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Climate Change and Sustainable Development

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Abstract

This paper argues that in the future the primary focus of policy research and global agreements should be the de-carbonization of economic development. Consequently, instead of treating climate stabilization and economic development as separate and equal, the strategy should be to re-integrate the two global policy goals, in part by separating responsibility (and funding) from action. This will require an approach that goes beyond Kyoto. The paper invokes the example of the Manhattan Project to argue for a massive, globally funded public investment program for the deployment of renewable energy technologies in developing countries.

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Keywords: carbon emissions, climate change, sustainable development, international cooperation, mitigation, adaptation

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Climate Change and Sustainable Development

Tariq Banuri and Hans Opschoor

The purpose of this working paper is to raise critical issues on the relationship between climate policy and sustainable development. It criticizes current policy approaches, including that reflected in the Kyoto Protocol, on the grounds that they have inadvertently resulted in the placing of climate policy and development into separate boxes. Policy experience on climate stabilization has developed largely within the institutional, economic, and political context of industrialized countries, but policy analysis now needs to turn single-mindedly to the situation of developing countries. In the future, it would be necessary not only to induce adjustment in industrialized countries, but also to re-orient the growth process in the developing world towards de-carbonization. To this end, the working paper concludes with the identification of a set of questions for wider and urgent discussion.

To set the stage, Section 1 provides a brief summary of recent developments in the climate literature. There is virtually no doubt today that climate change is already happening, that it is caused by the emission and accumulation of greenhouse gases (GHGs) in the atmosphere, that it poses the gravest of dangers to life on this planet, and that much of its impact is already "locked in" because of past actions, but the most extreme costs could be avoided if policy responses are put in place immediately. Section 2 moves from climate trends to stabilization, and summarizes global as well national actions (in particular those developed under the Kyoto Protocol) to reduce greenhouse gas emissions. In retrospect, these have proven highly inadequate and have not produced an appreciable impact. The ideas that are being discussed on how to proceed beyond Kyoto are framed within the same overall approach. Their main weakness is the absence of credible measures that can reassure developing countries that the development agenda will be reconciled and integrated into climate action.

De-carbonized economic development requires an approach that goes beyond Kyoto. Instead of separating climate and development, it should separate responsibility (and funding) from action. This implies a shift from the language of emission targets or rights to the language of investment, a language that provides the core of development thinking. A concrete option is to initiate a globally funded public investment program in developing countries, using the example of the Manhattan Project, to deploy available renewable technologies on a massive scale. Section 4 presents some initial ideas on this approach, and recommends research and analysis on critical themes.

The climate problem

Climate change is a serious and urgent issue. The Earth's climate is changing, and the scientific consensus is not only that human activities have contributed to it significantly, but that the change is far more rapid and dangerous than thought earlier (IPCC 2007)[1]. In this section, we will only highlight some of these points (for more detail, we refer to IPCC 2007 and Stern 2006).

The global mean temperature of the earth is rising; it has risen by 0.7°C in the 20th century, and continues on an upward trend. This has already begun to impose costs (e.g., in the form of heat waves, frequency of extreme events, and recession of glaciers), but these are still within the bounds of common experience.

1 The precise statement is that IPCC now has "very high confidence that the globally averaged net effect of human activities since 1750 has been one of warming".

However, further temperature increases contain the potential of much larger and even catastrophic impacts. There is close to a scientific consensus over the threshold of the so-called 2-degree line, namely an increase of 2°C above pre-industrial levels, beyond which catastrophic change is highly probable. Successive assessments by the Intergovernmental Panel on Climate Change (IPCC) have increased the confidence in the evidence as well as the theory.

The "flaming arrows"[2] diagram in figure 1 (taken from Stern 2006) is probably the best illustration of the results of this research. It is a sobering diagram. It shows the expected (probabilistic) relationship between different levels of GHG concentrations (400, 450, 550, 650, and 750 parts per million (ppm) of carbon dioxide equivalent (CO_2e)) and temperature increase. The lower diagram translates this information into the potential impacts on food supply, water and ecosystems, the effects for extreme events and the risk of irreversible system changes. These are colour coded for confidence: yellow for likely, orange for very likely, and red for extremely likely.

The danger is that the mutually reinforcing effects of global warming may take the world to a temperature increase of 3°C or higher, with potentially severe consequences. Consider only the item in the last row of the diagram, "Onset of the irreversible melting of the Greenland Ice Sheet". The arrow starts at about 1.5°C, changes to orange at 2°C, and is red by the time it reaches 3°C. The implications of such a melting are enormous, including potentially a 7 metre rise in sea level (see Baer 2007). Even though on this issue, as well as on some other projected impacts of climate change, discussions are ongoing about their probability, the events that they relate to are clearly of a magnitude that avoiding them is vital.

While climate change results from activities all over the globe (with rather unevenly spread contributions to it), it may lead to very different impacts in different countries, depending on local/regional environmental conditions and on differences in vulnerability to climate change[3]—independent of the contributions to climate change of these countries. It is likely to undermine the sustainability of livelihoods as well as development. The worst impacts will fall on developing countries, in part because of their geographical location, in part because of weak coping capacities, and in part because of more vulnerable social, institutional, and physical infrastructures.

The challenge of stabilization

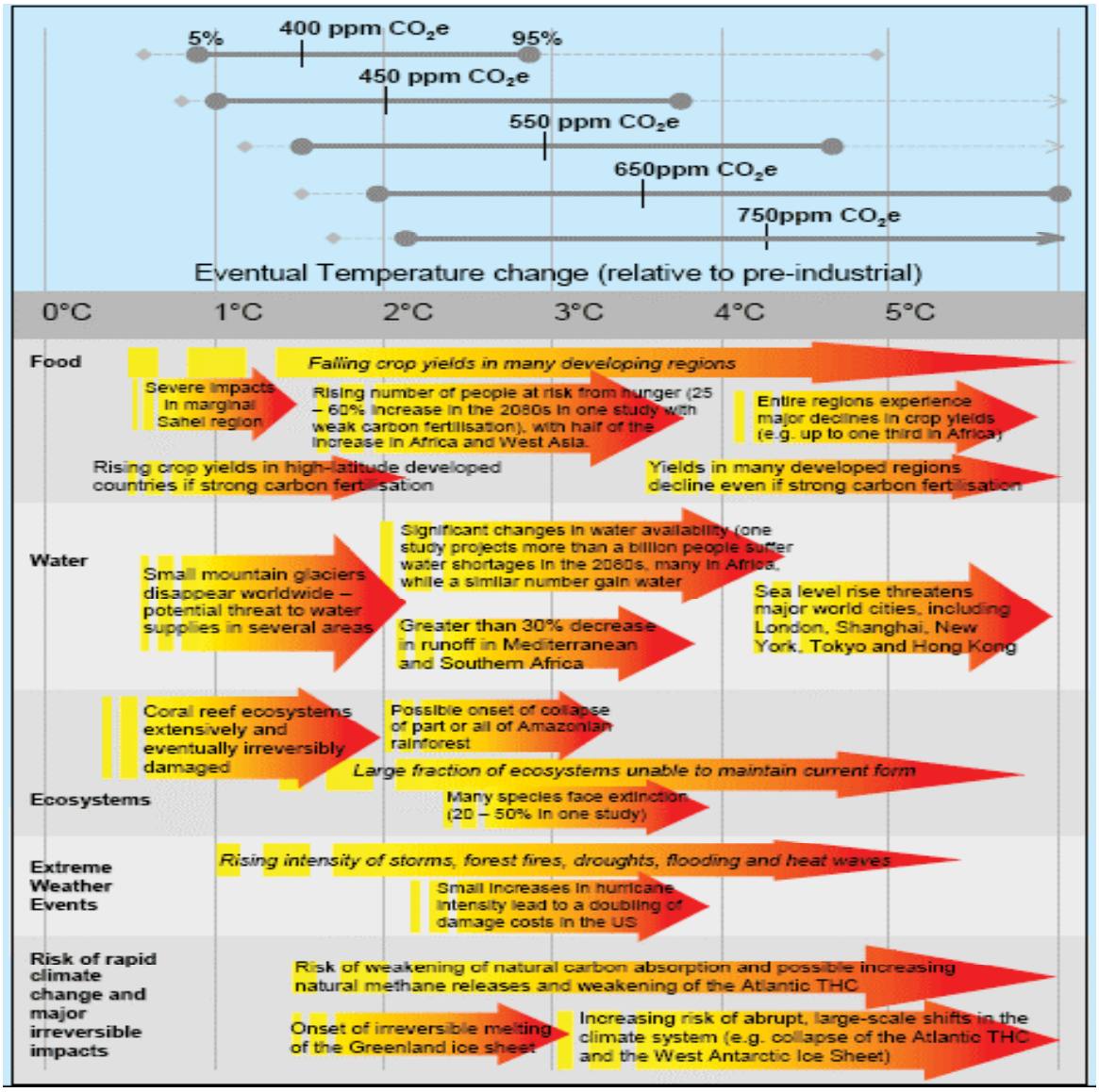
The main factor in anthropogenic climate change is the increase in the concentration of carbon in the atmosphere over time. This increased concentration has been caused by the emission of GHGs as a result of economic activities, including energy, industry, transport, and land use, many of which rely upon fossil fuels. The most important GHG, carbon dioxide, CO_2, currently constitutes 77 per cent of the global warming potential. Other contributors are methane (from agricultural sources), and land use change such as deforestation. Concentration level has increased because emissions during the last two centuries were in excess of what could be absorbed, and the excess GHGs began to accumulate in the atmosphere. The concentration of CO_2 alone has increased by some 100 ppm over this period (Stern 2006). Current global emissions contribute another 2-3 ppm of carbon dioxide equivalent (CO_2e) GHGs per year.

