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Author(s):	CLAs:	Jayant Sathaye and Adil Najam		
	LAs:	Chris Cocklin, Tom Heller, Franck Lecoque, Juan Llanes, Jiahau Pan, Steve Rayner, John Robinson, Roberto Scaheffer, Youba Sokona, Rob Swart, Harald Winkler		
	CAs:	Sarah Burch, Andrew Wyatt		
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Sustainable Development and Mitigation

EXECUTIVE SUMMARY

The concept of sustainable development was adopted by the World Commission on Environment and Development, which defined it as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." There is general agreement that sustainable development involves a comprehensive and integrated approach to economic, social and environmental processes. Discourses of sustainable development, however, have historically focused primarily on the environmental and economic dimensions. The importance of social, political and cultural factors – for example, poverty, social equity, governance – is only now getting more recognition. From a climate change perspective, this integration is essential in order to articulate development trajectories that are sustainable.

Addressing Sustainable Development Concerns

Since its emergence in the 1980s, the term 'sustainable development,' has given rise to concerns which may be grouped into three categories. First, the variety of definitions of sustainable development has raised concerns about definitional ambiguity or vagueness. Second, it is clear that the term can be used to support cosmetic environmentalism, sometimes called "greenwashing". In response to these two concerns, it has been argued that vagueness may constitute a form of constructive ambiguity that allows different interests to engage in the debate, and the concept to be further refined through implementation.

Indeed, as we illustrate in this chapter, implementation at the macro and sectoral level is beginning to be quantified through improved monitoring and analytical techniques, and standards are being developed and implemented in order to be able to verify claims about sustainable practices. At the macro level, measures of welfare, e.g. Index of Sustainable Economic Welfare, that are alternatives to GDP have been developed and reported for dozens of countries. Many show a slower increase in welfare than that measured by the Gross Domestic Product in recent decades. At the sector level, green certification, monitoring tools, and emissions registries are some of the ways that progress towards sustainable development is being measured and reported by industry and government entities.

Thirdly, some argue that because biophysical limits constrain the amount of future development that is sustainable, the term is an oxymoron and is inherently delusory. Others point out that the concept of sustainable development is anthropocentric, thereby avoiding a reformulation of values

that may be required to pursue true sustainability. While very different in approach and focus, both these criticisms raise fundamental value questions that go to the heart of present debates about environmental and social issues.

Sustainable Development ←→ Climate Change

There is a growing literature on the two-way nature of the relationship between climate change and sustainable development. The notion is that policies that pursue sustainable development and climate change mitigation can be mutually reinforcing. That climate change mitigation can have ancillary benefits or co-benefits which will contribute to the sustainable development goals and that sustainable development can create conditions in which climate change mitigation can be effectively pursued. For example, one of the finding in the Third Assessment Report was that it will be extremely difficult and expensive to achieve stabilization targets below 650ppm from baseline scenarios that embody high emission development paths. Conversely, low emission baseline scenarios may go a long way toward achieving low stabilization levels even before climate policy is included in the scenario.

It is important to recognize, however, that the sustainable development and climate change relationship is not always mutually beneficial. Climate change mitigation, can be the cause of other environmental problems, and development that is sustainable in many other respects may increase GHG emissions. Nevertheless, framing the debate as a sustainable development problem rather than an environmental one may better address the immediate goals of all countries, while acknowledging that the driving forces for emissions are linked to the underlying development path.

Decisions about technology, investment, trade, poverty, biodiversity, community rights, social policies, or governance, which may seem unrelated to climate policy, may have profound impacts upon emissions, the extent of mitigation required, and the cost and benefits that result. Conversely, climate policies that implicitly address social, environmental, economic, and security issues may turn out to be important levers for creating a sustainable world.

Mitigative Capacity

Mitigative capacity is the capability to reduce anthropogenic greenhouse gas emissions or enhance natural sinks. It is a function of technology, institutions, empowerment, wealth, equity, skills, infrastructure, and information, and depends on social, biophysical and technological constraints. Countries face "social, cultural, political, and economic constraints" as well as barriers within the decision-making process itself. Additional constraints include high opportunity costs of devoting resources to climate policy, the strength of vested interests that oppose the implementation of mitigative measures, and issues raised by the distribution of power within different levels of government, industry, and other entities. The mitigative capacity to reduce emissions can thus be low, even when significant abatement opportunities exist.

The notions of adaptive and mitigative capacity advanced in the IPCC Third Assessment Report appear to reinforce the idea that the capacity to develop and implement climate response strategies are essentially the same as those required to develop and implement policies across a wide variety of domains. In translating capacity into actual mitigation or adaptation activities, however, these capacities may become more specific. The issues and cases discussed in this chapter suggest that the challenge of implementing sustainable development is not confined to the developing countries. The nature of the challenge in industrialized countries, however, tends to be different than in developing countries.

Alternative Development Pathways

After the publication of the IPCC TAR[1], several new baseline scenarios relating to climate change or global sustainability were published. Most of them confirm the main findings of SRES. For the Millennium Ecosystems Assessment (MEA), four scenarios explored implications of alternative development pathways for global and regional ecosystem services, loosely based on the SRES but developed and enriched further. The scenarios assume - consistent with SRES - that greenhouse gas emissions are strongly determined by the socio-economic development path. For the next 50 years, all scenarios find that pressures on ecosystems services increase with the extent of the pressure being determined by the particular development path. The MEA scenarios identify climate change next to land use change as a major driver of biodiversity loss in the coming century. The MEA scenario analysis thus emphasizes that the development of ecosystem services, biodiversity, human well-being and the capacity of the population to deal with these developments is largely determined by the choice of development pathway.

The connections between alternative development pathways and international trade are often left unexplored. International trade allows a country to partially "de-link" its domestic economic systems with its domestic ecological systems, as some goods can be produced by other economic systems. To fully address global emissions reductions, thus an integrated multi-country perspective is needed.

Recently, several studies have explored development pathways for developing countries that are consistent with lower greenhouse gas emissions. A common finding of the studies for South Africa, Senegal, Bangladesh, Brazil, China and India is that it is possible to develop pathways which combine low GHG emissions with effective responses to pressing regional problems. In the energy sector, energy security and reduced health risks can be effectively combined with low greenhouse gas emissions, even without explicit climate policies. Enhanced soil management, avoiding deforestation and encouraging (re-)afforestation can increase carbon storage, while also serving the primary goals of food security and ecosystem protection.

Sustainable Development Policy Choices

GHG emissions are influenced by, but not rigidly linked to economic growth, but policy choices can make a difference. In some cases, such as energy efficiency, selected mitigation options perform at least as well as others in meeting their sustainable development goals, including costs, but perform better than other options in terms of GHG emissions reductions.

Some general conclusions emerge from examples that are cited in this chapter:
Sectors that are farther away from the production frontier – i.e., where production is lower than what would be possible with optimal use of available inputs – have opportunities to adopt "win-win-win" policies, i.e., policies that bolster growth, meet other sustainable development goals, and also, incidentally, reduce GHG emissions relative to a baseline.

[1] The TAR distinguished between strategies *decoupling growth from resource flows* (e.g., resource light infrastructure, eco-intelligent production systems, "appropriate" technologies and full-cost pricing), and strategies *decoupling well-being from production* (intermediate performance levels, regionalization avoiding long-distance transport, low-resource lifestyles).

Sectors that are closer to the production frontier also have opportunities to reduce emissions by meeting other sustainable development goals. However, the closer one gets to the production frontier, the more the trade-offs become apparent.

To have a lasting impact, however, what matters is not only that a "good" choice is made at a certain point in time, but also that the initial policy has persisted for a long time – several decades. One reason is that mitigation rate depends on the rate of technological and/or land-use change, which exhibits considerable inertia and thus requires a sustained effort. This raises deep institutional questions about long-term commitments, particularly in societies where the time span of policy-makers is short.

It is often not one policy decision, but an array of decisions that may be necessary to influence emissions, especially when considering large-scale and complex dynamics of human settlements. This highlights the issue of coordination across policies in several sectors, and at various scales.

Role of State, Market, Civil Society and Partnerships

There has been an evolution in our understanding of how sustainable development and climate change mitigation decisions are taken by societies. In particular, this includes a shift from government defined strictly by the nation-state to a more inclusive concept of governance which recognizes the contributions of various levels of government (global, transnational / regional, local) as well as the roles of the private sector, non-governmental actors, and civil society. The more that climate change issues are routinized as part of the planning perspective at the appropriate level of implementation, the national and local government, the firm, the community, the more likely they are to achieve desired goals. However, merely piggybacking climate change onto an existing political agenda is unlikely to succeed.

State:

It has long been recognized that different countries have different institutional capacities to implement emissions mitigation strategies. However, the issue has not been widely taken up in the climate change policy literature and has been largely absent from the IPCC until now. This is surprising since the idea of differentiated capacities is explicitly recognized in the principle of differentiated responsibilities, embodied in the creation of Annex 1 and Annex 2 countries within the Framework Convention on Climate Change.

A substantial body of political theory identifies and explains the existence of national policy styles or political cultures. The underlying assumption of this work is that individual countries tend to process problems in a specific manner, regardless of the distinctiveness or specific features of any specific problem; a national "way of doing things". An explicit recognition of these differences would help towards forming partnerships and coalitions across countries.

An important, though often neglected issue in the choice of policy instruments is the institutional capacity of governments to implement the instrument on the ground. This is often a matter of what countries with highly constrained resources think that they can afford. However, even industrialized nations exhibit significant variation with respect to the characteristics that would be considered ideal, which include:

- a well developed institutional infrastructure to implement regulation
- an economy that is likely to respond well to fiscal policy instruments because it possesses certain characteristics of the economic models of the free market

- a highly developed information industry and mass communications infrastructure for educating, advertising, and jawboning
- a vast combined public and private annual RD&D budget for reducing uncertainties and establishing pilot programs

To the extent that these close to ideal conditions for conventional policy instruments are missing, policy makers are likely to encounter obstacles to their effectiveness.

Market:

Industry is a central player in environmental stewardship. Increasingly, the private sector has been recognized not only as a partner in implementation, but also as a stakeholder in policy design. Over the past 25 years, there has also been a progressive increase in the number of companies that are taking voluntary steps to address sustainability issues at either the firm or industry level. Some of the more widely acknowledged corporate sustainability drivers are:

- Regulatory compliance
- Markets
- Reputational value
- Cost savings
- Stakeholder relations
- Finance sector drivers
- Ideological commitments

From the perspective of firms, there are both internal and external barriers to change. Internal barriers include an absence of commitment and leadership at senior levels, corporate culture, organizational structure, and the specific characteristics of plant and operations. External impediments to change in support of sustainability include a persistent emphasis in the markets on short-term profit, accountability systems that ignore social and environmental performance, the inability to adequately influence supply chain relationships, and the risks to the individual firm of enacting fundamental change while the mainstream remains locked into the neo-classical growth model.

Although there has been progress, the private sector can play a much greater role in making development more sustainable. As the number of companies which operate both profitably and more sustainably increases, the view that addressing social and environmental issues is incompatible with shareholder maximization is losing ground.

