WMO INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE UNEP

DEVELOPMENT, SUSTAINABILITY AND EQUITY

PROCEEDINGS OF THE SECOND IPCC EXPERT MEETING ON DES

Havana, Cuba 23-25 February 2000

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Foreword

The Intergovernmental Panel on Climate Change (IPCC) was established in 1988, under the joint sponsorship of the World Meteorological Organisation (WMO) and the United Nations Environment Programme (UNEP), to review the vast scientific and technical literature on climate change and provide scientific, technical and economic assessments on these issues. Through its reports and methodologies, workshops, and expert meetings, the IPCC has become a primary source of independent peer-reviewed scientific information for governments and other organisations participating in the United Nations Framework Convention on Climate Change (UNFCCC).

The IPCC First Assessment Report (FAR), issued in 1990 served as a fundamental basis for negotiations leading to the UNFCCC in 1992. The 1990 IPCC Report included assessments of emissions scenarios, the scientific evidence for climate change, the impacts of climate change, and response strategies to climate change. In addition, there was a special report on developing countries.

The Second Assessment Report (SAR) issued in 1995, as well as a series of technical papers and special reports, served as important sources of information during negotiations leading to the Kyoto Protocol in 1997. In the IPCC SAR, the scientific basis for the assessment of the climate system was updated (in volume 1), the potential impacts and response options were explored in greater detail (in volume 2) and the economic and social dimensions of climate change were assessed (in volume 3). However, limited effort was devoted to integration of the three volumes, which were basically produced independently.

Several hundred experts from around the world have embarked upon the IPCC Third Assessment Report (TAR) since 1997. One of the greatest challenges facing this report is to establish closer co-ordination between the three IPCC Working Groups. Working Group I is focusing on the scientific aspects of the climate system and climate change; Working Group II is assessing the vulnerability of ecological systems, socio-economic sectors, and human health to climate change; and Woking Group III is assessing the mitigation of climate change. This will help to produce a set of three integrated reports that will provide the basis for the planned Synthesis Report of the TAR, to be published in 2001.

The Synthesis Report itself seeks to address policy-relevant scientific, technical and socio-economic questions formulated by policy makers involved in the UNFCCC negotiations. These broader issues are generally not limited to the specific domain of any single working group. In addition, it has been increasingly acknowledged that climate strategy should be closely interwoven with other policies; notably those in the area of overall sustainable development. The very process of addressing these policy-relevant questions underlined the need to place climate change response measures in the context of issues such as development, equity and sustainability (DES). The IPCC Plenary has recognised this need and encouraged the authors of the TAR to better integrate DES issues into the Report, through a careful evaluation of available research literature in this area, that goes beyond climate change per se.

Therefore, I am very pleased that Working Groups II and III have taken the initiative to organise a number of expert meetings in this area. The main goals are: (a) to increase co-ordination among, and inform lead authors about DES issues and climate change; and (b) to better place the TAR in the context of development, equity and sustainability; through enhanced access to the best available scientific, technical, economic and social information from across the world.

Developing countries will play a key role in the determining future climate change policy. Perspectives on climate change policies and their context are very different amongst developing regions. Thus, the organisation of the Second Regional IPCC Expert Meeting on DES for Latin America and the Caribbean in Havana, Cuba, was very appropriate. Taking as reference the results of the First Expert Meeting on DES, Colombo, 27-29 April 1999; this meeting further explored and developed ideas on DES, along the lines already identified at the Lead Authors meetings of the Working Groups II and III, with the ultimate goal of: (a) incorporating climate change strategies smoothly into the sustainable development agenda, notably in Latin America and the Caribbean; (b) assessing and rectifying any shortcomings in the treatment of DES issues in the first drafts of Working Groups II and III of the TAR; and (c) encouraging the participation of experts from Latin America and the Caribbean in this debate.

This Proceedings volume reflects the richness of the debate carried out during the meeting, and provides new inputs to the worldwide debate on the linkages between climate change and sustainable development.

Robert Watson
Chair, IPCC

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This volume benefited greatly from the guidance of the international steering committee, and the co-operation of the paper authors during the compilation of the proceedings. The editors would also like to thank Gladys Hernández, Julio Torres, Rosa Cabrera and Ivette Miranda for their contribution in the preparation of the final draft.

The organisation of the meeting and the preparation of these proceedings would not have been possible without the assistance of the IPCC Secretariat, Technical Support Units of Working Groups II and III of the IPCC, Netherlands National Institute for Public Health and Environment (RIVM), UNDP Office in Havana, Regional Office of UNEP for Latin America and the Caribbean, Ministry of Science, Technology and Environment (Agency of Environment) of Cuba, and Centre for World Economy Studies (CIEM) in Havana.

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SECOND REGIONAL EXPERT MEETING ON "DEVELOPMENT, EQUITY AND SUSTAINABILITY", HAVANA, 23-25 FEBRUARY 2000

SUMMARY

Ramon Pichs, Neil Leary and Rob Swart

I. Introduction and Framework

The Second IPCC Expert Meeting on Development, Equity and Sustainability (DES) was held in the Hotel Copacabana, Havana, Cuba, on 23-25 February 2000.

Taking as reference the results of the First Expert Meeting on DES, Colombo, 27-29 April 1999; this meeting further explored and developed ideas on DES, along the lines already identified at the Lead Author meetings of the Working Groups (WG) II and III, with the ultimate goal of:

- incorporating climate change strategies smoothly into the sustainable development agenda;
- assessing and rectifying any shortcomings in the treatment of DES issues in the first drafts of WG II and WG III Reports (Third Assessment Report, TAR);
- encouraging the participation of experts from Latin America and the Caribbean in this debate. The meeting was conceived with a regional (Latin American and Caribbean) focus.

The participants included 30 invited experts on climate change: 17 from Latin America and the Caribbean; 6 from North America; 4 from Asia; 2 from Europe and one representative of the UNDP Office in New York. Ten Cuban experts also attended the meeting.

Dr. Rosa Elena Simeon, Minister of Science, Technology and Environment of the Republic of Cuba opened the meeting on the evening of Wednesday, 23 February 2000. In her speech, the Minister emphasised the requirement of climate change response strategies, integrating development, equity and sustainability issues, at the global, regional and local levels. She also stressed the efforts of Cuba in dealing with the climate change related challenges. Dr. Osvaldo Martinez, Director of the Centre for World Economy Studies (CIEM) and President of the Commission for Economic Affairs of the Cuban Parliament referred to the socio-economic gap between the North and the South in the context of globalisation; and pointed out the importance of properly dealing with DES concerns in designing responsible environmental strategies. Dr. Tomihiro Taniguchi and Dr. Bert Metz

addressed the meeting on behalf of the IPCC Bureau, highlighting the relevance of the DES as one of the cross-cutting issues of the IPCC TAR.

During the two sessions (A & B) and the Round Table of Thursday 24 February, eighteen speakers expressed their views with respect to the international debate on DES issues and climate change response strategies, with particular reference to the Latin American and the Caribbean context.

Session A, chaired by Mohan Munasinghe, Sri Lanka, and Ramon Pichs, Cuba, focused on Sustainable Development and Climate Change. This session included two introductory presentations, with particular reference to the framework for incorporating DES into the TAR (by Mohan Munasinghe, Sri Lanka; and John Robinson, Canada); and three main topics: Socio-economic and Emission Scenarios for Latin America and the Caribbean (by Emilio Lebre La Rovere, Brazil; and Mario Nuñez, Argentina); Climate Change Impacts and Adaptation / Implications for Sustainable Development (by Max Campos, Costa Rica; and Americo Saldivar, Mexico); and Climate Change Mitigation / Implications for Sustainable Development (by Humberto Rodriguez, Colombia; and Carlos Suarez, Argentina)

Session B, dealing with equity and climate change was chaired by Ronaldo Seroa Da Mota, Brazil, and included two basic topics: Equity and Climate Change Response Strategies (by Juan Llanes, Cuba; Luiz Pinguelli, Brazil; Raul Estrada-Oyuela, Argentina; and Tom Heller; USA); and Equity and Climate Change / Lessons for Latin America and the Caribbean (by Hector Sejenovich, Argentina; and Omar Masera, Mexico).

This working day was closed with a **Round Table,** chaired by Ramon Pichs, Cuba. In this round table, four panellists (Eduardo Sanhueza, Chile; Carlos Rios, Colombia; Leonard Nurse, Barbados; and Angel de la Vega, Mexico) explored the opportunities and barriers for incorporating climate change response strategies into the sustainable development agenda.

The programme for Friday 25 February was organised in two sessions (C & D), with ten basic presentations oriented to assess and rectify shortcomings in the treatment of DES issues in the first drafts of WG II and WG III TAR.

Session C was chaired by Bert Metz, The Netherlands, and included eight speakers. Neil Leary, USA; Saleemul Huq, Bangladesh; Luis Mata, Venezuela; and Stewart Cohen, Canada particularly referred to DES in the WG II TAR; while Luiz Pinguelli, Brazil; John Robinson, Canada; Carlos Gay, Mexico; and Rob Swart, The Netherlands, based their presentations on DES in the WG III TAR.

Session D, chaired by Tomihiro Taniguchi, Japan, was devoted to the Rapporteurs (Neil Leary, TSU-WGII; and Rob Swart, TSU-WG III) Summary and the general discussion on next steps.

A **public symposium** was organised after the meeting, chaired by Dr. Gisela Alonso, President of the Agency of Environment of Cuba; with attendance of around 80 participants from Cuban institutions dealing with DES issues. WG III co-chair Bert Metz based his presentation on the current developments on climate change at the international level; Raul Estrada Oyuela, Argentina referred to the Latin American and the Caribbean context; and Luis Paz presented the Cuban experience on climate change adaptation and mitigation.

II. Summary of Lessons for and from Latin America and the Caribbean

During the sessions dealing with the Latin American and the Caribbean perspective on DES issues, in the context of climate change response strategies, some basic ideas were presented and discussed. The summary of the discussion presented here reflects views and ideas expressed by participants in the meeting and is not a summary of IPCC views or findings on sustainable development and equity issues as they relate to climate change.

Basic ideas expressed by the participants in the sessions on Latin America and the Caribbean:

- The increasing recognition of the interconnectedness of social, economic and environmental conditions and issues. The three standard dimensions of sustainable development do not map simply or unidimensionally onto three dimensions of DES.

- Future greenhouse gases (GHG) emissions are the product of complex dynamic systems, determined by driving forces such as population growth, socio-economic development and technological change. Scenario building can provide a powerful tool and a framework to discuss impacts of climate change, adaptation and mitigation strategies, as well as sustainable development issues. Further research -particularly regional studies- is needed to improve the representation of the narrative scenario components by modelling approaches.

- Climate change response strategies, based on sustainable development considerations, would be an important component of policies designed to face the challenges of globalisation and the structural changes brought by neoliberal reforms in Latin America and the Caribbean. Environmental education and community participation are crucial for the implementation of climate change policies within an agenda for sustainable development.

- The Latin American and the Caribbean contribution to the climate change mitigation strategies can be analysed by examining the low regional coefficient of specific CO_2 emissions per energy unit. However, the privatisation of the energy systems in several Latin American and the Caribbean countries has accelerated during the 90s, and this process, under the particular conditions of some Latin American and the Caribbean

countries, has tended to increase GHG emissions, with negative impacts for climate change mitigation. Experience in other regions has demonstrated that under different conditions privatisation can lead to lower emissions.

- In addition to national policy measures, new international procedures are required to transfer economic resources to developing countries, in general, and to Latin America and the Caribbean, in particular, taking into account the relatively low contribution to climate change from the region compared to industrialised countries, and to enhance the region's future contribution to more efficient solutions for climate change mitigation. International systems of compensatory taxes could be explored as sources of funds to support sustainable development objectives in the developing countries, in synergy with the climate change response strategies.

- An integral approach, based on long-term socio-economic sustainable development, instead of short-term oriented free market forces, would be crucial for additional contributions of Latin America and the Caribbean to climate change mitigation.

- The unequal income distribution in the world and within the region is a key element for identifying the levels of responsibility of different countries and social groups, in the debate and negotiations on climate change. Equity problems have been analysed mainly among nations, but some equity questions must be analysed from the regional point of view and also from the sub-national point of view.

- Adequate inclusion of equity criteria in the TAR, with special reference to intragenerational equity, is a condition *"sine qua non"* for the credibility of the Report and its acceptance by the developing countries. The literature on the model of "contraction and convergence" must be properly considered in the TAR.

- The burden of emission reduction compares with other international imposed burdens as the foreign debt of the developing countries, although they are not fully comparable. Based on equity considerations, for almost all developing countries a global QELROS[1] framework is unacceptable. It appears more promising to explore alternative policy frameworks for the developing countries, such as benchmarking of sectoral technologies or efficiencies. Those policy frameworks should consider the specific DES priorities of the developing countries.

- Future regional research must consider the development of indicators for measuring and registering the contribution of the various socio-economic sectors to climate change in the national accounts. Special attention must be paid to the socio-economic and cultural effects of climate change mitigation policies.

[1] Quantified Emission Limitation and Reduction Objectives

- Climate change adaptation and mitigation strategies require a long-term approach due to the long-term perspective of climate change as a global environmental problem. The analysis of mitigation/ adaptation response options needs an alternative decision-making framework that fully integrates sustainability, equity and development concerns. In this regard, it is essential:
  - to consider how these options contribute to: productivity (efficiency), stability, policy reliability, resilience, adaptability, equity, and self-reliance;
  - to derive indicators for each of the attributes and options;
  - to integrate the different indicators in a multicriteria decision making framework .

- Adequately designed and implemented mitigation options in the forest sector may present environmental and socio-economic benefits. Mitigation/adaptation options in this sector must address equity concerns related to differences among countries, options and social groups; capacity building; technology and development; effective community participation; and consistency with regional/ national sustainable development priorities.

- With regard to technology policies to achieve the goals of the Climate Change Convention, it is important to take into account the increasing technological gap between the North and the South. Technology can not be seen as a goal in itself. In analysing climate change response options both technological and social aspects have to be considered. Current modelling approaches are not very well equipped to deal with social issues, particularly not at the regional level.

- It is required, in the region, further research on the opportunities and challenges derived from the flexibility mechanisms of the Kyoto Protocol (CDM, in particular) for sustainable development. Market price distortions over real values is the root of some statements about lower emission reduction costs in developing countries. Therefore, to fully understand the implications and opportunities of the CDM for Latin America and the Caribbean, especially in terms of full social cost, possible projects would have to be evaluated taking into account all elements of development, sustainability and equity for the Latin American and the Caribbean nations.

III. Summary of Discussions on WG II-TAR

The general framework applied by WG II for the assessment of vulnerability to climate change is one that can readily integrate sustainable development and equity issues. Vulnerability to climate change is defined as the degree to which a system is susceptible to damage or adverse effects from climate change. It is a function of system exposure to climatic variation, the sensitivity of the system to climate stimuli, and the adaptive capacity of the system to adjust to climatic stimuli. The future development path will shape each of the three determinants of vulnerability.

The location of future development is a determining factor of future exposure of human populations and resources to climate variation. The rate and character of development are determining factors of non-climate pressures acting on systems such as population growth, land and other resource use, and air and water pollution. These pressures can fundamentally alter the sensitivity of systems to climate stimuli. The rate and character of development will also determine adaptive capacity by shaping the amount and distribution of access to resources, information, technology and skills that can aid adaptation.

The first draft of the WG II report already makes effective use of this framework for linking sustainable development and equity issues to climate change vulnerability. Most draft chapters identify non-climate pressures acting on systems and review evidence of potential effects of non-sustainable development on natural and human systems and the potential consequences for the vulnerability of systems to climate change. There is also consideration of the implications for adaptive capacity of development that either exacerbates or closes gaps in access to resources, technology and information between developing and developed countries, or across different segments of the population. The draft report includes limited assessment of the pathways by which climate change impacts may alter future development prospects and differences in the impacts by region and by social-economic group. Finally, the draft report considers the potential for adaptation to climate change to promote or conflict with sustainable development and equity objectives.

In the next draft of the WG II report, further effort is needed in three areas. First, the links between development paths and climate change exposure, sensitivity, and adaptive capacity need to be elaborated and made explicit. Second, the potential impacts of climate change on development are only touched upon in a few chapters and need to be explored further. And third, the potential for adaptation response strategies to jointly promote reduced vulnerability to climate change, sustainable development, and equity needs to be evaluated consistently across chapters.

How far the next draft can go on these issues will be limited by the information available in the literature. A number of participants in the discussions urged that the report give explicit coverage of research needs to fill in the existing gaps in the literature. Comments highlighted the need for research at regional scales to better understand the exposures, sensitivities, adaptive capacities, and vulnerabilities at these scales and to better link these issues to sustainable development and equity issues. Research also needs to look at how different segments of the population may be differentially affected.

The discussion pointed to a need for assessment of linkages between adaptation and mitigation responses. The draft reports of WG II and WG III both indicate that the performance, costs and benefits of adaptation and mitigation options are strongly dependent on the future development path. Care is needed to assure that consistent scenarios of future development are used to consider and compare adaptation and mitigation performance, costs and benefits. Attention needs to be given to the possible existence of and nature of trade-offs and synergies between adaptation and mitigation responses. The assessment

should take care to note that the benefits of adaptation tend to be local and private, while the benefits of mitigation tend to be global and public, and to consider what implications these differences have for climate policy decisions.

IV. Summary of Discussions on WG III-TAR

ADEQUACY OF TREATMENT OF DES ISSUES IN IPCC WG III - TAR

- Of the chapters of the first draft of the IPCC-WG III TAR, only chapters 1, 2 and 7 pay significant attention to DES issues, the others pay either lip service to DES, or discuss only elements in a way that is disconnected with the rest of the chapters.
- The phrasing of the linkage between sustainable development and climate change is very important: saying that the development path is more important than climate policies suggests that climate policies would be unimportant; rather the synergy has to be emphasised: climate policies are more effective, easier to implement, and possibly cheaper in a policy environment aiming at sustainable development.
- If DES criteria are taken into account in addition to direct costs, they can effect the ranking of technological options and policies and measures.
- Authors have difficulty in addressing DES issues. They should make extra effort in identifying such literature, should consider non-published/non-peer reviewed literature also, and otherwise identify gaps in knowledge and formulate research recommendations.
- The concept of mitigative capacity can help link the current climate change issues in the report to DES issues; this is especially relevant for describing sectoral and regional differences.
- Considering alternative development pathways is important. It is not only important how the cake is cut, also how it is cooked.

LINKAGES WORKING GROUPS II AND III

- While the SAR focus was on costs-benefits (to help deciding IF action is needed), the TAR seems to move towards mitigation-adaptation in a DES framework (to help deciding WHAT action is needed); important issues to be discussed between WG II and WG III include trade-offs, synergies and co-benefits.
- WG II emphasises strengthening adaptive capacity; WG III mitigative capacity; it should be discussed how these could be combined.
- While earlier IPCC reports used emissions profiles and emissions scenarios, the TAR tends to shift towards the use of alternative development pathways that affect both mitigation and adaptation.
- Sequestration options for mitigation depend on climate impacts, can affect vulnerability to impacts of climate change and adaptation options.

V. Actions after the Expert Meeting

- A draft summary of the meeting was available to the IPCC Community by the end of March 2000.

- A draft proceedings, consisting of a summary and the revised papers, was available to the IPCC Community in electronic format by the end of July 2000. This electronic publication allowed WG II and III Lead Authors (LA) to consider the suggestions of the expert meeting before the last LA meetings for the TAR (Lisbon, 8-10 August 2000, for WG II LAs; and Cape Town, 21-25 August 2000, for WG III LAs).

1

DEVELOPMENT, EQUITY AND SUSTAINABILITY (DES) IN THE CONTEXT OF CLIMATE CHANGE

IPCC Guidance Paper for Lead Authors of the Third Assessment Report (TAR)

Mohan Munasinghe

Note: This paper was originally written as a Guidance Paper for the Lead Authors of the Third Assessment Report (TAR) of the Intergovernmental Panel on Climate Change (IPCC). It was presented at the IPCC Expert Meeting on Development, Equity and Sustainability (DES), held in Colombo, Sri Lanka, 27-29 April 1999. Both the paper and the meeting were designed to help provide guidance to lead authors in dealing consistently with the cross-cutting themes of development, equity and sustainability, which are pervasive throughout the Working Group (WG) II and WG III reports. The paper has been revised based on comments received at that first DES meeting. This draft has also benefited from comments gratefully received from many colleagues (too numerous to mention here), at the first WG III and WG II Lead Authors Meetings (in Bilthoven, December 1998; and Geneva, January 1999, respectively), as well as those provided via several e-mail conferences. All shortcomings are my responsibility.

1. Overview and Objectives

Development, equity and sustainability are key cross-cutting issues that pervade the IPCC Third Assessment Report – especially chapters of WG II and WG III. They are also key concepts that are well established world-wide (but not always well-defined), in the minds of both decision-makers and the general public. Relating these issues more explicitly to climate change is important, for two reasons. First, there are fundamental scientific and epistemological links between DES issues and climate change phenomena. Second, such an analysis will add to the cogency of arguments and ultimate acceptability of strategies to address climate change problems. It will help to underline the essential point that climate change is a key element of the broader search for sustainable development paths – a universal goal already enshrined in the post-Rio consensus on Agenda 21 (*WCED 1987*; *UNFCCC 1993*). Strengthening these linkages in the TAR will also offset criticisms that past efforts to develop climate change strategies have focused too narrowly on technical

analyses, without paying adequate attention to the socio-economic aspects (*Newby 1993; Cohen et al. 1999*).

Accordingly, this paper seeks to outline an integrative framework that links the themes of development, equity and sustainability in the context of national decision making today. A holistic approach is necessary because these broad themes overlap and are not easily separable. The concept of sustainable development (including its economic, social and environmental dimensions) provides a useful starting point, and hence the TAR authors might consider the following broad and long term questions, in relation to DES issues:

1. How will expected development patterns and scenarios affect climate change?
2. How will climate change impacts, adaptation and mitigation affect sustainable development prospects?
3. How could climate change responses be better integrated into sustainable development strategies?

A major challenge for the TAR is to find the appropriate balance between the larger tapestry and its constituent threads. Ideally, the TAR should provide an overall meta-framework which could coherently integrate the different elements relating to DES (i.e., key issues, disciplinary viewpoints, etc.)[1]. This would be more persuasive – especially to decision-makers and non-specialist readers. At the same time, each specific element or discipline needs to be represented as accurately as possible, within the broader framework – to satisfy scientific and professional readers. If different disciplinary approaches and methodologies predict different outcomes, this should be explained clearly in the TAR. Furthermore, there is likely to be some dilution of rigour as we start from concepts and theory, and move through practical models, to field level implementation of methodologies. Clearly, this paper is far too short to provide exhaustive coverage of all aspects of these wide-ranging issues. Instead, it focuses on providing some helpful insights, by setting out several underlying unifying concepts that will help to ensure consistency in the treatment of DES issues as they recur across different chapters. The intention is to provide individual lead authors greater flexibility in building on these ideas from their own disciplinary viewpoints, as appropriate for their chapters.

The paper is organised as follows. In Section 2, the close relationship between DES and the rather elusive concept of sustainable development is described. The focus here is on synthesising a holistic and balanced approach that defines and integrates development, equity and sustainability in relation to the three key elements of sustainable development – economic, social and environmental. Two broad integrative approaches involving optimality and durability are outlined. Section 3 summarises the potentially severe impacts of climate change on long term sustainable development and human welfare. The TAR could help to better inform decision-makers by analysing the extent to which climate change could threaten future prospects for achieving fundamental national goals involving

[1] Three special reports prepared as a prelude to the TAR, have already sought to address DES issues – see *IPCC (2000a), IPCC (2000b),* and *IPCC (2000c).*

DES. Section 4 explores the links between macroeconomic and sectoral development policies, and climate change mitigation and adaptation. It examines how climate change measures could be incorporated more smoothly into conventional economic policies without undermining human welfare and growth potential – especially in the poorer countries. The TAR could help to clarify how more priority might be placed on restructuring development to reduce greenhouse gases (GHG) emissions while maintaining growth (e.g., using win-win and no-regrets strategies). Finally, in Section 5 an attempt is made to provide guidance to authors by identifying the relevance of the foregoing for the different chapters of the TAR (see Table 1 and Annex 1). Several other annexes provide further details about selected topics.

2. Development, Equity and Sustainability as Integral Elements of Sustainable Development

2.1. SUSTAINABLE DEVELOPMENT

The world is currently exploring the concept of sustainable development or "development which lasts" – an approach that will (inter-alia) permit continuing improvements in the present quality of life at a lower intensity of resource use, while leaving behind for future generations enhanced stocks of assets (i.e., manufactured, natural and social capital) that will provide undiminished opportunities for improving their quality of life. While no universally acceptable practical definition of sustainable development exists as yet, current approaches to the concept of sustainable development draw on the experience of several decades of development efforts.

Historically, the development of the industrialised world focused on material production. Not surprisingly, most industrialised and developing nations have pursued the economic goal of increasing output and growth, during the twentieth century. By the 1960s the large and growing numbers of poor in the developing world, and the lack of "trickle-down" benefits to them, resulted in greater efforts to directly improve income distribution. The development paradigm shifted towards equitable growth, where social (distributional) objectives, especially poverty alleviation, were recognised as distinct from, and as important as economic efficiency. Protection of the environment has now become the third major objective of development. Through the 1970s, a large body of evidence accumulated that environmental degradation was a major barrier to development, and new proactive safeguards were gradually introduced (such as the environmental impact assessments).

Currently therefore, the concept of sustainable development has evolved to encompass three major points of view: economic, social and environmental, as shown in Figure 1 (see for example, *Munasinghe 1993*). Furthermore, there is increasing agreement that these three critical elements need to be treated in a balanced manner, and one may envision sustainable development in terms of an appropriate vector of economic, social and environmental attributes.

It is useful to review how the treatment of sustainable development (and DES issues) has evolved during the IPCC process, as depicted in Figure 2. The first assessment report (FAR) dealt almost exclusively with the science of climate change. Attempts to address DES issues in the second assessment report (SAR) were not very satisfactory. The intent of the TAR is to explore the intersection between climate change and DES issues more systematically. Ultimately, a feasible climate change response needs to be embedded integrally within an overall sustainable development strategy for humankind (rather than merely added to it).

As summarised in Table 1, it is also helpful to define the three key cross-cutting issues in the TAR – development, equity and sustainability – in terms of the economic, social and environmental dimensions of sustainable development. The various writing teams need to determine the appropriate interpretation, depending on the specific context in which the ideas of development, equity and sustainability are used in the different chapters of the TAR. Although the exact definition of sustainable development paths is not within the scope of the TAR, it may be more feasible to assess whether climate change and potential response strategies might make future development prospects more or less sustainable.

2.2. DEVELOPMENT

Development is strongly associated with economic growth, but has important social dimensions as well (see also, the section on equity below). Economic progress is often evaluated in terms of welfare (or utility) – measured as willingness to pay for goods and services consumed.[2] Many economic policies typically seek to enhance income, and efficient production and consumption of (mainly marketed) goods and services. The stability of prices and employment are among other important objectives. The degree of economic efficiency is measured in relation to the ideal of Pareto optimality which encourages actions that will improve the welfare of at least one individual without worsening the situation of anyone else. The idealised, perfectly competitive economy is an important (Pareto optimal) benchmark, where efficient prices play a key role in both allocating productive resources to maximise output, and ensuring optimal consumption choices which maximise consumer utility. The well known cost-benefit criterion that accepts all projects whose net benefits are positive (i.e., aggregate benefits exceed costs), is based on the weaker "quasi" Pareto condition – which assumes that such net benefits could be redistributed from the potential gainers to the losers, so that no one is worse off than before. More generally, interpersonal comparisons of (monetised) welfare are fraught with difficulty (both within and across nations, and over time) – e.g., the value of human life.

[2] However, the equation of welfare with monetary income/consumption has been challenged. For example, Buddhist philosophy (over 2500 years old) still stresses that mental contentment is not necessarily synonymous with material consumption. More recently, *Maslow (1970)* and others have identified hierarchies of needs which provide psychic satisfaction, beyond mere goods and services.

Social development usually refers to improvements in both individual well-being and the overall welfare of society (more broadly defined), that result from increases in social capital – typically, the quantity and quality of social interactions that underlie human existence. Institutional capital refers mainly to the formal laws as well as traditional or informal understandings that govern behaviour. Organisational capital is embodied in the entities (both individuals and social groups) which operate within these institutional arrangements. The level of mutual trust and extent of shared social norms help to determine the stock of social capital. There is an important element of equity and poverty alleviation as well (see below). Thus, the social dimension of development includes protection strategies that reduce vulnerability, improve equity and ensure that basic needs are met. It implies that socio-political institutions will adapt to meet the challenges of modernisation, which often destroy traditional coping mechanisms that have evolved in the past (especially to protect disadvantaged groups).

Development in the environmental sense is a more recent concern relating to the need to manage scarce natural resources in a prudent manner – because human welfare ultimately depends on ecological services. Ignoring safe ecological limits will increase the risk of undermining long-run prospects for economic growth and consumption (see Section 4). *Dasgupta and Maler (1997)* point out that until the 1990s, the mainstream development literature hardly mentioned the topic of environment (see for example, *Stern 1989; Chenery and Srinivasan 1988 and 1989;* and *Dreze and Sen 1990*). An even more recent review paper on economic growth in the prestigious *Journal of Economic Literature* mentions the role of natural resources only in passing *(Temple 1999).* One important implication of the foregoing is that TAR authors addressing DES issues need to systematically search well beyond the mainstream journals – in as many different countries and languages as possible.

2.3. EQUITY

Equity is an ethical and usually people-oriented concept with primarily social, and some economic and environmental dimensions (see Annex 3 for details). It focuses on the basic fairness of both the processes and outcomes of decision-making – i.e., procedural and consequential equity, mentioned in the *UNFCCC (1993).* The equity of any action may be assessed in terms of a number of generic approaches, including parity, proportionality, priority, utilitarianism, and Rawlsian distributive justice (*IPCC 1996c: chapter 3*).[3] Societies normally seek to achieve equity by balancing and combining several of these criteria. Poverty alleviation, improved income distribution and intra-generational (or spatial) equity are key aspects of economic policies seeking to increase overall human welfare (*Sen 1981, 1984*). *Brown (1998)* points out shortcomings in utilitarianism, which underlies much of the economic approach to equity. Broadly speaking, economic efficiency provides guidance on producing and consuming goods and services more efficiently, but is unable to provide a means of choosing (from a social perspective) among alternative

[3] For example *Rawls (1971)* stated that "Justice is the first virtue of social institutions, as truth is of systems of thought".

patterns of consumption which are efficient. Equity principles provide better tools for making judgements about such choices.

Social equity is also linked to sustainability, because highly skewed or unfair distributions of income and social benefits are less likely to be acceptable or lasting in the long run. Equity is likely to be strengthened by enhancing pluralism and grass-roots participation in decision-making, as well as by empowering disadvantaged groups (defined by income, gender, ethnicity, religion, caste, etc.) *(Rayner and Malone 1998)*. In the long term, considerations involving inter-generational equity and safeguarding the rights of future generations, are key factors. In particular, the economic discount rate plays a key role with respect to both equity and efficiency aspects (*Arrow et al. 1995; IPCC 1996c: chapter 4*).

Equity in the environmental sense has received more attention recently, because of the disproportionately greater environmental damages suffered by disadvantaged groups. In the same vein, poverty alleviation efforts (which traditionally focused on raising monetary incomes), are being broadened to address the degraded environmental and social conditions facing the poor. In short, both equity and poverty have not only economic, but also social and environmental dimensions, and in turn, they will need to be assessed within the TAR using a more comprehensive set of indicators (rather than income distribution alone). An even broader approach to equity involves the concept of fairness in the treatment of non-human forms of life or even inanimate nature. One view asserts that humans have the responsibility of prudent "stewardship" (or "trusteeship") over nature, which goes beyond mere rights of usage (see for example, *Brown 1998*).

2.4. SUSTAINABILITY

Sustainability has emerged most strongly in the environmental context, but may be defined also in economic and social terms (*Munasinghe 1993*). The environmental interpretation of sustainability focuses on the overall performance or health of ecological systems – defined in terms of a comprehensive, multiscale, dynamic, hierarchical measure of resilience, vigour and organisation (*Costanza 1999)*. The classic definition of system resilience was provided by *Holling (1973)*, in terms of the ability of an ecosystem to persist despite external shocks – where both the magnitude of the stress which the system can withstand, and the time to recovery, are key indicators.[4] Vigour is associated with the primary productivity of an ecosystem. Organisation depends on complexity and structure. In this context, natural resource degradation, pollution and loss of biodiversity are detrimental because they increase vulnerability, undermine system health, and reduce resilience (*Perrings and Opschoor 1994, Munasinghe and Shearer 1995)*. The notion of a safe threshold (and the related concept of carrying capacity) are important – often to avoid catastrophic ecosystem collapse *(Holling 1992)*. It is useful also to think of sustainability in

[4] *Petersen et al. (1998)* argue that the resilience of a given ecosystem depends on the continuity of related ecological processes at both larger and smaller spatial scales (Annex 2). See also, *Pimm (1991)*, and *Ludwig et al. (1997).*

terms of the normal functioning and longevity of a nested hierarchy of ecological and socio-economic systems (see Annex 2 for details).

Social sustainability is able to draw on the foregoing ideas, since habitats may be interpreted broadly to also include man-made environments like cities and villages (*UNEP et al. 1991*). Reducing vulnerability and maintaining the health (i.e., resilience, vigour and organisation) of social and cultural systems, and their ability to withstand shocks, is also important (*Chambers 1989, Bohle et al. 1994, Ribot et al. 1996*). Enhancing human capital (through education) and strengthening social values and institutions (like trust and behavioural norms) are important tools to increase the resilience of social systems and improve governance. Another key requirement is social inclusion – which seeks to ensure equitable access to the full range of benefits of sustainable development, both within and across nations. Preserving cultural capital and diversity across the globe, strengthening social cohesion and networks of relationships, and reducing destructive conflicts, are integral elements of this approach. An important aspect of empowerment and broader participation is subsidiarity – i.e., decentralisation of decision-making to the lowest (or most local) level at which it is still effective. In summary, for both ecological and socio-economic systems, the emphasis is on improving system health and their dynamic ability to adapt to change across a range of spatial and temporal scales, rather than the conservation of some "ideal" static state (see Annex 2).

The modern concept underlying economic sustainability seeks to maximise the flow of income that could be generated while at least maintaining the stock of assets (or capital) which yield these beneficial outputs (*Solow 1986, Maler 1990*).[5] Economic efficiency continues to play a key role – in ensuring both efficient allocation of resources in production, and efficient consumption choices that maximise utility. Problems of interpretation arise in identifying the kinds of capital to be maintained (for example, manufactured, natural, and human resource stocks, as well as social capital have been identified) and their substitutability (see next section). Often, it is difficult to value or compare these assets and the services they provide, particularly in the case of ecological and social resources (*IPCC 1996c: chapter 5*). Even key economic assets may be overlooked, for example, in informal or subsistence economies where non-market based transactions are important. The issues of uncertainty, irreversibility and catastrophic collapse pose additional difficulties, in determining dynamically efficient development paths (*Pearce and Turner 1990*). Many commonly used microeconomic approaches rely heavily on marginal analysis based on small perturbations (e.g., comparing incremental costs and benefits of economic activities). Such methods assume smoothly changing variables and are therefore rather inappropriate for analysing large changes and discontinuous phenomena. More recent work (especially at the cutting edge of the economics-ecology interface) has begun to explore the behaviour of large, non-linear,

[5] This approach is based on the pioneering work of Lindahl and Hicks. For example, *Hicks (1946)* implies that peoples' maximum sustainable consumption is "the amount that they can consume without impoverishing themselves". Much earlier *Fisher (1906)* had defined **capital** as "a stock of instruments existing at an instant of time", and **income** as "a stream of services flowing from this stock of wealth".

dynamic and chaotic systems, as well as newer concepts like system vulnerability and resilience.

2.5. CONSISTENT INTEGRATION OF DEVELOPMENT, EQUITY AND SUSTAINABILITY CONSIDERATIONS

Many national policy decisions taken today could well affect future climate change prospects significantly (see Section 4 for details). In order to develop an effective and practical climate change strategy that is more convincing to decision-makers, the various chapters of the TAR need to integrate and reconcile the development, equity and sustainability aspects within a holistic and balanced sustainable development framework. Economic analysis has a special role in contemporary national policymaking, since some of the most important decisions fall within the economic domain. While mainstream economics which is used for practical policymaking has often ignored many crucial aspects of the environmental and social dimensions of sustainable development, there is a small but growing body of economic analysis and applications which seeks to address such shortcomings.

To synthesise a more holistic framework for analysing DES issues, TAR lead authors need to make a special effort to identify the type of literature which attempts to bridge interdisciplinary gaps – not only in the economic but also the ecology and sociology literature.[6] Environmental and resource economics attempts to incorporate environmental considerations into traditional neo-classical economic analysis. The growing field of ecological economics goes further in combining ecological and economic methods to address environmental problems, and emphasises the importance of key concepts like the scale of economic activities (for a good introduction, see *Costanza et al. 1997).* Some areas of ecological science such as conservation ecology have proposed alternative approaches to the problems of sustainability (primarily of ecological systems) – including the crucial concept of system resilience. Recent thinking in sociology has explored ideas about the integrative glue that binds societies together, while drawing attention to the concept of social capital and the importance of social inclusion. *Munasinghe (1994)* proposed the more neutral term "sustainomics", which focuses explicitly on sustainable development, and envisages "a comprehensive, integrative, balanced, transdisciplinary framework for making development more sustainable" [7].

Two broad approaches are relevant for integrating the economic, social and environmental dimensions of sustainable development. They are distinguished by the degree to which the concepts of **optimality** and **durability** are emphasised. While there are overlaps between

[6] See for example, recent issues of journals like *Ecological Economics,* and *Conservation Ecology* (an internet publication).

[7] Sustainomics attempts to integrate key elements of the economic, social and ecological dimensions of sustainable development (including the optimality and durability approaches), and maintain stocks of these three types of capital, while balancing southern concerns about continuing development, growth and equity, with the northern emphasis on sustainability.

the two approaches, the main thrust is somewhat different in each case. Uncertainty often plays a key role in determining which approach would be preferred. Thus, relatively steady and well-ordered conditions may encourage optimising behaviour that attempts to control and even fine-tune outcomes, whereas chaotic and unpredictable circumstances are likely to favour more durable responses that simply enhances survival prospects (e.g., a subsistence farmer facing uncertain conditions).

Optimality

The optimality-based approach has been widely used in economic analysis to broadly maximise utility (or welfare), subject to the requirement that the stock of productive assets (or welfare itself) is non-decreasing in the long term.[8] In practice, utility is often measured mainly in terms of the net benefits of economic activities, i.e., the benefits derived from development activities minus the costs incurred to carry out those actions (see *Markandya and Halsnaes 1999;* and *IPCC 1996c:chapter 5*; for more details about valuation and costing). More sophisticated economic optimisation approaches seek to include environmental and social variables (e.g., by attempting to value environmental externalities, system resilience, social capital, etc). However, given the difficulties of quantifying and valuing many such "non-economic" assets, the costs and benefits associated with market-based activities tend to dominate in most economic optimisation models.

Basically, any growth path characterised by non-decreasing stocks of assets (or capital) is sustainable – the optimal one maximises economic growth as well. Some analysts support a "strong sustainability" constraint, which requires the separate preservation of each category of critical asset (for example, manufactured, natural, socio-cultural and human capital), assuming that they are complements rather than substitutes[9]. One version of this rule might correspond roughly to maximising economic output, subject to side constraints on environmental and social variables that are deemed critical for sustainability (e.g., biodiversity loss, or meeting the basic needs of the poor). Other researchers have argued in favour of "weak sustainability," which seeks to maintain the aggregate monetary value of the total stock of assets, assuming that the various asset types may be valued and that there is some degree of substitutability among them (see for example, *Nordhaus and Tobin 1972).*

Side constraints are often necessary, because the underlying basis of economic valuation, optimisation and efficient use of resources may not be easily applied to ecological objectives like protecting biodiversity and improving resilience, or to social goals such as promoting equity, public participation and empowerment. Thus, such environmental and social variables cannot be easily combined into a single valued objective function with

[8] *Pezzey (1992)* and *Islam (1998)* provide useful reviews of sustainable economic growth models. Some ecological models also optimise variables like energy use, nutrient flow, or biomass production – giving more weight to system vigour.

[9] Measuring some of these types of assets poses significant problems (e.g., see *Atkinson et al. 1997).*

other measures of economic costs and benefits. Moreover, the price system (which has time lags) often fails to reliably anticipate irreversible environmental and social harm, as well as non-linear system responses that could lead to catastrophic collapse. In such cases, non-economic indicators of environmental and social status would be helpful – e.g., area under forest cover, and incidence of conflict (see for example, *Munasinghe and Shearer 1995, Hanna and Munasinghe 1995, UNDP 1998, World Bank 1998a*). The constraints on critical environmental and social indicators are proxies that represent safe thresholds which help to maintain the viability of those systems. In this context, techniques like multicriteria analysis may be required, to facilitate trade-offs among a variety of non-commensurable indicators. Risk and uncertainty will also necessitate the use of decision analysis tools (*Moss and Schneider 1999; Toth 1999; IPCC 1996c: chapter 2*).

Durability

The second broad integrative approach would focus primarily on sustaining the quality of life – e.g., by satisfying environmental, social and economic sustainability requirements. Such a framework favours "durable" development paths which permit growth, but are not necessarily economically optimal. There is a greater willingness to trade off some economic optimality for the sake of greater safety, especially among more risk-averse and vulnerable societies or individuals who face chaotic and unpredictable conditions – in order to stay within critical environmental and social limits (see later discussion on the precautionary principle). The economic constraint might be framed in terms of maintaining consumption levels (defined broadly to include environmental services, leisure and other "non-economic" benefits) – i.e., per capita consumption that never falls below some minimum level, or is non-declining. The environmental and social sustainability requirements may be expressed in terms of indicators of "state" that seek to measure the vulnerability or health (resilience, vigour and organisation) of complex ecological and socio-economic systems. There is clear potential for interaction here due to linkages between the sustainability of social and ecological systems – e.g., social disruption and conflict could exacerbate damage to ecosystems, and vice versa. In fact, long-standing social norms in many traditional societies have helped to protect the environment (*Colding and Folke 1997*).

Constraints based on sustainability could be represented also by the approach discussed earlier, that focuses on maintaining stocks of assets. This approach views the various forms of capital as a bulwark that decreases vulnerability to external shocks and reduces irreversible harm, rather than mere accumulations of assets that produce economic outputs. System resilience, vigour, organisation and ability to adapt will depend dynamically on the capital endowment as well as the magnitude and rate of change of a shock.

Complementarity and Convergence of Approaches

The determination of an appropriate target trajectory for future global GHG emissions (and corresponding target GHG concentration) provides a useful illustration of these two

approaches (for details, see *IPCC 1996c* or *Munasinghe 1998a*). Under an economic optimising framework, the ideal solution would be to first estimate the long-run marginal abatement costs (MAC) and the marginal avoided damages (MAD) associated with different GHG emission profiles – see Figure 3(c), where the error bars on the curves indicate measurement uncertainties. The optimal emission levels would be determined at the point where future benefits (in terms of climate change damage avoided by reducing one unit of GHG emissions) equal or just exceed the corresponding costs (of mitigation measures required to reduce that unit of GHG emissions), i.e., MAC = MAD at point R_{OP} .

Durable strategies become more relevant when we recognise that MAC and/or MAD might be poorly quantified and uncertain. Figure 3(b) assumes that MAC is better defined than MAD. First, MAC is determined using techno-economic least cost analysis – an optimising approach. Next, the target emissions are set on the basis of the affordable safe minimum standard (at R_{AM}), which is the upper limit on costs that will still avoid unacceptable socio-economic disruption – this is closer to the durability approach.

Finally, Figure 3(a) indicates an even more uncertain world, where neither MAC nor MAD is defined. Here, the emission target is established on the basis of an absolute standard (R_{AS}) or safe limit which would avoid an unacceptably high risk of damage to ecological (and/or social) systems. This last approach would be more in line with the durability concept.

Another example involves national level policymaking and macroeconomic management, which often involves a combination of optimal economic modelling and more fuzzy socio-political considerations, to arrive at a pragmatic decision.

It would be useful to explore the potential for convergence of the optimising and durability approaches, in practice. Such a process could be facilitated by the TAR. This implies that wastes ought to be generated at rates less than or equal to the assimilative capacity of the environment – in particular, GHG emissions into the global atmosphere. Renewable resources, especially if they are scarce, should be utilised at rates less than or equal to the natural rate of regeneration. Non-renewable resource use should be managed in relation to the substitutability between these resources and technological progress. Both wastes and natural resource input use might be minimised by moving from linear throughput to closed loop mode. Thus, factory complexes are being designed in clusters – based on the industrial ecology concept – to maximise the circular flow of materials and recycling of wastes among plants. Finally, both inter and intra-generational equity (especially poverty alleviation), pluralistic and consultative decision-making, and enhanced social values and institutions, are important additional aspects that should be considered (at least in the form of safe constraints). Such an integrative framework would help to incorporate climate change response measures within a national sustainable development strategy.

The rate of total GHG emissions (G) may be decomposed by means of the following identity:

$$G = [Q/P] \times [Y/Q] \times [G/Y] \times P ;$$

where [Q/P] is quality of life per capita; [Y/Q] is the material consumption required per unit of quality of life; [G/Y] is the GHG emission per unit of consumption; and P is the population. A high quality of life can be consistent with low total GHG emissions, provided that each of the other three terms on the right hand side of the identity could be minimised (see also Section 4.2 and Figure 4 on "tunnelling" and "leapfrogging"). Reducing [Y/Q] implies "social decoupling" (or "dematerialization") whereby satisfaction becomes less dependent on material consumption – through changes in tastes, behaviour and social values. Similarly [G/Y] may be reduced by "technological decoupling" (or "decarbonisation") that reduces the intensity of GHG emissions in consumption and production. Finally, population growth needs to be reduced, especially where emissions per capita are already high. The linkages between social and technological decoupling need to be explored (see for example, *IPCC 2000a*). For example, changes in public perceptions and tastes could affect the directions of technological progress, and influence the effectiveness of mitigation and adaptation policies.

3. The Potential Impacts of Climate Change on Development, Equity and Sustainability, and Principles Underlying Response Strategies

The climate change problem fits in quite readily within the rather broad conceptual framework described above. Decision-makers would be especially interested in the TAR's assessment of how serious a threat climate change poses to the future basis for improving human welfare – in relation to DES. Some of the potential linkages, and the principles and concepts that apply in such cases are outlined below.

3.1. DEVELOPMENT

First, global warming poses a significant potential threat to future development activities and the economic well being of large numbers of human beings. In its simplest from, the economic efficiency viewpoint will seek to maximise the net benefits (or outputs of goods and services) from the use of the global resource represented by the atmosphere. Broadly speaking, this implies that the stock of atmospheric assets which provide a sink function for GHG needs to be maintained at an optimum level. As indicated earlier, this target level is defined at the point MAC = MAD. The underlying principles are based on optimality and the economically efficient use of a scarce resource, i.e., the global atmosphere.

When considering climate change response options, several ideas and principles which are widely used in environmental economics analysis would be useful – these include the polluter pays principle, economic valuation, internalisation of externalities, and property rights. The polluter pays principle argues that those who are responsible for damaging emissions should pay the corresponding costs. The economic rationale is that this provides an incentive for polluters to reduce their emissions to optimal (i.e., economically efficient) levels. Here, the idea of economic valuation becomes crucial. Quantification and economic

valuation of potential damage from polluting emissions is an important prerequisite. In the case of a common property resource like the atmosphere, GHG emitters can freely pollute without penalties. Such externalities need to be internalised by imposing costs on polluters that reflect the damage caused.[10] In this context, the notion of property rights is also relevant to establish that the atmosphere is a valuable and scarce resource which cannot be used freely and indiscriminately.

3.2. EQUITY

Second, climate change could also undermine social welfare and equity in an unprecedented manner. In particular, both intra- and inter-generational equity are likely to be worsened (*IPCC 1996c*). Existing evidence clearly demonstrates that poorer nations and disadvantaged groups within nations are especially vulnerable to disasters *(Clarke and Munasinghe 1995, Banuri 1998)*. Climate change is likely to result in inequities due to the uneven distribution of the costs of damage, as well as of necessary adaptation and mitigation efforts. A more disaggregate analysis in the TAR would contribute significantly to our understanding of differential effects among and within countries.[11] Inequitable distributions may not only be ethically unappealing, but also unsustainable in the long run (*Burton, 1997)*. For example, a future scenario that restricts per capita carbon emissions in the south to 0.5 tons per year while permitting a corresponding level in the north of over 3 tons per year, is unlikely to be durable – because it will not facilitate the co-operation of developing countries (see also Annex 3). More generally, inequity could erode social capital, undermine cohesion and exacerbate conflicts over scarce resources.

One starting point is the principle that climate change should not be allowed to worsen existing inequities – although climate change policy cannot be expected to address all prevailing equity issues. Some special aspects include: (a) the establishment of an equitable and participative global framework for making and implementing collective decisions about climate change; (b) reducing the potential for social disruption and conflicts arising from climate change impacts; and (c) protection of threatened cultures and preservation of cultural diversity. The polluter pays principle (mentioned earlier) is based not only on economic efficiency, but also on equity and fairness. An extension of this idea is the principle of recompensing victims – ideally by using the revenues collected from polluters. There is also the moral/equity issue concerning the extent of the polluters obligation to compensate for past emissions (i.e., a form of environmental debt). Weighting the benefits and costs of climate change impacts according to the income levels of those who are affected, has also been suggested as one way of redressing inequitable outcomes (*Squire and Van der Tak 1975*). *Kverndokk (1995)* argued that conventional justice principles would favour the equitable allocation of future GHG emission rights on the basis of population. Equal per capita GHG emission rights (i.e., equal access to the global

[10] Externalities were defined and treated in rigorous fashion, originally by *Pigou (1932).*

[11] Some of the DES implications of recent large scale disasters like El Niño might provide useful case study material.

atmosphere) is consistent also with the UN human rights declaration underlining the equality of all human beings. Some equity related issues are elaborated in Annex 3 – including potential efficiency-equity and equity-equity trade-offs[12].

3.3. SUSTAINABILITY

Third, the sustainability viewpoint draws attention to the fact that increasing anthropogenic emissions and accumulations of GHG might significantly perturb a critical global subsystem – the atmosphere (*UNFCCC 1993*). In fact, climate change policy is more likely to achieve its goals if it is an integral part of sustainable development strategy and well integrated with sustainability objectives at appropriate decision-making levels. Sustainability will depend on several factors, including: (1) climate change intensity (e.g., magnitude and frequency of shocks); (2) system vulnerability (i.e., sensitivity to impact damage); and (3) system resilience (i.e., ability to recover from impacts). Changes in the global climate (e.g., mean temperature, precipitation, etc.) could well threaten the stability of a range of critical physical, ecological and social systems and subsystems (*IPCC 1996b*). More attention may need to be paid to the vulnerability of social values and institutions which are already stressed due to rapid technological changes (*Adger 1999)*. Especially within developing countries, loss of social capital is undermining the basic glue that binds communities together – e.g., the rules and arrangements which align individual behaviour with collective goals (*Banuri et al. 1994*). Existing international mechanisms and systems to deal with transnational and global problems are fragile, and unlikely to be able to cope with worsening climate change impacts.

Several concepts from contemporary environmental and social analysis are relevant for developing climate change response options, including the concepts of durability, optimality, safe limits, carrying capacity, irreversibility, non-linear responses, the precautionary principle, and adaptive and mitigative capacity. Durability and optimality could be developed as complementary and potentially convergent approaches (see earlier discussion). Under the durability criterion, an important goal would be to determine the safe limits for climate change within which the resilience of global ecological and social systems would not be seriously threatened. In turn, the accumulations of GHG in the atmosphere would have to be constrained to a point which prevented climate change from exceeding these safe margins. It is considered important to avoid irreversible damage to bio-geophysical systems and prevent major disruption of socio-economic systems. Some systems will respond to climate change in a non-linear fashion, with the potential for catastrophic collapse. Thus, the precautionary principle argues that lack of scientific certainty about climate change effects should not become a basis for inaction, especially

[12] Traditionally, economic analysis has addressed efficiency and distributional issues separately – i.e., the maximisation of net benefits is distinct from who might receive such gains. Recent work has sought to interlink efficiency and equity more naturally. For example, environmental services could be considered public goods, and incorporated into appropriate markets as privately produced public goods (*Chichilnisky and Heal, forthcoming*).

where relatively low cost steps to mitigate climate change could be undertaken as a form of insurance (*UNFCCC 1993*).

The notion of strengthening the ability of ecological, social and economic systems to adapt has been proposed as a means of decreasing their vulnerability to climate change. Such adaptive capacity would depend on underlying system characteristics such as technological options, resources and their distribution, institutions, human and social capital, risk spreading mechanisms, and information management ability. Similarly, mitigative capacity measures the ability of a system to reduce its contribution to climate change. Mitigative capacity might be influenced by available technological and policy options, resource availability and distribution, and human and social capital stocks.

4. Incorporating Climate Change Strategies into Conventional Decision-making

As seen in the previous section, climate change is likely to undermine the sustainability of future development. The procedures for conventional environmental and social impact assessment at the project/local level (which are now well-accepted world wide), may be readily adapted to assess the effects of micro-level activities on GHG gas emissions (*World Bank 1998b*). The *OECD* (*1994*) has pioneered the "Pressure-State-Response" framework to trace socio-economic-environment linkages. This P-S-R approach begins with the pressure (e.g., population growth), then seeks to determine the state of the environment (e.g., ambient pollutant concentration), and ends by identifying the policy response (e.g., pollution taxes).

At the same time, national policymakers routinely make many key macro-level decisions that could have (often inadvertent) impacts on both climate change mitigation and adaptation, which are far more significant than the effects of local economic activities. These pervasive and powerful measures are aimed at addressing economic development, environmental sustainability and social equity issues – which invariably have much higher priority in national agendas, than climate change. For example, many macroeconomic policies seek to induce rapid growth, which in turn could potentially result in greater levels of GHG emissions, or increase vulnerability to the future impacts of climate change. The TAR could help to focus more attention on such economywide policies, whose environmental and social linkages have not been adequately explored in the past.

TAR authors should bear in mind that climate change strategies and policies that are consistent with other national development measures, are more likely to be effective, than isolated technological or policy options. In particular, the highest priority needs to be given to finding win-win policies which yield not only DES benefits, but also enhance climate change adaptation and mitigation efforts (see for example, *Jochen and Hohmeyer 1992)*. Such policies could help to build support for climate change strategies among the traditional decision-making community, and conversely make climate change specialists more sensitive to sustainable development needs. They would reduce the potential for

conflict between two powerful current trends – the growth oriented, market based economic reform process, and protection of the global environment.

4.1. NATIONAL ECONOMYWIDE POLICIES

The most powerful economic management tools currently in common use are economywide reforms (which include structural adjustment packages). Economywide (or countrywide) policies consist of both sectoral and macroeconomic policies which have widespread effects throughout the economy. Sectoral measures mainly involve a variety of economic instruments, including pricing in key sectors (for example, energy or agriculture) and broad sectorwide taxation or subsidy programs (for example, agricultural production subsidies, and industrial investment incentives). Macroeconomic measures are even more sweeping, ranging from exchange rate, interest rate, and wage policies, to trade liberalisation, privatisation, and similar programs. Since space limitations preclude a comprehensive review of interactions between economywide policies and climate change, we briefly examine several examples which provide a flavour of the possibilities involved (for details, see *Munasinghe 1997; Jepma and Munasinghe 1998*).

On the positive side, liberalising policies such as the removal of price distortions and promotion of market incentives have the potential to improve economic growth rates, while increasing the value of output per unit of GHG emitted (i.e., so called “win-win” outcomes). For example, reforms which improve the efficiency of energy use could reduce economic waste and lower the intensity of GHG emissions. Similarly, improving property rights and strengthening incentives for better land management not only yields economic gains but also reduces deforestation of open access lands (e.g., due to “slash and burn” agriculture).

At the same time, growth inducing economywide policies could lead to increased GHG emissions, unless the macro-reforms are complemented by additional environmental and social measures. Such negative impacts on climate change are invariably unintended and occur when some broad policy changes are undertaken while other hidden or neglected economic and institutional imperfections persist. In general, the remedy does not require reversal of the original reforms, but rather the implementation of additional complementary measures (both economic and non-economic) that mitigate climate change. For example, export promotion measures and currency devaluation might increase the profitability of timber exports. This in turn, could further accelerate deforestation that was already under way due to low stumpage fees and open access to forest lands. Establishing property rights and increasing timber charges would reduce deforestation, without interrupting the macroeconomic benefits of trade liberalisation. Similarly, market-oriented liberalisation could lead to economic expansion and the growth of wasteful energy-intensive activities in a country where subsidised energy prices persisted. Eliminating the energy price subsidies could help to reduce net GHG emissions while enhancing macroeconomic gains.

Countrywide policies could also influence adaptation, negatively or positively. For example, national policies that encouraged population movement into low-lying coastal areas might increase their vulnerability to future impacts of sea level rise. On the other hand, government actions to protect citizens from natural disasters – such as investing in safer physical infrastructure or strengthening the social resilience of poorer communities – could help to reduce vulnerability to extreme weather events associated with future climate change *(Clarke and Munasinghe 1995)*.

In this context, economic-environmental-social interactions need to be identified and analysed, and effective sustainable development policies formulated, by linking and articulating these activities explicitly. Implementation of such an approach would be facilitated by constructing a simple Action Impact Matrix or AIM (*Munasinghe 1997)*. As explained in Annex 4, such a matrix could help to promote an integrated view, by meshing development and climate related decisions with priority economic, environmental and social issues.

4.2. RESTRUCTURING GROWTH

Economic growth continues to be a widely pursued objective of most governments, and therefore, reducing the intensity of GHG emissions of human activities is an important step in mitigating climate change. Given that the majority of the world population lives under conditions of absolute poverty (e.g., over 3 billion persons subsist on less than USD 1 per day), a climate change strategy that did not unduly constrain growth prospects in those areas would be far more attractive to decision-makers. In this vein, the TAR might help to identify approaches that would modify the structure of growth (rather than restricting it), so that GHG emissions are mitigated and adaptation options enhanced.

The above approach is illustrated in Figure 4, which shows how a country's GHG emissions might vary with its level of development. One would expect carbon emissions to rise more rapidly during the early stages of development (along AB), and begin to level off only when per capita incomes are higher (along BC). Typically, a developing country would be at a point such as B on the curve, and an industrialised nation might be at C. The key point is that if the developing countries were to follow the growth path of the industrialised world, then atmospheric concentrations of GHG would soon rise to dangerous levels. The risk of exceeding the global safe limit (shaded area) could be avoided by adopting sustainable development strategies that would permit developing countries to progress along a path such as BD (and eventually DE), while also reducing GHG emissions in industrialised countries along CE.

As outlined in Section 4.1 and elaborated in Annex 4, growth inducing economywide policies could combine with imperfections in the economy to cause environmental harm. Rather than halting economic growth, complementary policies may be used to remove such imperfections and thereby protect the environment. The TAR might be able to encourage a more proactive approach whereby the developing countries could learn from the past

experiences of the industrialised world and leapfrog in terms of both technologies and policies. Thus, they may be able to adopt sustainable development strategies and climate change measures which would enable them to follow "tunnelling" development paths such as BDE, as shown in Figure 4 (*Munasinghe 1997*). Thus, the emphasis is on identifying measures that will help delink carbon emissions and growth, with the curve in the figure serving mainly as a useful metaphor or organising framework for policy analysis.

This representation also illustrates the complementarity of the optimal and durable approaches discussed earlier. It has been shown that the higher path ABC in Figure 4 could be caused by economic imperfections which make private decisions deviate from socially optimal ones (*Munasinghe 1998b).* Thus the adoption of corrective policies that reduce such divergences and thereby reduce GHG emissions per unit of output, would facilitate movement along the lower path ABD. From the durability viewpoint, reducing the higher level of environmental damage at C would be especially desirable to avoid exceeding the safe limit or threshold representing dangerous accumulations of GHG (shaded area in Figure 4).

Several authors have econometrically estimated the relationship between GHG emissions and per capita income using cross-country data and found curves with varying shapes and turning points (*Holtz-Eakin and Selden 1995; Sengupta 1996, Unruh and Moomaw 1997; Cole et al. 1997*)**.** One reported outcome is an inverted U-shape (called the environmental Kuznet's curve or EKC) – like the curve ABCE in Figure 4. In this case, the more socially optimal path BDE could be viewed as a sustainable development "tunnel" through the EKC (*Munasinghe 1995).*

5. Summary and Scope for Application of DES Considerations in TAR Chapters

DES issues have been identified as central elements of the TAR, and it is expected that these considerations will be addressed in most of the chapters of WG II and WG III. The TAR authors might consider the following broad and long term questions, in relation to DES issues:

1. How will expected development patterns and scenarios affect climate change?
2. How will climate change impacts, adaptation and mitigation affect sustainable development prospects?
3. How could climate change responses be better integrated into sustainable development strategies?

In this context, development, equity and sustainability are integral elements of sustainable development, which suggests that individual human beings, communities and economies need to be developed (e.g., through quantitative and/or qualitative improvements), while sustaining ecological, geophysical and social systems. The economic, social and environmental dimensions of sustainable development need to be given balanced treatment (although the emphasis will vary by chapter). To achieve this outcome, TAR authors should

make a special effort to systematically search well beyond the mainstream journals, for the small but growing volume of literature in economics, sociology and ecology which seeks to bridge interdisciplinary gaps – in as many different countries and languages as possible.

Table 1 contains a preliminary evaluation of how the various issues relating to development, equity and sustainability discussed earlier, might be relevant for different chapters of the WG II and WG III reports, and Annex 1 sets our more specific questions for the chapter authors. The many impacts of climate change and alternative strategies to address the issue might be evaluated broadly in terms of their long term effects on: (a) human welfare and equity (b) the durability and resilience of ecological, geophysical and socio-economic systems (even in the face of sudden, non-linear system shocks); and (c) the stocks of different kinds of capital (e.g., manufactured, natural, human and socio-cultural assets). The various chapters will need to identify specific economic, social and environmental indicators, at different levels of aggregation ranging from the global/macro to local/micro, that are relevant to such an assessment. It is important that the indicators be multi-dimensional in nature, practical, comprehensive in scope, and account for regional and scale differences. A wide variety are described already in the literature *(Liverman et al. 1988, Kuik and Verbruggen 1991, Opschoor and Reijnders 1991, Holmberg and Karlsson 1992, Adriaanse 1993, Alfsen and Saeba 1993, Bergstrom 1993, Gilbert and Feenstra 1994, Moffat 1994, OECD 1994, Munasinghe and Shearer 1995, Azar et al. 1996,UN 1996, CSD 1998, UNDP 1998, World Bank 1997: 1998a).*

Measuring economic, environmental (natural) and social capital raises various problems. Manufactured capital may be estimated using conventional neoclassical economic analysis. Market prices are useful when economic distortions are relatively low, and shadow prices could be applied in cases where market prices are unreliable (e.g., *Squire and Van der Tak 1975*). Natural capital needs to be quantified first in terms of key physical attributes. Typically, damage to natural capital may be assessed by the level of air pollution (e.g., concentrations of suspended particulate, sulphur dioxide or GHG), water pollution (e.g., BOD or COD), and land degradation (e.g., soil erosion or deforestation). Then the physical damage could be valued using a variety of techniques based on environmental and resource economics (e.g., see Annex 5, *Freeman 1993*, *Munasinghe 1993*, *Teitenberg 1992*). Human resource stocks are often measured in terms of the value of educational levels and earning potential. Social capital is the one which is most difficult to assess (*Grootaert 1998*). *Putnam (1993)* described it as "horizontal associations" among people, or social networks and associated behavioural norms and values which affect the productivity of communities. A somewhat broader view was offered by *Coleman (1990)*, who viewed social capital in terms of social structures which facilitate the activities of agents in society – this encompassed both horizontal and vertical associations (like firms). The institutional approach espoused by *North (1990)* and *Olson (1982)* provides an even wider framework, which includes not only the mainly informal relationships implied by the earlier two viewpoints, but also the more formal frameworks provided by governments, political systems, legal and constitutional provisions, etc.

Equity issues (within and among nations, and across generations) deserve careful consideration – in view of the wide differences in income and GHG emission levels, as well as potential climate change impacts across the globe. A useful starting point would be to assess whether climate change will worsen existing inequities, even though a climate strategy cannot be expected to address all equity-related problems. The TAR needs to assess the fairness of alternative outcomes with regard to climate change impacts, mitigation and adaptation, as well as the distribution of emissions rights across nations and over time. Also, there are fundamental differences in the roles of developing and industrialised countries – e.g., eventually, the former may well have to reduce their emission levels below some "business-as-usual" baselines while the latter will need to make significant cuts in emissions with respect to current levels. This raises important opportunities for mutually beneficial (and also harmful) interactions among countries in a closely linked global economy, that deserve to be assessed in the TAR.

While much of the work on climate change issues has focused on the global or regional level, its eventual impact and ultimate responses will be relevant mainly at the national and subnational levels. Therefore, climate change strategy needs to be harmonised with national sustainable development policies. Correspondingly, the choice of development paths will have as great an (indirect) influence on climate change as mitigation and adaptation policies designed explicitly for climate change. The TAR could help to clarify how greater priority might be placed on adjusting the development path to reduce GHG emissions, without undermining prospects for improving human welfare.

The TAR will be more useful as a practical guide for decision-makers if it is able to assess the viewpoints of not only governments but also civil society, business, NGOs and other stakeholders. In matters affecting the implementation of adaptation and mitigation measures, institutional and governance issues will be crucial. From the operational viewpoint, so-called "win-win" climate change strategies are the most desirable – i.e., those that enhance all three elements of sustainable development (economic, social and environmental). Policies and measures which advance one element at the expense of another need to be analysed within a framework that permits variations in the time frame for implementation, and facilitates trade-offs (e.g., increase manufactured capital while depleting both social and natural capital; or improve the resilience of a social system while increasing the vulnerability of an ecosystem).

