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climate policy

Review

Linkages between climate change and sustainable development

Noreen Beg [a,*,1], Jan Corfee Morlot [a], Ogunlade Davidson [b], Yaw Afrane-Okesse [b], Lwazikazi Tyani [b], Fatma Denton [c], Youba Sokona [c], Jean Philippe Thomas [c], Emilio Lèbre La Rovere [d], Jyoti K. Parikh [e], Kirit Parikh [e], A. Atiq Rahman [f]

[a] *OECD, Paris, France*
[b] *Energy and Development Research Centre (EDRC), Cape Town, South Africa*
[c] *ENDA-TM, Dakar, Senegal*
[d] *LIMA/PPE/COPPE/UFRJ, Rio de Janeiro, Brazil*
[e] *Indira Gandhi Institute of Development Research, New Delhi, India*
[f] *Bangladesh Centre for Advanced Studies (BCAS), Dhaka, Bangladesh*

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Abstract

Climate change does not yet feature prominently within the environmental or economic policy agendas of developing countries. Yet evidence shows that some of the most adverse effects of climate change will be in developing countries, where populations are most vulnerable and least likely to easily adapt to climate change, and that climate change will affect the potential for development in these countries. Some synergies already exist between climate change policies and the sustainable development agenda in developing countries, such as energy efficiency, renewable energy, transport and sustainable land-use policies. Despite limited attention from policy-makers to date, climate change policies could have significant ancillary benefits for the local environment. The reverse is also true as local and national policies to address congestion, air quality, access to energy services and energy diversity may also limit GHG emissions. Nevertheless there could be significant trade-offs associated with deeper levels of mitigation in some countries, for example where developing countries are dependent on indigenous coal and may be required to switch to cleaner yet more expensive fuels to limit emissions. The distributional impacts of such policies are an important determinant of their feasibility and need to be considered up-front. It follows that future agreements on mitigation and adaptation under the convention will need to recognise the diverse situations of developing countries with respect to their level of economic development, their vulnerability to climate change and their ability to adapt or mitigate. Recognition of how climate change is likely to influence other development priorities may be a first step toward building cost-effective strategies and integrated, institutional capacity in developing countries to respond to climate change. Opportunities may also exist in developing countries to use regional economic organisations to assist in the design of integrated responses and to exploit synergies between climate change and other policies such

* Corresponding author. Tel.: +1-202-473-3178; fax: +1-202-522-3256.
E-mail address: nbeg@worldbank.org (N. Beg).

[1] Noreen Beg has recently moved from the OECD to the World Bank. The article highlights the results of work commissioned by the OECD. However the views presented in this paper are those of the authors; they do not represent those of the OECD or of its member countries.

as those designed to combat desertification and preserve biodiversity.

Keywords: Climate change; Sustainable development; Developing countries; Economic and social development; Energy; Forestry; Institutional change; Capacity building; CDM; GHG mitigation policies; Climate change impacts; Biodiversity and climate change; Desertification and climate change

1. Introduction

Successfully limiting global climate change to "safe" levels in the long-term is likely to require connecting climate change policies to sustainable development strategies in both developing and industrialised countries. An exploration of linkages between climate change and sustainable development from a "developing country perspective" must start by considering local and regional circumstances and policy contexts. Five different regional or national situations were recently explored in individual papers covering Brazil, India, the west African region, South Africa, and south Asia perspectives. The results of these case studies summarised here.[2] The case study authors identify issues and approaches relevant to an evolving regime for addressing climate change, given various national and regional circumstances and priorities for sustainable development, including economic profiles, political interests, institutions and capacities. The authors consider the risks of climate change and the role of climate mitigation and adaptation policies within a sustainable development context, aiming to identify possible synergies between development priorities and climate policy objectives. Despite recognition of adaptation as an important target for policy, the background papers and this synthesis paper mainly emphasise mitigation policy.

This paper highlights main findings looking across these individual "case studies" around five themes:

- elaborating a framework for thinking about climate change within the broader context of sustainable development;
- exploring why developing countries should care about climate change;
- identifying and exploiting synergies for win–win policies and addressing trade-offs;
- strengthening institutions to address climate change in an integrated way—across and within institutions governing the global environment, across national ministries, across sectors and different levels of government; and
- extending the international regime to address climate change.

2. A framework

Three main sets of policy questions emerge in a discussion about the inter-linkages between policies for climate change and those aimed at sustainable development in developing countries (Fig. 1). The first relates to long-term "ecological" thresholds for climate change, which, if established, would constrain the level and timing of allowable global emissions. Any decision on the desirability of thresholds will be driven by society's concern about the risks associated with climate change impacts and by views on

[2] The case studies were commissioned by the OECD in 2001 as part of a pilot project on climate change and sustainable development. Final versions of the case studies will be released by the OECD under the responsibility of the authors in early 2002 (see www.oecd.org).