Civil society employs ‘civic will’ to the policy discourse and it can motivate policy in three distinct but related ways. First, it can push policy reform through awareness-raising, advocacy and agitation. Second, it can pull policy action by filling the gaps and providing such policy services as policy research, policy advice and, in a few cases, actual policy development. Third, it can create spaces for champions of reform within policy systems so that they can assume a salience and create constituencies for change that could not be mobilized otherwise.

Partnerships:

The strategies of partnership, self-help and community empowerment have been used to encourage participation and to promote the idea that environmental problems are best addressed through communities working together, and with government and industry. Partnership programs can provide citizens groups with a lever for increasing pressure on both governments and industry. As bounda-

ries between and within public and private sectors have become blurred, however, questions have arisen about the authority, responsibility and accountability of different actors.

Closely related to the idea of partnerships is the idea of stakeholder dialogue and input. Local involvement in public-private partnerships may help resolve the stand-offs over global environmental agreements like the UNFCCC. Cooperative environmental governance models offer advantages such as a more structured framework for pluralist contributions to policy, consensus-building, more stable policy outcomes, and social learning. Deliberative public-private partnerships work most effectively when investors, local governments and citizen groups are willing to work together to implement new technologies, and produce arenas to discuss these technologies that are locally inclusive

Regional variations and priorities

Regional groupings in the climate change literature differ by purpose and context. Given the variety of criteria used in such groupings, we rely on a combination of income and political considerations for grouping countries into developed, developing, and transitioning countries.

Developed nations possess comparative advantages in technological and financial capabilities in mitigation of climate change. The US, Norway, Japan and a few other developed nations are focusing more of their efforts on sinks and carbon sequestration. As the impacts of climate change in these countries are manageable, priority mitigation areas for countries in this group may lie in improving energy efficiency, building new and renewable energy and carbon capture and storage facilities, and to foster a mutually remunerative low-emissions global development path through provision of technological and financial resources to the developing world.

With the enlargement of the EU, economies in transition as a single group do not exist. Nevertheless, central and eastern Europe and the Commonwealth of Independent States do share some common features in socioeconomic development and in climate change mitigation and sustainable development. Although the rate of economic growth in the past 15 years has been low at 0.3 percent per annum, it is expected that future economic and GHG emissions rates would be high in many countries. Measures to decouple economic and emissions growth might be especially important for this group. This suggests a large potential for emissions reductions through institutional reform and increase in energy efficiency.

Some large developing countries are among the top 25 GHG emitters. This handful of developing countries are projected to increase their emissions at a faster rate than the industrialized world and the rest of developing nations as they are in the stage of rapid industrialization. For these countries, climate change mitigation and sustainable development policies can complement one another; however, financial and technological assistance can support these countries to pursue a low carbon path of development.

For most other developing countries, adaptation to climate change takes priority to mitigation as they are more vulnerable to climate change and less carbon dependent. As both adaptive and mitigative capacities are low, development aid can greatly help to reduce vulnerability to climate change and to keep/increase carbon storage in forest and soils through CDM. OPEC countries are unique in a sense that they may be adversely affected by development paths that reduce the demand for fossil fuels. Diversification of their economy is high on their agenda.

For most Small Island States, the key SD issue is the adoption of a comprehensive adaptation and vulnerability assessment and implementing framework with several priorities: sea level rise (high percent of the population located in coastal areas), coastal zone management (including specially coral reefs and mangroves), water supply (including fresh water catchments), management of upland forest ecosystem, and food and energy security. For some islands, extreme events like tropical hurricanes, and El Niño and La Niña events are an important threat.

Mainstreaming climate change into development choices

How can the concept of alternative development pathways be used to bring about more sustainable development? Based on a number of Indian case studies, Heller and Shukla (Heller and Shukla 2003) propose operational guidelines which can integrate development and climate policies into the future development pathways of developing countries. Case studies in Tanzania, Fiji, Bangladesh, Nepal, Egypt, and Uruguay show how climate change adaptation can be integrated with national and local development policies, often as a no-regrets strategy. Implementation of such no-regrets strategies is however, not without challenges.

Mainstreaming climate change mitigation into development policies appears to be discussed mainly in multilateral development cooperation circles. Still, in practice climate change issues are not systematically incorporated into sector lending. Multilateral development banks could explicitly integrate climate change considerations into their guidelines for country and sector strategies, and apply a greenhouse gas accounting framework in their operations.

In industrialized countries, climate change continues to be regarded mainly as a separate, environmental problem that is to be addressed through specific climate change policies. The European Commission's proposed Sustainable Development Strategy addresses climate change through dedicated climate change policies, rather than more holistic changes. This approach fails to recognize that climate change and development paths are mutually dependent, and that climate change will have negative global impacts that might indirectly affect countries deemed to be not directly vulnerable to climate change impacts.

12.1 Introduction

12.1.1 Framing the problem

12.1.1.1 History and current understanding of the concept

The concept of sustainable development had its roots in the idea of a sustainable society (Brown 1981), and in the management of renewable and non-renewable resources. The concept of sustainable development was introduced in the World Conservation Strategy (IUCN 1980) and adopted by the World Commission on Environment and Development, which launched sustainability into political, public and academic discourses and defined the concept as "development that meets the needs of the present without compromising the ability of future (ACRIB (Air conditioning and Refrigeration Industry Board) 2000)generations to meet their own needs" (WCED (World Commission on Environment and Development) 1987) While this definition is commonly cited, there is no consensus in academic or policy circles on the concept or how to apply it in practice (Cocklin 1995; Pezzoli 1997; Banuri, Weyant *et al.* 2001; Robinson 2004)(IPCC (Intergovernmental Panel on Climate Change) 2001: 93). It is commonly held, however, that sustainable development has three broad dimensions - economic, social and environmental (Figure 12.1)[2].

[INSERT **Figure 12.1** here]

Since its emergence in the late 1980s, the term 'sustainable development,' has given rise to considerable debate. Concerns about the concept can be grouped into three categories (Robinson 2004). First, the variety of definitions of sustainable development (Pezzoli 1997; Mebratu 2001) has raised concerns about definitional ambiguity or vagueness. In response, it has been argued that this vagueness may constitute a form of constructive ambiguity that allows different interests to engage in the debate, and the concept to be further refined through implementation (Banuri and Najam 2002; Robinson 2004).

Second, it is clear that the term 'sustainable development' can be used to support cosmetic environmentalism, sometime called greenwashing, or simply hypocrisy (**Athanasiou** 1996; **Najam** 1999). One response to such practices has been the development of greatly improved monitoring, analytical techniques, and standards, in order to be able to verify claims about sustainable practices (see Section 12.3.1).

Finally, the most serious concern about sustainable development is that it is inherently delusory. Some critics argue that because biophysical limits constrain the amount of future development that is sustainable, the term "sustainable development" is itself an oxymoron. Others point out that the concept of sustainable development is anthropocentric, thereby avoiding a reformulation of values that may be required to pursue true sustainability. While very different in approach and focus, both these criticisms raise fundamental value questions that go to the heart of present debates about environmental and social issues.

There is a growing literature on the nature of the relationship between climate change and sustainable development (Cohen, Demeritt *et al.* 1998; Munasinghe and Swart 2000; Schneider, Easterlig *et al.* 2000; Banuri, Weyant *et al.* 2001; Morita, Robinson *et al.* 2001; Smit, Pilifosova *et al.* 2001;

[2] The concept of 'human security' addresses many of the same issues as sustainable development, and stresses that human welfare, livelihoods, and social systems are heavily influenced by environmental variability while human dimensions also shape the environment

Beg, Morlot *et al.* 2002; Markandya and Halsneas 2002; Metz, Berk *et al.* 2002; Najam, Rahman *et al.* 2003; Swart, Robinson *et al.* 2003; Wilbanks 2003). Much of this literature emphasizes the degree to which climate change mitigation can have effects, sometimes called ancillary benefits or co-benefits, which will contribute to the sustainable development goals of the jurisdiction in question. This amounts to viewing sustainable development through a climate change lens. It leads to a strong focus on integrating sustainable development goals and consequences into the climate mitigation policy framework, and on assessing the scope for such ancillary benefits. For instance, reductions in greenhouse gas emissions might reduce the incidence of death and illness due to air pollution and benefit ecosystem integrity – both of which are elements of sustainable development (Beg, Morlot *et al.* 2002). The challenge then becomes ensuring that actions taken to address global environmental problems help to address regional and local development (Beg, Morlot *et al.* 2002).

A complementary approach is based on the finding in the Third Assessment Report that it will be extremely difficult and expensive to achieve stabilization targets below 650ppm from baseline scenarios that embody high emission development paths. Conversely, low emission baseline scenarios may go a long way toward achieving low stabilization levels even before climate policy is included in the scenario (Morita, Robinson *et al.* 2001). This approach recognises the contribution that sustainable development can make to climate change mitigation - equivalent to viewing climate change through a sustainable development lens - and emphasizes the need to study how best to achieve low emission development paths (Metz, Berk *et al.* 2002; Winkler, Spalding-Fecher *et al.* 2002; Davidson, Halsnaes *et al.* 2003; Heller and Shukla 2003; Robinson, Bradley *et al.* 2003; Shukla, Nair *et al.* 2003; Swart, Robinson *et al.* 2003)

It has further been argued that sustainable development might decrease the vulnerability of all countries, and particularly of developing countries, to climate change impacts, thereby contributing to both mitigation and adaptation efforts. Framing the debate as a development problem rather than an environmental one may better address the immediate goals of all countries and particularly developing countries and their special vulnerability to climate change, while acknowledging that the driving forces for emissions are linked to the underlying development path (Yohe 2001; Metz, Berk *et al.* 2002; Winkler, Spalding-Fecher *et al.* 2002).

12.1.1.2 Determinants of mitigative capacity

As outlined in the Third Assessment Report (Working Group II, Ch.18 and Working Group III, Ch. 1)[3], the ability to implement specific mitigation and adaptation measures is dependent upon the existence and nature of mitigative and adaptive capacity, which make such measures possible and affects their extent and effectiveness. In that sense, specific mitigation and adaptation measures are rooted in their respective capacities. In turn these capacities influence development pathways.

As noted in the TAR (Banuri, Weyant *et al.* 2001), "a nation's mitigative capacity reflects its ability to diminish the intensity of the natural (and other) stresses to which it might be exposed" (p. 103). As yet, however, relatively little work has yet been done in identifying the determinants of mitigative capacity. Yohe (Yohe 2001) has suggested the following list of determinants that may be interrelated:

1. range of viable technological options for reducing emissions (and the possibility of access to these technologies);

[3] For discussions on adaptive capacity, see Working Group II, Chapter 18.1, 18.5 and 18.6. For the introduction of mitigative capacity, see Working Group III, Chapter 1.5.

2. range of viable policy instruments with which the country might effect the adoption of these options;
3. structure of critical institutions and the derivative allocation of decision-making authority;
4. availability and distribution of resources required to underwrite their adoption and the associated, broadly defined opportunity cost of devoting those resources to mitigation;
5. stock of human capital, including education and personal security;
6. stock of social capital, including the definition of property rights;
7. country's access to risk-spreading processes (e.g., insurance, options and futures markets, etc.); and
8. ability of decision makers to manage information, the processes by which these decision makers determine which information is credible, and the credibility of the decision makers themselves.