If material growth is the main issue, while uncertainty is not a serious problem, and relevant data is available, then the focus is more likely to be on optimising economic output, subject to (secondary) constraints based on social and environmental sustainability. Alternatively, if sustainability is the primary objective, while conditions are chaotic, and data is rather weak, then the emphasis would be on paths which are economically, socially and environmentally durable or lasting, but not necessarily growth optimising. The TAR analysis could help to clarify the different viewpoints and explore the potential for greater convergence and complementarity of these approaches. In the same vein, the TAR could also better reconcile the natural science view which relies more on flows of energy and

matter, with the sociological approach that focuses on human activities and behaviour – by examining the relative advantages of using such alternate viewpoints in addressing the various aspects of climate change (e.g., in the application of integrated assessment models or IAMs, which contain submodels that represent ecological, geophysical and socio-economic systems; *Newby 1993, IPCC 1997*).

Atmospheric GHG accumulation is basically depleting one critical environmental asset. Adaptation strategies which are aimed at offsetting this disinvestment by increasing other kinds of assets (e.g., building higher sea walls or developing salt resistant crops to combat sea level rise), suggest that the weak sustainability rule might be relevant. Basically, if some degree of climate change is inevitable, then the enhancement of coping mechanisms will become especially critical, especially for the most vulnerable groups. Mitigation strategies which seek to slow down or eventually reverse GHG accumulations (at lowest cost) imply that the strong sustainability rule should apply to the atmospheric asset.

When all important impacts of a specific climate change option may be valued in economic terms, the usual approach of comparing the corresponding costs and benefits will provide useful insights.[13] Where certain critical impacts cannot be valued (i.e., reduced to a single monetary "numeraire"), other techniques such as multicriteria analysis could be helpful. High levels of uncertainty and risk might be dealt with through the use of modern decision analysis frameworks (*Moss and Schneider 1999; Toth 1999; IPCC 1996c: chapter 2*).

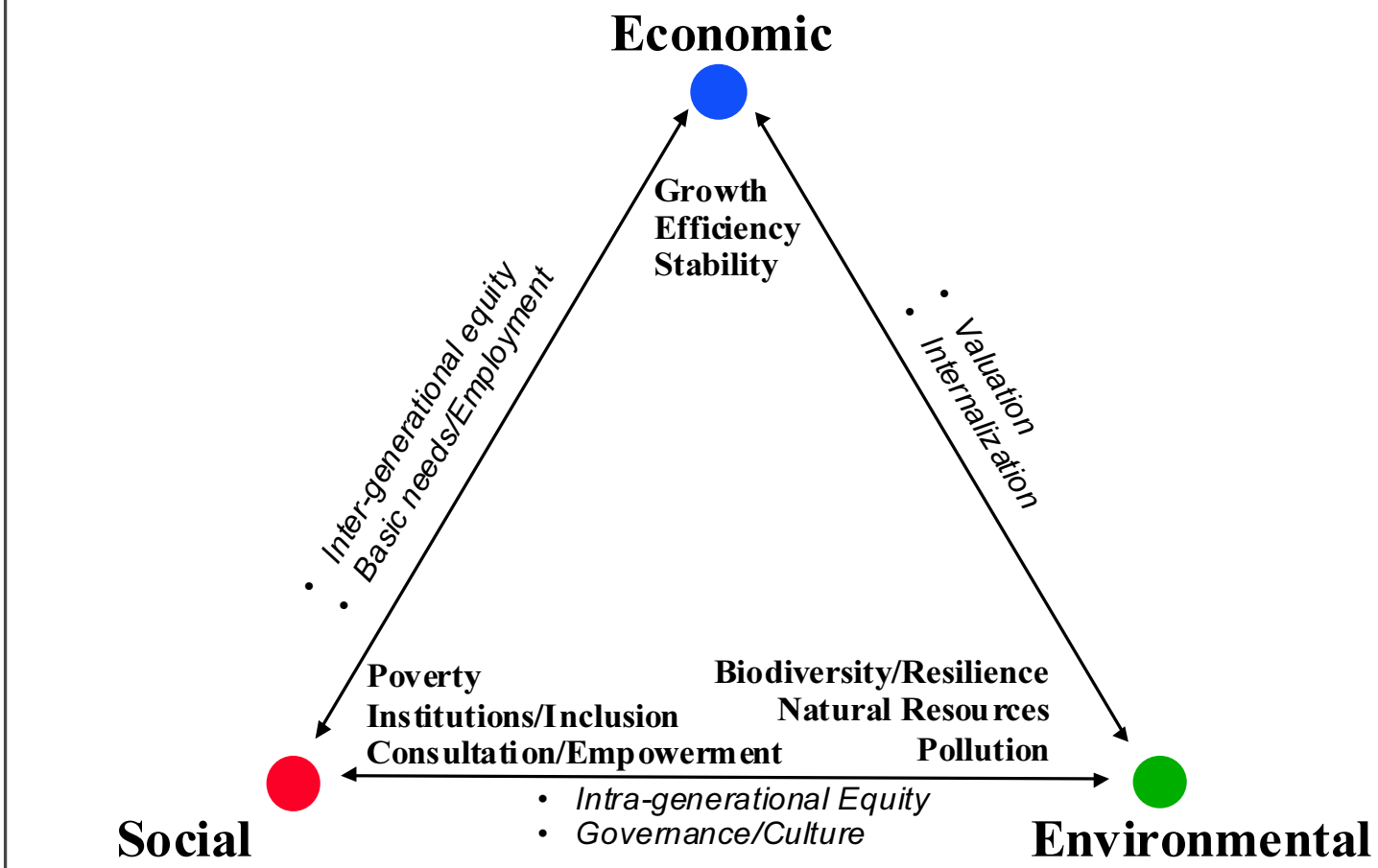
[13] *Markandya and Halsnaes (1999)* provide a good review of climate change costing methodologies. Annex 5 provides a brief summary of the crucial topic of valuing environmental externalities and assets. The economic valuation of environmental impacts is a key step in incorporating the results of project level environmental impact assessment into economic decision-making (e.g., cost-benefit analysis). At the macroeconomic level, recent work has focused on incorporating environmental considerations such as depletion of natural resources and pollution damage into the system of national accounts (*UNSO 1993, Atkinson et al. 1997, World Bank 1997). Costanza (1999)* seeks to broaden the definition of valuation to include: (1) efficiency based values (conventional economic willingness-to-pay); (2) fairness based values (which capture community or social preferences); and (3) sustainability based values (that are related to contributions to systemwide and global functions).

Table 1: Development, equity and sustainability – Links with Sustainable Development and Relevance for TAR Chapters

Issue	Sustainable Development Link	UNFCCC principles	Checklist of DES context issues for IPCC TAR chapters	WG II Chapters	WG III Chapters
Development	**Economic:** Trad. development economics; Neoclass. economics. **Social:** Social development; Social impact assessment. **Environmental:** Envir. Impact assessment; Environmental economics.	Article 5: sustainable economic growth	• Diverse views on management of economic development (markets, governments, communities) • Maximise net benefits of economic activities (optimality) • Costs and benefits of climate change response • Influence of different discount rates	• 1,2,3,10-17, 18, 19 • 2,18,19 • 2,18,19 • 2,10-17,18,19	• 1, 2, 10 • 7,8,9 • 5,6,7,8,9 • 7,8,9
Equity	**Economic:** Income distributional analysis; institutional economics. **Social:** Social justice; Juridical equity. **Environmental:** Natural resource trusteeship; Deep ecology; Animal rights.	Article 3: specific needs and special circumstances of developing countries Article 4: developed nations to take lead; socio-economic development and poverty eradication are the first and overriding priorities of developing countries	• Diverse views on social goals of development and especially on ways to achieve these (markets, governments, communities) • Interregional, intraregional, intertemporal/intergenerational equity • Fair burden sharing in mitigation ("common but differentiated responsibilities") • Fair burden sharing in adaptation (reducing social disruption, protection of vulnerable/threatened cultures) • Procedural and consequential issues related to equity • Equitable and participatory decision-making	• 1,2,10-17,18,19 • 2,18,19 • NA • 1,2,18,19 • 18,19 • 2,18,19	• 1,2,3,4,5,6,10 • 1,2,7,8,9,10 • 1,2,6,10 • NA • 10 • 10
Sustainability	**Economic:** Hicks-Lindahl/ weak sustainability rule, Natural resource management. **Social:** Social systems stability and resilience; Social capital. **Environmental:** Ecological systems resilience/vulnerability; Natural capital; Strong sustainability rule	Article 2: ultimate objective is to avoid dangerous interference with the climate system	• Diverse views on environmental sustainability: weak and strong sustainability frameworks • Local, sectoral, national and global environmental pressures • Ultimate objective of UNFCCC: stabilisation of GHG concentrations • Uncertainty, irreversibility and non-linearity (catastrophe)	• 2,10-17,18,19 • 10-17 • 18,19 • all	• 1,2,10 • 1,2,5,6,7,8,9 • 1,2,3,4,10
Synthesis	Integrate with sustainable development strategies	Article 3: policies to be integrated into national (sustainable) development programs	• Durable and optimal approaches • Synergies, conflicts, trade-offs • Regional differences • Appropriate sustainable development indicators	• all • 18,19 • 10-17, 18,19 • all	• all • 1,2,10 • all • all

Source: Rob Swart, Mohan Munasinghe, John Robinson, and Deborah Herbert.

Figure 1. Elements of Sustainable Development



Source: M. Munasinghe (1993)

Figure 2. Climate Change and Sustainable Development

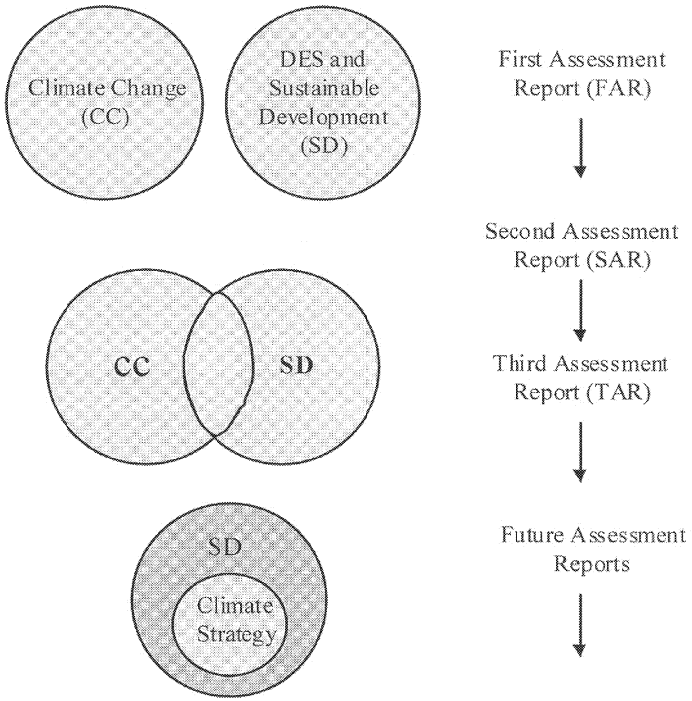
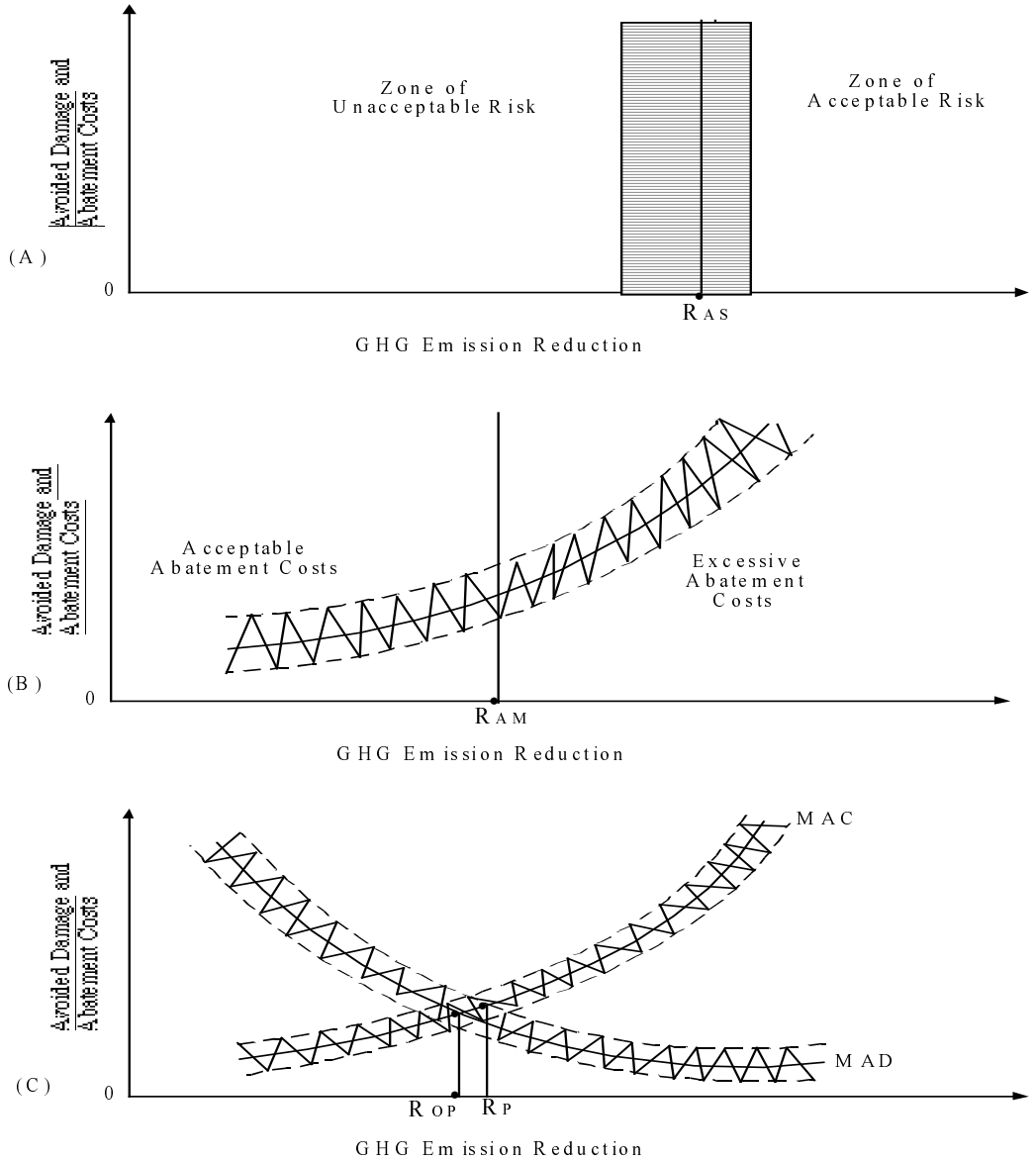
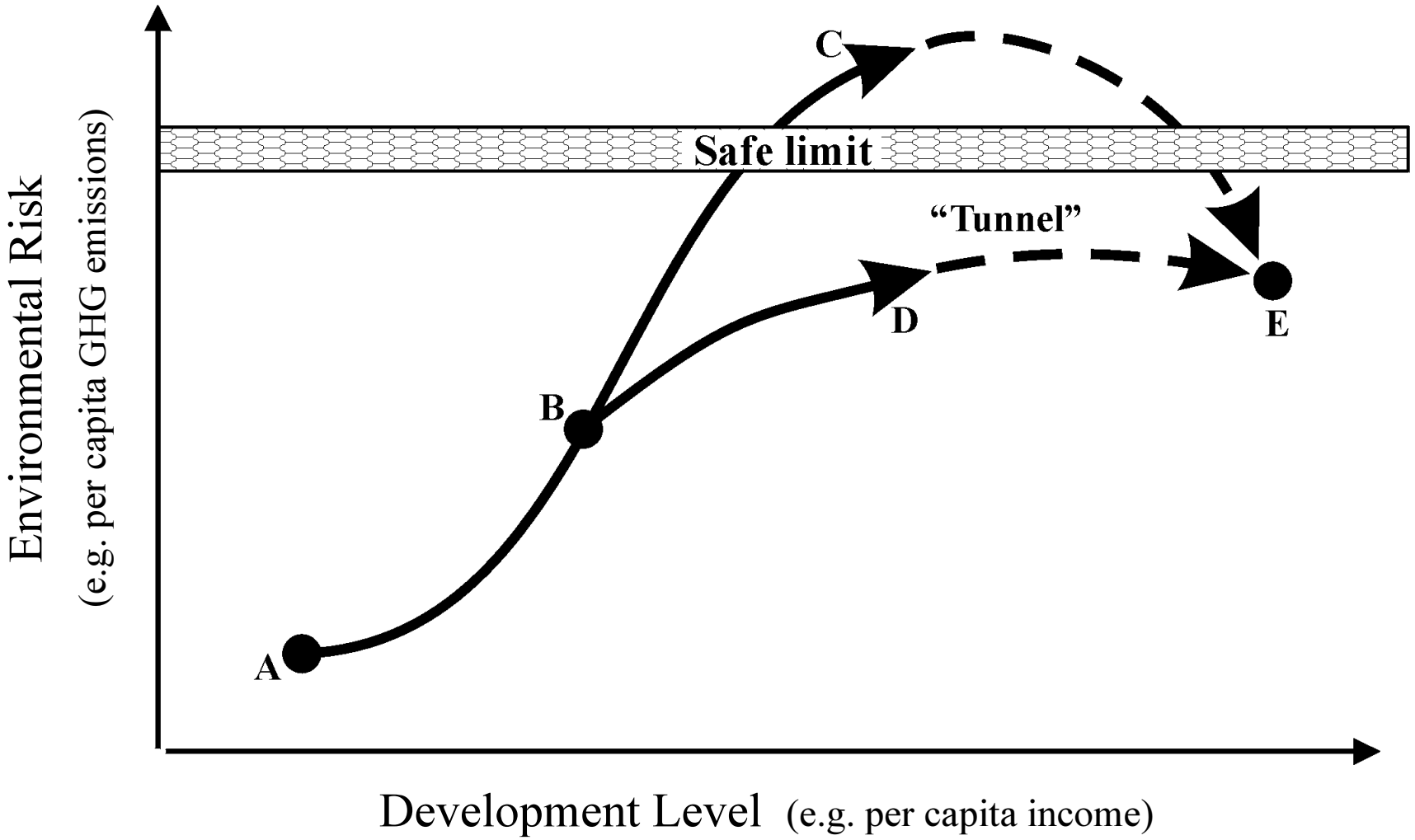


Figure 5. Determining abatement targets: (a) absolute standard; (b) affordable safe minimum standard; (c) cost-benefit optimum



Source: Adapted from *IPCC 1996c*, Figure 5.10

Figure 4. Environmental Risk versus Development Level



Source: *Munasinghe 1995.*

DEVELOPMENT, EQUITY AND SUSTAINABILITY (DES) IN THE CONTEXT OF CLIMATE CHANGE

ANNEX 1: SOME QUESTIONS ON DEVELOPMENT, SUSTAINABILITY AND EQUITY TO BE ADDRESSED IN WGII AND WG III (Prepared by Rob Swart)

1A. WG II Chapters

PART I. SETTING THE STAGE FOR IMPACTS, ADAPTATION AND VULNERABILITY: CHAPTERS 1-3

- What is the diversity of views on development, sustainability and equity that forms the backdrop for the assessment of impacts, adaptation and vulnerability?
- How do the WGII policy-relevant scientific questions relate to the context of development, sustainability and equity?
- How do various methods for assessing impacts, adaptation and vulnerability relate to the economic, social and environmental aspects of development, e.g. durable and optimal approaches, weak and strong sustainability methods?
- What do alternative methods of incorporating uncertainty in the assessment imply for decision making in the perspective of development, sustainability and equity?
- What are appropriate economic, social and environmental indicators for assessing impacts, adaptation and vulnerability?
- What are the development, sustainability and equity implications of the impact and adaptation aspects of the various scenarios that have been assessed.

PART II. SECTORS AND SYSTEMS – IMPACTS, ADAPTATION AND VULNERABILITY: CHAPTERS 4-9

- General: what do potential impacts and adaptation options imply for human welfare, durability of biogeophysical and socio-economic systems, and stocks of capital?
- What do the potential impacts or vulnerabilities imply for development opportunities in the associated societal sectors?
- What do the potential impacts or vulnerabilities imply for environmental sustainability, e.g. local pollution, resilience of ecosystems in view of gradual and/or irreversible or non-linear environmental changes?
- What are the economic, social and environmental implications of adaptation options in the various sectors and systems?
- Which adaptation options are also useful for economic, social or environmental reasons other than climate change?
- What are key uncertainties and how sensitive are the findings for different key assumptions, such as discount rates?

PART III. REGIONAL ANALYSIS – IMPACTS, ADAPTATION AND VULNERABILITY: CHAPTERS 10-17

Taking into account the specific regional priorities, perspectives and circumstances:

- What do the potential impacts or vulnerabilities imply for economic and social development opportunities, e.g. size and distribution of income?
- What do the potential impacts or vulnerabilities imply for environmental sustainability, e.g. local pollution, resilience of ecosystems in view of gradual and/or irreversible or non-linear environmental changes?
- What are the economic, social and environmental implications of adaptation options, for example in terms of equitable burden sharing amongst sub-regions and major sectors/actors?
- What are key uncertainties and how sensitive are the findings for key assumptions, such as discount rates?

PART IV. GLOBAL ISSUES AND SYNTHESIS: CHAPTERS 18-19

- *What kind of generic conclusions can be drawn with respect to*
  - The implications of adaptation options in the context of development, sustainability and equity
  - The vitality of vulnerable social, cultural and environmental systems?
  - The role of adaptation options in an overall development strategy that takes into account economic, social and environmental sustainability?
- What kind of generic conclusions can be drawn for decision making processes dealing with vulnerability, impacts and adaptation, including
  - Procedural and consequential issues related to equity, e.g. as referred to in UNFCCC Articles 3 and 10?
  - Equitable and participatory decision making processes?
  - Interregional, intraregional, and intergenerational equity?
  - The evaluation of "dangerous interference of the climate system" including the environmental, social and economic dimensions of UNFCCC Article 2?

1B. WG III Chapters

SCOPING AND SCENARIOS: CHAPTERS 1-2

- What is the diversity of views on alternative development pathways, sustainability, equity and the role of different actors, that forms the backdrop for the assessment of climate change mitigation?
- How do the WGIII policy-relevant scientific questions relate to the context of development, sustainability and equity?
- How do various methods for assessing mitigation options relate to the economic, social and environmental aspects of development, e.g. durable and optimal approaches, weak and strong sustainability, inter- and intraregional and intergenerational equity?

- What are appropriate economic, social and environmental indicators for climate change mitigation?
- What are the development, sustainability and equity implications of the mitigation aspects of the various scenarios that have been assessed, including burden sharing in scenarios that lead to stabilisation of GHG concentrations?

OPTIONS, BARRIERS AND OPPORTUNITIES, POLICIES AND MEASURES: CHAPTERS 3-6

- What are economic, social and environmental implications of possible GHG mitigation options at different levels of scale (projects, systems)?
- What are key economic, social and environmental barriers and opportunities from the different perspectives on development, sustainability and equity mentioned in chapters 1-2?
- how can policies, instruments, and measures be evaluated from these different viewpoints on development, sustainability and equity?
- For different (combinations of) options, opportunities, policies and measures, what are ("win-win") synergies for more than one – or all – aspects of development, sustainability and equity?

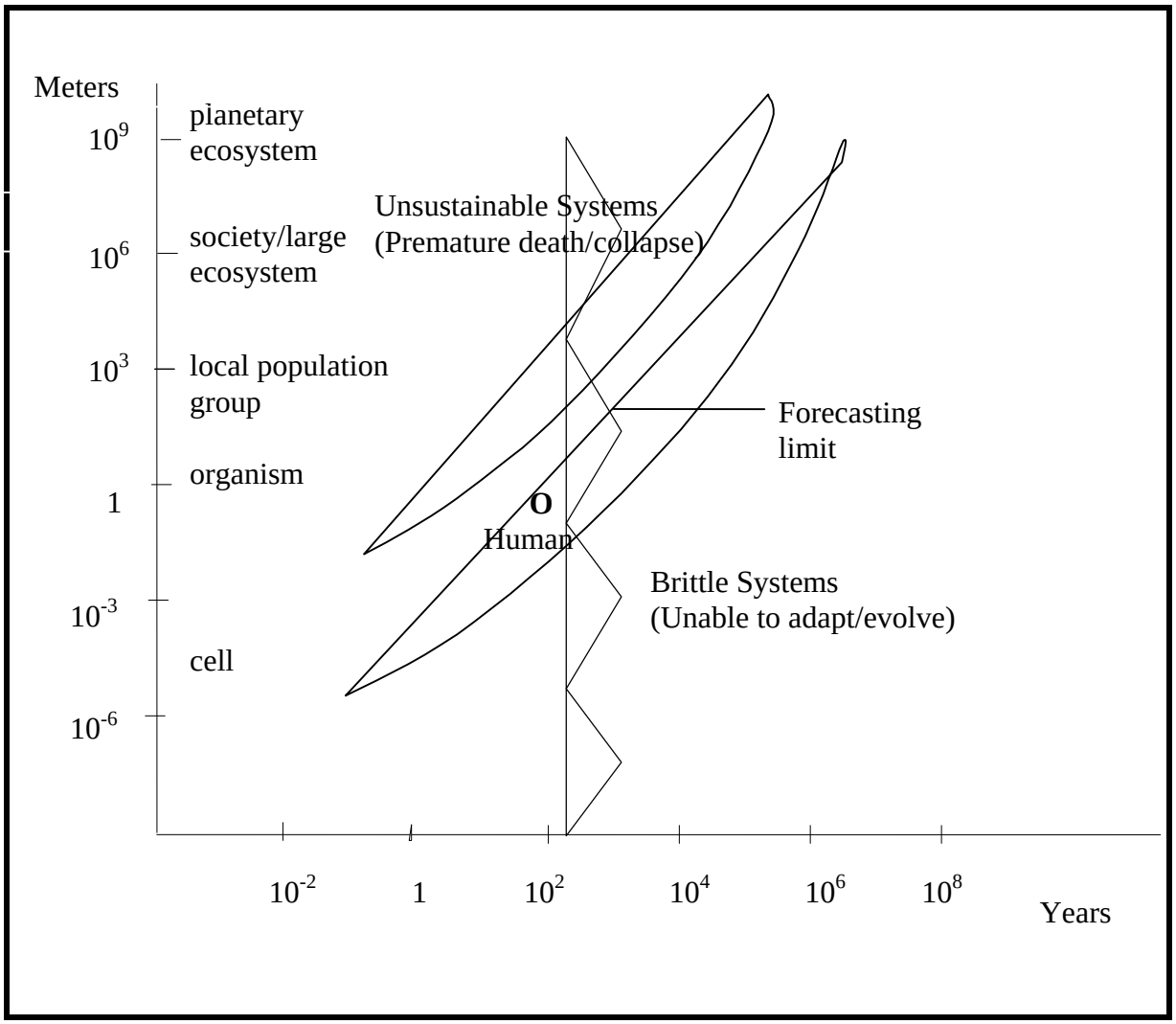
COSTS AND ANCILLARY BENEFITS OF MITIGATION: CHAPTERS 7-9

- How do different costing methodologies relate to different views on development, sustainability and equity (e.g. durability versus optimality)?
- What are the economic, social and environmental costs and ancillary benefits of the various options discussed in the chapters 3-7 at various geographic levels and for different sectors/actors?
- How may (combinations of) options affect the common but differentiated responsibilities of countries over time, including a fair sharing of the burden?
- How equitable do (combinations of) options affect different societal sectors?
- How do different perspectives on development, sustainability, and equity lead to different assessment of costs and ancillary benefits of climate change mitigation?
- What are the considerations to apply particular discount rates in assessing costs of mitigation options in view of development, sustainability and equity issues?
- How do measures in some countries affect the development, sustainability and equity perspectives in other countries?

DECISION-MAKING FRAMEWORKS: CHAPTER 10

- How do different decision principles, decision-making frameworks and decision analytical frameworks relate to the economic, social and environmental aspects of development, sustainability and equity, e.g. from a durability or optimality viewpoint?
- How can the mitigation-related policy-relevant scientific questions be addressed in this context?
- What kind of generic conclusions can be drawn for decision making processes dealing with climate change mitigation, including
  - Procedural and consequential issues related to equity, e.g. as referred to in UNFCCC Articles 3 and 10?
  - Equitable and participatory decision making processes?
  - Interregional, intraregional, and intergenerational equity?
  - The environmental, social and economic dimensions of UNFCCC Article 2?
- What do alternative methods of incorporating uncertainty in the mitigation assessment imply for decision making in the perspective of development, sustainability and equity?
- What are synergies and trade-offs in the assessment of climate change mitigation in the context of development, sustainability and equity?

ANNEX 2. SPATIAL AND TEMPORAL ASPECTS OF SUSTAINABILITY



An operationally useful concept of sustainability must refer to the persistence, viability and resilience of organic or biological systems, over their "normal" life span. In this ecological context, sustainability is linked with both spatial and temporal scales, as shown in the figure. The X axis indicates lifetime in years and the Y axis shows linear size (both in logarithmic scale). The central O represents an individual human being – having a longevity and size of the order of 100 years and 1 meter, respectively. The diagonal band shows the expected or "normal" range of lifespans for a nested hierarchy of living systems starting with single cells and culminating in the planetary ecosystem. The bandwidth accommodates the variability in organisms as well as longevity.

Environmental changes that reduce lifespans below the normal range imply that external conditions have made the systems under consideration, unsustainable. In short, the regime

above and to the left of the normal range denotes premature death or collapse. At the same time, it is unrealistic to expect any system to last forever. Indeed, each sub-system of a larger super-system (such as single cells within a multi-cellular organism) generally has a shorter life span than the super-system itself. If subsystem lifespans increase too much, the encompassing super-system is likely to lose its plasticity and become "brittle" – as indicated by the region below and to the right of the normal range *(Holling 1992)*. In other words, it is the timely death and replacement of subsystems that facilitates successful adaptation, resilience and evolution of larger systems. *Holling (1973*) defined resilience in terms of the ability of an ecosystem to persist despite external shocks, while *Petersen et al. (1998)* argued further that the resilience of a given ecosystem depends on the continuity of ecological processes at both larger and smaller scales.

We may summarise the foregoing by arguing that sustainability requires biological systems to be able to enjoy a normal life span and function normally, within the range indicated in the figure. Thus, leftward movements would be especially undesirable. For example, the horizontal arrow might represent a case of infant death – indicating an unacceptable deterioration in human health and living conditions. In this context, extended longevity involving a greater than normal life-span would not be a matter for particular concern. On the practical side, forecasting up to a time scale of even several hundred years is rather imprecise. Thus, it is important to improve the accuracy of scientific models and data, in order to make very long-term predictions of sustainability (or its absence) more convincing – especially in the context of persuading decision-makers to spend large sums of money to reduce unsustainability. One way of dealing with uncertainty, especially if the potential risk is large, relies on a precautionary approach – i.e., avoiding unsustainable behaviour using low cost measures, while studying the issue more carefully.

ANNEX 3. EQUITY ISSUES

Equity in the context of a social decision requires a fair and just outcome. It is an important element of the collective decision-making framework needed to respond to global climate change (see Box 3.1 for details).

Box 3.1 Why is Equity Important?

Equity considerations are important in addressing global climate change for a number of reasons, including: (a) moral and ethical concerns; (b) facilitating effectiveness; (c) sustainable development; and (d) the UNFCCC itself.

First, the principles of justice and fair play are important in themselves, in all types of human interactions. In particular, practically most modern international agreements, including the UN Charter, enshrine moral and ethical concerns relating to the basic equality of all human beings and the existence of inalienable and fundamental human rights. Equity is also embodied explicitly or implicitly, in many of the decision-making criteria used by policymakers.

Second, equitable decisions generally carry greater legitimacy and encourage parties with differing interests to co-operate better in carrying out mutually agreed actions. The successful implementation of a collective human response to the problem of global climate change will require the sustained collaboration of all sovereign nation states and many billions of human beings over long periods of time. While penalties and safeguards will play a role, decisions that are widely accepted as equitable are likely to be implemented with greater willingness and goodwill than those enforced under conditions of mistrust or coercion. In brief, co-operative and effective outcomes are more likely when all parties to the decision feel that it is fair.

Third, as explained earlier, equity and fairness are extremely important elements of the social dimension of sustainable development. Thus the impetus for sustainable development provides another crucial reason for finding equitable solutions to the problem of global warming.

Fourth, the UNFCCC has several specific references to equity in its substantive provisions. To begin with, Article 3.1 states that "The Parties should protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities. Accordingly, the developed country Parties should take the lead in combating climate change and the adverse effects thereof." Other equity-related principles emphasised in Article 3 include: (a) the right to promote sustainable development; (b) the need to take into account the specific needs and special circumstances of developing country and vulnerable parties; (c) the commitment to promote a supportive and open international economic system; and (d) the precautionary principle (to protect the rights of future generations).

According to Article 4.2(a), all developed country parties, including those with economies in transition, are required to take the lead in mitigating climate change. Furthermore they are required to transfer technology and financial resources to developing country parties that are particularly vulnerable to the adverse effects of climate change in meeting the costs of adaptation (Article 4.4). Another reference to equity in Article 4.2 (a) requires developed country parties to commit themselves to: "adopt national policies and take corresponding measures on the mitigation of climate change. These policies and measures will demonstrate that developed countries are taking the lead in modifying longer-term trends in anthropogenic emissions consistent with the objective of the Convention...taking into account the difference in the Parties" starting points and approaches, economic structures, available technologies and other individual circumstances, as well as the need for equitable and appropriate contributions by each of the Parties to the global effort regarding that objective." Finally, Article 11.2 requires the Convention's financial mechanism to "have an equitable and balanced representation of all Parties within a transparent system of governance."

The foregoing provisions of the UNFCCC provide important guidance on how equity considerations should influence or modify the achievement of the Convention's objectives. While protecting the climate system is considered to be a "common concern of humankind", the developed countries (and transition economies) are expected to take a lead in initiating actions and assume a greater share of the burden. Furthermore, in burden sharing emphasis is placed on applying equity considerations among developed countries as well. The responsibilities of the present generation with respect to those of future generations are also referred to. Finally, equity is mentioned in the context of governance, to emphasise the importance of including procedural elements which guarantee distributive outcomes that are perceived to be equitable.

Procedural and Consequential Equity

The requirements of the UNFCCC indicate that equity principles must apply to: (a) procedural issues – how decisions are made; and (b) consequential issues – the outcomes of those decisions. Both aspects are important because equitable procedures need not guarantee equitable decisions, and conversely, equitable outcomes could well arise from quite inequitable decision-making processes. Support for the convention and acceptance of it's recommended course of action will depend largely on widespread participation by the global community and on how equitable it is perceived to be, by all participants.

Procedural equity itself has two components. First, pertaining to participation, equity implies that those who are affected by decisions should have some say in the making of these decisions either through direct participation or representation. Second, relating to the process, equity must ensure equal treatment before the law – similar cases must be dealt with in a similar manner, and exceptions must be made on a principled basis

Consequential equity also has two elements, relating to the distribution of the costs and benefits of: (a) impacts and adaptation to climate change; and (b) mitigating measures (including the allocation of future emissions rights). Both the elements (a) and (b) have implications for burden sharing among and within countries (intragenerational and spatial distribution); and between present and future generations (intergenerational and temporal distribution). The equity of any specific outcome may be assessed in terms of a number of generic approaches, including parity, proportionality, priority, classical utilitarianism, and Rawlsian distributive justice. Societies normally seek to achieve equity by balancing and combining several of these criteria. Self interest also influences the selection of criteria and the determination of equitable decisions. Consequential equity as applied in the international arena is derived largely from these principles which were developed originally in the context of human interactions within specific societies.

A human response to climate change requires the application of equity at an even more elevated (global) level, where there is far less practical experience. Cultural and societal norms and views about ethics, the environment, and development complicate efforts to achieve a worldwide consensus on matters of both procedural and consequential equity. Even the urgency of a response to climate change is subject to dispute. Given the different meanings, philosophical interpretations, and policy approaches associated with equity, judgement plays an important role in resolving potential conflicts. Ultimately, any global response strategy will be a compromise between different world views, each of which is also influenced by self interest and attempts to shift the compromise in ones own favour. As an example, the practical difficulties of allocating future emissions rights among nations are explored in Box 3.2 (*Munasinghe 1998a)*

Box 3.2 How Might GHG Emissions Rights be Allocated Fairly?

Suppose that the analysis of climate change yielded a target level of desirable worldwide GHG emissions in the future (e.g., see the section on the global optimisation process). To illustrate the issue more clearly, we will take a single constant level of emissions that will achieve some desired stabilisation case (e.g., S550 or stabilisation of atmospheric GHG concentrations at 550 ppm of CO_2 equivalent before year 2150). The principles of allocation discussed below would apply in exactly the same way to any other case involving an alternative emissions profile such as IS92c (see *IPCC 1996a*). One method of allocating constant emissions might be based on ethics and basic human rights – i.e., equal per capita (EPC) emission rights for all human beings. The total national "right to emit" would then be the product of the population and the basic per capita emissions quota.

Figure B.3.1 illustrates the dynamics of this allocation issue in simplified form. The line EPC indicates the constant level of per capita emissions, if the total global emissions target were allocated equally to all human beings during the decision-making time horizon. If we assume a total permissible accumulation of 800 GtC during the 100 year period 2000-2100 corresponding to the S550 case (see *IPCC 1996a*), shared equally among the global population of about 6 billion persons (in 2000), then the constant average per capita emission right would amount to 1.33 tonnes of carbon (TC) per year, up to 2100 – as shown by the solid line EPC in the figure. A more precise calculation might seek to aggregate both past and future emissions (using discounting techniques), to yield the grand total over any given period of time.

The points IC and DC represent the average current per capita GHG emissions of the industrialised (i.e., OECD nations, Eastern Europe and former Soviet Union), and developing countries, respectively. Although the figure is not exactly to scale, IC (about 3.5 TC per capita per year) is both above EPC and considerably larger than DC (about 0.5 TC per capita). Thus, the industrialised countries would need to cut back GHG emissions significantly if they were to meet the EPC criterion – which would entail economic costs (depending on the severity of the curtailment in each country). On the other hand, the developing countries have considerable room to increase their per capita emissions, as incomes and energy consumption grow.

An alternative allocation rule is based on equi-proportional reductions (EPR) of emissions. In this case, all countries would reduce emissions by the same percentage amount relative to some pre-agreed baseline year, to achieve the desired global emissions target. Assuming a global average emission rate of about 1.47 TC per capita per year in 2000 (indicated by the broken line E2000 in the figure), implies that all countries would need to curtail carbon emissions by about 10% to meet the EPR criterion (as shown by the broken lines ICEPR and DCEPT in the figure). Clearly, given the primary impetus provided by energy to economic development, such a solution would severely restrict growth prospects in the developing world – where per capita energy consumption is low, initially.

Thus the EPC and EPR approaches would result in some hardship and inequity to the developed and developing countries, respectively. Another related equity issues is whether past emissions should be considered also or ignored in deciding the current and future quotas. Suppose we assume that the future global atmospheric concentration of CO_2 must be stabilised at 550 ppmv. Over 80% of carbon accumulated up to 1990 have resulted from fossil fuel use in the industrialised world. Clearly the industrialised countries have used up a significant share of the "global carbon space" available to humanity while driving up atmospheric CO_2 concentrations from the pre-industrial norm of 280 ppmv to the current level of about 360 ppmv. Therefore, the developing countries argue that responsibility for past emissions should be considered when future rights are allocated. Correspondingly, it would be in the industrialised countries interest to use a fixed base year population (e.g., in the year 2000) as the multiplier of the per capita emissions right (e.g., EPC) in determining total national emission quotas. This would penalise those countries which had high population growth rates, since their allowed national quota (determined by the base year population) would have to be divided up among more people in the future.

In practice, it is possible that some intermediate requirement which falls between EPC and EPR might emerge eventually from the collective decision-making process. For example, EPC may be set as a long term goal. In the shorter run, pragmatic considerations suggest that both the industrialised and transition countries be given a period of time to adjust to the lower GHG emissions level, in order to avoid undue economic disruptions and hardship – especially to poorer groups within those countries (see transition emissions paths ICTR and DCTR in the figure). Even if some industrialised nations might argue that the goal of EPC emissions rights for all individuals is too idealistic or impractical, the directions of adjustment are clear. Net CO_2 emissions per capita in industrialised countries should trend downwards, while such emissions in developing countries will increase with time. This result emerges even if the objective is a more equitable distribution of per capita emissions, rather than absolute equality of per capita emissions.

Another adjustment option might be the facilitation of an emissions trading system. For example, once national emissions quotas have been assigned, a particular developing country may find that it is unable to fully utilise its allocation in a given year. At the same time, an industrialised country might find it cheaper to buy such 'excess' emissions rights from the developing nation, rather than undertake a much higher cost abatement program to cut back emissions and meet its own target. More generally, the emissions trading system would permit emissions quotas to be bought and sold freely on the international market, thereby establishing an efficient current price and even a futures market for GHG emissions (burden reallocation is also possible through activities implemented jointly).

Note: *Numerical values in this box have been chosen for illustrative purposes only.*

Source: *Munasinghe (1998a).*

Nevertheless, from a pragmatic viewpoint significant progress towards a global consensus would be made if the decision-making framework could harness enlightened self-interest to support equitable or ethical goals. For example, developed countries are likely to have a self-interest in taking the lead and shouldering the major burdens of addressing climate change issues because their own citizens have shown greater willingness to pay to solve environmental problems, Similarly, developed nations would enjoy greater opportunities for trade and export if developing country markets grew without being disrupted by climate change, and the former could also avoid the significant negative spillover impacts of world-wide instability arising from disasters associated with climate change. At the same time, the higher risks and vulnerability faced by developing countries provides them an incentive to seek common solutions to the climate change problem.

Equity and Economic Efficiency

While the previous section reviewed some arguments for reconciling equity and economic self interest, among nations, conflicts between economic efficiency and equity may arise due to assumptions about the definition, comparison and aggregation of the welfare of different individuals or nations. For example, efficiency often implies maximisation of output subject to resource constraints. This approach can potentially result in an inequitable income distribution. Overall welfare could drop depending on how welfare is defined in relation to the distribution of income. Conversely, total welfare might increase if appropriate institutions can ensure appropriate resource transfers – usually from the rich to the poor.

In the same context, aggregating and comparing welfare across different countries is a disputable issue. Gross National Product (GNP) is simply a measure of the total measurable economic output of a country, and does not represent welfare directly. Aggregating GNP across nations is not necessarily a valid measure of global welfare. However national economic policies frequently focus more on the growth of GNP rather than it's distribution, indirectly implying that additional wealth is equally valuable to rich and poor alike, or that there are mechanisms to redistribute wealth in a way that satisfies equity goals. Attempts have been made to incorporate equity considerations within a purely economic framework, by the weighting of costs and benefits so as to give preference to the poor. Although systematic procedures exist for determining such weights, often the element of arbitrariness in assigning weights has caused many practical problems. At the same time, it should be recognised that all decision-making procedures do assign weights (arbitrarily or otherwise). For example, approaches based on economic efficiency which seek to maximise net benefits assigns the same weight of unity to all monetary costs and benefits – irrespective of income levels. More pragmatically, in most countries the tension between economic efficiency and equity is resolved by keeping the two approaches separate, e.g., by maintaining a balance between maximising GNP, and establishing institutions and processes charged with redistribution, social protection, and provision of various social goods to meet basic needs.

The lack of proper institutions to carry out such a redistributive role on an international scale, raises concerns over how – if at all – national welfare levels can be compared internationally. The extreme viewpoints are that: (a) welfare levels should be compared as though all countries value each others' welfare equally (i.e., equivalent welfare functions exist across countries, and equal weights might be assigned to each); and (b) that each country is concerned primarily with its own welfare and bears no responsibility for the welfare of any other (i.e., welfare cannot be aggregated and compared across countries). Since climate change constitutes situations where the activities of one country affect others. a convention on climate change must arrive at some compromise between these two extremes.

Intragenerational (Spatial) Equity

While equity is not synonymous with equality, differences between countries clearly affect issues of international equity. International response strategies will eventually translate into actions adopted at the national level, and therefore should reflect equity concerns within countries as well. Several categories of differences between countries that are relevant to the question of equity, are discussed next.

Wealth and Consumption: Wealth is perhaps the most obvious and prevalent difference between (and within) countries. Measured in terms of GNP, the World Bank's 1994 World Development Report (*World Bank 1994*) states that more than half the world's population (58.7 percent) live in countries classified as "low income". These countries have an average per capita GNP of $390. In contrast, 15.2 percent of the world's population live in 'high income economies' which have an average per capita GNP of $22,160. The remaining 26.1 percent of the population live in the "middle income economies" which have an average per capita GNP of $2,490. Such wide variations in per capita income between countries imply that simply comparing this measure of welfare may be inappropriate (as explained in the previous section).[1]

These differences have direct implications for the way climate change is addressed. For instance, activities in developing countries that produce greenhouse gases are generally related to fulfilling "basic needs". They may result from generating energy for cooking or keeping tolerably warm, engaging in agricultural practices, consuming energy to provide barely adequate lighting, and occasionally for travel by public transport. In contrast emission of greenhouse gases in developed countries is likely to result from activities such as operating personal vehicles and central heating or cooling, and energy embodied in a wide variety of manufactured goods and the use of such goods. Therefore, the level of personal wealth is directly related to the welfare impacts of reducing greenhouse gas emissions *(WCED, 1987)*. Furthermore, wealth has a direct bearing on the vulnerability to the impacts of climate change. By virtue of being richer, some countries will be able to adapt more effectively to climate change. A similar relationship between the poor and the rich also prevails within countries.

Poorer countries may be less prepared, to adopt mitigation and adaptation strategies due to several reasons. First, poverty has implications for urgency of other national priorities and of time scales used in policy planning. Wealth has a direct correlation to personal discount rates (i.e., discount rates decline with rising wealth). The more affluent have a greater share of disposable wealth to invest in the future, and therefore are able to conceptualise longer

[1] One method of comparing incomes across countries is to use purchasing power parities (PPPs) instead of market exchange rates. PPPs are used to adjust exchange rates, such that the monetary value of a standard basket of commodities (typically including food, clothing and shelter) is equalised across all countries. Such a correction tends to provide a better assessment of the ultimate welfare provided by income levels in different nations. However even when incomes are adjusted based on purchasing power parities, wide differences in real per capita income are still evident among countries.

planning time horizons. The poor are forced to focus on shorter term objectives such as basic survival necessities.

A similar phenomenon applies to national level economic and political systems as well. Consequently, interest rates are higher in poorer countries, capital is more scarce, and the emphasis of policy planning is on the short term needs, such as poverty alleviation, and employment generation. The focus of government may be to keep up with infrastructure needs due to rapidly rising demands. They may not have the luxury to consider optimal development strategies as some richer countries may be able to. Thus national wealth affects both actual investment decisions as well as broader public policy planning capability.

The IPCC Special Report on Developing Countries addresses this concern by stating that, "the priority for the alleviation of poverty continues to be an overriding concern of the developing countries; they would rather conserve their financial and technical resources for tackling their immediate economic problems than make investments to avert a global problem which may manifest itself after two generations." Similarly, Article 4.7 of the FCCC states that, "economic and social development and poverty eradication are the first and overriding priorities of the developing country Parties" and thus their commitments to implementing climate change responses will be influenced by these. considerations. Even though concerns about climate change are likely to grow in the developing countries (especially those who consider themselves the most vulnerable), they are likely to lack the resources to address the issue.

Contributions to Climate Change: Countries vary in the nature and degree of contribution to climate change. Many different gases and sources contribute towards climate change. The capacity of sinks to absorb carbon emissions also differs widely between countries. The range of sources and sinks may not be an issue of equity, but different ways of aggregating and presenting the data can have implications for equity considerations. In particular, developing countries emit much less per capita and have contributed less to past emissions. In this context, some authors have argued that the industrialised countries owe the developing world a “carbon debt”, due to disproportionately high GHG emissions in the past (see for example, *Munasinghe 1993;* and *Jenkins 1996*). The developing countries also need considerable "headroom" to allow for the growth of future economic output and energy consumption, since they are starting from a much lower base (see also Box 3.1). At the same time, there are many variations within developed and developing countries which must be acknowledged as well. Simply differentiating along the lines of developed and developing countries will exclude many important issues from the analysis. The incorporation into the decision-making process, of equity issues associated with variations in the contributions to climate change, would be critical both in facilitating the reaching of a world-wide consensus on burden sharing, and in subsequently implementing difficult mitigation and adaptation measures.

Incidence of and Vulnerability to Impacts: The incidence of impacts may bear no relationship to the pattern of GHG emissions, which violates equity principles and is inconsistent with the "polluter pays" and "victim is recompensed" approach that has been applied already to more local environmental pollution problems. In particular, the negative effects of climate change are likely to be most pronounced in tropical regions typically occupied by developing countries. In addition to asymmetries in the incidence of impacts, many developing countries are more vulnerable to the effects of global warming, because of fewer resources, weaker institutional capacity, and smaller pool of skilled human resources, to draw on in times of crisis. The plight of poor and subsistence level communities, or low lying small island nations subject to sea level rise, will be quite bleak. Therefore, both humanitarian and equity principles need to be invoked to provide them some relief, along the lines of the principles and procedures established during the United Nations international decade for natural disaster relief (IDNDR).

Equity within Countries: Almost all the arguments mentioned above in the context of equity across countries, also apply to equity within individual nations. Fortunately, there are many existing mechanisms within countries (such as subsidised food, healthcare and schooling, social security, or progressive taxation) to ensure action consistent with what is considered acceptable and proper, and achieve proper redistribution of resources. Equity issues, especially in the form of views about what constitutes justice, will influence the formation, decisions and credibility of these institutions. Although the capacity and legitimacy of these institutions may vary, they provide a useful framework within which climate change issues can begin to be addressed at the national and sub-national levels.

Intergenerational (Temporal) Equity and Discounting

Most of the points enumerated earlier with respect to spatial equity also affect equity across time, and in very similar ways. First, future generations may be richer or poorer than the present generation. Second, those living in the past and the present would undoubtedly be the contributors to future climate change impacts. Third, while future generations will have to bear the consequences of GHG emissions made in the past, they will also benefit from sacrifices and investments made by their forbears. At the same time, it is unclear whether our descendants will be more or less vulnerable to the effects of climate change.

At the same time, there are two fundamental issues that require us to pay special attention to intergenerational equity. First, all decisions relating to climate change are made by the generation living at that time. To the extent that future generations are not represented in the ongoing decision making process, particular care needs to be exercised to ensure that their rights are protected. Second, once a chain of events unfolds, it will be difficult to compensate future generations for past mistakes or miscalculations. Once again, extra prudence is required to avoid imposing future burdens that are both irreversible and impossible to compensate. Nevertheless, generations do overlap in practice (e.g., parents and children), and this is likely to result in the automatic incorporation of some intergenerational concerns into the discount rate and decision making in general.

Social Rate of Discount: There are various equity-related mentioned earlier that may be used to ensure a desirable measure of temporal equity. From an economic viewpoint, one of the principle instruments available to influence the allocation of resources across time is the social rate of discount (see Box 3.3). Indeed, the conclusions derived from any long term analysis of climate change policy will depend crucially on the numerical value of discount rate that is selected. It is important to bear in mind that we are discussing the real discount rate where the effects of inflation are netted out. Furthermore, conceptually the interest rate (at which present day capital will grow into the future) is the exact mirror image of the discount rate (at which future expenditures should be discounted to the present date).

Since discounting is a method for comparing economic costs and benefits that occur at different times, it will have a direct bearing on intergenerational equity. In the case of climate change analysis, the effects of discounting will be especially pronounced for two reasons: (a) the relevant time horizons are extremely long; and (b) many of the costs of mitigation occur relatively early, while potential benefits lie in the distant future. In brief, as far as present-day decisions are concerned, a higher discount rate will reduce the importance of future benefits (of avoided climate change damages) relative to the near term costs (of mitigation measures).

There are two main approaches to practically determining a value for the social rate of discount in climate change analysis – one based on the social rate of time preference (SRTP) and the other on the (risk-free) market returns to investment (MRI). While the concepts underlying these two approaches may appear to diverge, when practical adjustments are made both the SRTP and MRI tend to produce estimates for the social rate of discount that are comparable. Thus estimates for SRTP vary from 1 to 4% and MRI from 3 to 6% per annum (for details, see *Arrow et al. 1995*).

Box 3.3 Discount Rate

Basic Concepts

The social rate of discount (SRD) is defined as the one used by decision-makers in determining public policy. The main text indicates that some fundamental issues of value and equity are involved in the choice of such a social discount rate. In addition to the technical aspect of comparing economic costs and benefits over time, the sustainable development dimension described earlier provides a more overarching guideline – that each generation has the right to inherit a set of economic, social and environmental assets that are at least as good as the one enjoyed by the preceding generation. In subsequent discussions, mention of the discount rate refer to the social rate of discount, unless otherwise specified.

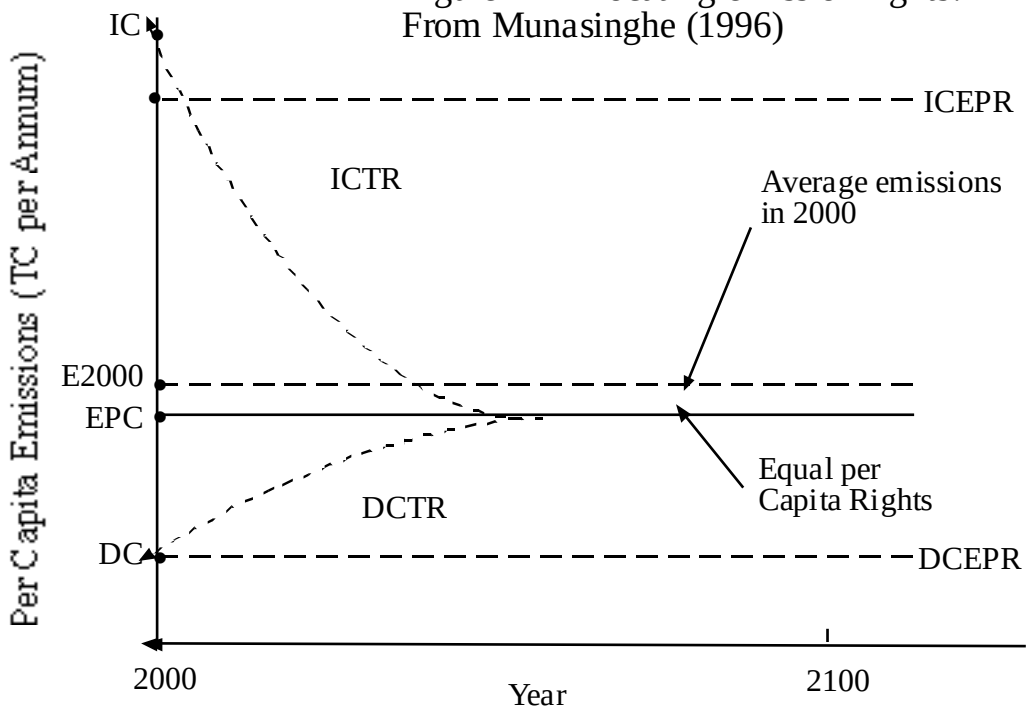
Even in traditional cost benefit analysis used in project evaluation which is far less complicated than climate change decision-making, the choice of a discount rate is not clear cut (see for

example, *Munasinghe 1993*). Discount rates vary across countries, depending on behavioural preferences and economic conditions. Furthermore, it is considered prudent to test the sensitivity of the results by using a range of discount rates (usually about 4 to 12 percent per annum), even for a project within a given country.

Starting from the theoretically ideal (or first best) situation of perfectly functioning, competitive markets and an optimal distribution of income, it is possible to show that the discount rate should be equal to the marginal returns to investment (or marginal yield on capital) which will also equal the interest rate on borrowing by both consumers and producers (*Lind 1982*). More specifically, there are three conditions to ensure an efficient (or optimal) growth path. First, the marginal returns to investment between one period and the next should equal the rate of interest (i) charged from borrowing producers. Second, the rate of change of the marginal utility of consumption (or satisfaction derived from one extra unit consumed) from one period to the next should be equal to the interest rate (r) paid out to lending consumers. Third and finally, the producer and consumer rates of interest are equal (i.e., i = r), throughout the economy and over all time periods.

As we deviate from the ideal market conditions and optimal income distribution, the determination of the discount (or interest) rate becomes less clear. For example, taxes (subsidies) may increase (decrease) the borrowing rate to producers above (below) the interest rate paid to consumers on their savings (i.e., i unequal to r). More generally, if the three conditions do not hold because of economic distortions, then efficiency may require project or sector specific discount rates that would include so-called second-best corrections to compensate for the various economic imperfections. In extreme cases, there is no theoretical basis for linking observed market interest rates to the social rate of discount. Nevertheless, market behaviour would still provide useful information to estimate the social rate of discount.

Figure B7 Allocating emission rights.
From Munasinghe (1996)



ANNEX 4. LINKAGES BETWEEN COUNTRYWIDE POLICIES AND THE ENVIRONMENT

Countrywide policies consist of both sectoral and macroeconomic policies which have widespread effects throughout the economy, and therefore, it is not surprising that their environmental and social consequences could be both positive and negative (see for example, *Munasinghe 1997*). Sectoral measures mainly involve a variety of economic instruments, including pricing in key sectors (for example, energy or agriculture) and broad sectorwide taxation or subsidy programs (for example, agricultural production subsidies, and industrial investment incentives). Macroeconomic policies and strategies are even more sweeping, ranging from exchange rate, interest rate, and wage policies, to trade liberalisation, privatisation, and similar programs. Such economywide policies are often packaged within programs of structural adjustment and sectoral reform, aimed at promoting economic stability, efficiency and growth, and ultimately improving human welfare. Although the emphasis is on economic policies, other non-economic measures (such as social, institutional and legal actions), are also relevant.

Some Stylised Results and Analysis

It is difficult to generalise about the environmental and social impacts of economywide policies, because the linkages tend to be extremely complex and country specific. For example, a recent study indicated that even the purely economic impacts of structural adjustment programs are difficult to trace comprehensively (*Tarp 1993)*. Nevertheless, we attempt to summarise below some stylised results concerning the impacts of countrywide policies on various indicators of sustainability, in three broad categories – beneficial, harmful and unknown effects. In the first group are the so-called "win-win" policies, where it is possible to achieve simultaneous gains in all three areas of sustainable development (i.e., economic, social and environmental) when economywide reforms are implemented. The second category recognises important exceptions where such potential gains cannot be realised unless the macro-reforms are complemented by additional environmental and social measures which protect both the environment and the poor. The third and final category consists of impacts that are less predictable, mainly because of the complexity of the linkages involved, and the long-run time perspective. This section ends with a theoretical analysis of the various linkages between economywide policies and the environment.

IMPACTS OF ECONOMYWIDE POLICIES ON SUSTAINABILITY

Beneficial Impacts

Several studies indicate that liberalising reforms which seek to make desirable alterations in the structure of the economy, often contribute to both economic and sustainability gains. Such changes include the removal of price distortions, promotion of market incentives, and

relaxation of trade and other constraints (which are among the main features of adjustment-related reforms). For example, reforms which improve the efficiency of industrial or energy related activities could reduce economic waste, increase the efficiency of natural resource use and limit environmental pollution. Similarly, improving land tenure rights and access to financial and social services not only yields economic gains but also promotes better environmental stewardship and helps the poor.

In the same vein, there is evidence to show that shorter-run policy measures aimed at restoring macroeconomic stability will generally yield economic, social and environmental benefits, since instability undermines sustainable resource use and especially penalises the poor. For example, price, wage and employment stability encourage a longer term view on the part of firms and households alike. Lower inflation (and discount) rates not only lead to clearer pricing signals and better investment decisions by economic agents, but also protect fixed income earners.

Avoiding Harm

A number of researchers have pointed out how economywide structural reforms have had adverse environmental and social side effects. Such negative impacts are invariably unintended and occur when some broad policy changes are undertaken while other hidden or neglected policy, market or institutional imperfections persist. The remedy does not generally require reversal of the original reforms, but rather the implementation of additional complementary measures (both economic and non-economic) that remove such policy, market and institutional difficulties. These complementary measures are not only socially and environmentally beneficial in their own right, but also help to broaden the effectiveness of economywide reforms. Typical examples of potential environmental damage caused by remaining imperfections include:

Policy distortions: Export promotion measures that increase the profitability of natural resource exports, might encourage excessive extraction or harvesting of this resource if it were underpriced or subsidised (for example, low stumpage fees for timber). Similarly, trade liberalisation could lead to the expansion of wasteful energy-intensive activities in a country where subsidised energy prices persisted.

Market failures: Economic expansion induced by successful adjustment may be associated with excessive environmental damage – for example, if external environmental effects of economic activities (such as air or water pollution), are not adequately reflected in market prices that influence such activities.

Institutional constraints: The benefits of countrywide reforms could be negated by unaddressed institutional problems, such as the poor accountability of state-owned enterprises (which would allow them to ignore efficient price signals), weak financial intermediation, or inadequately defined property rights. Such issues tend to undermine incentives for sustainable resource management and worsen equity.

Stabilisation: The shorter term stabilisation process also may have unforeseen adverse environmental and social impacts. For example, general reductions in government spending are often required to limit budgetary deficits and bring inflation under control. However, unless such cutbacks are carefully targeted, they may disproportionately penalise expenditures on environmental protection or poverty safety nets. Another important linkage is the possible short-term adverse impact of adjustment induced recession on poverty and unemployment, whereby the poor are forced to increase their pressures on fragile lands and "open access" natural resources – due to the lack of economic opportunities elsewhere. As before, complementary measures to limit the adverse consequences of adjustment would be justified – on both social and environmental grounds.

Less Predictable and Longer Term Effects

Economywide policies will have additional longer term effects on sustainability, whose net impacts are often unpredictable. Some of these effects need to be traced through a general equilibrium framework that captures both direct and indirect links. For example, several studies confirm that adjustment-induced changes often succeed in generating new economic opportunities and sources of livelihood, thereby raising incomes and helping to break the vicious cycle of environmental degradation and poverty. However, while such growth is an essential element of sustainable development, it will necessarily increase the overall pressures on environmental resources. At the same time, properly valuing resources, increasing efficiency and reducing waste, will help to reshape the structure of economic growth and limit undesirable environmental impacts. Finally, environmental policies themselves could have impacts on income distribution and employment.

Up to now, we have focused on the use of complementary policies to limit environmental and social harm, without interfering with the economywide reforms themselves. However, it is prudent to recognise that if the threat to long term sustainability is great enough, the countrywide policy reform process itself may need to be modified directly.

Action Impact Matrix (Aim): A Tool for Policy Analysis, Formulation and Co-ordination

Economic-environmental-social interactions may be identified and analysed, and effective sustainable development policies formulated, by linking and articulating these activities explicitly. Implementation of such an approach would be facilitated by constructing an Action Impact Matrix (AIM) – a simple example is shown in Table A4.1, although an actual AIM would be very much larger and more detailed (*Munasinghe 1997*). Such a matrix helps to promote an integrated view, meshing development decisions with priority economic, environmental and social impacts. The far left column of the table lists examples of the main development interventions (both policies and projects), while the top row indicates some of the main sustainable development issues (including GHG emissions). Thus the elements or cells in the matrix help to: (a) identify explicitly the key linkages; (b)

focus attention on valuation and other methods of analysing the most important impacts; and (c) suggest action priorities. At the same time, the organisation of the overall matrix facilitates the tracing of impacts, as well as the coherent articulation of the links between a range of development actions – that is, policies and projects.

A stepwise procedure, starting with readily available data, has been used effectively to develop the AIM in several country studies that have been initiated recently (for instance, Brazil, Chile, Nepal, Philippines, and Sri Lanka). This process has helped to harmonise views among those involved (economists, environmental specialists and others), thereby improving the prospects for successful implementation.

Screening and Problem Identification: One of the early objectives of the AIM-based process is to help in *screening and problem identification* – by preparing a preliminary matrix that identifies broad relationships, and provides a qualitative idea of the magnitudes of the impacts. Thus, the preliminary AIM would be used to prioritise the most important links between policies and their sustainability impacts. For example, in the top row of Table A4.1, a currency devaluation aimed at improving the trade balance, may make timber exports more profitable and lead to deforestation of open access forests and increased GHG emissions. The appropriate remedy might involve complementary measures to strengthen property rights and restrict access to the forest areas.

A second example might involve increasing energy prices closer to marginal costs – to improve energy efficiency and decrease GHG and other emissions (second row of Table 2). A complementary measure involving the addition of pollution (carbon) taxes to marginal energy costs will further reduce emissions. In the same vein, a major hydroelectric project is shown lower down in the table as having two adverse impacts – inundation of forested areas and villages – as well as one positive impact – the replacement of thermal power generation (thereby reducing GHG emissions). A re-afforestation project coupled with adequate resettlement efforts may help not only to address the negative impacts, but also enhance carbon fixing.

This matrix-based approach therefore encourages the systematic articulation and co-ordination of policies and projects to achieve sustainable development goals. Based on readily available data, it would be possible to develop such an initial matrix for many countries. Furthermore, a range of social impacts could be incorporated into the AIM, using the same approach.

Analysis and Remediation: This process may be developed further to assist in *analysis* and *remediation*. For example, more detailed analyses and modelling may be carried out for each matrix element in the preliminary AIM which represented a high priority linkage between economywide policies and environmental impacts that had been already identified in the cells of the preliminary matrix. This, in turn, would lead to a more refined and updated AIM, which would help to quantify impacts and formulate additional policy measures to enhance positive linkages and mitigate negative ones.

The types of more detailed analyses which could help to determine the final matrix would depend on planning goals and available data and resources. They may range from the application of conventional sectoral economic analysis methods (appropriately modified in scope to incorporate environmental impacts), to fairly comprehensive system or multisector modelling efforts – including CGE models that include both conventional economic, as well as environmental or resource variables. Sectoral and partial equilibrium analyses are more useful to trace details of direct impacts, whereas CGE modelling provides a more comprehensive but aggregate view, and insights into indirect linkages.

