production (**Mexico is among** the 20 countries with the **highest levels of greenhouse gas** emissions in the world and is responsible of the 2% of world emissions). Because of this, Mexico needs a mechanism that provides capital for energy infrastructure, which at the same time is environmentally friendly.

Since Mexico is a developing country and its government does not have sufficient capital to make incremental investments in emissions mitigation options, Mexico needs a transfer of funds and technology from other countries. For reducing greenhouse gas emissions in the energy sector, there are several projects, which represent development alternatives. Among these projects are the following: projects that implement mechanisms to reduce greenhouse gas emissions during the process of electricity generation; implementation of projects that generate energy by using renewable or non polluting fuels (for example, the change to using fuel such as natural gas or hydrogen); and projects that recover methane from mines, landfills or farms to be used as fuel for the production of electricity.

The CDM responds to this. It is a mechanism that allows Mexico to receive investment in the energy sector from Annex I counties, but which will be "green" investments, investments that will help to reduce greenhouse gas emissions. This can represent a once in a lifetime opportunity because the development of the energy sector of Mexico can be sustainable. On the other hand, this is a win-win situation, because foreign investors not only will receive a profit from their investment in the Mexican energy sector, but also, if these energy projects help to reduce greenhouse gas emissions, certificates of emissions reduction (CER's) will be issued to them. These certificates will help them (investors and at the end their countries) to achieve their emissions reductions goals agreed to in the Kyoto Protocol.

CDM Implementation in Mexico

To date, there are several CDM projects that are being carried out in México such as: the Scolel Te project (a forest sink for CO_2 absorption); salicornia cultivation in the Bahía de Kino, Sonora; reforestation of the Sierra Gorda biosphere in Queretaro (for emissions reductions); reforestation in the Lacandona Forest, etc.

Nonetheless, Mexico still is in the process of creating the special governmental entity required to register and approve CDM projects. This entity is going to be formed by the Ministry for the Environment and Natural Resources (SEMARNAT) and the Ministry for Energy (SE). However, for the purpose of forging ahead in this process, projects are currently being carried out for the reduction of emissions, registered as such.

Despite the fact that there is no legislation in Mexico that regulates the provisions of the Kyoto Protocol, it is still possible to implement CDM projects with legal certainty. The key is to enter into agreements between that Responsible for the Project, and between the Operational Entities and the Responsible of the Project. These agreements regulate the obligations of each party, establish their responsibilities at each and every stage of the project, provide for and agree upon the volatility of prices and of credit issues, establish terms relating to force majeure and risk, and above all, precisely regulate the property rights that they generate, especially those regarding CER's. Regarding the legal certainty that has to be given to the activities that are carried out with the National Authority and the Executive Board, they have to be duly documented and certified in accordance with the regulations indicated by the Kyoto Protocol.

2 Challenges and Perspectives

From my point of view, there are some obstacles that have to be overcome in order to implement as many CDM projects as possible and so take advantage of the unique opportunity that they offer to Mexico:

- There is a lack of coordination between the authorities that are responsible for the different sectors;
- There is no focus on the part of Mexican industry with respect to the potential of CDM projects and of other green markets and on the profitability of using them;
- There is no regulatory system that offers legal certainty to investors engaged in these types of projects and
- The procedures for determining base lines and the measuring of emissions require confirmation.

As a consequence of the above, Mexico is faced with a challenge to create:

- A National Agency for the registration and authorization of CDM projects;
- Regulatory systems that provide certainty in the implementation of CDM projects;
- Regulation of a future trade emissions market and
- An infrastructure for information about projects and the issuing of certificates of emissions reduction that allows full publicity, registration and implementation of the projects being considered.

Only in this way will Mexico be able to take advantage of this unprecedented opportunity.

3 References

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SHORT PAPER BY KELEBOGILE MOROKA

Department of Environmental Affairs & Tourism
Global Climate Change Sub-directorate
Private Bag x447
0001 Pretoria
South Africa
E-mail: Kmoroka@ozone.pwv.gov.za

1 National Circumstances

The Republic of South Africa occupies the southernmost part of the African continent with a surface area of 1 219 090 km^2. South Africa lies within a drought belt with an average rainfall of only 464 mm, which is typically unreliable and unpredictable. The population was estimated to be 40.6 million in 1996 with a 2.2% annual growth rate. It is the government's aim to stabilise the population at 80 million by the year 2100 with a 1.9% growth rate.

Unemployment is estimated to be 35% of the population, which is currently growing at 2.2% per annum. Increasing unemployment is contributing to the expansion of the informal sector, which is estimated to provide approximately 12% of the labour force and 7% to Gross Domestic Product (GDP).

South Africa has a low but improving economy with a GDP of 296,1 billion USD in 1999. The economy was originally built on natural resources, with mining and agriculture being the main contributors. More recently there has been a shift from production to manufacturing. Tourism is the fourth largest industry and has been recognised as one of the key drivers for job opportunities and economic empowerment.

2 Vulnerability and Adaptation to Climate Change

Potential changes in climate may have significant effects on various sectors of South African society and economy. The South African Country Studies Programme identified the health sector, maize production, plant and animal biodiversity, water resources, and rangelands as areas of highest vulnerability to climate change, and proposed suitable adaptation measures to offset adverse consequences. Two key cross-sectoral adaptation options that link the various sectors are the establishment of improved national disaster co-ordination and management and the raising of awareness on the potential effects of climate change.

The South African economy is vulnerable to the possible response measure implemented by Annex 1 countries, since the economy is highly dependent on income generated from the production, processing, export and consumption of coal. Conversely, export could increase to non-Annex 1 countries. Investigations have been recently initiated to evaluate the potential impact of response measures on the South African economy.

Global Climate Model (GCM) computer simulations were used to develop regional climate change scenarios and to assess the potential effects of a changed climate. The predicted changes to the South African climate over the next 50 years included: a warming of between 1°C and 3°C; a broad reduction of approximately 5 to10% of current rainfall; increased daily maximum temperatures in summer and autumn in the western half of the country; increased incidents of flood and drought; and, enhanced temperature inversions exacerbating air pollution problems.

3 Malaria

The projected climate change scenarios for South Africa will result in an extension of the malaria prone areas, and due to the increasing length of summer, a greater number of people will be exposed to the risk of malaria for longer periods of time. The modelling predicted that the area of the country potentially prone to malaria will more than double in the next 50 years, and that 7.8 million people will be at risk, with 5.2 million of these people not previously resident in malaria risk areas. Significant resources are currently being applied to implement control measures to limit the rates of infection, but should the affected areas increase as predicted by the studies, the disease would become more difficult to manage. The increased resistance to pesticides has recently necessitated the re-introduction of DDT for malaria vector control.

4 Schistosomiasis (Bilharzia)

It has been estimated that in 1996, between 3 and 4 million people were infected with one or more species of schistosoma in South Africa. Theoretical modelling suggests that as temperature increases occur, a larger area of South Africa will be conducive to the survival of schistosomoa, and consequently a greater portion of the population will be at risk of infection. With the increases in unexpected weather phenomenon, for example flooding, the distribution of the snail host may increase, and the potential for urinary schistosomiasis would exist in areas that are currently free of the disease. Community Water Supply and Sanitation projects currently being undertaken by the Department of Water Affairs and Forestry will contribute to the prevention of infection by schistosomiasis but the ultimate goal of providing everyone with basic water and sanitation services will take many years.

5 Water Resources

Even without climate change it is predicted that South Africa will fully utilise its surface water resources by about 2030. The most significant impacts of climate change on water resources are the potential changes in the intensity and seasonality of rainfall. While some regions may receive more surface water flow, water scarcity, increased demand for water and water quality deterioration are very likely to be problems in the future. Climate change may also alter the magnitude, timing and distribution of storms that produce flood events. The arid and semi-arid regions, which cover nearly half of South Africa, are particularly sensitive to changes in precipitation. Desertification, which is already a problem in South Africa, could be exacerbated as the climate changes. Adaptation options identified to limit the effect that climate change may have on water resources include strategic resource management issues, drought relief measures, design of infrastructure and communication.

6 Rangelands

Climate change scenarios predict a general aridification of rangelands. The predicted lower rainfall and higher air temperatures will affect fodder production and impact on the marginal costs of ranching. Over the savannah regions in the northeast of the country, forage production may decrease by about one fifth, which would impact the cattle ranching industry by reducing the national cattle herd by about 10%. Beef production would, however, not be affected to the same degree, as greater numbers of the beef herd are fattened in feedlots before being slaughtered. Fire intensities are predicted to increase by about 20% due to the increase in grass fuel load. Climate change may also affect the frequency and spatial extent of livestock disease outbreaks, such as foot and mouth disease. An improved monitoring and forecasting system for fire hazards and droughts will assist and may be beneficial even without climate change occurring.

7 Maize

Maize production contributed to 71% of grain production in 1996. To meet the increasing food demand, agriculture has to expand by approximately 3% annually. Under the climate scenario that predicts a hotter drier climate, maize production will decrease by approximately 10 to 20% over the next 50 years and that speciality crops grown in specific environmentally favourable areas may also be at risk. An increase in pests and diseases would also have a detrimental effect on the agricultural sector, and invasive plants could possibly become a greater problem. Adaptation measures should mainly focus on changing agricultural management practices, such as more effective use of water resources, planting drought resistant crops, or changing the land use to grazing. To reduce the risk of famine, marginal production areas could be kept economically viable by planting drought resistant crops or changing land use to grazing.

8 Forestry

The South African forestry industry is highly sensitive to climate change. Currently, only 1.5% of the country is suitable for tree crops and the forestry sector is affected by factors such as land availability, water demand and socio-economic conditions. General aridification, due to lower rainfall and higher air temperatures, will affect the optimal areas for the country's major tree crop species, and impact the marginal costs associated with planting in sub-optimal areas. Shifts in the optimum tree growing areas could impact the profitability of fixed capital investments such as saw mills and pulp mills. The decrease in production would also be detrimental to the planting of trees to serve as carbon sinks. More temperature tolerant cultivars within the current tree species could be selected, but it is more probable that more lucrative uses for the land, such as sub-tropical fruits, may compete for the land currently under tree plantations.

9 Biodiversity

Biodiversity is important for South Africa because of its importance in maintaining ecosystem functioning, its proven economic value for tourism and its role in supporting subsistence lifestyles. The combined effect of climate change, increasing human population and increasing per capita consumption will result in major changes to biodiversity. Climate change scenario modelling indicates a reduction of the area covered by the current biomes by between 38 and 55% by the year 2050. Of the 179 species of animals examined, 143 indicated range contractions and four are predicted to become extinct. Of concern is the predicted expansion of insect pests, such as the brown locust, to areas that were previously cooler.

The predicted rise in temperature would have an effect on the sea surface temperature and this would result in the migration of species residing along the coast. Studies have also indicated that there will be an increase in the occurrences of 'red tide' on the west coast. Other results of climate change are predicted changes in sand inundation on the eastern coast and a predicted increase in storms.

The establishment of a biodiversity monitoring network would identify those species that will be affected by climate change, and may assist in the identification of species that could serve as indicator species. Conservation planning is required to ensure that the effects of climate change are buffered.

SHORT PAPER BY HELENA AL-NABER

Eco Consult
Jude Centre, Salem Al-Hindawi St. Sheisani
P.O. Box 941400, Amman 11194
Jordan
E-mail: Helena.naber@eco-jo.com

1 Significance of Climate Change in Jordan

Jordan is one of the poorest countries in terms of water resources in the world. The Water Stress Index (WSI), developed by Malin Falkenmalk to serve as an indicator of water availability in a region, places Jordan in the category of Absolute Water Scarcity with a WSI of 327 m^3/capita/year in 1990, and an expected WSI of 121 m^3/capita/year estimated for year 2025. Moreover, reliance on groundwater and surface water resources for municipal, industrial and agricultural uses has greatly depleted available water resources, and has degraded the quality of others either due to increased salinity resulting from over abstraction, or infiltration of pollutants.

Numerous projects aimed at resource augmentation and demand management are being implemented, and many options for obtaining new water resources are being sought. Among these options are some expensive projects such as the pumping of water from the Disi aquifer in the south to Amman (a distance of approximately 400 km), and desalination options for Aqaba.

In light of the acute water problem, and the constant need to find solutions in order to satisfy the constantly increasing demands from municipal, industrial, tourist, and agricultural sectors, there is a general view that many other pressing issues concerning the environment in Jordan seem to fade: among these issues, are the issues of air pollution, desertification, loss of biodiversity, and climate change.

Nevertheless, the issue of climate change is of direct relevance to the issue of water in Jordan. Jordan depends mainly on precipitation within the country for rain fed agriculture, and for the replenishment of renewable surface and groundwater resources. Average rainfall ranges from 600mm/years in the northwest to less than 50mm/year in the south and eastern directions. The rainy season is between October and May, and 80% of the annual rainfall occurs between the months December to March.

It has been estimated that the present levels of precipitation are approximately 80% of the long-term average. Moreover, there is a shift in the rainy season, which begins later and the spring periods persist longer. It should be noted however that areas in Jordan are not affected in the same manner, in that areas receiving average annual precipitation of 450 to 600 mm/year seem to receive now 15% less precipitation than five decades ago, while areas that received 100-200 mm/year five decades ago now receive approximately 5 to 7% less precipitation.

The decreased amount of rainfall and the expected increase in temperature (a maximum highest recorded in July of 1998 in the Jordan Valley Ghor Safi area of 48.6°c), would affect the availability of water resources and the groundwater recharge which would further decrease the availability of renewable water resource.

Changes in temperature and precipitation are expected to affect a number of sectors, such as the agricultural sector where ensuing changes in water availability and resource management are expected to change the patterns of future crop production. Moreover, the prevalence of rain fed agriculture is expected to change in light of changes in the amounts of rainfall and a shift in the winter and spring seasons. Drought resistant crops will need to be introduced to withstand the additional stress from the changing climate conditions. In its turn, changes in agricultural mechanisms will impact the farmers and may lead to a shift of power towards more empowered farmers who will be able to afford the economic burden of the changing agricultural landscape.

Taking into consideration that only 9% of Jordan's area is cultivable and forests cover less than 1% of the total area, one of the main issues facing Jordan is desertification, resulting from the re-allocation of water resources from the needs of nature to anthropogenic needs, land use changes, and soil erosion. It is expected that changes in rainfall and increased temperature, would increase the desertification rate, especially in the semi arid areas and rangelands in the Jordanian Highlands, leading to an increase in the rate of loss of natural habitats, loss of species, and impacts on Jordan's wetlands.