A brief point on the statistics is needed here. Data on emissions and concentrations are a combination of several unequal components (carbon dioxide, methane, chlorofluorcarbons [CFCs] and other gases),

2 The title "flaming arrows" was proposed by Paul Baer (2007).

3 For regional differences in vulnerability to climate change, see e.g. UNEP/Earthscan Global Environmental Outlook 2002.

Figure 1.
Climate change and its probable consequences



Note: The above figure illustrates the types of impacts that could be experienced as the world comes into equilibrium with more GHGs. The top panel shows the range of temperatures projected at stabilization levels between 400ppm and 750ppm CO2e at equilibrium. The solid horizontal lines indicate 5-95% range based on climate sensitivity estimates from the IPCC 2001 and a recent Hadley Centre ensemble study. The vertical line indicates the mean of the 50th percentile point. The dashed lines show the 5-95% range based on eleven recent studies. The bottom panel illustrates the range of impacts expected at different levels of warming. The relationship between global average temperature changes and regional climate changes is very uncertain, especially with regard to changes in precipitation. This figure shows potential changes based on current scientific literature.

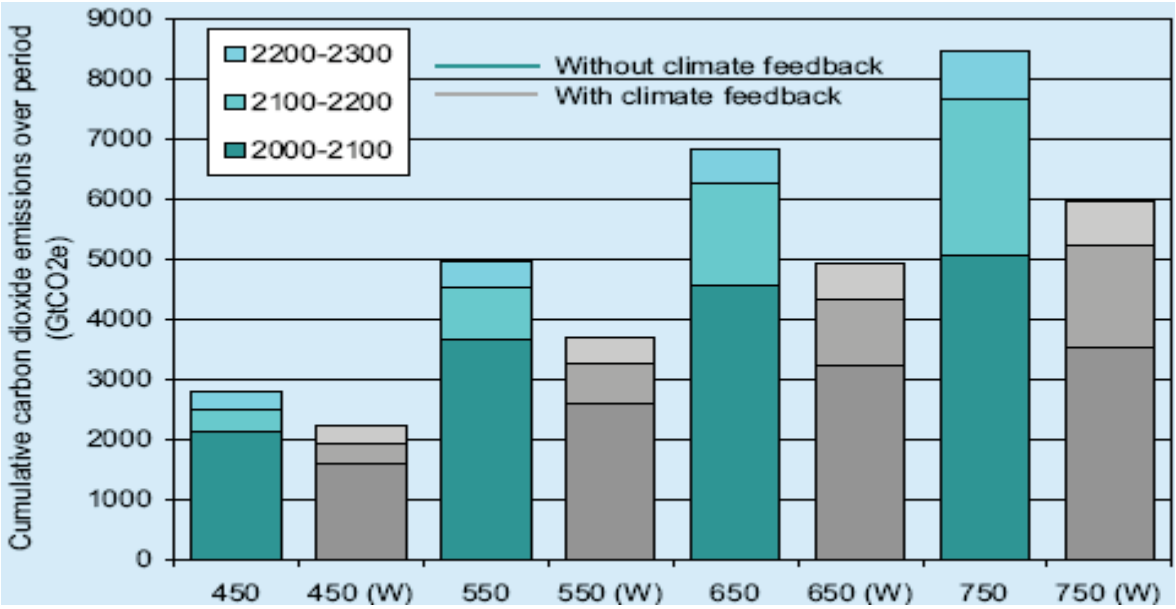
Source: Stern Review, Part III, page 197. Reproduced under the terms of the Click-use licence.

each of which has a different impact on radiative forcing (or warming) and different life expectancy. The literature translates them into a single number, which is generally carbon dioxide equivalent, or carbon. But while this is useful for some purposes, it can be misleading for others. Taking a hundred-year view would suggest focusing only on the long-lived gases (mainly carbon dioxide), but in the medium run, the numbers need to give equal weight to the shorter-lived gases (mainly methane). In the following discussion, we use the unit most appropriate for the issue being addressed. But this may lead to some confusion because of the

apparent inconsistency with data that address other issues. Finally, some of the data on GHG emissions only include emissions from the burning of fossil fuels, and do not include, in particular, emissions resulting from changes in land use.

The 2 degree line corresponds roughly to a concentration of 450 ppm of CO_2e GHGs. This is very close to the current concentration level of 430 ppm CO_2e (including 380 ppm of CO_2 and the rest from other GHGs). If the target is 450 ppm CO_2e (in other words, the "safe" temperature increase of 2 degrees), then cumulative emissions between now and the year 2100 would have to be less than 2,100 giga (billion) metric tons (tonnes) of CO_2 ($GtCO_2$). Since current emissions of carbon dioxide alone are 35 $GtCO_2$, this is equivalent to about 60 years at current rates. If a higher stabilization target of 550 ppm CO_2e (corresponding to the 3 degree line) is selected, then cumulative emissions for the century can reach 3,700 $GtCO_2$ (Stern 2006). Finally, continuation of current trends would result in a concentration of 750 ppm CO_2e by the end of the century, with a probable temperature increase of well over 4°C (see figure 2).

Figure 2.
Cumulative emissions of carbon dioxide at stabilization



Note: The above figure gives illustrative results from one study that shows the level of cumulative emissions between 2000 and 2300 for a range of stabilization levels (carbon dioxide only). For the green bars, natural carbon absorption is not affected by the climate. The grey bars include the feedbacks between the climate and the carbon cycle (stabilization levels labeled as (W). Comparison of these sets of bars shows that if natural carbon absorption weakens (as predicted by the model used), then the level of cumulative emission associated with a stabilization goal reduces. The intervals on the bars show emissions to 2100 and 2200.

Source: Stern Review, Part III, page 197. Reproduced under the terms of the Click-use licence

The challenge is to allocate the total permissible "budget" over the next 100 years in such a way as to cause minimum ecological disruption and ensure sustainable development. This can be done through several different dynamic trajectories. Stern (2006) proposes a peak in the next 10 to 20 years and a steady decline thereafter, converging to a sustainable (i.e., absorbable) level of around 5 $GtCO_2$ per year by the end of the century. He notes that delaying the peak in global emissions would increase the rate of reduction needed subsequently, and delay of more than 20 years would render the targets unachievable.

In order to clarify further the implications of the stabilization challenge, the following identity (Bierbaum *et al* 2007) is helpful:

$$C = P \times (Y/P) \times (E/Y) \times (C/E) \quad (1)$$

where:

- C is carbon dioxide emissions, E is energy use, Y is GDP (gross domestic product), and P is population.
- E/Y is called the "energy intensity of GDP"
- C/E is called the "carbon intensity" of energy supply.

This identity shows that a reduction in carbon emissions requires a reduction in one or more of the following:

- *Population*: A decline in population growth would bring about a proportional reduction in emissions, without any change in affluence, energy efficiency, or carbon intensity.
- *Income*: A slowdown in growth of per capita income (although considered not desirable by most analyses) would similarly reduce emissions proportionately.
- *Energy and Carbon Intensity*: By investing in energy efficient production, fuel switch, land use change, carbon storage and sequestration (CSS), and improving the efficiency of conversion of fossil fuels into energy, the volume of emissions would be reduced for a given quantum of energy use and, ultimately, production. Where feasible and appropriate, less energy and carbon intensive patterns of consumption and production (PCPs) would reconcile economic growth and GHG-emissions.