Thus, mitigative capacity can be a function of technology, institutions, empowerment, wealth, equity, skills, infrastructure, and information (Yohe 2001). In other words, the ability to adapt and the ability to mitigate depend on a mix of social, biophysical and technological constraints (Tompkins and Adger 2003), all of which are components of a nation's development path. Accordingly, a country's mitigative capacity might be low if it is weak in any one of the above determinants. Although few recent studies have explicitly examined the concept of mitigative capacity, some scholars have pointed to the necessity of broadening these lists of determinants to include important factors such as socio-political aspirations (Haddad 2005), risk perception, and perceived adaptive capacity (Grothmann and Patt 2005) implementing national policies to mitigate climate change, governments need a variety of capacities, including those to carry out inventories of their greenhouse gas emissions and assess various options for protecting the climate. Human capital (i.e., skills, (determinant 5 above), financial resources (determinant 4), and information management (determinant 7) may be crucial at this stage. Formulating and implementing national climate policies is enhanced by policy coordination at the national level, and in many cases, with buy-in from key domestic constituencies, including industry, provincial governments, NGOs, and the public. This may require new laws or regulations covering diverse economic sectors, and the need to exercise regulatory control over private or public entities to ensure that policies are enforced.

Governments may face "social, cultural, political, and economic constraints" as well as barriers within the decision-making process itself (IPCC (Intergovernmental Panel on Climate Change) 2001). Other constraints could also be added to these, including high opportunity costs (determinant 4) of devoting resources to climate policy, the strength of vested interests that oppose the implementation of mitigative measures, and issues raised by the distribution of power within different levels of government. The mitigative capacity to reduce emissions may thus be low, even when significant abatement opportunities exist.

Yohe suggests a similar set of determinants for adaptive capacity, but adds the availability of resources and their distribution across the population. These determinants of both adaptive and mitigative capacity agree closely with those offered by (Moss, Brenkert *et al.* 2001) and (Adger, Brooks *et al.* 2004).

Clearly adaptive and mitigative capacities are closely related, and are rooted in the underlying development path. The difference lies perhaps mostly in the use to which a capacity gets put. For example, both adaptation and mitigation will require financial resources, but the use to which those resources are put will typically be different. These differences are not large, however, and for present purposes we will use the term response capacity to designate the combined capacities to undertake both adaptive and mitigative measures

Although the adaptive and mitigative capacity literature does not claim that building capacity will necessarily lead to improved responses to the climate change risk, little work has been done to explicate the widely noted variation in response to climate change among communities and nations with similar capacities. It is apparent, therefore, that capacity is a necessary, but not sufficient, condition for mitigative action. Phenomena such as risk perception, science/policy interactions, and relationships between industry and regulators, for instance, may play some role in determining whether or not capacity is turned into action in response to the climate change risk. Considerable research must be carried out to further investigate the nature of the capacity/action link, and its connection with components of the underlying development path.

12.1.1.3 Alternative development paths determine the capacity for both adaptation and mitigation

Development paths underpin the baseline and stabilization emission scenarios that will be discussed in Chapter 3 of Working Group III and used to estimate emissions, climate change and associated climate change impacts[4]. The determinants of mitigative and adaptive capacity can be expected to vary across the underlying emission scenarios reviewed in this Fourth Assessment Report. Different underlying scenarios imply different levels and types of mitigative and adaptive capacities, and thus different likely or even possible levels of mitigation and adaptation.

There thus exists a close connection between mitigative and adaptive capacities (here collectively called response capacities) and the underlying socio-economic and technological development paths that give rise to those capacities. In important respects, the determinants of response capacities are critical characteristics of such development paths.

[INSERT **Figure 12.2** here]

This situation is summed up in Figure 12.2, which shows mitigation and adaptation measures as being rooted in mitigative and adaptive capacity. The mitigative and adaptive capacities are in turn contained within, and strongly affected by, the nature of the development path in which they exist. The figure also illustrates that mitigation, adaptation, and their respective capacities overlap substantially but are not identical.

The importance of the connection shown in Figure 12.2 among measures, capacities and development paths is twofold. First, as pointed out in the Third Assessment Report, a full analysis of the potential for mitigation or adaptation policies must also include some consideration of the capacities in which these policies are rooted. This is increasingly being reflected in the literature being assessed in other chapters of this assessment[5]. Second, such an analysis of response capacities should in turn encompass the nature and potential variability of the underlying development paths that strongly affect the nature and extent of those capacities. This suggests the desirability of an in-

[4] The climate change and climate change impact scenarios assessed in the Fourth Assessment Report will be primarily based on the SRES family of emission scenarios, which define a spectrum of different development paths, each with associated socio-economic and technological conditions and driving forces. Each family of emission scenarios will therefore give rise to a different set of response capacities.

[5] On adaptive capacity, see especially chapters 17 and 18 of the Working Group II volume. Mitigative capacity is discussed further below. Each of the regional and sectoral chapters in Working Group II, and sectoral chapters in Working Group III will also discuss adaptive or mitigative capacity as relevant to their region/sector.

tegrated analysis of climate policy options that assesses the linkages among policy options, response capacities and their determinants, and underlying development paths[6].

The linkages between climate policy measures and development paths described here also suggest another important connection between the degree of mitigation and/or adaptation that is possible and how much may be desired in a given situation. This occurs because the underlying socio-economic and technological development paths are connected not only to the response capacities and thus the responses themselves but also to the amount of adaptation or mitigation. This is so because the development path in any given scenario will strongly influence the levels of GHG emissions, the associated climate change, the likely degree of climate change impacts, and thus the desired mitigation and/or adaptation in that scenario (Nakicenovic and Swart 2000; Metz, Berk *et al.* 2002; Swart, Robinson *et al.* 2003). Climate change is thus a potentially critical factor in the larger process of society's response to changing historical conditions through its choice of developmental paths(Cohen, Demeritt *et al.* 1998).

Decisions about technology, investment, trade, poverty, biodiversity, community rights, social policies, or governance, which may seem unrelated to climate policy, may have profound impacts upon emissions, the extent of mitigation required, and the cost and benefits that result. Conversely, climate policies that implicitly address social, environmental, economic, and security issues may turn out to be important levers for creating a sustainable world (Reddy, Williams *et al.* 1997).

12.1.2 Principles, goals, targets and measurement

Since the 1992 Earth Summit in Rio de Janeiro and the adoption of Agenda 21, sustainable development has become more widely recognized. Agenda 21 articulated the necessity of harmonising human development with environmental constraints. There is general agreement that sustainable development involves a comprehensive and integrated approach to economic, social and environmental processes (Munasinghe 1992; Banuri, Hyden *et al.* 1994; Najam, Rahman *et al.* 2003). However, discourses of sustainable development have historically focused primarily on the environmental and economic dimensions (Barnett, 2001), while overlooking the need for social, political and/or cultural change (Barnett 2001; Lehtonen 2004; Robinson 2004). Indeed, even current debates on Article 2 of the UNFCCC emphasise the environmental dimension of climate change issues. As the sustainable development concept has evolved, the importance of social, political and cultural factors – for example, poverty, social equity, governance – has increasingly been recognized (Lehtonen 2004) to the point that social development[7] is now given equal status as one of the 'three pillars' of sustainable development. This is evidenced by the convening of the World Summit on Social Development in 1995 and in the fact that the Millennium Summit in 2000 highlighted poverty as fundamental in bringing social issues into balance with the environmental aspects of sustainability. The environment-poverty nexus is now well recognized and the linkage between sustainable development and achievement of the Millennium Development Goals (MDGs) has been clearly articulated (Jahan and Umana 2003). In order to achieve real progress in relation to the MDGs, different countries will settle for different solutions (Dalal-Clayton 2003), and these development trajectories will have important implications for the mitigation of climate change.

Even though social, political and cultural concerns are increasingly being integrated into discussions of sustainable development, they are still viewed as issues separate from environmental con-

[6] Such an integrated assessment approach was proposed in the *Synthesis Report* of the IPCC's Third Assessment Report (Watson, 2002).

[7] Taken here to include also political and cultural concerns.

cerns. As Lehtonen (Lehtonen 2004) explains, the models of sustainable development conceive of social, environmental (and economic) issues as 'independent elements that can be treated, at least analytically, as separate from each-other' (p. 201). The underlying assumption is that these elements are at odds with one another and need to be reconciled. This approach tends to overlook the many interconnections between environmental and social, political and cultural issues (Lehtonen 2004). From a climate change perspective, this integration is essential in order to define sustainable development trajectories.

To measure progress towards sustainable development requires the development and systematic use of robust set of indicators and measures. Agenda 21 explicitly recognizes in chapter 40 that a prerequisite for action is collection of data at various levels (local, provincial, national and international) indicating the status and trends of the planet's ecosystems, natural resources, pollution and socio-economy. As pointed out by Farsari and Prastacos (Farsari and Prastacos 2002), indicators have evolved as a useful tool for making development more sustainable, evaluating progress made and illustrating the complexity of this task and concepts and parameters involved. A plethora of indicators (Human Development Index, Index of Sustainable Economic Welfare, Genuine Progress Indicator, Measure of Domestic Progress, Index of Economic and Social Well-Being, Human Well-Being, Environmental Sustainability Index, Ecosystem Wellbeing Index, etc.) has progressively emerged in an attempt to go beyond GDP as the indicator of development. Boulanger (Boulanger 2004)observes that the various indicators can be classified according to four main approaches: (1) the socio-natural sectors (or systems) approach, which focuses on sustainability as an equilibrium between the three pillars of sustainable development but which overlooks development aspects, (2) the resources approach, which concentrates on sustainable use of natural resources and ignores development issues, (3) a human approach based on human well being, basic needs, and (4) the norms approach, which foresees sustainable development in normative terms. Each of the approaches has its own merit and weaknesses. Based on the various sets of indicators, a great deal of effort has been made since Rio 1992 to develop measurement frameworks for sustainable development at local, national, regional as well as at international levels. Those efforts include among many others the OECD's Pressure - State - Response framework, the World Bank measuring the wealth of the nations scheme, the United Nations Commission of Sustainable Development indicators, the barometer of sustainability and ecological footprint approaches (Farsari and Prastacos 2002). The development of a "global entropy model" incorporates the conditions for sustainability (Ruebbelke 1998) by employing available entropy data to demonstrate up to what extent improvements in entropic efficiency should be accomplished to compensate the effects of increasing economic activity and population growth. Despite these various efforts at measuring sustainability, few of them offer an integrated approach to measuring environmental, economic and social parameters (Corson 1996; Farsari and Prastacos 2002; Swanson, Pinter *et al.* 2004). Additionally, few of these macro-indicators expressly include measures of progress with respect to climate change.

Since the Earth Summit in Rio in 1992 and in the process of preparation of the World Summit on Sustainable Development (WSSD), important worldwide initiatives have been developed to promote sustainable development. The various United Nations regions along with individual nations have elaborated their action plan for sustainable development taking into account their specificities. It is at the national level that efforts have been undertaken in order to track progress toward implementation of actions directed at achieving national sustainable development strategy objectives. Swanson *et al.* (Swanson, Pinter *et al.* 2004) have compiled country case studies with clear mechanisms and responsibilities for process monitoring of sustainable development related strategies. They identify that "developing a set of indicators to track progress toward sustainable development on the ground is a complex process consisting of many components". Thus, they emphasize that "the selection of outcome indicators reflects what is important and, therefore, ultimately must iden-

tify priority issues that should be monitored. As such, the development of indicators may best be integrated with a process for setting sustainable development objectives (e.g., in the leadership stage of strategic management). Once priority issues are identified, SMART indicators need to be developed, that is, indicators that are Specific, Measurable, Achievable, Relevant/Realistic and Time-bound. Once an indicator has been developed, the data must be collected, presented and analysed to interpret trends".