Due to Jordan's location between four different bio geographic regions (Mediterranean, Irano-Turanian, Sudanian and Desert habitat), the country enjoys a high rate of biodiversity. However, there has been close concern over the protection of wildlife and biodiversity which is suffering due to a number of reasons, including: destruction of Eastern Badia ecosystem destruction caused by grazing, soil erosion, the loss of natural plant cover and the introduction of alien plants into the area; cutting of forest trees; expansion of urban areas into agricultural land, and overgrazing.

An important aspect of climate change is the social aspect. Changes in precipitation, temperature, extent of desertification, availability of water, will in its turn affect and be affected by such issues as population growth, and urban encroachment on agricultural lands, which further decreases the amount of water percolating into the ground. At present, Jordan has one of the highest population growth rates in the region, with a doubling time estimated at 19.3 years. The increase in population will not only increase the demand for water and land, thus putting even more stress on Jordan's natural resources, but will also contribute to an increase of Jordan's emission rates of greenhouse gases.

In addition to the environmental and natural resources problems that are facing Jordan, is Jordan's commitment in the Kyoto Protocol. One of the main issues is how to balance the need for economic and social growth, while at the same time abiding by the provisions of the protocol?

The effect that the Kyoto Protocol, once in force, will have on Jordan needs to be assessed as well. There is little available information now on what is taking place in other countries, and how will Jordan be impacted in terms of economy and environment. Moreover, the effect of the Kyoto Protocol on Jordan needs to be viewed in light of Jordan's other trade agreements such as its accession to the World Trade Organization, Jordan-US Free Trade Agreement, Jordan – European Agreement, and many bilateral agreements that Jordan is a signatory to.

The effect of climate change has also a political dimension. It is a common problem that affects many countries in the region, and finding the solutions for it opens new ways for scientific cooperation between the different countries in the region, especially where it concerns the Dead Sea and the Jordan River basin, for Jordan, Israel, and Palestine.

SHORT PAPER BY MAURICIO NINE

Ministry of Foreign Affairs
Department of Environmental Affairs
Esmeralda 1212, 14th floor, (1007)
Capital Federal
Argentina
E-mail: nmr@mrecic.gov.ar

1 Brief and General Overview of the Importance of Climate Change on Argentine International Negotiation Strategies and on the Decision-Making Process of Development Policies in Argentina

The main objectives of the Argentine Ministry of Foreign Affairs in the field of environment are:

- To promote the sustainable use of its natural resources;
- To preserve the resources and conditions which constitute the basis of its primary production;
- To generate the best possible market access conditions for our products and to avoid trade distortions and the incorrect use of environmental arguments for protectionism purposes;
- To take as much advantage as possible of the scarce financial and technological resources available in the international community to assist developing countries in their sustainable development policies;
- To receive from the international community the required resources to foster national scientific research and technology development in the field of environment.

Regarding climate change, there is sufficient scientific evidence to show that its impacts are not geographically equitable. In Argentina, for instance, we are clearly threatened by the possible evolution of the greenhouse effect predicted by most models used because most of our primary production depends directly on climate conditions. We therefore stand out as a country with high vulnerability to Climate Change.

On the other hand, we have great potential as regards development in the field of clean renewable energy sources, which implies an equally great potential to contribute to the global efforts to mitigate Climate Change.

The Environmental Affairs Department of the Argentine Ministry of Foreign Affairs, which is where I work, has the primary competence to deal with international Climate

Change negotiations and fora. All relevant stakeholders follow the negotiation processes closely through interaction with this Department. Briefings and work sessions are organized on a regular basis, both before Climate Change international meetings (to receive the inputs from these stakeholders when preparing our position and defining our objectives) and after them (to inform stakeholders about the results).

When dealing with Climate Change, this Department is well aware that responses to it must be aimed at the very heart of the way our industrial society is organized today and at the heart of our agricultural production practices. To summarize: any measure taken in response to Climate Change will inevitably affect many of our present unsustainable methods of production and consumption.

We also know therefore that it will take some more time and sound arguments to convince some "defensive" sectors – both at national and international level - that a proper response to Climate Change could also generate new economic opportunities and that it could entail possibilities for economic and technologic innovation.

In any case, any proposed solution to the threats of Climate Change will only be viable if it is "global". And the fact that any result of negotiations within the UNFCCC and other fora will have to be satisfactory to all Parts involved is what guides Argentine negotiators to permanently seek to facilitate agreements between developed countries (which have binding and specific commitments to reduce the emission of greenhouse gases) and the developing countries which make up the G77 + China.

Ever since the Climate Change negotiation process started, Argentina's main objective has been to promote the adoption of policies, measures and targets which aim to mitigate Climate Change in order to comply with the UNFCCC objective of stabilizing greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the Climate Change.

Argentina encourages the ratification of the Kyoto Protocol by as many countries as possible. In the World Summit on Sustainable Development (WSSD) held last year in Johannesburg, the Argentine delegation was very supportive of the proposal to include a paragraph calling for its ratification, which was finally included in the Plan of Implementation of the WSSD.

Argentina actively promotes the use of the financial and technology transfer mechanisms provided for in both the UNFCCC and the Kyoto Protocol. In doing so, Argentina works towards creating a scenario where it can benefit as much as possible from the emerging carbon market through the Clean Development Mechanism of the Kyoto Protocol.

The Department in which I work promotes the realization of Argentine emission reduction and/or carbon sequestration projects through its participation in the Executive Committee of the Argentine Designated Authority of the Clean Development Mechanism (Kyoto Protocol) and in the Board of the Prototype Carbon

Fund of the World Bank. Also, this Department organizes regular workshops on the formulation of this kind of project.

Argentina chaired the Subsidiary Body of Implementation of the UNFCCC during 2001 and 2002 and Argentine delegations integrated by officials from the Department I work in, always participate in the meetings of both Subsidiary Bodies of the UNFCCC.

Argentina also follows closely the work within the Intergovernmental Panel on Climate Change (IPCC). At present, Argentina holds the co-presidency of IPCC Working Group II on Impacts, Adaptation and Vulnerability. The Environmental Affairs Department of the Ministry of Foreign Affairs periodically organizes work sessions with the experts who take part in the regular work of the IPCC to assess its progress.

Argentina works to make sure that our national experts and government officials have an adequate level of representation in the various seminars, workshops and capacity building activities. The main objective of these efforts is to contribute to the various initiatives and projects which emerge from all the fora and institutions related to Climate Change and to acquire the knowledge and experience required for a full participation in the field of Climate Change which should lead to fair and equitable benefits for all countries.

SHORT PAPER BY G. SRINIVASAN

Department of Science & Technology
Earth System Science Division
Technology Bhawan
New Delhi
India
E-mail: srinidst@alpha.nic.in

Climate Change: the Indian Scenario

India and the tropical region are unique in the context of climate change and its impacts both in terms of science and in terms of the human dimensions. The warmest sea surface temperatures over the globe occur over tropical oceans, which drive vigorous circulations resulting in the heaviest rainfall amounts observed on earth. Most of the countries in this region are developing and in the low-income category where major percentage of the population is agrarian and pastoral. Subsistence economics in the tropical region is predominantly biomass based with most of the day spent in fodder and fuel collection, animal care and grazing. Lives of people in this region are therefore intimately and critically dependent on the environment and natural resources that can be impacted by climate change. India has witnessed a transition from a predominantly rural based agrarian society to a diversified economy during the past fifty years. Informal and traditional sectors with weak markets co-exist with growing formal and modern sectors. Long-term environmental concerns will therefore be dictated by future dynamics of energy consumption and technology selection in various sectors.

At present our understanding of the impact, particularly at regional and micro-levels is poor, our observational network and inventory of carbon emissions and other GHGs insufficient, our data base inadequate especially in terms of impact on diverse sectors of the economy and even our models far too global and generic to enable a proper scientific assessment. At the policy level, the scientific inputs which should feed into policy making are not available and even if available are too academic and abstruse to make a difference to policy makers. As a consequence policies do not factor in climate change impact issues at all. Technology development is still dominated by conventional concerns. Even those concerned with environmental and ecological degradation have an insufficient understanding of the long-term consequences of climate change.

In the Ministry of Science and Technology we have been deeply concerned that insufficient attention has been paid to building scientific & technological capacity in response to climate change. There is an immediate need to re-orient our science and technology to respond to the threats of climate change, and build our capability to deal with issues of environment. Such efforts will also enable us to interact more effectively at international fora, where participant countries agree on a common course of action. The present initiative by the Department of Science and Technology to evolve a concept for establishing an International Center for S&T Capacity Building in Climate Change represents a first step in a series of efforts needed in this direction.

SHORT PAPER BY NENI SINTAWARDANI

Ministry of Research, Science and Technology
Deputy Minister for Research, Science and Technology Development
Jl. MH. Thamrin 8
Jakarta 10340
Indonesia
E-mail: nenisintawardani@lipi.fisika.net

1 An Overview of the Importance Climate Change in Indonesia

Over the last few decades, research in the natural sciences has unveiled a number of specific complex relations between human activity and environmental change on a global scale. Many scientific assessments confirm that global life support systems, such as climate, biodiversity and water resources, are significantly affected by human activities.

Societies face the need to develop creative response strategies. Most effective would be a reconsideration of the ways and means by which we meet our primary human needs in the field of energy, food, water, shelter, transport, etc, as these activities are responsible for much of the global environmental change we are witnessing. But this is easier said than done. A major part of the world's population is struggling with fulfilling even basic needs, while the more wealthy part is hesitant, not to say reluctant, to reconsider the systems of production and consumption that brought them prosperity.

Climate change is one of the global environmental problems that has attracted much attention among scientists, including economists, and they have provided policy makers with many contrasting recommendations. Fossil fuel combustion for energy generation is still increasing. The concentration of greenhouse gases in the atmosphere (mainly carbon dioxide, but also nitrous oxide, methane, hydrofluorocarbons, etc.) results in global warning. Common scenarios forecast a doubling of CO_2 emissions before the end of the 21st century, and this is expected to lead to an increase in the average global surface temperature by 1 to 6 degrees material wealth worldwide make this scenario not unrealistic.

When calculating the cost of climate change, the current scientific understanding is grossly insufficient to provide an overall estimation of the costs of the many complex damages associated with climate change. These complex damages include loss of coastal zones due to sea level rise, loss of biodiversity, spread of vector-borne diseases and the occurrence of extreme climate events.

For example, in the last 5 years, the burning tropical forest in Indonesia results i.e.:

- Haze/smoke that can affect the local and regional and global climate;
- Loss of biodiversity of plants and animals;

- Increase of poverty.

Resource conservation remains a burden on economic growth, although the magnitude of the burden is subject to discussions. Some people fear that the costs of resource conservation are progressively increasing for future generations. The output and wealth generated by the economy depend on the set of technologies in use for production, which is only a small subset of all potential technologies available. Through research we slowly advance the set of available technologies, often referred to as our knowledge stock. Some technologies are environment friendly, compared with others that cause pollution. For a sustainable future we will have to search for technologies that increase resource intensity of production.

Without the institutional linkage and networking in the aspect of global climate we have difficulties to forecast or predict the occurrence of natural phenomenon such El Nino or La Nina that affected our food availability. That is why the scientific community must highlight a new set of challenges, particularly the need for:

More and better science;

Long-term perspectives;

Broad-based, participatory approaches to research;

Capacity building and communication and

Education and communication.

SHORT PAPER BY LEIDY PEDRE SIERRA

Department of International Collaboration
Ministry of Science, Technology and Environment
Havanna
Cuba
E-mail: leidy@citma.cu

Brief Assessment of the Importance of Climate Change, in particular, by Decision Makers

One of the subjects which is discussed with greater intensity in different international environmental forums is the Climate Change, mainly the adverse effects of this phenomenon on small insular states - territories that are among the most vulnerable - in different sectors like agriculture, natural ecosystems, water resources, coastal areas, population, health and tourism.

The most recent studies have demonstrated that the present situation of the climate at global level far from improving has got worse. The small insular states, as it is mentioned previously, are the most vulnerable to take the negative hits of this phenomenon and to a great extent they are those more seriously affected by the increase of the sea level.

The archipelago of Cuba, located in the western zone of the Caribbean Sea, between North America and Central America, is integrated by the Island of Cuba, the Island of the Youth and more than 4195 of keys. It is not free of Climate Change effects, and it has been affected during the last years by an increase of skin temperature of the air, greater frequency of severe droughts, increase of rains during the winter, a greater influence of the El Niño/South Oscillation effect, increase of the cyclone activity, etc.

The phenomena previously described not only exert a negative influence on Cuba but also on other territories with similar characteristics. On these bases, it becomes essential that our countries take immediate measures to fight the adverse effects Climate Change exerts on our territories, which influence, to a great extent, our sustainable development.

Cuba has undertaken directed actions to fight the problems caused by Climate Change: the fortification of its legislative framework, the creation of national discussion groups on the impact of Climate Changes, mostly about the elevation of the sea level, the implementation of a national strategy directed to the development and promotion of renewable sources of energy such as wind, solar, biomass and hydro- for the sake of replacing fossil fuel, etc.

The recognition of the present Climate Change situation, as well as the debates taking place in many international forums force us to take measures on the subject in the different areas that are under our attention. Scientists have to be conscious of the gravity of this phenomenon, and decision-makers have to remain alert about what happen in each debate and negotiation that are being developed, and in particular, have to know how to identify the opportunities that allow us to fight such a phenomenon.

Hence, decision-makers should understand the importance of creating capacities, recognising the present state of the climate, the impacts that climate change exert on our social-economic development, the measures of adaptation and mitigation, as well as the knowledge to recognise and to identify the opportunities that have been developed during the last years through different international forums. The knowledge of these issues will help in the elaboration and development of integrated strategies, able to respond to the real conditions of our countries.

It is important that decision-makers are conscious of the problem and that at the same time they are able to direct activities aimed at solving the problems caused by Climate Change, in the short and long term.

In addition, it becomes essential to identify suitable technologies for such aims to be able to access such sustainable technologies.

The main actors involved in questions related to Climate Change and the governments, in general, must recognise the necessity to adopt the international instruments such as the United Nation Framework for Climate Change, as well as the Kyoto Protocol that has not yet taken into effect, among others.

It is important that our countries recognise the Clean Development Mechanism, as one of the most important economic tool provided by the Kyoto Protocol, which could enable the transfer of sustainable technologies from Annex I countries to Non-Annex I countries.

It would be praiseworthy to emphasise that the measures that we should take must not be limited to the national level, but must be taken at a regional and international level, considering that the Climate Change is not limited by countries' borders. At the same time, the importance of international collaboration must be recognised.