Reverting to the current trends, in 2005, out of the total emission of 36 $GtCO_2$, about three quarters, i.e. 27.5 $GtCO_2$, (equivalent to 7.5 billion tons of carbon)[4] were emitted by energy systems alone, according to the following breakdown (adapted from Bierbaum *et al* 2007):

$$6.42 \times 10^9 \textit{ persons} \times \$6{,}541/\textit{person} \times 12.1 \textit{ MJ/\$} \times 54.3 \textit{ kg}CO_2/\textit{GJ} = 27.5 \times 10^{12} \textit{ kg}CO_2$$

where:

GJ is gigajoules of primary energy, and $kgCO_2$ means kilograms of carbon dioxide emitted

Table 1 presents this information along with the projections of the IPCC's baseline scenario IS92a for the year 2100. According to this scenario, population will increase from 6.42 to 11.3 billions by 2100, world GDP will increase eight-fold, and energy use will triple from current levels, while the fraction of energy supplied from fossil fuels will drop from over 80 per cent to under 60 per cent. The result, under business as usual, is that notwithstanding the improvements in energy efficiency and reduction of dependence on fossil fuels,[5] emissions would reach 75 $GtCO_2$ by 2100 (and atmospheric CO_2e concentration of over 700 ppm).

Table 1 helps illustrate both the scale of the challenge and the crucial importance of de-carbonization. First, note that stabilization at 450 ppm CO_2e will require emissions to be about 5 per cent of their projected value. The mid-point target of 50 per cent reduction in emissions by 2050 is consistent with this vision. Second, given the limited flexibility in further depressing the population and per capita income (see below), and quite possibly, energy intensity, the major focus of adjustment will have to be in the reduction of carbon intensity. Regardless of the specific policy instruments chosen for this goal, the end result must be to

4 One ton of carbon is equivalent to 3.67 tons of carbon dioxide.

5 If efficiency had not improved, the emissions would be three times higher (i.e. roughly 165 Gt CO_2).

Table 1.
IS92a Projections of Key Drivers and Parameters of Climate Change

	Population billions	*GDP/capita PPP$*	*Energy Intensity MJ/$*	*CO_2 Intensity $KgCO_2/GJ$*	*CO_2 Emissions $GtCO_2$*
2005 data	6.4	6,541	12.1	54.3	27.5
2100 projections	11.3	29,730	4.5	49.2	75.4
Needed for 450 ppm CO_2e	Little change possible, but final figure could be between 9 and 11 billions	Higher income considered desirable, but quality of growth could be improved	Major potential for change in this area. It needs to be about 5 per cent of the projected numbers.		~4.0

Source: http://sedac.ciesin.org/ddc/is92/

reduce to a trickle the extraction of fossil fuels from the ground. The inadequacy of the current policy package is indicated quite vividly by its impotence in affecting the rate of extraction of fossil fuels.

Various studies (e.g. Pacala and Socolow 2004, Stern 2006, Bierbaum *et al* 2007) show that we have the requisite technological knowledge to be able to reduce energy and carbon intensities, and therefore carbon emissions, by as much as 80 per cent over the course of the century. A number of these technological solutions have already been put in place (mainly in industrialized countries), but because this has been done in a fragmented manner, the results are well below the potential.

The current record

UNFCCC (1992), recognizing the significance of climate change, aims at achieving the stabilization of concentrations of GHGs in the atmosphere at a level "that would prevent dangerous anthropogenic interference with the climate system, within a time frame sufficient to allow ecosystems to adapt naturally, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner" (adapted from UNFCCC, art. 2). Here, we will continue to discuss "prevention", to later on take our cue from the latter part to "enable development to proceed in a sustainable manner".

The UNFCCC was followed by the Kyoto Protocol of 1997, under which industrialized countries (the so-called Annex I countries) agreed to a 5.2 per cent reduction of GHG emissions (compared with 1990 figures) between 1997 and 2008-12, i.e. over 10-15 years.[6] Even these modest targets are not quite being fulfilled.

In fact, as shown in table 2, global CO_2 emissions increased 17 per cent between 1990 and 2003 (from 22 to 26 $GtCO_2$), North America by 16 per cent (from 5.5 to 6.4 $GtCO_2$), Western Europe by 4.5 per cent, Asia and Pacific by 53 per cent (from 6.3 to 9.7 $GtCO_2$), Africa by 47 per cent (from 0.6 to 0.9 $GtCO_2$), and Latin America by 24 per cent (from 1.0 to 1.3 $GtCO_2$). Overall, Europe and North America showed a slight decline (from 13.7 to 13.2 $GtCO_2$), but this was because of the severe economic recession in the former Soviet Union. Currently, the absolute levels of emissions are moving the world away from the Kyoto targets with respect to emission reductions in 2012 compared with 1990. In order to move towards these targets (and especially those of UNFCCC) *and* have on-going economic growth, there would have to be a significant decoupling or *delinking* of GHG-emissions from economic growth.

In terms of relative contributions to emissions, in 2003, North America and Europe contributed 55 per cent of total CO_2 (down from 62 per cent in 1990), while Asia and Pacific contributed 37 per cent.

6 The detailed targets include 8 per cent for the EU-15, 7 per cent for the US, 7 per cent for Japan, and no targets for developing countries. Kyoto is seen as a first step towards achieving the (far more ambitious) FCCC-objectives.

Table 2.
Emissions, population and GDP by region, 1990-2003

Region	*GtCO2 emissions 1990*	*GtCO2 emissions 2003*	*Population (millions) 1990*	*Population (millions) 2003*	*GDP (1990$ billions) 1990*	*GDP (1990$ billions) 2000*
Africa	0.6	0.9	636	868	425	645
Asia & Pacific	6.4	9.7	3,041	3641	6,119	9,154
Europe	8.2	6.8	800	823	7,814	9,904
Latin America & Caribbean	1.1	1.3	444	546	1,458	2,066
North America	5.5	6.4	283	325	7,591	11,097
Polar	-	-	-	-		
West Asia	0.4	0.8	75	111	(264)	440
Global	22.2	26.0	5,280	6,314	23,671	33,305

Source: Geodata, UNEP (http://geodata.grid.unep.ch)

Finally, the available statistics indicate that:

- CO_2 emissions *per unit of GDP* globally dropped by 15.9 per cent; in North America 19.5 per cent, and Western Europe 20 per cent. Among developing countries, Asia registered an increase of 1 per cent, and Latin America almost 17 per cent, while Africa dropped by 1.5%.
- *Per capita* emissions in 2003 were: North America 19.8 tCO_2, Western Europe 9 tCO_2, South Asia 1.2 tCO_2, Central Asia 5.9 tCO_2, and Central and Eastern Africa 1 tCO_2. Globally, CO_2 emissions *per capita* showed a slight drop (-1.5%); in North America, there was a slight rise (+1.5%), in Asia, this was 26%, in Latin America, there was a drop of 4.1% and in Africa, a rise of 10%; Western Europe had a drop of 1%. On the whole, the developing countries have shown a small and constant rise to reach a level of 1-2 tCO_2 per capita, and the industrialized countries showed fluctuations around an average of 12 tCO_2.

The conventional approach: Separate climate and development

Until now, climate discussions have, quite understandably, been dominated by climate scientists. Although the IPCC process, in particular, has tried to bring in scientists from other disciplines, especially economics, and from different geographical regions, it has not been very successful in attracting sufficient numbers of experts in development theory or practice. One indication of this failure is the inability to organize a special report on climate change and sustainable development. More generally, the literature on the links between climate change and sustainable development remains sparse, unfocused, and fragmented. The result is that the development process is, at best, a backdrop in the evolving climate debate.

This is rather unfortunate, since for developing countries (that now contribute roughly half and the most rapidly rising component of global emissions), the climate issue is, in its essence, a development issue. If even the moderate projections of climate change are realized in practice, the development process would be reversed, and severe social, political, and economic disruptions will describe the landscape of the South for the foreseeable future. On the other hand, *any successful solution to the climate problem will have to come from within the development process*; it will need to *begin,* rather than end, with developing countries, and be based on a deep understanding of how development occurs.

This paper will not attempt to fill this void. At this point, the purpose is merely to raise key issues so that they can be introduced into the debate from the perspective of development. Further detailed work will have to be undertaken in pursuing some of these issues in depth, before concrete policy recommendations can be made.