At the sectoral level, several initiatives are being implemented to measure and monitor progress towards sustainable development. In the buildings sector for instance, the US Green Buildings Council, has established Leadership in Energy and Environmental Design (LEED) that sets a voluntary, consensus-based national standard for developing high-performance, sustainable buildings. About 2000 large buildings have received certificates. The Global Reporting Initiative (GRI) is a multi-stakeholder process whose mission is to develop and disseminate globally applicable Sustainability Reporting Guidelines. These Guidelines are for voluntary use by organisations for reporting on the economic, environmental, and social dimensions of their activities, products, and services. Over 700 large industrial corporations are annually reporting their SD progress using these guidelines. Industry sectors, such as cement and aluminium, have their own initiatives to track progress towards SD. (see Section 12.3.1 for further information on sectoral indicators).

Box 12.1a. *Alternative approaches to estimate macro progress towards sustainable development*

Correcting GNP

Several well known monetary indicators assess welfare by including corrections to GNP. One such index, the Index of Sustainable Economic Welfare (ISEW), takes as its basis the measure of consumer expenditure, which also underlies the GDP, and then makes a number of additions and subtractions to account for certain environmental and social factors including, for example, (positive) contributions from unpaid household labor, and (negative) contributions from resource depletion, income inequality and environmental damage (**Daley** and Cobb 1989). Others include Hueting's Sustainable National Income (SNI), and efforts by Pearce-Atkinson to develop a Measure of (weak) Sustainability (**Yohe** and Moss 2000)

Spatial Indices

These indices express the demand for natural resources that a society generates in terms of space, or the environmental load of the Society. The approach is related to the 19th century Malthusian concept of absolute scarcity, and discussions about the carrying capacity of the Earth (**Pfaundler** 1902), mainly from an anthropocentric point of view. These indices are based on the concepts of environmental space (**Buitenkamp**, Venner *et al.* 1993), ecospace and ecological footprint (**Opschoor** 1995; **Rees** 1996). The categories of land use (use of space) includes: a) crop and grazing land for current diet, b) wood plantations for several uses, c) urban, infrastructure and occupied areas, d) absorption of CO_2, and e) requirements to produce equivalents to fossil energy.

HANPP

The index of Human Appropriation of Net Primary Production was proposed by Vitousek *et al.* (**Vitousek**, Ehrlich *et al.* 1986). This approach specifies the amount of energy that humans divert for their own use in competition with other species as NPP is the condition for life in earth. The index shows that with a human population of 5.2 billion, 40% of NNP was diverted for human use. Doubling the human population to 10.4 billion would be impossible if results in a doubling of the appropriation to 80% because environmental services will collapse with this magnitude of encroachment.

Material intensity of consumption (MIPS)

Developed at Wuppertal Institute (**Schmidt-Bleek** 1994), this indicator adds up the directly and indirectly used materials for production measured in tons, comparing material input with services provided for each sector. MIPS allows an estimation of the dematerialization of economies.

I= PAT

Proposed by Ehrlich et. al, this indicator tries to avoid shortcomings from the concept of carrying capacity ap-

plied to human societies, where I is the human impact on the environment, P the human population, A the affluence (presumably per capita income) and T the effect of technology on the environment. It has been commonly used in decomposing the impact of population, economic activity, and fuel use on historical and future carbon emissions (**Schipper**, Ting *et al.* 1997; **Schumacher** and Sathaye 2000; **IEA** 2004).

Other approaches

The development of a "global entropy model" inspects the conditions for sustainability (**Ruebbelke** 1998) by employing available entropy data to demonstrate up to which extent improvements in entropic efficiency should be accomplished to compensate the effects of increasing economic activity and population growth. The model uses three main variables (technology, population and wealth) to determine human production of entropy and to simulate sustainability gaps. Since available technologies are very low in entropic efficiency the model suggest that technological improvements should account for the effort.

A lesser known effort is Naredo and Valero's (**Naredo** and Valero 1999)research towards the "physical cost" of resources extraction.

12.1.2.1 Legal principles and sustainable development

As the concept has evolved, principles of sustainable development have progressively been internalised in various national and international legal instruments (Boyle and Freestone 1999; Decleris 2000). Law contributes to the process of defining the concept of sustainable development through both international (treaty) law and through national law. International environmental treaties generally cite sustainable development as a fundamental principle by which they must be interpreted, but rarely provide any further specification of content. For example, the Climate Change Convention, the Convention on Biological Diversity, the Convention to Combat Desertification, and the ACP-EU Development Co-operation Agreement. Article 5 of 1995 Fish Stocks Agreement (FSA) requires states to adopt measures to maintain or restore stocks to their maximum sustainable yield. Similarly, Article 6 of the Convention on Biological Diversity (CBD) requires Parties to develop national strategies, plans and programs for the sustainable use of biological diversity, while Article 7 requires Parties to integrate into national decision-making consideration of sustainable use of biological diversity. Additionally, the Kyoto Protocol implements principles of sustainable development - in particular those of equity and rights to development – through provisions for differentiated responsibility of developed and developing countries in reducing greenhouse gas emissions.

Since there are few disputes under treaties subject to authoritative interpretation, the judicial or arbitral record in defining the applied meaning of the sustainable development principle is not helpful. National or regional law can supplement this absence in two ways. First, it may make decisions that refer to sustainable development in national law, whose meaning may then be used by international authorities as a source for future international interpretation. Second, national legislation or court decisions may be cited, if sufficiently widespread, as the foundation for recognizing the principle of sustainable development as customary international law.

At a national level, principles of sustainable development are being implemented in various regions and countries, including New Zealand and the EU. For example, New Zealand's Resource Management Act 1991 requires all decisions under the Act to consider and provide for sustainable management of natural and physical resources (Furuseth and Cocklin 1995), wherein sustainable management "…means managing the use, development and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic and cultural well-being and for their health and safety…" (G.N.Z. (Government of New Zealand) 1999). Similarly, the 2000 EC Water Framework Directive is seeking to operationalize principles of sustainable use in the management of EU waters (Rieu-Clarke. 2004).

In spite of a voluminous discussion in legal journals or treatises of the normative content that authors suggest ought to be ascribed to sustainable development, there is no basis at present in authoritative decisions to suggest that consensus is widely enough shared among nations to found as customary understanding of the principle (Bodansky 1995). Rather, the dispersion in the normative discussion of the legal definition of sustainable development is no less wide than in other pertinent literatures (Kysar 2003). The more likely course of legal evolution may be to build up the content of a sustainable development principle from subsidiary environmental and equitable legal doctrines such as the polluter pays principle, precautionary principle, principle of differentiated responsibility and the common heritage of mankind, some of which are more likely to receive authoritative applied definitions in national adjudication.

12.1.3 Coverage of Sustainable Development in Earlier IPCC Reports

The topic of SD has been discussed either implicitly or explicitly in several IPCC reports. The First Assessment Report (FAR) focused primarily on the technology and cost-effectiveness of mitigation activities. This focus was broadened in the SAR to include issues related to equity, both procedural and consequential and across countries and generations, and to environmental (ancillary benefits) and social considerations (IPCC (Intergovernmental Panel on Climate Change) 1996). Relying on the Brundtland Commission's definition, sustainable development was noted as one approach to address intergenerational equity concerns (Chapter 5, SAR). The SAR recognized that there are different views in the literature about the extent to which infrastructure and knowledge can substitute for other aspects of sustainable development, such as the environment. The different ways to value human life and its implications on the assessment of damages were an important point of discussion. The SAR recognized that since climate change is likely to affect the tropics (mostly the developing countries) more than other climes, valuation of all human life at the developed country level would significantly increase the damage estimates for the developing countries (Chapter 7, SAR). The SAR also introduced a discussion of integrated assessment models that hold the promise of reflecting tradeoffs between efficiency and equity, and social and environmental implications of mitigation activities.

The Third Assessment Report further broadened the treatment of SD by addressing issues related to global sustainability (TAR)(Metz, Berk *et al.* 2002). The report noted three broad classes of analyses or perspectives: efficiency and cost-effectiveness, equity and sustainable development, and global sustainability and societal learning (Chapter 1, TAR). It noted the advantages of a portfolio approach to mitigation policy and analysis rather than one that relies on a narrow set of policy instruments or analytical tools. The TAR introduced the concept of mitigative capacity as a means to integrate results related to the aforementioned three perspectives. The determinants of capacity include the availability of technological and policy options, and access to resources to underwrite the implementation of these options. The report noted that global future scenarios that show falling GHG emissions tend to show improved governance, increased equity and political participation, reduced conflict, and improved environmental quality (Chapter 2, TAR). They also tend to show increased energy efficiency, shifts to non-fossil energy sources, and/or shifts to a post-industrial economy, stabilization of population at a low level, and expanded provision of family planning and improved rights and opportunities for women. The TAR notes that it may be possible to significantly reduce GHG emissions by pursuing climate objectives through general socio-economic policies. Further, adoption of state-of-the-art environmentally sound technologies may offer particular opportunity for sustainable development while reducing GHG emissions.

The preparation of the TAR was supported by IPCC Expert Group Meetings that were specially targeted at sustainable development and social dimensions of climate change (Munasinghe and Swart 2000; Jochem, Sathaye *et al.* 2001) noted the various ways that the TAR's treatment of SD could be improved. They emphasized the linkages between development, equity, and sustainability, and noted that where situations are chaotic, and data are weak, emphasis would be on paths that are durable from all aspects, and not necessarily economically optimizing, which tends to be the area of interest for many long-term modelers. (Munasinghe and Swart 2000; Jochem, Sathaye *et al.* 2001) focus on the role that society plays in influencing energy consumption choices, and ways that these may be modified to promote sustainable development pathways.

12.2 Implications of development choices for Climate Change Mitigation

12.2.1 Alternative Development Pathways

12.2.1.1 Alternative development paths as well as climate policies determine GHG emissions

For much of the last century, the dominant path to industrialization was characterized by high concurrent emissions of greenhouse gasses. The IPCC's Third Assessment Report concluded that committing to alternative development paths can result in very different future greenhouse gas emissions. Development paths leading to lower emissions will require major policy changes in areas other than climate change (Metz, Berk *et al.* 2002). The development pathway pursued is a important determinant of the costs of mitigation and can be as important as the emissions target in determining overall costs (Hourcade, Shukla *et al.* 2001). These findings were based on an extensive analysis of both model-based emissions scenarios (Morita and Lee 1998), a survey of more qualitative studies (Robinson and Herbert 2001) and a comparison of stabilization scenarios (Morita, Nakicenovic *et al.* 2000), based on the IPCC SRES scenarios (Nakicenovic and Swart 2000).