SHORT PAPER BY FLORENCIA B. PULHIN

Forestry Development Environmental/Environmental Forestry Programme
College of Forestry and Natural Resources
University of the Philippines Los Banos College
Laguna
Philippines
E-mail: enfor@laguna.net

Climate Change and the Forests of the Philippines

The Philippines is one of the Southeast Asian countries within 5 to 15^0 latitude. It is composed of approximately 7,100 islands covering about 30 mill. ha. The climate is humid tropical with rainfall between 2000 to 4000 mm in most areas. Of these total land area, 16 mill. ha are classified as forestlands. These do not necessarily contain forests because most of these areas had undergone various conversions in the past. About 5.4 mill. ha remain as natural forests consisting of primary dipterocarp forests, secondary forests, mossy forests, pine forests and mangrove forests. Primary or virgin forests cover 0.8 mill. ha while secondary forests cover 2.7 mill. ha. About 10.4 mill. ha are highly degraded grassland areas and swidden farms.

Tropical forests like the forests of the Philippines play a vital role in climate change mitigation. Various experts claimed that they store huge amounts of carbon. Calculations made by the Environmental Forestry Programme of the College of Forestry and Natural Resources, University of the Philippines Los Baños revealed that in the protection of forests, around 159 million tons of carbon are stored in the aboveground biomass. In addition, they are able to sequester about 2.1 Mg/ha/yr. The main value of the protection forests in relation to climate change is that they keep their carbon intact. Thus, it is important that these forests are protected.

In secondary forests, around 412 mill. tons of carbon are stored in their aboveground biomass. In terms of carbon sequestration, secondary forests are able to sequester 6.5 Mg/ha/yr. On the negative side, however, it is estimated that second growth forests releases the following amount annually: harvest (0.3 mill. tons) and deforestation (8.8 mill. tons).

Brushland areas in the Philippines compose of 2.3 mill. ha. Based on estimations, brushland areas store around 67 mill. tons of carbon in the aboveground biomass. It is noteworthy that this type of forests have lower storage capacity. However, it is able to sequester about 9.4 Mg/ha/yr.

Tree plantations are established in denuded areas of the Philippines. This is the main strategy that the Philippine government is using in rehabilitating degraded areas. Usually, fast growing species are used in tree plantation establishment. Based on current forestry statistics, existing tree plantations in the country contain total carbon in the aboveground biomass of 30 mill. tons. Rate of aboveground biomass of this type of land use is 11.1 Mg/ha/yr.

In the Philippines, people inhabit most upland areas. As a result, establishment of community-based projects through the use of agroforestry technology is the usual strategy of the government to keep the remaining forests intact. It is estimated that there are 5.7 mill. ha of agroforestry farms in the Philippines. This area includes both forest-tree based farms as well as coconut plantations and fruit orchards. Thus, carbon stored in the aboveground biomass of agroforestry farms is 297 mill. tons. The rate of aboveground biomass in this type of land use is 6 Mg/ha/yr.

Grassland areas in the Philippines comprise of 1.18 mill. ha. Based on this statistics, there are 15 mill. tons of carbon stored in the aboveground biomass of this land use type. However, in terms of annual rate of sequestration, grasslands do not sequester anything because it is regularly burned.

Overall, Philippines' forests are potential sinks of carbon dioxide. Thus, they are very important in the issue of climate change.

In terms of impacts of climate change to Philippines forest resources, a number of likely changes in the forests have to be outlined:

- There will be more conversion of forested lands into agriculture areas. The decreasing arable lands will bring this about because these areas will be drier when climate change occurs. Thus, farmers will convert forested lands into cultivated areas;
- Precipitation will increase during wet months and will cause serious soil erosion and flood problems in denuded areas and watersheds covered with grasses. This will further decrease productivity of these areas;
- Grasslands and shrublands will be more vulnerable to fire because of increased temperature and decreased rainfall;
- Decrease in biodiversity may occur as a result of increased temperature. There will be movement of tree species to higher elevation causing extinction of species requiring cooler temperatures. Thus, biodiversity of fauna is also expected to decrease;
- Mangrove forests will be severely damaged because of siltation due to increased soil erosion in the upland areas;
- Occurrence of pest and diseases is expected to increase as a result of warmer temperatures. This will result in a significant decrease in the species composition of the forests

Thus, adaptation strategies must be formulated to prepare for the likely impacts of climate change. Policies and programs that will fully support these strategies must be put in place.

SHORT PAPER BY BALGIS ELASHA OSMAN

Higher Council for Environment & Natural Resources (HCENR)
HCENR-Gamma-Street
10488 Khartoum
Sudan
E-mail: balgis@yahoo.com

1 Adaptation Opportunities, Barriers and Strategies

1.1 Definitions

1.1 **Sensitivity** is the degree to which a system will respond to a change in conditions.

1.2 **Vulnerabilit**y defines the extent to which a change in conditions may harm a system. It is a function of both the system's sensitivity and its ability to adapt.

1.3 **Adaptation** refers to "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities"

1.4 **Adaptability** defines the extent to which adjustments are possible in a system, in response to an actual or projected change. Adapted from IPCC (1995) .

1.5 Types of adaptation:

1.5.1 Autonomous, (in the absence of planning)- cost of residual damage is higher

1.5.2 Reactive, incremental - need for a catalyst, e.g. environmental catastrophe to trigger the adaptation.

1.5.3 Planned adaptation (appropriate planning decision is made). Planned adaptation relies on a deliberate response to identifiable impacts resulting from the effects of climate change

2 Common Themes when Developing a Strategy for Adapting to Change

- Vulnerability to change is determined by the frequency and magnitude of extreme events and not on average events or changes in average events;
- Adaptations to current climate risks are generally consistent with adapting to future changed conditions, so we can usefully deploy them now;
- The capacity to adapt varies by region and through time;
- The enhancement of the capacity to adapt is necessary to reduce vulnerability;

- Developing countries have lower adaptive capacity (IPCC 2001);
- Coping capacity can improve where people have financial resources, access to technology, high levels of education and training, good health, security, strong institutions and effective organisations;
- Climate adaptation strategies are simply a form of risk management and are best implemented if they are a component of or a modification to an existing management programme.

3 Opportunities

3.1 Macro-scale opportunities

Increasing frequency and intensities of climate threats may generate commitment from governments to take actions to enhance adaptation to climate change. The development of the Adaptation Policy Framework: A Guide for Policies to Facilitate Adaptation to Climate Change can improve the knowledge, societal awareness and government's preparedness.

3.2 Micro-scale opportunities

A rich history of community-based coping strategies exists, which can be supported and built upon to increase community resilience and adaptive capacity.

Numerous projects exists which have successfully increased community resilience to climate impacts; these too can be supported, built upon, and scaled up, to increase community resilience and adaptive capacity.

4 Barriers

4.1 Examples of macro-scale barriers

Significant challenges exist in developing adaptation strategies, due to such factors as uncertainties in climate change science related to extent and rate of climate change impacts.

- Difficulties in ascertaining necessary timeframes for adaptation, and institutional barriers to adaptation;
- Knowledge uncertainty, arising from our incomplete understanding of the interaction between natural and human processes. Awareness and recognition of climate threats by policy makers can assist in putting adaptation and long-term planning on the economic development agenda;

- Relief dependency, (donors providing support and food stocks to drought stricken communities – without addressing the root causes) this may increase the vulnerability to future disasters;
- Lack of broad powerful integrated strategies addressing issues of adaptation to climate change;
- The divergence between the priorities determined in global negotiations and local-level priorities;
- Little research work on the practical application of policy measures for adapting to climate change.

5 Examples of micro-scale barriers

- Compounding problems of poor/worsening local conditions (e.g., land degradation, social network breakdown);
- Lack of community resources (financial, human, social, etc) to enhance own resilience;
- Lack of local institutional capacity and resources to support community resilience-building.

6 Adaptation Strategies in Sudan

6.1 Examples of strategies for macro-scale action

- Ensure that the evolving policy framework is built on enhancing the capacity to manage forthcoming change rather than allowing stagnation and the emergence of barriers to adaptation;
- Incorporate adaptation into national and sector-specific development planning;
- Link the adaptation plans to specific community development objectives to make them more attractive options for policy makers and development planners;
- Maintain synergies between the UNFCCC and related environmental conventions, especially Biodiversity and Desertification, in relation to adaptation and coordinate the implementation of their respective national strategies and action plans.

6.2 Examples of strategies for micro-scale action

- Understanding the processes, priorities and dynamics of local communities before formulating practical adaptation strategies;

- Identify and share lessons from successful community-based resilience-building experience – both autonomous and project-based (AF-14 project goal);
- Channel resources from the national adaptation process (capacity building activities, financial support, etc) to local organizations capable of facilitating and supporting community-based resilience-building activity;
- Explore means for harmonizing the adaptation policy developed at the community level with nationally developed policies, i.e., focus more on community–driven adaptation measures, assessing of traditional knowledge and practices evolved upon exposure to past and current extreme climatic events, analyse the enabling environment that supported the development of this knowledge.

7 Challenges

- How to ensure that the evolving policy framework is built, enhances the capacity to manage forthcoming change rather than allowing stagnation and the emergence of barriers to adaptation?;
- How to incorporate adaptation into national and sector-specific development planning?;
- Prescribe specific frames for adaptation plans to make them look more attractive options for policy makers and development planners;
- Understanding the processes, priorities and dynamics of local communities before formulating practical adaptation strategies;
- How to deal with difficulties in integrating policy measures for adaptation into an existing, policy framework with multiple drivers and demands on resources?

SHORT PAPER BY OLOGUN R. OLUGBENGA

Town Planners Registration Council of Nigeria
P.M.B. 7012, ADCPA P. O. Area 1
Garki-Abuja
Nigeria
E-mail:olurolands@yahoo.com

IMPORTANCE OF CLIMATE CHANGE IN NIGERIA

Climate, a product of weather components over a long period of time (over 10 years) is very important in the economy of Nigeria. A climatic element that comprises temperature, rainfall, humidity amongst others is by no means minute in shaping Nigeria's economy. Especially, as Nigeria is both an agrarian economy as well as a developing country whose fate hinges above average on climatic elements. Any slight change is usually a disaster.

The main areas amongst others where climate change has significant impacts on the physical, economic and environmental condition of Nigeria include the following:

- **Agriculture:** The vicissitudes of frequent climate change has impacts on Nigeria's agriculture leading to crop failures, animal mortality, deforestation and drought. This is manifested in frequent temperature, wind and seasonal changes in the environment.
- **Health:** Many lifes had been lost and many continue to be lost due to inclement weather through high and low temperatures. Heat and cold related diseases such as meningitis have led to the death of many people.
- **Production:** The mainstay of both industrial and domestic production in Nigeria is energy. It derives about 95% of its power supply from Hydro-Electric Power (H.E.P.) generation. H.E.P. generation is dependent on water level in its various water dams. Climate change has resulted in the collapse of water turbines due to unpredictable water levels.

  The resultant effect of this is that scarce foreign reserves are used in importing heavy duty electricity generating sets for both industrial and domestic use. The carbon generated by these worsens the ozone layer in the atmosphere, which in turn aggravates climate change. Again, at the domestic level, trees are felled for charcoal and firewood for cooking purposes. This brings about deforestation and extinction of natural habitats, a contributor to climate change.
- **Communication/Transportation:** Climate changes have worsened visibility of vehicular transport and aircrafts. Flight cancellations, road mishaps and air disaster occur due to sudden change in visibility due to weather (Climate) changes.

The areas mentioned above are some examples how climate change affects the life and economy of Nigerians and Nigeria respectively.

Climate change study would enormously be useful for someone like me, a training facilitator by virtue of my employment. This opportunity, if granted, would enable Nigeria and Nigerians be let off the hook of problems that climate change bring.

SHORT PAPER BY MONICA B. WEHBE

Universidad Nacional de Rio Cuarto
Facultad de Ciencias Económicas
Ruta Nac. 36, km 601
X5804BYA Rio Cuarto
Argentina
E-mail: mwehbe@eco.unrc.edu.ar

Importance of issues related to Climate Change for the "South of Cordoba"(Argentina)

It is widely agreed that climate change is, among others, a consequence from human activities and that man will be affected because of it. His environment will change and he will need to adjust to it in order to maintain his different life styles. *Impacts* from climate change could differ between regions and groups, the same as their *vulnerability* levels and their capacity of *adaptation* to it. However, there still exists lack of information regarding these three aspects in many regions of the world.

At the same time, it is increasingly recognized that the vulnerability of agricultural populations cannot be solely understood through quantification of biophysical impacts. Rather, socio-economic and institutional factors can play an equal or even greater role in determining how particular populations will be affected by climatic events and change, and how such populations will be able to respond and adapt. The process by which farmers make decisions to manage the multiple risks they face is central to vulnerability assessment.

There were two main issues at world level that affected agriculture. Since 1975 a new technological paradigm has become one of the main characteristics on the international economic scene, turning the meaning of comparative advantages (based on natural resources being possessed) into one of competitive advantages, those which can be created (based on industrial processing and services). Thus the non-industrialized agro-exporter countries had a great loss in international markets that has been mainly developed on manufactured goods. Another fact was the international crisis that took place in the first half of the 1980's and had affected international markets of primary goods: a severe and persistent fall in commodity prices, basically as a consequence of protectionist and subsidized policies in the most developed countries, based also on new technological changes.

At the national level, the 1980's ended with an internal crisis, inflationary pressures and high indebtedness levels, affecting basically relative price structures between sectors (mostly against those internationally traded goods). Since the beginning of the 1990's the economic reforms – attached to structural adjustment policies - implied: new state roles, privatisation of state enterprises, economic deregulation (mainly related to the agricultural sector), liberalization of trade, and a price stabilization plan based on a fixed exchange rate.

In the “South of Cordoba”, a region - sub-humid pampas in the central part of Argentina - which economic productive base is highly dependent on agricultural production, transformations that took place during the 1980’s and 1990’s at macro and sector levels as a consequence of both global and national trends made mainly small and medium size primary producers to fall into a very precarious situation. At the same time the policy context has allowed increasing agricultural commodity production, although economic growth was uneven among different goods being produced and among producers. Access to resources became more and more difficult for medium and small size farmers who currently relay on their own means to adapt to impacts from climate and institutional change and variability.

Capitalist family farming in the region has been possible in the past by the availability of good soils, access to land, availability and access to technology, infrastructure (roads, railroads, markets an services in general), public technological institutions and economic policy that, with its ups and downs, favoured enterprise’s and family’s reproduction.