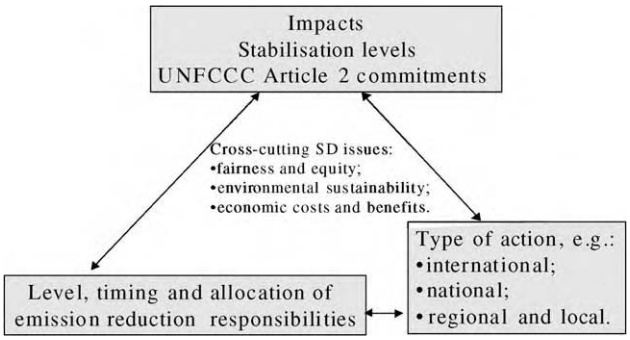


Fig. 1. GHG mitigation policy questions and sustainable development issues.

what is considered to be “dangerous” or “socially unacceptable.” A second set of questions relates to the global levels of emission reduction and the allocation of responsibilities to mitigate emissions among parties or countries; decisions on allocation will be driven by fairness and cost considerations. In turn, if established, general rules about emission reduction responsibilities will be a driver for global, national, and local mitigation policies. A third set of questions concerns the formulation of these policies, which include the design of mitigation and adaptation actions, choice of instrument, point of implementation and so on.

Central concerns about sustainability—economic, social and environmental dimensions—will necessarily influence action in each of these areas. Preferences and priorities for each of these cross-cutting issues influence the approach to evaluation of climate policy options and the recommended course of action.

The social dimension of sustainability raises a number of important “fairness” issues in the context of climate change. These can be divided with respect to outcomes and to process (Banuri et al., 1996; Rayner and Malone, 2000). On the outcome side, relevant issues include the distribution of impacts of climate change and the distribution of responsibilities (and economic impacts) for mitigation and adaptation action, considering both inter- and intra-generational dimensions. Fairness in the process of making climate policy includes participation and access to decision-making, which will inevitably determine the perceived fairness of any policy and ultimately its effectiveness. In an international context, an agreement that is not perceived as fair will not be ratified or implemented. This social dimension also encompasses institutional capacity, which will also determine the ability to participate in decision-making about climate change (or any other environmental problem).

Another cross-cutting sustainability issue relates to maintaining eco-system “health”. Climate change may threaten eco-system health in a number of important ways, including accelerating irreversible change such as through loss of species and of habitats (e.g. coral reef systems). Such concerns lead decision-makers to focus on “durability” as opposed to optimising the “economic use” of natural resources—the main objective in the economic dimension (Munasinghe and Swart, 2000). Economic optimisation is typically assessed through cost-benefit (CBA) and cost-effectiveness analyses of different alternatives. In both approaches, cost efficiency is achieved, either as net welfare costs (in the case of global CBA) or through minimisation of direct costs for a given target or set of targets (in the case of cost-effectiveness). Although the non-economic dimensions of environmental and social sustainability are important, neither CBA nor cost-effectiveness analyses deal well with these aspects. This is due in part to difficulties in quantifying in monetary terms many of the potential environmental and social impacts

of action (or inaction). Despite these uncertainties, economic assessment approaches have the advantage of being well known, widely accepted and frequently used to support policy and investment decisions.

Though economic optimisation goals still tend to dominate policy decisions, policy-makers increasingly acknowledge through the use of durability goals that natural capital may be unique and that irreversible change may be unacceptable.[3] In the climate area, durability goals may call for the establishment of thresholds or critical levels that respect ecological limits (Munasinghe, 2001; Yohe and Moss, 2000; Toth et al., 2001), such as thresholds for CO_2 concentrations or rates of temperature change in a given time frame. Establishing such thresholds would be based on a review of relevant impacts and a determination of what is and is not "socially" acceptable. In practice, however, uncertainty about the climate impacts associated with alternative threshold levels is likely to thwart political consensus on such thresholds.

The durability-based approach may also be extended to encompass broader (and multiple) goals aimed at maintaining "quality of life."[4] This might come at the cost of "optimal" economic growth. In contrast, economic "optimality" would tend to maximise economic growth, sometimes at the expense of "quality of life" (Munasinghe, 2001). Munasinghe (2001)proposes to combine the strengths of each to establish an "integrative, comprehensive, balanced . . . and practical meta-framework for making development more sustainable." This would tend to focus decision-making on the *structure of economic development* rather than on simply the *magnitude of economic growth* (Munasinghe, 2001). Developing such a framework could assist in the systematic evaluation of trade-offs and synergies among climate and development policy alternatives.

3. Why should developing countries care about climate change?

Studies show that some of the most adverse effects of climate change will be in developing countries, where populations are most vulnerable and least likely to easily adapt to climate change. Changes in temperature, water supply and quality will impact on agricultural production, human settlement and health, biodiversity and animal migratory patterns (IPCC, 2001a,b).