Table A4.1. Example of a Simple Action Impact Matrix (AIM).

ACTIVITY/POLICY	MAIN OBJECTIVE	IMPACTS ON KEY SUSTAINABLE DEVELOPMENT ISSUES			
		Land Degradation	*GHG Emission*	*Resettlement*	*Others*
Macro-economic & Sectoral Policies	Macroeconomic and sectoral improvements	Positive impacts due to removal of distortions Negative impacts mainly due to remaining constraints			
· *Exchange Rate*	· Improve trade balance and economic growth	(-H) (deforests open-access areas)	(-M) (releases carbon stocks)		
· *Energy Pricing*	· Improve economic and energy use efficiency		(+M) (energy effic. reduces emissions)		
· *Others*					
Complementary Measures[2]	Specific/local social and environmental gains	Enhance positive impacts and mitigate negative impacts (above) of Broader macroeconomic and sectoral policies			
· *Market Based*	· Reverse negative impacts of market failures, policy distortions and institutional constraints		(+M) (pollution tax reduces emissions)		
· *Non-Market Based*		(+H) (property rights reduce deforestation)	(+M) (fixes carbon)		
Investment Projects	Improve efficiency of investments	Investment decisions made more consistent with broader policy and institutional framework			
· Project 1 *(Hydro Dam)*	· Use of project Evaluation (cost Benefit analysis, Environmental Assessment, Multi-criteria Analysis, etc.)	(-H) (inundates forests)	(+M) (displaces fossil fuel use and reduces emissions)	(-M) (displaces people)	
· Project 2 *(Re-afforest and relocate)*		(+H) (replants forests)	(+M) (fixes carbon)	(+M) (relocates people)	
· *Project N*					

Source: *Munasinghe 1993.*

Notes

[1] A few examples of typical policies and projects as well as key environmental and social issues are shown. Some illustrative but qualitative impact assessments are also indicated: thus + and - signify beneficial and harmful impacts, while H and M indicate high and moderate intensity. The AIM process helps to focus on the highest priority environmental issues and related social concerns.

[2] Commonly used market-based measures include effluent charges, tradable emission permits, emission taxes or subsidies, bubbles and offsets (emission banking), stumpage fees, royalties, user fees, deposit-refund schemes, performance bonds, and taxes on products (such as fuel taxes). Non-market based measures comprise regulations and laws specifying environmental standard (such as ambient standards, emission standards, and technology standards) which permit or limit certain actions ("dos" and "don'ts").

ANNEX 5: ENVIRONMENTAL VALUATION

Economic valuation of environmental assets and services is an important input to the decision-making process. There has been some modest progress in recent years, in both the theory and application of valuation methods. The conceptual basis for valuation and various practical techniques are briefly summarised below *(for details, see Munasinghe 1993)*.

Valuation Concepts

The basic purpose of valuation is to determine the *total economic value* (TEV) of a resource. TEV consists of two broad categories: use value (UV) and non-use value (NUV); i.e., TEV = UV + NUV. *Use values* may be broken down further into: (1) direct use value (DUV); (2) indirect use value (IUV); and (3) potential use value or option value (OV). Direct use value is the immediate contribution an environmental asset makes to production or consumption (e.g., food or recreation). Indirect use value includes the benefits derived from functional services that the environment provides to support production and consumption (e.g., recycling nutrients or breaking down wastes). Option value is the willingness to pay now for the future benefit to be derived from an existing asset. *Non-use values* are based generally on altruistic, non-utilitarian motives (*Schechter and Freeman 1992*), and occur although the valuer may have no intention of using a resource – one important category called existence value arises from the satisfaction of merely knowing that the asset exists (e.g., a rare and remote species).

For the practitioner, what is important is not necessarily the precise conceptual breakdown of economic value, but rather the various empirical techniques that permit us to estimate a monetary value for environmental assets and impacts. However, the results derived from some of these techniques are uncertain even in developed economies, and therefore, their use in developing countries should be tempered by caution and sound judgement.

The willingness to pay (WTP) of individuals for an environmental service or resource is the economic basis for a variety of available valuation techniques (*Kolstad and Braden 1991*). WTP is strictly defined as the area under the compensated or Hicksian demand curve which indicates how demand varies with price while keeping the user's utility level constant. Equivalently, the difference between the values of two expenditure (or cost) functions could be used to measure the change in value of an environmental asset. The former are the minimum amounts required to achieve a given level of utility – for a household (or output – for a firm) before and after varying the quality of, price of, and/or access to, the environmental resource in question. All other aspects are kept constant. However, the commonly estimated demand function is the Marshallian one – which indicates how demand varies with the price of the environmental good, while keeping the user's income level constant. In practice, it has been shown that the Marshallian and Hicksian estimates of WTP are comparable under certain conditions (*Willig 1976*). Furthermore, in a few cases

once the Marshallian demand function has been estimated, the equivalent Hicksian function may be derived in turn. The payments people are willing to accept (WTA) in the way of compensation for environmental damage, is another measure of economic value that is related to WTP. WTA and WTP could diverge significantly (*Cropper and Oates 1992*). In practice either or both measures are used for valuation.

Valuation Techniques

Valuation methods may be categorised according to which type of market they rely on, and by considering how they make use of actual or potential behaviour (see Table A5.1). The most useful methods are based on how environmental quality changes affect directly observable actions, with the consequences valued in conventional markets.

Table A5.1. Techniques for Valuing Environmental Impacts.

	TYPE OF MARKET		
TYPE OF BEHAVIOUR	**Conventional market**	**Implicit market**	**Constructed market**
Based on actual behaviour	Effect on Production Effect on Health Defensive or Preventive Costs	Travel Cost Wage Differences Property Values Proxy Marketed Goods	Artificial market
Based on intended behaviour	Replacement Cost Shadow Project		Contingent Valuation

Source: *Munasinghe (1993)*

Effect on Production. An investment decision often has environmental impacts, which in turn affect the quantity, quality or production costs of a range of productive outputs that may be valued readily in economic terms.

Effect on Health. This approach is based on health impacts caused by pollution and environmental degradation. One practical measure related to the effect on production is the value of human output lost due to ill health or premature death. The loss of potential net earnings (called the human capital technique) is one proxy for foregone output, to which the costs of health care or prevention may be added.

Defensive or Preventive Costs. Often, costs may be incurred to mitigate the damage caused by an adverse environmental impact. For example, if the drinking water is polluted, extra purification may be needed. Then, such additional defensive or preventive expenditures (ex-post) could be taken as a minimum estimate of the benefits of mitigation.

Replacement Cost and Shadow Project. If an environmental resource that has been impaired is likely to be replaced in the future by another asset that provides equivalent services, then the costs of replacement may be used as a proxy for the environmental damage – assuming that the benefits from

the original resource are at least as valuable as the replacement expenses. A shadow project is usually designed specifically to offset the environmental damage caused by another project – eg., if the original project was a dam that inundated forest land, then the shadow project might involve replanting an equivalent area of forest, elsewhere.

Travel Cost. This method seeks to determine the demand for a recreational site (e.g., number of visits per year to a park), as a function of variables like price, visitor income, and socio-economic characteristics. The price is usually the sum of entry fees to the site, costs of travel, and opportunity cost of time spent. The consumer surplus associated with the demand curve provides an estimate of the value of the recreational site in question.

Property Value. In areas where relatively competitive markets exist for land, it is possible to decompose real estate prices into components attributable to different characteristics like house and lot size, air and water quality. The marginal WTP for improved local environmental quality is reflected in the increased price of housing in cleaner neighbourhoods. This method has limited application in developing countries, since it requires a competitive housing market, as well as sophisticated data and tools of statistical analysis.

Wage Differences. As in the case of property values, the wage differential method attempts to relate changes in the wage rate to environmental conditions, after accounting for the effects of all factors other than environment (e.g., age, skill level, job responsibility, etc.) that might influence wages.

Proxy Marketed Goods. This method is useful when an environmental good or service has no readily determined market value, but a close substitute exists which does have a competitively determined price. In such a case, the market price of the substitute may be used as a proxy for the value of the environmental resource.

Artificial Market. Such markets are constructed for experimental purposes, to determine consumer WTP for a good or service. For example, a home water purification kit might be marketed at various price levels, or access to a game reserve may be offered on the basis of different admission fees, thereby facilitating the estimation of values.

Contingent Valuation. This method puts direct questions to individuals to determine how much they might be willing-to-pay (WTP) for an environmental resource, or how much compensation they would be willing-to-accept (WTA) if they were deprived of the same resource. The contingent valuation method (CVM) is more effective when the respondents are familiar with the environmental good or service (e.g., water quality) and have adequate information on which to base their preferences. Recent studies indicate that CVM, cautiously and rigorously applied, could provide rough estimates of value that would be helpful in economic decision-making, especially when other valuation methods were unavailable.

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2

DEVELOPMENT, EQUITY, SUSTAINABILITY AND CLIMATE CHANGE. CHALLENGES FOR LATIN AMERICA AND THE CARIBBEAN

Ramon Pichs

1. Development, Equity, Sustainability and Climate Change

During the last decades the issues related to development, equity and sustainability have received special consideration in the context of the international debate on the environmental dimension of globalisation.

The concept of sustainable development must be analysed in the context of the broader debate on the concept of development. The *World Commission on Environment and Development (WCED 1987)* defined *sustainable development* as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Despite its ambiguity, this basic concept (general approach) assumes that the economic and social goals of development must be defined in terms of sustainability.

According to the United Nations Development Program *(UNDP 1995)* the *human development* paradigm contains four main components:

- *Productivity*, referred to economic growth as a subset of human development;
- *Equity,* in terms of equal opportunities;
- *Sustainability*, focusing on the access to opportunities for present and future generations, and considering that all forms of capital – physical, human, and environmental – should be replenished.
- *Empowerment*, with regard to the requirement of full participation of people in the decision making process.

Taking the general concepts of *sustainable development and human development,* as a starting point, three main interrelated dimensions of sustainable development can be identified, as complementary aspects of the same agenda:

- *Economic sustainability* assumes that social and environmental dimensions of sustainable development must be defined with economic considerations (i.e. economic efficiency in resource allocation) in mind;
- *Social sustainability* assumes that economic and environmental dimensions must be defined by taking into account social considerations (i.e. intragenerational and intergenerational equity);

- *Environmental sustainability* assumes that the economic and social dimensions must be defined by considering environmental constraints.

Thus, by following an integrative approach, sustainable development *(or sustainable human development)* must be defined as a multi-dimensional process, that has to be "sustainable" in economic, social and environmental terms. Each of these dimensions is necessary but not a sufficient condition for sustainability.

As part of this debate, the *eco-development* paradigm attempts to integrate social factors and goals with the long term economic and ecological ones, striving for the "co-development" of society and the environment, by actively restructuring the economy according to both ecological and equity criteria *(see Sagasti and Colby 1992).* These authors present eco-development as the first paradigm of environmental management in development that is based equally on developing and industrial country experiences, philosophies, needs, and logic. For Sagasti and Colby, sustainable development is an idealistic goal, not a strategy, and eco-development is the more integrative strategic paradigm of how to achieve sustainable development.

In the debate on sustainability, H. Daly refers to three values in conflict: efficient allocation of resources (efficiency); equity or just distribution (justice); and optimal scale (sustainability) *(see Pantin 1994).* These values in conflict could be associated with the three main dimensions of sustainable development as follows:

- *Efficient allocation of resources* — *economic sustainability*
- *Equity and just distribution* — *social sustainability*
- *Optimal scale* — *environmental sustainability*

With regard to the relation between *economic sustainability and climate change*, it is worth noting that many countries, having economic growth as their primary end, have pursued "development strategies" adapted to this end. In those conditions, unsustainable patterns of economic growth have tended to increase climate potential, particularly when those patterns have prevailed during long time periods. Consequently, climate change response strategies must be oriented to drastically altering unsustainable patterns of economic growth.

The time perspective is crucial in dealing with the interaction between the three dimensions of sustainable development (economic, social and environmental dimensions) and climate change. Taking into consideration the complex nature of climate change, as a global environmental problem; effective climate change response strategies (including technological and economic policies) must be designed by following a long-term perspective. Short-term oriented economic policies tend to disregard the complexity and scope of climate change response requirements.

In this context, new and cleaner technologies and growing efficiency in resource use (as basic components of sustainable development strategies) would significantly reduce the negative implications of climate change, by limiting the GHG emissions per unit of

production. The massive introduction of new and cleaner technologies, as part of the climate change response strategies, could also have a positive contribution to social goals, as new climate friendly technologies generally employ more people *(see UNDP 1998)*. The access of developing countries to climate friendly technologies would contribute to the efforts of these countries to elude the wasteful patterns of economic growth followed by the North.

Concerning the linkage between *social sustainability and climate change*, on the one hand, inequity could undermine social cohesion and exacerbate conflict over resources and climate change. Rich people pollute more, generate more waste, put more stress on natural resources, and contribute more to global warming; while poor and landless people are often caught in a vicious circle of poverty-resource degradation-poverty, that also contributes to climate change. More than 500 million poor people live in marginal lands *(UNDP 1998).*

On the other hand, concerning the geography of environmental deterioration, climate change is likely to result in inequities due to the uneven distribution of costs of damage, as well as of necessary adaptation and mitigation efforts. Existing evidence clearly demonstrates that poorer nations and disadvantaged groups within nations are specially vulnerable to climate change *(Munasinghe 1999).*

Even though poor people often bear the brunt of climate change, they are seldom the principal creators of the damage. Developing countries, particularly their poorest people, are expected to be hit hardest by the failing harvest (e.g. Sub-Saharan Africa, Arab States and South Asia) and rising of the sea level derived from global warming (e.g. small islands). Consequently, the existing inequalities and patterns of poverty and hunger will be worsened, with women facing greater risks due to their social and economic roles *(see UNDP 1998).*

In this context, intragenerational and intergenerational equity must be key components of social sustainability in the climate change response strategies. Differences between countries, regions, social groups and generations must be recognised and dealt with adequately.

Although climate change policy cannot be expected to address all prevailing equity issues, climate change response strategies should not be allowed to worsen existing inequalities. In this sense, the principle of compensating victims could be considered as an extension of the polluter pays principle; and special attention must be paid to the polluter obligation to recognise and mitigate past emissions (ecological debt) *(see Munasinghe 1999).*

Environmental sustainability mainly focuses on preserving the resilience and dynamic ability of biological and physical systems. In this regard, H. Daly has proposed four operational principles of sustainability:

- the main principle is to limit the human scale of throughput to a level which, if not optimal, is at least within the carrying capacity

- technological progress of sustainable development should be efficiency-increasing rather than throughput-increasing
- harvesting rates of renewable resources should not exceed regeneration rates, and waste emissions should not exceed the renewable assimilative capacity of the environment
- non-renewable resources should be exploited but at a rate equal to the creation of renewable substitutes *(see Pantin 1994).*

In this debate, it is also relevant to discuss the interaction between climate change and other local, regional and global environmental problems. In fact, climate change interacts with other environmental problems, such as urban pollution, acid rain, loss of biological diversity, stratospheric ozone depletion, and land degradation. This reinforces the requirement for an integrated assessment of environmental sustainability in dealing with climate change response strategies.

The current debate on (hydrofluorocarbons) HFCs and (perfluorocarbons) PFCs in the context of the efforts to protect the stratospheric ozone layer, on the one hand, and the efforts to safeguard the global climate system, on the other hand, reveal the requirements of a coherent approach in the multilateral environmental agreements. HFCs and PFCs are among the substances that are being used as replacements for ozone depleting substances; however, at the same time, HFCs and PFCs have high global warming potentials.

In summary, the main ideas on development, equity and sustainability, with relevance for the IPCC Third Assessment Report, are key ingredients in the debate on the three main dimensions of sustainable development (i.e. economic sustainability, social sustainability and environmental sustainability). The identification of these dimensions has contributed to the further elaboration of the original concept of sustainable development. In practice these dimensions are closely interrelated in such a way that each of them is a necessary though not a sufficient condition for sustainable development.

The socio-economic and environmental experience of Latin America and the Caribbean region reflects the unsustainability of the patterns of economic growth followed in the region during the last two decades. This experience also reveals the requirement for a significant restructuring of the development strategies, in consistency with the priorities of most of the regional population.

2. Development, Equity, Sustainability and Climate Change. Challenges for Latin America and the Caribbean

In terms of economic growth, during 1990-99 the regional gross domestic product (GDP) increased by 3.2% per year, as average, versus 1% during the 1980s. However, the rate of economic growth in 1990-99 is well below the average growth during 1945-80 (5.5%), and quite modest with regard to the rate of 6% required to overcome the technological and

social backwardness, according to the UN Economic Commission for Latin America and the Caribbean (ECLAC), *(see CEPAL 2000).*

In terms of social disparities, the economic policies implemented in the region in the last decades have not contributed to equitably share the costs of the crises and the burden of the adjustments among the several sectors of the population. Consequently, these policies have provoked, in many cases, an additional deterioration of the socio-economic conditions of the poorest. This growing process of social exclusion has highly negative environmental implications.

Poverty has been identified as one of the main threats for sustainable development in Latin America. According to estimates of ECLAC, there are 224 million people living under the line of poverty and most of the poor (80%) lives in environmentally vulnerable areas. At present, 23% of the regional population does not have access to fresh water, 29% is deprived of sanitation services, and 21% does not have access to basic health services.

Thus, the economic, social and environmental unsustainability contributes to the vicious circle between underdevelopment, poverty and environmental deterioration. In many cases, the programs of macroeconomic adjustment, implemented in the region during the last two decades, have reinforced this vicious circle by severely reducing the environmental budgets and by aggravating the social conditions in several Latin American and Caribbean countries.

Latin America, with 8.4% of the world population accounts for 8.9% of the global GDP and 4.4% of the total exports of goods and services. As part of its rich natural endowment, Latin America possesses 23% of the fertile lands, 31% of the fresh water, 23% of global forest, 40% of the animal and vegetal species, 20% of the hydro-energy potential; and huge mineral reserves. However, the implementation of effective strategies for sustainable development in the region faces serious obstacles due to the persistence of political, socio-economic, financial and technological barriers.

Some of the most significant environmental problems affecting Latin America and the Caribbean are the erosion, saltiness, and declining productive capacity of the soil; deforestation; loss of biodiversity; atmospheric pollution; water pollution; and mismanagement of urban and hazardous wastes.

More than 10% of the regional territory (more than 300 million hectares) is considered to be degraded land in Latin America and the Caribbean, where agriculture and agro-industry are particularly important. This problem has been accelerated by the prevailing systems of land distribution in the region, where around 10% of the population controls 90% of the fertile land. In most of the cases, soil erosion has been associated with deforestation, overgrazing and chemical degradation.

The environmental deterioration and the alterations of ecosystems in Latin America and the Caribbean can be explained, to a great extent, by the effects of the so-called "Green

Revolution", carried out since the 1950s with the active participation of foreign companies. This process also contributed to the emigration of farmers to the urban areas, with adverse environmental implications in the cities *(see Gligo 1994).*

Soil degradation is closely related to deforestation. With 57% of the world tropical forests, Latin America and the Caribbean have shown one of the highest rates of deforestation among the developing regions in the last 20 years. Deforestation has been accelerated by the expansion of the agricultural frontier, the growing harvesting of wood for commercial uses, wild fires, the construction of communication networks (roads, railways, etc.), and the inefficient use of traditional fuels derived from forests, among other causes.

Among other negative implications, deforestation has accelerated the reduction of sinks for greenhouse gases; and has considerably contributed to the loss of biological diversity in Latin America and the Caribbean, considered the richest region in the world in biodiversity resources, particularly in the tropical areas. The loss of biodiversity sensibly affects wide sectors of the population, including indigenous communities, for whom these resources represent their means of production, means of living, sources of energy and sources of medicines.

Controlling atmospheric pollution, including the emission of greenhouse gases, is another environmental challenge for the Latin American and Caribbean region. This environmental problem is specially associated with the activity of three main sectors: transportation, industry and energy. Some Latin American cities, such as Mexico City, Sao Pablo and Santiago de Chile, show high levels of atmospheric pollution.

The contribution of the energy sector to atmospheric pollution in the region can be explained, to a great extent, by a high dependency on fossil fuels and low energy efficiency. During the last three decades, Latin America reduced its dependency on fossil fuels due to the expansion of renewables as hydroenergy; nevertheless, at present, fossil fuels still account for around 90% of the regional balance of commercial energy; and the average per capita emission of CO_2 is 2.6 metric tons/year *(UNDP 1999).*

These economies have not carried out integral and sustainable policies for the efficient use of energy due to the financial and technological restrictions affecting the region. During 1972-90 more than 90% of the financial assistance provided by foreign agencies was devoted to projects for increasing energy supply, while only 1% was allocated to projects designed to improve energy efficiency *(CEPAL 1991).*

In this context, a growing number of low-income people do not have access to basic energy services with the required quality. Around 60% of regional population depends on firewood and charcoal as domestic fuel; and in several cases traditional fuels based on biomass account for more than 40% of the total energy balance: Nicaragua (43%), El Salvador (44%), Honduras (50%), Paraguay (51%), Guatemala (61%) and Haiti (87%) *(UNDP 1999).*

Around 406 thousand deaths per year are provoked by air pollution in Latin America and the Caribbean; and 70% of these deaths are caused by air pollution inside the houses, due to the intensive use of traditional fuels *(UNDP 1998).*

The traffic of hazardous wastes across the borders is another big concern for Latin America and the Caribbean. During the first half of the 1990s, around 150 shipments of dangerous wastes were carried out from developed countries to the region; in many cases under the label of "recyclable material" *(see Clapp 1994).*

The dynamics of the regional population is still generating hard tensions in terms of additional requirements of food, fresh water and natural resources. The regional population has increased by 1.7% during 1993-2000, while the population of the developed countries has only increased by 0.4%. Consequently, if the present trends continue, the regional population would double by the year 2034, according to UNDP calculations.

Concerning the relation between trade and environment, it is worth noting that international trade barriers have affected Latin America and the Caribbean, like other developing countries; particularly those barriers imposed by the developed countries on the flow of environmentally sound technologies.

Latin America and the Caribbean show a high dependency on raw materials and/or industries and services that require an intensive use of natural resources. During the last few years, commodities have accounted for around 50% of the regional export income. This dependency has considerably increased during the last two decades and the current structure of the Latin American and Caribbean exports is more vulnerable than the corresponding structure 20 years ago.

Under these conditions, the export efforts of the region in terms of increasing volume, to compensate the decreasing commodity prices, tends to generate greater tensions on the environment. In 1998 the regional export volume increased by 8%, to partially compensate the low export prices for commodities in that year *(CEPAL 1999).*

Latin America and the Caribbean are also characterised by a high socio-economic and environmental vulnerability, as reflected by the high propensity to natural disasters, such as atmospheric phenomena, floods, earthquakes, volcanic eruptions, etc.; and the limited adaptive capacity to deal with these problems. For instance, according to the last records with regard to El Niño, the severe droughts and floods provoked by this phenomenon since 1997 have particularly affected the Andean countries, with a total cost of 15 billion dollars. Central America and the Caribbean have been seriously affected by hurricanes in the last few years (i.e. Georges and Mitch). The estimated costs of the Mitch hurricane for Central America amounted to around 7 billion dollars *(CEPAL 1998).*

With regard to the linkage between DES issues and climate change in Latin American and Caribbean countries, it is relevant to note that this region could be seriously affected by climate change. For instance, the rise of the sea level, and the potentially higher probability

of hurricanes and tropical storms could have negative implications for the Caribbean States and low-coast Latin American countries. Agriculture, tourism, fishing, basic services (i.e. fresh water provision) and other sectors could also be affected by the expected consequences of climate change; with high socio-economic costs for the region. Some of these problems are already affecting the region.

It is worth noting that the contribution of Latin America and the Caribbean to global warming is relatively small in comparison to the contribution of the developed countries. For instance, in 1996 Latin America and the Caribbean only accounted for 5% of the emitted CO_2, while the developed countries accounted for 44% (only USA, more than 22%) *(UNDP 1999; OLADE/CEPAL/GTZ 1997).*

3. Conclusions

In summary, the implementation of regional and national climate change response (adaptation and mitigation) strategies would provide great opportunities for these countries if DES issues are properly considered in the decision making process. This applies to the policies and measures to foster the regional adaptive and mitigative capacity. Integrating such climate change response with other policies in pursuit of development, equity and sustainability offers possibilities for significant co-benefits. Examples of such synergies are the simultaneous abatement of local air pollution and GHG emissions, protection of biodiversity and preserving carbon sinks, and avoidance of dependency on imports of fossil fuels and regional GHG emissions by developing regional renewable energy resources.

However, the macroeconomic reforms carried out in the region during the last two decades reveals lack of integration between the three dimensions of sustainable development. Under these neoliberal reforms the main priority has been the economic objectives, particularly economic efficiency, without proper consideration of social and environmental issues.

In the energy sector, for instance, the reforms, guided by the objective of profit maximisation in the short term, and the concomitant process of privatisation have seriously limited social and environmental investments during the last two decades. In fact, these reforms are characterised for their adverse implications in several sensitive areas such as rural electrification, energy saving, and renewable energy.

In general, the environmental deterioration in the region is the combined result of several external and internal factors. These factors include the historical process of erosion of natural resources in the region resulting from the relations of subordination and dependency with respect to the North; and the high environmental cost of the consumption and production patterns of the elite in the region. It can be also noted that populations living in poverty or extreme poverty tend to intensively utilise the scarce natural resources at their disposal to merely survive. Strategies to address these problems can be compatible with limitation of the regions' contribution to the problem of climate change and reduce its vulnerability.

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3

SOCIO-ECONOMIC AND EMISSION SCENARIOS FOR LATIN AMERICA

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1. Introduction

Future greenhouse gas (GHG) emissions are the product of complex dynamic systems, determined by driving forces such as population growth, socio-economic development, and technological change. They future evolution is highly uncertain, in the long run. Scenarios are alternative images of how the future might unfold and are an appropriate tool to analyse how long-term driving forces may influence future emission outcomes and to assess the associated uncertainties. They assist in climate change analysis, including the assessment of development, sustainability and equity issues.

The Intergovernmental Panel on Climate Change (IPCC) developed long-term emission scenarios in 1990 and 1992. These scenarios have been widely used to analyse possible climate change, its impacts and options to mitigate climate change. In 1995, the 1992 scenarios were evaluated. The evaluation recommended addressing significant changes in the understanding of driving forces of emissions and methodologies since 1992. This led to a decision by the IPCC plenary in 1996 to develop a new set of scenarios. The new set of "reference" scenarios (not including additional climate initiatives, as required by the Terms of Reference) has been developed by a multidisciplinary team in a four-year exercise spanning the period 1996-1999. As its outcome, the Special Report on Emission Scenarios (SRES) has passed through the expert and government reviews and will be submitted to the approval by IPCC Plenary in its next session to be held in Kathmandu (Nepal), on March 11-15th, 2000.

This paper makes a first attempt to present key assumptions and results of some scenarios developed for Latin America within the SRES framework. The main purpose of this presentation is to illustrate the potential of using scenarios analysis to enlighten the discussion on the nexus between climate change and sustainable development in the region.

The second chapter summarises the main features of the methodological approach followed in the SRES to develop the new set of reference scenarios, drawing extensively on the main report *(Nakicenovic et al. 2000)* and its Summary for Policy Makers (SPM). After an

extensive assessment of driving forces and emissions in the literature, four different narrative “storylines” were developed to describe consistently the relationships between emission driving forces and their evolution. For each storyline several different scenarios were developed using six different modelling approaches to examine the range of models that use similar assumptions about driving forces. One preliminary scenario from each family (associated with each storyline), referred to as a “marker”, was used to solicit comments during an “open process” held throughout 1998 with the support of a web site to enable wide participation and feedback.

In the third chapter, the main inputs and results of some long-term socio-economic and emission scenarios for Latin America are presented within the SRES framework. The main difficulty to ensure a wider participation from the Latin American scientific and policy-making community in the SRES “open process” was that all the SRES scenarios disseminated so far refer to the world as a whole and to four world regions only: OECD, economies in transition, Asia and ALM (Africa, Middle East and Latin America). In order to overcome this barrier, a request was made to the six SRES modelling teams to supply a set of key assumptions and results for Latin America from their model runs, to be presented in this meeting. The figures shown in this chapter were taken from the data provided by the Pacific Northwest Laboratory (PNL), from the MiniCAM model runs of the four SRES "marker" scenarios[1] *(Pitcher 2000)*.

Finally, the concluding chapter highlights the potential contribution of Latin American sustainable development toward the prevention of climate change, as well as the need to pursue the methodological efforts aimed at improving the development of long-term socio-economic and emission scenarios for the region.

2. The Special Report on Emission Scenarios of the Intergovernmental Panel on Climate Change

Given the complexity and the inertia of the greenhouse effect, long-term GHG emission scenarios are needed to assess GHG concentrations, global temperature increases and sea-level rise over the next century and even further. However, by 2100 the world will have changed in ways that are hard to imagine. The previous IPCC reference scenarios (from the IS92 family) have tested different combinations of population and economic growth rates in a parametrical approach to derive long-term emission scenarios needed by climate models.

[1] "Marker" scenarios are those scenarios that were included in the "open process". These scenarios were later slightly revised on the basis of this open process and the IPCC review, and two additional "illustrative" scenarios were added to the final SRES report in response to goverment critique, leading to six scenario groups with associated illustrative case.

The new set of IPCC reference socio-economic and emissions scenarios was developed to represent the range of driving forces and emissions in the scenario literature so as to reflect current knowledge about underlying uncertainties over their evolution during the next century. They exclude only outlying "surprise" or "disaster" scenarios in the literature. No judgement is offered in the SRES report as to the desirability of the scenarios and probabilities of occurrence are not assigned to them.

In order to fulfil this ambitious task, the major methodological breakthrough of the SRES exercise was to provide four different narrative "storylines", A1, A2, B1 and B2, allowing to add a qualitative context for scenario quantification. Each storyline assumes a distinctly different direction for future developments, such that the four storylines differ in increasingly irreversible ways. Their characteristics in terms of key emission driving forces such as population growth, economic development and technological change are summarised in the box shown in the next page *(Nakicenovic et al. 2000).*

Each SRES scenario represents a specific quantitative interpretation of one of the four storylines. All the scenarios based on the same storyline constitute a scenario "family". Six different models were used to develop several scenarios for each storyline. The six models used are representative of different modelling approaches and integrated assessment frameworks in the literature. Therefore, the resultant 40 SRES scenarios encompass the range of uncertainties caused by the characteristics of different models that lead to variations in the calculated GHG and sulphur emissions.

Within each family two main types of scenarios were developed – those with harmonised input assumptions and those with alternative quantifications of the storyline. Markers, which are harmonised, were not intended to be the median or mean scenarios from their respective families. Indeed, in general it proved impossible to develop scenarios in which all the relevant characteristics matched mean or median values. Each marker scenario is no more or less likely than any other scenario within a given family.

The four A1 scenario groups are distinguished by their technological emphasis on coal (A1C); oil and gas (A1G); non-fossil energy sources (A1T); or a balance across all sources (A1). Rapid growth leads to high capital turnover rates, which mean that early small differences among scenarios can lead to greater divergence by 2100. Since the A1 family has the highest growth rates, it was selected to show this effect.

Main characteristics of the four SRES storylines and scenario families

The A1 storyline and scenario family describes a future world of very rapid economic growth, low population growth and rapid introduction of new and more efficient technology. Major underlying themes are convergence among regions, capacity building and increased cultural and social interactions, with a substantial reduction in regional differences in per capita income. The A1 scenario family branches out into four groups that describe alternative directions of technological change in the energy system.

The A2 storyline and scenario family describes a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, resulting in high population growth. Economic development is primarily regionally oriented, and per capita economic growth and technological change are more fragmented and slow compared to other storylines.

The B1 storyline and scenario family describes a convergent world with the same low population growth as the A1 storyline, but with rapid change in economic structures toward a service and information economy, reduction in material intensity and the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to economic, social and environmental sustainability, including through improved equity, but without additional climate initiatives.

The B2 storyline and scenario family describes a world in which the emphasis is on local solutions to economic, social, and environmental sustainability. It is a world with moderate population growth, intermediary levels of economic development and less rapid and more diverse technological change than in the B1 and A1 storylines. While policies are also oriented towards environmental protection and social equity, they are focused on local and regional levels.

Source: *Nakicenovic, et al. 2000: p. 2.*

All the inputs and results presented in this paper refer to the four SRES marker scenarios. Tables 1a and 1b show a comparison between the previous IS92 scenarios and the SRES scenarios concerning the assumptions used for income per capita levels in the different world regions as for 2050 and 2100, respectively. A narrowing of income differences among world regions is assumed in many of the SRES scenarios. In 2100, the ratio between income per capita levels in industrialised countries (IND) and developing countries (DEV) varies from 1.6 (A1) to 4.2 (A2), substantially lower than the range explored by the IS92 scenarios: 3.9 (IS92e) to 6.0 (IS92e). Two of the scenario families, A1 and B1, explicitly explore alternative pathways that gradually close existing income per capita gaps in relative terms, with industrialised countries levels lower than the double of income per capita in developing countries by the end of the next century.

Table 2a illustrates the dates (rounded to the next five years) when developing countries reach 1990 levels of industrialised countries for a number of key indicators, while Table 2b shows the dates when developing countries reach parity and overtake projected industrialised countries levels, in the four SRES marker scenarios.

It is interesting to note that, according to the SRES marker scenarios assumptions, developing countries would reach the 1990 levels of industrialised countries early in the 21st century (until 2030) for most indicators, with exception of the per capita indicators. In terms of GDP per capita (measured according to market exchange rates), developing

countries would reach 1990 levels of industrialised countries only in the second half of the next century (excepted in A2, which assumes that this level would be reached only in the 22nd century). Carbon dioxide emissions per capita in developing countries would remain below the 1990 levels of industrialised countries across all the marker scenarios, as well as primary energy per capita consumption levels in most cases (with the sole exception of A1, which assumes that developing countries would reach this threshold around 2070).

Developing countries would overtake projected industrialised countries levels of GDP (measured according to purchasing power parity), primary energy consumption and annual carbon dioxide emissions early in the 21st century (until 2030). All the per capita indicators of developing countries shown in Table 2b remain below projected levels for industrialised countries during the whole 21st century. Cumulative carbon dioxide emissions since 1800 from developing countries would overtake the contribution from industrialised countries between 2040 (in the case of A1) and 2110 (for B2).

3. SRES Assumptions and Results for Latin America: Socio-Economic and Emission Scenarios

The inputs and results for Latin America presented here were supplied by MiniCAM model runs of the four SRES marker scenarios. The evolution of carbon dioxide emissions, their main driving forces and key indicators from 1990 to 2100 are summarised in the following figures attached at the end of this paper:

- Population (thousands of inhabitants)
- GDP (measured according to the purchasing power parity) (billion dollars)
- GDP (ppp) per capita (US$/cap)
- Energy Intensity (energy consumption / GDP – MJ/US$)
- Primary Energy Consumption (not including non-commercial renewable energy – Exajoules)
- Carbonisation Index of the energy sector (carbon emissions from the energy sector / primary energy consumption – tC/MJ)
- Carbon dioxide emissions from the energy sector (MtC)
- Carbon dioxide emissions from land use change (MtC)
- Total carbon dioxide emissions (from the energy sector and land use change – MtC)
- Carbon dioxide emissions per capita (total carbon dioxide emissions / population – tC/cap)

Recent population projections are generally lower than those in the IS92 scenarios. Three different population trajectories were chosen from recently published projections to correspond to the socio-economic developments in the storylines. The A1 and B1 scenario families share the lowest trajectory increasing to around 70 million by 2050 and declining towards roughly 60 million by 2100, which combines low fertility with low mortality. The B2 scenario family is based on the long-term UN median 1998 population projection of nearly 100 million by 2100. The A2 scenario family is based on a high population growth

scenario of over 160 million by 2100 that assumes a significant decline in fertility for most regions and a stabilisation at above replacement levels. It falls below the long-term 1998 UN high projection.

All scenarios describe futures with high GDP growth ratios in Latin America over the next century. A1 shows the fastest economic growth reaching a regional GDP level in 2100 more than 50 % higher than in the other three scenarios.

The combination of different economic and population growth trajectories leads to a wide range of GDP per capita figures in 2100. Measured in terms of purchasing power parity, the highest levels are reached again in A1 (more than seven times the A2 level) followed by B1 (more than twice the B2 level).

Energy intensity indicators (measuring the energy consumption related to GDP) consistently decrease over the next century across all the scenarios. The B1 scenario shows the fastest reduction, leading to the lowest value in 2100, followed by A1 with an energy intensity in 2100 nearly twice higher than in B1, while A2 and B2 show similar final values of roughly three times the B1 level in 2100.

Primary energy consumption (without non-commercial renewable energy) growths slowly and eventually stabilises around 40 EJ in the B1 scenario, contrasting with much higher growth rates in the other scenarios. A1 shows the highest final value in 2100 (roughly 4.5 times the B1 level) followed by A2 and B2 with similar intermediary levels (around 3.5 times the B1 level).

The carbon content of the energy supply, measured by its carbonisation index (in tC/MJ), decreases continuously in A1, first slowly and sharply after 2080 to reach the lowest value of all scenarios in 2100. The second lowest level is reached in B1 with a different path : fast reduction until 2060, followed by stabilisation and slight increase after 2080. In B2, it is slowly reduced in the first half of the next century and eventually stabilises. Finally, in A2 an initial period of slow reduction until 2030 is followed by resumed growth to reach a final level in 2100 just slightly lower than in 1990.

Carbon dioxide emissions from the energy sector increase slowly in the B1 scenario, reaching the lowest level among all scenarios in 2100, less than doubling current levels. In A1, emissions show the highest growth until 2070 eventually followed by a sharp reduction after 2080, which allows for reaching the second lowest value among the four scenarios in 2100, still roughly three times higher than in B1. Continuous growth of these emissions is shown in B2 and A2, with the latter reaching a final value in 2100 nearly five times higher than in B1.

CO_2 emissions from land use change peak in the SRES marker scenarios around 2030 and then gradually decline. This pattern is consistent with many scenarios in the literature and can be associated with slowing population growth and increasing agricultural productivity. These allow a reversal of current deforestation trends, eventually leading to carbon dioxide

sequestration after 2070. Only in A2 do net anthropogenic CO_2 emissions from land use remain nearly zero through 2100. Sequestration increases fastest in the A1 and B1 cases, after 2070.

Total carbon dioxide emission from the energy sector and land use change peak around 2030 to continuously decrease eventually, until reaching negative values in 2100 for the scenario B1. The highest growth rate until 2050 is obtained in the scenario A1, followed by a stabilisation until 2080, when a sharp reduction is observed leading to the second lowest level in 2100. In the scenario B2 a slow growth leads to a final level in 2100 slightly higher than in 1990. The growth rate is higher in the scenario A2, leading to a 2100 value 2.5 times the 1990 level.

Finally, total carbon dioxide emissions per capita follow a similar pattern, with the main differences being the vicinity of A2 and B2 behaviours, with virtually stabilised emissions per capita from 2000 on, and the A1 path standing much higher than the other scenarios until a sharp reduction from 2080 to 2100, reaching a final value only slightly lower than in A2 and B2 cases.

4. Conclusions

This initial attempt of presenting SRES scenarios for Latin America must be broadened by the analysis of other SRES scenarios than the marker scenarios as well as by the consideration of modelling approaches other than the MiniCAM results discussed here.
However, some preliminary general conclusions can be drawn in two main areas :

CONCERNING THE IMPLICATIONS FOR MITIGATION ANALYSIS AND DEVELOPMENT, EQUITY, SUSTAINABILITY ISSUES (DES):

The wide spectrum of possible future development paths in Latin America, as well as in other developing countries is once again illustrated. The difference between long-term outcomes of distinct reference scenarios can be much wider than the difference between a given baseline and a mitigation scenario. Thus, the real challenge is to design and implement sustainable development strategies, which can make a crucial contribution towards the prevention of climate change even without additional climate initiatives. For example, if a B1 world would materialise, “reasonably low cost” mitigation options could lead to the stabilisation of carbon dioxide concentration in the atmosphere at a 550 ppm level. However, this does not mean that an attitude of “wait and see” would be appropriate, because a tremendous effort to implement a number of policy measures in different fields is required to make a departure of current trends towards a B1 development path feasible.

CONCERNING METHODOLOGICAL ASPECTS:

The SRES methodological approach presents considerable progress since the construction of the previous set of IPCC reference scenarios, in 1992 (the IS92 scenario family). The

narrative descriptions of possible futures add context to the quantified assumptions, inputs and outputs of socio-economic and emission scenarios. Therefore, scenarios building can provide a powerful tool and an useful framework to discuss impacts of climate change, adaptation and mitigation strategies as well as sustainable development issues. Further research is needed, however, to improve the representation of the storylines by the modelling approaches. The translation of storylines features into model variables deserve careful analysis at a disaggregated level, beyond the four world regions presented in SRES, not only to enhance the transparency of the exercise but also to improve the representation of different regions in the models, thus contributing to enhance the quality of their overall results.

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Table 1a

Income Per Capita in the World and by SRES Region in 1,000 US$ (at 1990 Prices and Exchange Rates). Data is given for the IS92 Scenarios and the SRES Marker Scenarios.

Income per Capita by World and Regions, (1,000 US$1990 per capita)								
		Regions						
Year	**Scenario**	**OECD90**	**REF**	**IND**	**ASIA**	**ALM**	**DEV**	**WORLD**
1990	**SRES**	19.1	2.7	13.7	0.5	1.6	0.9	4.0
2050	**IS92a,b**	49.0	23.2	39.7	3.7	4.8	4.1	9.2
	IS92c	35.2	14.6	27.4	2.2	2.9	2.5	6.3
	IS92d	54.4	25.5	43.4	4.1	5.4	4.6	10.5
	IS92e	67.4	38.3	56.9	5.9	7.7	6.6	13.8
	IS92f	43.9	21.5	35.8	3.3	4.1	3.6	8.1
	A1	50.1	29.3	44.3	14.9	17.5	15.9	20.8
	A2	34.7	7.1	26.1	2.6	6.0	3.9	7.2
	B1	49.8	14.3	39.1	9.0	13.6	10.9	15.6
	B2	39.2	16.3	32.5	8.9	6.9	8.1	11.7

Table 1b

Income Per Capita in the World and by SRES Region in 1,000US$ (at 1990 Prices and Exchange Rates).
Data is given for the IS92 Scenarios and the SRES Marker Scenarios

Income per Capita by World and Regions, (1,000 US$1990 per capita)								
		Regions						
Year	**Scenario**	**OECD90**	**REF**	**IND**	**ASIA**	**ALM**	**DEV**	**WORLD**
1990	**SRES**	19.1	2.7	13.7	0.5	1.6	0.9	4.0
2100	**IS92a,b**	85.9	40.6	69.5	15.0	14.2	14.6	21.5
	IS92c	49.2	17.6	36.5	6.4	5.8	6.1	10.1
	IS92d	113.9	51.3	88.8	20.3	17.7	19.1	28.2
	IS92e	150.6	96.6	131.0	34.6	33.0	33.8	46.0
	IS92f	69.7	31.3	54.9	11.9	10.7	11.4	16.8
	A1	109.2	100.9	107.3	71.9	60.9	66.6	74.9
	A2	58.5	20.2	46.6	7.8	15.2	11.0	16.1
	B1	79.7	52.2	72.8	35.7	44.9	40.2	46.6
	B2	61.0	38.3	54.4	19.5	16.1	18.0	22.6

Table 2a

Date (rounded to nearest five years) when DEV countries reach 1990 levels of IND countries. Dates are given for the four SRES marker scenarios only.

Reaching 1990 IND levels	**A2**	**B2**	**A1**	**B1**
GDP (mex)	~ 2030	~ 2020	~ 2015	~ 2020
GDP (ppp) (IIASA runs)	~ 2010	~ 2005	~ 2000	~ 2000
GDP (mex) per capita	> 2100	~ 2080	~ 2050	~ 2060
Primary Energy	~ 2010	~ 2010	~ 2005	~ 2005
Primary energy per capita	–	–	~ 2070	–
Annual CO_2	~ 1995	~ 2000	~ 1995	~2005
Cumulative CO_2 since 1800	~ 2020	~ 2030	~ 2015	~ 2020
CO_2 per capita	–	–	–	–

Table 2b

Date (rounded to nearest five years) when DEV countries reach parity (and overtake) projected IND country levels. Dates are given for the four SRES marker scenarios only.

Overtaking IND	A2	B2	A1	B1
GDP (mex)	~ 2060	~ 2035	~ 2030	~ 2035
GDP (ppp) (IIASA runs)	~ 2030	~ 2020	~ 2015	~ 2010
GDP (mex) per capita	–	–	–	–
Primary Energy	~ 2015	~ 2020	~ 2010	~ 2005
Primary energy Per capita	–	–	> 2100	–
Annual CO_2	~ 2000	~ 2005	~ 1995	~2005
Cumulative CO_2 since 1800	~ 2050	~ 2110	~ 2040	~ 2050
CO_2 per capita	–	–	–	–