Since the beginning of the 1980’s that situation rather changed, deterioration of relative prices for agriculture added to the increase of its fixed cost of production and reduced its income purchasing power. The consequence, called forth from the international and national levels, was a weak financial and economic position and high levels of indebtedness for many small and medium size farms. The need to increase production scales allowed an important process of land property and tenancy concentration4, which in sum became translated into:

- Differentiated technology access. New technologies are not incorporated mainly as capital inputs and free knowledge are disappearing;
- Differentiated market access. The most direct and new commercialization channels are not accessible to individual small and medium size farms;
- Differentiated credit access. With the restrictions of direct credit for the rural sector and higher levels of indebtedness it is almost impossible to get money for small and medium farms;
- Deterioration of cooperative systems. Almost every cooperative has disappeared due to unintended outcomes;
- Land deterioration. Agricultural intensification and monoculture, differentiation between landowners and entrepreneurs and short contracts make land deterioration and yields diminish.

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4 By 1999 the average farm size was of 553 hectares; below this there were the 76% of total agricultural producers with the 28% of the land, and above that average there were the 24% of total producers with the 72% of land.

Increasing evidence that economic growth does not necessarily implies a parallel in sustainable development has come to awaken interest of social, economic, environmental and political scientists of our region in determining and analysing which factors contribute to these processes. Sustainable development refers to the possibility of achieving economic growth within a frame of social equity and based on an efficient use of natural resources in the short and long run. Achieving these goals –altogether- is usually threatened by different factors coming from outside and inside the unit of analysis. In relation to climate variability and change, it will be useful to adopt a notion of vulnerability that relates it to the possibilities or constraints to cope with or recover from the exposure to a number of adverse events while *sustaining development* whether at sector, local or individual (household) levels.

In this sense assessment of social vulnerability to climate variability and change must take into consideration how previous development patterns may have produced particular adaptations, which in turn have affected production and producers' vulnerabilities today and how this in turn will affect agricultural development in the future. Populations that are currently highly vulnerable tend also to suffer from a degrading resource base (after consecutive losses) that in turn affects their vulnerability conditions in the future. For policy concerns, it is important to determine the factors that constrain adaptation that are intrinsic to the development context, recognizing that it is not only climate that drives adaptation and affects impacts but also the development context in which production takes place and how agricultural producers manage to pursue a particular livelihood strategy.

Rapporteur feedback and working group papers

RAPPORTEURS' FEEDBACK ON DISCUSSIONS HELD ON 8 SEPTEMBER

BY

G. SRINIVASAN[1], INDIA

1 Session on Science of Climate Change

In all three presentations made during this session the topics covered were GHG emission trends and future scenarios; climate change observations and modeling, and Impacts. Following main points emerged during discussions:

- There are compelling observational evidence and supporting evidence from model simulations that are indicative of climate change taking place. There is an urgent need to respond to these changes to mitigate and adapt to their damaging influences;
- Some science issues are however open to questioning and further investigation. Some examples where there is scope for further work are areas like the regional role of vegetation as net carbon sources or sinks and need for further observations and analysis of trends in the southern hemisphere;
- Emission scenarios present story-lines of possible future development in the time span of 50-100 years. The scenarios would also derive consequences at the policy level. Developing country perspectives may differ, particularly on interpretation of globalisation vs. regional efforts, sustainability and equity issues;
- Backstopping policy with well researched science inputs is important for environmentally oriented development decision making process. Awareness creation and capacity building for mainstreaming issues into national development plans, and action oriented science were some of the methods suggested;
- People-first and problem oriented approaches based on analysis of individual cases are perhaps preferable. Merits of bottom-up and top-down approaches need to be considered. For vulnerability and adaptation bottom-up may work better, and top-down may work better for mitigation efforts. Need to take up top-

[1] Department of Science & Technology, Earth System Science Division, Technology Bhawan, New Delhi

down and bottom-up approaches when one is addressing Vulnerability & Adaptation issues;

- Precautionary principle i.e. to develop strategies to cope with current adverse situations and to build capacities to bear the consequences of the future were stressed;
- Necessity for an integrated approach to link Vulnerability and Adaptation studies with the MDG and to see how AR4 will address these issues;
- Need to encourage and find methods and approaches for sustained capacity building efforts to address climate change issues;
- Cooperation and capacity building for using regional climate models to understanding local climate change impacts. Discussion on scope for cooperation and capacity development for use of regional climate changed models to able to conduct targeted impacts research studies;
- Scientific methods to distinguish human induced changes from the natural changes in climate.

RAPPORTEURS' FEEDBACK ON DISCUSSIONS HELD ON 8 SEPTEMBER

BY

MP DE WIT[1], SOUTH AFRICA

2 Session on Policy of Climate Change

Papers presented were:

- The Political context of Climate Change – History and State of the Negotiations, Dr Enno Harders and
- The Relevance of Climate Change Negotiations for Developing Countries, Prof C Dasgupta.

2.1 Prelude

It was almost 18:00 after a long and intensive day of teaching, listening and participation. To add to this the chairman in his closing remarks mentioned the word "dinner". I volunteered to report on the key points raised in the above presentations as well as in the ensuing discussion, but it became crystal clear that a different strategy was needed to keep the attention of the participants. It is one of combining scientific fact with what one might call "rapporteurial licence" - if such a word exists. This is a slightly adjusted and written-up version of it.

2.2 A dog's life

One day in 1988 a couple, named IC and DC[2] overlooked the global village from the porch of their home. Over the hill came of creature, it looked like a kind of dog but they were not sure. They were convinced that this creature needed attention and called it closer. They decided to call it a dog, named CC[3]. The more they kept looking at it, they started realising that this is a very particular kind of dog...

[1] CSIR, Environmentek, Environmental and Resource Economics Group, PO Box 395, Pretoria, 0001, South Africa.

[2] Industrialised Countries (IC), Developing Countries (DC)

[3] Climate Change (CC)

Key issues

The IPCC was created in 1988.

At first climate change (CC) was treated as an environmental issue, it soon become apparent that energy production and consumption is an integral pat of it, as well as economic, social and political issues. It is a global problem impacting on all spheres of human activity.

Comments

The nature of this problem keeps changing. Earlier presentations and discussions did refer to the fact that the IPCC bases its work on the best available scientific evidence. What if this evidence fails to include most of the "action-orientated" research focussed on issues regarding poverty and the environment, as mainly exercised in developing countries (DCs)?

With some hesitation they decided to take care of it. At least IC, but DC did support IC in building a dog-house and provide some toys to play with. And, they agreed on the fact that CC is now part of their household. There was no turning back.

IC and DC started talking: what must this dog be taught? Well DC said, we have

Key points

- International organisations and institutions were created with tight reporting formats and responsibilities. The UNFCCC was ratified by most of the world's nations, opening the door for a Secretariat in Bonn, an annual Conference of Parties where outstanding issues regarding climate change can be discussed, and mechanisms by which scientific inputs can be given to various processes (SBSTA, SBI).
- These achievements provided the framework wherein climate issues can be addressed.

Comments

- The benefits of this intensive process will come increasingly under scrutiny, especially if it starts showing signs of failing to deliver a global agreement on how to deal with climate change

differentiated responsibilities and you have to take responsibility for CC and help me adjusting to him being around here. And, yes, it might be helpful if you commit to something upfront on what you want to achieve with CC. So said so done, a specific time schedule was added to the households chores where IC and DC have some chats about CC and what to do with her. After a while they agreed on a blueprint. It took some time to reach this stage as CC proved not to be the average dog. After many quarrels, IC and DC still do not agree on the details embedded in this blueprint. However, they did agree on some training schedule: CC must be a leaner and better dog – something they want to be proud of. A vet was called in helping to design a flexible way to achieve this.

It was just after this that IC got a stroke and lost 36% of functionality. While DC as going on with life, IC got increasingly frustrated with CC, but never came to the point of abandoning the poor dog. The rest of IC's functioning system was telling that it is just not the right thing to do. The persistence seems to be rewarded: there is even hope that the blueprint will be accepted by year-end increasing the chances that CC will now be handled with all the attention it deserves.

Key points

- Dates and standards were set wherein representatives from industrialised and developing nations could meet annually to discuss progress on the UNFCCC.
- In 1997 the Kyoto Protocol was adopted, further formalising the flexible mechanisms (AIJ, CDM and emissions trading)
- The United States withdrew from the climate change negotiations and the Kyoto Protocol in 2001
- The required 55 states or the number of states accounting for 55% of the 1990 Annex I CO_2 emissions, ratifying the Protocol is, as yet, not met. Some optimistic insider information is that this will be achieved by year-end.

Comments

- Will the existing compliance system under the Kyoto Protocol, and the penalties proposed under these, be transposable to a world that moved beyond the first commitment period in 2012?
- There is some evidence in the US of decoupling econ growth and CO_2 emissions, without making use of flexible mechanisms – what are the lessons and how did this inform the US position on the Kyoto Protocol?
- Do flexible mechanisms will be able to help the masses of increasingly marginalized poor people in developing countries?
- How will rules regarding baselines and additionality (environmental and/or project) be handled? And sinks in the CDM?

Some time before these unfortunate events, IC and DC had serious discussions about how to measure the dog's performance. This came to good effect when CC was taken to the supermarket in its first ever walk away from its home. The erratic mood swings of CC proved to be a main source of embarrassment for IC. The lean and mean pills just do not seem to really make an impact, and the vet has indicated that tangible results should be booked quite soon, or otherwise new strategies need to be devised.

Key points

- EU trading scheme operational by 2005
- Some EU nations close to meeting targets (e.g. Germany, Sweden), but some other nations in EU very far of (e.g. Greece, Spain)
- Some developing countries have shown evidence of national environmental programmes
- Expressed need to win the US back onto the Kyoto Protocol.
- Annex I countries agreed to a 5% reduction of carbon dioxide by 2000 when compared to 1990 levels and that some demonstratable progress should be booked on flexible mechanisms by 2005.

Comments

- Although initiatives have been taken, emissions markets are thin and risky, especially with uncertainty regarding the international agreements on the Kyoto Protocol and the force of international law in such a complex area.

Then DC start thinking again about whole idea of getting CC in the house: "IC, we have agreed that you should feed CC and take care of it. After all, it was you who brought the animal in the house..". But DC is not so sure anymore, and starts thinking about these principles they have agreed on some years ago. DC tries to make a compelling case, that whatever happens, DC will in any case not be responsible or capable to take jointly take care of CC. And yes, please remember that CC is causing many problems, not least that DC's health starts deteriorating. But IC will not budge: "what we have agreed upon many years ago must be re-evaluated. We live in a dynamic world, please be a bit more … understanding. I have had enough taking care of CC all on my own." DC continues to point to their agreement that DC was never meant to take care of it anyway. Furthermore, did IC live up to the expectations to make CC a dog one can safely take with you to the supermarket? But, despite feeling sure about the facts, DC starts feeling uneasy, why does IC bring this up in the first place? They all know that if IC does not get well soon, the chances of having a good CC may never happen anyway.

DC feels it is time for a moral lesson and calls their little boy ic/dc in the room: "Boy, if you ever have choice, please do not take a dog in your home." He replied: " Well, if you and IC can stop bickering on how to educate CC, please do so. I like the dog, as a matter of fact I have start calling him C - it just sounds better."

Key points

- Developing countries in general have:
    - Low per capita income
    - Low per capita GDP
    - Higher vulnerability to climate change
- Developing countries expect from industrialised countries:
    - To bear the full burden of mitigation (equity)
    - To address adaptation issues (moral and legal obligation)
    - Implement mitigation in DCs if incremental costs are borne b y ICs

Comments

- There are some powerful exceptions to the general issues binding DCs together, these exceptions (Petroleum dependant economies, DCs with high per capita emissions) will certainly test the principles of IC commitments agreed upon in the UNFCCC
- It may be worth to examine the scenario that IC will default and agreements under the UNFCCC will not hold. In what position will that leave DCs?

RAPPORTEURS' FEEDBACK ON DISCUSSIONS HELD ON 9 SEPTEMBER

BY

V. KUMAR[1], INDIA

3 Session on Mega Cities and Emission Limitation in the "South"

3.1 Mega Cities

3.1.1 Introducing Speech

Ms. Pauline Midgley of University of Stuttgart made a presentation on mega cities and Climate Change. Her presentation covered both the aspects – how does growth of mega cities contribute to climate change and also how climate change would impact mega cities. According to Ms. Midgley there were only 38 % city dwellers but this number is projected to rise to 66 % by 2030. Mega cities are defined as cities having as population more than 10 million. In 1950 there were only 3 mega cities but in 2000 this number grow to 15 and is further projected to grow to 25 by 2030. Globally there is a trend to urbanisation, which means movement of resources, and population to urban centres. This is more prominent in developing countries. Urbanisation has economic, social and economic impacts.

Ms. Midgley presented a balanced approach by bringing in the positive as well as negative aspects of climate change. Whereas mega cities are responsible for various social and environmental problems, health, education and poverty, it opens the gate for global cooperation and business opportunities. She was of the opinion that with appropriate planning and legislations, the problems associated with mega cities can be taken care of.

3.1.2 Discussions

People asked if there were different ways mega cities were growing into and if the advantages and disadvantages of their different ways have been analysed.

Some examples of the role of appropriate policies in growth of mega cities were presented in terms of public transport and traffic management from China and Mexico City. There was a question if one can define an optimum size for mega cities, which can maximise benefits and reduce disadvantages.

Some people in the audience demanded that while developing a city sufficient space should be left for its later growth and expansion. However, in general, due to lack of space it is not practised.

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[1] The Energy and Resources Institute; Darbari Seth Block Habitat Place, Lohdi Road; New Delhi

A peculiar concern raised was that the growth of mega cities might take an altogether different route than the one projected as present, due to a paradigm shift in information and communications technology.

3.2 Emissions Limitation: Views from the South

3.2.1 Presentation by Dr. Sokona

Mr. Sokona was of the view that for Emissions limitation the two most important issues were:

- Integrating local and global issues and
- Reversing development paradigm.

The process would include following:

- Equity within and between generations;
- North-south cooperation;
- Strategic vision of society's future in short, medium and long term.

The UNFCCC is the centrepiece of the process of emission limitations and it requires global cooperation in terms of financial assistance, technical assistance and capacity building.

Mr. Sokona discussed what kinds of opportunities were available for developing countries in a climate change and sustainable development paradigm. He also discussed the opportunities that the developing countries could offer to industrialised countries for global cooperation in emissions limitation. According to Mr. Sokona, for industrialised countries the environment is more important and drives the sustainable development, whereas for developing countries the development is more pressing and drives sustainable development. He highlighted the view that among developing countries also there are various categories and it were the EIT, NIC, EC, MIC & LIC providing maximum opportunities in terms of emissions limitation. The least developed countries were the least likely to provide any sector for emission limitation.