In Chapter 3 (Nakicenovic 2007), different development paradigms are discussed with respect to how they weight various economic, social and environmental dimensions. Diverse historical and cultural backgrounds, geographic characteristics and resource endowments provide different countries with different sets of choices. At the same time, every region has the choice to follow different development paths. While developing countries tend to follow the example of developed countries in terms of energy use, this need not be so, since the early stages of infrastructure development offer opportunities to satisfy the populations' needs in different ways. Many of the factors that determine a country or region's development pathway, and, closely related, its energy and greenhouse gas emissions, are subject to human intervention. Such factors include economic structure, technology, geographical distribution of activities, consumption patterns, urban design and transport infrastructure, demography, institutional arrangements and trade patterns. The later choices with respect to these factors are made, the fewer opportunities there will be, because of lock-in effects. An assessment of mitigation options should not be limited to technology, although this is certainly a key factor, but should also cover the broader policy agenda. Climate change mitigation can be pursued by specific policies, by coordinating such policies with other policies and integrating them into these other policies, but also by mainstreaming climate mitigation objectives into general development choices, i.e. taking climate mitigation objectives routinely into consideration in the choice and pursuance of particular development pathways.

Section 12.2.2 discusses how development policies not explicitly targeting greenhouse gas emissions can influence GHG emissions in a major way. For example, six developing countries (Brazil, China, India, Mexico, South Africa and Turkey) have avoided approximately 300 million tons a

year of carbon emissions over the past three decades, with many of these efforts being motivated by common drivers such as economic development and poverty alleviation, energy security, and local environmental protection (Chandler, Schaeffer *et al.* 2002). Many other developing countries have pursued similar policies. Put another way, there are multiple drivers for actions that reduce emissions, and they can produce multiple benefits, with the most promising policy approaches being those that capitalize on natural synergies between climate protection and development priorities, to simultaneously advance both objectives.

But this does not mean that there are always only positive effects even if economic development with relative low carbon emissions is possible. Some studies have shown that, depending on how priorities are set, some conflict between local atmospheric pollution problems and global climate change issues may arise (Schaeffer and Szklo 2001). This is because some of the most cost-effective, environmentally-friendly power generation technologies for the global environment available in developing countries, such as biomass-fired or even some hydroelectric power plants, may not be sound for the local environment (due to SO_2, NO_x and particulate emissions in the former case, and flooding in the latter). Conversely, abating local air pollution generally is also beneficial from a global perspective. Still, there are a few exceptions. For example, some of the most environmentally-friendly power generation technologies for the local environment, such us natural gas fired-thermal plants and even natural gas fueled-fuel cells may not be sound from a global environmental perspective (due to the low, but existing, carbon emissions). Decreasing sulphur and aerosol emissions (with the exception of black carbon) to address local air pollution problems can increase local radiative forcing. Thus, exploring alternative development paths requires careful assessment of both local environmental priorities and global environmental concerns.

In developed countries, development choices made today can lead to very different energy futures. In the TAR, Banuri *et al.* (Banuri, Weyant *et al.* 2001) distinguished between strategies decoupling growth from resource flows (e.g., resource light infrastructure, eco-intelligent production systems, "appropriate" technologies and full-cost pricing) and strategies decoupling well-being from production (intermediate performance levels, regionalization avoiding long-distance transport, low-resource lifestyles).

The connections between alternative development pathways and international trade are often left unexplored. International trade allows a country to partially "de-link" its domestic economic systems with its domestic ecological systems, as some goods can be produced by other economic systems. In such cases, the impacts of producing goods impact the ecological systems of the exporting country (where production takes place) rather than the ecological system of the importing country (where consumption occurs), One popular way of showing that the impacts of the economic activities in many nations affect an area much larger than within their national boundaries is the ecological footprint (Wackernagel and Rees 1996; Venetoulis, Chazan *et al.* 2004).The environmental effects of soy and hard wood production for export as fodder and construction material, respectively, are well-known concrete examples. As a consequence, when it comes to discussing the implications of development choices for climate change mitigation, it is not enough to discuss alternative development pathways for individual countries. To fully address global emissions reductions, an integrated multi-country perspective is needed (Machado, Schaeffer *et al.* 2001).

Box 12.1b. *Greenhouse gas emissions avoided by non-climate drivers: the Brazilian example*

In the field of energy, experience with policies advancing energy efficiency and renewable energy use confirm that although developing countries need to increase their energy consumption in

order to fuel their social and economic development, it is possible to do so in a cleaner and more sustainable manner. These policy choices can have a significant impact on energy trends, social progress and environmental quality in developing countries (Geller, Schaeffer *et al.* 2004). In Brazil, programs and measures have been undertaken over the past two or three decades in order to mitigate economic and environmental problems, which have included not only improvements in the energy supply and demand side management but also specific tax incentive policies encouraging the production of cheap, small-engine automobiles (<1000 cc) to allow industry to increase their production (and create more jobs while increasing its profits) and to make cars more accessible to lower-income sectors of the population. These policies have led to lower carbon dioxide emissions than would otherwise have been the case. Results of these programs and measures show that, in the year 2000 alone, some 11% in CO_2 emissions from energy use in Brazil have been reduced compared to what would have been emitted that year, had previous policy decisions not been implemented . Interestingly, though these actions were not motivated by a desire to curb global climate change, if the inherent benefits related to carbon emissions are not fully appraised in the near future, there is a chance that such "win-win" policies will not be pursued to the extent desirable in the future, and may even be discontinued. (Szklo, Schaeffer *et al.* 2005).

12.2.1.2 New global scenario analyses confirm the importance of alternative development paths for mitigation

After the publication of the IPCC TAR, several new baseline scenarios relating to climate change or global sustainability were published - but most of them in fact confirm the main findings of SRES (See also Chapter 3). For the Millennium Ecosystems Assessment (MEA), four scenarios explored implications of alternative development pathways for global and regional ecosystem services, loosely based on the SRES but developed and enriched further (Alcamo and Et al 2005; Carpenter and Pingali 2005; Cork, Peterson *et al.* 2005). The MEA scenarios distinguish themselves in terms of international relationships (globalisation versus regionalisation) and the attitude towards ecological risks (pro-active or reactive), but also in terms of management style towards ecosystems (laissez-faire, replacement, conservation and learning). The scenarios assume - consistent with SRES - that greenhouse gas emissions are strongly determined by the socio-economic development path. For example, the Technogarden scenario assumes rapid technological development and climate policies, while the Adapting Mosaic model assumes equity-oriented regional development, a model assumed to have lower GHG emissions than the globalizing, material economic growth-oriented Global Orchestration and the protective, security-oriented Order from Strength scenarios. For the next 50 years, all scenarios find that pressures on ecosystems services increase with the extent of the pressure being determined by the particular development path. The MEA scenarios identify climate change next to land use change as a major driver of biodiversity loss in the coming century. The quality of the services do differ strongly by scenario - with the most positive scenarios finding a clear improvement of some services and the most negative scenario (Order from Strength) finds a general decrease.

The MEA scenario analysis thus emphasizes that the development of ecosystem services, biodiversity, human well being and the capacity of the population to deal with these developments is largely determined by the choice of development pathway. The scenarios include climate change considerations - with a slightly broader differentiation in emissions than IPCC SRES. This is caused by the fact that the global, pro-active scenario (Technogarden) assumes relatively stringent climate policies aiming to stabilize greenhouse gas concentrations. The reported range in temperature change is

smaller than range reported by IPCC as the MEA assumed only one median value for climate sensitivity (and used one single model).

UNEP (UNEP (United Nations Environment Programme) 2002) used the SRES scenarios as well as the scenarios of the World Water Vision (Gallopin and Rijsberman 2000) and the Global Scenario Group (Raskin, Gallopin *et al.* 1998)as inspiration for the development of four alternative development pathways for the third Global Environmental Outlook (UNEP/RIVM 2004). The names of the UNEP scenarios (Markets First, Policy First, Security First and Sustainability First) clearly illustrate the relative emphasis societies put on different issues while pursuing particular development pathways. Shell's Low Trust Globalization, Open Doors and Flags scenarios explore how different future development pathways could affect the company's business environment (Shell 2005). Four scenarios developed by the US National Intelligence Council (Davos World, Pax Americana, A New Caliphate and Cycle of Fear) explore how the world may evolve until 2020 and what the implications for US policy might be, focusing on security concerns (NIC (National Intelligence Council) 2004) While environmental and climate change concerns play a marginal role in the NIC analysis, the scenarios show the possible impacts of alternative development pathways in some regions for other regions.

12.2.1.3 Different regions have different possibilities and priorities for alternative development pathways

Recently, interest at the regional level in exploring development pathways which are consistent with lower greenhouse gas emissions has increased (e.g., (RIVM 2004). This appears to be valid primarily for developing countries. Case studies for South Africa (Davidson, Halsnaes *et al.* 2003), Senegal (Sokona, Thomas *et al.* 2003), Bangladesh (Rahman, Alam *et al.* 2003), Brazil (La Rovere and Americano 1999), China (Jiang, Dadajie *et al.* 2003) and India (Shukla, Nair *et al.* 2003) focus on the future in the priority areas of energy supply, food security and fresh water availability. A common finding of these studies is that it is possible to develop pathways which combine low GHG emissions with effective responses to pressing regional problems. In the energy sector, energy security and reduced health risks can be effectively combined with low greenhouse gas emissions, even without explicit climate policies. Enhanced soil management, avoiding deforestation and encouraging (re-)afforestation can increase carbon storage, while also serving the primary goals of food security and ecosystem protection.

Some illustrative examples are given here. In South Africa, policies intended to address fuel diversification through import of natural gas from Mozambique and to improve efficiency in the coal sector have simultaneously reduced air pollutant and GHG emissions (Davidson, Halsnaes *et al.* 2003). For Brazil, more sustainable agricultural practices (e.g., zero-tillage), agroforestry and reforestation in the Amazon and elsewhere, the ethanol programme and improved access to electricity through decentralized renewable energy supply are all policies compatible with low carbon emissions (La Rovere and Romeiro 2003). In India, pathways with improved regional co-operation lead to more rapid development and penetration of environmentally sound technologies, which are likely to lead to reduced health risks through reduction of air pollutants, while at the same time lowering GHG emissions (Shukla, Nair *et al.* 2003). In Senegal, programs to reduce deforestation are coupled with reductions of local air pollution and lower GHG emissions (Sokona, Thomas *et al.* 2003). In China, focusing on high priority issues such as availability of affordable energy and reducing health risks due to air pollution in urban areas, can lead to energy choices that although primarily focused on local priorities, also lead to lower GHG emissions (Jiang, Dadajie *et al.* 2003). In Bangladesh, pathways are being explored with an emphasis on increasing energy and food security with low associated GHG emissions (Rahman, Alam *et al.* 2003).

In several developing countries, different future development pathways have been explored in systematic scenario exercises, often supported by western business groups, e.g. for China (Ogilvy and Schwartz 2000), the Mont Fleur scenarios for South Africa (Kahane 2002), the Guatemala Vision (Kahane 2002), Destino Colombia (Cowan, Eidinow *et al.* 2000), Kenya at the crossroads (SID/IEA (Society for International Development and the Institute of Economic Affairs) 2000). Usually these scenarios explore different pathways with an emphasis on political and economic choices, with little attention to environmental concerns.