Figure 1. Population in Latin America

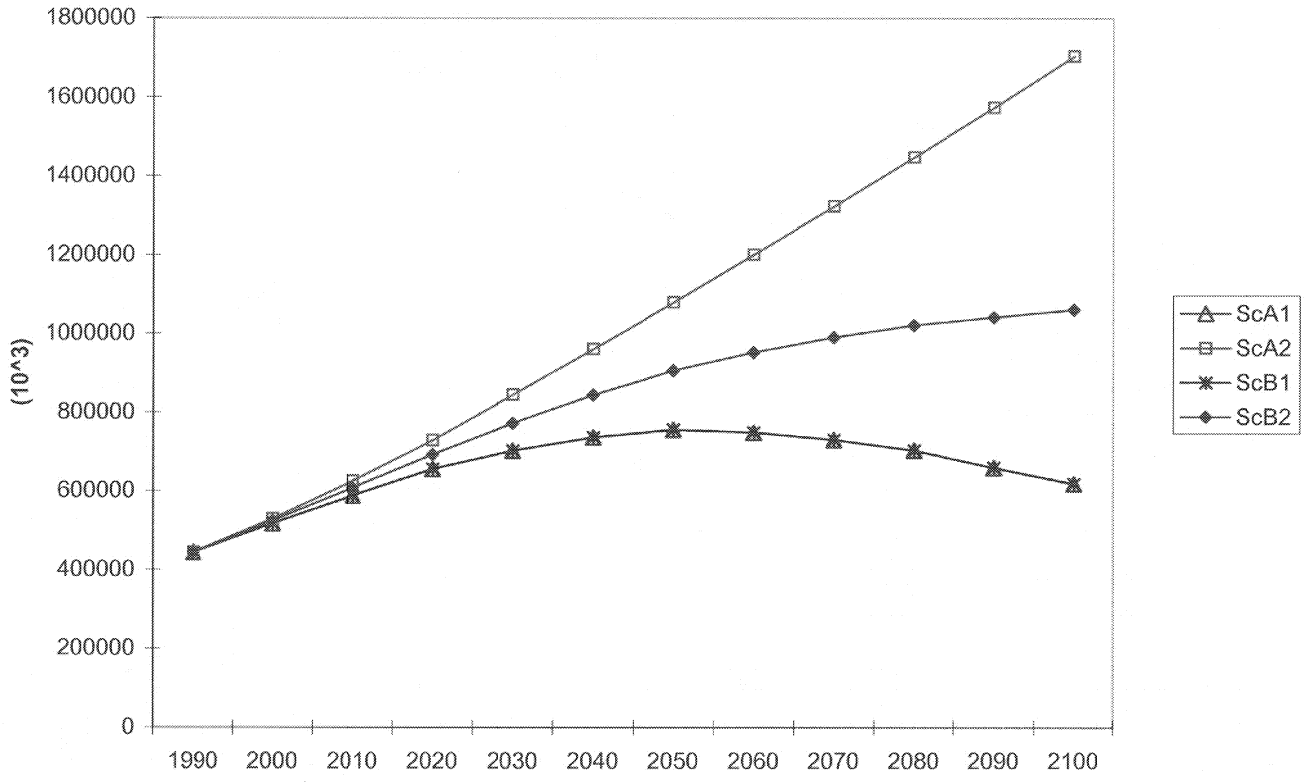


Figure 2. GDP(ppp) in Latin America

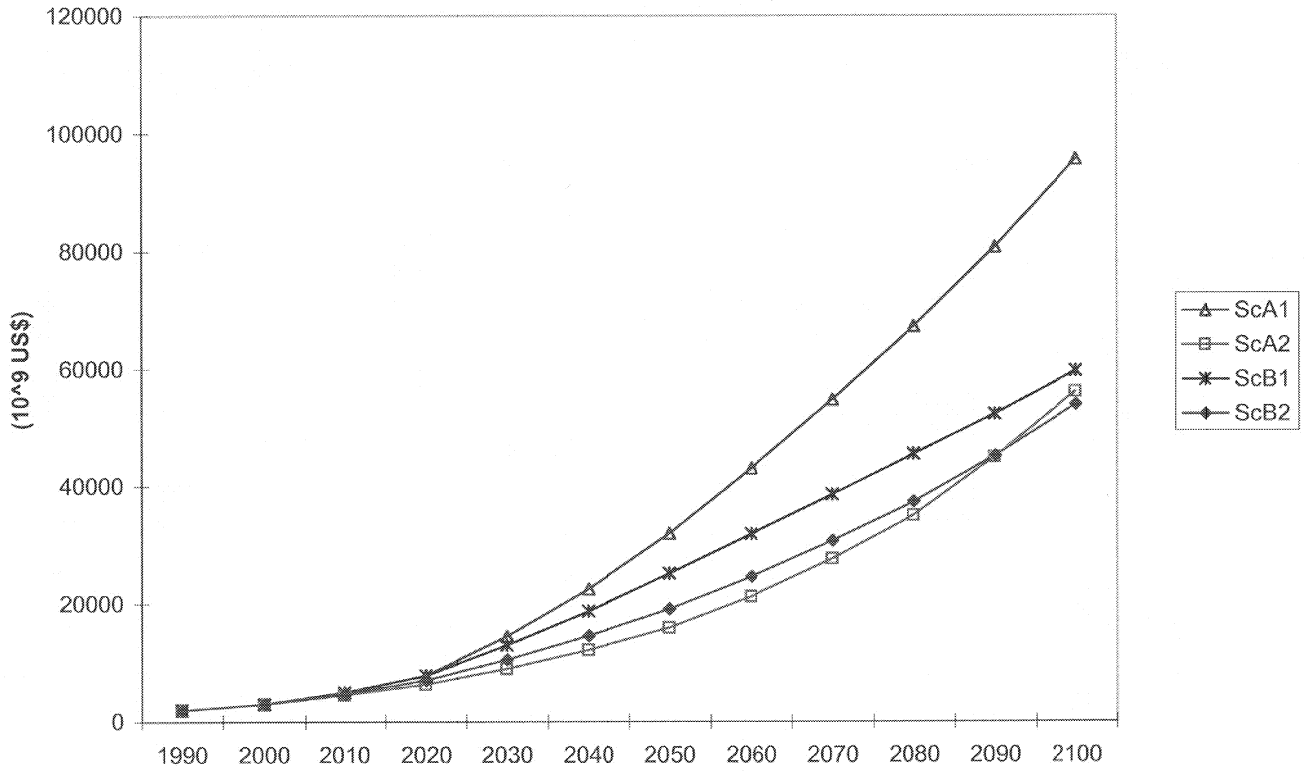


Figure 3. GDP(ppp) per capita in Latin America

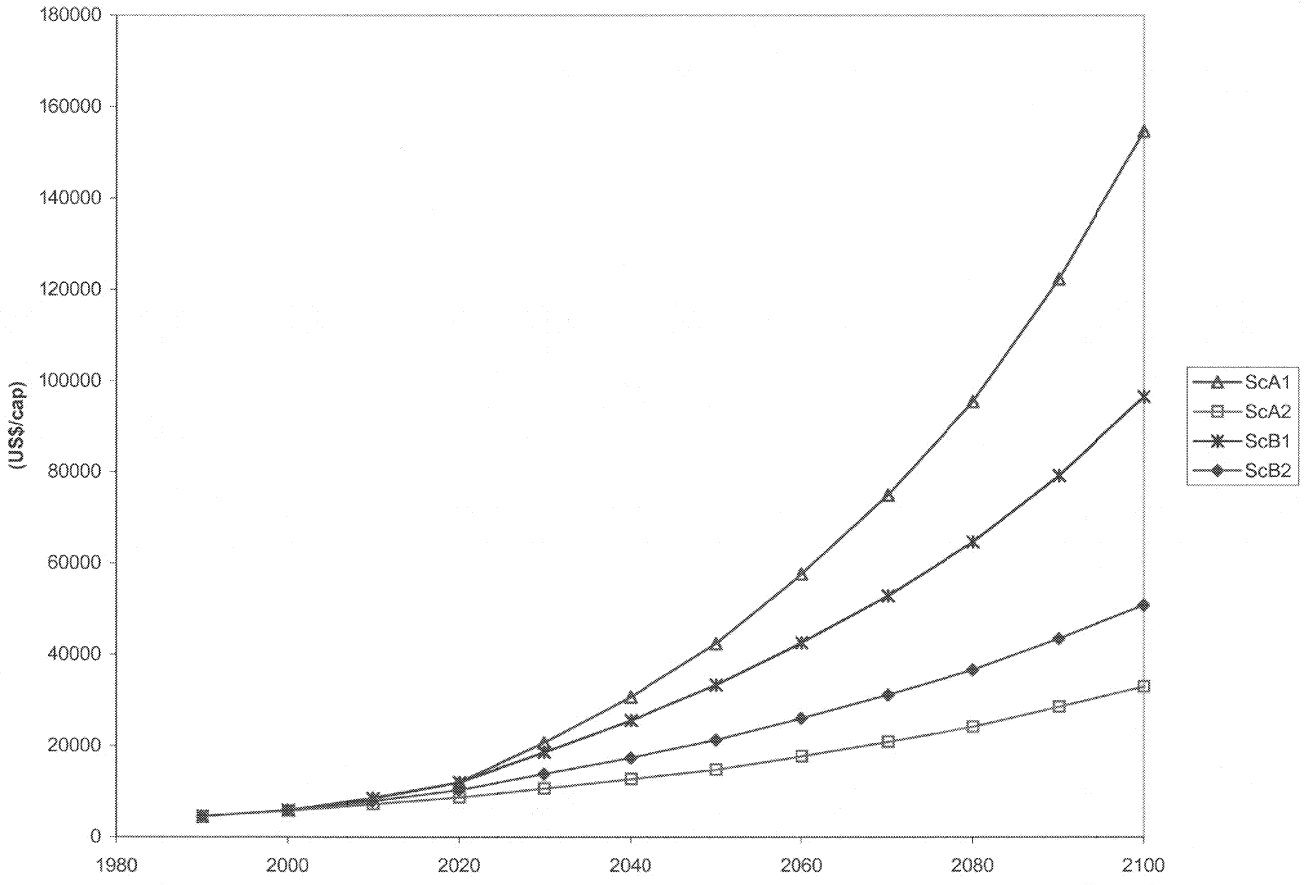


Figure 4. Energy Intensity in Latin America

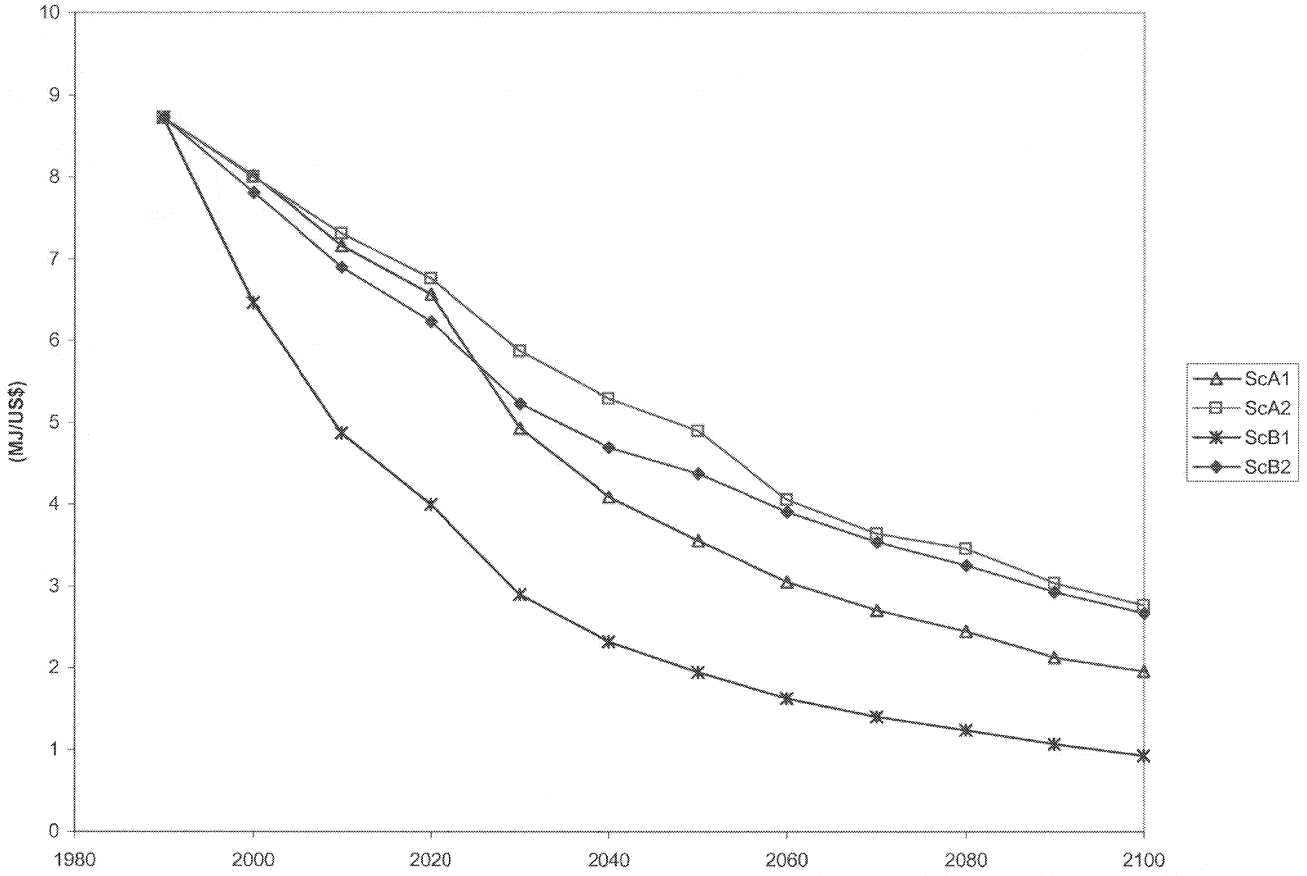


Figure 5. Primary Energy Consumption in Latin America

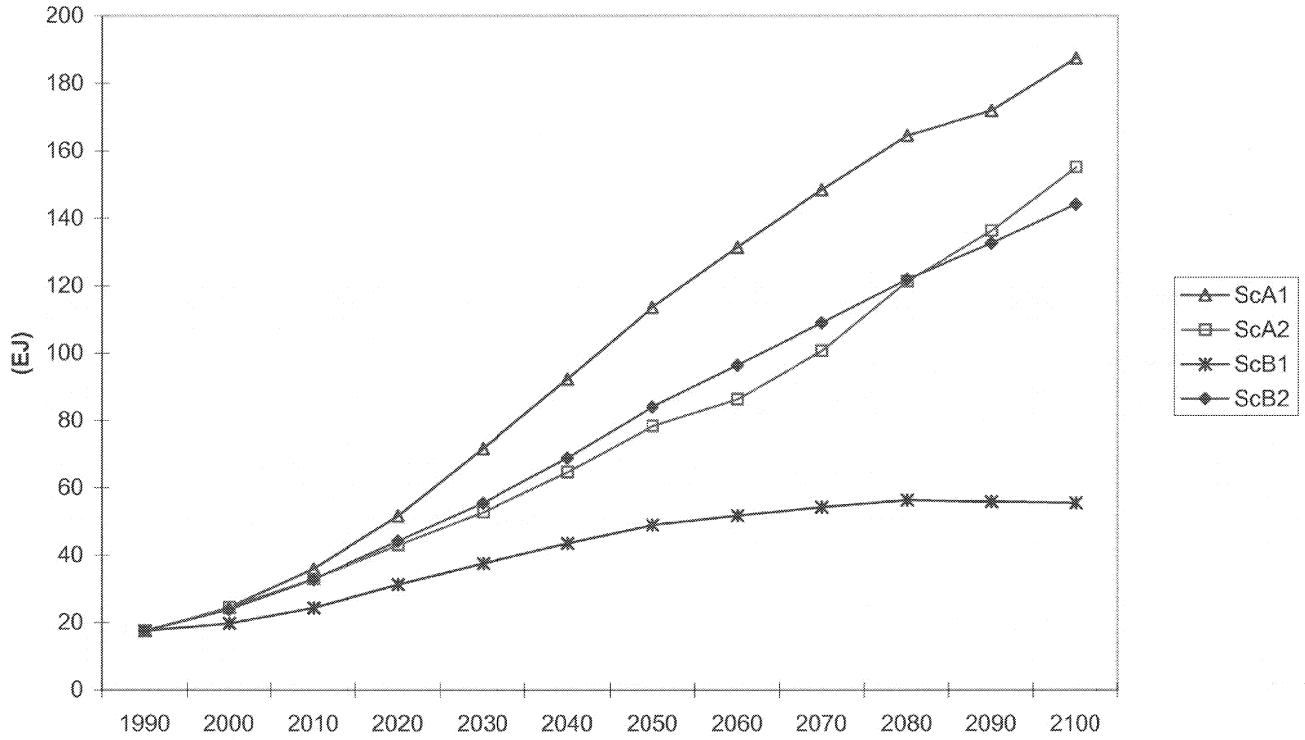


Figure 6. Carbonization Index in Latin America

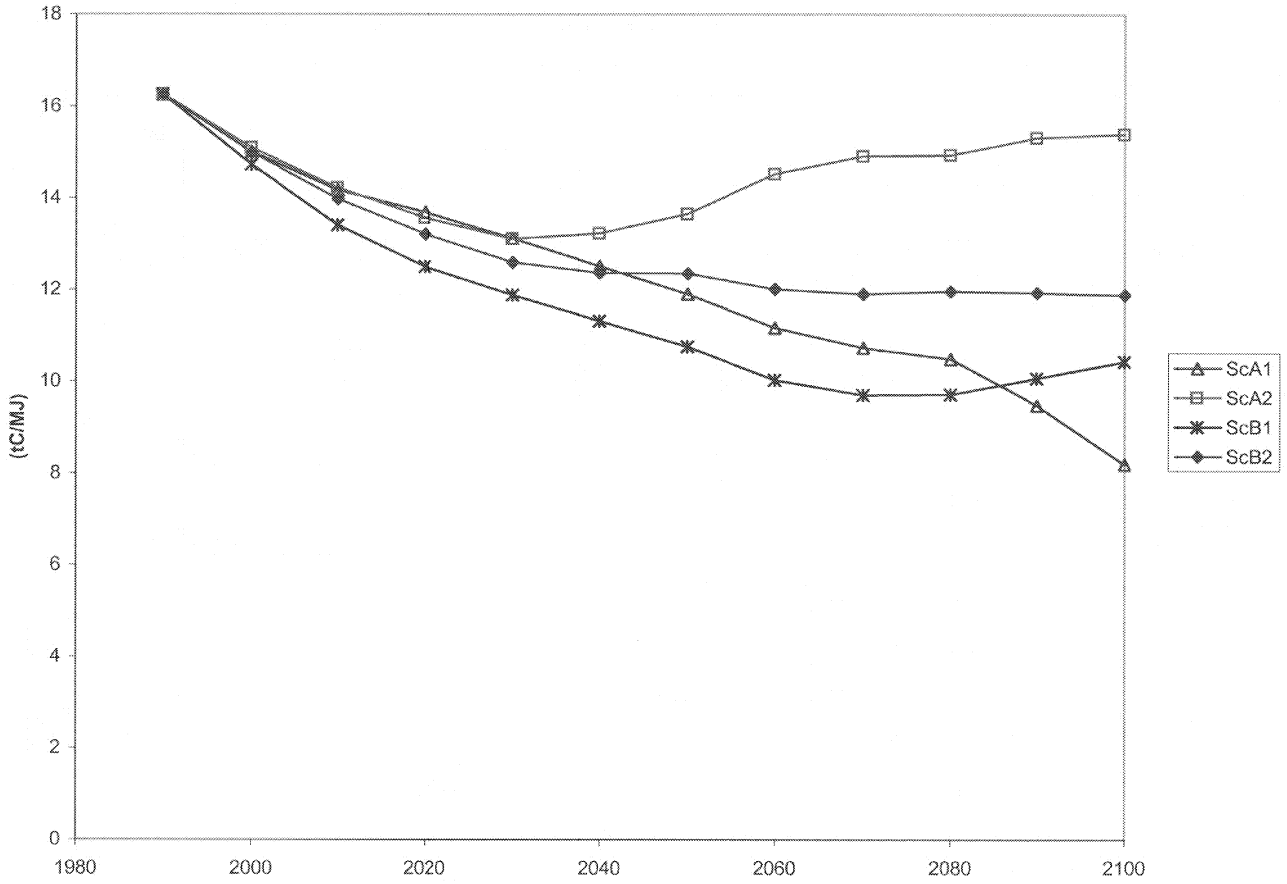


Figure 7. Carbon Emissions from the Energy Sector in Latin America

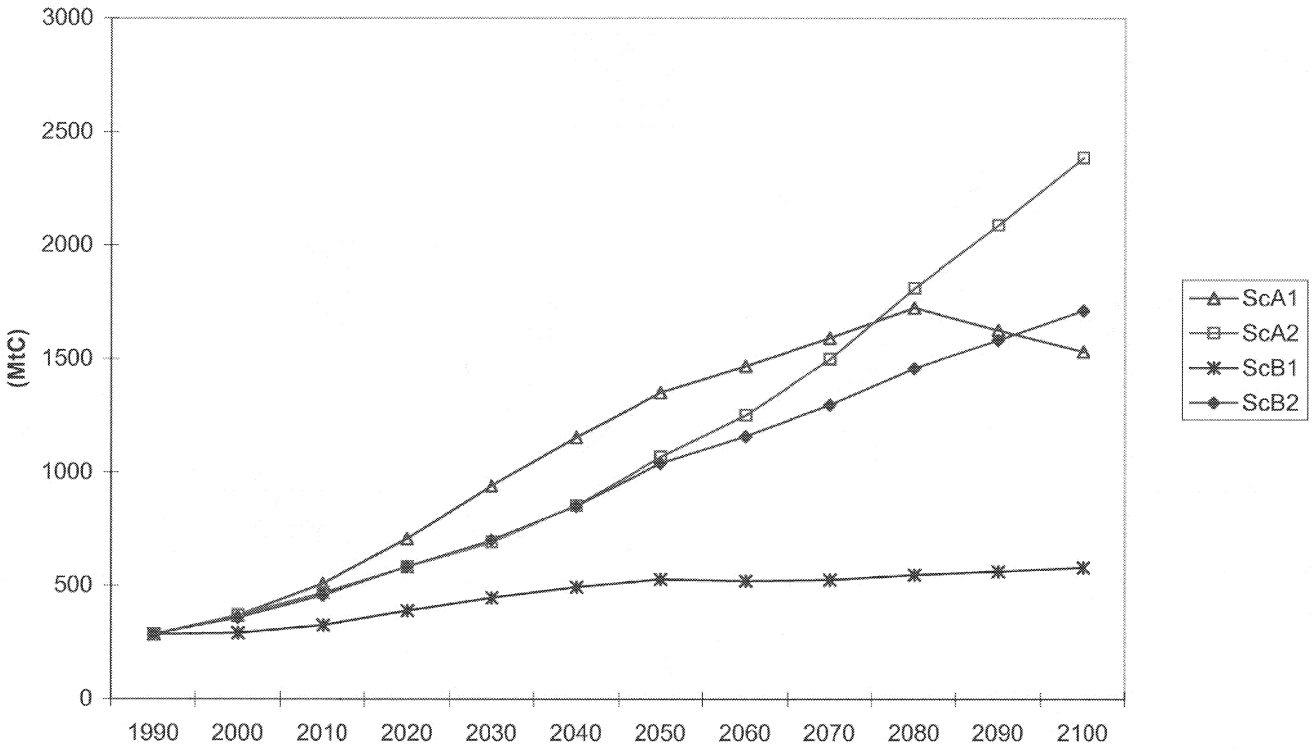


Figure 8. Carbon Emissions from Land Use in Latin America

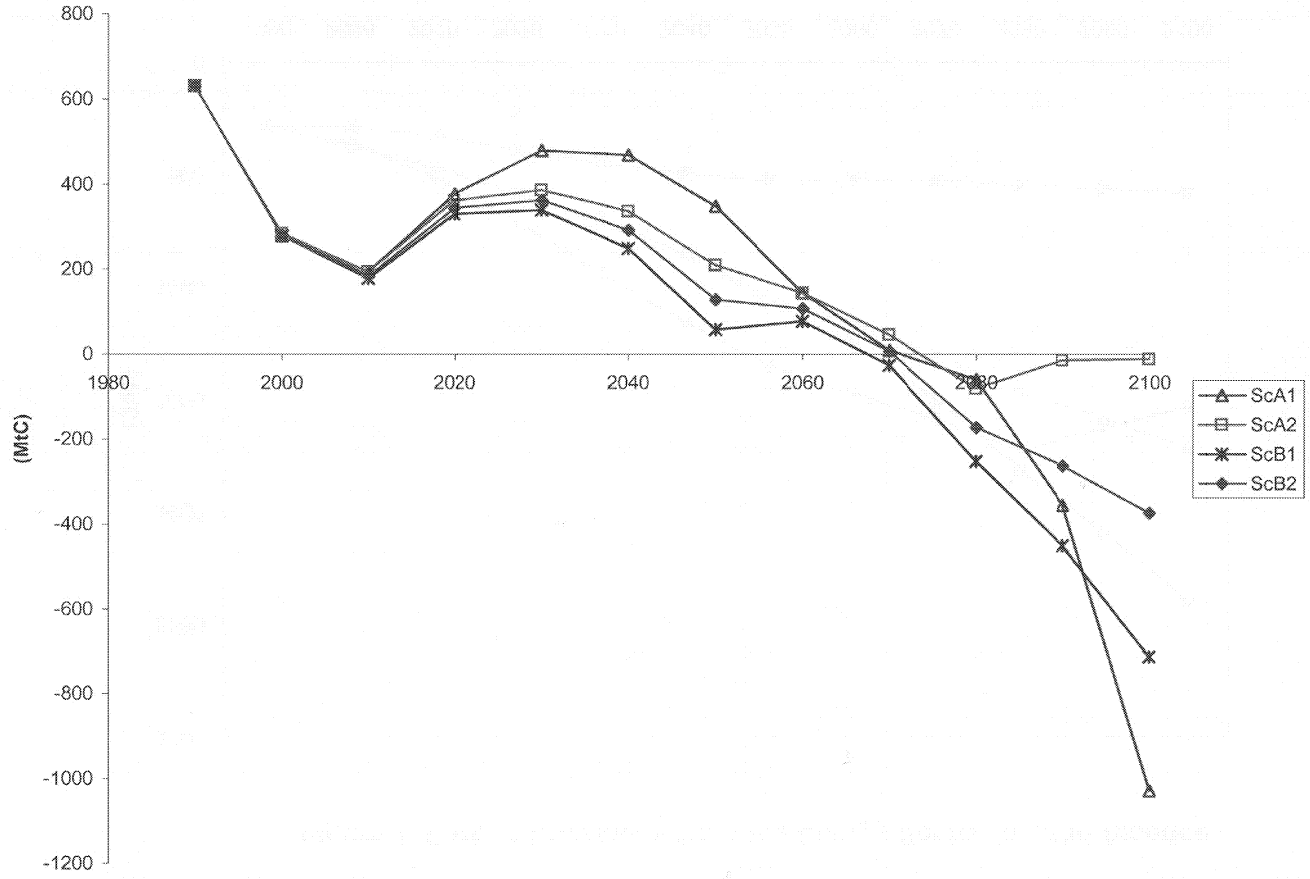


Figure 9. Total Carbon Emissions in Latin America

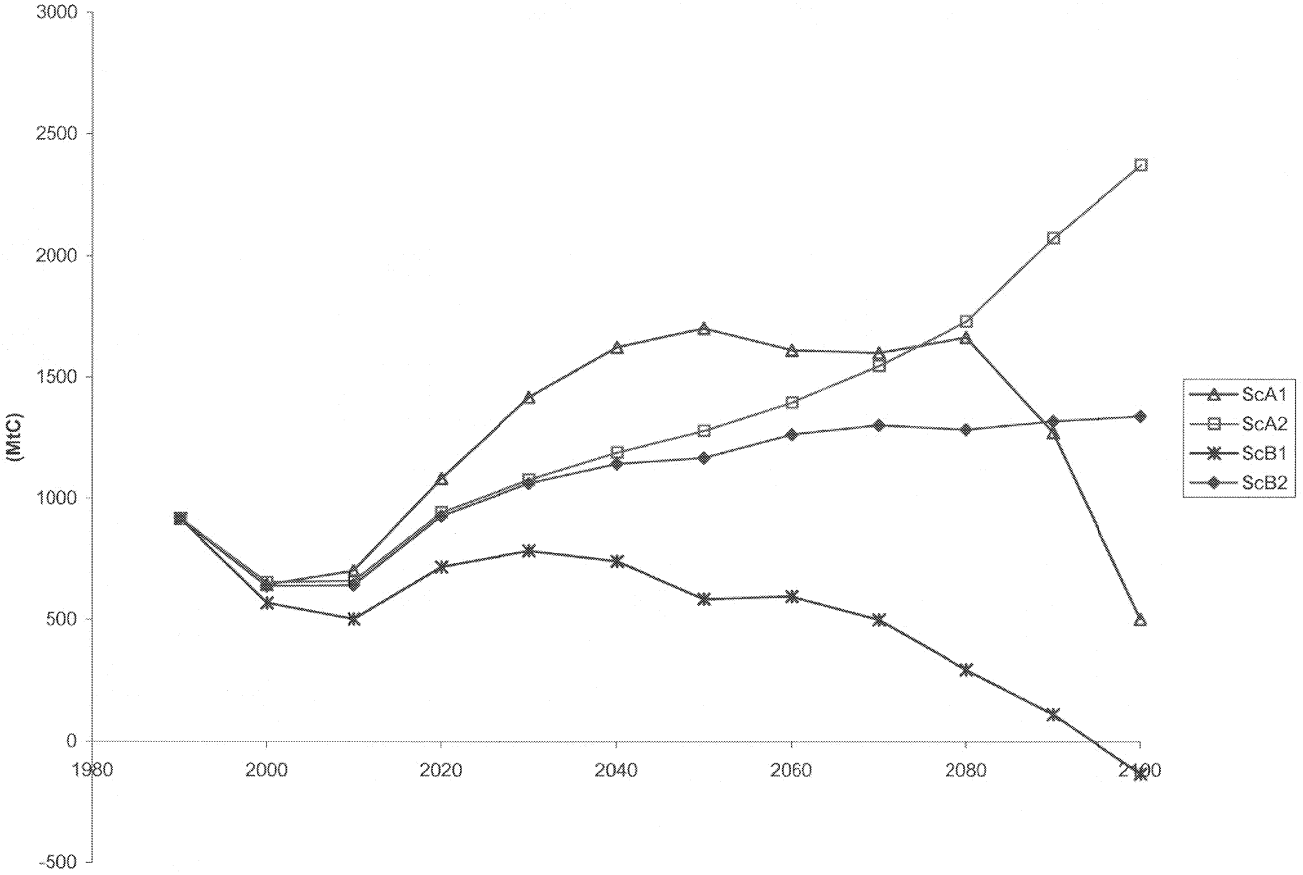
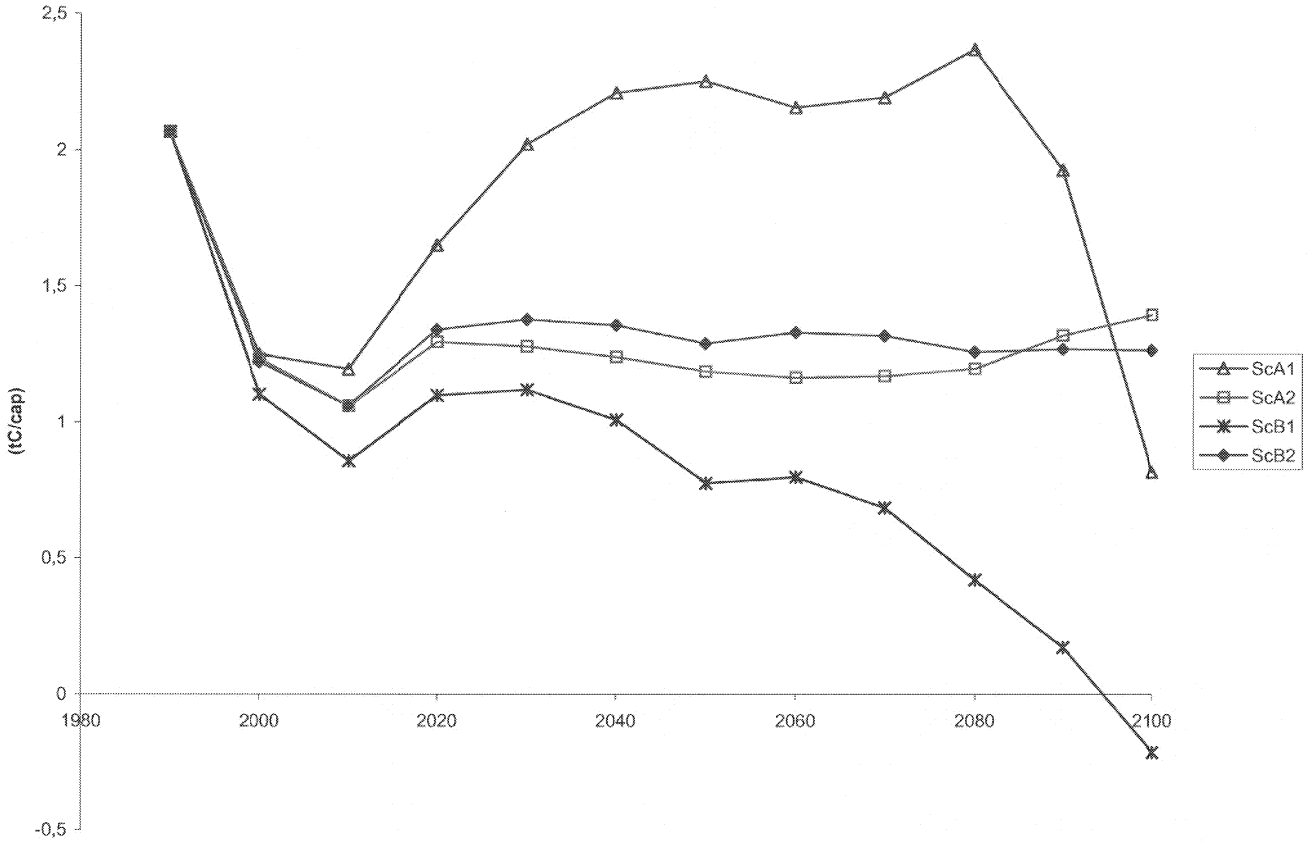


Figure 10. Carbon Emissions per capita in Latin America



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4

SUSTAINABILITY TOWARDS DEVELOPMENT

Américo Saldívar

1. Offences of Globalisation and Modernity

If we take stock of the "misfortunes" of capitalist growth, and of the processes of internationalisation and globalisation of technologies, commerce and capitals, which go with it, we observe precisely the high costs and the losses that it has implied in social and environmental terms. We are witnessing anthropocentric processes with high levels of injustice and inequality. The analysis of climate change and its expressions allows us to see the different ways in which the South must pay for the "environmental costs" originated by growth and progress in the "North". All these issues are combined with a situation of highly unsustainable development for the former.

In this paper I intend to demonstrate how climate change (CC) constitutes one of the most important consequences of the pitfalls in environmental policies at world level. At the same time, climate change is a variable that explains the environmental crisis.

2. The Impacts

A decade ago, the majority of inhabitants of industrialised countries achieved the highest possible level of development and well being. An additional *per capita* unit of improvement in the quality of life and well being requires of extraordinary economic *outputs* and exerts enormous pressure on the natural resources, as well as on the functions and services provided by the environment. The same is true for employment: for it to grow 1% annually, it is necessary to have a 3% economic growth in the same period. In other words, material progress and quality of life are no better today than they were in the 80s. From now on, the bill for what was achieved must be paid. The invoice accounts for increased pollution in the atmosphere, waters, rivers, seas and soil, as well as the increased scarcity of resources, both in quantity and in quality. No doubt, the greatest damage done is the deterioration process of the quality of ecosystems and biodiversity, as well as the consequent global climate change and global warming, both as cause and effect of that same process.

To acknowledge the above situation is as urgent as it is necessary given that it is usually assumed that atmospheric pollution is a problem of the industrialised nations, whilst more than 90% of deaths attributed to this cause takes place in the developing countries *(PNUD 1998: p. 68).* Worse still, unpredictability and recurrence of natural catastrophes such as flooding, hurricanes, droughts and fires, hit poorer nations strongest. Evidence of this are deterioration, loss of biodiversity and the terrible and regrettable consequences left by the successive tropical depressions of autumn 1999 over more than a quarter of Mexico's territory, or the more recent natural disaster in Venezuela which claimed tens of thousands of victims.

Let us now see the major consequences of climate change:

- Global warming
- Increased atmospheric pollution
- Ozone layer reduction, UV rays and skin cancer
- Extreme and erratic changes in weather and climate conditions
- Unpredictability and recurrence of natural catastrophes
- Deforestation and acute changes in vegetation and agricultural patterns.
- Higher risks to illnesses and increased vulnerability to their carriers
- Increased rates for mortality, injuries and infectious diseases[1]

All these direct and indirect effects, consequences, ailments and diseases manifest themselves with particular aggressiveness and fury at the beginning of the new century, mostly affecting poor nations and vulnerable groups.

3. Unsustainable development and inequity

Climate change constitutes a two-way phenomenon given that it is both cause and effect of biophysical conditions in the region, of the socio demographic characteristics and of the economic growth modes. Climate change represents one of the greatest socio-economic and environmental vulnerabilities and risks of our times.

Climate change is first ranked in a list of the 27 most acute problems of the planet. According to the United Nations *(PNUD 1998: p. 66),* although it is the poor who suffer environmental damages the most, they rarely are the main ones responsible for causing them: "The rich contaminate the most and therefore contribute to global atmospheric warming".

It is not inconsequential that, for example, the *per capita* index of annual emissions of CO_2 in the industrialised countries is 11.4 tons, against 2.0 tons in the developing countries

[1] Given the proliferation of illnesses such as malaria, yellow fever, dengue fever, encephalitis, cholera -- before sole patrimony of tropical climates--, which are now affecting milder (temperate) climates where they were little known, and therefore attacking people who are less resistant to them.

(PNUD 1998: p. 202). Thus, the economic and social implications of the mitigating actions that must be adopted are of particular importance to developing countries.

4. Energy

Countries in the North must reduce their level of emissions, in general, and curtail increments in greenhouse gases emissions in particular, both in relative and in absolute terms. This does not mean that developing nations assume a passive attitude towards the climate change phenomena. Rather they must contribute in an active and different manner, within the framework of equity and sustainability, to implement mitigation strategies and foster efficient use of non-renewable energy resources (fossil fuels), or better still, the extensive use of renewable energy resources.

It is important to underscore that reduction of pollutants constitutes just one small step in terms of achieving immediate and important reductions in climate change.

Fossil fuels currently constitute 90% of the energy balance in Latin America. There is an increased tendency to energy consumption, the growth of which overrides GNP growth.

Emissions of the main greenhouse gases – CO_2, CH_4 and N_2O – are mainly due to energy consumption and production systems, industrial structures, transport systems, agricultural and livestock activities, and agro forestry, as well as the prevailing consumer patterns of the population. Thus, one of the main problems of globalisation is that it sticks to current patterns of production and consumption, particularly of non-renewable energy resources.

5. Adaptation and Mitigation

In relation to technological development, in the mid and long term we should:

- Generate new technologies for the exploitation of the biomass, wind and solar energy.
- Reappraise the use of a safe nuclear energy as an alternative to environmental degradation concerns and to the use of non-renewable resources.

Core commitments of a strategy, which combine the objective of reducing the levels and emissions of greenhouse gases with sustainable development, could be:

- To increase efficiency in the production and consumption of energy
- To introduce clean (green) technologies to minimise environmental impacts
- To modify the prevailing energy system by reducing consumption of fossil fuels
- To incorporate intensively the use of non-traditional energy resources

6. Developing sustainability

The solution to the global environmental problems demands global multiple solutions, shared and co-responsible. Actions to mitigate climate change imply costs and benefits that must be adjusted to the principle of joint responsibilities with differing contributions according to:

1. The economic and social possibilities of each nation
2. The greenhouse gases emissions

In addition to these issues, an analysis of shared and differentiated costs can be determined according to criteria such as:

- Income and consumption levels
- Energy efficiency
- Development level and degree of the countries and regions
- Implementation and efficiency in mitigation actions (particularly in carbon capture)
- Level of subsidies to production and consumption systems that are environmentally unsustainable or non-conducive

States must assume international commitments in conditions of equity and of distribution of costs and benefits to society, where those nations that take climate change control and mitigation actions are duly compensated. Such actions could be:

- additional or compensatory taxes for the use of fossil fuels (see infra);
- reduction of emission rates;
- use of alternative clean (green) technologies;
- compulsive reforestation policies; etc.

As an example, in countries of the South, impetus should be given to strategies of compensation (incentive scheme bonus) to owners of forests to foster soil-use preservation through the CTOs (Certified Tradable Offsets)[2]

According to the Mexican Environment Minister, Julia Carabias, in 1999 protection was granted to 37 million hectares – that represents a fifth of the national land –, so as to prevent deforestation and to preserve threatened species. The number of protected natural areas was also increased and 80% of them have their own economic resources. Additionally, a programme of subsidies for owners of jungles and forests was promoted with 17 million US dollars granted to resource sustainable preservation and exploitation programmes.

In the short, mid and long-term horizons it is necessary to search for positive synergies among the efforts to combat and mitigate climate change, seeking the objectives of

[2] Let us remember that phytoplankton and the forests are the most powerful oxygen-producing "engines".

development, intergenerational equity and sustainability. The challenge to a Mexican strategy on climate change would be precisely searching for the three-fold objective of preservation and sustainable use (for example, of the fossil fuels and of biodiversity), and at the same time generating an equitable distribution of the benefits derived from its rational exploitation *(CONABIO 1998: p. 288)*

7. Proposals

The effective implementation of the Convention and the Kyoto Protocol on Climate Change deals with three basic principles: environmental protection, sustainable economic growth and equity intra and inter generations and among nations. Hence, those countries that have benefited from highly entropy centred processes should give fiscal and credit facilities to those poor nations that have contributed most with its biotic resources to the development and well being of the rich nations. The number and amount of facilities and supports could be defined by considering at least two criteria, always geared to achieving sustainable development in the counties of the Southern Hemisphere:

- With an amount equivalent to the external aid proposed in Agenda 21 (0.7% of its annual GNP)
- With an amount equivalent to the value (cost) of the environmental functions and services for carbon capture provided naturally by developing countries.

Among others, a way to conduct these transfers could be through the reduction of royalties for the use of environmentally sound leading-edge technology.

8. Conclusions: Towards the sustainable community

To sum up, in the short, mid and long term the issue is to develop lines of research to enhance knowledge of the socio-economic and environmental impacts, as well as of the adaptation level of the non-industrialised countries and regions, both at micro and macro level, derived from the strategies of control and mitigation of climate change.

The mitigative capacity of a society will depend on resources, technology, institutional capacity, as well as adaptative capacity. The governments of the non-Annex I countries must encourage their scientific participation in climate change and IPCC issues, viewing these not only as a mechanism of raising and obtaining funds, but as an opportunity to interchange human, physical (technologies) and natural capital.

It must be assumed that, in addition to the capitalist model of production, the division between poor and rich countries affects the ecological equilibrium. It must also be acknowledged that higher and enhanced technologies have not achieved positive results in combating and reducing poverty.

One of our hypotheses suggests that the globalisation project that would benefit people and nations is failing, if it has not yet failed. Thus, sustainable development can become an emergent and feasible alternative project to confront the crisis of globalisation and the structural disruptions brought by the neoliberal reforms. This implies the *creation of intensive programmes of environmental education, the active involvement of communities in their environmental problems, as well as in strategies of food self-sustainability.*

*****

CDM and Compensatory taxes

The need to expand and regulate the participation of all State Parties to the Convention and Protocols of Climate Change in a differentiated manner can be determined as well through a *system of compensatory taxes.*

The three scenarios proposed in a simple and expeditious fashion for the implementation of such taxes would be:

- In agreement with those greenhouse gas emissions above the measures of developed countries or OECD member countries
- Emissions above the world average
- Emissions above the developed countries average

With this tax, a fund could be created and its resources channelled to cover the following objectives and functions:

- To finance reforestation programmes in countries that have humid and tropical forests
- To subsidise non-polluting green technologies for an amount equivalent to their market price, deducting their production costs
- To support research on technological innovation, health effects, risk evaluation and preventive measures, geared towards the design of an ecological tax system, among other issues.

The above proposal will need to redefine and revisit the Clean Development Mechanism (CDM) and to impose new commitments to the Kyoto agreements. The principles of equity and shared responsibility in CC problems among all countries will be better met if we combine the CDM (Article 12) with Compensatory Taxes applied to the countries less committed to reducing per capita GHG emissions. This "joint implementation" and pressure will improve the speed and effectiveness of commitments, particularly to the Annex I State Parties.

Until now, the solution to the many problems raised by climate change depends on the premises of sustainable development.

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5

VIEW OF LATIN AMERICA
THE REGION'S CONTRIBUTION TO CLIMATE CHANGE PROBLEMS.

Carlos. E. Suárez

1. Introduction

The idea of this paper is to present the past contribution of Latin America and the Caribbean (LAC) to the GHG emission control and reduction, in particular for CO_2.

We begin with making physical analysis of the evolution of the Decarbonization Energy Index during the period 1970-1990 and then the most recent years in the 90s[1].

On this basis, we make use of a new approach, trying to find an economic/monetary value for this contribution and its relation with the present international negotiations as to the UNFCCC.

2. GHG Mitigation Measures in Latin America up to now: An Overview

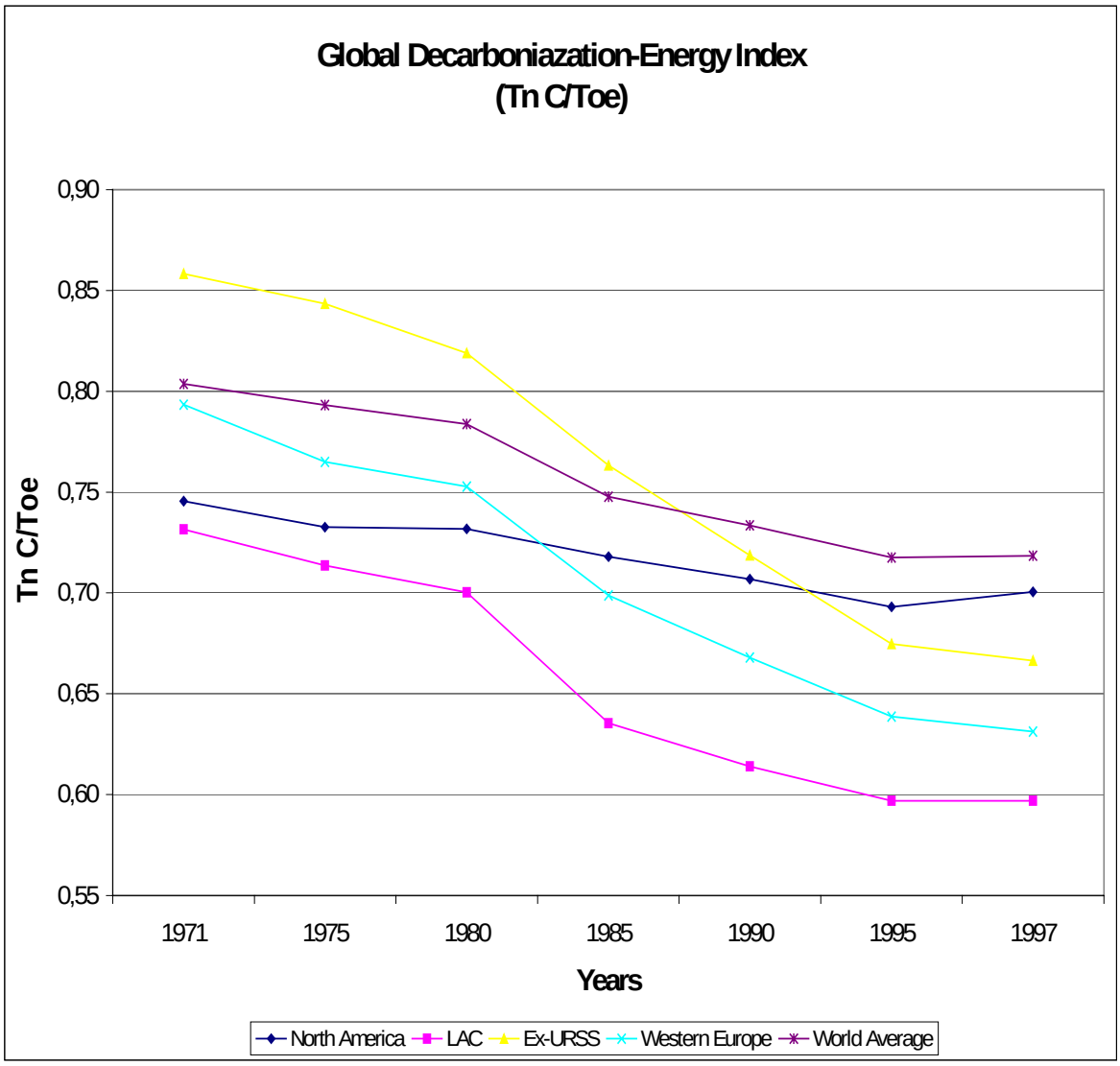
2.1. THE SITUATION AT THE WORLD LEVEL.

In the present paper, we asses the fundamental contribution that LAC have already made to the mitigation of greenhouse gases (GHG), basically CO_2, from 1970 up to now.

This contribution is illustrated by the fact that this region of the world possesses the lowest coefficient of specific CO_2 emissions per energy unit (sometimes also called "Global Decarbonization Energy Index" (GDEI) and is among the regions that have shown the greatest decline in such coefficient, specially between 1970 and 1985 (see figures 1 and 2).

[1] Decarbonization Energy Index refers to the relationship between the absolute emissions of CO_2 and the respective energy consumption that originates these emissions. It could be calculated in different ways (eg. $TnCO_2$/boe, $TnCO_2$/Gwh).

Figure 1



Source: Own calculations on the basis of energy data from *BP (1998).*

Taking into account the dominance of energy sources, the behaviour of CO_2 is a good indicator of the whole set of GHG, and consequently, we will concentrate our analysis only on CO_2. In the absence of specific data for each sector and energy source in every country, international CO_2 emissions coefficients have been kept constant for the whole period.

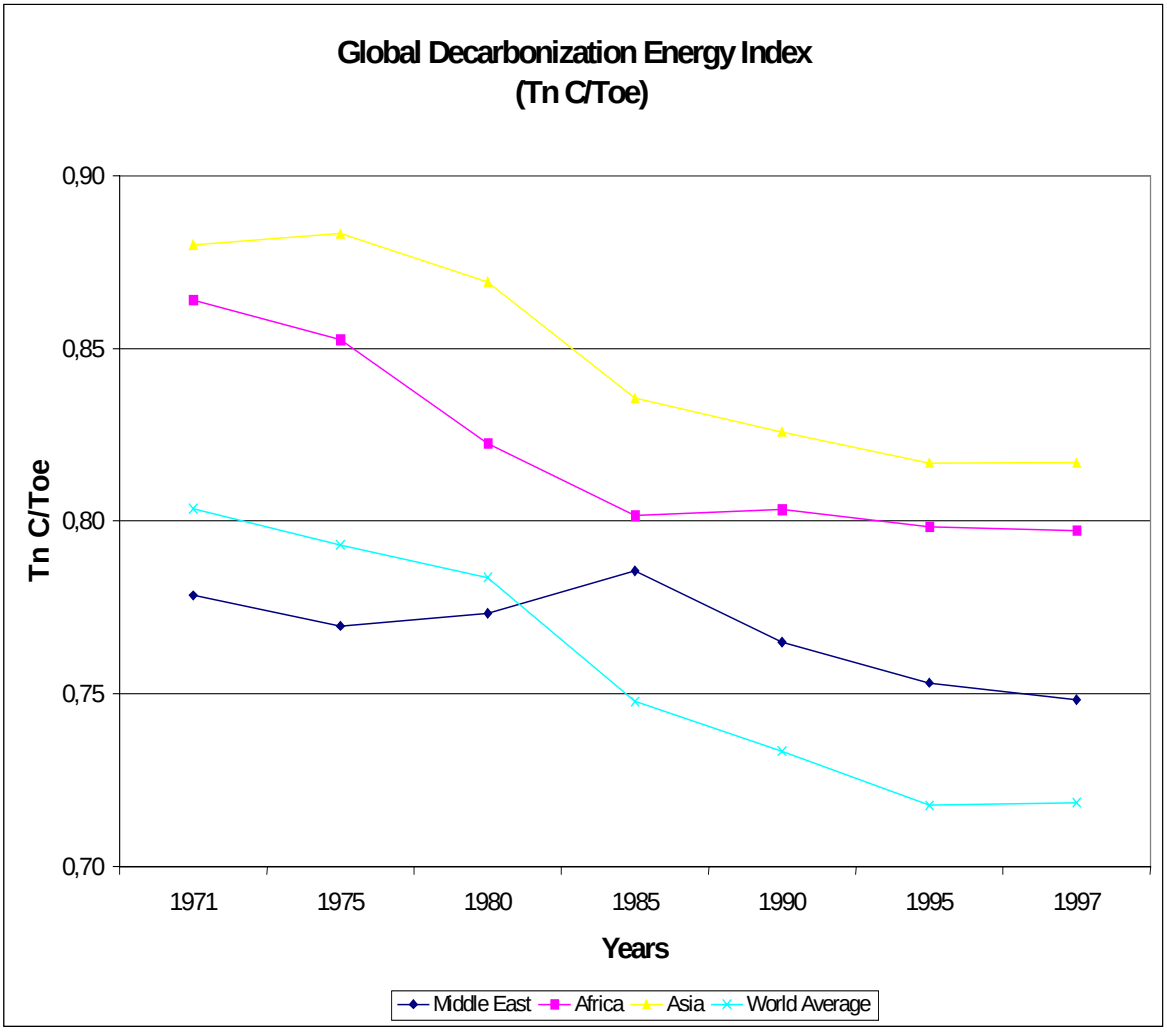
Although we do not explicitly mention other negative environmental impacts associated with the development and operation of energy systems, it is not our intention to ignore or underrate them. In this paper, however, we focus our analysis on the climate change issue.

In 1997, LAC had the lowest specific emissions for the total energy system with 0.597 TnC/toe equivalent to only 83% of the world average, due to the high share of hydroelectricity and natural gas in the energy balance of the region and the low share of coal. Additionally, this index has been reduced by 18.4% between 1970 and 1997 against only 10.7% for the world average.

This average value for LAC is particularly important taking into account that the value for natural gas, the lowest between fossil fuels, is 0,608 TnC/Toe.

In Figures 1 and 2 we can see that all other developing countries' regions are above the world average and all industrial countries' regions and economies in transition have GDEI higher than LAC, but lower than the world average.

Figure 2

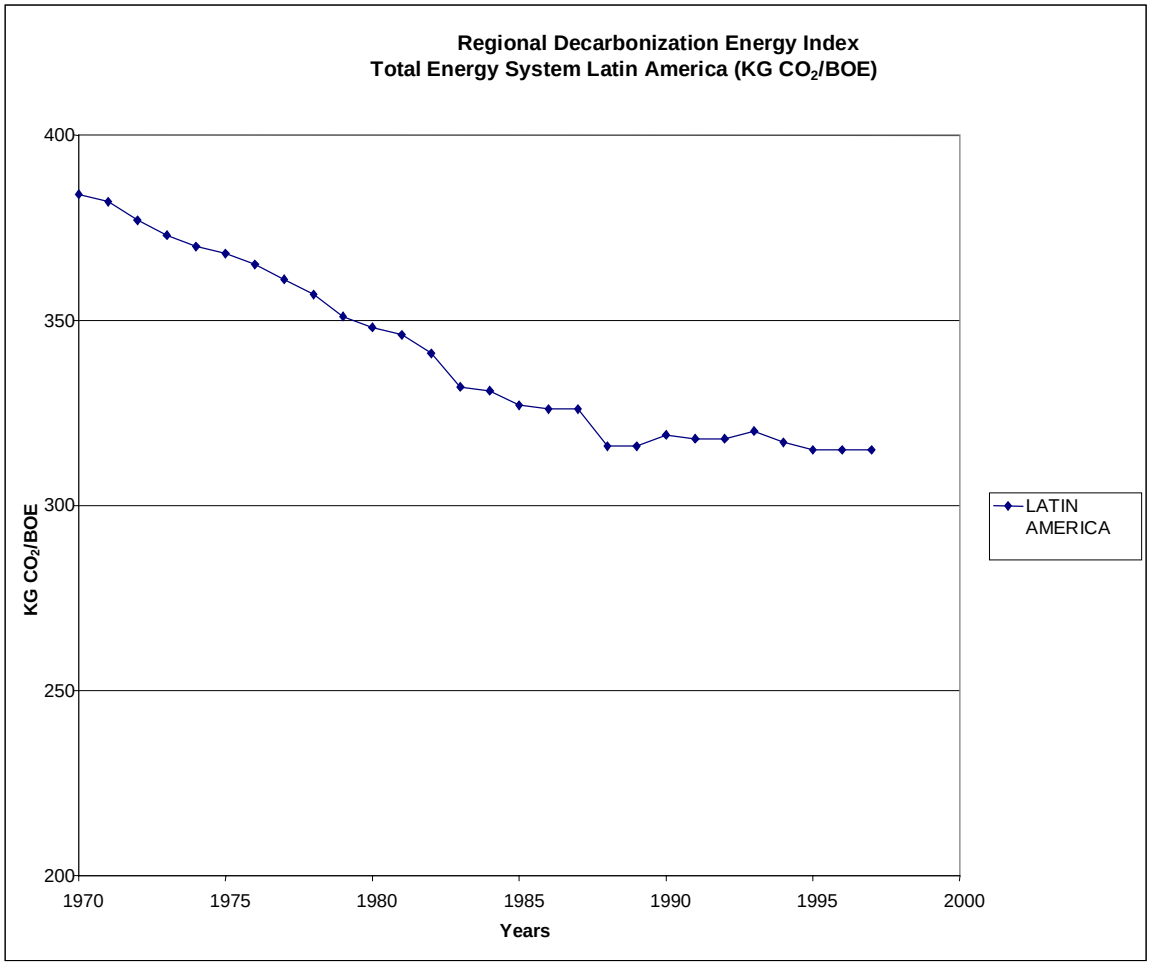


Source: Own calculations on the basis of energy data from *BP (1998)*

2.2. THE LAC SITUATION IN PARTICULAR

Going more in detail about LAC and using for this purpose the data produced by OLADE (Latin America Energy Organisation) through the SIEE (Energy Economic Information System) we arrive at Figure 3.

Figure 3



Source: *OLADE 1998*

In this case, the biomass is included in the group of primary energy sources and the CO_2 emissions are calculated in a detailed way for each sector of final energy consumption and including main transformation processes (power production and refineries), as well as the flaring of the natural gas. The GDEI in this case is presented in kg CO_2 per barrel of oil equivalent (kg CO_2/boe).

2.2.1. The period 1970-1990

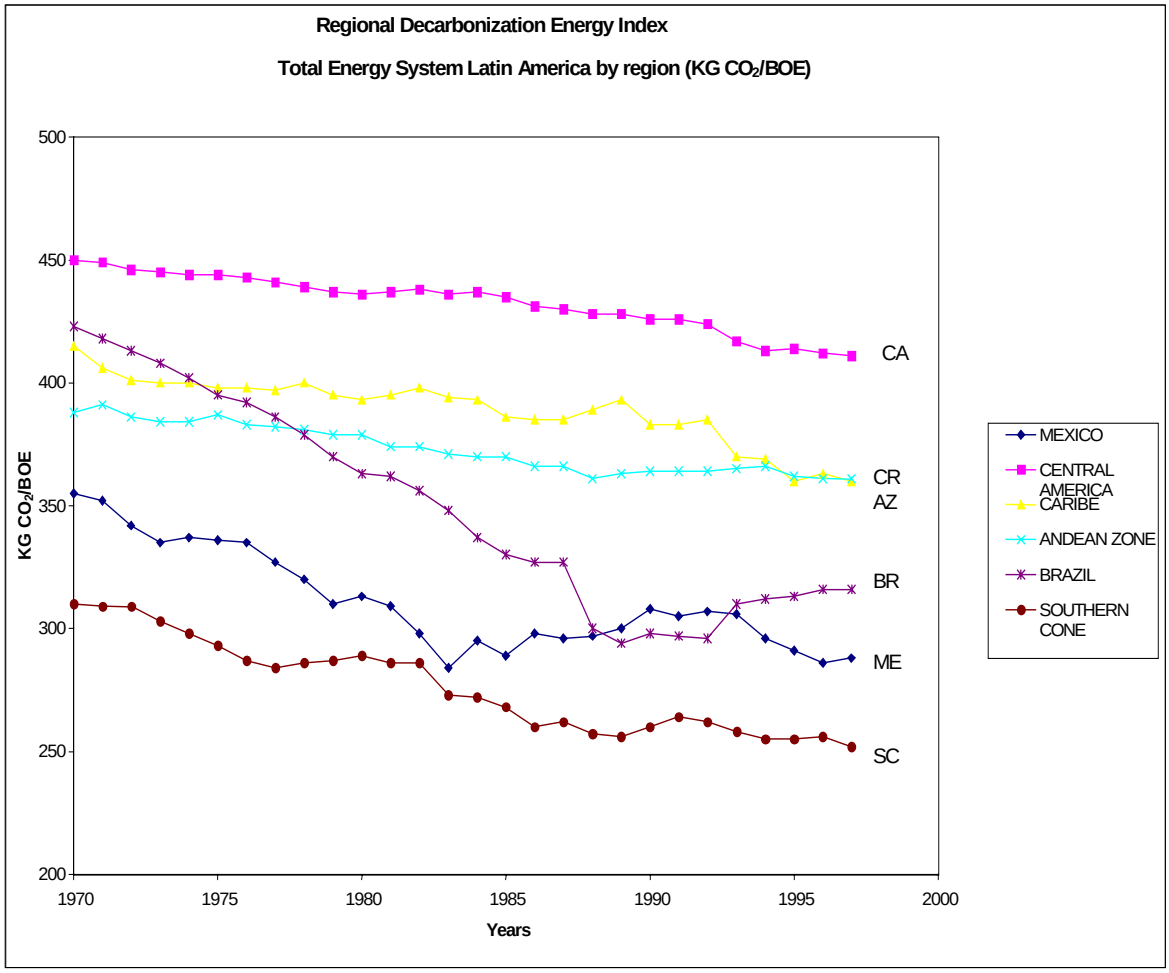
In this 20-year period there was a steady decline of GDEI up to 1988.

From this year onward a stabilisation of the index began that will continue through the 90´s up to 1997.

The total decline from 1970 to 1990 is of 17%.

Regionally (see figure 4), the most important reduction was achieved in Brazil (-29.0%) followed by Mexico and the South Cone (-17%). In contrast, the Index was reduced only by 5-7% in the other three regions (Andean Zone, Caribbean, and Central America).

Figure 4



Source: *OLADE 1998*

The continued decrease of the Index was the result basically of the substitution of hydroelectric, natural gas, geothermal and nuclear energy for the oil derivatives, coal and biomass, even if those substitutions were made basically for energy reasons and/or to reduce dependence on fossil fuels and not necessarily for climate change reasons.

If we make a detailed analysis of the energy balances of the LAC countries and regions, it became apparent that the reduction of the Index occurred for the following reasons, among others:

- A significant increase in the use of primary electricity (hydro, geothermal and nuclear) in all regional energy supplies, particularly up to the mid-eighties. (from 26.5% in 1970 to 41.3% in 1990, and 43.9% in 1997)
- A decrease in the use of biomass in the residential, commercial and service sectors as well as in the industrial sector (total biomass in primary and secondary energy consumption goes down from 29.9% in 1970 to 20.5% in 1990, and 17.1% in 1997).
- A strong reduction of the natural gas flaring specially in the Andean Zone, Mexico and the South Cone as a result of control measures taken in the countries (from 47.6% in 1970 to 12.3% in 1990, and only 10.1% in 1997).
- An increase in the use of natural gas, both for power production and various final consumption sectors (from 13.7% of primary and secondary energy consumption in 1970 goes up to 19.0% in1990, and 21.6% in 1997).
- An increase in the use of electricity in the final consumption sectors also contributed to a sustained decrease of sectoral index of CO_2 specific emissions.
- Widespread reduction in the use of oil derivatives, specially the heavier ones, and sometimes coal, contributed to a reduction of the Index.
- In the case of Brazil the use of the ethanol fuel from sugar cane as a substitute for gasoline.
- In the case of Argentina the development of the natural gas vehicles with a fleet of nearly 450.000 vehicles in 1995, the largest at world level, representing about 10% of the car fleet.

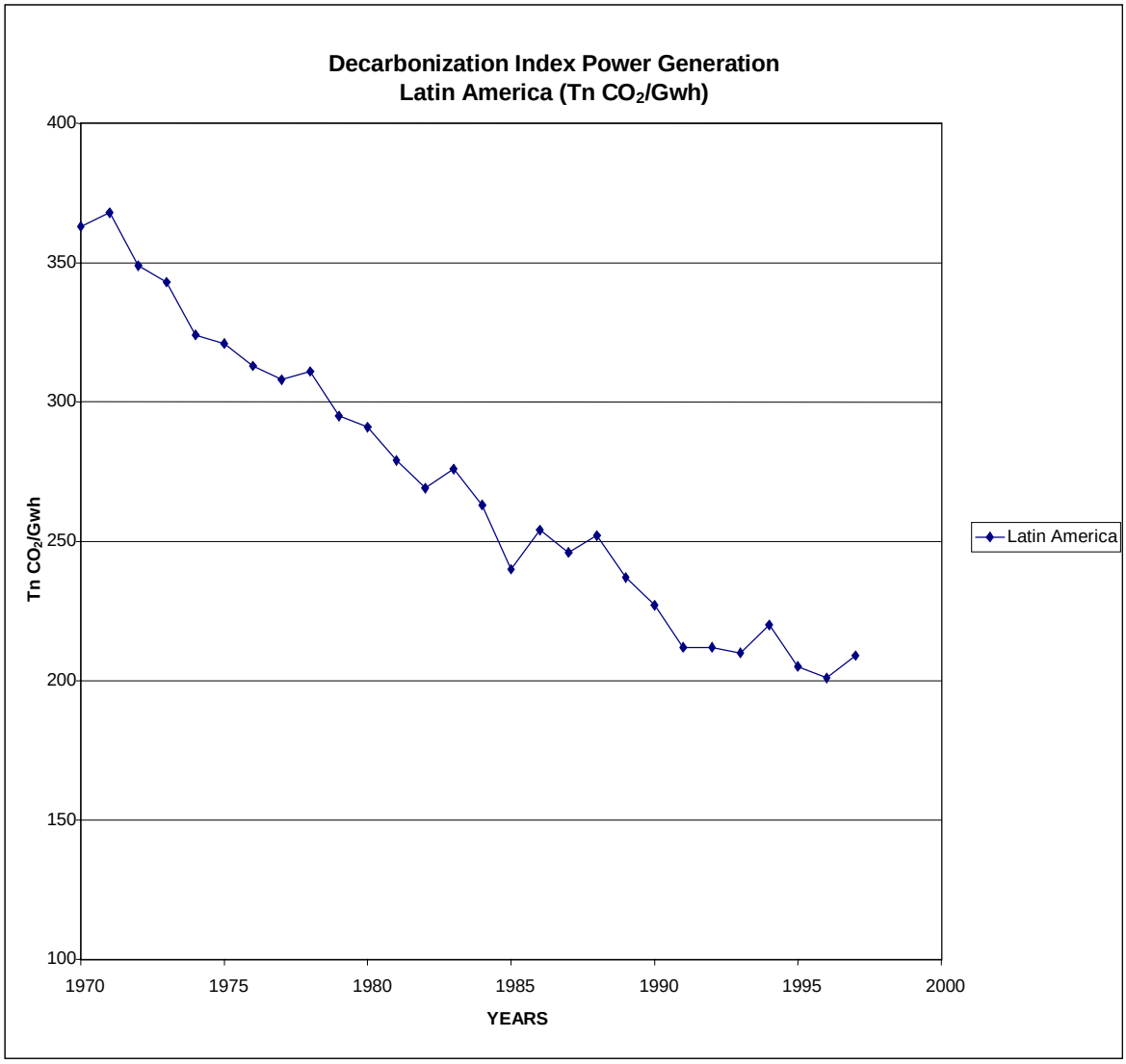
The influence of the first aspect, related to power production, can be clearly illustrated in Figures 5 and 6 where we can see that the Decarbonization Index for Power generation ($TnCO_2$/Gwh) had also been decreasing systematically during the 70s and 80s arriving, in 1990, to a value that is 37.5% lower than in 1970.

In this case the reduction of the Index corresponds at the same time to the substitution process and the increase in the energy efficiency of power production in similar proportions.

In the period 1970-1990, there were very important changes in the structure of inputs for power generation in LAC, primary electricity (hydro, geothermal and nuclear) increased its share from 26.5% to 41.3%; at the same time natural gas went from 13.8% to 15.1%

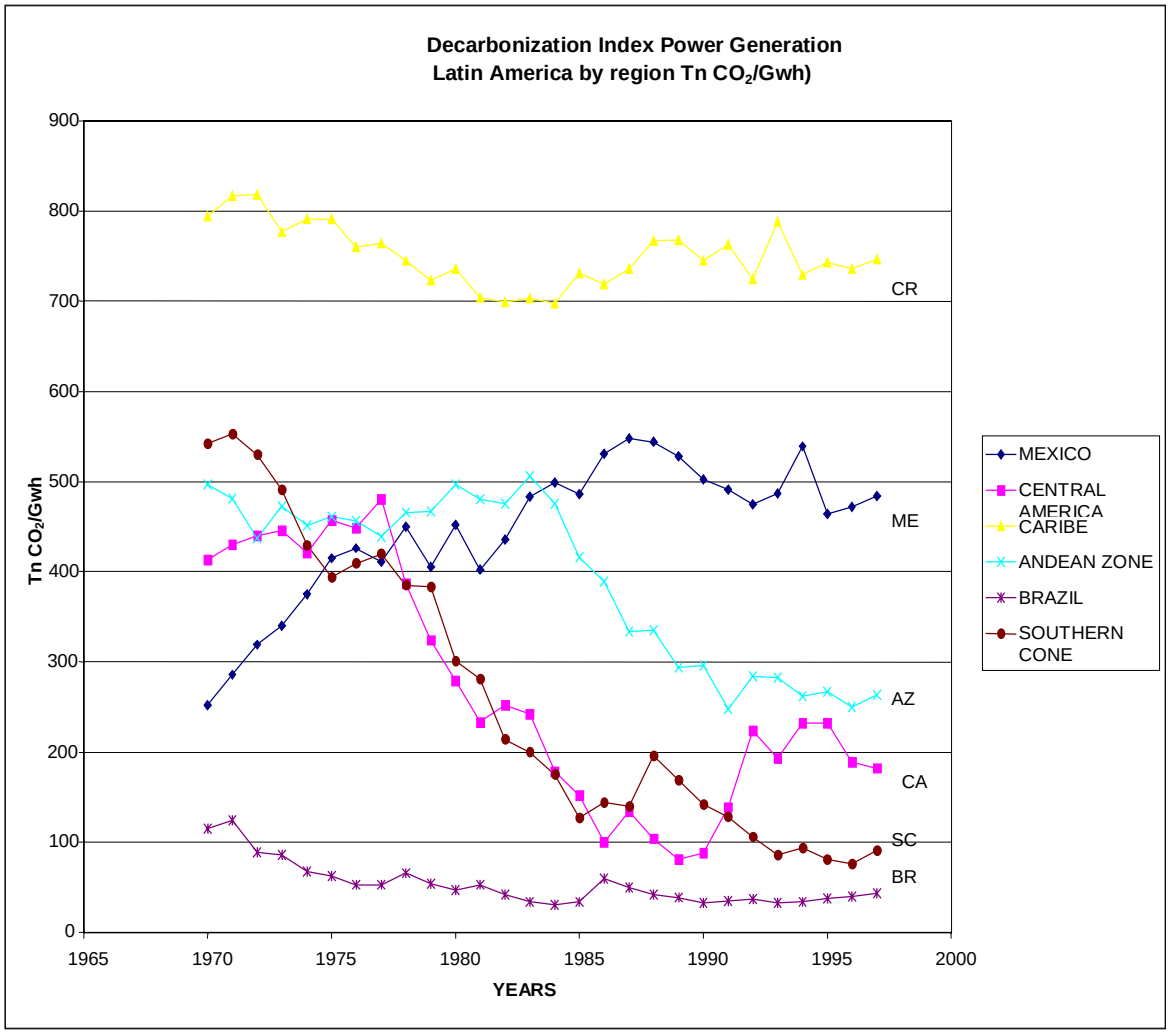
covering both the decrease of oil derivatives and the biomass products from 51.4% to 32.0%. The only negative influence was the increase of the coal share from 8.3% to 11.6%.

Figure 5



Source: *OLADE 1998*.

Figure 6



Source: *OLADE 1998.*

At the regional level we can see in Figure 6 that the average behaviour of the Index for LAC was the result of very different processes at the subregional level. In Central America, Southern Cone and Brazil the reduction is very important (between 70 and 80%) and continued basically up to 1985.

In the Andean Zone it began only in 1983 and continued up to 1991. The total reduction between 1970 and 1990 is 40%.

The Caribbean area had an important reduction (12.2%), but then the tendency changed and the Index began to increase again.

Finally in the case of Mexico the process went in another way and the Index increased almost 100.0% between 1970 and 1990.

2.2.2. The period 1990-1997

In the most recent years the evolution of the GDEI for the total energy system (kg CO_2/toe) remains stable around the values already observed at the end of the 80´s.

At the subregional level there is also a certain stabilisation, but with more variability and the increase in the Brazilian case compensates for the decreases in other subregions.

From the substitution point of view even if the share of primary electricity sources continues to increase, the pace is slower than in the previous period and this situation can also be seen in the evolution of CO_2 specific emissions for power production ($TnCO_2$/Gwh) in Figure 5 where a certain stabilisation began in the 90s. The reduction in this period is due mainly to the increase in the average efficiency of power production and not because of the substitution process that have slowed their pace.

At subregional levels (Figure 6) we can identify that in all cases appeared in the last years of the series a certain tendency to increase the specific emissions that could be the beginning of a full reversal of the past decrease of the Index.

If we ask what are the reasons behind this last process we can identify at least two basic questions:

On the one side, there is a very important technological change in the power production sector, basically the development of the natural gas turbine, (both open cycle and combined cycle) that implies a very important increase in energy efficiency and a lowering of the capital and total cost of producing electricity.

This change can also be beneficial to the climate change viewpoint when this technology replaces other fuels (like oil or coal) or even old steam turbines functioning with natural gas but with lower efficiencies.

On the contrary, when the change is away from primary electricity sources like hydro, geothermal, nuclear or other renewables, the total and specific emissions of CO_2 and other GHG will increase, and this is the current situation in several LAC countries.

On the other side, beginning in the mid 80s, deep institutional and regulatory changes in the regional energy system began to develop in LAC. These changes are leading to partial or total privatisation of energy systems that had previously, for the most part, been managed by state enterprises.

This process has accelerated during the 90s and is presently progressing at various speeds and with different characteristics in the countries of the region.

These changes have had a positive result for the financial situation of the enterprises and for the microeconomic and/or energy efficiency of the system, but from the climate change standpoint, they can have negative consequences due to the replacement of an energy development strategy based on the use of local resources (especially renewable ones, with zero GHG emissions) with a strategy that is typical of the private sector behaviour based on minimising direct cost in the short term and especially interested in the minimisation of capital costs and of different types of economic and/or financial risks.

This change is already apparent in several countries, where the new power stations contracted and put into operation after privatisation are only thermal, largely based on open cycle and/or combine cycle gas turbine, except for some hydroelectric projects that were still decided upon within the framework of the previous strategy.

Then both processes reinforce themselves, and if we take into account at the same time the decrease in oil prices at the international level in 1998, and the increase of availability of natural gas in different countries of LAC, it is possible to doubt about the future possibilities of maintaining the previous trend of Decarbonization Index, both at the power production level and at the total energy system level.

Up to now we have analysed the question in physical terms. In the following point we will try to add some monetary values to this physical values.

3. An Analysis in Economic Terms.

From the climate change point of view, the Framework Convention on Climate Change (FCCC) has established the need to reduce the GHG emissions at world level. In 1997 at the Kyoto Conference of the Parties (COP3) some concrete and obligatory commitments had been agreed upon, in particular for the Annex I Countries.

In order to get this reduction, a series of actions have been proposed with different cost levels.

Considering recent studies by UNEP's Collaborating Centre on Energy and Environment at RISO National Laboratory in Denmark (UNCEE/RISO), it is possible to know that the cost of the various alternatives for the mitigation of CO_2 emissions vary in terms of the country where the mitigation occurs, the technologies used and the type of project envisioned. In the European countries surveyed, the estimated cost ranged from 20 US$ to 100 US$ per

ton of CO_2[2], while in developing countries the values ranged between 2 US$ and 80 US$ per ton of CO_2[3].

If we use a conservative figure of 30 US$/Tn$CO_2$, we can say that the mitigation effort already achieved by LAC between 1970 and 1997 has a very important economic value.

For estimating the avoided CO_2 emissions in LAC energy systems, as a result of the substitution strategy among energy sources and the use of primary electricity sources with zero GHG emissions, we can compare the real values between 1970 and 1997 with those that would result when applying the CO_2 specific emissions of 1970. The difference amounts to 3.570 millions tons of CO_2[4].

But the projects and developments that have allowed these non-emissions will continue to function for at least another 20 years, on average avoiding an additional 5.150 millions tons of CO_2[5].

If we value the total 8.720 million tons of CO_2 avoided at the average mitigation cost of 30US$/Tn$CO_2$ we obtain a total value of 261.700 million US$ that represent about 40% of the total foreign debt of LAC[6].

Unfortunately, the economic value of CO_2 emissions reduction resulting from this 27 years of concrete action by LAC countries, cannot be recovered on the basis of the present rules and conventions at the international level.

The Climate Change negotiations have not considered, up to now, such contributions already made by non-Annex I Countries, which are under no obligation to cut down their GHG emissions.

Thus, these "emissions credits" from past efforts have no value on the international market and, in accordance with the game rules currently under discussion, could not be capitalised by LAC for paying for other development needs, like health or education or for repaying at least a portion of the foreign debt.

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[2] In Table IV of *UNEP (1992)*, values range from 15 to 75 ECU/ton of CO_2 for various European Countries. At the 1999 exchange rate, this means 20-100 US$/Tn$CO_2$

[3] The studies on several developing countries of the previous report (Note 2) yield data ranging from 2 to 80 US$/Tn$CO_2$. In the case of Brazil values vary from 45 to 80 US$/Tn$CO_2$. Options with negative costs are not considered

[4] When comparing real emissions for the 1970-1997 period with those that would result when applying the CO_2 specific emissions for 1970 of 363 kg CO_2/boe to the total Energy supply, we estimate a difference of 3.570 millions tons of CO_2, value at 30 US$/ton which means 107.100 million US$.

[5] If the savings in the last year (1997) in relation with the 1970 GDEI are considered to remain constant for an additional period of 20 years we reach a total of 5.150 million ton of CO_2 that valued at 30 US$/ton means 154.500 million US$. (Note 4) plus (Note 5) means 261.600 million US$.

[6] This has been estimated on the basis of data from *OLADE (1998)* for the total LAC foreign debt.

On the contrary, recent debates in Kyoto and Buenos Aires, have focused on determining both a mechanism for the future emission savings trading as well as a possibility of saving (banking) surplus emissions savings from one period to another in the future, for the Annex I countries.

We deem it only fair that within the framework of the future UNFCCC negotiations the relevant international organisations and both the industrial and the developing countries, analyse how the past emissions reductions efforts carried out by non-Annex I Countries, with additional impacts extending into the future, could be valued and/or rewarded.

In the future, LAC may be able to make additional contributions to GHG emission control as part of their essential and ongoing process of socio-economic sustainable development, although such contributions will not occur based strictly on market forces.

Specific policy measures will be required to optimise socio-economic aspects of GHG emissions control, consistent with the microeconomic behaviour on the private sector.

In addition to national policy measures, new international procedures are required to transfer economic resources, to developing countries in general and to LAC in particular, as a counter part of their contributions, past and future, towards a more efficient solution of the Global Climate Change problem.

4. About The Future

After the long economic crisis of the 80s the region has begun a process of growth during the 90s with some short crises, like the one in 1995, produced by the financial situation in Mexico.

Nowadays, the WB studies indicate that the growth of GDP may continue in the next 10 years, and accelerate after 1999.

1998	2.5 % annually
1999	0.6% annually
2000	3.0% annually
2001-2007	4.4% annually

This means a total increase of 43.6% for the GDP up to the year 2007.

The future growth of GHG emissions in general and of CO_2 in particular will depend on one side, on the evolution of efficiency in energy use (energy intensity of GDP) and on the other side, on the evolution of the Decarbonization Energy Index.

As we have seen in point 2.2, the DEI Index has been stable during the last 10 years after decreasing during a period of 18 years.

We have also seen that for some subregions (e.g., Brazil, Mexico) and for some activities (e.g. power production) the Index has even begun to increase and these tendencies are something to be worried about.

For the Index to decrease again, it is necessary to develop a strategy trying to use the natural gas, the less harming of the fossil fuels, basically to replace coal and/or oil derivatives in the Transportation, Industrial and/or Residential sectors in all countries where natural gas (or LPG) could be available and not only to use it in power generation.

For this purpose there are a series of primary electricity sources with zero GHG emission (hydro, wind, geothermal, nuclear, etc.) that from the climate change point of view are more advantageous.

But in this case, some problems arose because in general these solutions are more capital intensive than the alternatives, and their advantages are evident only in the long term.

The most recent financial crisis at the world level beginning in Asia, going through Russia and nowadays in LAC itself through Brazil, tightens the financial and the economic markets producing not only an economic short term crisis that can clearly be denoted in the WB prevision previously mentioned for the year 1999 with a decrease in the GDP/capita, but also more difficult times to get financial resources and surely at higher cost.

This situation, combined with the normal behaviour of the private actors, now responsible for a very important share of the energy system in several countries of LAC, make the development of the long term, primary electricity solutions proposed here very difficult.

Therefore, it is necessary that both the national governments and the international organisations find the way to internalise the climate change costs of the thermal solutions in order to give a new opportunity to primary electricity solutions, within the present institutional framework.

On the other hand, we have said at the beginning of this point that bettering the efficiency of energy use was the other route to decrease GHG emissions in general, and CO_2 in particular.

But again, in general, measures for rational use of energy imply a long-term strategy with initial investments that are then recovered through energy savings.

If we add to the previous situation the low level of 1998 oil prices that, in real terms, reached levels previous to the oil shock of the 70´s, the possibilities for LAC to reduce the rate of increase of GHG emissions are not so good.

In some way, the international community and the national governments need to develop policies and measures for a concrete application of the "pollution pay principle" in relation with the emissions of GHG that are at the origin of the climate change issue.

Some efforts are already under way in the energy system of LAC, some of them with the support of the World Bank, such as:

- the development of the Natural Gas Vehicles in Argentina from 1984;
- the increase in energy efficiency in power production in Argentina in the 90´s;
- renewable energy in the rural market in Argentina;
- the program to use the ethyl alcohol (ethanol) in cars in Brazil from 1976;
- the biomass Power Commitment Demonstration Project in Brazil;
- the Mexico High Efficiency Lighting Project;
- the reduction of natural gas flaring in several countries;
- the demand-side Management Demonstration Project in Jamaica;
- the Caribbean Planning for Adaptation to Climate Change in the Caribbean countries.

But much more has to be done if we want to reduce the pace of GHG emissions growth in the coming years. This increase is unavoidable for the region in order to maintain the socio-economic development for the bettering of the quality of life of all and every citizen of LAC.

Finally it is important to highlight that all countries in the region have signed and ratified the United Nations Framework Conventions on Climate Change (UNFCCC) and recently have undertaken the construction of the National Greenhouse Inventories in response to UNFCCC requirements, and with the financial and technical support of the GEF and the US Country Program. The results of the inventories will provide a better picture of the situation in the region.

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6

SUSTAINABILITY AND EQUITY IN THE CLIMATE CONVENTION

Luiz Pinguelli Rosa

1. The Clean Development Mechanism: Issues and Choices

One of the most important achievements of the Rio Conference in 1992 was to differentiate between the responsibility of the North and the South in the Climate Convention of the UN. The goal of reducing greenhouse gas emissions in 2000 to the same level as of 1990 was decided only for Annex I, which includes all developed countries. Presently we know that the above goal will not be achieved and that it was changed by the Kyoto Conference in 1997, while a mechanism has been proposed for investments from the North to avoid carbon emissions in the South at low costs *(Agarwal and Narain 1991; Banuri et al. 1996).* The former Activities Implemented Jointly *(Rosa 1997)* was transformed into a Joint Implementation mechanism restricted to Annex I Countries. The Clean Development Mechanism (CDM) was approved in Kyoto as a consequence of the Brazilian proposal for a Clean Development *Fund (Meira and Miguez 1998),* supported by the G77, the Group of Developing Countries in the Climate Convention. However, CDM needs to be regulated. The Buenos Aires (1998) and Bonn (1999) Conferences of Parties did not advance much in this direction.

A two-day regional workshop in Brazil entitled "The Challenge of Securing Financing and Ensuring Capacity Building in CDM projects" was held in Rio de Janeiro in September 1999. The workshop was organised by Coordenação dos Programas de Pós-Graduação de Engenharia, Universidade Federal do Rio de Janeiro (COPPE/UFRJ, Rio de Janeiro, Brazil); the Pacific Institute for Studies in Development, Environment and Security (Oakland, CA, USA); Environnement et Développement dans le Tiers Monde (ENDA, Dakar, Senegal); The Bangladesh Centre for Advanced Studies (BCAS, Dhaka, Bangladesh); and The Woods Hole Research Center (WHRC, Woods Hole, MA, USA). It was a follow up of the North-South Network on Climate Change, created after the Rio Plus Five Meeting and involved the same institutions.

The objectives of the workshop were to:

1. Look carefully at what makes the CDM special, what separates the CDM from the other mechanisms and other kinds of international joint ventures.
2. Evaluate options to secure finance for CDM projects.
3. Secure and promote capacity building to strengthen the capability of institutions and communities.
4. Start the development of a general framework for evaluating the technical aspects of the CDM in support of the political negotiations.
5. Lead the discussion on the principal points of the CDM: sustainable development and emissions reduction.

The results of Rio were presented in a parallel workshop in Bonn, during the COP5, in 1999. The two-day workshop held in Rio de Janeiro had a productive discussion and debate, involving all participants and the main features of CDM and Certified Emissions Reductions (CERs): (a) generation of real, measurable and long-term benefits for, mainly, the developing countries; (b) additionality of emission reductions; (c) the share of proceeds; and (d) models and procedures in relation to the implementation of the CDM.