According to him the expectations of the south regarding emissions limitation are

- New sources of financial assistance investment to promote sustainable development while mitigating emissions;
- New channels for promoting transfer of environmentally sound technologies;
- Equity concerns in solving global environmental issues.

Mr. Sokona also highlighted the concerns of the south and summarised the sectors where mitigation opportunities were available. He also discussed the policy choices for mitigation.

Mr. Sokona was very categorical while saying that though it is moral responsibility of ICs to provide the financial and technological support, yet the DCs should get their homework done well.

3.2.2 Discussion:

A hypothetical but important issue was raised if the South can be proactive in mitigating area emissions without financial and technological support from the North.

Another concern raised was that the capacity building programs in south were mostly sporadic and short lived, thus not proving very effective. There was a suggestion if some research centres or universities could take of such programmes with support from the North.

RAPPORTEURS' FEEDBACK ON DISCUSSIONS HELD ON 9 SEPTEMBER

BY

M. T. CABRAL[1], BRAZIL

4 Session on Adaptation

4.1 – Adaptation: a Challenge for the "North" and the "South"?

Claudio Forner (Colombia) – UNFCCC[2] Secretariat

4.1.1 – Introduction

The UNFCCC recognizes two main roads of action to deal with CC[3]: adaptation and mitigation. The presentation is an overview of adaptation in the context of the Convention.

4.1.2 – Conceptual Framework

Adaptation:

- Autonomous Adaptation: performed by systems without conscious intervention
- Planned Adaptation: performed with human conscious intervention

Adaptability or Adaptive Capacity: ability of a system to adapt to CC

Impact: negative or positive consequences of CC on natural and human systems

Vulnerability: degree to which a system is susceptible to the impacts of CC

Vulnerability = Impacts – adaptive capacity – planned adaptation

4.1.3 – Adaptation and Climate Change

The adaptive capacity is determined by social and economic conditions: developing countries have less resources available to perform adaptive measures.

4.1.4 – Adaptation in the UNFCCC

Negotiations within the framework of UNFCCC have so focused more on mitigation. There is a need to set up a global agenda for adaptation.

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[1] Division of Environmental Policy and Sustainable Development, Ministry of Foreign Relations, Brazil.
[2] UNFCCC – United Nations Framework Convention on Climate Change
[3] CC – climate change

At first, efforts in the field of adaptation concentrated on the analysis of the impacts of CC. Nowadays, the focus is on the establishment of a framework for action. The starting point has to be the experience accumulated by societies in their relationship with the natural environment.

On that basis, national policies for adaptation need to be put in place, based on three pillars: Capacity Building; Vulnerability Assessment; Specific Adaptation Measures.

4.1.5 – Issues for discussion

- Local stakeholders participation
- Setting up a global agenda for adaptation
- Equity issues related to adaptation to CC
- Competing problems: definition of priorities
- Capacity building
- Funding and cooperation
- Policy frameworks for adaptation

4.1.6 – Participants' Interventions[4]

Youba Sokona (Mali) – CC entails not only problems, but also opportunities for DCs[5].

Chris Sear – to deal with adaptation, the starting point should be the people, not a policy framework, as stated by Forner.

Mauricio Nine (Argentina) – there needs to be a consensus on the need for a global agenda for adaptation, as well as the corresponding funds.

Jürgen Lottmann (Germany) – Some countries will benefit from the effects of CC. Adaptation policies are often indistinguishable from general development policies.

C. Dasgupta (India) – Agriculture is one of the sectors most affected by CC. That could be a good reason for the establishment of a large international cooperation scheme.

Claudio Forner – There are already research efforts in course, especially at FAO[6]. The UNFCCC is not the right forum for that type of research.

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[4] The text below is an attempt to reflect the general ideas put forward at the discussions. It is not a literal transcript of participants' speeches.
[5] DC – Developing Country
[6] FAO – Food and Agriculture Organization

4.2 – Adaptation: Case Studies in the "North"

Chris Sear (United Kingdom)

4.2.1 – Introduction

Using the concepts presented in the previous presentation, adaptive capacity can be seen as the ability to respond to changing circumstances, mitigating harmful effects of CC and at the same time generating benefits. Sustainable development strategies should strengthen adaptive capacity. Adaptation shall be conceived as something done "for" the people, not "to" the people.

In many instances, mitigation and adaptation efforts can be mutually reinforcing. The study of adaptation and mitigation strategies in the "north" can be useful for the definition of similar strategies applicable to the "south".

4.2.2 – Energy Saving Houses

In many countries, both in the "north" and the "south", a great amount of energy is spent in heating and cooling buildings. A mitigation strategy based on the use of established technologies and building practices can entail significant reductions in energy consumption. Such a strategy should include, among others:

Tight construction (reduced air infiltration):

- Tight ducts;
- Improved insulation;
- High performance windows;
- Energy efficient heating & cooling equipment.

4.2.3 – Sustainable Urban Drainage Systems (SUDS)

The impacts of extreme climate events due to CC are similar in the "north" and the "south", and many adaptation strategies are applicable in both cases. Sustainable Urban Manage Systems are designed to manage surface water runoff with the use of a set of simple techniques that include, among others:

- Porous pavements for roads and car parks;
- Infiltration trenches beside reads and car parks;
- Swales (wide, shallow ditches) to slow surface water flow;
- Infiltration basins and permeable conveyance systems;
- Passive treatment systems – filter strips, retention ponds, wetlands;

4.2.4 – Human Health: Adapting to Heat and Cold

Current adaptive measures with respect to heat and cold in Europe include:

- Legislative and administrative measures
    - Building codes and guidelines;
    - Educational programs – esp. about water intake;
    - Weather watches and warnings.
- Technical
    - Improved insulation, air flow and air conditioning;
    - Urban planning for "cooler cities".
- Behavioral
    - Hydration and sensible drinking;
    - Work breaks in hot weather;
    - Sensible clothing;
    - Air conditioning in homes and vehicles.

4.2.5 – Flooding

- Current adaptive measures with respect to flooding in Europe include:
    - Flood control and sanitation infrastructure;
    - Early warning systems;
    - Public health measures against outbreaks of infectious diseases;
    - Land use planning and sustainable building programs.

4.2.6 – Vector Borne Diseases

- Legislative and administrative measures:
    - Surveillance;
    - Education programs;
    - Vaccination programs.
- Technical:
    - Window and door screens;
    - Biological control of vectors;

    - Vector habitat control.

- Behavioral:
    - Use of insect repellents;
    - Use of bed nets;
    - Improved water storage and gardening practices;
    - Self inspection.

4.2.7 – Vector and Food-Borne Diseases

- Legislative and administrative measures:
    - Education campaigns for safe food storage;
    - Enforcement of hygiene standards in hotels and restaurants;
    - Watershed protection legislation;
    - Water quality regulation;
    - Better coastal outfalls and “clean beach”campaigns;
    - Public alerts (eg. to boil drinking water).
- Technical:
    - Imroved cleaning materials;
    - Improved food preparation techniques;
    - Genetic/molecular screening of pathogens;
    - Improved sanitation in public toilets;
    - Improved sewerage cleanup.
- Behavioral:
    - Improved food preparation and hygiene;
    - Boiling of untreated water.

4.2.8 – Participants’ Interventions

Marco Cabral (Brazil) – Example of adaptation strategy with positive mitigation effects: About 90% of Brazil’s electric power comes from hydric sources. Due to exceptional rain shortages, the country faced a power supply crisis in 2001. A campaign to stimulate the efficient use of energy lead to a reduction of over 10% in power consumption, with lasting effects.

Balgis Osman (Sudan) – Example of adaptation strategy with positive mitigation effects: In order to prevent the depletion of the country's forests, important for local climate regulation, a campaign was launched to stimulate the use of mud instead of wood in housing construction. As a result, forested area increased, with a positive mitigation effect due to the increase in carbon stocks in the form of biomass.

Jiahua Pan (China) – Although there are theoretical similarities between adaptation strategies in the "north" and the "south", there are important practical differences, related to the different development levels. With regard to the relation between adaptation and mitigation activities, although there are win-win situations, there may also be tradeoffs. For instance, the construction of dykes for the prevention of floods is an energy intensive activity, which entails the emission of GHGs[7].

Claudio Forner (Colombia – UNFCCC) – It is useful to compare adaptation experiences in the "north" and the "south", but it is important to bear in mind that there are significant differences.

5 Session on South-North Cooperation

5.1 –Conflicting Interests – Contrasting Visions: Finding a Balance

Youba Sokona (Mali) – ENDA / TM

Participants' Interventions
Mauricio Nine (Argentina) – Success of CDM[8] should be judged by comparison to the other two flexible mechanisms.

Youba Sokona – There are two fallacies regarding CDM: first, the assumption that it will draw additional resources for developing countries; second, that companies will make money by implementing CDM projects. Aside from that, most least developed countries don't have conditions to attract CDM projetcts.

Jürgen Lottmann (Germany) – Only consultants are making money with CDM so far. It doesn't make sense to equate non Annex 1 countries to developing countries. G-77 needs to be rediscussed.

Olubenga Ologun (Nigeria) – There is a lot of room for south-south cooperation; technologies developed in countries like China and India are often more useful to other developing countries than those coming from the "north".

[7] GHG – Greenhouse Gas
[8] CDM – Clean Development Mechanism

Jiahua Pan (China) – CDM is a market instrument, but it's political dimension is perhaps even more important.

5.2 – Clean Development Mechanism: Effective and Efficient for "North" and "South"?

Jürgen H. Lottmann (Germany) – Head of the Central Environment Unit – KfW

Participants' Interventions

Martin de Wit (South Africa) – Due to the European Carbon Trade System, the liquidity of the carbon market has been disturbed, and prices of certificates have been pushed down. Developing countries will have to reexamine the perspectives of CDM.

Balgis Osman (Sudan) – Are companies interested in the environmental benefits arising from CDM projects, or are they only interested in CERs[9]?

Jürgen Lottmann – Companies are mainly interested in CERs, but environmental benefits will come as a consequence. In the selection of countries for CDM projects, companies are likely to pay significant attention to the effectiveness of the host country's judicial system, in order to guarantee their investment.

5.3 – Carbon Sinks: Enhancement & Management.

Reinhard Leithner – Technische Universität Braunschweig

Participants' Interventions

Marco Cabral (Brazil) – This presentation has raised serious scientific doubts about the causal relationship between CC and anthropogenic emissions of CO_2. In your view, are the efforts to mitigate CC vain, and is the Kyoto Protocol, as the American Government says, "fatally flawed"?

Reinhard Leithner – Indeed, the current mitigation efforts will have little effect on CC. However, it is useful to rationalize the use of Fossil Fuels, in order to preserve resources for the future. In the field of CC, the main challenge is technological, not economical, political, or legal.

5.4 – Technology Transfer: Experiences and Perspectives.

Holger Liptow – Climate Change Programme / GTZ

Participants' Interventions

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[9] CER – Certified Emission Reduction

Neni Sintawardani (Indonesia) – Aside from the successful cases described in this presentations, are there examples of unsuccessful cooperation projects, and if so, what were the main reasons for failure?

Holger Liptow – Certainly not all projects are successful. Problems usually arise when local stakeholders are not sufficiently involved. Ownership crucial for the success of technical cooperation projects.

Mauricio Nine (Argentina) – Is technology transfer an indispensable condition for the implementation of CDM projects? LULUCF[10] projects are not likely to involve technology transfer, and one such conditionality would only add another difficulty for the implementation of CDM projects.

Holger Liptow – It is not a conditionality, but it will be better for developing countries if CDM projects also involve technology transfer.

Unrecorded participant – One of the main problems about technology transfer is that important technologies are often protected by intellectual property rights, and therefore cannot be transferred.

Jürgen Lottmann (Germany) – Experience shows that in most cases intellectual property rights does not pose a problem in technology transfer projects. As for CDM projects in the energy sector, they are not likely to involve sophisticated technologies protected by intellectual property rights, and therefore there is room for technology transfer.

Reinhard Leithner (Germany) – Regarding the technology transfer project in the coal sector in China, mentioned in the presentation, the 1% increase in efficiency resulting from the project could be easily obtained by Chinese engineers, without the aid of German experts.

Holger Liptow – China certainly has competent engineers that could have performed that task, but nobody had done it until that point, and the German cooperation has made a difference by providing and “outside push”.

Kelebogile Shirley Moroka (South Africa) – The benefits of international technical cooperation are limited, because very often there is only a partial transfer of technology, and local users have to depend on foreign experts for repair and maintenance of the equipments installed.

[10] LULUCF – Land Use, Land Use Change and Forestry

WORKING GROUP A
EMISSION LIMITATIONS IN THE "SOUTH"?

Conclusions

We used the questions proposed as a guide in our debate. Some of them were interrelated. Some others triggered additional questions. We therefore decided to summarize our opinions in the following statement:

We, Group A members, think that DCs should not commit themselves to any kind of binding emission limitation target.

In stating this, we are bearing in mind the full relevance of the principle of "common but differentiated responsibilities" in the field of the mitigation of climate change and we think that it would not be ethically fair to expect the contribution of DCs to mitigation to be of the same nature and extent of that of the ICs.

However, DCs will continue to implement voluntary mitigation actions keeping in mind their overriding priorities within the framework of their relevant development paths.

The feasibility of implementing mitigation actions varies from one country to the other and also according to the sectors involved.

In order to enhance DCs mitigation capacity, the conditions regarding financial assistance and technology transfer specified in Article 4.7 of the UNFCCC should be met. This could be done, inter alia, by operationalizing some of the already proposed funds and frameworks, both multilateral and bilateral (e.g. the Special Climate Change Fund).

It is worthwhile emphasizing that any financial support should be additional to existing ODA commitments and any financial support in the framework of the CDM, which we acknowledge as a useful mechanism which helps ICs in meeting their commitments while contributing to SD in the DCs.

WORKING GROUP B

EMISSION LIMITATIONS IN THE „SOUTH"?

1 Internationally agreed framework under the UNFCCC:

- IC are complied to reduce GHG emissions;
- DC will reduce GHG emission under a voluntary regime;
  Considering that it is only under voluntary regime that DC will reduce their emissions: UNFCC marks certain elements so the voluntary GHG emissions reductions from DC take place:
  - Adequate Institutional Infrastructure;
  - Relevant capacities:
    - Technical;
    - Scientific;
    - Informative;
  - Adequate resources;
  - Worthwhile Market.

Kyoto Protocol has not entered into force. Current Conditions:

- IC:
  - US is responsible of the 25% of the global emissions and they pulled out;
  - Russia is responsible 17% of the global emissions and has not ratified;
  - "Relative" compliance of EU in emissions reductions;
  - Emissions reductions achieved not always by design;
  - More expensive to decrease emissions than in DC;
  - Conclusion: High risk scenario.