We approach the climate-development nexus from two directions. Section 3 presents key elements of the conventional approach that have emerged thus far, in which climate and development have come to be treated as independent goals and domains of analysis. It ends with a set of questions pertinent to the Post-Kyoto agenda (see below, subsection entitled "Beyond Kyoto"). In Section 4, we will reverse the lens and try to raise a set of questions from the development perspective, namely asking what does development theory and development experience teach us about integrating climate change mitigation (and de-carbonization) directly into the process.

The conventional approach is structured around strategies for mitigation. As such, it follows the logic of equation 1, and asks how policy can be made to affect the four determinants of GHG emissions: population, income, energy intensity, and carbon intensity.

Population growth

The link between population and development derives from the fact that population growth today is mainly in the South. However, compared with the projections from the 1980s, which predicted population increases to up to 22 billion, growth rates have started descending and global population is now expected to reach a stable level during this century, at around (or slightly above) 10 billion. Bierbaum *et al* (2007) propose targeted policies for population planning as part of the climate package, and these should certainly be encouraged. However, since the impact of such policies is difficult to assess, given that population retardation is already supported by several policy mechanisms, it can only be a small and relatively unpredictable component of the package. Currently, population planning policies are in place in several countries, but these are because of their intrinsic desirability rather than because of the urgency imparted by climate concerns.

Economic growth

On economic growth, while Bierbaum et al (2007) suggest a slowdown of the global growth rate by 1 per cent, presumably through aggregate demand contraction, in order to slow down the growth of emissions proportionately, most analysts have not discussed this option explicitly (except insofar as a slowdown might result indirectly from other measures). An argument could be made for a deliberate slow down of the growth rate in OECD countries in order to bring their ecological and especially climate footprint closer to the resource limitations. Given the current level of growth rates in most OECD countries more may in fact be expected of changes in the quality or content of economic growth there, as captured in the international discussion on production and consumption patterns (see below).

However, as far as developing countries are concerned, the rate of economic growth is viewed as the pre-eminent policy goal. This is especially so today, as growth rates in developing countries (especially in Asia) have started to accelerate and offer the genuine hope of narrowing the gap between rich and poor countries. As such, a serious threat to this momentum could also constitute a threat to global stability and mutual trust. In fact, as the text of the UNFCCC bears explicit witness, the economic growth of developing countries has increasingly come to be viewed as a global responsibility—because it is the only mechanism the world has found thus far to address the vast inequality in incomes, wealth, and access to basic needs, human rights, and political participation. This is indicated, as we saw, by Article 2 of the UNFCCC which explicitly aims at achieving "stabilization of greenhouse gas concentrations … within a time-frame sufficient to allow ecosystems to adapt naturally to climate change,… and to enable *economic development to proceed in a sustainable manner*." [emphasis added] The message is repeated at several points in the text, including in each clause of the Principles (Article 3). The most direct is Paragraph 3 of the Principles, which states,

"The Parties have a right to, and should, promote sustainable development. Policies and measures to protect the climate system against human-induced change should be appropriate for the specific conditions of each Party and should be integrated with national development programmes, taking into account that economic development is essential for adopting measures to address climate change".

The result is that the bulk of the attention has been directed at the two other parameters: energy intensity and carbon intensity. The question is how to sustain economic growth while reducing the carbon footprint. Four influential ideas are relevant here: sharing the carbon budget, separating climate and development (the clean development mechanism (CDM)), empirical analyses of de-linking, and the so called environmental Kuznets Curve.

Sharing the carbon budget

Perhaps the most significant early contribution to the debate over climate and development was in a path breaking paper by Anil Agarwal and Sunita Narain (1991) who proposed an agreement on equitable rights to the global commons. The implication of this formula is that development becomes a dependent variable, while the independent variable is the *relative* status of rich and poor countries. By creating an equal base as far as rights to the global commons are concerned, this formula at least provides a potential for equalization of consumption, if not a sustained growth in income. Although the formula proposed by Agarwal and Narain could not form the basis for a compromise agreement, it helped inform the preambular language of the UNFCCC (both on the commitment to sustainable development referred to above, and the acknowledgement of the primary responsibility of the North).

The idea behind the allocation of per capita emission rights is, on the one hand, to provide an incentive for selecting low carbon technological and consumption options, and on the other hand, to compensate poor countries for their low emissions through financial transfers. After remaining on the sidelines of the climate debate for 15 years, the idea has now re-emerged with the strong endorsement by the German Chancellor Angela Merkel.

Kyoto compromise: Separate climate and development

The actual compromise, reached under the Kyoto Protocol, was to separate climate and development as two independent goals, to be pursued independently of each other. Under the formula, only the rich countries (termed Annex I parties) made commitments to reduce emissions (by an average of 5.2 per cent below 1990 levels by 2008-12) by deploying domestic policies and measures of a mitigative nature. Developing countries were exempted from such obligations. While this compromise might well reflect genuine disagreements—in the North, whether development is a global responsibility, and in the South, whether climate is a global responsibility—it was also the result of confusion between *responsibility* (for the problem as well as the solution) and the *action*. It is quite possible for the nations of the world to be agnostic over responsibility while agreeing where action is most needed and may be most effective.

To establish a minimal link between climate and development, the Protocol established the so-called 'clean development mechanism' (CDM). The aim of the CDM is to help Annex I countries meet their emission reduction obligations by investing in cost-effective solutions in developing countries, a link that could also help the latter (non-Annex I Parties) achieve their sustainable development goals (more on this later). Other examples of attention to the needs of developing countries are the measures identified to reduce the impacts on these countries of Annex 1 parties' climate policies such as the removal of subsidies to environ-

mentally unfriendly technologies and technological development of non-energy uses of fossil fuels. Yet, these examples do not bridge the gap between development and climate concerns.

De-Linking

The remaining two options, namely reduction of energy intensity and carbon intensity, are grouped here, where we look at the link between aggregate economic growth and carbon emissions.

From a technological perspective, reducing emissions can be the result of:

- enhanced energy efficiency (focus: CO_2)
- changing the composition of the global energy mix (focus: CO_2),
- enhanced carbon capture and storage options,
- reducing GHGs other than CO_2.

From an economic perspective, delinking may be the result of spontaneous structural changes in production patterns to do with a variety of causes including changing consumption patterns, responses to (fossil) fuel price rises (real or anticipated), and energy and emissions efficiency gains due to policy interventions. Moreover, as expectations about the firmness of policies related to emissions and sustainable development solidify, the private sector may identify new market opportunities and additional incentives (such as subsidies on innovation) may accelerate that. The latter considerations suggest several options for policy interventions for making development more sustainable and for addressing the UNFCCC challenges.

The Environmental Kuznets Curve and carbon-emissions

Some studies carried out in the early 1990s suggested that as countries developed away from low income levels, the level of environmental pressure associated with economic activity would initially be high, then level off as average incomes grow and, beyond a certain threshold (varying per type of environmental pressure), even drop. Inverted U-curves like this, for emissions or emissions per unit of GDP in relation to average income, have been labeled Environmental Kuznets Curves (EKCs); they have been seen as a basis for expectations that on-going economic growth would eventually erase environmental degradation.

Before we go into this literature, it may be useful to make a framing observation. The inverted-U pattern, although applied controversially to some variables (including not only environmental variables, but also those of income inequality), is well known in history. There are self-corrective ecological and modernization processes inherent in development (related to agglomeration, urban immigration, etc.) that act to mitigate the risks of monotonic increase (Erhardt-Martinez *et al.*, 2002). The classic example is the demographic transition, a pattern in which declining death rates initially led to a bulge in population growth, but the subsequent decline in birth rates made possible a new equilibrium, albeit at a higher level of population.

But an uncritical invocation of the EKC pattern is not without risk. The danger is in three areas.

- First, that this literature, often inadvertently, tended to represent such a process as being somehow "natural", in the sense that it is seen as coming out of normal economic choices, rather than from conscious policy decisions, institutional developments, and social changes. Viewing it as a natural process can lead to policy complacency, which can become dangerous in certain circumstances.
- The second danger is to overlook the fact that even if the counter-pressures will force adjustment and facilitate a new equilibrium, the delay itself might be dangerous. In a sense, there is a

race between adverse trends and corrective mechanisms, and as testified by several examples of collapse (see Diamond 2005), the adverse trends can win out in certain cases. For example, if no action had been taken on population management, the ultimate stable level might have been far higher than currently envisaged, and this could well have led to famines, wars, catastrophic environmental collapse.

- Third, the privileging of a single trajectory of change can result in obscuring other trajectories that would pose lesser challenges or lower social or other costs.