Understandably, vulnerability to the adverse impacts of climate change is one of the most crucial concerns of developing countries engaged in climate policy discussions. It is also a critical element in planning any long term climate and development strategy. A survey of studies undertaken since the IPCC Second Assessment Report (SAR) showed aggregate monetised impact estimates, based on current economic conditions and populations, for a 1.5–2.5 °C temperature increase (Tol et al., 2000). These studies indicate a greater economic vulnerability of developing countries to climate change. At lower levels of climate change, damages might be mixed across regions; for example, poorer countries are likely to be net losers, and richer countries might gain from moderate warming. In tropical and subtropical regions—where some crops are near their maximum temperature tolerance and where dryland, non-irrigated agriculture dominates—yields are likely to decrease for even small changes in climate. This is especially true in Africa and Latin America, where decreases in overall agricultural productivity of up to 30% are projected

[3] Along these lines, OECD Environment Minister's recently called for the establishment of environmental thresholds that respect limits to *regeneration* and *substitutability*, respecting the *assimilative capacity* of eco-systems, and avoiding *irreversible change* (OECD, 2001b).

[4] Here "quality of life" is used broadly to represent multiple goals of economic and social well-being, as well as social and environmental resiliency over time.

during the next century (Watson, 2000). At higher levels of change (more than 2–3 °C), net damages occur in almost all regions (IPCC, 2001a,b).

Developing nations face greater vulnerability because of their reliance on agriculture, their lower tolerance to coastal and water resource changes, and lower financial, technical, and institutional capacity to adapt (causing higher health impacts, for example). While sustainable development might reduce this vulnerability, uncertainties about the rate of climate change and pattern of economic development in poorer countries raise questions about whether development could occur fast enough to make a difference. Few studies have considered dynamic responses to steadily increasing greenhouse gas (GHG) concentrations, and the implications of multiple stress factors. This issue was highlighted recently by IPCC as critical for further research (IPCC, 2001a,b). In the absence of dynamic analyses, it is hard to determine whether certain impacts are in fact best mitigated or avoided through GHG emissions reduction or through other policies, such as improved health care or infrastructure development (OECD, 2001a).

The issue of vulnerability and adaptation to climate change is one of the top environmental concerns of the west African region (Denton et al., 2002). The GHG emissions of countries in the region are insignificant in global terms; the major sources of emissions that exist are from land-use changes and deforestation. However, west African is one of the most vulnerable areas to climate change due to its propensity for drought and desertification, its dependence on subsistence agriculture, and its vulnerability to poor rainfall. The Sahel in particular would be hugely affected by further desertification, caused by a combination of the extension of arable land due to rapid by population growth, deteriorating soils, and declining run-off from major catchments areas (Denton et al., 2002). South Africa is also highly vulnerable to climate change effects. An important facet of the country's vulnerability is expected to be impacts on human health, especially through the main vector-borne diseases of malaria and schistosomiasis (Kiker, 2000). Nevertheless, South Africa also has relatively significant adaptive resources to address these effects (Kiker, 2000).

South Asia is extremely vulnerable to climate change impacts, given its high levels of poverty, low human development indices, inadequate legal and governance mechanisms, and vulnerability to extreme weather events (Rahman et al., in press). An Asian Development Bank (ADB, 1994) study analysed the direct impacts on the Sri Lankan economy, using estimates for loss of agricultural production (detailed in Rahman et al., in press). Estimates for losses were based on available research findings, expert opinion and subjective judgement and resulted from changes in the production of rice, rubber, coconut, coarse grain, vegetables, and tea. The result was an adverse impact on the economy estimated to be in the range of 1.5–2.0% of GDP in 2010.

In a detailed study of India, Kumar and Parikh (1997, 1998)examined the impact of temperature rises on agricultural yields, output, income and prices. With a temperature increase of 2 °C and an accompanying precipitation increase of 7%, farm level total net revenue is estimated to fall by 9%, whereas, with a temperature increase of 3.5 °C and precipitation increase of 15%, the fall in farm level total net revenue would be nearly 25%.

Beyond the direct economic impacts, crop failure due to climate change could also increase unemployment, destabilise food security, further increase competition for scarce resources, and increase social inequity (Rahman et al., in press). In addition, there are significant risks associated with sea-level rise in some of the world's poorest regions.[5]

[5] In India, a 1 m rise in sea-level would displace 7 million persons at current population levels (ADB, 1994). In Bangladesh, 35% of the land would be submerged by a 1 m rise, affecting the many millions who live along the coastal delta.

Climate change is clearly relevant to priority development objectives such as combating poverty, food security, access to basic services such as clean water, sanitary living conditions and energy, and education.