- DC:
  - Some projects have been developed;
  - No real incentives to reduce emissions;
  - No financial resources;
  - The more vulnerable ones for the CC effects.

- World:
  - Temperature stills going high and a solution needs to be implemented.

2 Step Forward

- *DC shall be compelled to reduce emissions?*
  - Morality:
    - It is ethically demandable but in a basis of: proportion, equity and according to capacity and national sustainable developments goals;
  - Guiding Principles:

  - DC should be considered not as a block of countries, but be considered according to its own development (transition industries-developing countries-poor countries);
  - Climate Change policies can be integrated in the sustainable development plans.
- Feasibility:
  - Investment from IC is necessary for the development of projects that reduce emissions and require technical assistance and financial resources. DC will develop projects that reduce emissions, but which do not require incremental financial investment or technical qualifications. This due to the fact that DC countries have priority needs (actual survival) that require the available resources.

- *Under the basis before referred, projects that can be developed and are being developed are*:
  - Sudan: Energy sector: Biomass-gas;
  - Brazil: Transport sector and waste disposal; alternative energy; land use;
  - China: Transport sector; vehicle shifting (i.e. Bicycles); industrial efficiency –but problems with small industries;
  - Mexico: Change of fuel used for producing electricity; land use programs;
  - Kenya: Transport sector, private cars-public transport;
  - India: Efficiency in industrial production; more efficient agricultural methods;
  - Philippines: Transportation (clean air act); waste recycling; EIA requested; carbon sinks;
  - Argentina: change of fuel; change of agricultural methods;
  - Vietnam: Energy efficiency and energy conservation programs;
  - South Africa: Electricity generation.

WORKING GROUP A
ADAPTATION

1 ADAPTATION IS A GLOBAL ISSUE

Adaptation is Global. It is global because the need for it is caused by a global problem i.e. climate change. Climate change impacts ICs and DCs both. There may be regional and local differences in the type of impacts but these local/regional impacts may have global repercussions given today's highly interconnected global society.

ICs may be in a better position to go for adaptation measures than the DCs due to the lower planned capacity (infrastructure, institutional framework, technical capacity and resources) of the latter. There is, therefore, an ethical imperative to alleviate suffering in DCs due to CC.

A big challenge is to set up a global agenda specifically on adaptation with inter alia specific funds and frameworks to support adaptation measures in DCs. There are no specific funds for adaptation measures which are fully operational at present. The support provided by ICs for adaptation activities should be additional to the support provided for mitigation activities. Thus, focus on adaptation should not undermine mitigation efforts.

2 CHALLENGES:

- Adaptation measures must be implemented before the actual impacts of climate change are felt. As for the impacts which are already felt, urgent action is needed;
- Adaptation has to be fast tracked. Simplified mechanisms for expedited access to funding and technical support are required;
- The adaptation capacity varies from country to country;
- Information sharing, training and public awareness are vital. Systematization of data and available knowledge, including traditional knowledge is important;
- Applied research on adaptation should be promoted and databases of successfully implemented measures should be developed;
- Resilience and coping capacity of communities should be increased, through sustainable livelihoods practices, cooperative efforts, insurance, etc.;
- Adaptation must be planned in the short, medium and long term;

- Bottom up approach is in most cases ideal. Involvement of local stakeholders directly affected by the impacts becomes essential;
- Adaptive experiences can sometimes be copied from the North to the South and viceversa;
- North-South cooperation and South-South cooperation should be promoted;
- Relationship between adaptation and sustainable development - Although adaptation is linked to the development agenda, the funding for adaptation has to be additional to existing ODA mechanisms. Of course it must be articulated with the general SD strategy of each country.

3 North – South Cooperation

State and Perspectives of North-South Cooperation in Climate Change.

The dimensions of cooperation identified for N-S cooperation are technology transfer, capacity building and financial assistance.

Most of the cooperation initiatives so far have been fragmented. This does not address the larger agenda on a sustained basis and is a waste of scarce resources. What is required is a long term cooperation strategy involving national expertise so that not only capacity is built and technology is transferred, but also a sense of ownership is generated.

Cooperation efforts must be focused on issues which are relevant to DC's local interests and needs. As far as advisable, local experts, skills, infrastructure, technology and know how must play a role in cooperation initiatives.

Participation of delegations and stakeholders from DCs should be enhanced in order to increase their proactive role in the CC system.

Establishment of RCCRCs in DCs / strengthening of existing research centers should be considered by the ICs and multilateral organisations to build capacity and share knowledge and information, thus promoting S-S cooperation.

WORKING GROUP B
ADAPTATION

1 Adaptation

Definition: Actions driven by policy and taken to reduce risk and vulnerability of climate change impacts at all levels in society from individual and community to national and international.

One of the key issues is that DCs need access to financial resources to adapt to changing climates.

Further aspects include:

- Adaptation policy needs to be integrated in national sustainable development policies;
- DCs have no choice with regard to adaptation. Traditionally DCs have implemented local adaptation strategies. In this regard, DCs need to organize traditional knowledge in order to adapt to natural problems, and from this position plan future adaptations plans. These plans will include requiring adaptation funds from IC. Examples are:
    - For example: Some communities that use to have sheep, due to drought they have changed to goats which are better adapted to drought;
    - Policies designed for water harvesting and water storage;
    - Monitoring and early warning systems are very important to plan ahead so to adapt to severe weather;
    - Urban planning, including building design that includes air conditioning.

Adaptation with mitigation are seen as distinct issues, but some projects can implement adaptation projects, that will have mitigation potential: i.e. Mangroves plantation (against coastal damages caused by severe weather and carbon sequestration) in Bangladesh.

In general, mitigation activities are more focussed on richer nations or richer sectors in DC societies; adaptation activities are more linked to poor sectors with less ability to adapt.

Options for DCs are:

- Develop own adaptation strategies on the basis of local knowledge and local empowerment;

- Continue accessing support under UNFCCC for adaptation.

2 Flexible Mechanisms

CDM was not created specifically for DCs, but for helping IC to achieve their Kyoto goals.

The CDM market is small, but there are some real and lucrative opportunities for DCs. Reasons for the small market are:

- US not included;
- Russia not yet ratified;
- EU has defined a EU "bubble" with limited space for CERs from CDM projects, excluding LULUCF.

Further issues affecting DCs are:

- LULUCF options are excluded under EU emission trading system (but still included under Kyoto Protocol) With such an exclusion those sectors that affect the poor most do not have a buyer anymore;
- DCs need to streamline the implementation of CDM in their countries:
    - agree on deadlines by when national authorities will endorse CDM in DCs;
    - Streamline CDM investments by not making the process overly complicated and bureaucratic.

Options available are:

- Baselines have to be settled as a national policy, so through base lines increase the "environmental level" of the country;
- Streamline CDM investments in DCs;
- A longer-term view needs to be taken. Depending on the development of the country, governments have to consider if they sell the certificates as CERs, directly converted into the EU trading system or if they bank them for use for possible future commitments.

3 Technology Transfer

Key issues:

- Owners of facilities to whom technologies are transferred need to be bought in;
- Full capacitation is needed of the owners and/or manager of the sector that is going to receive the technology;

- A technology assessment is needed for all DCs that informs different grades of assistance to DC from IC;
- Sometimes certain aspects of technology already exist, but a catalyst is needed to combine elements of to solve present necessities (reduction of emissions);
- Technology transfer for business will exist under constraints of investment and finances.

Option

- Conduct full technology assessments.

4 Cooperation

IC-DC cooperation needs to continue for the following reasons:

- Agreements have been made under the UNFCCC and need to serve as the basis for cooperation. That includes cooperation on the advancement of science, reporting as well as agreements on transfer of resources from ICs to DCs;
- High vulnerability of DCs;
- Ethical reasons.

DC-DC cooperation is especially important in the case of adaptation to climate change, but more limited options might exist for mitigation.

On cooperation around flexible mechanisms the possibilities of future emissions markets for DCs need to be kept open. The current developments point towards a division on “trade blocks” for carbon credits, with the EU leading the way. Russia and the US are likely to either separately or jointly come to a deal, leaving DCs out of most of the action. Certain limited amounts of CERs will be earned by these “blocks” in DCs, but this will never be a large share to the total amount reduced.

DCs can respond by organising their own block on emission trading, preceded by more intensive levels of DC-DC cooperation, if voluntary caps are taken on. However, a more feasible short-term option would be to increase DC-DC cooperation and make use of opportunities presented in DC-IC cooperation.

WORKING GROUP A
CORPORATIONS AND THE "SOUTH"

1 Definition

In our understanding the term: "Corporations", refers to entities that are operating in the South, including locally owned and multinational companies. irrespective of whether they are local private companies / national privatized companies / subsidiary companies / multinational companies. However, we limit to "large" businesses rather than SMEs.

2 Question definition

The questions posed by Dr. Salih in his presentation gave the general direction in which we formulated our questions. We have agreed to address two questions:

a) What are the main issues resulting from corporations operating in the South?

b) How should corporations / host states address the climate change agenda in the South?

2.1 What are the main problems resulting from the operations of Corporations in the South?

The main issues as we see them relate to:

- Many corporations that are operating in the South use obsolete technologies which result in low efficiencies and high GHG emissions;
- Local environmental pollution problems, which are not internalized into the cost of production;
- Violation of local environmental standards by large corporations: e.g. in some cases corporations are so powerful that they disregards local environmental regulations e.g. in Nigeria gas flaring regulations are not complied with leading to increase methane emissions;
- Pressure on host countries to establish legal framework and monitoring and burdensome compliance mechanisms;
- Transfer of corporations from the North to countries in the South where GHG emission standards are not applied / or allowed emission ranges are higher than in their home countries.

2.2 How should corporations / host state address the climate change agenda in the South?

- Companies should be transparent in their reporting of issues relevant to climate change. Companies and host countries should establish a transparent relationship e.g. reporting on corporations' GHG emissions and environmental practices. At the same time host states need to be transparent in regards to present and future policies and regulations both environmental and investment;
- Corporations on their own initiative need to encourage active involvement of stakeholders including, the often overlooked, local populations. Local populations need to be made aware of the environmental impacts and climate change issues associated with the operation of corporations in their localities e.g. during the oil pipeline construction through the Amazon in Brazil, local populations were made aware of the work implications;
- Corporations need to comply with environmental regulations and standards in the host countries.

At the same time…

- Host countries need to enhance their climate change and environmental legal framework through the establishment of relevant environmental standards and regulations. Emission reduction restrictions may lead to the transfer of energy intensive industries to the South. In order to deal with this possibility in a positive way the legal and institutional frameworks in the South should be strengthened;
- Corporations need to incorporate Corporate Social Responsibility principles into their practices, and raise awareness on climate change issues. Applying best practice in terms of energy efficiency would be part of a corporation's corporate social responsibility in the area of climate change. As part of CSR multinational corporations need to adhere to the high standards of efficiency and product output that they apply in the North;
- Corporations that are newly setting up need to use energy efficient advanced technologies;
- Corporations should use natural resources on a sustainable basis.

WORKING GROUP B
CORPORATIONS AND THE “SOUTH“

1 Drivers for corporate involvement in climate change

- Comply with international green norms, as well as international trade rules (WTO);
- Comply with national environmental norms;
- NGOs pressure;
- Comply with environmental requirements so to be able to receive financial resources;
- Address environmental domestic problems;
- Private sector cooperation-partnership with science and research that trigger new technologies that help to develop environmental friendly projects.

2 Problems that corporations have to face to address climate change issues

- Lack of a clear governmental policy regarding climate change projects (sometimes due of the change of government that implies the change of policies as well);
- Lack of a legal regime that gives certainty and security to the investors;
- Absence of a good relationship between the companies and the government;
- Absence of a good management within the companies and the government;
- Inadequate incentives;
- Lack of an enabling environment for investments;
- Lack of capacity.

3 Policies/ incentives to be implemented

- Incentives need to be more sustainable;
- Create common infrastructure for mitigating the impacts;
- New technologies to implement efficient technology;
- Proactive research.

4 Options

- Take advantage of the investments and financial opportunities that come with the CDM;
- Ratification of Kyoto Protocol;
- Identification of public partnerships with private for LULUCF projects.

5 Cooperation between companies and government towards CC

- For a positive cooperation between southern corporates and government necessary are
  - Information from the government to the companies about the problem of CC and the opportunities that it presents for the South;
  - Legal certainty and security;
  - A clear and stable governmental policy regarding climate change investments;
  - Good relationship between the companies and the government;
  - Good management within the companies and the government;
  - Promotion of Incentives;
  - Promotion of investments;
  - Capacity building.

6 Key questions addressed

What are the fundamental CC problems resulting from Corp-South activities?

Activities developed by the corporate south companies:

- Land use;
- Transport;
- Electricity generation;
- Waste;
- Coal dominance.

What are the fundamental CC problems faced by the Corp-South activities?

(sectors vulnerable)

- Tourism;

- Hydropower;
- Pulp and paper;
- Fisheries.

Corporate Social Responsibility and what does it mean in the CC Context?

- First focus on local action and then go for global actions; in consequence some adaptation activities for CC are taken by the companies;
- Transfer of technology needs to take place;
- Small companies do not address local responsibilities with regard to the communities they are located in;
- Some transnational companies do care about local responsibilities issues;
- Addressing climate change can be a positive for other reasons;
- Legal framework has to be enhanced to compel small industries to comply with environmental legislation.

Is there sufficient awareness of externalities and climate change cost in the south?

Generally, there is very limited awareness of climate change effects in DCs, and therefore its externalities. Nevertheless, local environmental externalities (e.g. water) have been increasingly integrated in environmental policies of some DCs (e.g. environmental taxes), but global environmental externalities have not been addressed.

How does this affect their attitudes towards corporate activities?

- Government can make it obligatory to report emissions;
- Response to local externalities may have a positive side effect towards global externalities;
- Legal and environmental policies could require transnational companies to implement activities that reduce global externalities.

7 Focus in post Kyoto priorities

- Research and knowledge generation;
- Institutional development building capacity;
- Technology assessment and forecasting;
- South-South cooperation in development of a post Kyoto period;
- Negotiation for enhanced access to the carbon market;

- Government awareness, conscience, and will for establishing a suitable framework and environment for the implementation of CC policies.

Closing Panel

Welcome Address by Dr. R. Junker

Director General 6 of the Federal Ministry of Education and Research

on the occasion of

the final event of the Summer School

Ladies and Gentlemen,

I would like to welcome you warmly at the Federal Ministry of Education and Research in Bonn and to convey the greetings of Federal Minister Bulmahn.