There are some questions to be resolved:

- The determination for Annex I Parties on the "parts of their quantified emission limitation and reduction commitments under Article 3" that can be covered by CERs. Parties' views range from prescribing a precise limit for acquisitions of CERs to being silent.
- The "fungibility" among the mechanisms. While some Parties wish to see full fungibility (i.e. one CER is equivalent to one unit of assigned amount and can be used in exactly the same fashion), others do not accept the concept of fungibility.
- The eligibility criteria for project activities. Under the CDM, Parties are addressing the type of projects (related to gases, sectors, technologies and contribution to sustainability) which can be validated or registered, including whether and under which conditions projects which were started under the AIJ pilot phase would become eligible as CDM projects.
- Possible inclusion of sequestration projects in the CDM.
- The design of baselines and additionality. So far, one detailed submission has been made for the technical appendix on this issue. Other submissions may follow before COP6. Among experts, three major options are being discussed: a project-specific approach, a technology matrix/"benchmark" approach and a "top-down" approach, each with its own methodological and economic implications. For project proponents and developers, being interested in simplicity (low costs) as well as credibility (certainty that the product, i.e. the CER is indeed generated through due certification), the outcome of the discussion on this issue is of particular relevance.
- The use of CERs obtained from 2000 onwards (Article 3.10). A number of Parties are considering the possibility of retroactive certification from the year 2000 onwards.
- Project monitoring, verification and certification. These are mainly issues of procedure where the avoidance of a conflict of interest concerning the operational entities engaged in the various stages is of importance. In this context, the role of the intergovernmental

process and bodies, such as an executive board, is to be defined (e.g. functions such as accreditation/designation of operational entities and issuance of certified emission reductions).

- Registries for tracking CERs. National registries by Parties being involved in the CDM are being called for. No detailed technical inputs on a registry system have so far been provided by Parties but there are indications that some Parties may wish to consider one tracking/registry system for all three mechanisms.
- Reporting by Parties. Proposals exist that Annex I Parties should report on their CDM activities within their reporting commitments under Article 7.1 and 7.2, and that non-Annex I Parties should do so within their national communication under guidelines to be determined.
- Modalities for the share proceeds. Parties are proposing various interpretations of the term and present options for its uses (adaptation and covering administrative costs of the CDM).
- Adaptation assistance criteria and a possible adaptation fund. A technical appendix has been proposed to contain details on this issue.
- Roles of the executive board and operational entities. Parties are not only addressing the range of functions which each of these bodies/entities may perform but also their respective authority.
- Project financing. A range of options is being proposed, addressing in particular situations where a purely market-based approach may not be sufficient.

CDM has two distinct aspects: a good side (an optimist one) and a bad side (a pessimist one). The first one looks at all the basic intended characteristics of this mechanism, such as contributing to sustainable development; attracting foreign investment; leveraging technological progress; promoting capacity building and institutions' strengthening. Therefore, CDM could give the opportunity to enhance economic growth and simultaneously to decarbonise the economy. But, CDM can also have a bad side if priorities will not be set by host countries and the design would be overburdened, thus not allowing these objectives to be met. We can see that the CDM is a potentially powerful instrument but has to be used with caution and care.

The potential of the CDM for developing countries is enormous, mainly, in emission reduction, equitable participation in climate change efforts and investments. But to reach this potential that the CDM offers to the developing countries, CDM projects have to attend to two essential aspects: (a) the projects must contribute toward sustainable development objectives of the host country; and (b) the projects and host countries must be able to attract sizeable investments. For the first aspect there are two points to discuss: (a) CERs represent only one type of several financial instruments which can be used to promote sustainable development; and (b) the CDM will not contribute to sustainable development unless developing countries do assume that responsibility. On the aspect of attracting investments, the amount of investments that CDM will be able to attract will depend in a large part on the competition among CDM projects and with other flexibility mechanisms.

There are at least two initiatives in Brazil for selecting projects that could be eligible for the CDM. One of these was proposed at the Aspen Forum Workshop. Projects were proposed to be divided into four principal groups: forestry projects, fuel and energy conservation, electric energy generation, and renewable sources. The other initiative is a partnership between COPPE and the government of Rio de Janeiro to create the International Virtual Institute of Global Change and the Rio Clean Development Program. This program has two principal objectives: promote the implantation of economic and social projects in the State of Rio de Janeiro that will reduce greenhouse gases emissions and, at same time, will promote local sustainable development. This includes job generation besides promotion of a better quality of live for the population.

At the above mentioned meeting, there were two distinct opinions about the preferred relationship between a project and the market. In the Aspen Forum, the projects that were chosen were those more oriented for the market, i.e. the market potential was the key criterion. On the other hand, the Rio Clean Development Program looks for the possibilities that projects which are oriented primarily to promote sustainable development and to address local problems, have to offer to the market, i.e. sustainability is the most important criterion.

A second point that generated distinctly different opinions was the real role of the CDM. This mechanism could be only a new form of JI (e.g. primarily a deal between companies to reduce mitigation costs) or could make a serious attempt to contribute to the sustainable development of non-Annex I 's countries (e.g. with the creation of local committees and an international one that can support the negotiations). This second point was clearly related to the first one in the discussion. In a simple metaphor we can write:

CDM = Avoid Carbon Emission at Low Cost + Sustainable Development

2. Equity and Market in the Climate Convention

Consumption patterns are exported by the industrialised countries in the North to the developing countries in the South, through the market *(Rosa and Ribeiro 1998).* This is reinforced by the increase in the speed of communications which characterises the so-called globalisation process. In the South, market demand for production of goods and services, however, is mainly derived from only a part of the population which is affluent and able to imitate the consumption patterns of the North, including the high levels of energy per capita consumption. In some developing countries, like Brazil for instance, the higher income classes exhibit levels of energy consumption as high as those in the industrialised world, although usually not at levels comparable to those prevalent in regions such as the USA. The majority of the population in the developing world remains outside of this process, and exhibits very low energy consumption levels, as a consequence of the inequality in the income distribution which leads to unequal distribution of goods and services. So, the issue of equity *(Grubb 1996; Smith 1995)* among countries in the Climate Convention, concerning the implementation of measures for carbon emission abatement

and mitigation, has a counterpart in the internal inequality of income distribution, and so of energy consumption and of carbon emission, inside each country.

It is important to note that the consumption patterns exported to the South by the market, create an expectation of high energy consumption in the low income classes of these countries, in spite of the prevalent low overall levels of energy per capita. This expectation generates a latent demand for goods and services which is ready to surface at the smallest increase in income.

In general, the industrialised countries possess high levels of technical efficiency, which imply low energy intensity levels (toe/US$). However, as a research project by COPPE *(Rosa and Tolmasquim 1993)* has shown, there are examples in which the higher energy intensity levels in the developing countries do not necessarily imply physical energy intensity (toe/ton). The reason being that the monetary values (US$/ton) can be low in some cases. Also, in the industrialised world, the greater technical efficiency in transportation, for example, has not led to a decrease in the use of fossil fuels, due to the consumer preference for larger cars and the use of high speed motorways. Therefore, with the fall in the price of oil at the end of the decade of the 80s and along the 90s, there has been an increase in the energy per capita spent in transportation which has led to an overall low level of social efficiency, if one takes social and environmental aspects into account. The upper income part of middle class Brazil has now the same tendency of buying very large cars or vans with about three times the mass of normal cars. The engine efficiency improvement does not make up for the increasing size of the vehicles sold.

Any form of development in the South will affect climate change since energy consumption per capita in these countries is still very low, and therefore can only increase. The patterns of consumption, however, which are exported by the industrialised countries in the North to the developing countries are the ones which reinforce the use of fossil fuels, since they are based on the technology prevalent in these countries. Sometimes this occurs at the cost of the displacement of renewable energy sources and technologies. This is the case with the alcohol program in Brazil, which was faced with competition from the oil-based automobile industry, and the adoption of thermo-electricity generation in substitution of hydro-electric sources.

In addition, in the North, society can regulate unwanted market activities through strong democratic institutions. The South, in actual fact, exhibits a defective imitation of this process, in which a weak State is accompanied by greater susceptibility to corruption by large enterprises and to pressures from multilateral institutions that defend the position for an unregulated market.

Consumption patterns dictate demand for economic production of goods and services in the economy. The level of production determines employment and income, which feed back into demand through the market. The formal market in the developing economies is formed by only a small part of the population which is affluent and imitates the consumption

patterns of the North. Therefore, the part of the population left out of this process generates a demand which is met by the formation of informal production sectors, that produce inferior goods at lower costs, and offer only underemployment. As a result, the formal economy does not generate enough jobs to absorb the working age population, which itself perpetuates low income and unemployment, and lack of demand for formal market goods. The weakness of the democratic institutions in regulating the developing countries' economy only adds to the problem.

Until now, Brazil has had the advantage of a high percentage of renewable primary sources in its energy matrix. In transportation, alcohol has been used in cars since the oil shocks. But in a deregulated market alcohol does not compete with gasoline while the oil price is low. So, since the beginning of 90s, the deregulation policy in Brazil has led to the substitution of alcohol by gasoline in new cars; and hydroelectricity has been replaced by fossil fuel electricity generation in future plants. In the Brazil's case, the market does not lead to clean development.

3. Sustainable Development and Technology

The previous section has illustrated a particular aspect of the problem to achieve a sustainable development in the South, the solution of which could be supported by the development of appropriate science and environmentally sound technology. In the case of Brazil, for instance, there is a national system of research and development but institutional mechanisms are needed to link universities, institutes and private enterprises.

The problems that we face in Brazil, as well as Latin America in general, arise from the contrast between the modern side of the country and the poverty of most of the population. However, the very existence of the modern part indicates the potential for the changes which are needed. The question arises on how to bring about these changes, how to use science and technology for sustainable development as one tool among many others?

There are numerous reports and studies by governmental agencies, international organisations and NGOs, with many ideas and suggestions. How to select priorities among them, to make a start?. How to choose short term measures to be taken?. How to fill people with enthusiasm to implement the measures?

Within the purpose of presenting a rational approach to develop science and technology we start with a rather obvious method. It consists of the steps:

a) identification of the problems to be solved and the goals to achieve;
b) establishment of the postulates and principles;
c) selection of relevant information;
d) the analysis of information in the framework of an approach for understanding the present situation and the possibility of change;
e) concrete proposals to be implemented.

The first step has been considered in the beginning of this paper. Our postulates and principles could be the following:

a) We do not agree with the separation often made between poverty alleviation and the development of the modern economy.
b) We understand that modernisation means to expand the modern economy in order to get poor people out of poverty in a degraded subsistence economy, to become a worker and a consumer, as well as a human being with dignity in the society, without necessity of charity or alms.
c) To achieve the above objectives, which is the most important and to which technology must contribute, we will avoid two frequent biases:
   (i) it is not true that everything must be planned by the government;
   (ii) it is also not true that nothing must be planned by the government, expecting that only the market in an open economy would solve every problem.
d) Science and technology are different things. Science must be linked to technology because frequently new scientific results are transferred to technology; at the same time, technology changes fast, while the fundamentals of science, on which the technology is based, remain valid. However this does not mean that science is less important than its technological applications, because creativity works better in an environment of academic freedom. And freedom is necessary in an open society to allow for criticism on the political acts of governments as well as on economic power of big companies.
e) Technology can not be seen as a goal in itself, but it must be used to solve problems of the society and to develop the country. However it must be clear that technology is a tool and it is not enough to solve all problems, most of them also depending on economic rationality, social equity and political and ethical decisions.

There is a quite impressive amount of studies on the current Latin America economies in general, in publications and reports by international organisations. Why is there this international interest? A general answer is: the potential of economic growth in the region, the democratic regimes originating from a recent history of struggle by trade unions, political parties from the left and the centre, and civil society. But the main reason for the interest probably is the prospect for business opportunities in a large market. There are special factors which make Latin America interesting. They are listed below for Brazil, but many of them can be generalised to Latin America as a region. We add the limitations of these factors, according to our diagnosis:

1 - *Modernisation:* A modern economy does exist in Brazil, but it is limited socially and geographically. There are very modern urban areas in contrast with most of the country.

2 - *Education:* The elite has a good education and there are people with technical and scientific knowledge, which is not available to most of the population.

3 - *Job opportunities*: There are comparative advantages in many sectors, such as industry in general and manufacturing in particular, in minerals, agriculture and cattle farming with a high potential for growth, and associated job opportunities.

4. Income distribution: The great majority of the population lives in very harsh conditions of poverty, with little chance for improving the patterns of life because unemployment is very high and increasing. This majority is not integrated into the economy so development has not benefited them.
5 - *Natural resources:* The population is relatively large but with a low density of population. Large part of the territory is not developed and has large natural resources such as the Amazon forest with its very high biodiversity. There are regional economic disparities.
6 - *Infrastructure:* There are many kilometres of roads. The telecommunication is one of the best in the Third World. The energy matrix contains a very high component of renewable sources, including hydropower, alcohol used in car engines and charcoal used in the steel industry. Electricity consumption increases and there is considerable hydro-electric potential. The discovery of exploitable oil deposits and the development of off-shore technology in the country are important.
7 - *Modern private sector:* The potential for industrial development is promising because of the modern infrastructure. The private sector is the most important in the economy and there is a reasonable financial sector. Monetary policy has been successful in inflation control but salaries have been frozen and unemployment is high. Deregulation of the economy however produced a rather unstable equilibrium in some aspects, in particular a negative export–import balance and exponential growth of the government debt.
8 - *Role of the government:* The government has had a marked role in the economic development. The political system is stable and international relationships are very good. Recent privatisation of public services mainly through the sale of state companies to foreign and international corporations did not meet the expectations until now, especially in the electric energy supply.

The simple analysis of the above points allows us to see that only factor 4 is purely negative. Points 1 and 2 show the contrasts, as well as points 3, 4 and 5. The last ones, from 5 to 8 indicate that there are possible ways to solve the problems. Most of the analysis performed on the economic situation considers either only the positive points of the economic policy or purely the negative ones, according to who does the analysis. This usually is either an enthusiast of liberalisation of the economy or someone concerned with social inequalities. Here, we try to put all of the factors together. The next step is to discuss how to solve the problems.

The government has a role in public education, but it must focus on the increase of the skills of a large part of the population and improvement of the scientific and technological training of professionals. Economic sectors and actions must be integrated in a network developed to support sustainable growth. This must be done by creating employment. Education and employment could improve income distribution but in such a way that new consumers will expand the market for the modern economy .

In a very naive metaphor, it is possible, based on points 1 to 4, to select variables to be changed:

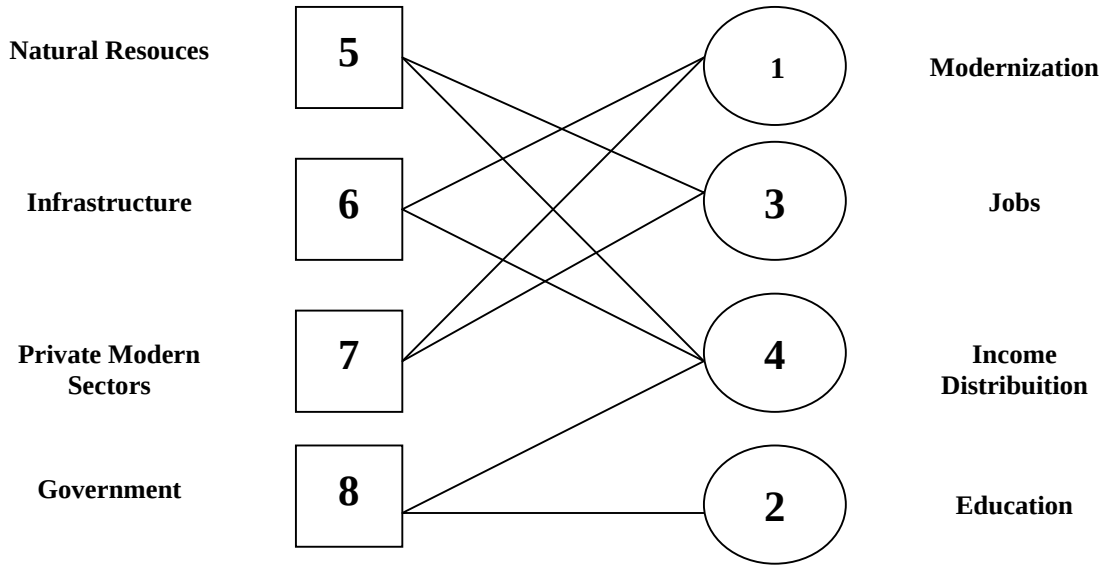
(1) expansion of modernisation,
(2) education of the whole population and diffusion of science and technology;
(3) increase of formal employment and creation of jobs,
(4) equitable income distribution to benefit the poor people.

According to the same analogy, points 5 to 8 could be considered to represent functions which can change the variables 1 to 4:
(5) natural resources exploitation and development of agriculture,
(6) infrastructure and energy supply for industrial development,
(7) private dynamics of modern sectors of the economy,
(8) role of government.

If we go on with this analogy, we remember that in mathematics the number of variables not exceeding the number of equations is a necessary but not sufficient condition for the existence of solutions. In our case there is no theoretical functional dependence expressed in a mathematical form. There are no deterministic equations to solve social and economic problems and even in recent mathematical descriptions of nature, the extreme sensibility of some natural systems to present conditions does not allow predictions. But the future can be improved by present actions. So it is necessary to look for the correct actions by taking into account the direction of economic as well as social development.

The actors are the private sector, workers, the government, civil society and international organisations. They should manage (diagram 1) variables indicating potential (5 to 8) in order to changing the variables (1 to 4) which refer to conditions. Natural resource exploration and agriculture (5) are more related to job creation (3) and income distribution (4); infrastructure (6) is more related to modernisation (1) and income distribution (household electricity supply, water, cross subsides, in 4); private dynamics (7) of the modern sectors of the economy are more related to modernisation (1) and job creation (3); the role of the government (8) is more related to education (2) and income distribution (through tax, social actions, 4). For that purpose actions need to be co-ordinated, through a social and democratic consensus, but with efficient institutional mechanisms involving small and large firms, the state, non-governmental organisations, and multilateral organisations.

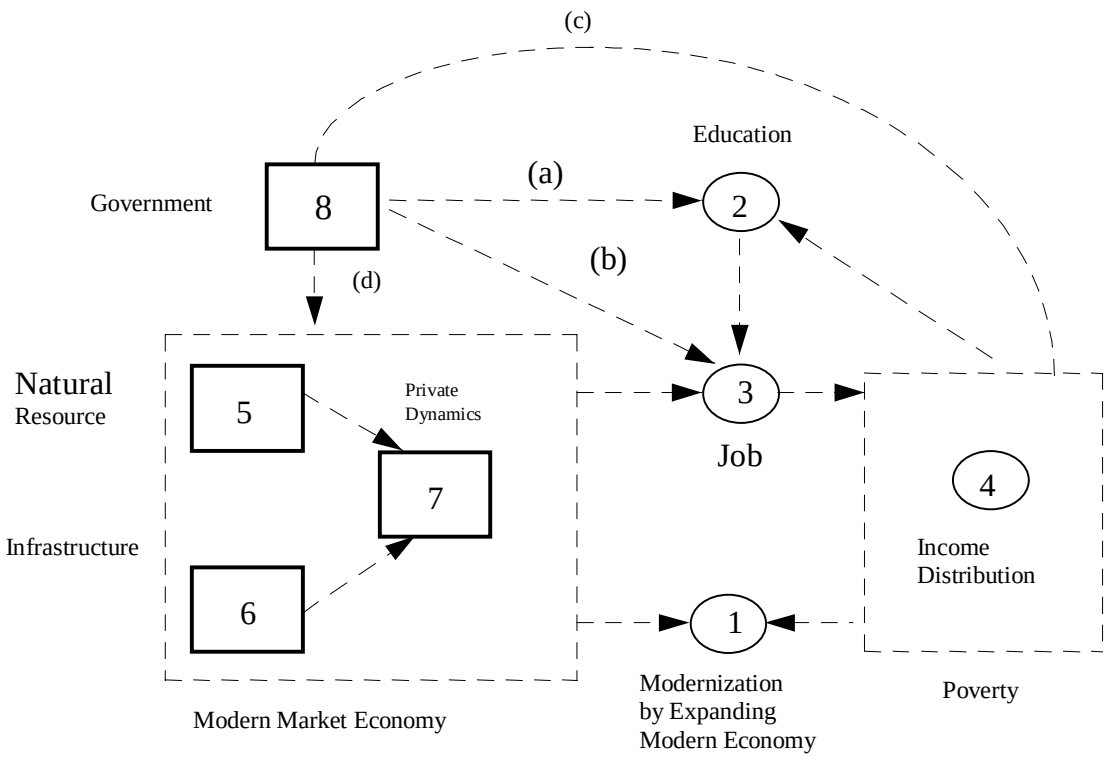
Diagram 1



For instance, the government must act on the state role (8) for public education (2). But it must be done to increase the skills of the population and to improve the scientific and technological knowledge of professionals for better employment (3). Economy sectors actions must be integrated in a network (5,6,7) for growing. But it must be done by creating employment (3), not only through direct formal jobs, but also by contracting small enterprises or individuals. Education together with employment can improve income distribution (4) and integrate the poor people in the modern economy. So, new consumers will expand the market to develop the modern economy (1)

Diagram 2 shows how the above mechanism works in a complex system approach.

Diagram 2



4. Proposals for Sustainable Development

The main relationships between variables and functions are in diagram 2:

a) natural resource exploration and agriculture are more related to job creation and income distribution;
b) infrastructure is more related to modernisation and income distribution (through household electricity supply, water, cross subsides);
c) dynamics of modern economic private sectors is more related to modernisation and job creation; (d) the role of the government is more related to education and income distribution (through tax, social actions).

There are four possible ways (a,b,c,d) for the government to start the process of taking people out of poverty, by education (2), job creation (3) and income distribution (4), which have the aim of including the whole population in the modern economy. This approach

does not consider separately the modern economy and the subsistence economy of the survival of the poor people, but it includes both.

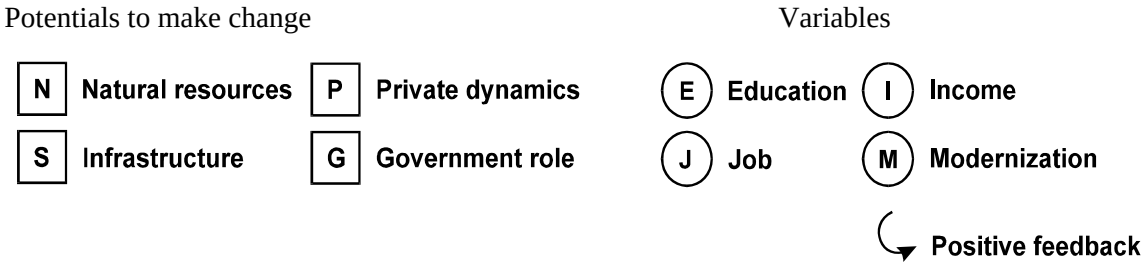
Expansion of the modern economic sectors to include the whole society, education, reduction of poverty, income distribution, all these changes involve scientific and technological knowledge, training and vocational skills. In this aspect this paper proposes special demonstration programs for the short term:

a) Improvement of education. See diagram 3a.
b) Appropriate technology for low cost housing with local materials, local job creation and local design. See diagram 3b.
c) Energy for rural areas, preferably renewable, such as small hydro and, for isolated communities, solar. See diagram 3c.
d) Labour intensive technologies to make local products, selected to be protected temporarily against imports. See diagram 3d .

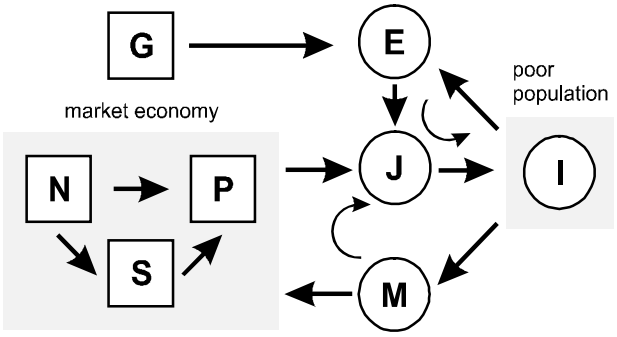
Points (b) and (c) could have support from the Clean Development Mechanism for abatement of carbon emissions in the atmosphere.

All these programs are proposed according to the approach developed above in order to create positive feedbacks in the economy, through starting action by governments on education, job creation, income distribution and economic development, with the goal of including poor people in the modern economy.

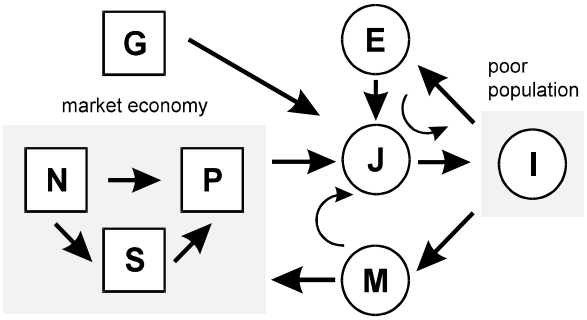
Diagram 3: Examples of Government Starting Actions



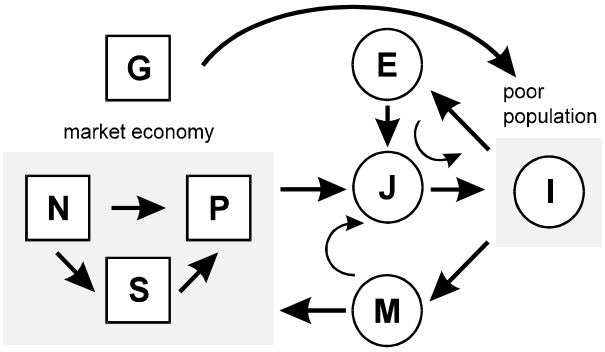
a) Improvement of Education, from Basic School up to University and High-tech. Institutes and Centres



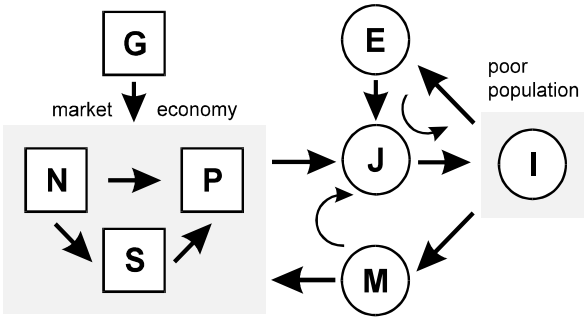
b) Appropriate technology for construction of popular houses



c) Energy for Rural Area and Small Communities



d) Protection of a few selected products of national labour intensive industries



5. Final Comments

This paper has shown that there are possibilities for developing countries to create positive feedback in the economy, through actions started by the government. Those governmental actions can be taken in the areas of education, job creation, income distribution and economic development. They must have the goal of including poor people in the modern economy and they could be eligible for the Clean Development Mechanism if they would demonstrably limit GHG emissions while promoting sustainable development.

However, there is a tendency to reduce the CDM to something like JI, restricted to business deals among private companies without paying enough attention to social and national priorities of Annex I countries. To reach the potential that the CDM offers to developing countries, the projects must contribute toward sustainable development of the host country and must be able to avoid GHG emissions in such a way to attract sizeable investments from Annex I countries.

This could be a way to achieve the goal of enhancing equity among countries in the Climate Convention, as well as to reduce the internal inequality of GHG emissions among the population of different income classes in developing countries.

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7

CLIMATE CHANGE MITIGATION AND EQUITY

Raúl A. Estrada-Oyuela

1. Introduction

The purpose of this paper is to refresh some ideas on equality, equity and credibility, to remember proposals with different equity approaches and to discuss the climate change mitigation burden and the developing countries' impossibility to implement quantified emission limitation and reduction objectives (QELROS) in equitable ways. The final part of this paper is a suggestion for a distinct method to organise the international mitigation effort.

2. Equality and Equity.

We should be talking and discussing about equality, but we talk and discuss about equity because we have agreed not to work on the basis of equality. It is quite obvious but sometimes we seem to forget it.

We know that all human beings are born equal, with the same rights and duties. However we clearly realise that in these global environmental matters neither human beings nor nations are equal and consequently we talk about equity instead of talking about equality.

It was different before; at least it was different in the words we used. Principle 1 of the Declaration on the Human Environment adopted at Stockholm in 1972, proclaims the equality of the human beings, but principle 3 of the Rio Declaration on Environment and Development, says that "the right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations", and even that concept of equitable right to development was matter of a reservation.

Equity has different meanings in different contexts, equality has one single meaning. In the legal process, equity is a system of jurisprudence serving to remedy inflexibilities of the law. In the field of the global commons like the atmosphere, the law is equality for every human being, but we use equity to moderate equality, to avoid equality, because equality is not acceptable for those who have been using a larger part of the atmosphere.

I'm not suggesting we should change the semantics we are using to understand each other. There are thousands of papers already developed using the concept of equity. What I want to point out is that when preparing de Third Assessment Report, IPCC writers must be aware that we use the concept of equity because in the present context it is not possible to build a system on the basis of equality. Vested interests are strong enough and difficult to accommodate if we work towards equity, but they will block any progress if the target is equality.

We shall use the available tools to negotiate, but it doesn't mean that we should forget that human beings are born equal. To reach and consolidate equality may be utopia, but utopia is needed to advance political ideals.

3. Equity as a Condition for Credibility

The document produced by M. Munasinghe points out that in the First and Second Assessment, equity was not an element adequately taken into account, and emphasises that equity, together with development and sustainability shall be present in TAR, particularly in WG II and III chapters. Mr. Munasinghe is clearly correct. Coming from the policy-making field, it takes some effort to understand the need of pointing out to scientific and economic authors that they must include equity in their analysis and conclusions.

Adequate inclusion of equity criteria in TAR is a condition "*sine qua non*" for its credibility. If TAR does not embody intragenerational equity, meaning it lacks equity for present times situations, the IPCC's aim will not be reached. Willing a credible assessment, it is imperative to incorporate equity criteria. Peoples who feel their situations and needs are not covered in the report, will not accept the report as reliable. Without due consideration of equity issues, TAR will lack the necessary condition to be recognised as valid assessment by developing countries.

4. Contraction and Convergence

Long before the end of the Framework Convention negotiation, the Global Commons Institute (GCI) has presented a proposal on contraction and convergence, aimed to reach equality in emissions per capita[1].

We all in this room know the GCI model where **contraction** is achieved after all governments, for precautionary reasons, collectively agree to be bound by a target of global GHG emissions, making it possible to calculate the diminishing amount of greenhouse gases that the world can release each year in the coming century, subject to annual scientific and political review. The **convergence** part of the proposal means that each year's

[1] See http://www.gci.org.uk

global emissions budget gets shared out among the nations of the world so that every country converges on the same allocation per inhabitant by an agreed date[2]. Countries unable to manage within their shares would, be able to buy the unused parts of the allocations of other countries. The entitlement of rights transferred in this trading is legitimised by the per inhabitant criteria.

Level of contraction and timing of convergence should be negotiated on the basis of the precautionary principle. Suggestions for emission reductions are well known and convergence should be achieved at medium term to satisfy legitimacy.

I have read that the Chairman of IPCC's WG I, Sir John Houghton, has said that this is the "logical approach". Analysis of Contraction and Convergence in TAR is a must if equity is going to be taken into account in the report.

5. The Burden of Emission Reduction

Now let us discuss which are the main difficulties to incorporate equity considerations in the IPCC assessment. Mr. Munasinghe's document, in its Annex III, throws aside reducing emissions in all countries, industrialised and developing countries, because it has been recognised that developing countries need to increase their emissions. But, taken into account the high cost for industrialised countries, the same Annex III also gives up the possibility of equalising emissions per capita among all nations in the shorter run. In fact that is why many industrialised countries oppose the Kyoto Protocol's entry into force. The main question then is how the burden of emission reduction compares with other internationally imposed burdens?

Coming from a developing country with a heavy external debt, I'm naturally inclined to compare the emission reduction burden with the burden of the external debt services. In fact they are not fully comparable. Payments of external debt services are transferred from countries in debt to creditor countries, but investments to reduce emissions remain where they are done and became assets. Payment of public debt is done from the public budgets of developing countries where monies are needed for public education and health, housing and social security, but industrialised countries investments to reduce emissions will come mostly from the private sector and will be apply to research, technology development and new equipment.

Even taking into account those differences, it is worth to compare both burdens and, as usual, the USA is the best example, not only because of the relevance of its emissions but also because of the wide availability of information. According to the US Department of Energy *(EIA 1998)*, to satisfy commitments under Kyoto Protocol's Annex B, that country

[2] Strictly, 80 countries are the source of 98% of global CO_2 emissions

should reduce 552 million tons each year during the commitment period. Possible reduction costs in different scenarios has been presented below.

Scenario	Cost per C ton	Yearly burden for USA Economy[3]	GDP Percentage
Umbrella Group + Eastern Europe + Key Developing Countries	$ 14	$ 7 x 10^9	0.07 %
Annex I + Key Developing Countries	$ 23	$ 12 x 10^9	0.11 %

Cost estimates of a possible fully domestic emission reduction of US's GHG according to Annex B, are well known and $ 185 per C/ton is a figure in the pessimist range. Applying the same parameters to a scenario of fully domestic reduction, it would be

Scenario	Cost per C ton	Yearly burden for USA Economy	GDP Percentage
100% domestic	$ 185	$ 96 x 10^9	0.94 %

At the same time, according World Bank statistics external debt services impact on developing countries GDP, in 1997 values, was

Argentina	6.3 %
Brazil	4.7 %
China	2.1 %
India	2.9 %
Indonesia	9.5 %
Malaysia	7.6 %
Mexico	10.9 %

It seems that analysing the external debt burden on developing countries GDP, additional approaches to equity may be found.

6. Are QELROS the Equitable Option for Mitigation?

A key to understand the difficulties in taking equity elements to TAR may be the modality adopted for mitigation commitments. From the beginning and on solid ground, the scientific community has indicated that in order to stabilise GHG concentrations in the atmosphere, GHG emissions must be reduced in certain percentages, being the percentage and the time frame of the reduction variables depending on political options. In the main

[3] The costs for the US would be lowest if trading would be limited to the "Umbrella Group", Eastern Europe and key developing countries, and somewhat higher if Western Europe would be involved in the trading too, competing for the Russia and Ukrainian "hot air".

context of the UNFCCC, percentage and time frame depend on the still pending quantified definition of Art.2.

Translation of that approach to legal binding terms in the Kyoto Protocol is shown as targets or QELROS established in Annex B for industrialised countries. UNFCCC asks for returning to 1990 emission levels and the Protocol mandates different percentages of limitation or reduction for the commitment period, taking 1990 as the base year. From the beginning it was evident that the rigidity of a base year for all Parties required some flexibility and thus the UNFCCC provides flexibility for industrialised countries in transition to market economy. That is also present at the Protocol, whose Annex B adds implicit acknowledgement of base year impact in the amounts assigned to some industrialised countries.

The fact is that we are facing a situation where it is very difficult to bring equity into play while acting with limitation or reduction targets as percentages of 1990 emission levels. May anybody state that assigned amounts of Annex B are equitable? Assigned amounts are the result of negotiation, in some cases they take data and other information into account and in other cases (as for Russia and Ukraine) they were simple imposed with negotiators' consent, possibly with the purpose of obtaining future advantages[4].

It is well known that in order to stabilise GHG concentrations in the atmosphere, industrialised countries will have to fulfil their mitigation commitments but, in addition, developing countries which are relevant because the volume of their emissions or the high level of emissions per capita, shall adopt and implement certain mitigation measures. In fact all Parties, industrialised countries and developing countries, are committed by Art.2.1.b) to adopt mitigation policies, however the extent to which developing country Parties will effectively implement that commitment will depend by effective implementation by industrialised countries of their commitments related to the financial mechanism and the transfer of technology.

But, is it possible to imagine an equitable participation of any developing country in the mitigation effort since its right to increase current emissions of GHG is peacefully recognised? I do not believe the answer could be found in the context of targets of emission limitation or reduction percentages. I do not think the solution is in the QELROS framework. That is why the equity question is so complicated.

Equity problems have been analysed mainly among nations because the States are the legal persons of the International Law, but some equity questions shall be analysed from the

[4] In a meeting with NGOs during the Kyoto Protocol negotiations, Aubrey Meyer asked me which differentiation criteria were being used in the process. As negotiations were very flexible, I answered that at the end of negotiations I would explain those criteria, and that allowed me to get out of the situation among the laughs of the audience. When the negotiation ended and the Protocol was adopted, Aubrey Meyer asked me again which were the criteria, and since I didn't knew the answer, I simply said that with QELROS agreed criteria were no longer relevant.

regional point of view and also from the sub-national point of view. Inside a developing country with a large population, may exist a population island equivalent to a small industrialised country population if income per capita or life styles are taken into account. It does not seem equitable to protect that population island with the same shield designed to protect "less developed countries", which is a subcategory inside developing countries group.

The principle of common but differentiated responsibility was implemented in the UNFCCC to differentiate developing countries from industrialised countries, and among industrialised countries those with economies in transition were again differentiated. The Protocol takes one step forward: quantified differentiation was implemented among industrialised countries. Even more, the "bubble" method created by Protocol Art.4 allows a group of countries to agree among themselves how to differentiate inside the group without any changes in the commitment of the "bubble" members vis a vis the other Parties. Equity also requires common but differentiated responsibility among developing countries, but it is difficult to implement through QELROS.

Mitigation efforts adopted as QELROS by industrialised countries, even with the differentiation of Annex B, do not offer a totally satisfactory answer to the equity question amongst industrialised countries. For instance, it doesn't look equitable that two countries with similar macroeconomic indicators and comparable production structures, end up with different QELROS because one belongs to a bubble and the other not.

For almost all developing countries QELROS are unacceptable[5]. Even when admitted as working hypothesis, they are not feasible as shown by the recent Argentine experience. Of course the main previous questions is that until industrialised countries as a whole do not take the leadership in mitigating climate change reducing their global emissions as promised in 1992, there is no way to start discussing the point. But even assuming that industrialised countries honour their commitment, the concept of developing countries emission limitations (not reductions, limitations) has two negative connotations for those counties: first, it smells as a limitation to growth which is unacceptable by definition, and second, it implies consolidation of current different emissions per capita levels, which is also unacceptable.

Developing countries in general do not have conditions to accurately project their economic growth in ten or fifteen years, and consequently they lack the possibility to estimate emissions on those terms. I believe that countries with economies in transition do have a similar difficulty, but they are covered by flexibility added to the Protocol. The Argentine case, which I witnessed from outside, is paradigmatic: at COP 4 the Argentine Government committed itself to announce a target the following year, but at COP 5 it was able to propose only a "dynamic target", in fact an equation dependent on future Argentine GDP which the Government was unable to estimate.

[5] Exceptions know until now are Argentina and Kazakhstan.

The interest in the Argentine announcement was big and the job done had solid domestic and international technical support. But it was not feasible to estimate with certainty economic growth for 2008/12. Lacking that needed projection a "dynamic target" was offered, "equal to the product of an index multiplied by the square root of the five year average of the GDP corresponding to the commitment period. The index is established at 151.5."

7. Efficiency Standards as Alternatives

If implementation of equity criteria on mitigation through QELROS implementation has so many difficulties, it seems convenient to start thinking on other means to limit and reduce emissions in a quantifiable way. All efforts already done on QELROS shall be kept and it is convenient to place the Kyoto Protocol to work, but other alternatives should be designed, complementary of what we have today and possible substitutive for commitment periods beyond 2012.

WRI has suggested *(Kate et al. 1999)* carbon intensity indexes, linking CO_2 emissions and GDP to take into account the global performance of a national economy. This method allows recognition of economic improvements in many developing countries, particularly in China, through implementation of economy efficiency measures. Those measures had produced reduction in GHG emissions by GDP unit, with increase in total emissions because the economic growth. This WRI proposal opens a new possibility, which is worth to explore from the equity point of view. The material has been published and consequently should not be excluded from TAR.

However, there are serious problems in utilising conventional currency values to compare substantially different economic situations. Everybody knows that GDP is a flow account, which does not represent the wealth of Nations, to use Adam Smith's title. Irrational exploitation of a natural resource will increase the GDP giving to the naïve the illusion of wealth when the assets decrease, the same way that reconstruction works after a natural disaster enlarge GDP.

Market prices distortions over real values, is the root of frequent statements about lower emission reduction costs in developing countries. Costs may be lower in fact in substitution of obsolete technologies, but they are not really lower if estimates are based on the use of natural resources at values bellow the values of the same resources in industrialised countries, in spite that production potential of the resource is identical in both cases. Realistic correlation only might be done on indicators of production potential weighted in volumes, not on domestic purchasing potential. The use of adjustment indexes like PPP may help to compare flows, but neither clarify external purchasing power nor solve the basic problem of correlating flows when wealth matter.

If a global standard by country based on GDP were not the solution, a reasonable alternative may be the adoption of a series of efficiency standards by gas for selected key sectors. In this way, it is possible to talk on certain volume of CO_2 emissions per steel or cement ton, or per Mw of thermally generated electricity, or per freight ton moved by ship or truck or airplane, or certain volume of methane emissions per thousand heads of cattle, or certain volume of HFC or PFCs or SF_6 per million of BTU in air conditioning, etc.

It may be suggested that Parties to the UNFCCC may formally commit themselves to standards of GHG efficiency to be achieved in a time frame. Taking into account the production volume of each sector an its projection, emission reductions may be estimated. If sectors for emission efficiency were rightly selected, the emissions reduction impact would be relevant from the point of view of GHG concentration at the atmosphere. At the same time, efficiency added in the selected sectors, will permeate other sectors of the economy, as it is usually the case in technology progress.

This multiple sector GHG efficiency standards mechanism has the benefit of not suggesting any limit to economic growth and should not be objections from the equity point of view. At the same time, it is not related to the "emissions per capita" element. These two issues were pointed out supra as the basic reasons for developing countries to reject QELROS implementation. Of course matters related to the financial mechanism and transfer of technology maintain their strong relevance, perhaps their relevance will be even stronger than in the QELROS scheme.

The mechanism naturally recognises the specific needs of each country, being equitable at the same time for industrialised and developing countries. For instance transport is a relevant source of emissions in geographically extended countries, requiring standards of efficiency in transport will make equity implementation easier than a simple target on emissions.

Adoption of emission standards has always been around in climate change negotiations and the fix as policies and measures according with UNFCCC Art.4.1. With the avalanche of proposals produced at the beginning of the Kyoto Protocol negotiations, efficiency standards were present. In the context of other international regulations, it seems that this suggestion may be middle of the way from ISO 14000 and PPM criteria discussed at the WTO's Trade and Environment Committee.

Subject to the acceptance of these ideas or a better elaborated one that somebody else could produce, it will be possible to think about another Protocol to the UNFCCC open to bind all Parties to the Convention because efficiency helps to achieve the objective of the Convention and its also compatible with Kyoto Protocol's Art.2 and 10. At the same time it will not impose non-equitable QELROS on developing countries, but it will be in line with common action for quantifiable results. Of course QELROS will offer results of simpler quantification, but in mid term the reduction trends are similar.

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8

CLIMATE CHANGE AND EQUITY IN LATIN AMERICA METHODOLOGICAL AND PRACTICAL ISSUES RELATED TO THE FORESTRY SECTOR

Omar R. Masera

1. Introduction: Integrating Climate Change into Sustainable Development Concerns

The United Nations Climate Convention of 1992 *(UN 1992)* and the more recent Kyoto Protocol on Climate Change *(UN 1997)* state that the different actions and policies directed to mitigate and/or reduce the impacts of a potential change in the earth's climate should be framed within the context of sustainable development.

Critical for the effective participation of non Annex I countries in the reduction of future GHG emissions growth, specifically for Latin American countries, is to identify mitigation options and future emission reduction paths that simultaneously contribute to advance the countries own sustainable development priorities.

One key element in this strategy is to develop alternative decision-making frameworks that fully integrate sustainability concerns. Specifically, we need to assess mitigation/adaptation options contributions to increase the systems generic "sustainability" attributes: productivity (efficiency), stability, reliability, resilience, adaptability, equity and self-reliance (Figure 1). Subsequently, key (strategic) indicators for each of the attributes and options could be derived and integrated in a multicriteria decision-making framework that allows a more adequate evaluation of the different options *(Masera et al. 1999).*

Another key aspect for effectively incorporating sustainable development concerns into climate change response strategies is to examine mitigation options that include both the energy and forest sector and to develop integrated scenarios, that allow a full examination of the different countries' alternative emissions paths.

In this paper, we briefly review the current situation of Latin American GHG emissions, assess the importance of incorporating forestry options in climate change mitigation strategies in the region and finish with a case study from Mexico where we illustrate how to design emission scenarios where climate change are a by-product of the country's own sustainable development strategies.

2. Latin America Global Climate Change and Equity: Importance of the Forest Sector

Latin America contributes approximately 4% of total CO_2 emissions worldwide, and also has low per capita emissions with respect to Annex I Countries (Figure 2). Historically, the region has a small contribution. Unlike other regions, there are very large emissions from deforestation, which is currently the largest worldwide (Figure 3). The region is also highly vulnerable to climate change impacts. There are also large disparities within Latin American countries in terms of total and per capita CO_2 emissions as well as from the relative share between emissions from energy vs. forestry (Figure 4).

Concerns about equity and, more generally, sustainability, makes the effective integration of forest options within the region's overall carbon mitigation scenarios and strategies a priority. Specifically, forest options should be incorporated into the overall mitigation strategies because:

- Given its large area, the forest sector in Latin America has the capacity to store very large amounts of carbon in vegetation and soils. However, currently it is also a large source of emissions due to deforestation and forest degradation, with the region's accounting for about half of total deforestation worldwide (approximately 7.4 million ha/yr).
- A large share of Latin American forests are highly diverse, some of them show the highest biodiversity on earth.
- Rural inhabitants are among the poorest in the region which shows a need to increase local income and employment opportunities.
- Social ownership of forest resources is important in some countries (in Mexico for example, 80% of forests are socially owned by rural communities).
- Adequately designed and implemented mitigation options in the forest sector present important environmental and socio-economic benefits, such as income and job opportunities, conservation of biodiversity and watersheds, and others.
- Fiscal and financial incentives still favour the conversion of forests to other land uses in many countries. Under these circumstances, carbon benefits could increase the competitiveness of forest options helping reduce the pressure for deforestation.
- The cost of forest mitigation options is competitive with those from the energy sector (see next section).
- Energy emissions need to grow because of development issues, however most deforestation may be avoided (population growth is not the main factor pushing deforestation in the region). In fact, the mitigation potential is large compared to energy and may help bridge the gap to alternative energy sources in the short/medium term (see next section).

To maximise the potential sustainable development benefits of forestry projects it is important to: [1]

[1] See also *Brown et al. 2000* for a more detailed discussion on sustainable development concerns related to carbon mitigation projects in the forest sector.

- Promote a balanced approach, that includes the whole range of forestry options available to the countries – from carbon sequestration projects such as agroforestry systems, restoration plantations, industrial plantation and bioenergy plantations, to carbon conservation projects such as forest management and protection.
- Increase and strengthen local capacity building in project formulation, implementation, and monitoring.
- Encourage technology adaptation, building on indigenous knowledge when appropriate.
- Assure and encourage the effective participation of local communities at all stages (e.g., SCOLEL TE Project, Mexico)

3. Climate Change Mitigation as a By-product of Sustainable Development Concerns: The Case of Mexico[2]

3.1. CURRENT SITUATION

As an oil exporting country, Mexico depends heavily on fossil fuels for satisfying its energy needs. About 96% of primary energy comes from these energy sources. CO_2 emissions related to energy use have grown from 297 $TgCO_2$ in 1990 to 331 in 1994 *(Sheinbaum and Rodríguez 1997)*. Deforestation and forest degradation have also been severe in the country, with an estimated loss of 670,000 ha per year *(Masera et al. 1997).* Approximately 136 $TgCO_2$ are emitted each year as a result of land use changes (185 $TgCO_2$ without accounting for forest regrowth in abandoned lands). Total carbon emissions reached 434 $TgCO_2$/yr (118 TgC/yr) in 1990, 27% of which came from land use changes *(Gobierno de México 1997).*

3.2. BUILDING FUTURE CARBON EMISSION AND SEQUESTRATION SCENARIOS

Current pre-programmed packages for carbon mitigation present some disadvantages: a) Little control on the actual computational procedure, b) The users depend on the packages programmers for any modification, c) The form in which the data has to be entered may not coincide with that in which information is available, so that a certain amount of exogenous data-processing has to be completed before the package can be used, and d) Most packages impose major constraints in the planning process *(Reddy 1995).*

For these reasons, the first step in the analysis was developing and adapting existing tools to our country's own needs. Specifically we decided to make an integrated analysis of energy and forestry options, and developed a simulation bottom-up accounting model for Mexico that allowed us to:

[2] The discussion of this section is based on the paper by *Sheinbaum and Masera (2000).* Refer to this article for a more complete discussion on the model, scenarios, and results.

a. Identify the country's sustainable development priorities

Through the "end use analysis of energy needs" and a demand-based analysis of forest products we identified the following activities that address national development priorities while simultaneously helping to reduce the current rate of GHG emissions growth: *a) within the energy sector* – increases in energy efficiency in the industrial, transportation, commercial, and residential sectors, switching to less carbon intensive fuels, and the establishment of standards for new equipment, and *b) within the forest sector* – the adequate conservation and management of native forests, afforestation of degraded and deforested lands, and promoting agroforestry systems.

b. Build reference (business as usual) and mitigation scenarios

We considered two different scenarios for the year 2010: a baseline scenario and a mitigation scenario. The reference or baseline scenario, assumes, in the energy sector, frozen intensities at the 1994 level; in the forestry sector, constant deforestation rates (as percentage of remaining forest area). The economic and population growth that determines the demand for energy and forestry products, is based on official projections. The mitigation scenario considers specific rates of penetration of mitigation technologies by sector. Only a limited set of options was analysed, thus the results presented should not be viewed as the total or maximum potential carbon mitigation for Mexico. This is particularly true for the energy sector, where data availability restrictions did not allow us to conduct an in-depth analysis of the transport sector.

c. Transform sustainable development priorities into GHG mitigation

The final step is to show the implications of the scenarios in terms of GHG emissions/sequestration. For this purpose we used appropriate emission factors to transform the identified needs and trends in each scenario – for example number of compact fluorescent bulbs to be installed, amount of area to be restored through reforestation, etc. into GHG emission/sequestration coefficients. Most of these emission factors have also been determined at the country level.

RESULTS

3.3. BASELINE SCENARIO

Total emissions will reach 879 Tg/yr of CO_2 by 2010. Energy emissions are expected to grow 149% in the 15 year time period (Figure 5). A net loss of 10.4 million ha (20% of the existing forest area) of forests is expected in the baseline scenario. Because the net deforestation rate is considered to be proportional to the remaining forested area, the annual area deforested declines in the future; as a result, annual carbon emissions from forestry would decline 33% between 1995 and 2010.

3.4. MITIGATION SCENARIO

We integrated energy and forestry options. The mitigation options related to energy use are: combined cycle plants, industrial efficient electric motors, industrial efficient boilers, industrial cogeneration, commercial and residential efficient lighting, efficient potable water pumping, passenger transportation in the Mexico City Metropolitan Area (MCMA) – inter-modal substitution – , and wind power generation. Three forestry mitigation options were analysed in detail: management of native forests, afforestation for forest restoration, and agroforestry systems. Table 1 presents the avoided CO_2 emissions for different energy and forestry options for the year 2010. The total mitigation potential for the options examined reaches 45 Tg of CO_2 in the energy sector and 262 Tg of CO_2 in the forest sector by 2010.

3.5. MITIGATION COSTS

Unit annual costs range from $ -45.9/ton CO_2 for residential lighting to $106.4 for industrial motors. The average costs for forestry options range from $ -3.5/ton CO_2 to $5.4/ton CO_2, depending on the option (Figure 6). The mitigation options that resulted in higher costs than the baseline scenario are forest management in the tropical areas, restoration plantations, agroforestry systems, metro and light train in the MCMA, and efficient industrial motors. It should be noted that even cost-effective options, such as efficient lighting or, very specifically, the sustainable management of native temperate forests, usually require substantially higher investment costs than conventional technologies. Also, specifically in the case of forestry options, costs are extremely site dependent, thus the average values presented here might be much higher or lower for specific projects.

3.6. DISCUSSION

We identified a mitigation potential of 393.3 Tg of CO_2 for Mexico by the year 2010. If this potential were realised, Mexico would reduce its total emissions by 7% from 1990 to 2010 instead of increasing them by 69% (baseline scenario). Per capita emissions would drop by 30% in the same period of time (from 6.2 to 4.3 ton of CO_2/cap), instead of increase them by 26%.

Thus, by properly implementing a series of promising mitigation options in the energy and forest sector, Mexico has the opportunity to significantly advance national development priorities for the period 1995-2010, while keeping its per capita carbon emissions at a low level and having a very modest increase in total emissions. Therefore, in principle, there should be no contradiction between the local and global interests.

Forestry options, particularly through the sustainable management of native forests as an alternative to deforestation, show the largest carbon mitigation potential in the short term. It should be noted, however, that forestry options are ultimately limited by available area, and

unless effective actions are taken in the energy sector, emissions will eventually continue growing at a rapid pace (see Figure 5). While resulting in less carbon emission reductions in the short term, given Mexico's strong dependence on relatively cheap oil resources, several energy options (like compact fluorescent lights) are extremely cost effective. In this case, a consistent and strategic effort is needed that begins at the present time to assure that efficient technologies and renewable resources make a substantial penetration beyond 2010. On the other hand, the large amount of carbon that could be potentially captured by forestry options, brings Mexico the opportunity to gain time for the development of a renewable energy path. Forestry and energy projects specifically aimed at carbon mitigation are already operating successfully *(SCOLEL TE 1997; Montoya et al. 1995; and De Buen et al. 1994)* or are only waiting for the final approval of financial resources *(UZACHI-IXETO 1997).*

4. Conclusions: Equity and Sustainable Development Considerations in Latin America Related to Climate Change

The effective incorporation of equity, and more generally, sustainable development concerns into climate change mitigation in Latin America is a priority. Several actions are needed for this purpose.

First, as stated by *Munasinghe (1999)* it is important to develop new evaluation/decision making frameworks, where the different mitigation options are not only addressed in terms of their potential carbon benefits, but also include concerns regarding the options contribution to economic efficiency, environmental resilience and stability, equity, adaptability, and self-reliance.

Second, as shown in this paper, we need to develop locally-adapted tools and methods that allow an integrated assessment of future mitigation scenarios in terms of the countries' own defined sustainable development needs. It is critical for the region that the analysis integrates both forestry and energy options, as for many countries, the former present substantial potential in the short term. Adequately implemented, forestry options may render large benefits in terms of local employment and income opportunities, conservation of biodiversity and other benefits. Integrating forestry and energy mitigation options may pave the way for capturing financial resources in the short and medium term – for example through the Clean Development Mechanism – that can help in the needed transformation to a non-fossil fuel energy economy in the long term.

Figure 1

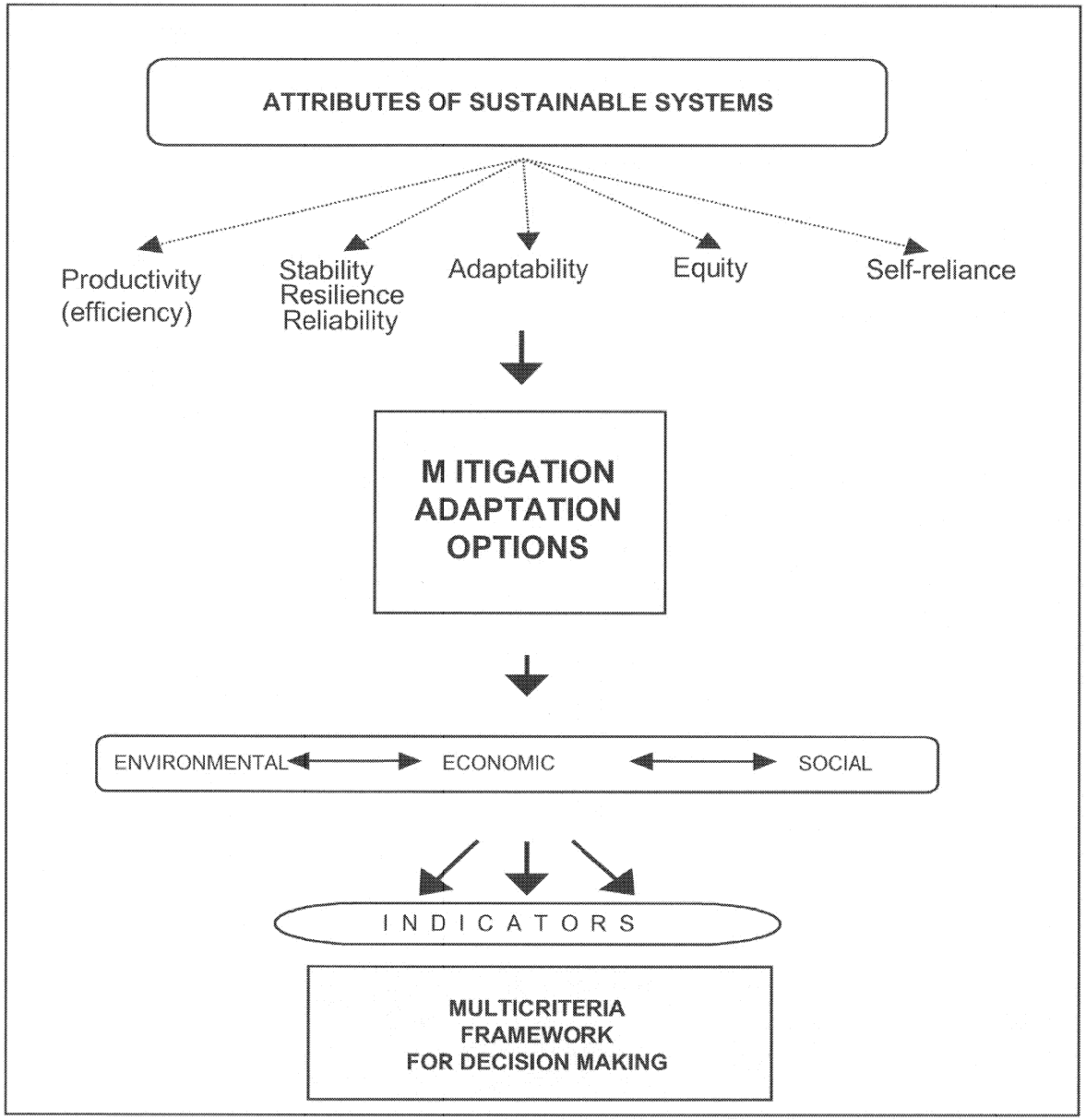

ATTRIBUTES OF SUSTAINABLE SYSTEMS
Productivity (efficiency)
Stability Resilience Reliability
Adaptability
Equity
Self-reliance
M ITIGATION ADAPTATION OPTIONS
ENVIRONMENTAL
ECONOMIC
SOCIAL
INDICATORS
MULTICRITERIA FRAMEWORK FOR DECISION MAKING

Figure 2
CO_2 Emissions by Region (1996)