Although there are questions regarding the methodology and selectivity of some of the studies, the net result is robust patterns were found only for a subset of indicators of water and air pollution indicators. On carbon emissions, the data suggest that so far, there is no *absolute delinking,* and hence, no EKC: emissions have risen in absolute terms. This creates the second danger alluded to above: there might be de-linking in the future, but it will come too late to save the human species (or, to use a well known Nietzschean aphorism, "there is hope, but not for us"). The other two dangers are also present. The relative de-linking that has occurred, has not taken place as a consequence of 'natural' processes underlying economic growth or economic choices, but because of conscious policy decisions.

Another important element relevant to climate change is the extent of forest coverage and changes therein. This is to do with the fact that forests can be carbon sinks, but that this can be counteracted by the solar radiation reflection effects of deforested land. Emissions from deforestation are estimated to come close to 20 per cent of total carbon emitted (Stern 2006). Comparing total forest extent in 2000 with that of 1990 (FAO 2000) indicate declines in Africa (-7.5%), Asia-Pacific (-1.1%), Latin America and Caribbean (-4.6%), and some increase in North America and Europe in the order of 1%. At national levels, there were declines in Brazil (-4%) and Indonesia (-11%), but increases in China (12%) and India (1%).

The evidence on delinking for deforestation is mixed. Some studies do find a relationship between poverty, together with population growth, and deforestation, but no clear trends at higher incomes. Even these studies are plagued by measurement problems. Based on the evidence, one may conclude that even where de-linking appears to be observed, it cannot be relied on solely. Here again, the relevance of properly designed policy interventions and the embedding of policies with climate-relevant impacts in the context of development policies are manifest.

More generally, the question before the world today is how to bring about a more radical transformation (a totally different trajectory) to avoid climate catastrophe, not how to tinker with existing marginal changes or fragmented patterns of deceleration. At the end of the day, the entire suite of policies has to deliver one major result: keeping fossil fuels under ground. Current trajectories do not point in this direction.

The role of policy

The prevailing approach to climate policy follows two tracks. One track is to see it as an investment program, which is to be assessed on standard cost and benefit grounds, the costs being those of investments required in new technologies, and the benefits those of avoided climate change (plus ancillary environmental and social benefits where relevant). The second approach is to see it as the provision of global public goods, and ask how independent economic actors, including states, can be induced to provide such public goods.

Both these approaches are covered expertly in the recent authoritative survey by Nicholas Stern (2006). Part III of the Stern Report provides a fairly detailed cost benefit calculation to conclude that the

global costs of current projections of climate change (i.e., in the absence of counter-measures) are in the range of 5-20 per cent of GDP annually (including 'non-market' effects, risks and uncertainty), and they exceed, by far, the annual costs of stabilization at 450 and 550 ppm CO_2e, which are 3 and 1 per cent of GDP respectively. However, given that some of the most extreme impacts are not properly valued, these costs are nothing but lower bounds on possible costs. Still, given that the costs of mitigation are significantly lower than those of avoided damage, the policy conclusion in favour of immediate action is fairly straightforward.[7] Later, Part VI of the report approaches the same problem in terms of the provision of global public goods.

Notwithstanding the legitimacy of both these approaches in policy making circles, one cannot escape feeling that they suffer from a common weakness, in that neither takes the development process as anything but a side show.

Recent policies

In this section, we will look at some developments of climate policy up till now, and what issues might arise in a path-dependent approach to a follow-up to the Kyoto-I period. The next section will present some initial thoughts on how to move if a new, development-oriented alternative were to be considered.

Since the UNFCCC, a number of policies have been put in place to address climate change, both at international and national levels, and aimed at adaptation as well as mitigation.[8] International policies and strategies are related mainly to the Kyoto process (see also 2.2.2). National policies are also often related to the Kyoto Protocol, where duties of states are listed, but in developing countries, they have followed national priorities or the availability of technical support. Other categories of instruments, such as *innovation* and *institutional capacity development,* can easily be related to mitigation and/or adaptation.

The Kyoto Protocol established several "flexible" instruments or mechanisms (Jepma and Van der Gaast 1999) designed to enable Annex 1 parties to reduce their costs of meeting targets by facilitating methods to reduce emissions or increase GHG removals in other countries: emissions trading, joint implementation and the 'clean development mechanism' (CDM). For developing countries, the most significant Kyoto mechanism is the CDM, whose objective is to incentivize the involvement of developing countries (through financial compensation for incremental costs) in mitigation.

There are concerns about the desirability as well as the efficacy of all of these mechanisms (Lohmann 2006). Particular criticism has emerged over some features of the CDM: it allows developed countries to continue emitting according to unchanged patterns of their consumption and production while denying developing countries the benefits of unconstrained development (Michaelowa and Dutschke 2000); and, by allowing industrialized countries to reap the benefits of relatively cheap options of emissions reductions in developing regions, these options will then have been exhausted if, in future, developing countries wish to undertake emissions reducing activities themselves.

7 Quite predictably, a number of neoclassical economists have tried to dismiss this report because of its choice of discount rate (see, e.g., Nordhaus 2006, Yohe 2006, Tol 2006). However, as pointed out by Gary Yohe, perhaps the most balanced among the critics, the discount rate is merely a side issue. The evidence on the threat is abundantly clear, and there is no question whatsoever that immediate action is warranted.

8 *Mitigation* aims at reducing levels of GHG in the atmosphere (by reducing either emissions or concentrations). *Adaptation* refers to changes in practices, processes or structures to take changing climate conditions into account, to moderate potential damages and to benefit from opportunities that arise from climate change (IPCC 2001).

Adaptation is a necessary component of climate policies given the inevitability of the emerging climate change impacts in the short run. Some action has been initiated in the domain of adaptation, but much of it is of a preparatory nature. The largest source of support is from the Global Environmental Facility (GEF):[9]

- From the GEF Trust Fund, some $50m per year are available for capacity building in the area of climate change adaptation;
- the Special Climate Change Fund (Adaptation Program), to finance technology transfer and economic diversification; funding is at the $50 million level, though part of it will come from regular ODA sources; this fund has a development focus;
- a Least Developed Countries Fund, to finance the preparation and implementation of National Adaptation Programmes of Action (NAPAs) in LDCs; this development-focused fund has a volume of $115 million;
- the Adaptation Fund (under Kyoto), to finance the implementation of adaptation projects; it is financed by a levy on CDM projects (2% of certified emission reduction (CER) revenues) and by other contributions, with a possible reach of $100 million towards 2012 (Stern 2006).

These are rather limited amounts of finance. In addition to its adaptation focus, GEF supports projects in developing countries that reduce or avoid GHG emissions (renewable energy, energy efficiency and sustainable transport) at the level of approximately $250m per year.

At the national level, developing countries have undertaken some measures aimed at reducing emissions or building capacity for adaptation, but their overall impact and synergy remain quite limited (Gupta 1997, Stern 2006), especially in the field of mitigation (Van Heemst and Bayangos 2004). A recent survey of climate-related conditions and responses shows the importance of a context-specific approach (UNEP/Earthscan 2002). Some examples of policies are listed below:

- *India*: India's Conservation Strategy highlights the need for coping mechanisms, especially in coastal areas. Some CDM projects have been initiated, and substantial research is under way on emissions reduction through the development of energy from sea waves, biomass, or sustainable transport. India has recently established an Integrated Energy Policy providing access to clean energy for the poor and increasing energy efficiency. The policy is to lead to an estimated reduction in GHG-intensity by 1/3.
- *Indonesia* has a national climate strategy. The government has prioritized adaptation measures over mitigation and works to enhance peoples' capabilities in coping with, for example, sea level rise. However, climate change legislation has no standards or targets.
- *Kenya* has an emerging climate policy with associated institutions such as a National Committee on Climate Change.
- *Brazil* has established inter-ministerial coordination for sustainable development and actively follows (and contributes to) international climate negotiations. Domestically, climate change does not appear to be a priority. Brazil wants its share of renewable energy to be at 10% in 2030.
- *China* aims at reducing its energy intensity (energy/GDP) by 20 per cent between 2005 and 2010, and meeting 15 per cent of its energy needs from renewable sources within 10 years.
- *Africa:* Almost all African countries have ratified UNFCCC and many support the Kyoto Protocol. They are potential beneficiaries of its mechanisms. Detailed inventories of emissions and sinks have been provided by many countries. Options for exploitation of alternative energy

9 http:/www.gefweb.org

sources (solar, wind, biomass, hydro) are being explored. Mitigation and adaptation options must be found to cope with impacts of changes in weather regimes, droughts and floods.