In developed regions, alternative pathways determine mitigative capacity. Improving energy efficiency, modernizing production and changing consumption patterns would have a large impact on future GHG emissions (Kotov 2002). Alternative pathways do not only apply to energy choices. For example, in North-America and Europe, UNEP (UNEP (United Nations Environment Programme) 2002) identifies land-use development, particularly infrastructure expansion, as a key variable determining future environmental stresses, including GHG emissions. Pathways which capitalize on advances in information technologies to provide a diverse range of lifestyle and spatial planning choices, will also affect energy use and GHG emissions. Scenarios could be used further by developed countries to explore alternative development pathways, and to understand the possible impact of development choices on climate change.

However, a fundamental discussion on the implications of alternative development pathways for climate change in general and climate change mitigation in particular in the industrialized countries has not seriously been initiated.

12.2.1.4 Sectors also have alternative development choices

The most important development choices relevant to climate change must be made in the energy sector. Energy plays a critical role in improving quality of life, especially for developing countries, but traditional energy choices have high associated GHG emissions. Though per-capita energy use is growing, developing countries are unlikely to catch up with the industrialized world within this century (UNDP (United Nations Development Programme) 2000). Energy services are crucial for economic development and to provide adequate food, shelter, clothing, water sanitation, medical care, schooling and access to information. Availability of energy is one of the key determinants of development.

Increased access to energy services can have a range of consequences for climate change, depending on the pathway pursued. Developing countries need to increase their energy use in order to fuel their social and economic development, but by pursuing energy efficiency and renewable energy, a cleaner and more sustainable energy future is made possible. Such policy choices can have a significant impact on energy trends, social progress and environmental quality in developing countries (Geller, Schaeffer *et al.* 2004). Access to cleaner forms of energy has several direct and indirect effects on well-being, including reduced birth rates, increased life expectancy and improved health,[8] increased ability to learn and study, and reduced pressure on local fuel resources. Access to energy is frequently identified as among the highest development priorities of the poor. The net effects of increased access to energy on greenhouse gas emissions depends on the balance of all direct and indirect effects.

[8] Access to sound energy in developing countries can imply lower reliance on polluting biomass stoves, improved access to safe drinking water and as a consequence lower child mortality, enhanced employment for women and reduced child labour in households (UNDP, 2000).

Policies which promote a more sustainable energy supply can promote economic and social development while also helping to mitigate climate change. Policies which strive to "de-couple" energy use from economic growth (e.g. moving towards a more service-based economy with a major role for information and communication technology) decrease the vulnerability of the energy system to external influences (such as increasing oil prices) and also have a major impact on GHG emissions. But also in the industrialized world the energy sector is confronted with a diverse set of challenges, including environmental ones, like climate change and health problems caused by particulate matter and other environmental problems, but also the increasing concentration of remaining oil and gas resources in a limited number of sometimes politically unstable regions. Also in these regions alternative development choices affect environmental and economic implications of energy demand and supply. Decreasing dependency on expensive energy imports can go hand in hand with addressing environmental effects of energy consumptions in industrialized countries.

Alternative energy pathways will depend heavily on the degree to which technological change is stimulated. Economic analysis supports public policies to induce technological change despite uncertainty of economic returns (Arrow 1962; Kornai 1967). Policies which encourage innovation and technological improvements may enable emissions reductions at costs far lower than can be achieved today. Without such incentives to stimulate development of new technology, it will be difficult to achieve desired emissions reductions. Technology policies could include tax incentives for research, internalization of externalized environmental costs, and a clear, well-defined and long-term emissions reduction commitment.

The presence of induced technological change lowers the costs of achieving emissions reductions by stimulating additional technological change and justifies more extensive reductions in GHGs than could otherwise be expected (e.g., Van der Zwaan, R. Gerlach *et al.* 2002; Goulder 2004),. Induced technological change alters the optimal timing of emissions abatement and announcing climate change policies in advance would probably reduce policy costs. To induce technological change and reduce GHG emissions in a most effective way, direct emission policies and technology push policies are required.

12.2.2 Changing Development Paths

The review of long-term scenarios in Section 2.1 shows that business-as-usual futures in countries with similar economic characteristics can result in very different emission profiles. This variation is due to different natural resource allocations, both renewable and fossil fuel reserves and rates at which new technology is adopted, but also policy decisions. Policies made today can dramatically impact future emission profiles.

The aim of this Section 2.2 is to further explore the synergies and trade-offs between development and GHG emissions. The section asks three main questions. First, under what circumstances do choices between high and low emissions trajectories emerge? Second, how are those decisions made? And third, why are "win-win" decisions not always adopted? To do so, Section 2.2.1 reviews the lessons learned from past experience, 2.2.2 examines what the literature on governance tells us about these choices, and 2.2.3 examines how key choices that are about to be made could impact on future emissions.

12.2.2.1 How development policies impact on GHG emissions: lessons from the past

The objective of this section is to discuss the synergies and trade-offs between development and GHG emissions, based on past experience. Since economic growth figures prominently among the objectives of policy-makers worldwide, Section 12.2.2.1.1 reviews what is known about the linkages between economic growth and emissions. Section 12.2.2.1.2 broadens the scope of the analysis by examining how policies aimed at achieving a variety of development goals – economic growth and/or others – have resulted in lower or higher emission trajectories. Section 12.2.2.1.3 concludes by drawing general lessons from the case studies reviewed in 12.2.2.1.1 and 12.2.2.1.2.

12.2.2.1.1 The relationship between economic growth and GHG emissions

Economic activity is a key driver of CO_2 emissions. As the economy expands, demand for and supply of energy and of energy-intensive goods also increases, thereby pushing CO_2 emissions upward. For industrialized countries, economic growth has become less reliant on domestic energy use, as the economy has shifted towards services and other less energy intensive industries, while shifting manufacturing and heavy industry elsewhere. In addition, energy efficiency often increases at higher levels of development. However, as the consumption in developing countries is indirectly responsible for rising energy demand in less developed countries, overall, economic growth is still linked to rising energy.

On the other hand, changes in input mix – e.g., substituting natural gas or renewables for coal –, and other technological change reduce emissions per unit of economic output. In addition, economic growth might drive in the development of institutions and preferences more conducive to environmental protection, and thus to emissions mitigation.

The balance between the scale effect of growth and the mitigating factors outlined above has generated intense scrutiny since the early 1990s. Much of the literature responds to the "environmental Kuznets curve" (EKC) hypothesis, which posits that at early stages of development, pollution per capita and GDP per capita move in the same direction, but that beyond a certain income level, emissions per capita will decrease as GDP per capita increases, thus generating an inverted-U shaped relationship between GDP per capita and pollution.[9] The EKC hypothesis was initially formulated for local pollutants in the seminal analysis of Grossman and Krueger (Grossman and Krueger 1991), but it was quickly expanded to carbon dioxide emissions. The EKC hypothesis has generated considerable research, and the field is still very active. Recent summaries can be found in Stern (Stern 2004), Copeland and Taylor (Copeland and Taylor 2004) or Dasgupta *et al.* (Dasgupta, Hamilton *et al.* 2004). With regard to carbon dioxide, the following conclusions can be drawn;

First, using GDP and emissions data over multiple countries and time-periods, studies consistently find that GDP per capita and emissions per capita move in the same direction among most or all of the sample (e.g., (Schmalensee, Stocker *et al.* 1998; Heil and Selden 2001; Wagner and Müller-Fürstenberg 2004; Ravallion, Heil. *et al.* 2000). A one percent increase in GDP per capita is found to lead to an increase in CO_2 emissions of 0.5% to 1.5% depending on the study. All studies also find evidence that this coefficient – the so-called elasticity of per capita CO_2 emissions relative to per capita GDP – is not constant but varies as per capita income rises.

Second, earlier studies consistently found that, beyond a certain level of GDP per capita (usually, but not always, higher than the highest per capita GDP in the sample considered), per capita CO_2 emissions would start decreasing as income increase – thus confirming the EKC hypothesis for car-

[9] The EKC is named after Simon Kuznets' model of an inverted-U relationship between income inequality and development (1955).

bon dioxide. However, the reliability of these estimates has been challenged recently on technical grounds (e.g., Harbaugh, Levinson *et al.* 2002; Millimet, List *et al.* 2003) for general discussions, and Wagner and Müller-Fürstenberg (2004) for a critical review focusing on carbon dioxide). Two main points emerge from more recent reviews. First, they cast doubt on the idea that the EKC hypothesis could be validated based on existing data. Second, they conclude that the relationship between GDP and emissions data is less robust than previously thought.

Third, studies using time-series at the country level find less robust relationships between GDP per capita and CO_2 emissions per capita. For example, (Moomaw and Unruh 1997) show that international oil price shocks, and not per capita GDP growth, explains most of the variations in per capita emissions in OECD countries. Similarly, Coondoo and Dinda (Coondoo and Dinda 2002) find that some degree of causality between emissions and income in developed countries and in Latin America, but limited causality in Africa and Asia. Recent work on the EKC (e.g., Dasgupta, Hamilton *et al.* 2004) also show that the relationship between GDP per capita and pollution is not as rigid as it seems, and in fact mostly disappears when other explanatory variables, notably governance, are introduced.

To sum up, the econometric literature on the relationship between GDP per capita and CO_2 emissions per capita does not support an optimistic interpretation of the EKC hypothesis that "the problem will take care of itself" with economic growth. On the other hand, the monotonically increasing relation between economic activity and CO_2 emissions that emerges from the data does not appear to be econometrically extremely robust, especially at country level. In other words, the pessimistic interpretation of the literature findings that growth and CO_2 emissions would be irrevocably orthogonal is not supported by the data either. There is apparently some degree of flexibility. However, the econometric studies mentioned do not distinguish between structural emissions and those that result from policy decisions. They thus provide limited information about how future policy choices may or may not influence emissions paths. Recent examples, such as the stabilization of China's CO_2 emissions from fossil-fuel combustion from 1997 to 2001, in the midst of very high economic growth (+30% over that period of time, (IEA (International Energy Agency) 2004), illustrates how important these elements of flexibility can be (Wu and Matsuoka 2005). To explore these choices, a more disaggregated approach is necessary.

The environmental Kuznets curve also fails to take into account the rising importance of traded goods in a countries emissions profile. Thus a countries that appear to have high levels of emissions and low per-capita income could have high emissions because it produces carbon-intense products for export, which are consumed elsewhere. This would be especially true of countries which are net energy exporters, or net exporters of products with high embodied energy, such as aluminium, petroleum products, chemicals, paper, or electricity itself. Similarly, a country which appears to have relatively low carbon emissions and high levels of per-capita income could actually be responsible for far more energy than is consumed domestically, due to imports of energy-intense products. The concept of the environmental footprint (Wackernagel and Rees 1996) recognizes that the total impact of a society's consumption is not limited to the local environment, but to all sites of production linked to the community through trade.

12.2.2.1.2 How development policies have impacted GHG emissions

Methodology

Subsection 12.2.2.1.2 reviews examples of how policies not intended for climate mitigation can have significant impacts on GHG emissions. This subsection is concerned with policies that have already been adopted and implemented,[10] and it draws examples from five sectors: energy, transportation, health, rural development and international trade. Even ex post, assessing the impact of specific policies on GHG emissions is difficult. First, policy packages usually encompass a wide range of measures, making it difficult to disentangle their individual effects. Second, absent command-and-control policies, or cases in which the emission-producing sectors are directly controlled by governments, public policies are only one of many incentives that decision-makers react to. Third, indirect effects of policies on emissions - such as increased demand induced by energy efficiency programs - are even more difficult to evaluate. And last, there is rarely a control group on the basis of which carbon savings can be evaluated. Thus, it might not be surprising that few studies directly analyze the link between policies and GHG emissions. To make up for this relative scarcity, this section also relies on studies that review the impact of policies on parameters that are either good proxies and/or key determinants of GHG emissions such as, for example, energy intensity of GDP or deforestation rate.