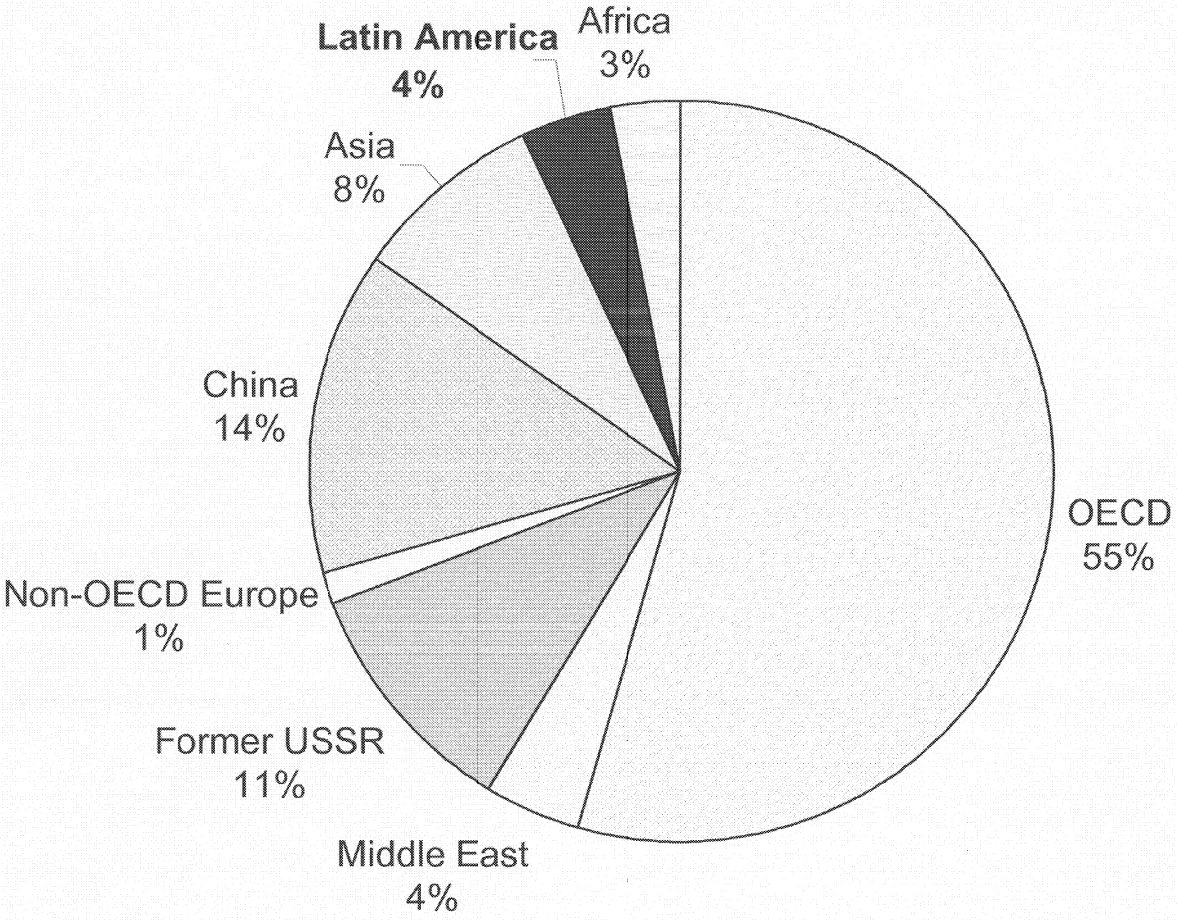


Figure 3
Land Use Change by Region

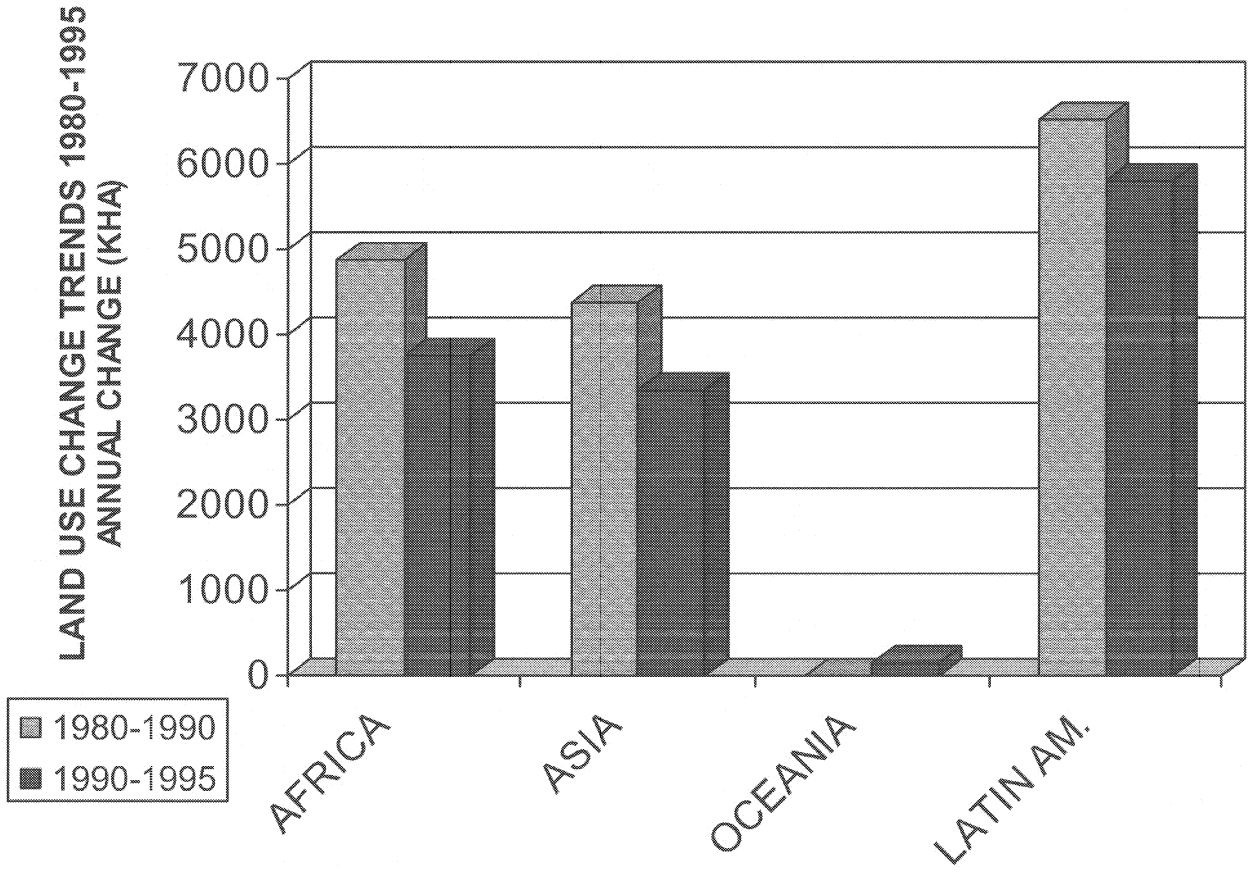


Figure 4

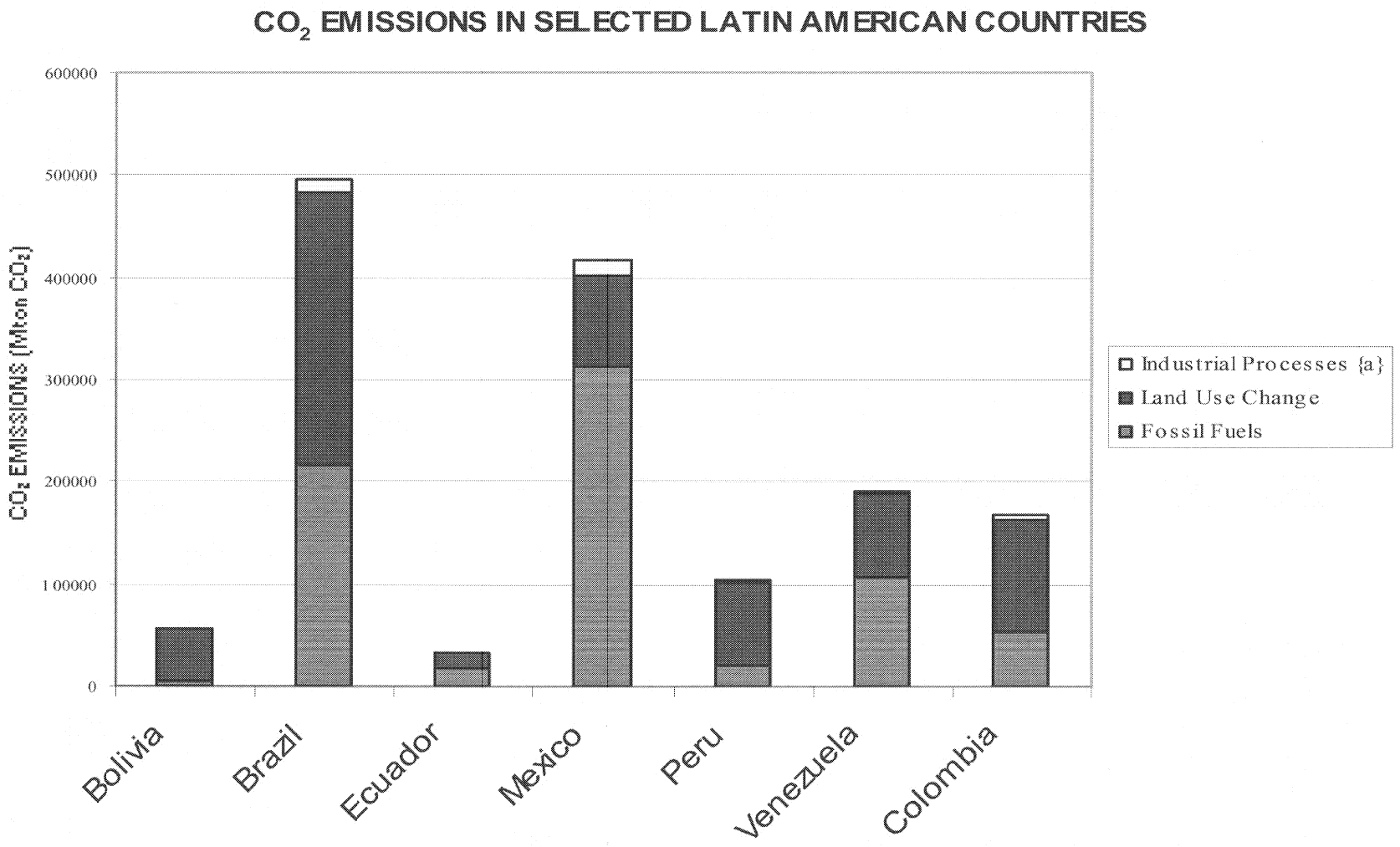
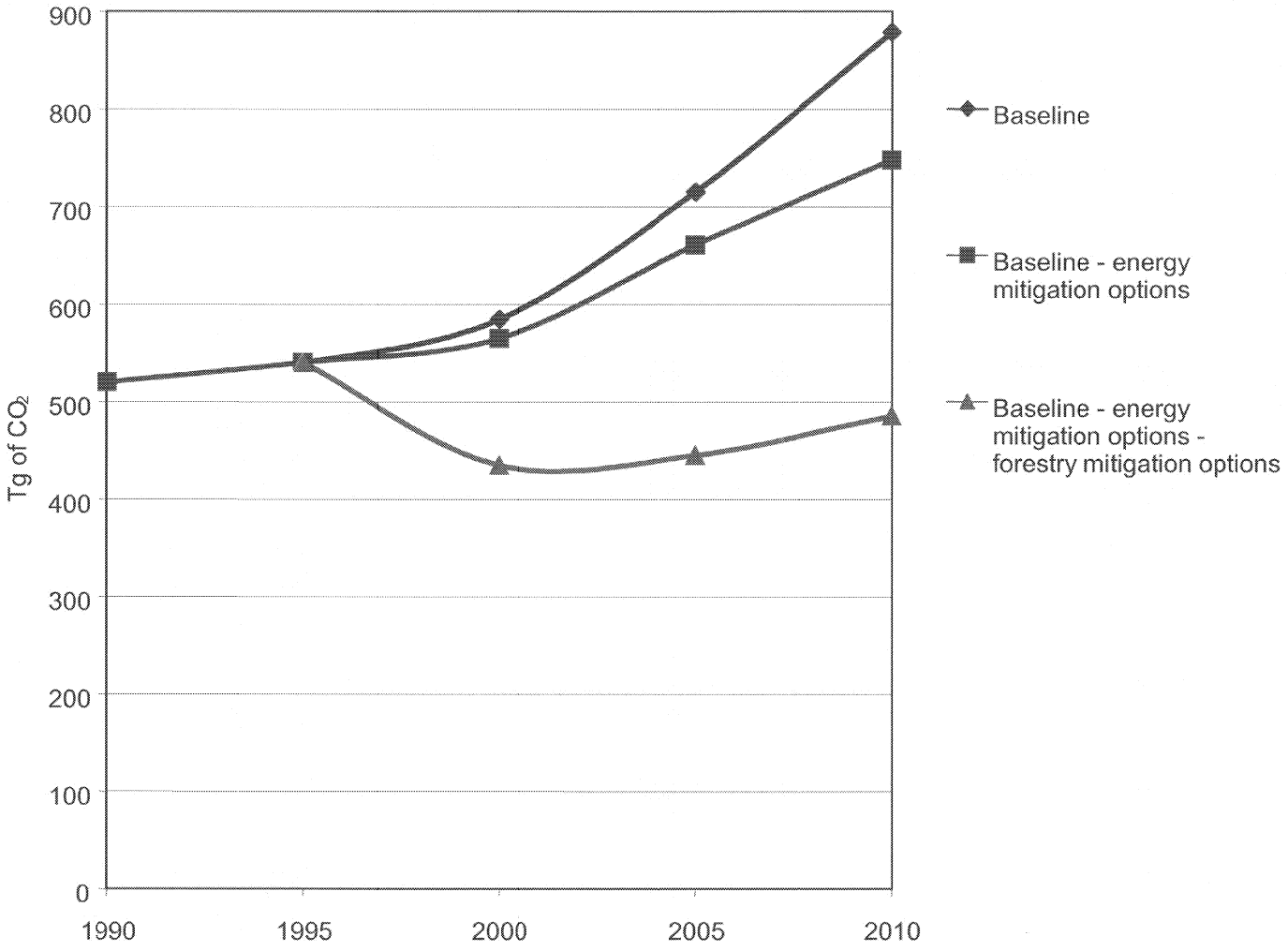
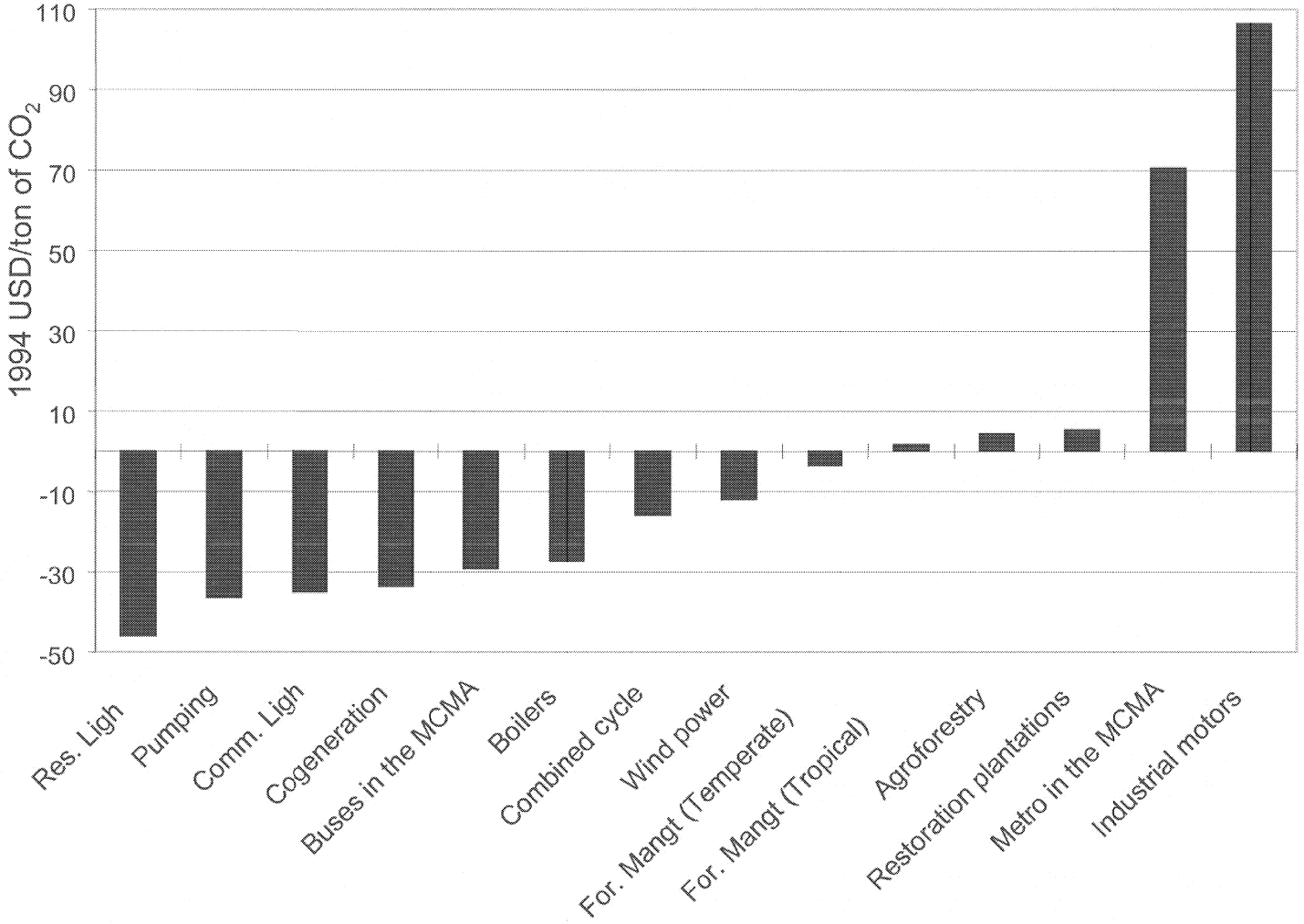

CO_2 EMISSIONS IN SELECTED LATIN AMERICAN COUNTRIES
CO_2 EMISSIONS (Mton CO_2)
600000
500000
400000
300000
200000
100000
0
Bolivia
Brazil
Ecuador
Mexico
Peru
Venezuela
Colombia
Industrial Processes {a}
Land Use Change
Fossil Fuels

Figure 5
Future CO_2 Emissions in Mexico: Reference and Mitigation Scenarios



Source: *Sheinbaum and Masera (2000)*

Figure 6. Mitigation costs for different mitigation alternatives in Mexico



Source: Adapted from *Sheinbaum and Masera (2000)*

Table 1
Avoided emissions of CO_2 in the mitigation scenario (Tg of CO_2)

Mitigation option	2000	2005	2010
Combined cycle plants	13.9	21.2	70.0
Residential lighting	0.7	1.6	2.5
Commercial lighting	0.5	0.8	1.2
Water pumping	1	1.1	1.2
Industrial motors	0.2	0.6	0.9
Industrial boilers	1	1.8	2.7
Buses in the MCMA	1.2	1.1	1.0
Industrial cogeneration	0.4	17.9	35.4
Wind power	1	6.6	12.2
Metro in the MCMA	0	2.0	4.0
Total energy	**19.9**	**54.7**	**131.2**
Forest Management (Temperate)	97	162	190.8
Forest Management (Tropical)	10.9	18.7	34.8
Restoration Plantations	16.4	29.7	31.4
Agroforestry	5.4	5.2	5.1
Total Forestry	**129.7**	**215.6**	**262.1**
Total	**149.6**	**270.3**	**393.3**

Source: *Sheinbaum and Masera (2000)*

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9

ENERGY MARKETS, OIL COMPANIES AND CLIMATE CHANGE ISSUES

Angel de la Vega

1. Introduction

The effects of global climate change affect every country, but not all are responsible in the same way of its causes. The response, nonetheless, should be global, involving as many countries as possible, but taking into account their development degrees and their priorities and needs. Recognising that no individual nation can effectively address a problem of this scope, governments within the UNFCCC have decided to address this challenge collectively, fostering collective initiatives to control the enhanced greenhouse effect, particularly emissions of CO_2 from fossil fuel combustion.

Indeed, the problem is very different for the less favoured countries with enormous needs as compared to those who have reached high development levels. The latter have recently undergone important changes in economic structure, technology and energy efficiency that make them relatively cleaner countries. However, because of historic reasons they have contributed to the current environmental problems; so they bear specific responsibilities. It is not possible to adopt one common standard.

In countries like Mexico, for which international commitments have not been set, the need to take on international commitments, not yet included in the UNFCCC, is discussed. International political pressure for such commitments will surely occur considering Mexico's growing involvement in the productive and financial globalisation. In the American continent the most rapid growth in carbon emissions between 1970 and 1997 was in Mexico (235%) followed by Brazil (220%) and Argentina (147%) *(DOE 1999b).*

On what basis can co-operation against global warming be implemented? Which role can international or local actors play, taking into consideration their influence on the global environment? How can international institutions influence individual choices in order to make international co-operation less problematic? How to make an objective differentiation and different countries' efforts compatible with the search for equity considering relative development degrees and historic responsibilities? Those are some of the questions frequently posed in the scientific literature and in international meetings.

True, global environment protection has been institutionalised step by step through the establishment of an international regime[1], which began to take form since the awareness of the impact of global warming and climate change over natural systems and the humanity increased. The Rio de Janeiro conference in 1992 and the Kyoto protocol have been important steps towards that institutionalisation, but the path ahead is still long and the enforcement difficulties abundant.

Last years' events show that barriers exist to fully integrate the DES (Development, Equity, and Sustainability) and climate change issues into the sustainable development agenda, but they show opportunities as well. Sorting out opportunities from challenges is indispensable for the advancement of dialogue, negotiations and international co-operation. One of the fields where there is no consensus is in the emphasis that environmental policies must have: command and control measures or more flexible instruments, which give more options and responsibilities to economic agents. There is a recent shift, indeed, towards giving a more important place to market instruments and agent decisions in order to reach environmental objectives and implement climate change policies. This is the case of the Kyoto Protocol's international trading system, which has been proposed as a key element of flexibility, but raises many doubts and criticism, including its relation with equity issues. The purpose of this paper is to put this shift to market-oriented policies and the role of some important agents as the international oil companies in a broader perspective.

It is important to develop a deeper inquiry in this direction, not only for theoretical or analytical reasons. In the international scene the debate on regulatory and control measures as opposed to market-oriented instruments is also a matter of confrontation and possible conflicts. Europeans, for example, are afraid that some countries as the USA give priority to international emissions trading leaving aside efforts to lower emissions in its own territory. They prefer, generally speaking, national restricting measures, as taxes or norms, in order to influence individual behaviour and firms systems of production. It is true that the Kyoto Protocol itself states that "the acquisition of emission reduction units is a complement of measures taken at the national level", but the USA does not accept this way of thinking and insists that markets are the main instrument the international community has to put it in place immediately, inspired by its successful sulphur emissions trading practice.

One point that does not seem to be fully understood is that the organisation of an international market needs the intervention of states and multiple actors and complementary measures at different levels. Markets are not a pure economic construction, but predominantly a social and institutional construction. Besides, even if an international emissions market is put in place in the first decade of the 21st century, it will face many problems because it is likely to apply only in industrial and energy sectors, while transportation is the source of emissions that grows more rapidly. Flexibility mechanisms

[1] A recent definition of international regimes has been proposed by *Young et al (1995):* Social institutions formed by a group of principles, norms, rules, procedures and programs which govern interactions between agents in a specific field of international relations.

will need complementary efforts to face this important problem, perhaps of a regulatory nature: however, what would be the reaction of the main international actors in this field such as the international oil companies to increased regulatory measures?

2. Towards a framework to take into account different agents and present realities of the global economy.

Presently there is no explicit structure of "international governance", but different trends indicate the world is heading toward the establishment of an international order conformed mostly by powerful countries and by the main agents in the economy.

Nations exist with their different institutions, power and interests, as shown in the case of the opposition of the American Senate to the ratification of the Kyoto Protocol, and also in the positions of other countries such as the members of OPEC or economies in transition. Certain developed countries advance arguments about their particular situation, such as France insisting on the fact that its energy base is mostly "clean as far as the greenhouse effect is concerned", and that during the 80s the country has lowered its emissions by 26.5% (but it does not indicate with the same insistence the place nuclear energy takes in its energy production, and the associated environmental and safety problems). Also developing countries (although their positions vary according to their current level of emissions, their dependency on carbon fuels, the energy contents of their exports, etc.) oppose to limitation or reduction agreements, pointing at their huge needs for development and the historic responsibility of industrialised countries regarding the emissions produced by their development and industrialisation and their effects on the environment and the climate.

The USA case is a very interesting one, "a nation whose economic strength relies on fossil fuels". Will the "business-as-usual environment" continue in the coming decades?. That is an environment where "there are no major policy shifts, no new energy-related legislation and no crisis to significantly alter the status quo", as the USA Fossil Energy Strategic Plan puts it *(DOE 1999a: p. 2-3)*. If we look at past trends, prospects for this country are not encouraging: energy consumption per capita was approximately the same in 1998 as in 1970, that is before the oil shocks. In this same period, North America's (USA, Canada and Mexico) carbon emissions increased nearly 40%, the USA alone being at the present time responsible for about 85% of the emissions of this zone[2]. The USA, which accounts for nearly 90% of North American GDP, produced more carbon emissions than all other countries of the American continent combined, with only 4% of the world's population.

The reference case in the Energy Information Administration (EIA) 1998 Annual Energy Outlook presents a scenario where energy prices in the year 2020 are largely unchanged; it does not assume any incentives to reduce carbon emissions and reflects an optimistic view

[2] See EIA, "Energy in the Americas", http://www.eia.doe.gov/emeu/cabs/theamericas.html.

of the USA's natural gas and world oil supplies. It is not surprising to find that, in this scenario, the fossil fuels share of the US market increases from 85% in 1995 to 90% in 2020. With total energy consumption increasing by over 30% during this period, energy-related CO_2 emissions increase nearly 39%. Obviously, compliance with environmental regulation will become more difficult if energy prices remain moderate and fossil fuel demand increases as anticipated in these projections.

2.1. THE INTERNATIONAL POLITICAL ECONOMY (IPE) AND THE BUILDING OF AN INTERNATIONAL FRAMEWORK

Regarding scenarios as the one described above and recent initiatives and proposals, usually one tends to give priority to the responsibility of governments to address the associated problems. However, if governments agree on objectives, those are often to be implemented by private agents. Although the Kyoto Protocol makes government accountable for national emission levels, cutbacks will have to be achieved by industries and other mostly private actors.

As a consequence it is important to define a framework to take into account new realities, agents and phenomena belonging to the current global economy. Tentatively we'll make use of the "International Political Economy" approach, one of whose major exponents was Susan Strange (1923-1998). This author did not specifically address the energy matters, since the four basic structures of the world system or global political economy she proposes -which conform the sources of structural power- are: control over security, control over production, control over credit and control over knowledge, beliefs and ideas[3].

For her, topics such as commerce or energy are secondary structures, which are determined by the four basic structures of security, production, financial backing and knowledge. It is possible, however to inspire oneself by her work to conduct a specific analysis of the energetic or environmental matters[4].

Since the beginning of that school of thought in the 60s, the growing importance of non-state agents received particular interest and, as a consequence of it, the changes on what national states could control, both in and outside their boundaries. Precisely one of the hypothesis which Susan Strange began to work on very early in her works is that "the territorial boundaries of states no longer coincide with the extents of the limits of political authority over economy and society", as she reminded in one of her latest books *(Strange 1996: p. ix).*

The analysis of international relations, understood only as relations between states, whose action evolves in terms of power, has been revised deeply by the international political economy analysis. New merely economic dynamics and strategies, as well as new actors,

[3] See *Strange (1988),* chapter 2. Nevertheless, the title of Chapter 9 of this book is: *Energy, the fifth factor.*
[4] I will use here contents from my article: *De la Vega Navarro (1998).*

shape the global economy and complement or challenge the action of states. The term "political" cannot be longer applied only to state policies, but also to the activities, strategies and policies carried out by other actors in the world system whose power has to be seriously taken into account. Those authorities different from the state, particularly private enterprises in finance, industry and commerce, have contributed more to the world market integration than governmental actions and can now be considered to be more powerful than the state to which the political authority over society and the economy supposedly belongs. In that sense, without denying the content of one of her most important books (*States and Markets*), Susan Strange might have preferred another title for it: "Markets and Authorities", as she put it[5].

In Susan Strange's analysis, an important aspect is the shift from "relational" power to "structural" power, which is to say, the capability, unequally distributed to influence the composition of the world economy and, as a consequence, the results of international competition. With this, a new topic pervaded the analysis: the role and relative influence of states and markets over the "governance" of the world economy. To Susan Strange, the direction of the balance in the world system is clear:

> The main outcome of this structural power has been a shift in the balance of power from states to markets. The United States, using its structural power to lock European, Latin American and now Asian and African economies into an open world market economy, certainly intended to reap benefits and new opportunities for American business. What its policymakers did not fully intend [...] was the enhanced power that this would give to markets over governments, including their own *(Strange 1996: p. 29).*

Doubtlessly, during the 80s and the first half of the 90s explicit policies modified in favour of markets, the "mix between authority and market", by proposing the generalised adoption of markets as mechanisms of co-ordination, sometimes even having precedence over states. From that point of view, big enterprises would be a primary element of importance, which implies a radical change for the traditional analysis of political power and of the role of the state.

Sometimes, the extension of a generalised regulation by markets has happened against the will of many states and even despite international organisations which support a more administered concept of international regulation. The United States position has been, in many occasions, precisely to take from states and international organisations most of regulatory prerogatives and to favour market actions. Given that evolution, the findings of Susan Strange are extremely useful, both regarding the dominant superpower action and the absence of a democratic accountability of markets.

[5] "Markets and Authorities" would have been a more accurate title *(Strange 1996: p. x).*

2.2. THE EXTENSION OF A REGULATION BY MARKETS IN INTERNATIONAL MATTERS AS THE CC ISSUES

As different research works have shown, globalisation is a process largely private sector driven:

> "It represents, therefore, a shift in the locus of decision-making not only from the nation-state to transnational actors but also from national governments to the private sector. For this reason, economic liberalisation and globalisation have often gone hand in hand....There is, however, one factor pulling in the opposite direction. As the global system becomes more integrated, there is a demand for international public goods that neither markets nor nation-states will provide....There are currently global rules and institutions, but they are not strong" *(Cable 1995).*

This demand for international public goods has grown in recent years. Even well-respected international organisations have criticised the role of markets on issues such as the ones we are concerned herewith:

> "Markets have fallen short of accounting for greenhouse gas emissions [...] To date, governments have not intervened adequately to compensate for such market shortcomings. In many ways, climate change represent the ultimate 'tragedy of the commons" *(IEA 1999: p. 7).*

In spite of this, there is the idea that the market mechanism is the best way to find the cheapest solution for cutting pollution in the world economy. Sceptic organisations as the American Petroleum Institute, that considers climate change a "highly uncertain problem", clearly shows its preferences when it comes to envisage the need of actions: "Should we turn to international bureaucracies and global mandates or should we rely on the energy, creativity, and flexibility of the private sector, the free market system, and public-private collaboration"?[6]

One instrument approved in Kyoto for limiting greenhouse gas emissions in order to curb global climate change was an international system for emission trading. But the rules for such commerce still have to be put in place. Parties may offset emissions increases in energy related CO_2 through decreases in emissions of methane or nitrous oxides. They may also take credit for reductions beyond their borders through, joint implementation and the clean development mechanism (CDM).

Crude oil, the biggest source of carbon dioxide emissions represents a physical commodity, while greenhouse gases like carbon dioxide are invisible and proposed now to be traded under an international regime. Nevertheless, carbon dioxide and other greenhouse gases will not become a true commodity until national or international legislation on emission trading is in place.

[10] "API's position": http://www.api.org/globalclimate/

Some international financial institutions are defining their strategies taking into account these perspectives as the actual future trends. World Bank, for instance, will develop an increasing role in:

> *Using international market mechanisms to reduce the cost of carbon abatement.* The establishment of an international market for carbon emission offsets or credits should cut the cost of dealing with climate change, and has been agreed in principle at the recent Kyoto conference on climate change. The WBG will help to develop this market *(The World Bank Group 1999).*

Precisely, The World Bank's Activities Implemented Jointly (AIJ) Program has been used to demonstrate the market-based "joint implementation" mechanism, affirming the potential of a carbon offsets market. It is assumed that "an efficient and equitable market in carbon emissions could mobilise substantial private sector resources, increase the development and the spread of more energy-efficient technology to World Bank client countries, and enhance the energy and environment portfolio of the World Bank itself" *(The Work Bank Group 1999)*

3. Energy, GHG Emissions and the Role of International Oil Companies

Basically, though not exclusively, the global climate change issue has to do with energy utilisation in economic activities (share of different sources, energy intensity, energy implications of different models or development patterns, etc.). Energy is at the heart of the Kyoto program because energy is the main source of greenhouse gases (GHG) accounting for about 85% of GHG emissions in developed countries.

Since energy contributes decisively to the problem, energy will have to bear the main responsibility for the emission reduction burden. Specialists agree that the main efforts have to be directed toward controlling fossil fuels emissions, but nobody has yet discovered the best way to break the link between economic growth and increasing energy consumption, especially in some rapidly growing developing countries. However, different positions concur to evidence the need for a broad economic shift away from (fossil) energy-intensive industries or activities.

As many other projections, the International Energy Agency (IEA) energy forecasts agree that fossil fuels will be a dominant energy source for the foreseeable future and hence show significant increases in energy related CO_2 emissions. Without the adoption of new policies, emissions could rise 30 percent above the 1990 levels. Policymakers consequently will have to direct their efforts toward controlling fossil fuels emissions. As stated above a business-as-usual world will continue to be powered by fossil fuels which, according to the IEA, are expected to provide 95 percent of additional global energy demands by 2020, with oil continuing to dominate world energy consumption.

The study of energy matters entails a necessary international dimension traditionally crossed by political and geopolitical implications, beyond only economic issues. That is why in many aspects the energy industries have always had broad and complex characteristics, especially the oil industry. Susan Strange addressed some of these characteristics when she said that governments, companies and markets are the three main agents on the international oil business:

> But in oil, the most important authority has often been not the state, as represented by the national government, but the oil company or a group of oil companies effectively managing the market *(Strange 1988: p. 194).*

Today, doubtlessly multinational companies occupy again the centre of the international energy scene. There has also been a substitution of administered regulations by market mechanisms in the determination of oil prices and generally an assertion of the role of the market as a mean of dominant regulation in the oil scene.

Concerning the environment, some groups denounce the world's major energy companies for contributing to global warming with their huge carbon emissions. A report issued last year looked at the 1997 production of the world's top 122 producers of coal, oil and natural gas, finding that 80 percent of the fossil carbon released into the atmosphere as man-made carbon dioxide is produced by these companies[7]. This report studies in detail how national oil companies like Saudi Aramco or National Iranian Oil Co. and corporate giants like Exxon Corp cause carbon emissions from fuel production. Unlike previous analyses of global warming that have largely focused on the issue of fossil fuel consumption, this report stresses the role of the producers of carbon-based fuels, putting in evidence the polluting behaviour of companies like Shell, Exxon, BP Amoco, ARCO and Chevron and their responsibility in reducing global warming pollution.

In that context and because of its importance it is necessary to become aware of the positions expressed through companies as important as Exxon. In a recently published article, an important executive from that company expressed the following:

> We should reject premature international initiatives like the Kyoto Protocol, which have the potential to cause economic harm for most nations, severely impacting some, while doing very little to influence the climate *(Flannery 1999).*

Exxon opposes climate change advancing the following arguments, as expressed in that article:

- The science is uncertain[8]:

[7] Report by the Natural Resources Deense Council, the Union of Concerned Scientists and the U.S. Public Interest Research Group (PIRG), July 1999.

[8] In this same direction, the API position is that if a consensus among scientists exists, it is expressed in a petition drafted by the Oregon Institute of Science and Medicine in February 1998: "There is no convincing scientific evidence that human release of carbon dioxide, methane, or other greenhouse gases is causing or will, in the foreseeable future, cause catastrophic heating of the earth's atmosphere and disruption of the earth's climate". See "API's position": http://www.api.org/globalclimate/

. Earth climate is affected by many complex variables, such as sunlight, clouds, orbital variations, ocean circulation, etc. The extreme complexity of the huge thermodynamic machine that the planet represents does not comply easily with models that still have too simple results and present many flaws.

. Throughout the last century there has been a slight warming trend in surface temperatures and the concentration of CO_2 has been increasing in the atmosphere. Concern has arisen that this accumulation will lead to global warming and climate change, with negative consequences for people and ecosystems. But we do not know definitely if the use of fossil fuels is contributing to this warming. Scientific observations still do not confirm that human activities and anthropogenic emissions have led to any global warming.

. In statements concerning global warming and climate change, politicians' positions have prevailed over the scientists'. In 1995 a Special United Nations Panel issued a report where scientists were careful not to make any firm conclusion about relating burning fossil fuels and global warming. Nevertheless, the executive summary was heavily influenced by government officials and it stated that: "The balance of evidence suggests a discernible human influence on climate".

- It entails large near-term costs:

  . So, there is uncertainty related to the global warming and climate change issues. The precautionary principle is often invoked in situations characterised by this level of uncertainty, but this principle provides no guidance on what actions to take in response to uncertain risks. Besides, precautionary measures come with very high, near-term economic and social costs.

  . To reach the targets established in Kyoto, many countries would have to accept dramatic consequences in their economic activities. Besides, reduction in fossil fuels use would mean increases in the price of gasoline and other fuels, significantly higher fossil fuel taxes, rationing, etc. Concerning the USA, Brian P. Flannery considered, in the referred article: To each the [Kyoto] target, the USA would have to stop all driving, or close all electric power plants or shut down every industry or reduce emissions in each area by over one third" (Flannery 1999: p.7)
- From this point of view of this Exxon Corporation executive, the conclusion is clear: "Kyoto restrictions would lower demand for goods in industrialised nations, decreasing the imports from most developing countries. That could significantly disrupt global trade and economic growth" (Flannery 1999: p. 8).

As in other fields, it is not possible to generalise positions and attitudes of oil companies about global climate change. Some companies have a strategic vision on their future investments, which include alternative energies to hydrocarbons and even research on global warming and climate change. In this direction other voices are heard, coming from the oil industry itself, assuming a possible scenario under which "technology and environmental concerns become a tremendous force for change, and more quickly than generally assumed. We will see multiple ways to power cars: hybrids, advanced batteries,

fuel cells, even cars that run on pure hydrogen"[9]. There also exist energy companies, which see the Kyoto Protocol as a means to commercial opportunities and of new investments[10]. Besides, several Europe-based oil companies, such as British Petroleum and Shell have shifted their position, have acknowledged the scientific evidence and have put in place actions to curb GHG emissions from their production activities, such as internal company emissions trading and emissions goals.

4. Final Considerations

It is fundamental to understand the new ways and procedures of economic domination and the strategies taken by the main agents which are expressed in today's world economy, either to take advantage of them, to denounce them or to get rid of them.

In the present world economy where both the nature and the ways to exert power have changed, markets seem to prevail, especially the financial ones. The balance state-market is changing, in favour of the second and this fact constitutes a fundamental change with serious implications for the world economy and democracy.

States and even international organisations now look for the margins of their options to maneuver, for instance to define the rules according to which market activities take place. In the international context, however, some states are more powerful than others -whether in the relational or structural sense- and can impose rules to make those markets work for their own benefit. On the other hand, big firms can influence the objectives agreed by the international community, as international oil companies manage to do. What is clear is that it is not possible to ignore those important actors in the international energy scene. It is important to track and analyse the evolution of their positions: between them there are some which try to participate in, rather than fight, technological breakthroughs that might make oil less important in the future. More than any other factor, the energy business of the coming years will be shaped by the interaction of environmental regulation, technological advancement and the investment patterns of energy companies. Some actors, such as some corporations in the international oil industry have not only recognised this fact, but also have started to direct their long-term investment strategies so as to survive in a future environment shaped by these new forces, trends and phenomena.

Concerning the oil exporting countries, they must accept the fact that climate change issues will influence energy policy and actors strategies in consuming countries. Rather than remain opposed or to be left aside in the process, they have to become active and

[9] Bijur, P., Texaco CEO in an address to the 17th Congress of the World Energy Council (Houston, September 14, 1998).

[10] BP Amoco, for example, has launched an in-house solution for trading carbon dioxide emissions. Twelve of the group's 126 business areas, with roughly 10% of its carbon dioxide emissions, are involved in this pilot project. The aim is to extend the system to the whole organisation by mid-2000.

constructive partners, join the debate, try to influence the formulation of policies and of worldwide implementation of climate change initiatives.

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10

DEVELOPMENT, EQUITY AND CLIMATE CHANGE IN LATIN AMERICA[1]

Héctor Sejenovich

1. Introduction

Since the beginning of the negotiations for the UNFCCC and the scientific assessments by the IPCC, we have been insisting on the need for a specific analysis of Latin America that would take into account the particular characteristics of our region and the need to develop a common regional policy.

Because of this, this meeting is very important for us, even more since now the problems related to climate change are treated in terms of sustainability, equity and development. In the region, we are going through an economical and social crisis, as well as an environmental one caused by, a.o., climate change. That makes it possible for us to embark on egalitarian developmental policies which take into account the strong restrictions resulting from the crises and finding the ways to advance to a sustainable economic, ecological and social development. It will be necessary to work simultaneously in different areas in order to achieve a better, more egalitarian and solidary society and to overcome the unequal distribution of wealth, the environmental degradation and the exhaustion of our resources *(Brundtland 1989).*

2. The Resources/Population Ratio in Latin America

The resource/population ratio in Latin America is much more favourable than that of other continents, showing a balance that could allow the full satisfaction of the population's needs. According to *Gilberto Gallopin (1989),* the Latin American population makes up 8% of the world population, and the subcontinent concentrates 23% of the potentially usable agricultural land, 12% of the cultivated area, 17% of the cattle-raising land, 23% of the forests, (46% of the tropical forests), 31% of the surface water and 19% of the potential hydroelectric power.

[1] This paper has been drafted using concepts used in the preparation of IPCC's Third Assessment Report (Working Group III, Chapter 8). The author was assisted by engineers Gallo Mendoza and Daniel Panario.

A first observation of these figures suggests that the big potential offered by Latin American resources is not used due to the lack of capital. This, in fact, has been assumed by certain traditional schools of development thinking for a long time. However, over the last decades we have seen an enormous flow of capital from our region in payment of interests of the foreign debt, which prevents the region from investing a part of production revenues in a sustainable growth.

Latin America foreign debt grows year after year due to the increase in the level of the interests accrued. In 1999, the Latin American foreign debt amounted to almost US$ 750,000 million and the debt/exports ratio for the region reached 216%. To make matters worse, the imports are growing and the exchange rates continue to deteriorate. On average the annual exports of the region would have to exceed imports by 17% so as to be able to pay merely the interests of the foreign debt.

This demonstrates our large capacity to generate capital that could be devoted to our development. We have immense resources as well as the capacity to generate the necessary capital which would allow for a sustainable development. Nevertheless, our role in the world market is mainly passive and marginal, giving rise to a production system that spoils natural resources, energy sources and natural ecosystems, and keeps a growing number of people in poverty. At the same time, the region does not yet play a leading role in the world in terms of the causes of and responses to climate change.

3. The Latin America Situation and Climate Change

Although there is almost no research on global climate change in the region and on the policies that could be implemented, our work in support of IPCC assessments have dealt with some partial aspects which provides an overview of the situation in the region.

The national communications prepared by the countries make up an important basis for the analysis of the region, but in general they have followed a methodology that did not link essential aspects, such as employment, property of land and natural resources, income distribution and the role of the different social actors in different countries. That is why it is necessary to elaborate an integral report. There are important antecedents, such as the work we published in “Our Own Agenda”. This was an answer from our region to the fact that “Our Common Future” failed to take into account a significant number of our needs.

We posed in “Our Own Agenda” that the conditions of the present economic and social crisis were caused by imperfect development modalities, misuse of resources in the developed countries and by the economy of poverty, inequity and the need to satisfy urgent demands in the short run in the underdeveloped nations. The challenge consists in designing a strategy of development which is in harmony with nature and with the future generations’ needs. We should pay special attention to the relationship between poverty, population and environmental tension in the developing countries.

All processes of transformation of nature express a particular society-nature relationship. Environmental problems can arise when an economic and social structure transforms nature in order to improve living conditions. If such transformation is carried out according to the dominant patterns of the economic and social structure prevailing in Latin America, a maximum profit is aimed at without considering the negative outcomes that it generates. This production process involves three closely interacting elements.

a) The process of production involves a concomitant process of degradation. Whenever a tree is felled, the soil is ploughed or an industrial process takes place there is some degree of degradation of raw materials, human resources, labour force, facilities and other inputs. Such degradation may or may not affect the self-regulating capacity of the natural system. But if we analyse the historical trends, we see that, in most cases, such capacity is affected, which enhances the process of deterioration. The balance between the emissions and uptake of greenhouse gases has become more and more negative because of the industrial development, increasing emissions and mechanisation, as well as the intense process of "artificialization" of nature that the green revolution implied. However, there have been other processes that favoured the net emissions balance, such as the sources of alternative power. The substitution of petroleum by biomass energy, hydroelectricity, nuclear energy and gas has decreased the amount of GHG emissions.

b) At the same time, available resources are not used effectively in the region. Since the beginning of the international division of labour (specialisation of the world economy), our continent has specialised in very few products that had a comparative advantage at the world level, preventing the countries of the region from taking advantage of a wide range of products themselves, which could have satisfied their populations' needs. This also led to privileging a few specific resources. An important part of the diversity of resources of the region was devoted to monoculture, which affected natural ecosystems, and their sink capacity and released greenhouse gases and other pollutants from forest burning.

The energy supply has always been dominated by a few sources of energy, whereas other sources of energy which could have competed with the former have remained neglected and therefore wasted.

c) Finally, the raw materials that are being used are used only partially and inefficiently. With regard to the use of energy, it can be pointed out that our production processes have been extremely wasteful and have low efficiency in the use of energy. However, over the last years there has been growing improvement in different countries of the region. The prevailing trends involve significant negative effects such as degradation and waste production and do not achieve an integral use of natural resources.

The traditional socio-economic indicators only give information on production, but fail to account for the levels of degradation, waste and social effects. But the process of transformation within our economic and social structure is determined by systemic

relationships in connection with the questions: for whom does the production take place (social objectives); where production takes place (regional aspects); how it is carried out (technological aspects); and which natural resources are used. According to current trends:

- production is focused on solvent markets, which can generate underconsumption and overconsumption, a decrease in the useful life of the products, and waste;
- production is carried out where the costs are lowest, which leads to the physical concentration of investments and to a drain of surplus from the regions;
- production is characterised by mass technology, lowering costs but not prices, and affecting the natural and social conditions because of the displacement of small and medium-sized companies;
- labour cost is reduced, which deteriorates and affects the health and living conditions of workers;
- production is performed without keeping in mind the sanitary conditions both inside and outside the factories, which affects the population's health;
- companies only produce those goods which enjoy comparative advantage in the world market, enhancing misuse of resources and causing the degradation of natural resources to be faster than their renewal rate.

Every environmental problem affects the social sectors in a different way. Their perception of the environmental problem depends on the history of the social actor; on the actor's personal relationships and on the social sector to which the actor belongs to or wants to belong to. Social actors, as products of this conception, react in a certain way, for example creating environmental institutions or movements, introducing environmental problems to existing political parties or founding new parties. Sciences also try to give an answer to these problems by creating interdisciplinary research programmes or targeted programmes with their own discipline, and by developing technological alternatives that in some cases result to be capable of solving the problems.

In these social and scientific conditions, the state's general reaction is to adopt certain policies which aim to improve the situation. Whether or not the state achieves its goal depends on the characteristics of the sectors involved in polluting activities; on the influence of the government in these sectors; on the social movements' ability to demand changes; and on the acceptance of the possible alternatives provided by the scientific community.

We firmly believe that the statements on sustainable development (and, previously, on ecological development) did not originate from the desks of national or international officials. We think that such officials have instead used and interpreted the (frequently partial) principles of the different social organisations increasing their certain coherence (which also means certain incoherence remains).

This common basis of our region is the product of the interaction between the different modes of development that have taken place in history. That is why we should try to understand this heterogeneity by analysing the main modes of development that the current

process of globalisation has forced upon us. Likewise, the comprehension of the different elements of the changes in these development modes will allow us to better understand the historical context in which they have occurred, the need to change them and the structural implications that the changes entail. Although the prevailing ways change, the ways of production characteristic for each development mode do not disappear, but interact with the new ones through relationships which are not very harmonic.

The importance of the modes of development and their reflections in the structure of consumption, in the demand of energy and in the development of alternative sources of energy are dealt with in the contributions of Working Group III to the Third Assessment Report of the IPCC.

In Latin America four modes of development, which are in turn intermixed with each other, can be distinguished in historical and prospective analysis.

a) A model focused on the export of agricultural products and raw materials.
b) A model aimed at industrial development and imports-substitution.
c) A passive and marginal role within the world market.
d) Sustainable development (with an active and creative articulation).

A) MODEL FOCUSED ON THE EXPORT OF AGRICULTURAL PRODUCTS AND RAW MATERIALS

This model got consolidated in many countries through the international division of labour, especially from the beginning of last century to l950. In several of these countries, this pattern still prevails. Its essential rationality promotes the intense use of the natural resources that yield comparative advantage at an international level. The hard currency derived from the export of these goods allows to buy the products that satisfy the existent consumer demand.

The energy supply system is largely determined by foreign influences. The high level of dependency on just a few sources of energy exacerbates ineffective resource use. Although the energy system largely depends on oil production, the degree of modification of nature and ecosystems and the technological development typical for this mode of development do not yet make it as dependent on energy as the next model of development (oriented towards industrial development and import substitution) is.

The use of available space is extensive rather than intensive. The exploitation of firewood, to a lesser extent coal (especially in Colombia and Chile) and oil in very dissimilar sectors lead to technological heterogeneity of the current productive structure. The experience during the war, when the industrial oil supply was cut down, demonstrated the possibility of using other sources of energy, including agricultural and forests waste.

The price of natural resources in the world market is essential for this pattern. When the world market consolidated, in the second half of last century, and especially when the

export of capital at international level began, ecosystems (soil, climate, sea, vegetation and other resources) came under increasing pressure. The countries found their "ecological niche" (in this case, closely related to the actual ecological concept) within the world production system, as suppliers of one, two or a few products for which they had a comparative advantage. Not only were these advantages strongly determined by low wages but also by the specific characteristics of the region's natural systems for the production of commodities such as sugar, coffee, tannine, rubber, wool, wheat, meat, and wood. *(Sunkel and Paz 1980).*

Naturally, because these products had to compete at the world level, the technology and the production methods used were very advanced. However , the predominant ecosystems in the region are complex, and highly diversified. The abrupt transformation of this system meant the elimination of the plants (shrubs, trees and herbs), animals (the whole tropical chain) and the introduction of monocultures, that had to be protected against indigenous products, e.g. through energy subsidies, which in spite of increasing production in the very short term, generated different degrees of contamination and waste *(Sunkel and Gligo 1982).*

Under such circumstances the systems created were extremely fragile from the ecological point of view and also in economic terms, since a significant part of this activity depended on the international prices on the world market, dominated by oligopolies in the industrialised central countries.

B) MODEL AIMED AT INDUSTRIAL DEVELOPMENT AND IMPORTS-SUBSTITUTION

This system was applied in the post-war period in various countries. It was based on an attempt to continue the pattern imposed in the post-war in Europe. It aimed to stimulate the industrial sector through large investments in basic sectors so as to develop a high technology industry that apart from substituting imports of final goods would produce raw materials and the capital assets required for a process of progressive national integration. The agricultural sector, through some changes in the agrarian property system and higher technology, would become a source of demand of industrial products. The industrial sector would, through large-sized companies, make use of the benefits of mass production that would reduce costs and with this the prices of the products, improving the quality of life of the population *(Fajnzylber 1984).*

There would also be an improvement in the training of personnel in the handling of complex industrial processes. The technological improvements of the large companies would spread to small and medium-sized companies, improving in turn the technological standard of the whole industrial sector. In order to achieve that, it was necessary to apply protectionist policies, to regulate the rate of exchange and to encourage credit.

However, the agricultural sector continued being the main source of income, before a significant increase in the level of industrial exports could be observed. With regard to energy, a significant part of the pattern oriented towards industrial development and import substitution is dependent on the wasteful use of cheap oil. The rationality with which the technologies were designed, the type of infrastructure built, the agricultural methodologies –which enjoyed subsidised fuel– were related to the generous availability of oil at a low price. Not only is oil essential as a source of energy, but also for the development of the petrochemical industry.

The inefficient use of energy and the excessive "artificialization" of nature were not so perceivable in economic terms, since the oil price was very low. The strong protectionist policies allowed national and foreign companies and settlements to be set up in the interior of the countries because of the favourable prices. In spite of the great influence of the large oil monopolies all these countries established or strengthened national oil and energy companies that determined the policy for the sector.

Although the technological development was important in all these countries, it continued to depend on the foreign countries (patents and royalties). So the increase in production also meant an increase in foreign debt. The state absorbed a significant portion of the labour force away from the private sector, but that was done inefficiently, since the state failed to carry out the necessary control. This, together with the promotion and encouragement of new technologies and production systems generated inflation, among other things.

The use of the ecosystems without any environmental planning led to inadequate use of agricultural land that did not take into account its capacity. The forest surface of the region was highly reduced. The process of sedimentation in rivers increased due to erosion, and there was a dramatic decrease in the service life of dikes, because of the lack of preventive management of the river basins. There were high levels of unemployment and underemployment and an increase in the level of non-registered employment. As a result, the unfairness of income distribution was significantly accentuated. Nevertheless, it did not yet reveal the situation some years later. Even so, an immense foreign debt accumulated. It is this foreign debt that limits the possibilities of development at present.

C) PASSIVE AND MARGINAL ROLE WITHIN THE WORLD MARKET

This mode of development is not an active development strategy, but it rather arises as a tool to stabilise economic and political conditions, in view of the previous models failing to achieve their goals. This mode of development implies the destruction of the protectionist system and a close integration of the region's economies with the rest of the world, following a pattern similar to that of model "a", though incorporating some significant changes. The degree of integration is frequently so high that it even reduces the importance of the nation states.

In this mode of development, the countries of the region should look for the niches in the world market which remain available in order to get the necessary income which allows to satisfy their populations' needs. The crisis of the previous, development-oriented model has taken place, to a large extent, as a result of the structural changes in the world economy, which strongly influence the role that natural resources and the environment can play.

The scientific and technological revolutions may help to solve the serious problems and restrictions to development that the world economic system is facing during the last decade. Such restrictions include the availability of raw materials, of energy, and labour force. The price of oil, the main source of energy had increased significantly. The prices of raw materials could increase too. Of particular importance was the meeting held in Algeria in l974, where the New Economic International Order was proclaimed. Labour cost had increased in Europe, especially in the 1970s. As a result, fundamental changes were implemented so as to overcome the restrictions and make sustainable development possible. That is how a boom of electronics, biotechnology and new materials was stimulated.

The industries dependent on oil began a relative decline, and no longer had the relative importance they once had. The reason for that was the growing importance of computer and information technology, and robotics. Generally speaking, the increase in production levels which has taken place in Latin America over the last years, has been accompanied by a lower use of energy, and this trend still continues.

In the second place, the new technologies change the economic relationship between employers and workers, since the threat of constant reduction of personnel exists permanently whenever technological advances are introduced and sectors are reorganised to compete with foreign companies.

In the third place, the demand for natural resources decreases in relative terms and changes its structure. Oil is no longer the essential factor and the demand for other traditional materials decreases. However, there is an increase in the world demand for " natural conservation" generated by the ability of natural ecosystems to absorb greenhouse gases. This capacity in developing countries is used at a global scale without any compensation by the developed countries. These countries have not only exceeded their own sink capacity, but also the sink capacity of the oceans and other shared ecosystems which in theory they share with the rest of the world. So, the industrialised countries can be considered to use the surplus of the current GHG emission-absorption balance in the developing countries. This imbalance further increased due to the slow economic growth or even decrease in economic production in many developing countries caused by structural adjustment policies.

In the fourth place, the advances of biotechnology are significant and could endanger the comparative traditional advantages related to the specific characteristics of the Latin American ecosystems. It should be noted that the natural advantages of the regional natural ecosystems could be, in part, artificially acquired. The wealth of the bio-diversity is being

commercialised on an increasingly large scale and many of the heterogeneous ecosystems are capable of returning to their natural conditions.

Over the last years genetically modified products have spread worldwide so as to improve the efficiency of certain plants and reduce production costs. It is unknown whether or not these products have harmful effects on human health, and this has led an important part of the world population to express their disagreement, especially when there is no warning about the risk posed by consuming them, influencing the consumers' freedom to choose. It is claimed that these products are very similar to the traditional ones, but they are not. They actually are likely to have undesirable effects or at least there are serious doubts if they may not be capable of having catastrophic consequences.

And, finally, markets have really become worldwide and the countries are rearranging their alliances. But in the world markets the industrialised countries continue to apply highly protectionist policies for their products. On the other hand in our countries, the adjustment policies have affected the industry, agriculture and mining in a selective way, as well as the unprotected development of one or more sectors that, in the light of comparative advantage on a world basis, could continue competing internationally. As to the borders between countries, they tent to be weakening, especially in the case of the small countries. That is why the creation of sub-regional blocks has been proposed. ECLAC and UNEP have analysed the eventual effects of adjustment policies on the processes of deterioration of the environment. These institutions have stressed the following aspects.

Policies that aim to reduce the fiscal deficit, as a basic means to adjust public finance according to the dominant economic paradigm, lead to a contraction of the allotments destined to public expenses and investments, and causes a reduction or suppression of activities related to control of natural resources, which increases the possibility of their degradation. These policies also cause delays, reduction or suppression of investments in new public constructions and in the repair and maintenance of the existing ones. This causes the deterioration of the infrastructure, the absence or deterioration of erosion protection against sedimentation in river beds and so on.

This situation also causes a decrease in environmental impact research. This exacerbates environmental deterioration and shortens the service life of infrastructure. In turn, the great reduction of public expenses affects research funding significantly, especially when not directly related to production. This also entails the reduction or elimination of special programs for children or needy sectors, which causes serious problems for the most vulnerable sectors of the population.

This is particularly serious, since, for example, the traditional way of accounting for national park expenditures is as government consumption, and, as a result, they are the first to be cut down. Only the population's awareness of national parks makes it possible to protect them. The evaluations carried out according to the traditional economic principles fail to take into account the need to consider parks as what they actually are: part of a

laboratory of nature, destined, among other things, to preserve certain natural systems, understand the relationships between them, if necessary to restore these relationships, as well as their functions as reservoirs of biodiversity of flora, fauna, genetic patrimony and landscape.

Recent energy policies, of which the implementation was already problematic, at present completely collapse because of the abrupt increase in the oil price. The privatisation of an important part of the electric power generation system eliminates all subsidies, and the whole product cost structure changes due to the increase in the price of energy. However, the consumption did not decrease. In many countries in the region, the services are deteriorating significantly because of the privatisation, which leads in turn to the break-up of large firms into several smaller companies that lack centralised control. In turn, the reduction of the amount of credit available due to the restrictive policies leads to a deep crisis in small and medium-sized companies, which generates a new process of concentration. This is favoured by the easy access that the large-sized and transnational companies have in the region.

To some extent, this third mode of development is a variant of the first one that we have analysed, and has developed as a result of the failure of the second, development-aimed policy.

The criticism that the stimulation took too long, discouraged competition, and encouraged oligopolies resulted in the abrupt end of all sort of stimulation of industrial development and the end of regional and social protection. It caused the state to give up its role as a producer, even as a “protector” and (in practice) as a regulator of the economic activity due to the weakening of the control capabilities caused by the implementation of adjustment policies.

Although, in theory, control mechanisms are said to be necessary to protect consumers, in practice, competition becomes the only arbiter. On the other hand, competition takes place under conditions of an imperfect market and can not achieve its theoretical objectives. Natural resource-related activities continue to have big and small externalities not reflected in the prices, and we are far away from a situation of free competition. Prices do not include costs that take into account the renewal of natural resources. The negative externalities strongly offset the comparative cost advantages of the sink capacity. Costs of natural resources are low in the underdeveloped countries, since environmental costs are disregarded. Special reference can be made to the exploitation of exotic plants, which grow in native forest areas (generally degraded) and get low prices on the market.

This third type of development occurs at a time when the effects of the scientific and technological revolutions cause a decrease in the demand of labour force, generating high levels of unemployment and underemployment.

As to natural resources, apart from the sink capacity, the presence of comparative advantages remains in Latin America. Nevertheless, the development of biotechnology makes it possible (with some restraints) to recreate the specific conditions of ecosystems artificially. This entails even more critical conditions for a type of development which is only based on comparative advantages and for a business sector which is little dynamic.

On the other hand, all the externalities generated by the different sectors begin to be more visible. The pollution in large cities, the contamination of food and the deterioration of the natural environment are part of the current crisis.

The developed countries are very worried about the possibility that the underdeveloped countries, especially the largest ones, adopt the development pattern that they once adopted. So, they are trying to reach agreement on technological changes in these countries that make it possible to avoid the increase in GHG emissions. They also ask the developing countries to take on "voluntary commitments" to reduce the amount of GHG emissions, even though the underdeveloped countries only generate 16 per cent of the world's GHG emissions. The Environmental Commission, which belongs to the Planning Institute of the Alliance (the political coalition that took over in Argentina in 1999) calculated that the voluntary commitment announced by the preceding government may represent a value of 2,330 million dollars (at 1997 prices). Bearing in mind that Argentina has already carried out significant reductions in the level of emissions (e.g. through the partial replacement of oil by with gas and hydroelectric energy), the forthcoming reductions will have a high level of imported inputs and capital assets (notably in the industrial and transport sectors).

The uptake capacity of the vegetation and its function as biosphere stabiliser has begun to become a merchandise. Until recently, carbon uptake was a freely available good, for which no price had to be paid. Genetic information makes up a similar case. In both cases, there should be at least some payment which covers the expenditure required for keeping the vegetation cover and providing the resources in order to enable integrated management of the resources and help increasing the population's living standards. Nevertheless, helping to protect or increase the uptake capability does not imply that the developed countries are free from meeting the provisions at the national level, such as the Kyoto Protocol of the UNFCCC and various national plans[2] require.

The indicators of development have also changed. During the development-aimed stage, the gross national product was the most common indicator of development. This indicator has been put into question about ten years ago. In practice, other indicators have been more frequently used at a later stage, such as the inflation rate, fiscal deficit, the balance of trade, the foreign debt and its interests, money issued, etc. Another indicator used is the production of "green" accounts, in which the cost of degradation of natural resources is also estimated, but without applying a different value theory.

[2] E.g., the USA has posed in the Climate Change Action Plan (1993) that joint efforts must be additional to domestic action.

The creation of capital accounts which value (physically and monetary) natural resources and record their changes due to production has been proposed, and several countries have begun to implement such proposals. Another issue which has been proposed is the need to create a special economic sector whose output would be recorded on the aforementioned capital accounts. This sector would guarantee the sustainable productivity of the ecosystems which provide resources for the various economic sectors. We come back to this below.

D) SUSTAINABLE DEVELOPMENT

The rationality of this development model lies in the satisfaction of population's basic needs (for the present and the next generations) through an intensive use of ecosystems in the long run, the maximisation of production and minimisation of degradation and waste. Technologies must be adjusted to these purposes and the population must actively take part in fundamental decisions involving development. This involves the democratisation and decentralisation of the state's structure *(Sejenovich and Panario 1998).*

On this basis, the sustainable development model has to have a creative relationship with the world market, searching every opportunity to have access to it. Nevertheless, the rationality of the model is focused on improving the living standard of the population, which means appropriate measures and technologies to produce and meet domestic demand have to be developed *(Gallo-Mendoza and Sejenovich 1999).*

Ecosystems could be considered as nature's factories which can help restoring degraded areas, avoiding wasting of resources; and energy subsidies should be minimised to harness and convey energy properly. In order to achieve that, the production costs of such factories must be paid for. From this perspective, it is necessary to elaborate the accounts of the natural patrimony on the basis of the management costs (which must be registered on the national accounts as fixed, non-produced capital assets) and to register the ecosystem sector on profit and loss accounts. For this purpose, input-output matrices must begin with natural resources and include the whole production process up to the final commercialisation. A National Environment Fund may provide the monetary resources which are necessary to make sustainable production possible.

The displacement of the population – caused by the new technologies – and global competition offers a new alternative to canalise the large productive capacity derived from the productive employment of the labour force. The use of the comparative advantages at the world level can not be a substitute for national production that guarantees employment and the satisfaction of basic needs. Both are necessary. The role of science and technology forms the basis for these changes. Focused on improving living standards implies the active involvement of the population in the resolution of their own problems. The growing democratisation and the organisation of the population supported by technological change, which aims to maximise production and minimise degradation and waste should work

together so as to make development possible at ecological, economic and social levels. Naturally, this requires a more active involvement of the State, a completely different pattern of income distribution, the environmental planning of the territory, applying ecological principles in the development of cities and the evaluation of investment projects in terms of their environmental aspects. An active participation of the population in the fundamental decisions should guide the actions, whose main purpose will have to be the satisfaction of the population's basic needs.

In theory, all Latin American countries are following the fourth model of development. It would only be necessary to read the reports that they submit at the evaluation meetings that are held every year in order to analyse the headway achieved and to what extent such headway meets the agreement in Agenda 21. In practice, there is a combination of development models in Latin America. The prevailing model (the third), according to which the macroeconomic stabilisation plans are devised, is equal to the first one, but it has been adapted to the present situation, and includes important differences with respect to natural resources, as follows:

- Concern is more focused on the so called "services" of ecosystems, including their relationship with climate change and the information embodied by biodiversity, rather than on natural resources as products. Nevertheless, their function as raw material sources remains.
- There exists greater awareness among the population of the relationship between the devastation of nature and living standards. On the part of the growing social movements, there is also a greater capability to perceive and understand serious environmental problems and respond to them facing such problems.
- The importance of many traditional natural resources has changed because of technological changes, which has changed the importance of the resources for the underdeveloped countries. In the imports-substitution, industrial development-aimed model, oil and steel made up the basic natural resources. In the current situation, instead, the essential raw material that chips are made of, can be found in all countries. The dependence on this raw material is completely different.
- The role of the state and the negotiation capacity of the underdeveloped countries are lower than before, but the awareness of environmental issues is higher.

The increasing awareness of the importance of sustainable development takes place at various levels: The state structure, where the sustainable development ideas frequently find a place, the environmental evaluation of projects, the greater involvement of the population in environmental issues and some serious attempts towards environmentally friendly land-use planning. Some environmental technologies are also applied in industry, and agriculture, and environmental concerns pervade science, the arts, and the population's awareness[3]. But even so, the third model of development is still dominant. We should take

[3] We could mention the declaration in favor of sustainable development and environmental principles made by representatives from all economic, social, cultural sectors. Although we acknowledge the importance of this kind of declarations, the analysis of reality teaches us that people should demand their implementation.

into account that environmental matters are already very important for large-sized companies. It has been estimated that no less than 10% of production activities in the world are directly related to the environment, including those by biotechnology companies.

At the same time, in spite of the external competition, part of the industrial development-aimed model (the second model) still continues and recreates itself, especially at the level of small and medium-sized companies, which are actually the main generators of employment. Most governments promise strong support to the survivors of the industrial destruction process that the "without-anaesthesia" economic opening has caused. Nevertheless, governments appear to be unable to permanently support the basis of renewable natural resources. The above characterisation accounts for the high degree of heterogeneity and the limited attention to the environment in the structure of development. Mitigating policies should take into account this context.

4. Development and Mitigating Policies

How do mitigating policies affect Latin America and how could they influence development and equity? Given the scope of this paper we will limit ourselves to mentioning some key aspects.

4.1. GENERAL ASPECTS

At first sight, it can be clearly realised that transport, energy, industry, and, to a lesser extent, sink capacity, are the sectors chosen for the implementation of mitigating policies in Latin America. Here we focus on the sink capacity due to the important potential of carbon sequestration in vegetation in our region. In biophysical terms, the two basic options for the mitigation of carbon in this context are:

1. A decrease (saving) in carbon emissions.
2. An increase in the fixation and storage of carbon.

The first option can be carried out by avoiding degradation and felling of forests; by replacing fossil fuels with biomass for the generation of power, e.g. electricity; by substituting industrial goods manufactured through process involving a great use of energy by wooden products, and, finally, by substituting cement by wood.

The second option includes the increase in the carbon density in given areas and/or in the stocks of carbon stored. This means reforestation or forest plantations (industrial or bioenergetic) on degraded soils. Alternatively, sustainable management of forest can be carried out (selective forestry, among others). The estimate of carbon reserves includes carbon stored in the vegetation (on and below the ground), in decomposing materials, soils and wooden products and the carbon saved in substituting fossil energy sources by wood. It should be kept in mind that the different carbon reserves increase or decrease as function of

the moment of rotation. For example, in a project of plantations the carbon stored in the vegetation increases constantly during the forest growth, falls abruptly during the harvesting and grows again after the reforestation.

4.2. THE HARNESSING COST AS PART THE INTEGRAL COSTS OF SUSTAINABILITY

As already mentioned, it is necessary to take into account the costs of exploitation and preservation as part of the total costs of sustainability of ecosystems.

In 1988 a method of physical and economic assessment of the natural patrimony was introduced in Latin America. This method has spread to other countries in the subcontinent. The Bariloche Foundation has elaborated a Capital Account Handbook by using this method. The first edition of this handbook was published in 1993 by the Bariloche Foundation jointly with the Federal Council of Investments and the government of Entre Rios Province. The second edition was published in 1996 by the Bariloche Foundation together with United Nations Environmental Program.

All economic sectors make use of nature, but in calculating costs they do not include the cost of renewal of the natural resources used. That was consistent with the traditional conception of the economic schools (that now have partially changed their views) that considered that the nature was inexhaustible and self-reproducible. Today we see that that is not true, and nature has its limits.

During the preparatory years of the United Nations Conference on Human Environment, held in Stockholm in 1972, and the years which followed it there was a discussion about the limits of growth, the real possibility of the exhaustion of resources, the need to adopt income redistribution policies rather than those restraining welfare and production as a means of making it possible to guarantee good living standards and environmental preservation. We can also see that the problems relating to the distribution of income are many and have become more and more serious. There are also serious problems concerning the lack of limits in the use of natural resources.

The capacity to absorb greenhouse gases has been thoroughly exhausted, which has generated changes in the climate. The economic sectors extract resources, but no renewal of natural resources is stimulated, which gives rises to serious problems of deterioration and misuse. The reproduction of nature has become an economic sector in itself, but it does not count as production. Its objective should consist in generating a sustainable ecosystem offering raw materials to the economic sectors. The main tasks that should be tackled would be the following:[4]

[4] If we analyze these tasks, we will see that they appear on the agenda of all environmental departments and ministries. Nevertheless, such state offices rarely get the necessary funds, and if they ever do, judging by the results, they do not always spend them on what they are supposed to.

- Research on natural resources (qualitative and quantitative) together with the analysis of their dynamics in connection with the several products and services that could be provided to the different social sectors, whether in their natural state or transformed. This leads to study at least the terrestrial and aquatic flora (trees and herbs), the terrestrial and aquatic fauna, surface and ground water, the soil and subsoil, the conservation of river basins and the preservation of the biosphere and landscape.
- The knowledge of ecosystem-type relationship that resources have with each other and of the relationship they should have in order to generate multiple goods. Likewise, the determination of the tasks to be carried out to make integrated sustainable production possible, which should in turn be compatible with the highest level of GHG sequestration.
- Market research that promotes the use of the different products, especially those consumed by local populations but not known enough at national and international level.
- Control and management of the natural resources and participation by the local population in these activities
- Policies to stimulate the regeneration of degraded areas.
- Reconstruction of the different ecological zones required to reach the objective of multiple production.

The expenses involved in executing these activities consist of costs of management and sustainability. Funds for these tasks will make the establishment of an ecosystem sector of the economy possible, dedicated to the generation of ecosystem services. Such sector should take care of:

- making or keeping the annual flow of renewable natural resources compatible with their generation capacity.
- protecting the absorption capacity of water, soil and air for solid, liquid and gaseous emissions.
- managing the rate of annual use of non-renewable resources accounting for their recycling and the development of (renewable) alternatives.
- preserving the natural conditions for natural ecosystems providing services for the population and for the economy.