4. Synergies and trade-offs for mitigation policies

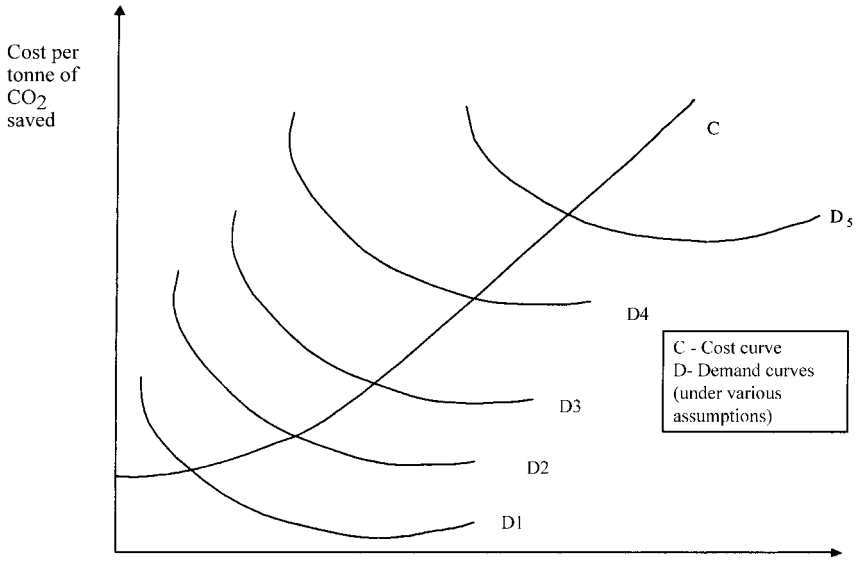
Though the first priority of developing country policymakers is to reduce poverty and encourage economic growth, climate change mitigation can offer an opportunity to revisit development strategies from a new perspective. The challenge is to ensure that actions to address environmental problems, including climate change will contribute to, rather than obstruct, local and regional economic development (Denton et al., 2002). However, policy-makers, financial institutions, and the manufacturing sector in most developing countries are largely external to the ongoing debate on climate change issues. In general, other more local environmental problems, such as desertification in Africa or air pollution in South Asia, are of more immediate relevance to the people and governments in these regions.

A key may be to demonstrate to policy-makers the interconnections between climate change management and other environmental and social benefits. From a climate policy perspective, such connections are often thought of as "ancillary benefits". The ancillary benefits of GHG mitigation include avoiding loss of human life or illness due to air pollution; and eco-system benefits, such as avoiding water quality problems from nitrogen run-off. Carbon mitigation can also have ancillary costs; for example, increased use of diesel fuels in transport could lead to additional particulate matter and health costs, despite better fuel efficiency and lower carbon emissions for a given distance travelled. Nevertheless, ancillary benefits are thought to outweigh ancillary costs overall, thus offsetting direct costs of mitigation, and they may be quite large especially in urban areas of developing countries (Davis et al., 2000; OECD, 2001b).

Fig. 2 shows a mitigation supply curve and a set of mitigation demand curves taking into account different concerns about ancillary benefits (Parikh and Parikh, 2002). If one were interested primarily in the removal of distorting subsidies, D1 would be the demand curve. If in addition, one wished to limit local air pollution and boost human health benefits, the relevant demand curve would be D2. D3 reflects concern about other environmental externalities that may affect quality of life, while D4 reflects concern about the eco-system. D5 adds an ethical dimension by extending concern to include species loss.

Quantitative estimates of these net ancillary benefits of GHG reduction in developing countries are starting to emerge in the literature (OECD et al., 2000). The relative value of these benefits in developing countries, compared to direct mitigation costs, tends to be large, mainly because baseline local air quality is generally poorer and carbon abatement costs may be lower in developing countries than in the industrialised countries. Ancillary benefits could be especially large in terms of saved lives and reduced illness per tonne of carbon abatement. Even so, developing countries need to ensure that measures to cut GHG emissions compare favourably with alternative measures (e.g. control technologies) in terms of reducing local air pollution (Dessus and O'Connor, 1999; O'Connor, 2000).

It is more likely that developing country policy-makers will consider GHG reduction as an ancillary benefit of "normal" development policies. For example, in South Africa, a number of policies governing the energy sector could achieve such synergies. These include energy efficiency programmes, renewable energy, and demand side management or household fuel switching strategies (Davidson et al., 2002).



Demand for Abatement	If primary concern is
D1	Removal of distorting subsidies
D2	D1 + local air pollution
D3	D2 + other local externalities, e.g. congestion
D4	D3 + ecosystem damage
D5	D4 + species loss

Fig. 2. Benefits may justify mitigation cost (Parikh and Parikh, 2002).

Several initiatives are also ongoing to introduce natural gas into South Africa, and may displace to some extent the use of coal. Increasing the share of natural gas in final energy supply and the effort in South Africa to improve energy efficiency and demand side management is likely to have significant GHG benefits.

In Brazil, renewable energy production and efficiency improvements in energy use in the 1980s have made a significant contribution to reducing GHG emissions. The programme of energy efficiency improvements in the use of electricity (PROCEL) alone has led to significant GHG emission mitigation (La Rovere, 2002). In 1997, GHG emissions from the Brazilian power sector were 17 million tonnes of CO_2equivalent. In this same year, PROCEL activities resulted in 1.2 million tonnnes of CO_2equivalent of GHG emissions being avoided. PROCEL's expansion, coupled with the strong increase of thermal power generation foreseen for the next two decades, is estimated to reduce GHG emissions from the power sector by 32% between 1990 and 2020 (La Rovere, 2002).