My name is Reinhard Junker; I am the head of the Research Ministry's Directorate General 6, which consists of two directorates, one for "Health and Life Sciences" and the other for "Research for Sustainability". The division on "Global Change", which initiated the Summer School on "Climate Change", belongs to the second directorate.

Ladies and Gentlemen,

You are now looking back on a week of intensive exchanges of views in Bad Münstereifel, and I am sure you have met many people and made new friends. I hope that this week has provided you with exciting discussions, new ideas and new impulses for your professional work.

We have come together in Bonn today for a final discussion of the results of the Summer School in Bad Münstereifel.

Ladies and Gentlemen,

Climate change, the topic that was at the centre of your Summer School, is of global significance. International climate research has been trying for many years to gain a better understanding of the climate system. This includes in particular climate variability and susceptibility to human activities. We are therefore well informed today about fundamental mechanisms and anthropogenic effects, such as the emission of greenhouse gases mainly by the industrialized countries of the North and the land-use changes in the countries of the South. Of course, there are still many open questions relating to the detailed understanding of processes, the possibility of non-linear effects, regional variations or the so-called extreme events. Researchers will therefore continue to be very busy in the future, too, trying to further improve our understanding. In Germany we also have a well-developed research infrastructure for this purpose:

Within the framework of the Federal Government-funded national research centres, for example, the Alfred Wegener Institute for Marine and Polar Research in Bremerhaven (AWI), the GeoForschungsZentrum Potsdam (GFZ), the centres in Geesthacht (GKSS), Jülich (FZJ), Karlsruhe (FZK) and the German Aerospace Centre (DLR).

Important contributions to research are also being made by the institutes of the Wilhelm-Leibniz Science Association, among them the Institute for Tropospheric Research in Leipzig, the Institute for Atmospheric Research in Kühlungsborn and the Potsdam Institute for Climate Impact Research, as well as institutions of the Max Planck Society in Hamburg, Mainz and Jena.

These institutional contributions are supported by additional project funding programmes, which are aimed mainly at the German universities, for example, the German Climate Research Programme of the BMBF (DEKLIM) or the funding activities of the Deutsche Forschungsgemeinschaft (DFG).

We are aware today that we must not be content with basic research alone. The suspicion of a growing human "fingerprint" on the climate system has become very strong, at least since the submission of the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) last year.

We must therefore do something - on the one hand in order to mitigate the man-made changes, keeping them within tolerable limits; on the other hand we must better adapt to and cope with the climate variations occurring today.

However, going on from knowledge to action is quite a challenge. Despite well-established international negotiating structures on the basis of the United Nations Framework Convention on Climate Change, only little progress has so far been achieved. The efforts - even those made by the highly developed countries as main emitters - to achieve the reductions stipulated in the Kyoto-Protocol vary greatly. The countries of the South on the other hand justifiably point to their right to pursue their own development, aiming at the improvement of present economic and social conditions.

For more than 10 years, the Federal Republic of Germany has been facing the challenge of reducing the emission of climate gases. Germany is one of the few countries worldwide, which have meanwhile achieved considerable success. A broad bundle of different measures in all relevant sectors is stipulated in our national climate protection programme for this purpose, including voluntary self-regulation by German industry in particular. Against this background, Germany is also committed at international level, in international climate protection negotiations, in order to motivate as many countries as possible to follow suit.

One thing, however, is clear: Within an international framework, relevant German activities can only make a small contribution to solving the global problem.

A major obstacle to the fast realization of the relevant climate protection goals worldwide is the fact that many countries, not only the countries of the South, find it difficult to reconcile climate protection with the framework conditions required for further economic growth. It is now generally acknowledged that the requirements of climate protection must be matched with approaches towards worldwide sustainable development. Such sustainable development must not only consider aspects of environmental protection but also the requirements of economic and social development. Germany, too, has begun to develop a national sustainability strategy.

However, the motto "food comes first" continues to be valid in less developed countries in particular. This is something, which the now highly industrialized countries have to accept to an increasing extent. We all live in **one world**, and future generations will measure our policy against the success we have achieved in taking all countries along with us on the path towards sustainable development.

Germany has traditionally had good relations with your home countries. In many cases there are good economic and cultural relations. However, against the background of the above-described situation, we want to expand and intensify these relations further. The Federal Republic of Germany is aware of its responsibility as one of the leading industrialized nations. In many regions of the world we can assist in solving economic and social problems or questions of climate and environmental protection. Cooperation in the fields of research and technology makes an important contribution in this respect and is frequently reflected in long-standing agreements on scientific and technical cooperation with your countries.

But we also need new instruments and measures in our cooperation, for example through the flexible utilization of the so-called Kyoto instruments, the intensified transfer of technology and know-how, capacity building, region-specific approaches and targeted bilateral strategies, among others. This policy must not be a one-way street – all sides must benefit from the success of such an approach. Also, we must not only look to very long-term goals, but also work out immediate joint options for mastering current problems, for example options for better adaptation to short-term climate variations or extreme weather. The BMBF has therefore begun to increasingly shift its funding in the relevant research areas to problems of climate change and climate protection measures. Your Summer School has been part of this effort.

Ladies and Gentlemen,

The Summer School in Bad Münstereifel was intended to provide you with an opportunity for exchanging views and for further training, also in the field of adequate management options in particular. But it was also intended to open up to us new ways of obtaining information and of learning from you. After all that I have heard about the past week, I am certain that the Summer School was a success for both sides.

Much work and commitment was required to achieve our goal, and I would therefore like to thank you, the participants, for your active participation and for sharing in this event. But I would also like to thank the local organizers from the Research Centre Jülich, the group of Mr. Fischer, and Professor Ehlers, the chairman of the meeting, who, with his personal experience and commitment, essentially contributed to the open and constructive atmosphere of the Summer School.

I would now like to wish you a successful final event here in Bonn and a good journey home later on.

I look forward to seeing you again and hope that our contacts and our cooperation will continue to develop successfully in the future.

Thank you very much for your attention.

Welcome Address by Dr. Gerd Eisenbeiß

Board Member of Research Centre Jülich

on the occasion of

the final event of the Summer School

Ladies and Gentlemen,

On behalf of the Research Centre Jülich I want to welcome you for your final presentation of the set of conclusions here at the Federal Ministry of Education and Research.

The Energy Research Program of the Research Centre Jülich, as part of the German energy research is clearly focussed on high tech developments in electricity producing conversion processes:

- We use our highly acknowledged competence in high temperature materials and processing technology for fuel cell development and power plants;
- We concentrate in the field of renewable energies on thin film photovoltaics;
- We are an important EURATOM association in fusion research;
- We do research work on nuclear safety and waste disposal and
- We have a strong systems analysis group, combining energy and environmental research under the unifying heading of sustainability.

In environmental research we cover all relevant compartments from the soil over the phytosphere to the atmos- and stratosphere looking especially into the complex interfaces and interactions of these compartments.

These areas are research fields demanding excellent science and highest technological level. At the same time an important part of these tasks is of a complex nature with high risk and long lead-time to success. Therefore the whole Helmholtz-Association including the Research Centre Jülich dedicated parts of their scientific potential to this challenge. I may a little bit proudly add that the international reviews of all Helmholtz programmes during the first month of this year confirmed our common strategy. Further more, the review panels gave a very high ranking to the programme parts presented by Jülich so that our research centre will get the biggest financial increase of all participating research centres.

The availability of a systems analysis group is of utmost importance because environmental, climate and energy aspects have to be analysed in one process in order to assess new technologies ad the strategy in climate protection as well as to help in focussing the research strategy.

Accordingly, the “Research for Climate Protection” Agency was set up by the Federal Ministry of Education and Research at the Programme Group Systems Analysis and Technology Evaluation (STE) of Research Centre Jülich.

The Agency’s tasks are:

- Support for the BMBF in the development and implementation of research programmes for the avoidance of and adaptation to global climate change.
- Intensifying the transfer of know-how about climate protection and adaptation measures to political and administrative decision-making processes;
- Contributions for creating capacity in “developing countries”, partner countries adequate structures

The “Summer School on Climate Change Mitigation and Adaptation. Identifying Options for Developing Countries” is a part of these tasks of the Agency. It should contribute to the exchange and transfer of knowledge between scientists and decision-makers in politics and economy. The Summer school brings together young leaders from science, industry and politics from developing and threshold countries in order to analyse the challenges of climate change and also the identify international and country-specific avoidance- and adaptation-related strategies. Furthermore, the Summer School hopefully leads to the creation of a network which the participants can make use of in the future of issues related to climate protection.

The last 10 days have been characterised by very interesting lectures. I saw some of the participants’ short papers and I am impressed by their quality. The excursions to the power plant in Niederaussem and the Solar City Jülich may have given you an impression of the great technological achievements in Germany.

German today is one of the leading countries in research and application of renewable energies. For example, about 40% of the worldwide capacity in wind energy has been erected in our country. At the same time, Germany will fulfil its obligation in GHG reduction until 2008 as promised in Kyoto; to-day only 3% are lacking.

Coming back to the summer school, the current status of the Science of Climate Change both from a natural science and a social science point of view have been presented. These very interesting presentations function as the basis for very fruitful discussions in the working groups.

I am very interested in your set of conclusions even if I am not able to stay here until the end of this ceremony.

I hope you not only enjoyed your attendance in the Summer School but that all of us can make use of the results in order to strengthen our common strategy for a sustainable development of our common planet earth.

CLIMATE CHANGE: PERSPECTIVES FROM DEVELOPING COUNTRIES

Presentation of a Set of Conclusions by the Participants to Representatives to the Representatives from Government, Business, Science and NGOs

Venue: Federal Ministry of Education and Research, Bonn

16th September, 2003

We would like to express our gratitude to the Federal Ministry of Education and Research for supporting the Summer School on Climate Change Mitigation and Adaptation. Also, we thank Mr. Fischer and Mr. Hüttner from the Research Centre Jülich, as well as Professor Ehlers from the University of Bonn, whose contribution was essential for the success of our course. This course has joined together representatives from governmental agencies, NGOs, private and academic institutions from nearly 20 countries. The contacts that we have established will be instrumental for our future work. We have increased our knowledge on climate change, and had a valuable opportunity to establish a dialogue with representatives from the academic, business, and governmental sectors in Germany. We also had an excellent chance to present the issues of climate change from the developing countries' perspective: so similar, yet so different. Developing countries have always played an active role in the climate change regime. Due to their greater vulnerability, they have a pressing need to implement adaptation measures. At the same time, they can contribute to mitigation efforts in cooperation with developed countries, on a voluntary basis. In the Johannesburg Summit, the international community recognized that efforts towards sustainable development should be focused primarily on implementation. In this context, we would like to present our vision for cooperation on science and policy issues between Germany and our countries in the field of climate change. Following is a set of priority areas identified during our discussions.

1 Governance

Institutions, administrative and legal frameworks on CC in most DCs need to be strengthened with international support. To enhance DC's capacity to fully participate in the international climate protection regime, and to provide certainty and stability to investors:

- Designated National Authorities for CDM should be created within a certain agreed upon deadline.
- Climate change policies should be made widely available.
- The involvement of relevant stakeholders in the decision-making processes on CC should be increased.

- Guidelines, operational procedures and funding mechanisms for implementation of mitigation and adaptation measures need to be finally agreed upon and implemented.

2 Sustainable Development

Assist in mainstreaming environmentally sustainable practices and climate protection into development plans. Keeping in mind the following:

- Climate change issues must be part of national development strategies;
- IC & DC partnerships on CC are needed to move towards sustainable development paths;Effective integration of traditional knowledge and modern technologies is required;
- Each DC's specific social needs, traditional and historical situations, and economic disparities need to be taken into account;Effective science-policy interface to achieve the ultimate objectives of the UNFCCC.

3 Cooperation

3.1 Technology Transfer

North-South cooperation for transfer of technologies that are proven and appropriate for DCs needs. Key issues include:

- Full technology assessments in DCs;
- Involvement of local resources and expertise;
- Transfer of skills associated with technology to ensure continuity of programs;Support from ICs to catalyse S-S cooperation and knowledge exchange through triangular initiatives;
- South-south cooperation within regional networks as an input;Strengthening of ICT resources in DCs.

3.2 Incentives

Access to carbon commodity markets need to be assured for the South. Key issues are:CDM participation in the carbon commodity market should be ensured, since these projects have the positive side-effect of "learning-by-doing" and they increase the participation of DCs in mitigation activities;

- The CDM should not be burdened with excessive additional transaction costs and practical obstacles for the implementation of projects;Multinational Companies should be encouraged to take advantage of CDM possibilities through their branches in DCs.

3.3 Research

Joint programmes focused on action-oriented research related to climate change are necessary. Key issues are:

- Financial and technical support should be provided by ICs for this purpose.
- The research should take into account the overriding priorities of DCs as spelled out in their national development strategies, e.g. poverty alleviation.
- Further examples include:
    - Establishment of monitoring systems, particularly regional observational networks for CC.
    - Providing DCs with access to regional climate models and capacity building on their use.
    - Involvement and strengthening of local research institutions working on CC.

3.4 Capacity Building

Capacity building to all stakeholders, covering the following:

- Negotiation skills
- Project design of adaptation and mitigation measures
- Science and information exchange
    - Monitoring and early warning systems

4 Mitigation

Voluntary actions for emissions reductions can be taken up with adequate technological and financial support from the ICs.

- DCs have no commitments to reduce GHG emissions;
- DCs should provide policy frameworks to encourage corporate investments in environmentally sound technologies, like the CDM;
- Some areas for cooperation would be sustainable production and use of energy, waste management and transportation;
- Modalities and procedures for afforestation and reforestation activities need to be defined. These need to be simple so as to keep the transaction costs low.

5 Adaptation

Considering the lower coping capacities of DCs and the commitments made by ICs under the UNFCCC there is an urgent need to set up and further implement a global agenda for adaptation.

This should include:

- Operationalisation and expansion of existing adaptation funds with fast track and simplified mechanisms for expedited access to funding;
- N-S cooperation to carry out vulnerability studies, and identify appropriate technological options suitable to local conditions with an emphasis on local traditional knowledge;
- Support for preparation and implementation of National Adaptation Plan of Action (NAPAs) in DCs;
- Technical support to implement adaptation measures and programs;
- Building resilience and coping capacities of communities by promoting sustainable livelihood practices, infrastructure development and insurance.

6 Conclusions

- We are all on the same boat, but on different decks.
- The UNFCCC – KP regime is a good start, but is not enough and any future international framework for action on CC will have to include further incentives for international cooperation.
- There are synergies between local sustainable development priorities in DCs and global efforts on CC mitigation and adaptation.
- Work on paradigm shifts for lifestyle changes leading to low emission societies is necessary.