How are the costs of sustainability calculated in order to be able to determine the ecological capital.? They are estimated taking into account the determination of units that are reasonably homogeneous (like forests, pastures, rivers, etc.) and work as factories of nature. Such factories are destined to produce multiple products, but there is a cost of production, that is the cost of management of the natural resources. The integral management cost could be estimated by considering all the natural resources used. The input-output matrix, which we call “natural resource inter-sector matrix”, is a useful tool, where the different natural resources are considered.

4.3. POLICIES THAT SHOULD BE IMPLEMENTED TO MAKE THE INTEGRATED MANAGEMENT OF THE RESOURCES AS A FRAME FOR CLIMATE CHANGE POLICIES POSSIBLE

The integrated management of natural resources as part of the ecological economic and social sustainability and, naturally, the policies of climate change, pose a challenge to achieve a real advance in environmental policies. These policies include at least the following:

- Policies aimed at the achievement of a legal institutional frame that lets landowners implement a strategy that offers them higher revenues and generate more employment. The means to achieve this could be fiscal or financial measures, training, prices, etc. Every country should use the most appropriate tools for its particular development model. Keeping in mind the high concentration of land property, the execution of this principle is essential.
- Policies aimed at the creation of civil associations, new companies, groups of professionals or co-operative societies whose goal is the integrated management of resources and ways of land occupation compatible with the legal organisation of the environment.
- Achieving real support from the state so as to establish ways of commercialisation of the new products both at home and abroad.
- Industrial policies which aim to incorporate clean technologies.

5. First Conclusions

1. As it can be inferred from this paper, there is a lack of research in the region on regional or national global climate change impacts, regional, national or international mitigating policies, employment, income distribution, aggregate demand, international terms of trade and complementary environmental and social benefits. Nevertheless, the research carried out, such as that done by Our Own Agenda, presents integrated visions that conjugate the concepts of development, equity, sustainability and climate change. At the same time, further research is stimulated by IPCC assessments.

2. Latin America requires its own complementary strategy. The need for dialogue and agreement has been stressed on several occasions at different meetings. Nevertheless, no joint research which could lead to a shared strategy has been done so far.

3. This results in a lack of knowledge at the academic level and also at the levels of private and public policies. The fact that the social agents that transform nature day after day are not aware of the changes in the conditions of production generated by climate change can lead to very serious economic impacts because of the vulnerability of the producers (especially the small ones) to these changes. In that sense, the investment in research is very important.

4. It is important to highlight the need to perform studies on the inventories of GHG emissions, mitigation, vulnerability and adaptability to climate change on the basis of those methods which are most appropriate for the reality of each country.

5. It is reasonable to assume that the region has an important sink capacity and carbon storage capability which could help mitigating policies.

6. The mitigating policies based on the use of the sink and storage capacity should follow the following guidelines:

- To prevent the carbon in the current vegetation, but subject to a productive and sustainable management and avoiding forest degradation and deforestation. This will increase the carbon storage capacity.
- To integrate the functions of sequestration and storage of carbon with other productive activities following the principles of integrated and sustainable management of ecosystems.
- In the case of forests plantations it is important to select species which are compatible with each other and adapted to local ecosystem conditions so as to avoid altering the balance and preserve biodiversity as much as possible.
- The management of these plantations should take into account the need for integrated ecosystem management, and apart from wood production and carbon sequestration, it should include aspects such as the sustainable use of fauna and flora, water, watershed protection, sustainable management of landscape and farm animals. So, the integrated services provided by the ecosystems will facilitate the direct and indirect generation of employment, whether permanent and transitory, and will trigger the generation of employment in the other economic sectors.

7. During the adjustment period which we are experiencing now, the use of renewable and non-renewable resources has been and still is aiming at reaping the highest profits in the shortest term. This seriously affects the sustainability of ecosystems and generates negative externalities that, in many cases, make ecosystem recovery impossible.

8. However, over the last years, environmental control and technological changes has begun to be implemented in Latin American countries in the industrial sector. This enhances higher energy efficiency. At the same time, this has helped companies to increase their income *(Chuknovsky 1996).* The changes in that direction are mainly aimed at:

- A more efficient use of energy.
- The re-use of waste materials.
- New industrial processes that support the integrated use of resources.

9. In the case of non-renewable resources, appropriate management technologies which are compatible with the environment have failed to be incorporated. This has worsened the processes of degradation, and resource destruction, and has led to the wastage of significant opportunities as well.

10. In spite of this, over the last years, and thanks to the advances achieved by the UNFCCC process, negotiations for the sustainable use of the ecosystems have been initiated. A remarkable case is that of the work done in Minas Gerais, Brazil, in the mining area. It is interesting to remark that competition and external requirements are considered to be the most important reasons why the companies modernised their environmental practices.

11. The industrial sector in the countries of the region mainly deals with activities that make intensive use of energy, such as steel and aluminium industries, whereas the industrial sector of developed countries specialises in activities which demand less energy, such as computer science, biotechnology and services in general.

12. The mitigation cost must be shared on the basis of the degree of responsibility in the generation of emissions, even in historical terms. In this regard, there are analyses and studies on the ecological debt of the North to the South. The following hypotheses would account for the reasons for such debt *(Sejenovich 1997):*

- The exports from the Third World to the developed world have historically generated negative externalities that are measurable in terms of the effects on nature caused by degrading agricultural practices, by the lack of integrated management of ecological zones in the case of forest harvest or by the exhaustion of extractive resources. The assessment of the negative ecological effects has generated liabilities that should be compensated.
- If the developed countries admit the implications of increasing the sink capacity in order to absorb part of their GHG emissions, it is evident that they should also acknowledge the legitimacy of the claim for the remuneration for the service paid by the stock of biomass that has been capturing the carbon.
- The clandestine use that large companies make of the territory of the underdeveloped countries to bury part of their dangerous residuals. Sooner or later, these activities come to light.

13. The costs of mitigation in the countries of the region are lower than in the industrialised countries mainly because the prices paid for the land and natural resources generally do not include their negative externalities.

14. Latin America shows the lowest rate of CO_2 emission per unit of energy generated.

15 The aforementioned substitution between energy sources has contributed to the control of the emissions of GHG in the region. Undoubtedly, the economic efforts made in most Latin American countries in order to substitute GHG emitting sources of energy with less polluting sources should be valued, since these efforts should be taken into account in the climate negotiations held to equitably share the costs of the global mitigation of GHG. In this regard, some estimates have been made by Latin American institutions, such as the Bariloche Foundation, and by European institutes, such as RISO/UNEP.

16. One of the elements that should be borne in mind when analysing the relationships between the measures of mitigation and their sector-related and social effects concerns the agricultural subsidy policy in the developed countries. Such policy has the following environmental consequences on the countries of the region:

- The low prices of the agricultural products from the region worsens the financial situation, which makes it difficult to face the cost of sustainable ecosystem management.
- It does not take into account the multiple services of ecosystems, discouraging the management and the valuation of bio-diversity in the region.
- The environmental regulations for the products imported from Latin America imposed by the industrialised countries necessitate the determination of the product characteristics (what makes a product to be qualified as environmentally sound). This makes it even more necessary to understand the ecosystems, how to use them, and the respective costs of sustainable management. Unless that takes place, products whose processes involve degradation and wastage are not likely to be qualified as environmentally sound.

17. The Latin American countries do not yet have their own technology development programs which would facilitate a sustainable management, especially in the industrial and transport sectors. This makes it necessary to implement a policy of integration so as to achieve an appropriate standard of production and improve the possibilities of supply through the agreements between the countries in the region. The conclusions of many studies have indicated the need to establish training programs in most of the countries of the region so that the studies on climate change would clearly reflect the particular situation of each country. In this way, mitigating policies could be implemented more easily, thanks to a better awareness of the situation by the social actors involved.

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11

IMPLEMENTING DES.
SOME IDEAS FROM THE ECONOMIC POINT OF VIEW

Juan Llanes Regueiro

1. Introduction

The atmosphere of the Earth is a classical case of a global common: all inhabitants on the planet can access the resource, but no one has the ownership or property right over it. Climate change caused by increasing atmospheric concentrations of GHG because of anthropogenic emissions, have become a very outstanding challenge faced by mankind today and potentially one of the most influential factors affecting welfare of present and future generations.

Economics of pollution suggest that abatement and damage costs can be determined in monetary terms and that polluters can internalise emission costs according to the polluters pay principle. Economic efficiency has been described primarily in terms of Pareto improvement.

The present situation in the climate change and global warming negotiations is far away from these principles to be applied. The foreseeable effects of climate change are not expected to lead to an improvement but to a deterioration of welfare, especially for developing countries. Economic efficiency should be considered in this context.

Such a situation, when theory and practice diverge, at least for a long time period, is typical in science when new tools are developed as a result of research, scientific debate, the confrontation of different ideas, or when a new scientific paradigm is developed.

This paper aims to discuss themes like development, equity and sustainability (DES). This will be done by introducing these concepts and trying to make them operational in the context of the present debate on climate change and global warming. These notes draw upon an earlier paper presented by M. Munasinghe in February 1999: "Development, Equity, Sustainability (DES) and Climate Change".

Development is the weakest defined DES concept because it is usually primarily linked to economics and to material production, neglecting social, cultural and environmental elements. So further "development" as defined until now is no longer desirable. In the

future, the concept of sustainability should include the concept of development. Is a development path useful if not sustainable in the long run? Is an economy efficient if growing in a unsustainable way?

The concept of development depends on social and cultural rationality and on the pluralistic understanding of welfare concepts. The reluctance from economic sciences to recognise economic rationalities other than those from "Homo economicus" and material welfare has contributed to the development of the science of economic anthropology. This discipline is devoted to the study of economic rationality of ancient and traditional societies, which developed in ways different from current society, and achieving important goals in the areas of sciences and equity. This of course does not imply that material welfare should be neglected.

2. Sustainability Issues

DES issues are concepts that, though the elements have developed at different times, are closely integrated and overlapping. Hence it is very difficult to separate them, if we are looking for a certain dominance of one of these concepts over others.

Strictly, sustainability is the key concept of the three elements. However, it remains an elusive one because of the complexity of the conditions necessary to operationalise the concept. But if – instead of looking for a precise, sustainable path – we try to find a more general guiding idea, then perhaps we could be successful.

Such an idea may be that in economic terms, sustainability is the possibility for granting a surplus or rent that can be distributed over time. If this turns to be impossible development and equity concerns cannot be adequately addressed.

From the economic point of view, such an income flow has been defined as a “Hicksian Income” by some economists (sustainability principle). *Hicks (1948: p. 172)* stated that "The purpose of income calculation in practical affairs is to give people an indication of the amount they can consume without impoverishing themselves. Following this idea, it would seem that we ought to define a man’s income as the maximum value which he can consume during a week, and still expect to be as well-off at the end of the week as he has been at the beginning. Remembering that the practical purpose of income is to serve as a guide for prudent conduct I think it is fairly clear that this is what the central meaning must be."

The main operational implication of the “Hicksian Income” is to keep each category of capital intact (human-made, natural, human and social capital), and to evaluate each category on the basis of the precautionary principle rather than on the basis of a cost-benefit criterion, and to act prudently. This has been called the strong sustainability criterion.

Georgescu-Roegen has introduced economists into the field of thermodynamics, calling for attention to and making a distinction between energy from flow and energy from stock,

focusing on the consequences of the first and second laws of thermodynamics. Energy is the scarcest resource for development and sustainability *(Georgescu-Roegen 1971).*

Commercial energy use per capita in developed countries is eleven times higher than that in developing ones, while 73% of the global warming is caused by energy use, a figure that is expected to increase in the future.

Living on energy from stock (fossil fuels) may be only a short momentum in the life span of mankind and the transition from energy from stock to energy from the flow (notably solar) is a major challenge for the XXI century. By using solar energy more efficiently than today, it would be possible to reach a stationary state with constant production *(Böjö, Mäler and Unemo 1994),* a basic condition for achieving sustainability.

Climate change mitigation studies focus more on short-term, low-cost alternatives of GHG abatement than on the long term switching away from fossil fuels towards renewable energy such as solar (flow energy). Mitigation studies should focus more on a safe transition to renewable energy and on the problems and costs associated with this alternative. Focusing only on low-cost, short-term alternatives supposes the maximisation of net benefits, but experiences with mitigation options demonstrate very clearly that several of these options do not focus on a transition to non-carbon energy. This must be corrected, in a way that the main point of mitigation studies should be a transition in a long-term, low-cost transition and not only short-term and low-cost mitigation options which do not contribute to such a transition.

Experts and specialists who may not support this idea, may at least agree that comparing results from both approaches, e.g. for a national study on available mitigation options may be very useful. Short-term, low-cost mitigation options in the transportation sector will focus on more fuel-efficient cars, but the increase in the number of cars, kilometres driven and higher speed will transform the whole panorama. Therefore efficiency improvements of end use mitigation options are not always a final solution for a long-term GHG mitigation.

The concept of equity has evolved together with ethical, moral, justice and fairness concerns but it also has a very important social and economic significance. In economics, equitable outcomes are linked to a fair income distribution. Most economists would regard this statement as a very reasonable one. However, in mainstream economics, this argument in favour of a more equitable distribution is often ignored because it requires interpersonal comparison of utility, which is seen as having no scientific economic basis.

3. Procedural Issues

Economic theory dealing with pollution (and climate change can be considered a especial case of pollution) generally applies as a standard approach the calculation of the down sloping curves of marginal abatement costs (MAC) and the increasing curves of marginal damage (MD). The optimal emission level is then determined at the cross point of both

curves (MAC=MD) which is the point known as the "minimum cost" *(Munasinghe 1999; Böjö, Mäler and Unemo 1994)*. Currently neither MAC nor MD can easily be determined.

When an ecological threshold is exceeded, then MD will increase in an exponential way, so that in some cases, the economic optimum will not be the environmentally optimal one. A regulatory or mixed approach (safe minimum standard, critical load, precautionary principle) could be the best solution when trying to avoid the risk of non-linear or irreversible environmental damage.

Standard methodologies used in mitigation studies *(e.g. Halsnaes, Callaway and Meyer 1998)* rely on determining the marginal cost curve of GHG emission reduction, so that an accurate overview is given about different mitigation options in a cost-effective way. Traditionally cost-benefit analysis cannot be applied because benefits from reduced GHG emissions are very difficult to assess, due to large uncertainties. In economic terms, the damage function for GHG is often not well defined.

Here again we need a guiding idea in the sense that some quantified value for avoided C emissions will provide better information to decision-makers than the zero value of most studies implicit by ignoring damage values.

It could be argued that the use of a cost-effectiveness criterion based on mitigation cost for country studies has to deal with other no less important uncertainties. These are: a) trends on fossil fuel prices, b) evolution of non-fuel technologies costs; c) exchange and inflation rates; d) long-term GDP estimates, and e) other uncertainty factors for the costs of each mitigation option.

Sathaye, Norgaard and Makundi (1993) have suggested that the shadow price of reduced climate change can eventually be determined in a way that takes into account the shadow price of avoided carbon at time t, the single year carbon reduction, the discount rate and the atmospheric decay rate of carbon. Others have suggested to use the opportunity cost from using alternative technologies to avoid emissions of carbon.

But in spite of serious attempts to produce a dollar figure for the release of a ton of carbon a consensus has not yet been reached. For practical purposes this means that we continue to manage the global atmosphere with default zero value for carbon accumulation albeit we know it has a certain value.

On the other hand, benefits from avoiding and limiting CFC emissions have been estimated at the global level. An 80% cut in emissions would generate health and environment benefits to the amount of 3553 billion dollars at 1985 prices with a cost of 22 billion dollars at 1985 prices at a 2% discount rate *(Turner, Pearce and Bateman 1994; US EPA 1988)*

For practical purposes, some agencies are using a "unit abatement cost" ranging between $20-25/TC *(Goodland and El Serafy 1998).* Costa Rica has sold Norway carbon certificates at $5/TC, what is a very low figure compared to other values quoted.

The GEF suggested *(Anderson and Williams 1993)* a shadow price to be attached to carbon emissions based on the cost of marginal backstop technologies rather than on the cost of the most promising non-marginal options. A figure of $1-29/TC was suggested as an initial estimate for the year 2010 with a present value of $25/TC in 1993 at a discount rate of 10%.

The value of avoided C-emission could be the basis for introducing a C-tax in Annex I countries. It will help also to provide a comparative cost assessment for evaluating and appraising fossil fuels-based projects, and for internalising GHG emission costs *(Goodland and E1 Serafy 1998)*, complying with the polluter pays principle, a fair and equitable method. This will help to qualify mitigation cost assessment and make non-carbon based technologies more competitive.

Taxation and internalisation of GHG emission associated with genuine moral and equity concerns would help to encourage non-Annex I countries to follow a climate change mitigation policy. The evaluation of fossil fuels-based projects with shadow prices or adding externalities will make GHG intensive fuels less, and make switching away towards renewable ones more attractive, at the same time enhancing intergenerational equity.

4. Equity between Annex I And non Annex I Countries

Equity between Annex I and non-Annex I countries is determined by the way the burden of GHG mitigation efforts is shared, albeit this is not the only burden imposed by climate change.

One of the most outstanding issues is that most developed countries over time have neglected earlier commitments to grant development aid to developing countries (Official Development Assistance), previous to climate change negotiations.

"New" existing financial flow should be offered possibly under a different concept, but with new and added conditionality. These financial flows derived from climate change negotiations should be additional to earlier "compromises" assumed by developed countries. This will be fair and equitable.

Another issue refers to the participation of developing countries in the GHG emission reduction effort. Industrialised countries must take the lead in decreasing emissions due to historic responsibilities. Hence the compliance of developing countries with the climate change response objectives must be seen as a fair equitable and meaningful participation in a global effort, based on welfare convergence criteria.

Several developing countries like China, India, Cuba and others are introducing several measures that are generating a decrease in energy intensity of GDP and as a result, actual emissions are lower than potential ones. Thus, the division of responsibilities between

developing and industrialised countries is important for mitigation, but not a constraining element for developing countries.

In the near future one should not consider developing countries as a whole, but distinguish between several very different groups of developing countries, such as:

- Countries with fast or moderately increasing GHG per capita emissions, large populations and large mitigation potential;
- Countries with moderately or low increasing GHG per capita emissions and small mitigation potential;
- Emerging economies with large GHG limitation or reduction potential;
- Countries without an important GHG reduction potential, but with high vulnerability and adaptation costs.

Participation of non-Annex I countries in a global climate change response effort is argued to be important because the lower cost in these countries complies with the equimarginal principle. But as *Estrada-Oyuela (1998: p.25)* stated: "The hypothesis that mitigation costs are lower in developing countries is true only if market distortions of value are adjusted, because otherwise everything is cheaper in developing countries, including labour and natural resources".

Economists know very well that mitigation costs are mainly determined by the availability of appropriate technologies. In this sense the cost differential is in a real sense a welfare differential. Fairness and equity depend less on the efficiency objective than on the objective as implied by welfare convergence criteria.

Another important issue refers to the same problem from another point of view. Different instruments or mechanisms that let Annex I countries achieve a emission reduction potential at costs eventually lower than for domestic measures must take into account that the cost differential should be distributed between investors and host countries on a fair and equitable basis. Incentives remain if Annex I countries achieve a cost-effective compliance with Non-Annex I countries. The marginal costs of GHG emission avoided should be determined not only with reference to the host country, but taking into account marginal costs from investing Annex I countries *(Dessus 1998; Sokona, Humphreys and Thomas 1998).*

The cost differential between a domestic action in the US and an action in a developing country could reach US$ 105-111 per ton of carbon *(Aggarwal and Narain 2000).* How should this saving be distributed?

Certain countries may have a large GHG saving potential with lower risks, better infrastructure, low bureaucracy costs and political stability so that they possible receive the bulk of capital flows from Annex I countries.

It is advisable that an equitable access to financial flows is granted and that mitigation projects be fairly distributed since private investment flows concentrated in 25-30 developing countries. From these only 12 have absorbed about 80 percent since 1990.

While UNFCCC, COP and IPCC have little influence on the present inequities of the global economy, decisions concerning climate change should at least not exacerbate existing disparities but on the contrary it should comply with convergence criteria.

Solutions to this challenge could involve: a) establishing regional quotas; b) establishing quotas based on GDP per capita income country groups; c) a mixed system giving extra credits to Annex I countries with an equitable distribution of emission reduction projects *(Paneyotou 1998; Sokona, Humphreys and Thomas 1998)*

With regard to equity in sharing adaptation costs, an equitable solution must be found because not all the countries have to deal with large adaptation costs and some countries are more vulnerable than others. The solution might be to impose a levy on transactions or funds dealing with GHG mitigation projects so that enough financial resources should be available to deal with this problem. This does not mean that resources should be freely granted. A methodology for assessing avoided cost derived from adaptation projects is needed, and a vulnerability index should be worked out and discussed, including not only economic but also environmental and social considerations.

For Latin America the most outstanding challenge is the different point of view towards climate change and energy policies, so that it will be difficult for these countries to design a common policy in their position as developing countries. It is very difficult to believe that these differences could be overcome so that the region would design a common policy in this strategic field in the near future.

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DEVELOPMENT, SUSTAINABILITY, AND EQUITY AND THEIR LINKS TO CLIMATE CHANGE VULNERABILITY

Neil Leary

1. Introduction

The Intergovernmental Panel on Climate Change is preparing its Third Assessment Report (TAR) on the science of climate change, its consequences, and response measures. The consequences of climate change are being assessed by Working Group (WG) II of the IPCC. The charge of the IPCC to WG II for the TAR included the request to examine the issues of climate change impacts, adaptation and vulnerability in the context of development, sustainability, and equity. At the time of presentation of this paper, an initial draft of the WG II contribution to the TAR had been completed and distributed internationally for review. In the coming months, the report will be revised to address reviewer comments, distributed for review again, and revised once more before being presented to the IPCC for acceptance. In this paper, the treatment of development, sustainability and equity in the initial draft of the WG II report is evaluated and recommendations are offered on how to improve their treatment.[1]

Development, sustainability and equity issues are relevant to climate change impacts, adaptation and vulnerability in three principal ways:

(i) How do development (sustainable or not sustainable) and equity (or inequity) in society influence who and what are vulnerable to climate change?

(ii) How will the sustainability of development and social equity be affected by climate change?

(iii) Can climate change adaptation policies and measures promote sustainable development and equity?

The draft WGII report provides a sound start on the first question by assessing the influences of development level, intensity and sustainability of resource use, and poverty on vulnerability to climate change. In the IPCC's second assessment report *(Watson et al.*

[1] At the time of publication of this paper, many of the shortcomings identified by the paper had been rectified in subsequent revisions of the WGII report, but some remain. Also, the content and conclusions of the Working Group II report underwent many changes in the review and revision process and any statements in this paper about the content of the draft report should not be relied upon as representing the final conclusions of Working Group II or the IPCC.

1996) and its report on regional impacts *(Watson et al. 1998),* it was concluded that the level of development is an important determinant of adaptive capacity and vulnerability to climate change. In particular, the previous reports found that developing countries have less capacity to adapt to climate change and consequently are on average more vulnerable than developed countries. Related to this is the finding that those who live in poverty lack access to resources that would aid adaptation to climate change and consequently are highly vulnerable. There is the potential then for climate change to have its greatest adverse impacts on those who are the least well off. It was also found in previous reports that climate change can act as an important new source of stress on systems that are already stressed by population growth, non-sustainable resource use, and pollution. In the draft WG II contribution to the TAR, these concerns continue to be important lines of inquiry and are well developed in the draft WGII report. The level of development, poverty, and stresses on systems from non-sustainable uses of resources will likely again be found to be important determinants of vulnerability to climate change.

The draft report is at present weakest in answering the second question. There are considerable obstacles that limit the depth and detail with which the influences of climate change on future development, the sustainability of resource use, and equity can be treated in the TAR. First is that the literature on climate change includes relatively little evaluation of these issues. Many of the estimated impacts of climate change can be expected to affect development and sustainability of natural resources, and to differentially affect people depending upon their individual social and economic status. But climate change studies typically have not explored these issues explicitly. Second is that the rates and patterns of development, the modes and intensity of future resource use, and the status of different groups or individuals within societies are influenced in complex ways by myriad forces. These forces will evolve in highly uncertain ways, particularly over the time frames of relevance to climate change.

In view of these obstacles, the treatment of the second question in the TAR must necessarily be highly qualitative, must be largely based on inference from indirect evidence, and in some instances can only be speculative. Marginal improvements can be made in the next draft. But the principal messages will be that climate change, and how we respond to climate change, will be factors that shape future development, sustainability of resource use, and equity However, we are largely ignorant of how, and this is an important area for future investigation.

Success in answering the third question is mixed. A few of the draft chapters explicitly consider the potential for adaptation responses to provide multiple benefits by reducing vulnerability to climate change, promoting sustainable development, and promoting the welfare of the poor. A few others emphasize enhancement of capacity to effectively manage resources or respond to variability that are likely to have favorable, but unstated, effects on sustainable development and equity. In a couple places the draft report identifies adaptations that could have adverse effects on the sustainability of non-market services

derived from natural resources. Still other chapters treat climate change adaptation very narrowly and provide little or no information of direct relevance to the third question.

In the remainder of the paper, some observations are made on the success of individual chapters of part II of the WGII report in answering these questions. Part II of the report consists of chapters that examine climate change impacts, adaptation and vulnerability of water resource systems, terrestrial and freshwater ecosystems, coastal and marine ecosystems, human settlements, financial services, and human health. Some suggestions for further integration of development, sustainability and equity into the chapters are also offered.

2. Water Resources

How do development and equity influence the vulnerability of water resources and water users?

The hydrology and water resources chapter of the draft report discusses various pressures on water resources and users. Growing water demands, including the use of water for disposal of wastes, are a significant pressure on water resources. Growth in water demand arises from growing populations, urbanization, expanding irrigation acreage, and growing incomes. Pressures on water resources also arise from land use changes that alter hydrology and the loading of sediments, nutrients and other pollutants that are carried by runoff. These stresses diminish water quality, divert water from the streambed where it supports various ecosystems, and increase competition among different potential users.

The role of social and economic factors as determinants of the capacity of different societies to adapt to the hydrological and water resource effects of climate change is emphasized in the chapter. Some specific determinants of adaptive capacity that are identified are wealth, water control infrastructure, monitoring systems, hydrologic and water use data, skills and tools for understanding patterns of variability, skills and tools for water and land-use management and planning, and effective social institutions that provide a framework for water management and planning. Access to these resources is less in developing than in developed countries and consequently adaptive capacity is expected to be lower in developing countries. Populations living in poverty also have relatively low capacity to adapt to and cope with climate change impacts on water.

While the chapter does a good job characterizing pressures other than climate change that act on water uses, and social and economic factors that determine adaptive capacity, little is said about differences in pressures and adaptive capacities across space and time. The chapter would benefit from additional details about regional differences in pressures and adaptive capacity and how they give rise to differences in vulnerabilities to climate change driven changes in the quantity, reliability and quality of water supplies. Additional details

about the limiting effects of poverty on adaptive capacity would also strengthen the chapter.

Much of the chapter is focused on the vulnerability of off-stream water withdrawals for human uses. But growth in off-stream water demands draws water away from in-stream uses of water for support of ecosystems and habitats and threatens the sustainability of these ecosystems and the services they provide. They are also threatened by land-use practices that result in the transport of sediments, nutrients and pollutants to surface waters. The specific responses of ecosystems to changes in water availability and quality should be treated in the chapters on ecosystems, but the water chapter needs to give greater attention to the problem of management of watersheds and the allocation of water to multiple uses, including in-stream uses.

How will hydrological and water resource impacts of climate change affect development, sustainability and equity?

Water withdrawals that are greater than 20% of the renewable water supply is considered by some to indicate that water stress is a limiting factor on development. The water chapter includes estimates from one study of the populations that live in regions for which water stress limits development, i.e. withdrawals exceed 20% of renewable supply, in the present and in the future, both with and without changes in climate. In 1990, one-third of the world's population lived in areas where development is water limited. In 2025, with no change in climate projected, 60% of the population would live in water stressed countries, the increase being attributable largely to population growth. If projected hydrologic effects of climate change derived from two model simulations of the Hadley Center (HadCM2 and HadCM3) are included, very slight increases in the population living in countries where water stress would limit development are estimated.

The evidence from this one study suggests that hydrologic effects of climate change will not significantly expand the number of countries for which water stress is expected to be a limiting constraint on development. However, the chapter notes that water stress is projected by this study to be made more severe by climate change in many countries of southern and western Africa and the Middle East, but decreased in parts of Asia. Further details about changes in water stress in those countries where withdrawals exceed 20% of supply in the absence of climate change should be added to the chapter. If these are areas of water stress under present climate, they are potentially highly sensitive to changes in hydrology and it would be useful to know if water stress is projected to increase or decrease in these countries. If they are also areas of low adaptive capacity, they may also be countries of high vulnerability for adverse impacts.

How climate change affects the sustainability of water use will be strongly dependent upon responses of water managers and users. The chapter notes that an important effect of climate change will be additional uncertainty about the water resource base. Management of water supply and demand will need to adjust to this uncertainty if objectives such as

sustainable use of water resources are to be attained. Wider use of the tools and techniques of decision making under uncertainty and increasing use of flexible strategies are identified as possible responses.

Because of limited adaptive capacity, developing countries are more vulnerable to adverse effects than developed countries. Those living in poverty are particularly vulnerable. But how important are water resource effects of climate change likely to be as a determinant of the welfare of the poor? The chapter does not address this important question. If there is not a sufficient basis for answering the question, it might still be raised in the chapter as a question needing further assessment in the future.

Can adaptations of water management to climate change promote sustainable development and equity?

The water chapter emphasizes the potential for numerous "no regrets" water policy changes. Such policies would provide benefits by addressing growing water demands and reducing risks associated with hydrologic variability, which in turn would reduce vulnerability to climate change. Supply and demand side management options are considered, and the chapter notes that demand side options are gaining favor as tools for promoting environmentally sustainable resource use, cost-effectiveness, and flexibility. Some no regrets options identified in the chapter include elimination of agricultural subsidies to reduce irrigation demand, elimination of subsidies for floodplain occupancy to reduce populations exposed to flood hazards, and recognition of environmental values in project evaluation to promote more rational project selection. Demand side options cannot, however, be pursued in isolation. This is stated to be particularly true in developing countries where objectives may include curbing demand and supplementing supply of safe water to meet human-health based standards. The discussion of no regrets water policy adaptation is focused principally on promotion of sustainable development with no explicit reference to promoting more equitable access to water.

3. Ecosystems and their uses

How does DSE influence the vulnerability of ecosystems and the users of their services?

The chapter on ecosystems assesses climate change impacts, adaptation and vulnerability for terrestrial and freshwater ecosystems, including agricultural systems. It employs the state-pressure-response model as a framework for assessing vulnerability. Within this framework, climate change is treated as one of many pressures that act upon ecosystems and the services that are derived from them. This framework is well suited for considering how land uses and other resource uses create pressures on ecosystems that affect their sustainability and that influence their vulnerability to climate change. However, the chapter is uneven in its application of the state-pressure-response model and in evaluating how pressures on sustainability might shape the vulnerability of ecosystems to climate change.

In a few instances the chapter notes that adaptive capacity is low in developing countries, and that this can make developing countries more vulnerable than developed. But details are lacking and for some of the ecosystems that are covered in the chapter there is no mention at all of development level as a determinant of adaptive capacity. Largely untouched in the chapter is the influence of poverty and lack of access to resources as factors that can shape the vulnerability of different populations to changes in the flow of services from ecosystems that may result from climate change. Consequently, it is difficult to draw conclusions from the chapter about equity implications of climate change impacts on ecosystems.

How will ecosystem impacts of climate change affect development, sustainability, and equity?

There is no explicit treatment of whether or not climate change poses a significant threat to the sustainable use of ecosystems, development prospects, or equity in access to the services of ecosystems. The focus of the chapter is largely on the climate change vulnerabilities of the various ecosystems themselves, and not on the vulnerabilities of populations who derive goods and services from the systems. Giving greater attention in the chapter to the vulnerabilities of these populations will open up opportunities to integrate effects of climate change on sustainable use of ecosystems, development prospects, and equity.

Can adaptation of ecosystem management and use to climate change promote sustainable development and equity?

The sections of the chapter on rangelands and forests explicitly discuss adaptation options that could produce multiple benefits in the form of reduced climate change vulnerability and promotion of sustainable development. The section on lakes and streams raises a cautionary flag by including an assessment of the potential for adaptations in water use and management to adversely impact lake and stream ecosystems (note that they do consider demand side options, which could protect both human withdrawal uses and instream ecosystem uses and are discussed in the water chapter). The forest section similarly notes that adaptations to assure wood product supply could adversely affect other uses of forests. The sections on agriculture, animals, and inland wetlands do not examine possible links between climate change adaptation and sustainable development, either positive or negative. Overall, there is almost no attention given to possible effects of adaptation on equity.

AGRICULTURE

Agriculture is described in the draft chapter as under pressure from rising demands for food to feed growing populations and from environmental changes that diminish agricultural production capacity such as degradation of land and water quality, increased tropospheric

ozone, and increased UVB exposure. Soil degradation is identified as a major emerging challenge that results from wind and water erosion, chemical depletion, water saturation, and salinization. The human origins of these pressures are noted, but the demographic, economic, and development processes that drive them receive little attention and there is no assessment of how pressures on agriculture vary with different development paths or levels. After describing the various pressures, there is no assessment of how these pressures influence the vulnerability of agriculture to climate change. That is likely because there is little if any climate change impacts work that explicitly incorporates these other pressures. But at a minimum, the chapter needs to clearly indicate that the reason for describing the various pressures on agriculture is that these pressures are anticipated to influence the degree and character of vulnerability to climate change. If a qualitative assessment of how these pressures are expected to influence vulnerability can be included, that would be even better.

There is also no assessment in the draft chapter of how climate change may interact with other pressures to influence future development, sustainability of resource use, or equity. A particularly important question to address is how climate change may alter the prospects for feeding a growing world population. The challenge of keeping pace with growing food demands is discussed in the chapter, but the potential influence of climate change is never explicitly addressed. The question should be raised in the chapter even if the answer is that no conclusions can yet be drawn.

The assessment of adaptation of agriculture notes that economic responses and adaptation can substantially limit damages of climate change, or yield net benefits in many instances, and that omission of these responses from modeling of agricultural impacts results in overestimates of impacts. Environmental limits on the potential for adaptation to offset negative impacts, such as poor soils and adverse local climate, are examined in the chapter. But there is no treatment of how social and economic factors may enhance or limit adaptation capacity. The chapter suggests that farmers in developing countries may have limited ability to adapt, but the causes or evidence of this are not discussed. Also, possibilities for adaptations in agriculture to promote reduced vulnerability to climate change, sustainable development, and equity are not addressed in the chapter.

The draft chapter includes a table presenting estimates of crop yield changes in response to climate change for sites in different countries. But the information is not exploited to illustrate patterns of more adverse effects in the low latitude, primarily developing countries, and less adverse or more beneficial yield changes in temperate latitudes, where the developed countries are located. Perhaps that is because these observations were already made in previous IPCC reports. But these are useful and important points to make again in the TAR.

The overall focus of the vulnerability assessment is on agricultural production and producers. There is little treatment of the vulnerability of human populations as the consumers of agricultural output. The focus on production yields a relatively benign view

of vulnerability to climate change. An important element that is missing is the vulnerability of those living in poverty. Does climate change pose additional risks of malnutrition or hunger for those living in poverty? Discussion of this question needs to be included in the chapter.

To summarize, there are a number of steps that could be taken to improve the integration of development, sustainability and equity issues in the agriculture section of the chapter. First would be to add an assessment, qualitative and with caveats if need be, of how other identified pressures on agriculture would affect the vulnerability of agriculture. Second would be to characterize how these pressures differ in developed and developing parts of the world, and how the differences influence vulnerability in these different parts of the world. Third would be to identify key social, economic and other determinants of agricultural adaptive capacity and assess what they imply about the adaptive capacities of developed and developing countries. Fourth would be to examine estimates of crop yield changes from different parts of the world to identify patterns that would help distinguish highly vulnerable areas from less vulnerable areas. Fifth would be to add assessment of how climate change would alter the vulnerability of impoverished populations to reductions in nutritional status and hunger. Sixth would be to give explicit attention to changes in agricultural practices and policies that could reduce the vulnerability of producers and consumers to climate change, promote sustainable agriculture, and promote equity. Each of these is an important line of inquiry for the authors to undertake. Their success will of course be limited by what is available in the published literature.

ANIMALS

The section of the chapter that addresses animals focuses narrowly on the effects of climate change, both observed and projected, on animal populations, distributions, diversity and behavior. Except for brief mention of habitat loss and fragmentation as a pressure on animals, there is no explicit recognition of other pressures on animals. Consequently, an opportunity is missed to evaluate how pressures of human population growth, economic development, growing intensity of use of natural resources, or poverty shape the vulnerability of animal populations to climate change. This failing should be rectified in the next draft of the chapter.

The section on animals includes treatment of some issues that are relevant to how climate change impacts on animals might affect sustainable use of fish and wildlife resources and equity. For example, possible effects on subsistence hunting and fishing activities are covered, as are possible changes in the distributions of animals that act as disease vectors and expose human populations to health risks. Potential extinctions of animal species are touched upon. There is also treatment of possible effects on recreational activities and tourism. Minor editing of these sections could readily make more prominent their relevance to sustainable development and equity concerns.

The draft chapter includes an outline for discussion of possible adaptations by humans to limit adverse impacts of climate change on animals that is to be further developed in the next draft. As this section is developed, the authors should give careful attention to potential changes in human use and management of natural resources that would have multiple benefits for limiting vulnerability to climate change, promoting sustainable use of animal resources, and promoting equity.

RANGELANDS

Rangelands are described as typically marginal lands with relatively low precipitation where human management and use are critical to their status. Human activities such as conversion to croplands and settlements, livestock raising, fuelwood harvesting, and diversion of water are sources of pressure on rangelands that have resulted in land degradation and desertification. Livestock grazing and other uses of rangelands can disturb the soil surface and result in soil compaction, decreased water penetration, increased runoff, increased exposure of soils to wind and water erosion, salinization, and loss of organic content. Increasing human populations in rangelands intensify these pressures. The draft chapter states that the impacts of climate change on most rangelands are likely to be small relative to the effects of other pressures. Some attention is given to the potential for these pressures to interact with climate change, affecting the vulnerability of rangelands and their uses to the effects of climate change and other pressures. This issue should be elaborated on in the next draft of the chapter.

The discussion of adaptation options emphasizes changes in land management practices that limit the vulnerability of rangelands to pressures from human uses of land, thereby also limiting their vulnerability to climate change. Many of the adaptations focus on livestock grazing: livestock density, selection of species, timing of use for grazing, and decreased use of marginal lands. Sustainable agriculture practices for food and fuelwood production on rangelands are also discussed. The chapter notes that lack of infrastructure and investment capital limit adaptive capacity in many parts of the world. Elaboration on this issue to provide more information about limits on adaptive capacity is needed, including differences in adaptive capacity between developed and developing countries.

FORESTS AND WOODLANDS

Human population and income growth give rise to a variety of pressures on forests and woodlands. Increased demand for food, other agricultural products, and human habitation results in conversion of forests to croplands and settlements. Increased demands for wood products, pulp and fuelwood increase harvesting pressures that can degrade forests. Increased recreation demands compete with other demands for forest lands. Increased air pollution degrades the condition of forests. These and other pressures such as disease, fire, and introduction of exotic species are described in the draft chapter, which notes that many of these pressures are greatest in the developing world where poverty and hunger are prevalent, harvesting of fuelwood is an important source of energy, and where tenure

systems may foster land use practices that are not sustainable. These pressures result in declining forest area each year and degradation of forests (i.e. loss of biomass). The chapter notes that these pressures are anticipated to reinforce the effects of climate change on forests and their uses. If possible, given the available literature, this theme should be supported with additional details, particularly regarding the vulnerability of impoverished populations that depend upon forests and woodlands for harvesting fuelwood.

Adaptation options that are discussed in the chapter include more effective land-use planning and allocation, increased investment in plantation forestry, and intensification of forest management. These options are ones that can offer multiple benefits, limiting forest degradation, supporting sustainable development objectives, and avoiding a "wood crisis" (i.e. serious imbalance between the supply and demand for wood products). The chapter notes that particular attention is needed to assure a sustainable supply of fuelwood for low-income populations that rely on this as a critical source of energy. Not addressed in the chapter are differences in adaptation capacity in different parts of the world and different populations.

The chapter highlights an important tradeoff: intensification of forest management to avoid a wood crisis can conflict with other uses of forest lands. With intensified management for wood may come reduced genetic diversity, poorer wildlife habitat, diminished recreation benefits, and lowered resilience to climate change and other pressures.

4. Coastal Zones and Marine Ecosystems

How do development and equity influence the vulnerability of coastal zones and marine ecosystems and the users of their services?

The draft chapter very clearly puts the vulnerability of coastal and marine ecosystems to climate change into the context of sustainable use of these resources. Coastal zones and oceans provide valuable resources and services that support diverse ecosystems, food production, industry, commerce, tourism and recreation. These resources and services are noted to be under stress from increased populations in coastal zones, degradation and destruction of habitat from land use changes, dredging, and other activities, land based pollution that is carried into coastal water bodies and oceans, over fishing, increased UVB radiation, and other pressures. The chapter notes that 20 percent of the world's population lives within 30 km of the sea and 40 percent within 100 km. The various pressures are expected to compound the effects of climate change and to impair the resilience of coastal and marine ecosystems for coping with climate change.

The discussion of vulnerability of coastal and marine systems to climate change gives considerable weight to socioeconomic factors. Coastal development and resource use practices condition the sensitivity of these ecosystems to climate change. Socioeconomic

factors such as technical and institutional abilities, economic wealth, and cultural characteristics are identified as determining a society's adaptation capacity.

The chapter could benefit from inclusion of further details about how pressures and adaptive capacity differ for different regions and/or different fisheries, and how these may give rise to different vulnerabilities by region or fishery. Much of the focus of the chapter is on the vulnerability of coastal and marine resources, such as fisheries. But comparatively little attention is given to the vulnerabilities of communities that are dependent on fisheries or other coastal resources. Greater attention to the vulnerabilities of coastal resource dependent communities is needed.

How will coastal zone and marine impacts of climate change affect development, sustainability, and equity?

There is no explicit treatment of this question in the chapter on coastal zones and marine ecosystems. The chapter implies that climate change may have a significant effect on the sustainability of some fisheries and this could be addressed more explicitly. The authors might also examine case studies of observed social and economic effects of fluctuations or collapse of fisheries. For example, how did the collapse of the Peruvian Anchovy fishery in the mid-70s affect development of coastal communities that participated in the fishery? What were the consequences for those who derived their livelihoods directly from the fishery? Can lessons be derived from this or other examples for development and equity effects of possible climate change impacts on fisheries?

Can adaptations in coastal zone and ocean fisheries management to climate change promote sustainable development and equity?

The discussion of adaptations in fishery management focuses largely on measures that can promote the sustainable use of fisheries and the need to take climate change into account for these efforts to succeed. Identified measures include improved and expanded monitoring to obtain information for better management of fisheries, sharing of the information obtained, modification of fishing industry effort, practices and investment to match biological productivity and responses to climate change, and protection of spawning areas and habitat. Further development of this section, including more information about how the discussed measures might both reduce vulnerability to climate change and improve sustainability of fisheries, would strengthen the chapter.

The discussion of adaptation of coastal zone management emphasizes enhancement of the resilience of coastal systems to sea level rise, coastal erosion and other pressures. It is argued that successful adaptation will require integration within current coastal management processes and practices. Implicit in the treatment of climate change adaptation is the complementarity with sustainable development objectives, but this needs to be made more explicit in the next draft of the chapter.

5. Human Settlements

How does DSE influence the vulnerability of human settlements?

The First Assessment Report found that poor coastal and agrarian communities and poor communities in arid regions are highly vulnerable to climate change. The Second Assessment Report extended these findings to include settlements in developing countries of mostly low income people located in hazardous sites such as floodplains and steep hillsides, often in or adjacent to urban areas, and often of informal or illegal status. Poverty and related lack of access to infrastructure, services and resources figured prominently in these findings. In the draft of the Third Assessment Report, poverty is once again emerging as an important defining characteristic of vulnerable settlements.

Chapter 7 of the draft WGII TAR takes an innovative approach, classifying human settlements into different types and evaluating the vulnerability of the different settlement types to climate change. The classification is based upon economic function and settlement size. In traditional rural and primary resource based settlements, vulnerabilities arise out of heavy dependence upon climate sensitive economic and subsistence activities such as growing food, raising animals, fishing, and harvesting wood and other resources from the land. Incomes and savings of households in these settlements are typically low, housing quality is often poor, and many do not have access to safe drinking water. Community infrastructure for water management, waste and sewage treatment, electricity supply, communication, transportation, and public health is modest relative to other types of settlements. These characteristics also contribute to vulnerability of these settlements. Riverine and coastal settlements are exposed to risks from flooding, sea level rise, and storm surges. Their degree of vulnerability for adverse effects will be shaped by, among other things, the incomes and savings of households, community infrastructure, and diversity of economic activity. Large urban settlements face impacts such as diminished air quality, heat stress, overtopping of sewer systems during floods, in-migration from impacted rural and coastal areas, and increased exposure to infectious diseases. Many of these threats are greater for urban settlements in the developing world than in the developed. Vulnerability is again a function of resources, and access to resources of different populations within urban areas. Informal or illegal settlements within or near large urban areas represent sub-populations who are likely to have lesser access to resources than others.

Issues of development and equity are woven throughout chapter 7's assessment of the vulnerability of settlement types. Much of the assessment, however, is based upon inferences from indirect evidence and speculation. Further work is needed to find studies that provide evidence to directly support the chapter's assessments of vulnerability. Sustainability is present but less prominent, and the text could be revised so as to bring out relationships between sustainable, or non-sustainable, development of communities and their vulnerability to climate change and other sources of stress.

How will climate change impacts on human settlements affect development, sustainability, and equity?

The discussion of climate change impacts on different settlement types is highly relevant to their prospects for development, sustainable or otherwise, and to equity concerns. But the links are not all there yet and will need further development in the next draft.

Can adaptations of human settlements to climate change promote sustainable development and equity?

Adaptation options are not explicitly assessed in the chapter to determine if they would promote the multiple goals of reduced climate change vulnerability, sustainable development, and equity. But the types of adaptations that are considered in the chapter are likely to produce multiple benefits. Adaptation options discussed in the chapter include: improved land-use planning, planning and designing new housing for growing populations that have low environmental impact and avoids sites exposed to flood and other hazards, improving water, sanitation, and electricity supply systems, improving flood control, diversifying economic activity, regularizing property rights, dissemination of information to increase adaptation capacity, and building efficient environmental institutions. The chapter emphasizes the importance of local participation in development of adaptation options as a determinant of success. This can also help to assure equity in the selection and implementation of adaptation options.

6. Financial Services

How do development and equity influence the vulnerability of financial services and their users?

Financial services such as insurance are an important mechanism for spreading risks associated with variable climate and extreme climate events and can potentially play an important role in spreading risks associated with climate change. Financial services are also important to the problem of climate change as a mechanism for supplying financial capital for building capacity to adapt to climate change, infrastructure for resource management, and for disaster preparedness, relief, and rehabilitation. The chapter notes that financial services are concentrated in the developed countries and that there is greater reliance on government and international development and assistance organizations for risk spreading and capital funds. This implies a lower capacity to cope with and adapt to climate change in the developing countries.

The relative scarcity of financial services in the developing countries, and the implications for adaptive capacity and vulnerability in the developing countries, is present as a theme in the draft chapter. But there is relatively little information. These issues should be

elaborated upon and further developed in the next draft. Treatment of these issues should be extended to examine poverty as a factor that limits access to financial services within a society and how this affects who is most vulnerable.

How will climate change impacts on financial services and its users affect development, sustainability and equity.

The draft financial services chapter includes discussion of natural weather hazards and finds that these hazards reinforce poverty in developing countries by taking lives, damaging scarce infrastructure, and diverting financial and economic resources from various uses to disaster relief and rehabilitation. Relative to GNP, weather related disasters in developing countries have been 20 to 30 times larger than in industrial countries. For example, floods and droughts associated with the 1982-83 El Niño caused losses of approximately 10% of GNP in Bolivia, Chile, Ecuador, and Peru. The toll of natural disasters on human life is also greater in developing countries than in developed. Africa and Asia account for 90% of deaths from natural disasters over the period 1973-97.

The observation that these types of impacts reinforce poverty and limit development is important. But the authors should try to take this further. Data on the percentages of capital funds, from domestic and international sources, allocated to disaster relief and rehabilitation in selected countries could help illustrate how much resources are diverted from other potential uses. Another possibility is to look at the potential effects of climate change on agricultural imports and exports, and how changes in net earnings compare to the overall currency earnings of countries. Studies of global agricultural impacts of climate change have included changes in food exports and imports so the information is potentially available for this.

7. Human Health

How do development and equity influence the vulnerability of human health to climate change?

The Second Assessment Report concluded that climate change would have predominantly adverse health impacts and that the vulnerability of human health to climate change would vary with the natural, technical, material and social resources of human populations. In the TAR, the draft chapter on human health stresses the importance of public health infrastructure for limiting vulnerability. Other factors that influence the vulnerability of communities to adverse health effects include water and sanitation infrastructure, nutritional status of the population, local food supplies and distribution systems, education levels and access to information, exposure to disease vectors, air quality, urban heat island effects, existence of early warning systems for extreme climate events, concentration of people in high risk areas, and flood control infrastructure. At the individual level, poverty is identified as an important determinant of vulnerability to adverse health effects.

Differences in these factors between developed and developing countries suggest that human health is more vulnerable to climate change in the developing countries. One billion people, largely in the developing countries, are without access to safe water for drinking and sanitation and up to 4 million people die prematurely each year as a result. Populations suffering from or at risk of malnutrition are concentrated in the developing countries. Air pollution problems are greatest in the cities of developing countries. Exposures to a range of infectious diseases are greater in the tropics and subtropics where many of the developing countries are found. To make matters worse, public health infrastructure in developing countries has substantially less capacity for coping with threats to human health than in developed countries.

These general features of human health vulnerability are prominent throughout the chapter. But it would nonetheless strengthen the chapter to provide more information about differences in public health infrastructure and other relevant infrastructure between developed and developing countries. This would help to support findings about their relative vulnerabilities.

Can adaptations to protect human health from climate change promote sustainable development and equity?

The adaptation options considered in the human health chapter are ones that would promote public health generally, a key goal of sustainable development, regardless of the effects of climate change. The draft chapter finds that the most effective measure is to rebuild public health infrastructure, which is stated to have declined in recent years in much of the world. Many diseases and public health problems that could be exacerbated by climate change can be prevented with adequate public health resources. Investments in public health training programs, disease surveillance, sanitation systems, disease vector control, immunizations, resources to respond to disease outbreaks, and resources to diagnose and treat disease are important components of efforts to rebuild public health infrastructure. Although unstated in the chapter, such investments would potentially bring the greatest benefits to those living in poverty and would therefore promote equity.

References

Watson, R.T., M.C. Zinyowera, and R.H. Moss (Eds), 1998. *The Regional Impacts of Climate Change: An Assessment of Vulnerability*. A Special Report of IPCC Working group II. Cambridge University Press, Cambridge, UK and New York, USA.

Watson, R.T., M.C. Zinyowera, and R.H. Moss (Eds), 1996. *Impacts, Adaptations and Mitigation of Climate Change: Scientific-Technical Analyses.* The Contribution of Working Group II to the Second Assessment of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK and New York, USA.

13

ASSESSMENT OF DEVELOPMENT, EQUITY AND SUSTAINABILITY (DES) IN IPCC-TAR, WORKING GROUP II, REGIONAL CHAPTERS

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1. Introduction

Chapters 10-17 of the IPCC Third Assessment Report (TAR) cover regional impacts and adaptation. At this scale, the unique relationship between climate and place is highlighted. This relationship has changed over time with the advent of changing technologies, institutions, economies and perceptions about environment.

In order for development, equity and sustainability (DES) issues to be represented in these chapters, authors would have to find literature that has placed global climate change in the context of regional development patterns and challenges. It is likely that at this time, the literature will provide few direct examples for TAR authors to use. In addition, few authors have tried to look at the connections between climate change impacts/adaptation and DES concerns, since much attention has focussed on emissions reduction, especially in developed countries. It should be possible, however, for Chapters 10-17 to consider DES with the assistance of the Munasinghe guidance paper, as well as Taniguchi and Tanaka, "User's Guide for Cross Cutting Issues Guidance Papers" (1st draft, January 2000).

2. General Comments on the TAR WG II First Order Draft

In his guidance paper, Munasinghe suggested three broad questions:

a) Will expected development patterns and scenarios make climate change better or worse?
b) Will climate change impacts, adaptation and mitigation make development more or less sustainable?
c) How could climate change responses be better integrated into sustainable development strategies?

These questions are treated quite differently among the eight regional impacts chapters from the Working Group II First Order Draft (FOD) report.

In general, developing country regions (Africa, Asia, Latin America, and Small Island States) have more extensive discussion of DES than the developed country regions, especially Europe and Polar Regions. In the Africa and Asia chapters, there are discussions that are relevant to questions ‘a’ and ‘b’. All chapters discuss vulnerability and coping capacity to varying degrees, with land tenure being of particular importance in Africa and Asia, and legislative instruments highlighted in Australasia, Latin America and North America. Subregional vulnerability and resilience are highlighted in Africa, Asia, North America and Small Island States.

Regarding ‘c’, the Europe chapter includes a section on global development scenarios and how they differ from the Special Report on Emission Scenarios (SRES), but very little discussion on DES in a European context, except for a brief comment in one subsection (see below). The North America chapter considers subregional water rights and methods of financial analysis, but needs to provide some examples of application of the latter. The Small Island States chapter describes vulnerability indices but does not indicate how DES concerns could be included in their design.

DES components are not used as key words in subsection titles (except for Australasia, 12.5.2.5 [Food and Fiber-Sustainability], and Europe, 13.4.2.3 [Synthesis-Regional Issues-Sustainability and Equity]). This makes it more difficult for the reader to find discussion on DES. Most chapters are including DES within discussions on ‘vulnerability’, ‘adaptation’, human dimensions (e.g. aboriginal communities, environmental legislation) and subregional cases. Perhaps there could be a subsection on DES within the synthesis section of these chapters (in most cases, this would be xx.4). DES topics from various sectoral and subregional contexts could be summarized here. This is discussed further in the final section of this report.

Finally, it should be noted that there is no opportunity in the regional chapters to look at the combined implications of adaptation and mitigation strategies on regions. For example, activities associated with carbon sequestration could affect land use choices, thereby altering regional patterns of food and fiber production, wildlife habitats and water resources. Emissions trading may influence urban and suburban planning, and the patterns of industrial activity. Adaptation to changing hydrologic regimes may affect hydroelectricity production, thereby leading to changing demand for fossil fuels. All these could affect regional development paths and the coping capacities of various regions to climatic variability as well as climate change. Where should such questions be raised? Is Working Group III already looking at this? There may be little information from the literature on these synergies, but at least the questions can be identified. This requires input from Working Group III, and could be a topic for Working Group II chapters 18 (e.g. 18.6.1) and/or 19 (e.g. 19.5).

3. Specific Comments on the First Order Draft (by chapter):

CHAPTER 10: AFRICA

Vulnerability and adaptation are major themes, linked with current development problems, including poverty, rapid population growth, rapid urbanization and lack of infrastructure. There is information pertinent to all three questions.

10.2.1.4 – p. 10/12 explores water resources impacts in the Senegal River Basin within two management frameworks – 'rice production policy' and 'natural resource management policy', and concludes that the latter is more sustainable under climate change than the former.

10.2.2.6 – An example of the link between adaptation, governance and sustainability. The role of aid from donor countries in determining proactive adaptation efforts is highlighted in 10.3.

10.2.6.5 – p. 36/7, lines 45/15; Sahel desertification has decreased human carrying capacity, and projected reductions in rainfall will exacerbate this trend.

10.2.6.6 – p. 37, lines 20-38; adaptations to the threat of desertification in the Sahel involve intensification of resource use or diversification of resource exploitation, or changes in herd migration and lifestyles of herders. Does this enhance sustainability?

CHAPTER 11: ASIA

SUMMARY – Sustainable development needs to promote resilience to current climatic variability; adaptations should be economic (p 5, lines 2-16) in the near term; rapid development is proposed to improve public food distribution, disaster preparedness and health care systems; modifying institutions responsible for resource management so that they promote rather than discourage adaptation (e.g. improve public education and literacy, adjust agricultural practices, promote international cooperation);

11.1.5.1 – p. 28 lines 4-6; development context; refers to drawdown of groundwater resources in coastal Asia thereby increasing the rate of relative sea level rise; lines 7-9 notes 'the unsustainable conversion of natural forests to palm oil plantations increased the probability of uncontrolled forest fires during the 1997 ENSO; lines 30-31 refers to sustainability and equity being sacrificed for economic growth, with examples in lines 33-41 describing impacts of insecure rights to land.

11.2 – underlying social factors in vulnerability of various regions and sectors;

11.2.2.3.3 – examples of impacts of current extremes on food supply, and future climate change may lead to increased demand for imports; this means that future food security in Asia will also depend on impacts on grain exporting regions.

11.2.2.4 – sustainable agriculture will depend on public policy support for various adaptation strategies, including diversification of agriculture, infrastructure development;

11.2.4.1 – rapid population growth in the coastal zone, combined with projected sea level rise, means that integrated coastal zone management is needed.

11.2.4.6 – relates to coastal zone vulnerability: page 50, lines 28-52; why have floods in Bangladesh had such catastrophic impacts? Discussion identifies economic insecurity of tenure, and inappropriate flood control measures. Page 51, lines 6-39 defines integrated coastal zone management as an iterative approach to sustainable development.

11.3.3 – discussion on the implications of adaptation strategies [e.g. page 64, lines 35-45 indicates that changes in how farmers operate or in what they produce 'may have significant disruption for poor people'; other examples given on pages 64-65 on adapting to water shortages, land cover changes and coastal zone protection].

CHAPTER 12: AUSTRALASIA

12.5.2.2 – adaptation to recent droughts has led to policy initiatives that have both economic and social dimensions (12.5.2.2.1, .3 and .4); future implications are also discussed.

12.5.2.5 – subsection on sustainability within section on food and fiber production refers to implications of current land use practices (e.g. land use change, inadequate drainage for irrigation); these practices are seen as damaging to biodiversity, air and water quality, and economic return; climate change is expected to exacerbate these problems.

12.8 – adaptation and DES considered in the context of multiple stresses on agriculture, forestry and ecosystems; reference to study by Vaile (not in reference list) on potential adaptation strategies and carbon sequestration, and that there may be social ramifications associated with losses of traditional activities (e.g. page 72 line 50 – page 73 line 32).

CHAPTER 13: EUROPE

13.1.6 – SRES and UK Department of Trade and Industry technology scenarios are compared; the latter consist of four 'world views' [World Markets, Global Sustainability, Provincial Enterprise, and Local Sustainability]; the UK scenarios are seen as having a broader context than the SRES scenarios, and the two sets make different predictions about climate change; the UK scenarios also include predictions about the most likely mitigation strategies to be followed.

13.3 – Adaptation strategies; these are covered for various sectors, especially agriculture and coastal zones, and are seen largely as a technical challenge.

13.4.2.3 – Sustainability and Equity; brief statement about concerns in mountain environments, coastal areas and the Mediterranean, and potential inequities that may result from subregional differences in abilities to adapt.

CHAPTER 14: LATIN AMERICA

14.1.3.4 – Socio-Economic Issues; costs of observed extremes, with greater impacts on poor people reflecting inequities between wealthy and poor people (poor people most affected by floods, storms, desertification); this illustrates high level of vulnerability resulting from inappropriate land use [page 15 lines 1-10]; successful adaptation measures in forestry and fisheries described, but attempts at obtaining higher levels of insurance coverage have not been successful [page 15 lines 49-53].

14.1.3.6 – Environmental Legislation – sustainable development strategies are discussed as environmental protection measures to be included in national and international economic policies [e.g. coastal and marine resources policies, page 17, lines 18-22]; public participation measures also described [e.g. page 15, lines 33-46].

14.2.3 – Sea Level Rise; little research on DES associated with response to sea level rise [page 29 lines 4-14].

Adaptation Potential and Vulnerability; not written yet.

CHAPTER 15: NORTH AMERICA

15.2.1 – Water Resources; includes discussion on water rights and how they vary across subregions [page 16 lines 31-47; page 17 lines 7-20].

15.2.6.2 – Financial Services; adaptation of insurance and brokerage industries, including ‘sustainable cost-benefit analysis’ [page 43, lines 26-33] which addresses concerns about discount rates which can reduce estimated costs of long term climate change damages and benefits of long term adaptation and mitigation measures.

15.3 – Subregional Issues; cases describe vulnerabilities and adaptation measures; example from Arctic Border includes aboriginal and other stakeholder responses to climate change scenarios and potential adaptive responses [page 49 lines 21-54 and page 50 lines 2-22].

15.4 – Synthesis not written yet.

CHAPTER 16: POLAR REGIONS

16.2.8 – Indigenous Peoples; this covers only case studies in the U.S., and describes the traditional subsistence lifestyle and culture being threatened by ecosystem shifts related to projected warming, as well as by economic influences from outside the region [page 23 lines 6-24]; no mention of literature from Europe, Asia or Canada.

16.3 – Adaptation Potential and Vulnerability; example of artificially induced ice jams to create floods in deltas threatened with lower water levels due to climate warming [page 24 lines 25-34].

CHAPTER 17: SMALL ISLAND STATES

17.2.8.1 – Human Welfare Settlement and Infrastructure; vulnerability to extreme weather events has led to changes in insurance coverage, and this may occur in the future [page 20 lines 21-24; also page 21 lines 47-54 and page 22 lines 1-3].

17.3.1.1 – Vulnerability; importance of community arrangements which are different from western societies [page 23 lines 8-16]; non-climate stresses can decrease the resilience of coastal systems to cope with climate variability and change [page 24, lines 24-31]; discussion on vulnerability indices and tools [page 24 lines 33-52 and page 25 lines 1-33] but the tools section does not indicate how DES concerns are incorporated into the design of the tools.

17.3.1.2 – Adaptation and Adaptive Capacity; limited capacity to cope with extreme events [page 25 lines 45-52].

17.3.2 – Regional and External Factors; long time horizons do not justify incorporation of climate change into national development plans [page 27 lines 17-21].

17.5 – Future Requirements; the restricted potential to migrate away from coastal areas will severely limit the options available [page 30 lines 32-36].

4. Looking Ahead to the Second Order Draft

The draft by Taniguchi and Tanaka, “User’s Guide for Cross Cutting Issues Guidance Papers” provides a check list that may be helpful to the regional chapters. *This list, however, suggests that the TAR authors from all the chapters, not just 10-17, will have to make some judgements that could easily go beyond what is specifically discussed in the literature being reviewed*. For example, one of the points in this list is:

“Is the treatment of economy, society and environment sufficiently balanced in meeting the challenges of sustainable development?”

The TAR would therefore have to define "sustainable development" as well as what the 'appropriate' balance is. Does the literature provide some specification for each region? Do we need to clarify or discuss the concept of sustainable development before the analysis of what is specified in the regional chapters? Do we need to understand what is sustainable development *diagnosis* and *strategies*?

Consideration of DES issues associated with impacts and adaptation at a regional level will require an explicit review of literature on observed adaptation, as well as assumptions on adaptation to scenarios of climate change. This may enable regional authors to compare climate-related adaptation with current trends in regional development.

Other points on the check list provide more practical guidance, such as "search...beyond the mainstream journals" and "are indicators used for the assessment of DES multi-dimensional in nature…" It may be necessary for some chapter teams to consider soliciting contributions from outside their teams on a number of DES issues. In Table 1 from Taniguchi and Tanaka, topics identified for regional chapters include:

a) views on managing economic development,
b) views on social goals,
c) views on environmental sustainability,
d) descriptions of environmental pressures from various scales,
e) risk of catastrophe, and
f) integration with sustainable development strategies according to a set of sustainable development indicators.

In most of the regional chapters, section xx.1 includes a subsection that focuses on regional context. Section xx.3 reviews adaptation potential and vulnerability, while xx.4 provides a place for discussion on cross-cutting issues such as DES. In section xx.1, items a-d could be included. Some of this material is already in these chapters, particularly from the developing countries. Item e could be considered in subsections on various sectors (e.g. food), and also in xx.3, but this will also depend on information on changes in extreme events that should be covered in xx.1. Item f should probably be placed in xx.4.

14

WHAT ARE ADAPTATION NEEDS AND HOW CAN THEY BE MET?

Ian Burton

1. Adaptation in Developed and Developing Countries.

The fact that adaptation to climate change is imperative and even urgent is now more widely recognized and accepted. That international cooperation is required to formulate and implement adaptation strategies has been accepted in the United Nations Framework Convention on Climate Change (UNFCCC), but the development of understanding about adaptation and movement towards international agreement on what steps should be taken has lagged behind mitigation. This paper reports a variety of current perspectives on adaptation, and summarizes the state of knowledge and thinking as reflected in recent research in a number of developing countries. On this basis it also identifies possible approaches to the development of international cooperation on adaptation in the context of the Climate Convention and the Kyoto Protocol.

Adaptation offers ways of reducing the impacts of climate change in both developed and developing countries. It is has been authoritatively concluded that for the United States and other developed countries the capacity to adapt is high *(National Academy of Sciences 1992).* This confidence has to be qualified in three ways. First it applies most to heavily managed socio-economic sectors listed in the National Academy report as farming, managed forests and grasslands, water resources, tourism and recreation, settlements and coastal structures, human migration and domestic tranquility (sic). Systems that are described as sensitive to climate change and where adaptation is questionable are listed as the natural landscape and marine ecosystems. Second, the costs of adaptation remain largely unchartered *(Rothman, Dale, Demeritt, Chiotti and Burton 1998; Halsnaes, Sathaye, Christensen 1998).* It is assumed that the costs will be relatively low in relation to national wealth, but this depends upon the magnitude and rate of climate change which remains uncertain. Third, confidence in the ability to adapt assumes that climate change will be slow and incremental, and will not involve low probability but potentially catastrophic events such as sudden shifts in ocean circulation (e.g. the North Atlantic thermohaline circulation) or the collapse of the west Antarctic ice sheet and a consequent dramatic rise in sea level (estimates range from 5 to 7 meters).