Urban planning activities undertaken by local governments can also contribute to mitigation of GHG emissions. For example, more than two decades of environmentally driven local administrations have turned Curitiba, Brazil, into a model for urban planning. A key local government initiative was the design of the expansion of the city along selected transportation axes. The creation of a fast and comfortable mass transportation system has resulted in considerable reduction in traffic congestion and

transportation time. Among the positive environmental externalities are significant reductions of local air pollution (including GHG emissions), not to mention avoidance of congestion and noise in urban areas (La Rovere, 2002).

4.1. CDM—a way to leverage GHG-friendly investment?

Significant international capital resources today flow to developing countries. Investors seek short-term profitable opportunities in financial applications, but are often not willing to face the large up-front costs, long payback periods and significant risks associated with investments in renewables, energy efficiency and afforestation projects that may mitigate GHG. Moreover, 80% of private foreign investments are concentrated in 12 rapidly developing countries. Meanwhile, OECD aid (in real terms) as a share of GDP has decreased significantly in the last decade (La Rovere, 2002; UN et al., 2000).

Clean Development Mechanism projects, as foreseen under the Kyoto Protocol, could play a role to reduce this resource gap. The CDM will allow developing countries either to initiate mitigation projects on their own, or to develop such projects jointly with industrialised countries and in return to "sell" certified emission reductions to these countries. How these challenges are addressed in the implementation of the Kyoto Protocol may set the tone for subsequent (post-Kyoto) negotiations on future mitigation commitments.[6]

In some countries, such as Brazil, the restructuring of the energy sector and the deregulation of the economy has contributed to an increase in GHG emissions from the energy sector. Under current market trends in Brazil, natural gas, oil and coal use are favoured over the deployment of the huge potential for renewable energy production and energy efficiency improvements available in the country (La Rovere, 2002). If successfully implemented, the CDM could play a role to help minimise the trend towards increased fossil fuel use in Brazil and other countries like it. However, the success may hinge in part on the ability of developing country governments to establish screening criteria to ensure that projects deliver long-term sustainability and technology transfer benefits as well as emission reductions (Parikh, 2000).

4.2. Possible policy trade-offs

Developing countries that adopt GHG-friendly sector policies must ensure that these policies are not implemented at the cost of reduced economic development. One critical concern is the within-country distribution of consumption of coal, oil and electricity by different rural and urban income groups, and their corresponding carbon emissions. Parikh and Parikh (2002)state that the poorer 50% of rural energy consumers in India emitted a mere 54 kg of carbon per person per year in 1990. The richest 10% of urban energy consumers emitted 12 times as much at 656 kg carbon per person per year. (This is still substantially below the world average of 1.1 t carbon per person and far below the average emission in developed countries.) Even projected emissions for 2020 demonstrate that the poorer 50% of rural energy consumers would emit a mere 60 kg carbon per person per year, and the richest 10% of urban energy consumers would emit 795 kg carbon.[7]

[6] Developing countries should receive benefits in terms of revenues or investment projects in return for CERs which are transferred to Annex B Parties.

[7] These projections assume an annual growth rate of per capita real income of 3.5%.

South Africa is faced with enormous socio-economic challenges. Among these, the inequality in energy service provision. Where in most Southern African countries less than 15% of the population have access to electricity (Ruffini, 2000), in South Africa that share stood at 66% at the end of 1999, with 80% and 46% of urban and rural households having access, respectively (NER, 1999). This is up from less than 35% with access in 1990 (Eberhard & Van Horen, 1995). Even after the success of the electrification programme to date, the majority of rural households are without access to electricity—and these communities have become more remote and expensive to deliver energy services. Futhermore, with the increased electrification of households, electricity demand, largely met by coal-fired power plants, is expected to rise. In a nation where access to modern energy services is still a major policy priority, it is difficult to argue for the prioritisation of GHG mitigation. While both energy efficiency and renewable energy are playing a growing role in providing energy services, as is the introduction of natural gas from southern Africa, switching completely away from coal fired electricity will be uneconomic in the short term.

4.2.1. Fuel substitution and potential income loss

Many developing countries still rely very heavily on coal as a source of energy. As local pollution reduction policies have only recently come into force, the heavy environmental consequences of coal use have been less of an issue for developing countries, where the focus has been on economic development. Developing countries argue that any agreement that would call for a switch to less carbon-intensive fuel sources should recognise and adequately recognise economic losses that might be occasioned by such a switch. For example, Parikh and Parikh (2002)any negotiation on future mitigation commitments should allow India the freedom to decide which type of energy or methods of power generation it uses. It would also be beneficial to have the flexibility to mitigate across GHG by reducing methane emissions through agricultural practices or forestry, and so on.

Economic impacts of mitigation action may also occur through changes in trade in exported energy products. For example, South Africa is the fifth largest producer and second largest exporter of hard coal in the world (IEA, 2001). South African exports totalled 9.3 billion Rands in 1999, or 5.5% of total exports (Chamber of Mines of South Africa, 1999; TIPS, 2001). Since it exports 68% of its coal to OECD countries and since most of its trading partners, such as European countries and Japan, have emissions reductions targets under the Kyoto Protocol, investment, trade and aid patterns are expected to be effected (Pershing, 1999; DME, 2001).