Energy

Four broad categories of energy policies are discussed here: electrification, liberalisation, energy efficiency, and energy security. With 1.6 billion person still without access to electricity in 2002 (IEA (International Energy Agency) 2004), electrification and in particular rural electrification is a major development objective in many countries. It is recognized that reliable access to electricity has highly positive impacts on human development, both directly, e.g. by limiting health hazards linked with particulates, or freeing time formally used to collect fuelwood, and indirectly by providing preconditions for the development of new economic and social activities, e.g., allowing for education activities at night (World Bank 1994; Toman and Jemelkova 2003). The implications of electrification programs for GHG emissions are ambiguous. Energy demand is likely to increase as a result of easier access and induced economic benefits. On the other hand, emissions per unit of energy consumed might decrease depending on the relative carbon content of the fuel that is used in the baseline (typically charcoal or kerosene) and of the electricity that is newly provided (de Gouvello and Maigne 2000). Public policies have a strong influence on this technology choice. In some cases, the technology is set directly by public decision makers. But even in case where it is left to private entities, public policies, such as the choice between centralized or decentralized models of electrification, or the nature of the fiscal system strongly constrain the technology choices. One example of such indirect impact is documented by Audinet and Hourcade. They find that the “equal price of electricity for all” principle embedded in French law has generated vast implicit subsidies from urban to rural areas and discouraged, over time, the development of cost-effective decentralized electrification alternatives to grid expansion. The expanded grid the country is locked into, however, is the source of very high maintenance and upgrading to accommodate increased demand from rural households and firm – much higher than would have occurred had decentralized solutions been implemented at the onset. The impact GHG emissions in France (not studies in the paper) are probably limited given the importance of nuclear for power generation in this country. But the link between equity considerations, fiscal policies and energy efficiency that this story unveils could apply to other countries as well.

[10] Section 2.2.3 reviews the implications for GHG emissions of policy choices that have yet to be made.

Many countries have embarked in the liberalization of their energy sector over the past two decades. These programs, with the objective to reduce costs and improve efficiency of energy services, have often several components, including inter alia privatization of the energy producers, separation between production and transmission activities, liberalization of energy markets, and lifting restrictions on capital flows in the sector. Some studies examine the effects of liberalization programs as a whole, while others focus on one component only, usually energy subsidy removals. Removing subsidies for energy prices has well-documented economic benefits. It frees up financial resources for other uses and discourages overuse of natural resources (UNEP (United Nations Environment Programme) 2004). On the other hand, reducing energy subsidies might have important distributional effects, notably on the poor, if not accompanied by appropriate compensation mechanisms. The impact of policies to reduce energy subsidies on CO_2 emissions is expected to be positive, as higher prices trigger lower demand for energy and induce energy conservation. For example, econometric analysis have shown that price liberalization in Eastern Europe during the 1992-1999 period was an important driver of the decrease in energy intensity in the industrial sector (Cornillie and Fankhauser 2002). Similarly, removal of energy subsidies has been identified as instrumental in reducing GHG emissions compared with the baseline in China and India over the past 20 years (Chandler, Schaeffer *et al.* 2002). On the other hand, without appropriate safety nets, subsidies removal can actually result in increased emissions if poor consumers are forced off-grid and back to highly carbon intensive fuels, such as non sustainable charcoal or diesel generators. For example, subsidies for LFG in Senegal under the PROGEDE program are estimated to have generated significant savings in terms of fuelwood use (Deme 2003).

Policies that increase energy efficiency – both on the demand and on the supply side – are pursued to reduce demand for energy without affecting, or while increasing, output at very low costs -- although some of the direct efficiency gains might be offset by increased demand due to lower energy costs per unit of output. The impact on CO_2 emissions, in turn, tends to be positive, but depend heavily on the carbon content of the energy supply. For example, Brazil National Electricity Conservation Program (PROCEL), created in 1985, has saved an estimated 12.9 TWh and an estimated 2.6bR$ from 1986 to 1997, i.e., 25 times as much as the amount invested in the program, while reducing emissions by an estimated 3.6MtCO2e over the same period of time (La Rovere and Americano 1999; Szklo, Schaeffer *et al.* 2005). Similarly, Gillingham *et al.* (Gillingham, Newell *et al.* 2004) estimate that the annual energy savings generated by all current Demand-Side Management programs in the U.S. represent about 6% of the country's non-transportation energy consumption, and lead to reductions in CO_2 emissions equivalent to (at most) 3.5% of the country's total.

Policies to increase energy security aim, e.g., at limiting dependency on individual suppliers, or at reducing the burden of energy imports on trade balances. Their impact on carbon emissions is ambiguous, depending on the nature of the policies and of the alternative fuel sources that are favored. For example, in response to the first oil shock, Brazil launched in 1975 the National Alcohol Fuel Program (PRO-ALCOOL) to increase the production of sugarcane ethanol as a substitute for oil, at a time when Brazil was importing about 80% of its oil supply.[11] The program resulted in large emission reductions, estimated at 1.5 MtCO2/yr (Szklo, Schaeffer *et al.* 2005). Brazil, on the other hand, also provides an example where emissions actually increased as a result of energy security considerations. During the 90s, Brazil faced lack of public and private investment in the expansion of the power system (both generation and transmission) and a growing supply-demand imbalance, which culminated in electricity shortage and rationing in 2001. This situation forced the country to

[11] PRO-ALCOOL was also as a way of assisting the domestic sugar industry at times of low international sugar prices.

install and run emergency fossil-fuel plants, which led to a substantial increase in GHG emissions from the power sector in 2001 (Geller, Schaeffer *et al.* 2004).

Transportation

Transportation is the fastest growing segment of CO_2 emissions in both the developed and the developing world [see also Chapter 7 on Transportation]. The level of these emissions results from the combination of the amount of travel that goods and people do make, and of the set of technologies with which those trips are made. Demand for and supply of transportation are largely inelastic in the short-run, but become endogenous in the longer run as people and activities change location, as new infrastructure are developed and as preferences evolve. A very wide array of policies affect these long-term dynamics. The set of transportation technologies available at any point in time, and their relative costs, are also influenced by public policies.

Two examples of how public policy choices have affected transportation supply, transportation demand, technology, and ultimately emissions from the transport sector are discussed in this section: one of urban planning at city level, and the other of national policy driving urban forms. the first example is the development and steady implementation of an integrated urban planning program in the city of Curitiba (Brazil) from 1965 onwards, which has allowed the city to grow 8-fold from 1950 to 1990 while maintaining 75% of travel commute by bus – a much higher public transport modal share than in other big Brazilian cities (57% in Rio, 45% in São Paulo) – as well as little congestion. As a result, Curitiba uses 25% less fuel than cities of similar population size and socio-economic characteristics. Two characteristics of the program seem to have particularly contributed to its success: (i) the fact that it integrated infrastructure and land-use planning, and (ii) the consistency with which successive municipal administrations have implemented the plan over nearly three decades (Rabinovitch and Leitman 1993).

The second example concerns urban forms in the United States and Europe (and Japan), the latter being on average rather compact while the former exhibit important sprawl. Nivola (Nivola 1999) notes that this difference cannot be explained only differences in demography, geography, technology or income. He argues that the combination of such public choices as, an acute bias towards public financing of roads to the detriment of other modes of transportation in the U.S. – against a more balanced approach in Europe; dedicated revenues for highway construction in the U.S.– against funds drawn from general revenues in Europe; lower taxes on gasoline in the U.S. than in Europe; housing policies more geared towards supporting new homes, and a tax system more in favour of homeowners in the U.S.; lower federal support to local governments in the U.S. than in Europe; or the quasi-absence of regulations favoring small in-city outlets against shopping malls in the U.S., is responsible for most of the differences in urban sprawl between the U.S. and Europe. In turn, this difference in urban forms generates widely different demands for transport services, for energy consumption (Newman and Kenworthy 1991), and for CO_2 emissions. A key point in Nivola's analysis is that most of these consequences were totally unintended, as these policies were adopted for non-transportation reasons (let alone for emissions reasons).

Health

Adverse human health effects of conventional air pollutants, such as particulates and ground-level ozone, are large and very costly, particularly in developing countries (World Bank 2003). Policies to limit the emissions of air pollutants or of their precursors (SO_2, NO_x and VOCs in particular) have been implemented throughout the globe. These policies impact directly on the emissions of a

wide range of gases and compounds that participate in the atmospheric chemistry of global warming (e.g., ozone, sulphate aerosols, OH radicals, etc.). These policies also impact directly on CO_2 emissions, because conventional air pollutants are often byproducts of fossil-fuel combustion,.

Prinn *et al.* (Prinn, Reilly *et al.* 2005)test the implications of combined caps on NO_x, CO, VOC and SOx and their results suggest that although each individual cap might have strong positive or negative implications for global warming, their combined impact on global warming would be minimal. This study does not, however, examine the direct implications of such policies on the consumption of fossil-fuels. The impact of local air pollution policies on fossil-fuel consumption, and thus on CO_2 emissions, depend on the nature of the policy implemented, and of the nature of the response by the polluters. For example, Eskeland and Xie (Eskeland and Xie 1998) find that air pollution programs in Santiago, Mexico City and other Latin American agglomerations are primarily pursued by programs promoting cleaner fuel, with very limited impact on demand. For example, the SO_2 cap-and-trade program in the United States might have had little impact on CO_2 emissions since it induced mostly substitution between high- and low-sulfur coal. Similarly,

Rural Development

Rural development policies have a direct impact on the emissions of or on the sequestration rate from biomass and soils. If few studies examine the direct impact of rural policies on CO_2 emissions, there is a widespread literature on the impact of such policies on deforestation rates, which can be taken as a proxy for emissions.[12] If the drivers of deforestation are complex, and involve an interaction of cultural, demographic, economic, technological, political and institutional issues (Angelsen and Kaimowitz 1999; Geist and Lambim 2002), most of these drivers are influenced by policy decisions.

Examples include agriculture intensification policies, which have ambiguous effects on deforestation. On the one hand, intensification increases the productivity of existing agricultural land. On the other, if it is accompanied by lower demand for labor, or if it results in higher attractiveness of agriculture relative to non-farm activities and thus triggers migration, it might in fact increase deforestation. Careful design of agriculture intensification policies is thus necessary to avoid unintended outcome on deforestation (Angelsen and Kaimowitz 2001). Evidence also suggest that rural road construction or improvement may have positive economic implications by providing better access to markets and basic services for remote population in developing countries (Jacoby 2000). New roads, however, may also encourage future deforestation (Chomitz and Gray 1995).