These caveats notwithstanding, the view that developed countries can cope with the necessary adaptation without the need for broad international agreement or action is well

established. It is being recognized however, that adaptation measures adopted in one country might have consequences for other countries. This applies most clearly in transboundary situations. For example, where adaptations to changing hydrological regimes are required in international river basins. To the extent that adaptation policies and measures may also affect the terms of trade both regionally (e.g. European Union, and North American Free Trade Agreement), and more globally (World Trade Organization) it seems likely that some international agreements or understandings will eventually be required.

In developing countries, the capacity to adapt is known to be much lower in most cases. This is due to a relative lack of financial resources, lesser availability and access to technology, weaker scientific research and development capacity, less effective institutions, social and governmental organization, and less development of skilled human resources. Not only the amount of national wealth but also its distribution is important. Countries with larger proportions of the population living in poverty also have less adaptive capacity.

This large divergence in adaptive capacity between developed and developing countries is the major reason that the impacts of climate change are likely to be much greater in those regions (i.e. low latitude, tropical regions) where climate change, measured in terms of mean temperature change, is projected to be least *(IPCC 1996a).* Significantly larger changes in mean annual temperature are projected for middle and high latitudes, but the fact that the more highly developed countries with greater adaptive capacity are largely located in these regions is expected to reduce impacts to a more tolerable level.

These circumstances raise at least four important questions about the use of adaptation as part of a more comprehensive and widely available portfolio of responses to climate change. First, it is important to be clear what is meant by adaptation to climate change. Second, there is the issue of the development of national policies or strategies for adaptation and the capacity to implement them. Third, there is the question of responsibility for adaptation and the fair distribution of costs. Fourth, there is the question of how adaptation fits into the portfolio of response, particularly its relationship to mitigation.

These questions involve international cooperation, at least in the case of the developing countries, and so they have to be addressed within the context of the Climate Convention and the Kyoto Protocol to the Convention, as well as the rapidly developing literature on the science of adaptation *(Washington Advisory Group 1999).*

2. The Climate Convention Context.

From the very outset of the negotiations on the United Nations Framework Convention on Climate Change in the late 1980s, adaptation to climate change was treated as secondary to mitigation. The ultimate objective of the Convention is stated as the “stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous

anthropogenic interference with the climate system". What has followed from this initial formulation is an overwhelming concentration on the issues of mitigation: how much mitigation is needed, when, at what rate, and what is the appropriate distribution of responsibility for achieving agreed targets on schedule? The requirement to reach international agreement stems from the global nature of climate change. Since all countries contribute greenhouse gases to the atmosphere, although in unequal amounts, it is imperative that all countries agree on their respective responsibilities in order to avoid the free rider problem. International negotiators have been drawn to this issue like insects to a candle flame.

Nevertheless the Convention does recognize the eventual need for adaptation and this is specified in Article 4.1 of the Convention as well as in Article 4.4 which provides that "Annex II Parties shall also assist the developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting the costs of adaptation to those adverse effects". According to one commentator, "this provision is the clearest expression of the acceptance that the Convention is as much about adaptation as it is about mitigation" *(Yamin 1998).*

Over the first five years of the life of the Convention, up to the signing (but not yet ratification) of the Kyoto Protocol in December 1997, the overwhelming amount of attention has continued to be devoted to mitigation. Five considerations help to explain the reluctance to address adaptation:

- Adaptation has been thought of as a long term strategy that can be delayed until the effects of climate change are more evident and less uncertain.
- Adaptation has been so broadly defined that the potential range of adaptation measures is extremely large, and there is neither adequate information on the costs of adaptation nor a basis for the determination of priorities.
- The Annex II Parties are concerned not to expose themselves to substantial and ill-defined demands for assistance under Article 4.4 and have provided guidance to the financial mechanism, the Global Environmental Facility, (GEF) that severely restrains the provision of assistance for adaptation.
- The GEF was initially established in response to a developing country demand for international funding to meet the additional costs of responding to the need for global environmental protection. A criteria for GEF funding therefore has been that global environmental benefits be demonstrated. In the case of adaptation, the benefits fall overwhelmingly in the place or country where the adaptation measures are taken, and for this reason it can be argued that additional funds above and beyond normal development assistance are not justified.
- Much development activity could be amended to take present day climate into account as well as its associated probable future variability and extremes *(Burton and Van Aalst 1999).* Since it is not now possible (and may never be so) for atmospheric science to distinguish with certainty between normal climate variability and climate change, on a local or regional scale, it follows that it is not possible on purely scientific grounds, to

distinguish between adaptation measures (and their costs) to normal climate and to climate change.

Two of these five considerations, lack of urgency, and lack of global benefits have lost some of their initial force:

- The recent dramatic increase in the costs of weather-related natural disasters has helped to create a sense of urgency. While it cannot be scientifically proven that the magnitude of currently experienced climate variability and extremes are linked to climate change there is certainly a possibility that this is the case. Atmospheric scientists generally agree that such a pattern is consistent with the changes that may be expected as a result of the destabilization of the atmosphere and the intensification of the hydrological cycle caused by climate change. The cost of weather-related disasters in 1998 exceeded the costs of all such disasters in the decade of the 1980s *(Annan 1999a; Annan 1999b).* The high losses of 1998 can be attributed to the unprecedented strength of the 1997-98 El Niño event. Here again a link to climate change is possible but not proven. Despite these necessary qualifications, the potential and probable links between climate change and current extreme events is sufficient to give cause for concern.
- The argument that adaptation measures do not yield substantial global benefits is offset by the recognition that the costs of adapting to climate change have in effect been imposed by the historical emissions of greenhouse gases largely from the Annex II Parties to the Convention. Indeed the acceptance of a responsibility to assist in meeting the costs of adaptation in Article 4.4 is tacit recognition of imposed costs. *(Fankhauser 1996).*

The remaining three reservations about adaptation are addressed in this paper, beginning with the issue of the broad definition of adaptation.

3. What is Meant by "Adaptation to Climate Change"?

The Framework Convention does not define adaptation, and there is a lack of a formally agreed general definition. The closest thing to an authoritative definition may be found in IPCC where it is stated that, "Adaptability refers to the degree to which adjustments are possible in practices, processes, or structures of systems to projected or actual changes of climate. Adaptation may be spontaneous or planned, and can be carried out in response to or in anticipation of change in conditions *(IPCC 1996b: p. 5).*

Clearly the scope of adaptation is very wide indeed. A useful taxonomy/anatomy of adaptation has been developed *(Smit, Burton, Klein and Wandel 2000).* The scope is dramatically reduced however if a distinction is made between adaptation to climate and adaptation to climate change *(Burton 1997).* Adaptation to climate has always been an essential part of the evolution and survival of both natural and human systems. So adaptation to climate change is not something that starts from scratch. It is an incremental process that builds upon a long history of prior adaptation.

It is sometimes claimed in the new research and policy literature on adaptation to climate change that adaptation is a new field about which there is little knowledge or experience. This is true if it is applied strictly to anthropogenic climate change. It would be a mistake however to assume that an entirely new field of science has to be created. In each of the socio-economic sectors at risk from climate change there exists both theoretical and practical knowledge concerning response to climate and climate variability and extremes *(Washington Advisory Group 1999).* The character of this knowledge differs from sector to sector. In agriculture, for example, there is a great deal of practical knowledge and local experience in every farming community which individual farmers use in making day-to-day decisions about choice of cultivars, timing and method of cultivation and the like. This is augmented by a considerable body of knowledge encompassed in crop models which describe the response of many different types of crops to a wide range of climatic and weather variables. Similarly, in the design of infrastructure including residential, commercial and industrial property, bridges, highways, drainage channels, docks and harbours and the like, weather and climate variables are taken into account in design standards which are often officially approved and for which construction companies are held responsible to ensure proper implementation. In water management, transport, forestry, tourism and recreation, health protection, and coastal zone management, factors of climate variability and extremes are often and should always be an element in design and decisions, either in formal or informal ways.

In order to develop a science of adaptation to climate change it is necessary to build upon this existing knowledge in increments that allow for a new and probably wider range of variability and extremes than has previously been considered. There is one important new element which does suggest that the science of adaptation to climate change requires more than incremental changes to the sum of previously employed methods for adapting to climate change. Risk management for climate and weather variability and extremes has previously been carried out in quite a compartmentalized way. Those concerned with weather and climate variability in agriculture have been able to develop their science quite separately from those similarly engaged in other sectors such as forestry, water resources, building and infrastructure design and so forth. Different weather variables with different underlying causes affected different sectors. Thus farmers are more concerned about the likelihood of frost or drought, and less concerned with the heating and ventilating of large buildings for human occupation. The sciences of agronomy, hydrology, forestry, architecture, construction design and engineering, the human health sciences and so forth have all developed their own approach and terminology for risk assessment. Now they are confronted with a common risk to which they are all vulnerable, admittedly in different ways and to different degrees. This common source of threat is forcing a convergence of methods and terminology towards what might be called integrated risk assessment for climate change. This process is only beginning, and its momentum can be seen in the growing field of integrated assessments.

4. The Identification of Adaptation Needs and their Assessment.

Within this broad conception of adaptation to climate change it becomes necessary to specify in each country and for each locality what adaptation needs are and to prioritize them. In developed countries it has so far been assumed that the various socio-economic sectors will have the capacity to adapt and that little or no overall planning or policy is required. To the extent that preparatory action is thought necessary this has tended to focus upon research for future adaptation heavily linked to climate impact studies.

In developing countries the search for adaptation needs and the development of priorities has received a little more attention. This stems from the fact that the need for adaptation is likely to be greater and the capacity is known to be less. It is also true that developing country governments have some hopes and demands that the developed country Parties to the Framework Convention will assist in meeting the costs of adaptation. It is therefore in their interests to be able to demonstrate that adaptation needs exist and can be assessed. This has been recognized in the decisions of the Conference Of the Parties to the Convention (COP). The Global Environment Facility (GEF) has been designated the financial mechanism for the Convention and carries out its functions under the guidance of and accountable to the COP. At the first meeting of the Conference of the Parties (COP-1) held in Berlin in 1995, it was agreed in Decision 11/CP.1. that adaptation would take place in developing countries in three sequential stages to deal with short, medium and long term strategies. The stages are specified as follows:

- Stage I: Planning. This covers studies to identify impacts of climate change, particularly vulnerable countries or regions and policy options for adaptation and capacity building.
- Stage II: For particularly vulnerable countries/regions identified in Stage I, measures, including capacity-building to prepare for adaptation, as envisaged in Article 4.1 (e).
- Stage III: Measures to facilitate adaptation, including insurance, and other adaptation measures as envisaged in Article 4.1 (b) and Article 4.4.

At the fourth meeting of the COP (Buenos Aires 1998) it was agreed to move from Stage I to Stage II, within the context of communications made by the Parties to the Convention Secretariat.

Up to the end of 1999 there has been remarkably little support to developing countries under Stage I or II. This has been explained by one commentator in terms of “the reluctance on the part of the GEF to finance adaptation measures” *(Yamin 1998).* This reluctance is said to be “fuelled by donor concern about responsibility for adaptation costs” *(Yamin 1998).* The reluctance stems in part from the GEF’s constitutional mandate to fund actions that result in “global environmental benefits”. It is argued that because adaptation benefits are overwhelmingly concentrated in the place where the measures are taken they generate no easily quantifiable global environmental benefits *(Werksman 1993).*

Potential adaptation measures in developing countries have also been studied under other arrangements. Prominent among these are the US Country Studies Program*, (Smith et al.*

1996), and the Country Studies supported by the GEF through the United Nations Environment Programme *(Republic of Cameroon 1998, Government of Pakistan 1998, Republic of Estonia 1998, Government of Antigua and Barbuda 1998, United Nations Environment Programme 2000).* In addition, the Netherlands has supported a number of Country Studies, and one project has been carried out in Uganda in association with the World Resources Institute and supported by the US Agency for International Development *(Apuuli, Wright, Elias, and Burton 2000).*

A review of these studies reveals no case in which a specific adaptation measure is identified that clearly applies to climate change alone, and does not also yield additional or co-benefits by the reduction of damages from known climate variability. Most of the studies have focused primarily on the potential impacts of climate change and have devoted little attention to adaptation beyond the creation of long lists of needed adaptation measures. In the course of the Uganda study, a useful distinction emerged between cross-cutting measures relating to a variety of government policies and programmes that are multisectoral, and single sector measures. These sectoral measures may be further subdivided into general and specific. In the case of Uganda the following cross-cutting measures were proposed at a workshop attended by government experts and policy makers, university based scientists and environmental non-governmental organizations *(Republic of Uganda 1997).*

1. *MULTI-SECTORAL AND CROSS-CUTTING MEASURES.*

- Strengthen Uganda's meteorological services so that they may provide reliable medium to long term advisories with respect to drought and floods.
- Strengthen the Early Warning Information capacity, especially for food security and short-term climate prediction.
- Incorporate climate change and variability information and projections into Uganda's long-term development plans, such as the National Environment Action Plan (NEAP), the Water Action Plan (WAP), the Forest Action Plan (FAP), the Poverty Eradication Action Plan (PEAP), and the Decentralisation Process.
- Carry out an inventory of existing practices and policies used to adapt to different climates in all line agencies and sectors, so as to begin more detailed identification of adaptation measures for evaluation and adoption.
- Ensure that the Uganda Disaster Preparedness Committee (UDPC) includes in its work plan long term hazard reduction related to climate change and climate variability.
- Promote awareness of climate variability and change and potential response alternatives throughout Ugandan society.

2. *SECTORAL MEASURES.*

General

- Review agricultural policies to find ways of reducing existing vulnerability, and avoid creation of new vulnerability.

- Renegotiate the Nile Waters Agreement to include climate change response plans on the utilization of Nile River waters.
- Review the Uganda Forest Action plan to ensure that climate variability and change have been considered.

Specific

- Reduce reliance on monoculture planting of bananas (matoke).
- Expand irrigation and increase irrigation efficiency.
- Both the Uganda government and communities should begin to adopt contingency planning for both droughts and floods, aimed at managing current climate variability especially in the most vulnerable districts
- Ensure that development at potential dam sites along the Nile River and other basins is controlled to ensure future development without encumbrances.
- Encourage water conservation at all levels of the community using appropriate methods including the use of market based systems.
- Enhance and strengthen the Uganda Tree Seed Project to ensure that original biodiversity is protected against climate change and climate variability to guard against irreversible species disappearance.
- Reduce geographic fragmentation of forests to ensure that forest types can freely migrate in the face of climate change.
- Encourage off-site biodiversity protection so as to avoid species extinction.

When this three-fold grouping of adaptation measures is applied to other adaptation studies almost invariably examples of all three types are identified. One of the most comprehensive studies of climate change impacts and adaptation needs at the national level has been completed in Antigua and Barbuda *(Government of Antigua and Barbuda 1998)*. Largely because the country is small (170 square miles and 64,000 total population in 1991), no part of the national territory was excluded from the study, and the six sectors examined account for virtually all the economic activity and environmental resources of the country. The study embraced coastal zones, fisheries, agriculture, (including forestry and livestock), water resources, human health, and human settlements and tourism.

For each of these sectors detailed studies of potential impacts were made and a substantial list of more than 60 adaptation needs was identified. No attempt was made to establish priorities for adaptation between sectors, although some preliminary screening of adaptation measures was carried out within sectors.

The report concludes that the major sources of impacts are likely to be hurricanes, sea level rise and drought. It is not possible to say with confidence to what extent hurricanes may increase in frequency and severity, or how rapidly sea level rise may occur, nor how much more frequent and intense the recurrent droughts may become under climate change. It is clear however, that all three of these phenomena now cause substantial damage to the economy, and that present adaptation measures are insufficient. Antigua and Barbuda

presents a clear "win-win" or "no regrets" adaptation case where augmentation of present measures is needed, which will yield higher benefits the more rapidly that climate change related impacts intensify. The water resources and human settlements and tourism sectors illustrate the situation.

The requirements for water already press hard on available supplies, especially in the dry season, and in recurrent drought years. There is competition among users for available water and when supplies are short municipal uses and the commercial hotel sector receive supplies at the expense of agriculture. The high seasonal and inter-annual rainfall variability increase the difficulty of efficient management. According to the report "there is no national water resources management policy or strategy to cope with the stressed water situation and the possible impacts of climate change" *(Government of Antigua and Barbuda 1998: p. 137).* A general sector-wide adaptation approach is proposed which would require the launching of a Water Resources Management Action Programme which would include but not be limited to the following components:

- More efficient management of existing supplies and infrastructure.
- Institutional arrangements to limit future demands, and to establish integrated water resources management.
- Strengthen water resources monitoring and information systems.
- Promote conservation.

In addition a large number of specific measures are proposed including:

- Installing a displacement device, which reduces the water the toilet tank will hold.
- Using low-flow faucets.
- Rehabilitation of watersheds.
- Construction of new reservoir capacity to capture and store excess flows produced by altered precipitation, run-off patterns, and storms.
- Construction of deep wells.

These are in addition to the existing plans of the Antigua Public Utilities Authority (APUA) which call for more desalination capacity; exploration of deep aquifers; automatic water transmission control; and reduction of unaccounted for water through leakage and waste control and reducing the number of illegal connections.

Hurricanes and tropical storms constitute the major risk to human settlements and infrastructure, including commercial buildings and tourist hotels. Even a small increase in the frequency and/or intensity of such storms could have severe effects on the economy of Antigua and Barbuda. Hurricane Hugo (September 1989) caused an estimated EC$ (East Caribbean dollars) 154.1 million in direct damage, including EC$130 million to buildings. This amounted to 17.6% of GDP, or in the order of five or more years economic growth at current average rates. Hurricane Luis (September 1995) had worse consequences and direct damages are estimated at EC$364.5 million or 30.5% of GDP, (in the order of 10 years of economic development).

Seven types of adaptation measures are proposed to reduce the vulnerability of human settlements and infrastructure to climate change as follows:

1. *Hazard Mapping*. The objective is to identify on maps the areas which are most vulnerable to the effects of climate change.
2. *Flood Control*. This measure includes the cleaning of watercourses and drains, and the prevention of filling in of the natural drainage system.
3. *Land Use Controls and Enforcement*.
    - zoning regulations to demarcate specific area for different types of land use, such as building densities and height limits within each zone.
    - building codes and planning and infrastructure standards.
    - set-back requirement for the coastal zone.
4. *Retrofitting Existing Structures*. Refurbish old structures to bring up to standards of the building code but most importantly, to strengthen their resilience against the hazards of global warming, hurricanes and droughts.
5. *Capacity Building.* This involves strengthening institutions such as the Development Control Authority and other agencies responsible for environmental management. It also involves improvements in inter-agency coordination.
6. *Improvement in forecasting and early warning systems* so as to increase preparedness capability.
7. *A public education and information systems programme*, to sensitize the public on the issue of global warming and its effects.

The Pakistan Country Study concentrated on three sectors – water, agriculture and forests *(Government of Pakistan 1998).* Within these three sectors the Pakistan study is one of the most sophisticated yet undertaken, especially in its use of socio-economic scenarios of future growth and development and its treatment of adaptation to climate change in the context of economic development. Pakistan, like Egypt, has a hot and arid climate that would support a much lower population were it not for exogenous river flow that permits extensive irrigation. Pakistan has the world's largest contiguous irrigation system in the Indus Plains with year round cropping in much of the area. Water potential, waterlogging and salinity, and water use efficiency are the current as well as the future key issues. Population growth has been rapid, from 32.5 million in 1947 at the time of independence to an estimated 140 million in 1997/8 and projected to reach in the order of 229 million by 2020 (medium growth variant).

A number of climate change scenarios were employed in the study. In general "the results show that while the total water storage in the system remains insufficient, the water resources operation under various climate scenarios shows that the problem will become more acute in the future. The problem will become more serious if the increase in temperature is coupled with a decrease in precipitation. … The net overall capacity of the system to supply water in time will decrease in Pakistan unless some urgent actions are taken" *(Government of Pakistan 1998: p. xiv).*

The adaptation strategy for the water sector may be summed up as “the conservation and efficient use of water in an informed an efficient manner” *(Government of Pakistan 1998: p. xviii.).* The report concludes that water managers will be forced to re-evaluate the whole system operation and revise the allocation of water for agriculture in various irrigated areas. Adaptation options include; “mitigating the hazards of floods; altering streamflow regime by the construction of reservoirs; alleviating economic damages of waterlogging and salinity; augmenting supplies and re-allocating the available resources”.

In the case of agriculture the Pakistan study reports that the production of major crops like wheat, rice, cotton and sugarcane has to be doubled by the year 2020 to meet the requirements of the country’s growing population. It is concluded that such expansion of production and the water that will be required as an input can be achieved. This will require adapting very high efficiency irrigation systems and improved agronomic practices. “The use of sprinkler and drip irrigation systems coupled with chemigation facility is a good example”. “The climate change would further demand to increase the annual growth rate in agriculture of around 0.1% and 0.2% for the periods 1997-2020 and 2021-2050 respectively” *(Government of Pakistan 1998: p.xx).*

The most general conclusion emerging from the Pakistan study, confirms earlier results from Uganda and Antigua and Barbuda, and is consistent with conclusions emerging from other research as for example in the U.S. Country Studies Program, as well as the more limited adaptation studies that have been completed in developed countries. Adaptation to climate change requires a great deal of action that is needed in any case. The threat of climate change implies that these actions should be accelerated if the same level of risk is to be maintained. Since the level of risk currently practiced in many countries is not consistent with sustainable development it is clear that climate change adds yet more force to the argument. But adaptation to climate change is not limited to the simple acceleration of development activities that are required in any case. Changes in policy and management practice and innovations in monitoring, forecasting and research are also needed.

5. The Assessment of Adaptation Measures.

Attempts to measure the costs of adaptation to climate change are few and far between. In the impact and adaptation studies cited, the common pattern has been that major emphasis is placed upon impacts, and then lists of possible adaptation options are generated. In some cases a preliminary screening of measures has been carried out, but nowhere to date has a thorough assessment of adaptation been made. This is not for lack of methodology or guidelines on how to proceed, nor for a lack of theory on costing. It is simply a matter of time before well-grounded estimates of adaptation costs become commonplace.

A compendium of decision tools to evaluate strategies for adaptation to climate change has been prepared for the Secretariat of the Framework Convention *(Status Consulting 1999).* Despite the use of the word “strategies” in the title most of the tools in fact refer to the

evaluation of specific projects. Nine tools are described that can are applicable to multiple sectors, including benefit-cost analysis, risk analysis, expert judgment, and a range of screening techniques. A further 23 tools are described for selected sectors; water 5, coastal zones 5, agriculture 11, and human health 2. These largely consist of models (both physical and economic) and some more general methodologies.

A more detailed description of the application of benefit-cost analysis has also been prepared for the Global Environment Facility *(Smith, Ragland, Raucher and Burton 1997).* In addition guidelines for impact and adaptation assessments have been prepared and widely disseminated in country study programmes *(Feenstra, Burton, Smith and Tol 1998; Benioff, Guill and Lee 1996).*

More theoretical groundwork on the potential costs of adaptation has been developed in a number of papers *(Fankhauser 1996, Markandya and Halsnaes 2000).*

In a practical demonstration of the application of benefit-cost methods Smith and others *(Smith, Tol, Ragland, and Fankhauser 1998),* report of three case studies consisting of flood prevention measures on the Meuse river in the Netherlands, the augmentation of storage capacity by 25% in a proposed water supply reservoir in the western United States, and adaptation to sea level rise by a 1 meter increase in the height of a bridge between New Brunswick and Prince Edward Island, Canada. In all three examples there is a case to be made in theory for precautionary or anticipatory adaptation measures involving changes in project design. In each case however, the benefits of such measures only justify the cost in the most severe assumptions about the occurrence of extreme events and the most favourable (to the project) discount rates. Discount rates greater than 5% result in virtually zero present value for avoided climate change impacts in the middle and latter part of the next century. In order for the bridge raising and the dam enlargement to be justified it is necessary to assume a 100% probability of a 1 meter sea-level rise, or a 10% decrease in precipitation respectively.

This literature does not negate the argument that precautionary or anticipatory adaptation merits consideration, especially in long-term infrastructure investments. The same group of experts *(Fankhauser, Smith and Tol 1999)* have proposed three “simple rules” to guide adaptation decision. They argue that adaptation measures should be considered now and not delayed until more concrete evidence of climate impacts is available; that measures to increase flexibility and robustness in project design can be justified, and that public (governmental) action to facilitate adaptation is needed because without it autonomous adaptation will either not take place or will be less than optimal.

However, the literature also strongly suggests that there is likely to be little justification for massive investment in adaptation measures in the short term. Adaptation measures, it seems, can be justified but at the project level the costs will be limited to marginal increases in the aggregate costs of projects justified, in their own right regardless of the amount and speed of climate change.

This conclusion seems likely to be robust at the level of projects (specific adaptation measures) and to some extent within sectors. As has been shown however, in the case studies of adaptation completed to date, there is an argument to be made for a more strategic approach to adaptation. None of the adaptation literature so far addresses the costs of multi-sectoral and cross cutting measures that are being advocated to strengthen the capacity to adapt. In the case of specific adaptation measures, it seems reasonable to make assessments in terms of the marginal increment that can be justified in project design to reduce potential losses from climate change related impacts. Where broadly based national programmes of water management (Pakistan), coastal zone management (Antigua and Barbuda), and management of floods and droughts (Uganda), are involved, it is not so clear how the benefits of incremental strengthening or acceleration is to be measured. Yet, at this stage in the evolution of the climate change issue, it is most probably the strengthening of national capacity to adapt, and the modification of existing development plans to take climate change into account, that is most urgently required.

6. Finding a Way

Gradually the reasons for the past lack of attention to adaptation are being removed. Studies have shown that some marginal increments in investments in adaptation measures at the project level can be justified. The same studies show that the costs of such measures are not likely to be large, at least in the short term. Even the difficult question of how to distinguish between the impacts of normal climate variability and anthropogenic climate change is proving not to be intractable and reasonable decisions can be made upon the basis of projections and models of climate change and its potential impacts and reasonable and transparent assumptions. The remaining questions have to do more with mechanisms for adaptation, and to what extent adaptation can be effectively addressed by itself (a protocol for adaptation?), or can be addressed simultaneously in some combined way with mitigation.

In the Kyoto Protocol adaptation funding is specifically linked to mitigation for the first time. Clause 12 which defines the Clean Development Mechanism (CDM) provides for a levy on mitigation agreements under the CDM to provide for the costs of adaptation in vulnerable developing countries. Negotiations are currently underway on the subject of the precise rules for implementation of the CDM, in anticipation of the day that the Kyoto Protocol will be ratified and go into force.

While these negotiations are naturally focused on the mitigation aspects of the CDM a number of important questions arise with respect to adaptation. Seven of these have been addressed by Farhana Yamin *(Yamin 1998).* This paper addresses an additional four questions.

1. The Kyoto Protocol recognizes three mechanisms for international cooperation in the reduction of greenhouse gas emissions. These are:

- Joint Implementation (JI) between Annex B Parties (the developed countries) (see Article 6) which involves transfers of Emission Reduction Units (ERUs) created by emission reduction or sequestration actions in one Annex B country to sources in another Annex B country in return for financial and other assistance.
- International Emissions Trading (IET) between Annex B Parties (Article 17) which involves transfer of Assigned Amount Units (AAUs) between Annex B countries.
- the Clean Development Mechanism (CDM) (Article 12), which involves transfers of Certified Emission Reductions (CERs) created through emission mitigation projects implemented in developing country Parties to Annex B Parties in return for financial and other assistance.

It is only one of the three mechanisms, (the CDM) which carries the adaptation levy. Other things being equal, this would seem to bias the choice in the direction of JI and IET, and hence reduce the extent to which the CDM is used, and accordingly reduce the potential funds to be generated for adaptation. Accordingly the question is whether in the interests of equity and in the generation of adaptation funds, the adaptation levy should not also be extended to all three of the mechanisms? Clearly this is a matter for governments to decide, but the answer presumably in part depends upon the need for adaptation assistance.

2. Even if the adaptation levy were to be extended to all three mechanisms, it is not clear how much money is likely to be generated for adaptation, and whether this is likely to be adequate. One preliminary estimate indicates that revenues for adaptation assistance could be as high as US $ 2.1 billion or as low as US $ 100 million on an annual basis *(Haites and Yamin 2000).* There are as yet no published estimates of the costs of aggregate adaptation needs in developing countries, (there are none in any country), although research suggests that the open ended need for funds that has been imagined is unlikely to materialize provided that reasonable and transparent assumptions are made about impacts, incremental costs and the pace of climate change.

3.Given that a case has been made for proceeding to Step II adaptation and that this was agreed at the COP 4 meeting in Buenos Aires in 1998, where will funds for adaptation come from in the event that the ratification of the Kyoto Protocol is delayed or postponed indefinitely? One possibility is that the size of the resources made available by the donor countries through the GEF could be increased to enable progress to be made in the implementation of Stage II adaptation, without reference to the level of the mitigation effort.

4. If the Kyoto Protocol comes into force as proposed, and assuming that funds for adaptation are generated by the CDM or all three mechanisms, what is a possible formula for allocation of the funds among the more vulnerable countries? Studies to date have tended to assume that funds would be allocated on a project by project basis as and when feasibility studies are carried out. There is some preliminary work underway on the

development of a vulnerability index to guide such a process, but it seems to be some time (probably years) away from completion and acceptance. An alternative or additional approach would be to develop a formula or guidelines linked to mitigation efforts. One of the stumbling blocks in the implementation of the Framework Convention has been the unwillingness of the developing country Parties to make any commitments to the reduction of their own emissions. On the other hand the developed country Parties have been slow to respond to the need for adaptation assistance. One way forward might be to develop a comprehensive approach to mitigation and adaptation in which developing countries would commit to some reduction in greenhouse gas emissions (and incidentally qualify to participate in JI and IET), while the developed countries would commit to a more flexible approach on assistance for adaptation.

5. This raises the question of the proper relationship between mitigation and adaptation. As it stands the more effective the CDM, and the more it is used, the more funds can be expected to be generated for adaptation assistance. In fact logic suggests that the reverse relationship should obtain. The more mitigation is undertaken presumably the less need for adaptation. A more appropriate relationship would therefore be one in which adaptation funds are increased in an inverse relationship to the achievement of mitigation targets and schedules. This logic stems from an economic optimizing perspective in which mitigation and adaptation are seen as competing alternatives in a zero sum game. The more of one then necessarily the less of the other. In terms of practice, rather than theory, it seems closer to the truth to suggest that the global community, as well as individual countries, will find it difficult to achieve enough of either. There is a prospect that climate change will not be slowed at a fast enough rate to prevent significant impacts. The precautionary principle might therefore be extended to the development of a mixed strategy of mitigation and adaptation neither of which would be dependent upon the other for its financial support or its agreed pace of implementation.

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15

ASSESSMENT OF DES ISSUES IN THE CHAPTERS 7-10 OF THE DRAFT THIRD ASSESSMENT REPORT OF WORKING GROUP III ON MITIGATION

Rob Swart

1. Introduction

In November 1999 the first order draft (FOD) of the IPCC Working Group (WG) III Third Assessment Report (TAR) was finalised. From November 1999 until January 2000 this draft was reviewed by some 150 experts around the world. At the time of the expert meeting on Development, Equity and Sustainability in Havana, the writing teams of the report had started developing a second draft to be finalised by May 2000. The results of the Havana meeting are planned to be taken into account by the teams in preparing their next draft. Following the requirements of the United Nations Framework Convention on Climate Change (UNFCCC) and the related shift in emphasis in research activities, in 1998 the IPCC has decided to place the TAR in the broader context of sustainable development. Thus IPCC recognises that synergies can be pursued between climate policies and sustainable development policies. IPCC identified the three issues of development, equity and sustainability (DES) as important aspects of sustainable development in this context. Climate policies could help further sustainable development objectives and sustainable development policies could support climate mitigation. To support the elaboration of this new context which would require a shift in emphasis and associated disciplinary expertise, the IPCC organised two Expert Meetings on Development, Equity and Sustainability, the first one in April 1999 in Colombo, Sri Lanka (Munasinghe and Swart, 2000)[1], and the second one in February 2000 in Havana, Cuba. This paper summarises how development, equity and sustainability issues have been taken into account in the first draft of the IPCC-TAR of Working Group III and which improvements can be considered. As requested by the organisers, it focuses on the chapters 7 (costing methodologies), 8 (national costs and ancillary benefits), 9 (sectoral costs and ancillary benefits) and 10 (decision making frameworks). It should be noted that the drafting of the TAR is still in its early stages and both the main text of the report and its summaries will be revised significantly in the coming months. Therefore, quotations from the first order draft in this paper are illustrative only and should not be cited any further.

[1] Mohan Munasinghe and Rob Swart (eds.): Climate Change and its Linkages with Development, Equity and Sustainability: Proceedings of the IPCC Expert Meeting held in Colombo, Sri Lanka, 27-29 April 1999, Published by LIFE, RIVM and the World Bank

2. Framework for discussion

The outline of the WG III TAR is attached. Figure 1 shows how DES issues have been framed in the first draft. Recognising the decision of attempting to make sustainable development the context of the report, in the scoping chapter 1 the emphasis is explicitly on DES issues. Critical comments from external reviewers on this first draft chapter show that much remains to be done to address DES issues in an adequate and neutral way that also relates to the other chapters. More specifically, the WG III TAR should stick to the IPCC mandate of climate change assessment, should not attempt to address comprehensively the broader issues of sustainable development, but focus on the linkages between the two. Chapter 2 on mitigation scenarios discusses the importance of alternative development pathways for assessment of mitigation options and their costs. Chapters 3 and 4 discuss technological and biological mitigation options, respectively. Chapters 5 and 6 discuss barriers, opportunities to overcome those, and policies, measures and instruments. In the current draft, these chapters 3-6 do not yet take DES issues explicitly as their context. Chapters 7, 8 and 9 discuss costing methods, national and regional costs, and sectoral costs, respectively. The chapters 8 and 9 do address linkages between climate change mitigation and sustainable development in a limited way, mainly through ancillary benefits (or ancillary impacts)[2] and spill-over effects[3] of mitigation activities in industrialised countries. Chapter 10 is intended to be a chapter that synthesises the information in the earlier chapters and relates the information to different decision making frameworks. In the next section of this paper the DES aspects of the chapters 7-10 are discussed in more detail, in parallel contributions the other chapters are being discussed.

While Figure 1 shows the situation in the first draft, Figure 2 shows how the treatment of DES issues could be strengthened and structured in the second draft. To stay within the mandate of IPCC, the emphasis of the report would remain on climate change (right hand box) and the linkages between sustainable development and climate change mitigation (arrows) rather than on sustainable development (left box) itself. Ancillary benefits, spill-over effects and distributional effects from mitigation actions would be discussed more broadly in more chapters than in the current draft. In this enhanced framework, the importance of alternative development pathways for assessments of technological options and their costs would not be limited to the chapter on scenarios, but also taken up in the chapters on mitigation options, policies and measures, and costs. Also attention would be paid in the second order draft to the potential positive and negative effects of general (sustainable) development for climate change mitigation policies such as structural adjustment programmes.

[2] Ancillary benefits or ancillary impacts are domestic side-effects of climate change mitigation measures such as health benefits of decreased urban air pollution or employment opportunities by decentralised energy supply options.

[3] Spill-over effects are effects of climate change mitigation policies in one country or region on other countries or regions, such as trade effects or transfer of technologies that are developed as a result of the policies.

The new concept of mitigative capacity was introduced by Gary Yohe (Yohe, personal communication), equivalent to adaptive capacity in Working Group II, to facilitate framing the various types of linkages in a coherent and systematic fashion. Mitigative capacity is defined as a system's ability to adopt means by which it might reduce its contribution to climate change and combines its capacity to implement mitigation options as well as vulnerability to climate intervention. It depends on:

- Current and future alternative development pathways
- International policies that influence the ability to pursue the preferred pathway
- National policies of countries with which there are significant interactions
- Viable technological options
- Viable policy instruments
- Resource availability and distribution
- Human and social capital

These issues all have development, sustainability and equity implications. Thus the concept of mitigative capacity offers a framework for linking climate change mitigation to development, sustainability and equity issues. The concept still being developed, at this stage only preliminary suggestions can be made as to how the concept can be elaborated in the various chapters of the WG III TAR.

In this paper, for the evaluation of the adequacy of the chapters 7-10 of the first order IPCC-WG III draft in accounting for DES issues, the following criteria were applied:

- Does the chapter assess the environmental, social as well as economic implications of mitigation options?
- Does the chapter address development, equity and sustainability issues related to the options and policies and their costs?
- How are these aspects framed (ancillary benefits, spill-over effects, distributional effects, impact on mitigative capacity, contraction and convergence, etc.)?
- Are both social and technological innovation captured?
- Does the chapter reflect different views on DES issues and analytical tools?
- If the answers are no, does the chapter identify gaps in understanding here, and provide suggestions for additional research?

3. Assessment of DES issues in IPCC-WG III TAR for the chapters 7-10

CHAPTER 7

Chapter 7 describes costing methodologies for mitigation responses. According to the outline approved by the IPCC, a key function of this chapter is to provide guidance for the subsequent chapters in which costs of mitigation are discussed. The first order draft of this chapter follows the outline closely and explicitly discusses various DES elements. It does address issues such as:

- Correction of net costs for side-effects that are the result of synergies or trade-offs between mitigation and general development policies. These side-effects (ancillary benefits) include a potential double dividend, joint environmental benefits, and impacts on new technology development and efficiency;
- Accounting for the importance of baselines for cost analysis (alternative development pathways);
- Evaluation of international and intergenerational equity implications of various policies and measures;
- Acknowledgement of the special situation in developing countries, such as technology transfer, capacity for innovation and diffusion, barriers for efficient technology use, institutional structure, employment creation and human capacity aspects;
- Valuation of external costs.

The chapter does conclude that although methods are available to address distributional concerns and integrate these into cost assessment, often this is not done because methods are difficult to apply and no consensus exists about the best way of doing so. This necessitates equity issues often to be considered separately. Different methods are available to dealing with equity issues in costs assessments: the usage of income weights (impacts on individuals with low incomes are given greater weight) and the use of average damage estimates (estimate the money value of impacts for different groups and apply the average to all individuals and countries).

Similarly, techniques to determine external costs (including environmental and social impacts) are available, but usually costly and not uncontroversial. The chapter mentions the availability of a framework for expanding cost analysis with an assessment of employment, income distribution, environmental changes, and sustainability indicators. The application of such a framework has been shown to have major implications on the cost effectiveness ranking of mitigation projects as compared to a focus on direct costs. According to the draft chapter, social costs of mitigation policies in developing countries in particular will be lower than financial costs in cases where the policies require presently unemployed labour and are reducing the damages of local non-GHG pollutants.

In summary, chapter 7 does a good job, from an economic perspective, not only highlighting the limitations of many current economic analyses in terms of addressing DES issues, but also in describing available methods that overcome these limitations, to be applied in later chapters. The chapter tends to focus on project costs, and less on regional/national/sectoral costs. Climate change measures do have ancillary impacts on sustainable development, and (sustainable) development policies have side effects for greenhouse gas emissions. The chapter does not discuss in detail how costs of such multi-purpose measures could be allocated to climate change or other issues.

CHAPTER 8

Following chapter 7 on costing methods, chapter 8 on national and regional costs of mitigation could be expected to also adopt the broader context of the social, environmental and economic elements of sustainable development. And indeed, some of the elements of the linkages between climate change mitigation and sustainable development feature in the first draft, notably ancillary benefits, spill-over effects, distributional effects and an attempt to quantify costs in terms of welfare impacts. The importance of alternative baselines is acknowledged, but the consequences of this for the cost assessments reported in the chapter (usually based on a single baseline approach) remain to be evaluated. Rather, baselines seem to be considered as arbitrary emissions profiles rather than representing an evolving full picture of a world to be ("alternative development pathways"[4]) that has important implications for the costs of mitigation.

Ancillary impacts of several types can result from GHG policies: reductions in air pollution associated with the reduction of fossil fuels, changes in water pollution associated with fossil fuel life cycle, and indirect effects on transportation, agriculture, land use practices, etc. The chapter notes that recent studies in several countries focusing mainly on the health benefits of reduced air pollution, show that the order of magnitude of these benefits may be comparable to the net costs of the mitigating measures. In addition, these benefits are accrued in the near term, and there is less uncertainty associated with them than with direct benefits of climate change mitigation. The treatment of ancillary benefits has two important limitations in the draft chapter: the discussion is limited to public health effects primarily, neglecting other environmental and socio-economic effects, and the information is not linked to the cost estimates reported elsewhere in the chapter.

Chapter 8 also addresses spill-over effects from emission constraints in Annex B countries on non-Annex B countries.[5] Again, while there are all kinds of possible many spill-over effects (e.g. as listed in chapter 9), the discussion in chapter 8 is limited to trade effects, ignoring other effects, such as stimulation for development, diffusion and transfer of environmentally sound technology.

In terms of distributional effects, the draft only mentions the regressive effects of a carbon tax on households in Annex-I countries, which can be totally or partially compensated by a

[4] The use of alternative development pathways in the analysis implies the assumption that mankind can influence its future.

[5] For example, the chapter argues that Annex B emission reductions will result in lower oil demand, which in turn will lead to a decline in the international price of oil. As a response, non Annex B countries may increase their oil imports and emit more than they would otherwise. Oil importing non-Annex B countries may benefit whereas oil exporters may experience a decline in revenue. A second example of “spill-over” effects involves the location of carbon intensive industries. A constraint on Annex B emissions will reduce their competitiveness in the international marketplace. Recent studies suggest that their will be some industrial relocation offshore, with Non-Annex B countries benefiting at the expense of Annex B countries. On the other hand, non-Annex B countries may be adversely affected by the decline in exports likely to accompany a decrease in economic activity in Annex B countries.

revenue recycling policy, depending on the form of the recycling. The chapter also pays some attention to studies that attempt to express costs in terms of different alternative indicators for welfare.

The approved outline explicitly asks for a full assessment of the social, environmental and economic impacts of (inter-)national policies and alternative pathways,. The draft chapter does pay attention to DES issues in separate sections, but does so only in an incomplete and scattered way. The information on the above effects is not integrated with the main body of the chapter, which focuses on macro economic effects of carbon taxes and carbon permit trading systems (main indicators are tax levels, permit prices, marginal cost per ton of CO_2 removed), without paying much attention to social and environmental effects. For the reader it is very difficult to compare the results of those studies with the scattered information on side effects, especially since these are only discussed in an incomplete fashion.

Finally, most studies discussed in the chapter apply a single baseline approach. The importance of alternative development pathways (different from alternative emissions profiles as in the chapter), as stressed in chapters 2 and 7, is not providing the context for the results presented. The implications of both higher and lower baselines should be discussed. As discussed in the earlier chapters, the synergy between climate and general economic/development policies can lead to lower GHG emissions and hence lower costs. Conversely, "reference" pathways with higher intensities of GHG emissions would increase costs of mitigation. Taking into account the importance in the climate debate of interregional inequity, chapter 8 would benefit from an assessment of the implications of different levels of inequity on costs of mitigation and their distribution. While "contraction" is discussed in the context of stabilisation scenarios, "convergence" in terms of income levels between regions, is not discussed. Regional differences may be addressed using the new concept of mitigative capacity.

In summary, chapter 8 could be improved by more adequately using the suggestions provided by chapter 7 and presenting DES issues more prominently as the context. Taking DES issues into account could both lead to higher or lower costs than reported in the assessment now. If lack of information from the literature would prevent this, the chapter should discuss gaps in knowledge and how these may be removed in the future.

CHAPTER 9

Chapter 9 has an objective very similar to chapter 8, but focuses on sectoral rather than national or regional costs.

Most attention is given to the various components of the energy sector. Basically, the draft chapter explores how mitigation measures would affect sectors, focusing on the economic output of the sectors as main indicator. Little attention is given to social and environmental side effects. Mainly for the coal sector, ancillary public health benefits are mentioned. For households, the chapter notes that the impact of mitigation on households comes directly

through changes in the technology and price of household's use of energy and indirectly through macroeconomic effects on income and employment. An important ancillary benefit is the improvement in indoor and outdoor air quality. Clearly, some sectors may win (renewable energy, agriculture, forestry, energy extensive industry) and others may loose (coal, oil, energy intensive industry) as a result of mitigation policies. This may have ancillary environmental impacts, while social effects, e.g. on employment and income, can be positive or negative. Negative effects can be reduced or compensated through appropriate policies. These effects are not systematically or comprehensively discussed in the current draft yet. The issue of alternative development pathways is only addressed in the section on the role of assumptions/baselines, but not to illustrate the dependence of the sectoral costs of mitigation measures on the overall direction of the economy and the pace of change.

In summary, similar to chapter 8, chapter 9 does address DES issues at the margin, notably through a discussion on sectoral ancillary benefits and spill-over effects. DES issues do not form the clear context of the assessment of sectoral costs and benefits. In this chapter, the new concept of mitigative capacity may be particularly helpful in addressing sectoral differences.

CHAPTER 10

Chapter 10 is designed to synthesise the scientific information in the earlier chapter from the perspective of decision making, acknowledging different decision making frameworks and analytical approaches. It also has some new elements, such as a discussion on different possibilities for the evolution of international climate change response regimes. It has four distinct sections, (1) introduction, summary of and progress since the Second Assessment Report (SAR), (2) policy-relevant scientific questions in climate change response: global and international issues, (3) international regimes and policy options and (4) local/national sustainable development choices and addressing climate change: the potential for synergy.

In the first section, the specific issues that characterise the climate problem are summarised. Here, the sentence: "Views diverge widely as to whether climate change is the grand opportunity to solve the immense problems of sustainable development and global distribution of wealth or whether broadening the scope for the anyway complex and controversial issue of climate change would run the risk of neither solving the climate problem nor improving prospects for sustainable development" suggests that the team does not appreciate yet the decision of taking sustainable development as the mandate of the TAR. This can be recognised in the ambivalent nature of the rest of the draft chapter. The use of jargon does not help here (heterogeneity or asymmetry rather than inequity, intergenerational transfers rather than intergenerational equity, policy interactions rather than synergy between climate change policies and sustainable development policies).

The draft of the second section on policy questions is well written. It has synthesised many policy relevant questions into just a few: What could be done? (mitigation and adaptation), when could this be done? (delayed reponse versus early action, "when flexibility"), where

could it be done? ("where flexibility"), who pays? (burden sharing, equity versus efficiency), how could it be done? (policies, technology transfer), in what context? (climate mitigation versus general sustainable development policies) and to what objective? (timing and level of stabilisation of GHG concentrations).

The chapter does pay some attention to equity issues in the "who pays" question, the "how" question and the "in what context" question. It would be interesting to add a reference to different mitigative capacities of different regions, sectors, and generations to this discussion. Also in the discussion of other questions development, sustainability and equity issues could be taken into account, such as the "when" question (intergenerational issues). Here, the risk of economic effects of short term action has to be weighed against environmental and social effects of acting later. Finally, also addressing the "to what objective" question requires attention to issues broader than levels of stabilisation of GHG concentrations, e.g. development, sustainability and equity issues as can be associated with the UNFCCC.

The draft third section on international regimes acknowledges that the development of climate policy will likely begin with actions that simultaneously achieve domestic objectives while yielding a climate benefit. The draft suggests that the political economy literature suggests that attention may have to move from targets to policies and that an adequate choice of policy measures can offset the sub-optimality of choices made on emission targets. The draft also notes that countries can use transfers or issue linkage strategies to achieve a better-cost distribution and then let policy measures achieve economic efficiency and environmental effectiveness, if the optimal policy can hardly be adopted for equity reasons. It seems that this section could address procedural equity issues in international regime formation in addition to the current emphasis on consequential equity.

The fourth section on the synergy between sustainable development at national, local and individual levels and climate change response is yet a somewhat arbitrary compilation of loose issues, including technology transfer and behavioural (lifestyle) changes. Nevertheless, this section offers an excellent possibility to bring the information on the global scale problem of climate change of the earlier chapters together and make the link with decision making at these lower levels, where decision making about climate change is intricately interwoven with other issues. At the end of the report, the implications of global climate change response for individual behaviour (back from systems to people) would make a powerful and concrete closure of the report.

4. Overall conclusions with respect to DES coverage in IPCC-WG III TAR chapters 7-10

The attached table summarises the main comments on chapters 7-10. Chapter 1 introduces DES issues as the context for the TAR. For cost assessment, chapter 7 lays the foundations for an appropriate treatment of DES issues in cost assessments. Nevertheless, the subsequent chapters 8 and 9 on national and sectoral costs and ancillary benefits of

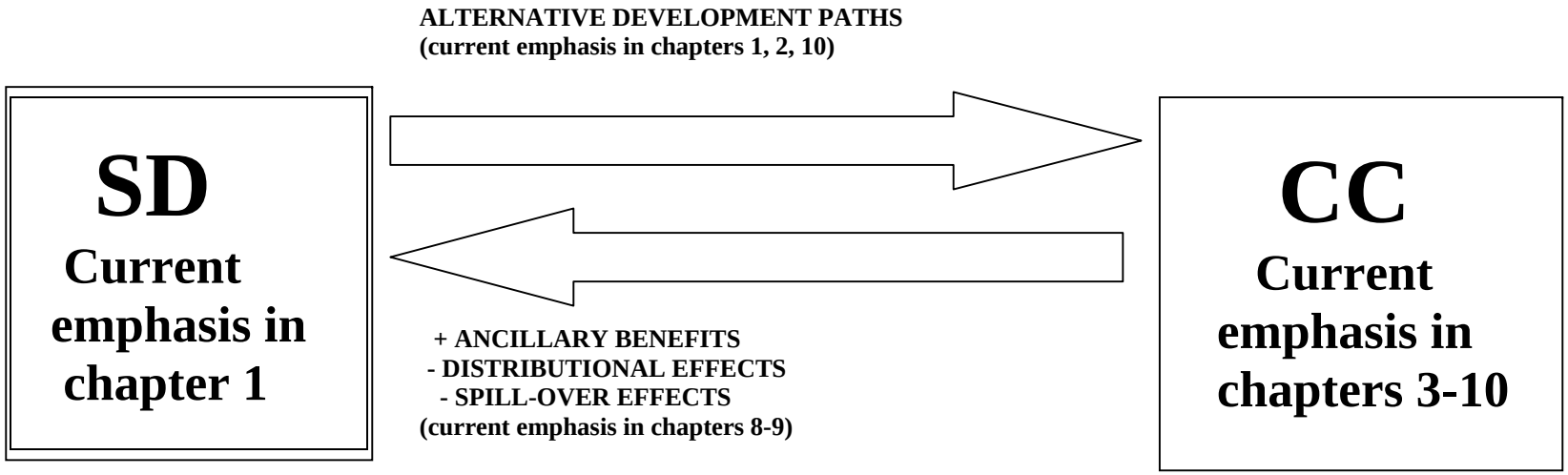
mitigation policies do not fully incorporate the DES context, and only partially follow the guidelines of chapter 7. It is recommended that the chapters 8 and 9 more closely follow the guidelines of chapters 1 and 7 and identify gaps in knowledge if the appropriate literature cannot be found. Links between climate change response options, their costs and sustainable development issues can be made without fundamentally rewriting the chapters. Figure 2 may provide a structure for doing this.

The synthesising components of chapter 10 should allow for bringing back to the foreground the DES context that was introduced in chapter 1 of the WG III report. It should more clearly describe what the information in the earlier chapters contribute to the answers to key policy questions from different decision analytical perspectives. The chapter is certainly going in the right direction, but does not do so yet, at least not in a coherent fashion.

In this paper, four elements of linkage between sustainable development and climate change mitigation were identified: alternative development pathways, effects of general (sustainable) development policies on climate change mitigation, ancillary benefits of climate change mitigation for sustainable development, and spill-over effects of climate change mitigation. *Alternative development pathways* are not seriously considered in any of the chapters 8-10, notwithstanding the importance for cost assessment . Neither are the *impacts of general (sustainable) development policies on climate change mitigation* considered in chapters 7-10. *Ancillary benefits* are being considered, but too narrowly: primarily public health benefits, disregarding impacts on fuel import dependency, human capacity, competitive advantages, employment, etc. Similarly *spill-over effects* are only concerned with economic trade effects, disregarding benefits for transfer of environmentally sound technology and other spill-over effects. Considering these four linkages would have implications for cost assessments. Applying the new concept of mitigative capacity could help providing a more systematic structure to discus the various linkages between climate change mitigation and sustainable development.

Finally, it should be acknowledged that this paper for this particular expert meeting on development, equity and sustainability does only looks at one aspect (DES) of the rich chapters of the report. Evidently, there are many more aspects discussed in the chapters, but this paper does not discuss any of the qualities of the chapters in these other respects. The critique in this paper intends to help improving the general quality of the chapters and their relevance for policy makers. The suggestions are framed according to the structure of Figure 2. The adequacy of this structure for the WG III TAR affects the relevance of the suggestions. Replacing another speaker at the meeting, the suggestions are based on only a one-time reading of the chapters. More thorough reading may have led to more, less, or different suggestions. It is the full responsibility of the IPCC-WG III TAR writing teams to judge if the suggestions made are justified and useful.

FIGURE 1: THE LINK BETWEEN SUSTAINABLE DEVELOPMENT (SD) AND CLIMATE CHANGE (CC) MITIGATION ISSUES IN THE TAR-WG III FOD

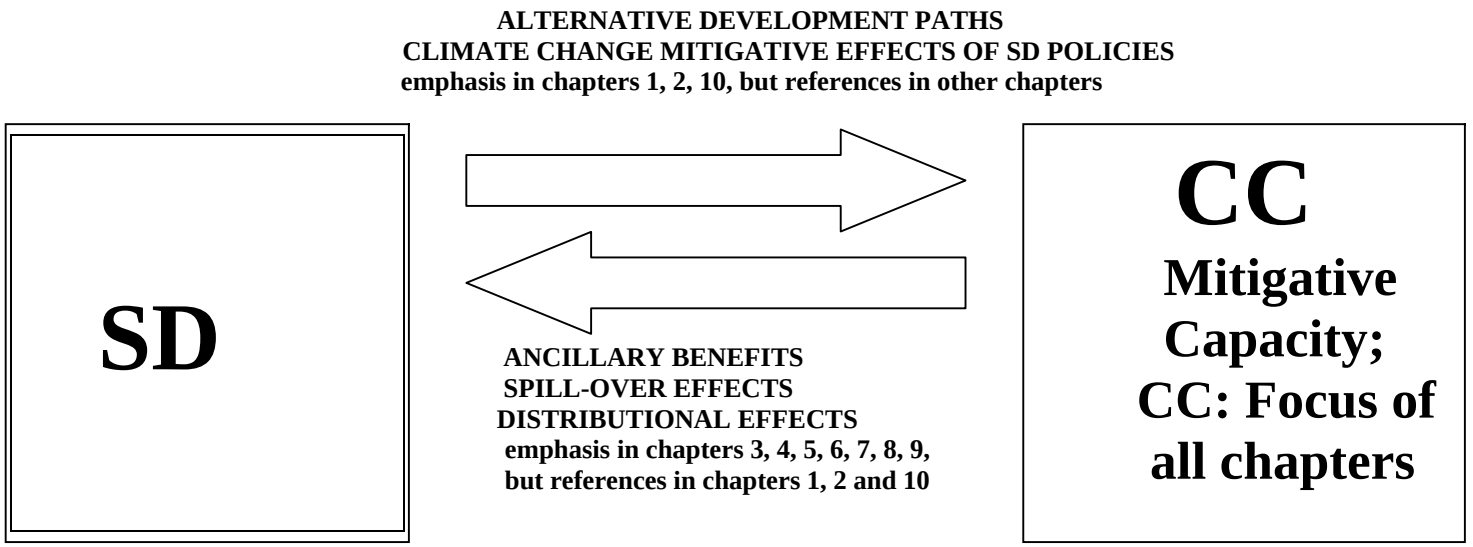


The focus should be on linkages between CC and SD rather than a definition or description of SD would be.

A. alternative socio-economic development paths and sustainable development policies have major implications for GHG emissions, climate change impacts and adaptive capacity

B. ancillary benefits and spill-over effects represent a major potential feedback from climate change mitigation to SD policy and prospects

FIGURE 2: POSSIBLE FRAMEWORK FOR SECOND ORDER DRAFT (SOD) TAR-WG III



"Mitigative capacity" is a system's capacity to implement mitigation options as well as its vulnerability to climate intervention

COVERAGE OF DEVELOPMENT, EQUITY AND SUSTAIBAILITY SUMMARY COMMENTS IPCC-WG III FIRST ORDER DRAFT CHAPTERS 7-10			
Chapter	**Linkage CC-SD**	**Treatment in chapter**	**Suggestions for improvement**
7	Alternative development paths	Importance of baselines for cost results emphasised	• Possibly acknowledge the conceptual difference between "baselines" and "alternative development paths"
7	Effects of SD policies on CC mitigation	Not dealt with	• Add discussion on this and on allocation of costs to CC and/or SD
7	Ancillary impacts	Discussed	• Stick to methods, move results to chapters 8/9
7	Spill-over effects	Discussed	
7	Distributional effects	Discussed	
8	Alternative development paths	Only mentioned as being important	• Include assessment on how higher/lower baselines would affect cost results • Pay some attention to equity/convergence
8	Effects of SD policies on CC mitigation	Not discussed	• Add discussion as far as literature allows (e.g. structural adjustment policies, privatisation, etc.)
8	Ancillary impacts	Mainly public health	• Add other ancillary impacts, such as employment, oil import dependency, agriculture • Integrate findings with rest of chapter
8	Spill-over effects	Trade effects of carbon tax/permit trading	• Mention other spill-over effects (see chapter 9 table)
8	Distributional effects	OECD households	• Add assessment effects in developing countries
9	Alternative development paths	Only mentioned as being important	• Include assessment on how higher/lower baselines would affect cost results
9	Effects of SD policies on CC mitigation	Not discussed	• Important for sectors: attempt to add discussion
9	Ancillary impacts	Limited discussion (coal, households)	• Add other ancillary impacts, such as employment, oil import dependency, agriculture • Add ancillary impacts for other sectors (transport)
9	Spill-over effects	Limited treatment	• Refer to chapter 8?
9	Distributional effects	Limited treatment	• Refer to chapter 8?
10	Alternative development paths	Only some suggestions in section on lifestyles	• Take alternative pathways into account when addressing policy questions • Refer back to chapters 1 and 2 and use in final section on CC-SD synergy
10	Effects of SD policies on CC mitigation	No discussion	• Possibly add discussion, if literature and earlier chapters allow
10	Ancillary impacts	No discussion?	• Add in addressing policy questions and SD-CC synergy
10	Spill-over effects	No discussion	• Add to discussion policy questions
10	Distributional effects	No discussion	• Add to discussion policy questions
ALL		Gaps in knowledge	• Formulate concrete research recommendations

ANNEX I. Basic Abbreviations

AAU	Assigned Amount Units
BTU	British Thermal Unit
CC	Climate Change
CDM	Clean Development Mechanism
CER	Certified Emission Reductions
CO_2	Carbon dioxide
DES	Development, Equity and Sustainability
ECLAC	(CEPAL, in Spanish) United Nations Commission for Latin America and the Caribbean
ERU	Emission Reduction Units
FAR	First Assessment Report of the IPCC
FOD	First Order Draft
GCI	Global Common Institute
GDEI	Global Decarbonisation Energy Index
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse gases
HFCs	Hydrofluorocarbons
IET	International Emission Trading
IPCC	Intergovernmental Panel on Climate Change
JI	Joint Implementation
LAC	Latin America and the Caribbean
OECD	Organisation for Economic Co-operation and Development
PFCs	Perfluorocarbons
PNL	Pacific Northwest Laboratory
PPP	Polluter Pays Principle
PPPs	Purchasing Power Parities
QELROS	Quantified Emission Limitation and Reduction Objectives
SAR	Second Assessment Report of the IPCC
SD	Sustainable Development
SOD	Second Order Draft
SPM	Summary for Policy Makers
SRES	IPCC Special Report on Emissions Scenarios
TAR	Third Assessment Report of the IPCC
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WCED	World Commission on Environment and Development
WG	IPCC Working Groups
WRI	World Resources Institute
WTO	World Trade Organisation

ANNEX II. Programme

SECOND REGIONAL EXPERT MEETING ON
"DEVELOPMENT, EQUITY AND SUSTAINABILITY"
HAVANA, CUBA, 23-25 FEBRUARY 2000

Sponsors: IPCC Working Group II and III

Steering Committee: T. Taniguchi, R. Pachauri, B. Metz, O. Davidson, J. McCarthy, O. Canziani, R. Swart, N. Leary, M. Munasinghe, R. Seroa da Mota, J. Robinson, R. Pichs, A. Rahman, T. Banuri, W. Sachs, E. Calvo, J. Weyant

Local Organisers: Government of Cuba (Ministry of Science Technology and Environment), in association with the Centre for World Economy Studies (CIEM) of Havana

Co-sponsors:
Regional Office of UNEP for Latin America and the Caribbean
UNDP Office in Havana, Cuba

Participants: Thirty international experts on climate change; and 12 Cuban experts

SCHEDULE

DAY 1 (23 February 2000)

15:00-17:00 Registration

17:00-17:10 Introduction by Dr. Ramón Pichs, Local Organising Committee, Deputy Director of the Centre for World Economy Studies (CIEM) of Cuba

17:10-17:20 Address by Dr. Tomihiro Taniguchi, Vice Chair of the IPCC

17:20-17:30 Address by Dr. Bert Metz, Co-Chair, WG III, IPCC

17:30-18:00 Address by Dr. Osvaldo Martínez, Director of the CIEM and President of the Commission of Economic Affairs of the Cuban Parliament

18:00-18:30 Keynote Address by Dr. Rosa Elena Simeón, Minister of Science, Technology and Environment of Cuba

19:00-21:00 Reception by the Local Organising Committee

DAY 2 (24 FEBRUARY 2000)

08:00-08:45 Registration

08:45-09:00 Welcome and Introduction to the Workshop
(R. Pichs)

SESSION A: SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

SESSION A.1. CHAIR: R. PICHS

09:00-09:30 *Topic No. 1:* Framework for Incorporating DES into the TAR / Results of the Expert Meeting on DES, Colombo, April 1999
Presenters: M. Munasinghe, Sri Lanka and J. Robinson, Canada

09:30-10:00 *Topic No. 2:* Socio-economic and Emission Scenarios for Latin America
Presenters: E. Lebre La Rovere, Brazil and M. Nuñez, Argentina

10:00-10:30 Discussion

10:30-10:50 Coffee

SESSION A.2. CHAIR: M. MUNASINGHE

10:50-11:20 *Topic No. 3:* Climate Change Impacts and Adaptation. Implications for Sustainable Development
Presenters: M. Campos, Costa Rica and A. Saldívar, Mexico

11:20-11:50 Discussion

11:50-12:20 *Topic No. 4:* Climate Change Mitigation. Implications for Sustainable Development. Presenters: H. Rodríguez, Colombia and C. Suárez, Argentina

12:20-12:50 Discussion

12:50-14:30 Lunch

SESSION B: EQUITY AND CLIMATE CHANGE

CHAIR: R. SEROA DA MOTA

14:30-15:30 *Topic No.5:* Equity and Climate Change Response Strategies
Presenters: J. Llanes, Cuba; L. Pinguelli, Brazil; R. Estrada-Oyuela, Argentina; and T. Heller, USA

15:30-16:00 Discussion

16:00-16:20 Coffee

16:20-16:50 *Topic No. 6:* Equity and Climate Change. Lessons for Latin America
Presenters: H. Sejenovich, Argentina and O. Masera, Mexico

16:50-17:20 Discussion

SYNTHESIS OF SESSIONS A - B

17:20-18:20 *Round Table:* Synthesis on Sustainable Development, Equity and Climate Change *(Opportunities and Barriers for Incorporating Climate Change Response Strategies into the Sustainable Development Agenda)*

CHAIR: R. PICHS

Panel:

- E. Sanhueza, Chile (Climate Action Network, Latin America-NGO)
- C. Rios, Colombia
- L. Nurse, Barbados
- A. de la Vega, Mexico

19:00-21:00 Reception by Dr. Luis Gómez-Echeverri, UNDP Office in Havana.

DAY 3 (25 February 2000)

SESSION C: DES IN WG II AND WG III TAR

CHAIR: B. METZ

09:00-09:30 *Topic No.7:* Assessment of DES in WG II TAR (Part 2: System/Sector Chapters). Presenters: N. Leary, USA and S. Huq, Bangladesh

09:30-10:00 Discussions

10:00-10:30 *Topic No. 8:* Assessment of DES in WG II TAR (Part 3: Regional Chapters). Presenters: L. Mata, Venezuela and S. Cohen, Canada.

10:30-11:00 Discussion

11:00-11:20 Coffee

11:20-11:50 *Topic No. 9:* Assessment of DES in WG III TAR (Chapters 1-6) Presenters: L. Pinguelli, Brazil and J. Robinson, Canada

11:50-12:20 Discussion

12:20:12:50 *Topic No. 10:* Assessment of DES in WG III TAR (Chapters 7-10) Presenters: C. Gay, Mexico and R. Swart, The Netherlands

12:50-13:20 Discussion

13:20-14:30 Lunch

SESSION D: DES AND TAR: NEXT STEPS

CHAIRS: T. TANIGUCHI

14:30-15:00 Recommendations for Incorporating DES into the TAR
Rapporteurs: N. Leary (TSU-WG II) and R. Swart (TSU-WG III)

15:00-16:30 General Discussion, Synthesis and Closure

16:30-16:50 Coffee

PUBLIC SYMPOSIUM

CHAIR: DR. GISELA ALONSO. President / Agency of Environment, Cuba

17:00-17:30 Current Developments on Climate Change - international level
Presenter: Dr. Bert Metz, WG III Co-Chair

17:30-18:00 Current Developments on Climate Change in Latin America and the Caribbean. Presenter: Dr. Raul Estrada-Oyuela, Ambassador / Argentina)

18:00-18:30 Current Developments on Climate Change in Cuba
Presenter: Dr. Luis Paz, Cuba,
Head of the National Group on Climate Change

18:30-19:00 General Discussion

19:00-19:30 Refreshments

ANNEX III. List of Participants.

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