Significant concern exists in South Africa about how the implementation of the Kyoto Protocol will affect the coal industry, and the 61,000 workers, it employs (Davidson et al., 2002; Winkler et al., 2001). Early implementation of measures to diversify the economy might limit the vulnerability of South Africa's economy to changes in the export fuel market, as a result of GHG mitigation policies (Wamukonya and Spalding-Fecher, 1999).

5. Institutional issues and capacity building

A key barrier to effectively addressing climate change concerns is the lack of integrated policy-making at global, national or regional and local levels of action and among different government agencies. For example, in many developing countries, road transport, road construction, energy use and vehicular pollution are each governed by separate departments and ministries (Rahman et al., in press). Similarly,

in the case of adaptation, health ministries, infrastructure, and coastal zone management agencies should work together to maximise efficiency given limited resources and ensure consistency with other policy priorities. Focus should be on increasing the ability of the public sector to assess, design and implement appropriate policies that satisfy sustainable development objectives and, within this context, begin to address climate change. A case study of the situation in west Africa provides a number of general insights that may also be relevant elsewhere (see Box 1).

Box 1. Building institutions for sustainable development in west Africa

In west Africa, as in many other developing country regions, responses to the problem of global warming are primarily procedural and focused on co-ordination of various institutions to implement minimum requirements or obligations under the UNFCCC. A recent survey of capacity building needs related to the Kyoto Protocol in 16 African countries showed that climate change is not yet a priority policy issue for most of the relevant decision-makers nor is this issue closely tied to national development strategies. Nonetheless, a majority of the respondents to the survey expressed their willingness to participate in the CDM debates and/or activities if they become operational. Thus there may be an action agenda on climate change for project oriented investment through the CDM.

In west Africa, regional co-operation with a view to eventual integration may be the optimal approach to sustainable development and to addressing issues such as climate change. Denton et al. (2002) argue for use of the Union Economique et Monétaire de l'Ouest Africaine (UEMOA) to co-ordinate and implement environmental and economic policies. In a region of great geographical and social diversity, geopolitical boundaries only rarely correspond to cultural and ecological zones. The causes and consequences of environmental degradation tend to be common across west Africa's various shared ecosystems: extensive farming, a loss of fallow area, demographic pressure, water-management complications and farmer–herder conflicts. Re-thinking development as a region-wide challenge may have enormous potential to bring about desired change.

Major challenges remain to achieving an integrated approach to climate change and sustainable development. Compartmentalisation at international level of debates on the various conventions is among the main difficulties encountered. Strong dependence on external resources—including financial, technical and scientific—weakens the ability to cope with constantly changing issues over time. Finally, poor information and low awareness about the potential benefits of inter-linkages of the various conventions (and the global environmental problems they address, including climate) hinders progress.

Source: Denton et al. (2002).

5.1. Links between conventions

The implementation of other international conventions can strengthen the integration of climate change concerns into sustainable development strategies. Besides, the clear example provided by the experience with the Montreal Protocol, the Biodiversity and Desertification Conventions deserve special attention. While the co-implementation of international environmental agreements is highly viable everywhere, an example is provided in Box 2 for the case of Brazil, in connection with the needs associated with adaptation to climate change (La Rovere, 2002).

Box 2. Biodiversity, desertification and climate change in Brazil

The threat of climate change can become a menace to the integrity of Brazil's Amazon rain forest ecosystem. Additionally, deforestation, largely in the Amazon, is currently a major source of GHG emissions in the country. Accordingly, there is an important synergy between the implementation of the biodiversity and climate change conventions in Brazil.

Expansion of the agricultural frontier in the Amazon Basin has traditionally been related to ill-conceived policies that have granted fiscal exemptions to big national and multinational industries installing huge farms and cattle raising activities, and leading to extensive forest clearing. After the removal of these subsidies, the relative contribution to forest clearing from small farmers' migration has increased. Deforestation is still fed by the lack of access to land by small farmers in the rest of the country, which is turn is due to insufficient agrarian reforms. Though the cost of stopping or modifying deforestation is difficult to estimate, preservation of the forest natural resource in Brazil may be a key to opening the possibility of long-term sustainable development in the region.

Policies adopted for both biodiversity and climate change conventions could strengthen or enforce protection of the Amazon forest. Concerning climate change, it seems wiser to place forest protection measures under the umbrella of adaptation policies, given the controversial aspects of including it under mitigation options, such as the CDM. Uncertainties about the carbon balance of mature tropical forests and the risk of important leakages from one site to another could jeopardise the GHG emission reduction credits of any forestry CDM projects.