- *Asia*: The Asia Least Cost Greenhouse Gas Abatement Strategies (ALGAS) project has identified a range of options to reduce GHG emissions.
- *Latin America and the Caribbean*: Mitigation and adaption activities include energy saving methods in such sectors as transportation, agriculture and waste management. The region is actively involved in developing renewable energy and carbon sinks (forests), as well as wind energy.

Synergies in climate and development policies

From the case studies mentioned in 2.4.1, it is clear that climate policies may impact development objectives in positive and negative ways, depending on the strategies, instruments, and contexts (Gupta 1999), and that development policies, e.g., on energy, forestry, agriculture (methane), transportation, or population, could be relevant to climate change. For example, in several countries (Brazil, India, and China), small-scale rural renewable energy projects or local forestry projects offer mitigating options with poverty benefits. There is a need for a more detailed analysis of such synergies, in terms of the categories indicated in table 3.

Significant outcomes can be expected outside the main diagonal in this framework and decision-making would benefit from analyses broad enough to capture the main elements across the matrix.

A particular area of potential synergy is between adaptation and poverty eradication. Van Heemst and Bayangos (2004) have analyzed the impact of climate change on poverty and the need for adaptation in developing countries. Climate change is likely to deepen poverty, directly as well as indirectly, and the poorest countries and groups are at the greatest risk (see also IPCC 2001). Given the delayed reaction on mitigation, even the best efforts may still result in significant climate impacts, hence the priority for adaptation in developing countries. Adaptation policies can often generate local benefits in the short run (investment in infrastructure, employment, etc).

Beyond Kyoto

The Kyoto Protocol asked for emissions reductions in 2008-12 by industrialized countries in the order of 5 per cent since 1990; it is clear (see above, subsection entitled "The Current Record") that in the longer run (in the course of the 21st century) much larger reductions would be required *globally* if the UNFCCC objective is to be met (IPCC 2007). The 2007 meeting of the G8 countries announced a call for halving global emission by 2050. It is clear that this would require a new impetus and that this is to come from the multilateral level. A much stronger effort towards effective climate policies would be part of the subject matter to be taken up in the context of negotiations towards a *post-Kyoto* agreement. This section develops a framework of questions that, in a path-dependent way, appear to be pertinent in such negotiations. They depart from the recognition of the need to look for synergies in climate and development policies, to include concerns

Table 3.
Policy matrix for identifying climate and development policy synergies

	Climate-related impacts (adaptive, mitigative; long term, short term)	*Development-related impacts (MDG, national objectives)*
Climate policies		
Development policies		

over instruments and mechanisms as developed thus far and the need to expand the set of instruments, as well as the need for funding the accelerated efforts towards mitigation of and adaptation to climate change.

Bringing climate and development together

To begin with, a new 'post-Kyoto'-focus will lead to a reconsideration of the main tenets of the Kyoto-approach: targets-oriented (in a step-by-step mode), radical differentiation as to commitments and duties by countries/regions, etc. The focus on targets has been frequently discussed, but has recently been gaining ground again. Yet, some key agents in emitting GHGs prefer other approaches, or are not yet committed to targets. Also, the level of the targets is to be addressed critically, in view of the new appreciation for the severity of the climate challenge. Countries and regions outside Annex I will need to be brought into more active roles, depending on their contributions to GHG emissions or their options for mitigation. And the approach to adaptation needs to be strengthened.

This reconsideration must be informed by analyses of the effectiveness of the approach, and by the availability of and alternatives to its various building blocks.

The United Nations Millennium Project's task force on environmental sustainability (Melnick *et al* 2005) recommended a series of mitigative measures (such as: investment in cost-effective and sustainable energy technologies, elimination of distorting subsidies favouring fossil fuels at the expense of renewable alternatives, the development of climate-friendly markets—e.g. carbon trading, targets for concentrations of GHGs, rationalized consumption and production patterns). There appears to be scope for strategies and development paths that would potentially lead to gains in terms of development as well as climate change mitigation objectives (Gupta 1997: 69). Examples are the gains from energy efficiency increases, mutual reinforcement in areas such as combating desertification and food security, forestry and sustainable development through 'payment for environmental services' schemes. At the domestic or national level, one sees demand for energy and transportation rising fast in many developing countries. Decisions made now on what technologies to deploy may have huge impacts on development paths and associated future emission levels. The point was made earlier that mitigation in developing countries may, by far, be the cheapest way internationally to achieve the UNFCCC climate objectives.

IPCC (2001) concluded that "adaptation can complement mitigation in a cost-effective strategy to reduce climate change risks; together they can contribute to sustainable development objectives". We propose that more involvement of the international community in adaptation is a must, given the inevitability of serious climate change impacts in the decades to come, before any mitigation effort would become effective. This is especially pertinent to least developed countries likely to be more affected by climate change impacts.

At present, poverty alleviation typically fails to consider vulnerability to climate change and adaptation needs (Van Heemst and Bayangos 2004). This is so in spite of the fact that adaptation policies can often generate local benefits in the short run (investment in infrastructure, employment, etc).

Where the Kyoto process appeared to largely separate climate and development considerations, any post-Kyoto arrangement would have to bring these two together.

Post-Kyoto instruments and mechanisms

The main challenge will be to design a system that would be attractive to a large number of countries with significant emissions, and would indeed lead to substantial cuts. Stern (2006) suggests that the key issues

in this new focus might be: (1) emissions trading or other forms of carbon pricing; (2) technological co-operation and supporting infrastructures (R&D and subsidies, deployment incentives for clean technologies; institutional capacity development); (3) removal of barriers to behavioural change (PCPs, regulation, information; international product standards, etc) (4) reduction of deforestation; and (5) adaptation.

Although systems of emissions trading at the international level are proposed as relatively efficient mechanisms for reducing GHG-emissions, actual practice has been heavily criticized (Lohmann 2006). Second, such mechanisms could then re-open debates about the allocation of CO_2-space or the carbon budget over countries in the form of emission quotas, but we suggest this aspect does not have the highest of priorities as discussed above.

Another policy issue in relation to the Kyoto-approach is that of the critical issues in the CDM. Michalelowa and Dutschke (2000) have identified a number of relevant impacts of CDM, including (next to obvious ones such as capital and technology transfer) the contribution to human capital formation, job creation, reduced inequality, reduction of other pollutants and protection of biodiversity. Obviously, these benefits do not occur always and everywhere, but they may arise—as well as negative externalities such as the impact of CDM on domestic innovation in both source and host countries, displacement of people and loss of arable land, etc (see also Lohmann 2006). Options that would provide a more appropriate combination of climate goals and development objectives and a fair sharing of benefits and costs of CDM need to be explored and discussed.

In renewed efforts at co-operation in climate policy, there is a further need for:

- better incorporation of climate related targets in the MDGs, and a more climate-oriented set of indicators as part of the systems of indicators for sustainable development and environmental quality;
- international exchange of best (national) practices;
- developing an appropriate international policy framework, including trade arrangements that incorporate environmental concerns, including those in the climate domain;
- harnessing innovative technologies in the GHG-reduction field and in other climate mitigation sub-domains, and co-operating internationally to disseminate and implement them;
- reconsidering the current structure and levels of support for adaptive and mitigative approaches—especially the former;
- reassessing traditional policy instruments in terms of their adaptability to better reflect climate-related externalities of production and consumption;
- developing effective partnerships with the private sector and civil society.

Funding and financial mechanisms

A main issue to be dealt with is that of funding. Adaptation is to be accelerated especially in developing countries. For adaptation, Stern (2006) estimates a need at the level of tens of billions annually in developing countries alone (and $15-150 billion in OECD). At present, there no commitment by Annex I countries to fund adaptation costs as such. The Marrakesh Accords based funds are rather limited. Donors and multilateral development institutions must support adaptation and mainstream it in their programs with developing countries.

A special funding mechanism has been proposed, under a special Multilateral Environmental Agreement for climate change adaptation, based on agreed cost-sharing rules, and funded from Annex 1 sources (Bouwer *et al* in Kok and De Coninck 2004).

Other options would be to find revenues in auctioning emission quotas, international GDP-taxes, levies on Joint Implementation Projects and/or on special activities such as air travel, etc.

The development approach

In the previous section, we have attempted to develop a list of issues for discussion and elaboration, given the experiences of the past 15 years. These will no doubt come to the fore in discussions about the Kyoto-agreement. We want to suggest that, in fact, taking one step back to get away from any path-dependency in policy development, what would actually be preferable is that a serious effort be undertaken to explore the possibilities of approaching climate issues from a development perspective. This more fundamental option is explored below.