Appendix

Climate Change Mitigation and Adaptation. Identifying Options for Developing Countries

7. – 17. September, 2003, Bad Münstereifel, Germany

Sunday (9/7)	**Monday** (9/8)	**Tuesday** (9/9)	**Wednesday** (9/10)	**Thursday** (9/11)	**Friday** (9/12)	**Saturday** (9/13)
Arrival of Participants	**Introduction** **9. 00** Introduction *Katenkamp BMBF, GER* *Ehlers, GER* **9.30** Introducing Ourselves - who we are and what we expect *Participants* **11.00 Coffee** **Science of Climate Change** **11.30** *Anthropogenic GHG Emissions: Sources and Trends* Schaldach, GER **12:30** *Climate Change: The impacts* Sear, UK **13:30 Lunch** **14:30** *Climate Change: Models, Scenarios and Observations* Cubasch, GER **15:30 Coffee** **Policy of Climate Change** **16:00** *The Political Context of Climate Change – History & State of the Negotiations* Harders, GER **17:30** *The Relevance of Climate Change Negotiations for Developing Countries* Dasgupta; IND	**Mitigation** **9:00** *Emission Reduction: The Options and Strategies in Europe* Hake, GER **10:15 Coffee** **10:45** *How to cope with rising Emissions from Developing Countries?* Dasgupta, IND **12:00** *Strategies for Sectoral Emission Reduction in Germany* Kleemann, GER **13:00 Lunch** **14:30** *Urbanisation and Global Environmental Change* Midgley, GER **15:30** *Emission Limitation: Views from the „South"* Sokona, SEN **16:45 Coffee** **17:15** *Emission Limitation in the "South"?* (Working Groups Participants)	**Adaptation** **9:00** *Adaptation: A Challenge for the "North" and the "South"?* Forner, COL **10:00 Coffee** **10:30** *Adaptation: Case Studies in the "North"* Sear, UK *Adaptation: Case Studies in the "South"* Szekely, MEX **11:30** Adaptation: Challenges & Options (Working Groups Participants) **12:30 Lunch** **South-North-Cooperation** **13:30** *Carbon-Sinks: Enhancement & Management* Leithner, GER **14:30** *Clean Development Mechanisms: Effective and Efficient for "North and South"?* Lottmann, GER **15:30 Coffee** **16:00** *Technology Transfer: Experiences & Perspectives* Liptow, GER **17:00** *State & Perspectives of the "North-South"-Cooperation* (Working groups Participants)	*Excursions* Future Power Generation: „Clean Coal" (RWE-Rheinbraun Bergheim) Renewables: Solar City, Jülich	**Business** **9:00** *Industry Contributions: Emission Reductions & Self-Commitments* Hein, GER **10:00** *The Role of Transnational Corporations in the Climate Business* Mock, GER **11:00 Coffee** **11:30** *Options for & Experiences of the Private Sector in Developing Countries* Baumann, GER **12:30 Lunch** **13:30** *Corporations and the "South"* (Working groups Participants) Introduction: Salih, MAR **15:30 Coffee** Continuation working group	Individual programme of the Participants (all day)
	19:00 *Dinner and "come together"*	**19:30** *Dinner*	**19:00** *Dinner*	**19.00** *Dinner*	**19:00** *Dinner*	Lunch + Dinner (available on demand)

Sunday (9/14)	**Monday** (9/15)	**Tuesday** (9/16)	**Wednesday** (9/17)
Social Program (optional) (all day, including lunch) Trip to the **Rhine River** **19.00 Dinner**	**Integrating the "South": Options & Strategies for a Global Climate Protection Regime** **9:00** *Evolution of Commitments under the UNFCCC* Höhne, GER **10:00** *Commitment to Human Development Goals with low Emissions - An alternative to emissions caps for post-Kyoto from a developing country perspective -* Pan, CH **12:00 Lunch** **13:30** **Working groups: discussions for a set of conclusions** *An Universal Climate Protection Regime?* *(Discussion all Participants)* Introduction: Salih, MAR *Questions:* *What are current obstacles in science and decision-making to promoting the understanding of global environmental change and formulating effective response strategies?* *Is there a need to integrate the "South" in the climate protection regime - under which conditions?* *What are the administrative and practical problems developing countries encounter in the implementation of cooperative measures?* *How does climate change impact on and interact with other development and environmental priorities?* *Where are synergies?* *Are there opportunities for local and global solutions? How can a better basis for cooperation be generated?* **15:00 Coffee** **15:30** Continuation working groups **16:30** *Discussion of the results of the two working groups and development of a set of conclusions (all Participants)* **19:00 Dinner**	**8:30** Trip to Bonn, BMBF **10:00** Welcoming and Introduction *MinDir Junker, BMBF* *Board member Eisenbeiß, FZJ* **10:15** **Presentation of Conclusions** *by Participants to the Representatives from Government, Business and Non-Governmental Organizations at BMBF, Bonn* *Reflections from an experienced observer* Vlek, NL **12:30 Lunch** **13:30** **Round Trip:** *Bonn – A Center of "South – North"-Dialogue & UNO-Institutions* "Guide": Ehlers, GER **Late Afternoon** Back to Bad Münstereifel **18:00** **Farewell Dinner**	**Departure**

Last Update 4th September

INDEX OF PARTICIPANTS

Andrew I. Ayeni
Federal Ministry of Environment
7th&9th Floor, Federal Secretariat,
P.M.B. 468, Garki, Abuja
Nigeria
E-mail: aiayeni@yahoo.com

Suruchi Bhadwal
The Energy and Resources Institute
Darbari Seth Block Habitat Place
Lohidi Road
New Delhi
India
E-mail: suruchib@teri.res.in

Isabel Bustillos
Presencia Ciudadana Mexicana
Zacatecas 206 PH, Colonia Roma
06700
Mexico D.F.
Mexico
E-mail: chabe55@hotmail.com

Marco Túlio Scarpelli Cabral
Ministry of Foreign Relations
Division of Environmental Policy and Sustainable Development
Esplanada dos Ministérios,
Brasilia
Brazil
E-mail: mcabral@mre.gov.br

Chao Qingchen
National Climate Centre
No. 46, Zhongguancun Nandajie, Haidan District
Beijing, 100081
China
E-mail: chaoqc@cma.gov.cn

Martin De Wit
CSIR, Environmentek
P.O. Box 395
Pretoria 0001
South Africa
E-mail: mdewit@csir.co.za

Eliezer Martins Diniz
Faculdade de Economia,
Administracao e Contabilidade
Universidade de Sao Paulo
Av. dos Bandeirantes, 3900
14040-900 Sao Paulo
Brazil
E-mail: elmdiniz@usp.br

Svetlana A. Dolgikh
Kazakh Research Institute for Environment Monitoring and Climate
Rozybakiev st., 291, app. 25
Almaty
Kazakhstan
E-mail: dolgikh@kniimosk.almaty.kz

Gamal El-Azaly
National Research Centre
El-Tahrir st., Dokki
Cairo
Egypt
E-Mail: elazaly@hotmail.com

Viviana Horna
May Planck Institute for
Biogeochemistry
Winzerlaer Str. 10
07745 Jena
Germany
E-mail: viviana.horna@bgc-
jena.mpg.de

Jiang Hui
Yueyang Environment Protection
Bureau
Number 57, Road yuedong
Yueyang, Province Hunan
China
E-mail: yyjh3593@sina.com

Chou Jieming
START Regional Research Centre for
Temperate East Asia
Chinese Academy of Science
Beijing, 10029
China
E-mail: choujm@tea.ac.cn

Vivek Kumar
The Energy and Resources Institute
Darbari Seth Block Habitat Place,
Lohdi Road
New Delhi
India
E-mail: kumarv@teri.res.in

Le Anh Ngoc
Ministry of Natural Resources and
Environment
Hanoi
Viet Nam
E-mail: vnccoffice@fpt.vn

Batbayar Luvsanpuntsag
"Environment21"
Ulan Bator
Mongolia
E-mail: jemr@magicnet.mn

Samwel O.O. Marigi
Kenya Meteorological Department
P.O. Box 30259
Nairobi
Kenya
E-mail: drmarigi_samwel
@yahoo.co.uk

Gabriela Julieta Gonzales Merla Laguna
Burguete, Celis Y Asociados, S.C.
Recreo #89-501 Del Valle c.p. 03100
México City
Mexico
E-mail: gabygmerla@hotmail.com

Kelebogile Shirley Moroka
Department of Environmental Affairs
& Tourism
Private Bag X447
0001 Pretoria
South Africa
E-mail: Kmoroka@ozone.pwv.gov.za

Helena Al-Naber
ECO Consult
Jude Center
Salem Al-Hindawi St, Sheisani
P.O. Box 941400
Amman 11194
Jordan
E-mail: Helena.naber@eco-jo.com

Leidy Pedre Sierra
Department of International Collaboration
Ministry of Science, Technology and Environment
Havanna
Cuba
E-mail: leidy@citma.cu

Mauricio Nine
Ministry of Foreign Affairs
Department of Environmental Affairs
Esmeralda 1212, 14th floor, (1007)
Capital Federal
Argentina
E-mail: nmr@mrecic.gov.ar

Florencia B. Pulhin
Environmental Forestry Programme
University of the Philippines Los Banos College
Laguna
Philippines
E-mail: enfor@laguna.net

Govindarajan Srinivasan
Department of Science & Technology
Earth System Science Division
Technology Bhawan
New Delhi 110016
India
E-mail: srinidst@alpha.nic.in

Balgis Elhasa Osman
Higher Council for Environment & Natural Resources (HCENR)
HCENR-Gamma Street -
Khartoum 10488
Sudan
E-mail: balgis@yahoo.com

Neni Sintawardani
Ministry of Research, Science and Technology
Jl. MH. Thamrin 8
Jakarta 10340
Indonesia
E-mail: nenisintawardan@lipi.fisika.net

Ologun Rolands Olugbenga
Town Planners Registration Council of Nigeria
P.M.B. 7012, ADCPA Post Office
Area 1
Garki-Abuja
Nigeria
E-mail: olurolands@yahoo.com

Monica Wehbe
Universidad Nacional de Rio Cuarto
Facultad de Ciencias Económicas
Ruta Nac. 36, km 601
X5804BYA Rio Cuarto
Argentina
E-mail: mwehbe@eco.unrc.edu.ar

INDEX OF LECTURERS AND ORGANISING COMMITTEE

Klaus Baumann
RWE AG
International Markets
Opernplatz 1
45128 Essen
Germany
E-mail: klaus.baumann@rwe.com

Ulrich Cubasch
Meteorologisches Institut der Freien Universität Berlin
Carl-Heinrich-Becker-Weg 6-10
12165 Berlin
Germany
E-Mail: cubasch@zedat.fu-berlin.de

Chandrashekar Dasgupta
The Energy and Resources Institute
Distinguished Fellow
Darbari Seth Block Habitat Place
Lohidi Road
110003 New Delhi
India
E-mail: dasgupta@teri.res.in

Claudio Forner
UNFCCC secretariat
Methods, Inventories and Science Programme
53175 Bonn
Germany
E-mail: cforner@unfccc.int

Jürgen-Friedrich Hake
Forschungszentrum Jülich GmbH
Programme Group Systems Analysis and Technology Evaluation (STE)
52425 Jülich
Germany
E-mail: jfh@fz-juelich.de

Enno Harders
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
11055 Berlin
Germany
E-mail: Enno.Harders@bmu.bund.de

Joachim Hein
Federation of German Industries (BDI)
Department of Environmental Policy
10178 Berlin
Germany
E-mail: j.hein@bdi-online.de

Niklas Höhne
ECOFYS Energy & Environment
50933 Köln
Germany
E-mail: n.hoehne@ecofys.de

Manfred Kleemann
Forschungszentrum Jülich GmbH
Programme Group Systems Analysis and Technology Evaluation (STE)
52425 Jülich
Germany
E-Mail: m.kleemann@fz-juelich.de

Reinhard Leithner
Institut für Wärme- und Brennstofftechnik
Technische Universität Braunschweig
38106 Braunschweig
Germany
E-mail: r.leithner@tu-bs.de

Holger Liptow
Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ)
Climate Protection Programme
65726 Eschborn
Germany
E-mail: holger.liptow@gtz.de

Jürgen Lottmann
German Development Bank
Head of Environmental Unit
Palmengartenstrasse 5-9
60325 Frankfurt am Main
Germany
E-mail: Juergen.Lottmann@kfw.de

Pauline M. Midgley
IER, University of Stuttgart
Heßbrühlstraße 49
70565 Stuttgart
Email: pauline.midgley@ier.uni-stuttgart.de

Thomas Mock
Hydro Aluminium Deutschland GmbH
Ettore-Bugatti-Strasse 6-14
51149 Köln
Germany
E-mail: Thomas.Mock@hydro.com

Jiahua Pan
Research Centre for Sustainable Development
Chinese Academy of Social Sciences
100732 Beijing
China
E-mail: Panjh@163bj.com

Karsten Sach
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
11055 Berlin
Germany
E-mail: Karsten.Sach@bmu.bund.de

Mohamed A. Salih
Institute of Social Studies
Politics of Development
P.O. Box 29776
2502 LT The Hague
The Netherlands
E-mail: salih@iss.nl

Rüdiger Schaldach
University of Kassel
Kurt-Wolters-Straße 3
34109 Kassel
Germany
E-mail: rschaldac@usf.uni-kassel.de

Chris B. Sear
serial_interface
31 The Landway, Bearsted
Maidstone, Kent ME14 4BE
United Kingdom
E-mail: chris_sear@btinternet.com

Youba Sokona
NDA Tiers Monde
Programme Energie
54, rue Carnot
B.P. 3370
Dakar, Sénégal
E-mail: energy2@enda.sn

Paul L. G. Vlek
Center for Development Research
Walter-Flexstr. 3
53113 Bonn
Germany
E-mail: p.vlek@uni-bonn.de

Eckart Ehlers
Institut für Wirtschaftsgeografie
Universität Bonn
53115 Bonn
Germany
E-mail: ehlers@giub.uni-bonn.de'

Wolfgang Fischer
Programme Group Systems Analysis and Technology Evaluation
Forschungszentrum Jülich
52425 Jülich
Germany
E-mail: wo.fischer@fz-juelich.de

Karl Ludwig Hüttner
Programme Group Systems Analysis and Technology Evaluation
Forschungszentrum Jülich
52425 Jülich
Germany
E-mail: k.l.huettner@fz-juelich.de

Ulrich Katenkamp
Federal Ministry of Education and Research
Department 622 Globale Change
53170 Bonn
E-mail:
Ulrich.Katenkamp@bmbf.bund.de

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