A multi-objective approach can also be applied to the implementation of the Desertification Convention. The acute desertification problem in Brazil, especially in the North-eastern region, can be seen in the indicators shown in Table 1. The North-eastern region of Brazil is the poorest region of the country, and its population density is much higher than in the Amazon, and it has traditionally suffered from severe droughts. Changes in rainfall patterns and in ENSO induced by climate change may further affect the already limited availability of water resources and aggravate the risk of famines due to the disruption of agricultural and cattle raising activities. Policies to implement the Desertification Convention are likely to go hand in hand with the adaptation of the North-eastern region to climate change.

Source: La Rovere (2002).

Table 1
Some land-use indicators in Brazil (million hectares unless otherwise indicated)

Total country area	845.651
Forest area (1980)	585.00
Forest area (1990)	563.91
Forest area (1995)	551.14
Average annual change 1980–1990 (%)	(0.6)
Average annual change 1990–1995 (%)	(0.5)
Total fertile land (including arid land)	80.76
Desertification of irrigated, cultivated and pasture land[a]	69.95
Desertification (% of total fertile land)[a]	87

Source: World Bank, 2000 (cited in La Rovere (2000)).

[a] Note: includes moderate, severe and very severe desertification, but no light desertification.

6. Extending the international climate regime

To be environmentally effective, future mitigation obligations under the UNFCCC will require participation of developing countries. Negotiations on the shape of future mitigation commitments are likely to be driven by two main issues: what is the level and timing for required global emission reductions? And, how to allocate the responsibility for required emission reductions? Answers to both questions will shape the costs of responding to climate change, in the aggregate and for individual countries (OECD, 2001a). Alternative development pathways, and the baseline against which emission reductions will be made, will also determine costs. The IPCC recently elaborated six different reference scenarios that show the possibility for a wide variety of possible energy futures. Over the 21st century, significant investment in new energy sources will be made which could significantly alter the energy mix compared to today. Most such investment today is directed to fossil resources. The nature of such investment in the future will determine the level and cost of required emission reductions (IPCC, 2000).

Most mitigation scenarios suggest that deep global emission reductions and lead times of half a century or more will be required to achieve any reasonable stabilisation target. Freezing emissions at current levels, for example, would only postpone the doubling of CO_2 concentrations until 2100, and would not be enough to prevent a continuing rise thereafter (IPCC 1996a,b). Reaching lower stabilisation levels (e.g. 450–550 ppmv) by 2100 would require earlier and more significant reductions, especially for the longest lived GHG (e.g. CO_2, HFC, SF_6). The timing and level of required emission reductions could also be affected by a need to limit the rate of climate change (e.g. thresholds for decadal change in global average temperatures) (Alcamo et al., 1998; Berk et al., 2001).

Participation in future agreements will also depend upon how required emission reductions are shared among countries. Notions of equity and fairness differ widely across countries but such notions are likely to drive decisions by developing countries about any future agreement on mitigation (Shukla, 1998; Yamin, 1999). Several authors have considered alternative design options for future mitigation commitments so as to encourage participation by all countries (Box 3). Parikh and Parikh (2002)have considered commitment design so as to discourage free-riding during the next negotiation period and beyond. They suggest that countries be made accountable for their own emissions for a specific period, say after 1990 or 2000. That is, whatever decisions are arrived at would be applicable retroactively from, say, 2000. The clock would then “start ticking,” and all emissions would be accumulated for each country even during negotiations. This way, future negotiations would conclude faster, leading to earlier policy actions to reduce emissions (Parikh and Parikh, 2002). Regardless of the outcome of the negotiations, these emissions would be shown against each country total, with the result that significantly fewer emissions would be available to them in future. The countries taking action in advance would be rewarded, and procrastinating countries would have to do more later.

Some innovative ideas have already been brought to the table by negotiators from non-Annex I countries. An interesting proposal was made by the Brazilian government at COP 3 in Kyoto (MCT, 1997): that the burden sharing among Annex I parties should be based upon the contributions to global temperature increase of each country since 1840 up to now, and not simply on their annual GHG emissions. La Rovere (2002)suggests that a more practical option would be to use the cumulative GHG emissions of individual countries since 1990 as a basis for establishing future mitigation targets. (This is of course similar to the proposal put forward by Parikh and Parikh, 2002, see above). The rationale for this proposal is based on

Box 3. Alternative forms of commitment
Some authors suggest that developing country participation under future commitment periods might start in the form of indexed targets—such as CO_2 per unit of GDP (Baumert et al., 1999). Fixing indexed targets would both avoid the possibility of "hot air" and would not penalise countries whose economic and emission growth are above expectations. Indexed targets, combined with the opportunity to trade any emission reductions below such "targets" is another possibility that would provide economic incentives to developing countries to reduce growth in emissions. Mitigation commitments could also take softer forms, for example non-binding targets, voluntary agreement upon future baselines against which emission reductions could be measured, or agreement to implement policies and measures to mitigate GHG (Philibert and Pershing, 2001).

the following:

- As illustrated by recent IPCC work (IPCC, 2000), cumulative emissions supply a reasonable "proxy" for the relative contribution to global warming of different parties to the UNFCCC, when considered in a time period limited to a few decades.
- Data reliability problems would be solved through proper review of inventories presented as part of national communications to the UNFCCC, which cover from 1990 on.
- The discussion about objective or subjective responsibility for global warming would be avoided as the harm caused by GHG emissions to the global climate was clearly established by IPCC in 1990.
- This principle can be immediately adopted without defining the exact date when non-Annex I countries would be committed to mitigation targets, which can be left open for future negotiations under the UNFCCC framework. The importance of this first step would be to convey a clear sign to non-Annex I countries that they will be rewarded by any early action towards a lower carbon development style. This will help them to face milder mitigation targets in the future, no matter when they will be committed to them.