So far, the focus initially was on addressing (sustainable) development from a climate-related point of departure (as was done in IPCC 2001). In a climate perspective, development pathways need to be found that not only will make economies emit less GHGs, but that also reduce vulnerability to climate change impacts and sustain the growth momentum.

Justified pleas have been made to—instead, or also—address climate change from a sustainable development viewpoint (Robinson *et al* 2006).[10] Linkage of climate change to development policies will "make development more sustainable". The arguments are that different socio-economic development paths will not only generate different adaptive capabilities and options, but will also affect mitigative capabilities and options and therefore lead to different emissions trajectories (IPCC 2001). Development-oriented policy areas that are climate relevant include policies in relation to land use (natural resources and agriculture), health, poverty (vulnerability), economic development (including trade and finance), energy (supply, demand, markets, security).[11] These policies in a 'non-climate track' are seen as crucial elements of policy efforts to decrease vulnerability to climate change, especially in the short run. Climate change could be integrated into policy development in that track. Sustainable development brings the diversification and flexibility necessary to improve adaptive capacity and eventually to increase the capability to also engage in mitigation efforts.

The main failing of the climate discussions is that they have not viewed climate as a development problem. This is apparent from the very approach of cost-benefit calculations (e.g., as employed by Stern 2006), which assumes a static world in which welfare comparisons can be made readily. Similarly, the costs of mitigation in Stern (2006) are based on static technology choices. This is the approach used in project selection in developing countries, but does not bear a direct or certifiable relationship with macroeconomic costs: economic growth, unemployment, balance of payments, and inflation.[12]

10 This will also be addressed in the forthcoming Working Group III report of the IPCC (expected in late 2007). (Now available at http://www.mnp.nl/ipcc/pages_media/AR4-chapters.html).

11 More detailed suggestions for combining climate policies with non-climate policies can be found in Kok and Coninck (2004).

12 Cost-benefit analysis has been used widely, at least since the 1960s, to assess development projects. The idea is that if the discounted net present value of a project is positive, it will add to overall economic welfare. Generally, these benefits are not translated into their macroeconomic impact. However, the underlying assumption is that growth and employment would be highest if the projects with the highest net benefits were undertaken. But this conclusion requires important and untested assumptions regarding synergies, technical change, learning by doing, efficient management, the treatment of invisible costs and benefits, and most importantly, between investment and growth. To take one example, Easterly (2003) finds no empirical support for the hypothesis of a strong correlation between investment and growth.

The integration of climate and development goals has several dimensions. At one level, it involves different ways of thinking about the relationship between the goals. At another level, it pertains to relationships between the North and the South. Finally, it has implications for the optimal suite of policy instruments.

The ideas suggested below are starting points for analysis. They are intended as a means of starting a discussion on an integrated approach to climate policy and sustainable development.

The analogy with structural adjustment

From a development lens, the problem appears somewhat different than from a climate perspective. To bring out some of the relevant issues in a development perspective, it might be useful to start with an analogy. The developing world has had considerable experience with precisely the situation in which the global community finds itself today, namely the emergence of structural imbalances because of past actions, leading to a series of crises and steadily worsening prospects. During the 1970s and 1980s, several developing countries found themselves seriously indebted, and facing recurrent fiscal and payments deficits, inflationary pressures, and persistent economic crises. Unlike climate change, a major cause of this imbalance was external shocks, especially the oil price increase, the financial crisis in the United States that led to unprecedented increases in interest rates, and exchange rate instability following the collapse of the Bretton Woods system. However, like climate change, a major cause of the imbalance was internal, namely "overspending", or excessive use of resources that turned out to be more costly than had been anticipated. In the structural adjustment crisis of the 1980s, the resource in question was international borrowing; in the climate crisis of the day, the resource is fossil fuels.

The industrial revolution was ushered in by the discovery of what was thought to be a "free" resource (fossil fuels). Belatedly, it turns out that this resource needed to be used sparingly. Between 1750 and 2000, the use of this resource resulted in the emission of a total of 2000 $GtCO_2e$ into the atmosphere, which was about twice the "available budget" of what the atmosphere could absorb safely. The excess of about 800 $GtCO_2e$ accumulated in the atmosphere, increasing CO_2 concentration from 280 to 380 ppm.[13] This can be seen as a debt that will have to be repaid through the reduction of emissions below the steady state level for several decades or centuries. However, the excessive use of fossil resources has also insinuated itself into economic behaviour and institutions. Emissions today are more than eight times what can be sustained in the long run. In other words, the world overspent the budget, went into debt, and also developed strongly in-grained habits that require going deeper and deeper into debt.

The structural adjustment experience provides some lessons for addressing this problem. The conventional remedy for the crisis was supposedly neutral, but in practice, highly regressive. It included cutting government expenditures, increasing taxation, devaluation, and monetary tightening. A more balanced approach, synthesized in the acclaimed volume by Cornia, Jolly and Stewart (1987), sought, as indicated in its title and subtitle, to bring about adjustment with a human face, which meant protecting the vulnerable and promoting growth.

Analogously, the world needs a structural adjustment program to readjust its economic behaviour in order to recover the required balance with the global climate system. However, it needs a program with a human face, one that protects the vulnerable while promoting growth.

13 As a rule of the thumb, about 8 $GtCO_2e$ adds one part per million to CO_2 concentration.

In case of structural imbalances, many policy makers delayed action in the hope that the problem was merely cyclical, and would disappear when the global business cycle resumed its upward momentum. In the case of climate change, significant segments of the relevant policy community have sought to delay action in the hope that the problem would simply disappear of its own accord. However, then as well as now, delay has its costs. The longer action is delayed, the higher is the cost in the form of human welfare as well as environmental integrity.

The world now is in a situation in which the bills have come due, creditors are knocking at the door, and action can be deferred no longer. The only question to be asked is not whether to undertake the adjustment, but how to structure it and how to time it so as to minimize aggregate costs, protect the vulnerable, and promote growth. This is, in part, why the discussion of costs and benefits appears misplaced. There were no such discussions in the structural adjustment episodes. The only questions pertained to the choice and timing of specific policy instruments.

One way of exploring this question is to start with a counterfactual: what would happen if all fossil fuels disappeared overnight? Obviously, it would be a nightmare scenario. Given the weight of associated corporations in global business, the stock markets would crash, giving rise to cascading bankruptcies, unemployment, recession, and severe adjustment trauma. Oil producing companies would be impoverished, resulting in migration, conflict, and war. The limited amount of fossil fuels left above ground would rise in price several-fold, resulting in the shutting down of industry, transportation, and home heating and cooking, especially in poor communities and poor countries. Food production, especially in industrialized agriculture, would be slashed. The list can go on.

From this scenario, it is easier to ask the next question. What could be done to ease the transition if there were a 50 year warning before the resources ran out? The major catastrophes hinted at in the previous paragraphs would be ideal candidates for the search for an adjustment with a human face.

Viewed in this manner, a number of issues will have to be rethought. Some thoughts on these are provided below.

Rethinking the roles of the North and the South

The current discussions seem to imply four different ways of building a basis for collective action between the North and the South:

- *Southern Commitments*: Much of the policy literature in OECD countries advocates the imposition of emission targets on developing countries (especially, though not exclusively, China and India) more or less in line with the Kyoto process. This is argued, on the one hand, as a means of bringing the United States into the Kyoto framework, and on the other hand, of ensuring that the source of most rapidly growing emissions is controlled. However, the implications of this strategy for development and economic growth in the countries concerned have been left quite vague.
- *Expanded CDM*: A second (though not unrelated) option is to expand the size of the CDM portfolio so that it can make a more appreciable dent in the emissions trajectories of developing countries. However, there is no clear relationship between this idea and the overall demands for maintaining the current growth momentum.
- *Tradeable Permits*: A third framework, again not entirely unrelated, is to establish a global 'cap and trade' regime for carbon emissions, based on some equitable formula for assigning emission

rights (e.g., see Frankel 2006). The idea is that while the wholesale financial transfers envisaged under the Agarwal-Narain (1991) formula are too onerous for rich countries, a formula could be found that gives the right incentives to all countries without immediate resource transfers.

- *De-carbonization of the South*: Following Agarwal *et al* (2001), the idea is to set up a global investment fund for the de-carbonization of the South.

Several comments can be made on these options. First, given the initial framing of the issue, the North-South discussions got mired in the very controversial question of equitable rights to the global commons. In other words, the first and third options became strongly linked, despite misgivings (especially in the North) over the resource transfer implications of emission rights.[14]

Those issues remain relevant, but might not be of as immediate a concern as thought initially. If the cuts required had been marginal in character, the rights to the commons would have remained an urgent issue. Given the depth of the cuts, it is quite clear that the final allocation would be far different from the situation that prevails today. It would make sense to think of the question of equitable rights to the global commons as a target for the year 2100. In the meanwhile, the goal of equity would be best served by enabling the South to sustain its developmental momentum (including co-operation enabling appropriate levels of adaptation) while making massive cuts in emissions.

In retrospect, the Kyoto compromise of initiating action in the North (while allowing the South to learn by doing) is not ideal either. It addresses neither the climate goal (emissions will actually keep rising under this dispensation) nor the development goal (developing countries are protected neither against expected future impacts of climate change nor against the possibility that severe emission cuts by them might become necessary in the near future).

This failure is, in part, the motivation for the fourth option listed above. It was first proposed in 2001 by the late Anil Agarwal and his collaborator Sunita Narain (in a volume put together by them together with two other colleagues, Anju Sharma and Achila Amchen). The proposal is that the mitigation process be launched in earnest in the South, through a globally funded public investment program. A useful analogy is that of the Manhattan Project, in which the necessary funding was provided by the public sector to deploy a technology that was on the anvil as it were. A similar mobilization of public funding is needed for deployment of renewable energy technologies, and thus, for a total reconfiguration of the rising investment in energy and transportation infrastructures.

In this case, however, the bulk of this investment will have to be made in the South. The purpose would be to bring about a change in trajectory where it is most cost-effective, namely where the investments have yet to be made. The result would be, on the one hand, a rapid decline in the emissions profile of the South, leading towards de-carbonization within one to two generations, and on the other hand, the facilitation of technological learning that would reduce the costs of renewable technologies for the North. This program would, in effect, reverse the current order of prioritization of action. Currently, the details of such a program have not quite been worked out (along the lines taken, for example, by Pacala and Socolow, 2004). A crash research program to identify and concretize options of this nature is required.

This implies the need for a clear separation between responsibility and action. From the UNFCCC onwards, there has been an explicit understanding that the responsibility for the accumulated emissions

14 One interesting consequence is that climate policies routinely have to go through contortions to try to show that emission rights are not property rights, while at the same time, treating them exactly as if they *were* property rights.

was that of the industrialized countries, and the responsibility for mitigation lay with countries that had the capacity to support such mitigation. However, this does not mean that the mitigation actions would also need to be made exclusively in the North. Rather, there is a need for an accelerated program of mitigation in the South. This needs to be funded appropriately. Some discussion was given to this in 2.4.3 and much more is taking place in the context of discussions on financing the provision of global commons in general; more work needs to be done to arrive at recommendations in relation to the development-climate nexus.

Rethinking technology transfer: The analogy with the Green Revolution

A third element of the crash program is learning the lessons from perhaps the most successful crash program of technology transfer, namely the Green Revolution. Like the current crisis situation, the question of famines and starvation was the spectre hanging over much of the South in the 1950s. Population growth rates had shot up, and agricultural yields and production lagged way behind. As a result, many food surplus countries had become dependent upon imports and food aid to meet their nutritional needs. There were fears and warnings of famines and starvation. Fortunately, the Green Revolution averted the catastrophe.

There are other parallels with the Green Revolution as well. As in the case of the Green Revolution, the world already has the technical knowledge to reduce emissions and shift to superior technologies. What is needed is a system that enables the effective harnessing of these technologies and placing them in the hands of producers and consumers. The Green Revolution accomplished this through an intricate and sophisticated network of institutions, including those for research, extension, education, credit, machinery, irrigation, policy development, and marketing. This network was built by strengthening and adapting existing institutions, rather than crafting wholly new ones. The result was, for example, that every agriculture graduate in South Asia arrived armed with the latest knowledge of hybrid seeds and associated inputs.

The climate crisis needs a similar massive investment in technology transfer, including by upgrading existing institutions of research, education (engineering, science, agriculture, and forestry schools, for example), credit, and policy. It also needs a strong extension network. After decades of awareness-raising, there is very little support, for example, for entrepreneurs who might wish to set up a wind farm in a developing country.

Rethinking costs

The requirement is not that of an incremental program that introduces marginal changes to existing trends, but of a fundamental re-orientation of the current developmental trajectory. This cannot be assessed through conventional cost-benefit accounting. Rather, it has to be approached through broader assessment techniques.

The estimate of the costs should proceed, not from a project accounting framework, but from macroeconomic variables that affect welfare: growth, employment, inflation, and fiscal and payments balances.

In going from microeconomic costs (such as those estimated by Pacala and Socolow [2004]) to macroeconomic outcomes, development theory has two broad approaches. The first, which is the conventional planning approach, dating back to the Mahalanobis-Feldman model and the Harrod-Domar growth model, uses an investment funds concept to connect stocks and flows. The second—deriving from Hirschman's concept of unbalanced growth, the role of technical change in the Solow growth model, and, more recently, Easterly's (2003) critique of conventional growth theory—looks to entrepreneurship, a platform for growth,

and the creation of a level playing field as critical elements in sustaining the growth momentum. There is a need to investigate the appropriateness of the two approaches to the current situation.

In fact, as Easterly (2003) has demonstrated, empirical evidence does not support two of the key founding concepts of development planning, namely a stable relationship between investment and growth, and a stable relationship of foreign resource inflows and investment. If this is granted, the question of a one to one trade-off between climate action and economic growth becomes very difficult to sustain. Still, in order to induce action, a fund for renewable technologies would have to be created on a scale that is commensurate with the projected scale of investment in energy and infrastructure in the South. In the end, the goal of such a fund might turn out to be more in terms of showing global commitment and sustaining confidence in the policy choices than in subsidizing the growth process.

Rethinking policy

The current policy discussions have tended to be concentrated on a single policy domain, namely the use of market mechanisms for the climate transition, and within this focus, on carbon trading as the desired policy instrument. This is unfortunate for several reasons. First, as Larry Lohmann (2006) has documented in excruciating detail, the current functioning of carbon trading leaves an enormous amount to be desired. This is, in part, because neither the science nor the institutions are ready to support this particular instrument. In part, this is because the lessons of the application of this instrument in other areas (e.g. sulphur trading) have not been acknowledged honestly. Finally, it is because of a quasi-ideological bias in favour of these instruments.

Second, these instruments are so far removed from the ultimate goal (keeping fossil carbon under ground) that it is difficult for the policy community to see the connections or assess the efficacy of the instruments.

Third, as Lohmann (2006) demonstrates, the instruments have become a means of maintaining not only the rights of powerful stakeholders (especially oil and energy corporations), but of enabling these stakeholders to persist with their current practices.

Fourth, this choice of instruments suggests that the challenge is to change things on the margin, rather than to transform the entire underlying structure of consumption and production. Price incentives are quite effective for introducing changes on the margin, but there is little evidence of price incentives inducing a fundamental transformation in the economy or society.

The result is that instruments that have succeeded well in other domains, especially in Southern countries, have not been considered explicitly. Roughly speaking this package (Lohmann 2006), consists of:

- large-scale public works
- subsidy shifting
- conventional regulation
- green taxes and other non-trading market mechanisms
- legal action
- all backed and monitored by popular movements and evaluated against ambitious short- and long-term targets.

A comprehensive menu of options will include these conventional policy instruments in addition to ones that allow for some flexibility in meeting agreed targets. However, the kind of accelerated establishment of emission rights, as envisaged under the Kyoto regime, might not be the most effective way of moving forward.

An unintended consequence of the current compromise is the problem of deferred policy. Market innovation and investment can be encouraged by an unequivocal policy stance. The current compromise is to opt for "painless" policies that induce some action and learning, in the expectation that future policies would reward actors who are most alacritous to initiate these actions. However, as Jeffrey Frankel (2006) has argued recently, such a reversal of policy commitment is highly problematic. For one thing, democratic governments cannot bind their successors, and therefore any policy that involves a future commitment by a successor regime is likely to be viewed as risky by the business community. The strongest incentives are likely to arise from front-loaded policies that create strong backward and forward linkages.

Regardless of the approach adopted, it is quite clear that policy inconsistency and shocks are far more debilitating to the growth momentum than static costs *per se*. The key question for policy makers is how to ensure that policy signals will remain consistent and clear over a period of time when several governments will change hands.

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