Taking this proposal as a starting point, further work could explore long-term global GHG emission scenarios to illustrate the combined effects of different trajectories of Annex I and non-Annex I GHG emissions. This analysis would supply useful insights to the negotiations on the initial date of non-Annex I countries commitment to mitigation targets, according to different targets for long-term stabilisation of GHG concentrations in the atmosphere. In general, annual GHG emissions from Annex I countries as a whole would be required to decline from the start of the time frame. Those from non-Annex I countries would be allowed to increase during an initial period to eventually stabilise, and finally decline until the end of the century.

The starting year for commitments to mitigate could be established for all non-Annex I countries simultaneously, based upon each individual country's relative contribution to the cumulative GHG emissions since 1990 (La Rovere, 2002). The contribution of Annex I countries as a whole to the CO_2 concentration level in the atmosphere in 1990 is estimated to be 79% .[8] This is larger than their contribution to the global annual CO_2 emissions in 1990 (75%) and lower than the contribution to the actual temperature increase due to CO_2 emissions registered in the same year, reaching 88% (IPCC, 1996a,b). These calculations

[8] These figures include CO_2 from fuel combustion only and could differ significantly if they were more comprehensive, e.g. via inclusion of land use change and forestry fluxes.

could be updated to the year when Annex I countries would actually implement some mitigation targets (e.g. 2008–2012 if the Kyoto Protocol is ratified). Then, the date when non-Annex I countries would reach a similar level of contribution to global cumulative GHG emissions since 1990 (somewhere between 50 and 90%, to be negotiated) would be set as the end of the grace period for all non-Annex I countries. This approach could provide an incentive to Annex I countries taking the lead, as the sooner they start implementing mitigation targets, then the sooner non-Annex I countries would come aboard (La Rovere, 2002)

7. Conclusions

Climate change does not feature prominently within the environmental or economic policy agenda of developing countries, yet evidence shows that some of the most adverse effects of climate change will be in developing countries, where populations are most vulnerable and least likely to easily adapt to climate change (IPCC, 2001a,b). It is also probable that climate change could exacerbate current inequities due to the uneven distribution of damage costs, in addition to the cost of mitigation and adaptation efforts. From a developing country perspective, it is essential that global agreements evolve on the basis of considerations of fairness and that developing countries participate actively in shaping and implementing the next steps toward mitigation and adaptation (Munasinghe and Swart, 2000). Broad participation in mitigation efforts opens the possibility to limit damage costs. In contrast, slow progress in mitigating global GHG emissions implies that climate impacts will constrain the potential for economic development in some of the poorest of developing countries.

Future agreements on mitigation and adaptation under the Convention will need to recognise the diverse situations of developing countries with respect to their level of economic development, their vulnerability to climate change, and ability to adapt to or mitigate it. This paper offers a few suggestions from analysts in non-Annex I countries about the design of equitable mitigation commitments: in particular, that the cumulative emissions of individual countries since a given date, say 1990 be used as a basis for establishing future mitigation targets. The paper also suggests that long-term global GHG emission scenarios be used to illustrate the combined effects of different trajectories of Annex I and non-Annex I GHG emissions. This analysis would supply useful insights to the negotiations on the initial date of non-Annex I countries commitment to mitigation targets, according to different targets for long-term stabilisation of GHG concentrations in the atmosphere.

Clearly economic growth and poverty reduction are the main priorities for developing country policy-makers, yet climate change mitigation can offer these countries the opportunity to revisit development strategies from a new perspective. Climate change considerations place renewed urgency on some options, such as energy efficiency, renewable energy, and sustainable land-use policies, and argue for better understanding the connections to other environmental problems. They also argue for improving the integration of environment and development issues along with other issues, such as income distribution. Despite limited attention from policy-makers, climate change policies could have significant ancillary benefits for the local environment. The reverse is also true, as synergies exist between transport, energy, forestry and environmental sustainability policies and climate change objectives (e.g. mitigation and adaptation).

In order to maximise the potential for synergy, increased institutional capacity and awareness building measures will also be needed. Integration—across ministries, between the private and public sector, through international conventions—is vital. Possibilities for such synergies include combining strategies

to fight desertification and preserve biodiversity, as well as to combat climate change. Adequate financial incentives are critical to ensure attention in developing countries to global environmental issues, as is recognition by all that climate change will inevitably influence development.

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