International trade

International trade has increased dramatically over the past decades, and nations worldwide have adopted policies aimed at reducing tariffs and other barriers to trade. There is a general consensus that, in the long-run, openness to trade is beneficial for economic growth. The pace of openness, and how to cope with social consequences of trade policies, on the other hand, are subject to much controversy (see (Winters, McCullough *et al.* 2004) for a review). The indirect effects of trade policies on GHG emissions via economic growth have already been discussed in section 2.2.1.1. On the other hand, the direct effects of trade policies on GHG emissions, via changes in the demand for goods and services, have seldom been studied, although evidence suggests that they can be signifi-

[12] Using this proxy, however, does not allow us to estimate how rural development policies might impact on emissions through over channels, for example through changes in demand for energy to transport agricultural products to markets.

cant. For example, Welsch (Welsch 2001) shows that foreign demand for German goods accounts for nearly a third of the observed structural changes in the composition of output and emissions of West Germany over the period 1985-1990. Similarly, Machado *et al.* (Machado, Schaeffer *et al.* 2001) report that inflows and outflows of carbon embodied in the international trade of non-energy goods in Brazil accounted for some 10 percent and 14 percent, respectively, of the total carbon emissions from energy use of the Brazilian economy in 1995.

12.2.2.1.3 Lessons learned from past experience

Sections 2.2.1.1 and 2.2.1.2 suggest that GHG emissions are influenced by, but not rigidly linked to economic growth, and that policy choices do make a difference. In some cases, such as energy efficiency, there are even "win-win" options available, that would perform at least as well as other options in terms of costs and other sustainable development goals, but would perform better than the others in terms of GHG emissions. Although the examples provided in 2.2.1.1 and 2.2.1.2 are very diverse, some general patterns emerge:

In any given country, sectors that are farther away from the production frontier – i.e., where production is much lower than what would be possible with optimal use of available inputs – have opportunities to adopt "win-win-win" policies, i.e. policies that free up resources and bolster growth, meet other sustainable development goals and also, incidentally, reduce GHG emissions relative to baseline. Examples include removal of energy subsidies in transition economies, or the mitigation of urban pollution in highly polluted cities. Implementing these policies could still generate winners and losers, but compensation mechanisms can be designed to make no-one worse off in the process.

Sectors that are closer to the production frontier – i.e. where production is close to the optimal given available inputs – also have opportunities to reduce emissions by meeting other sustainable development goals. However, the closer one gets to the production frontier, the more trade-offs are likely to appear. For example, relying on domestic energy sources more than is economically optimal might be beneficial for energy security reasons, but comes at economic costs to the country.

In many of the examples reviewed above, what matters is not only that a "good" choice is made at a certain point in time, but also that the initial policy has persisted for a long time – sometimes several decades – to truly have effects. The reason is that some of the key dynamics for GHG emissions, such as technological development or land-use patterns, present a lot of inertia, and thus need sustained effort to be oriented. This raises deep institutional questions about the possibility of making long-term commitments, particularly in democratic societies where policy-makers are in place only for short spans of time.

Another element that stems out of some of the examples outlined above is that it is often not one policy decision, but an array of decisions that are necessary to influence emissions. This is especially true when considering large-scale and complex dynamics such as human settlement. This raises, in turn, important issues of coordination between policies in several sectors, and at various scales.

National circumstances, including endowments in primary energy resources, but also institutions (World Bank 2003) matter to determine how policies ultimately impact on GHG emissions. For example, institutional differences in the respective powers of local, regional and central governments appear to be an important factor contributing to the higher prevalence of urban sprawl in the U.S.

Finally, the examples given above also reveal something about when there is limited or no choice. Factors that contribute to limiting the set of choices that policymakers include, (i) being close to the production frontier; (ii) being concerned with short-term emissions, rather than medium- or long-term emission, (iii) being unable to honor long-term policy commitments.

A final example of how very different development paths can unfold in relatively similar countries is given by Hourcade and Kostopoulou (Hourcade and Kostopoulou 1994) who analyze how France, Italy, Germany and Japan—countries with similar levels of development in 1973—responded to the first oil shock. They show that France moved aggressively to develop domestic supply of nuclear energy, that Japan made an aggressive shift of its industry towards less energy-intensive activities and simultaneously used its exchange-rate policies to alleviate the burden of oil purchases, and that Germany built up industrial exports to compensate the trade balance deficit in the energy sector. Much of the variations of CO_2 emissions per unit of GDP from 1971 to 1990 can be attributed to these choices. Yet while this indicator diminished by half in France, by a third in Japan, and "only" by a quarter in Germany (IEA (International Energy Agency) 2004), Hourcade and Kostopoulou observe no fundamental differences in the macroeconomic performances of these countries in the early 1990s, suggesting that widely different environmental outcome can be obtained at similar welfare costs in the long-run. In addition, they observe that the responses were for a large part driven by the country's pre-existing technologies and institutions, an issue that is explored more in depth in the following section.

12.2.2.2 State, Market, Civil Society and Partnerships

The potential for nations to take alternative development paths, some relatively more climate-friendly, implies that climate policy cannot be separated from mainstream policy decisions in key sectors such as energy, transport and land use. These policies lie at the core of both developed and developing countries' economic growth and security concerns unlikely to be strongly constrained by climate specific goals and instruments. Mainstreaming climate, in turn, implies the central importance for climate of political, commercial and societal institutions for decision-making and governance. The current diverse patterns of institutional histories and of institutional reforms in the majority of nations suggest that the study of alternative development paths and their effects on climate requires specific political economic and organizational knowledge in order to understand their national priorities and the policy choices under consideration by empowered agencies and actors. As described below, the emerging relations in each nation among the state, the market and civil society that compose the political constitution are central to analyzing and influencing the development paths enacted. In addition to widespread reforms in the political constitution of governance, development paths are also the products of each national government's political culture, preferred regulatory instruments and regulatory capacity - all factors that are still changing rapidly in both Annex I and non-Annex I states. These reforms in process enlarge the prospect that mainstream development policies and climate favoring options may be shaped to coincide.

12.2.2.2.1 From government to governance

Many changes in the way government is understood have occurred in response to social, economic, and technological changes our societies have undergone in the past several decades. This includes a shift from government defined strictly by the nation-state to a more inclusive concept of governance which recognizes the contributions of various levels of government (global, transnational/regional/local) as well as the roles of the private sector, non-governmental actors, and civil society. (Goodwin 1998): 10)(Rhodes 1996) The emergence of these new forms of governance

has been attributed to the need for new institutions to address the more complex problems of present-day society. (Beck 1992; Giddens 1998; Howes 2005).

Ideology and economic globalization have also played a role in the shifting focus from government to governance. Free market competition is now perceived by many actors as superior to government direction of the economy and commercial activities. (Goodwin 1998; Lewis, Moran *et al.* 2002; Levi-Faur 2005). Trade liberalization and privatization have diminished the ability of governments to directly control their economies. Simultaneously, command-and-control strategies are losing favor while market-based mechanisms, voluntary initiatives, and partnerships with non-governmental organizations have gained acceptance. (Lewis, Moran *et al.* 2002). According to Goodwin (Goodwin 1998): 'The role for government is seen as one of identifying stakeholders and then developing the relevant opportunities and linkages for them to be brought together to act for themselves'. (See also (Little 2001)

Recognizing the difficulty and limitations of trying to directly control their domestic economies in an increasingly open and globalize economy, governments now try to pursue economic growth through strategic policies designed to increase access to foreign markets, encourage inward foreign investment, maintain national competitiveness, and obtain favourable outcomes from trade agreements (Jessop 1997). While some believe that globalization has made national governments less powerful, others argue that rather than simply eroding government power, globalization has changed the ways in which governments operate and influence situations (Levi-Faur 2005). For example, the three key institutional sectors of society – government, market and civil society – have begun to work in closer collaboration, partnering with each other in multiple and diverse ways when their goals are common and their comparative advantages are differentiated (Najam, 1996, Hulme and Edwards, 1997; Davis, 1999).Of course, this is not to imply that they always, or even mostly work in partnership or have synchronous priorities; but it does mean that they have so more often than they did, including in terms of global climate change mitigation (Najam, 2000). The nature of global governance on a range of issues, including on climate change, is today best understood not only as what states do but as a combination of that which the state, civil society and markets do, or not do (Najam, Christopoulou and Moomaw, 2004).

The concept of sustainability has raised many questions about the traditional development model and the relationship between society, economy and the environment. It has also raised questions about the suitability of the traditional government model to meet the demands of managing the environment and economy sustainably (Lewis, Moran *et al.* 2002). Thus, responsibility for "environmental management has been shifted – upwards to international bodies and to transnational companies, and downwards to local governments and to businesses and resource users." In addition, individuals play a greater role in environment as consumers, private owners of land, and participants in the policy discourse as does civil society as one of the prime policy entrepreneurs in society. .

The more prominent role businesses and civil society groups has played in governance has not been without controversy. Some believe that only the state can act in the public interest, while industry and citizens are motivated by self-interest. Others see all actors as motivated by self-interest and, in this context, believe competition and the market ensure the best outcomes – public and private. In this view, civil society, consumers and industry bear greater responsibility and share the risks, while the state maintains a role in setting standards and auditing performance. Dryzek (Dryzek 1990; Dryzek 1997; Howes 2005)

While the roles, responsibilities and powers assigned to the respective actors remains a hotly contested subject, it is widely acknowledged that the responsibility for the environment and sustainabil-

ity has become a much broader project, no longer primarily the preserve of governments, but one involving civil society, the private sector, and the state. This section rests on the notion that greenhouse gas emissions mitigation, climate impacts adaptation, and sustainable development all depend on the institutional capability of humans in all arenas - the state, the market, and the community - to modify the practices of actors in each of those arenas.

12.2.2.2.2 State

It has long been recognized that different countries have different political constitutions and cultures that determine non-climate policies that impact emissions, as well as different institutional capacities to implement emissions mitigation strategies (Gerlach and Rayner 1988). The transition from government to governance recognizes the changing trends among political constitutions in developed and developing countries. These institutional reforms, while of varied speed and scope in individual states, broadly span the domains of government and market activity, the powers of public executive administration relative to that of legislatures and courts, the degree of federalism within nation states, the organization of the financial system and capital markets, the demands of corporate governance and corporate social responsibility, the structure of industrial organization and public utilities, the strength and engagement of civil society organizations, and the delegation of national sovereignty to multinational and regional law and regimes. (citations to be added) The predominant directions of these governance trends include shifts away from pervasive state command or planning of the economy toward more reliance on markets, a reduction in autonomous administrative agency controls in favor of less legislative delegation of powers and heightened judicial review of agency behavior, increased domestic decentralization of governmental authority, liberalization of state banking systems with lower capacity for selective financing of projects (especially large energy or transport infrastructure), reforms of company and security laws to allow minority shareholders to challenge the conduct of corporate managers and controlling shareholders, recognition of corporate social responsibility in social and environmental fields as prudent management, reduced tolerance of public and private monopolies and state sanctioned industrial associations in favor of substitution of independent regulatory bodies in areas of exceptional public interest (energy, telecommunications) and growing inter-corporate professional networks at both national and transnational levels, partial privatisation of state owned enterprises, and the proliferation of civil society organizations focused on policy formation, regulatory review, monitoring of market actor conduct, and challenging asserted public and private misconduct before legal (judicial) review authorities (Heller 2003, Hollingsworth and Boyer 1997, Berger and Dore 1996, and Schmidt 2002)).

The specific constellation of these reforms depends upon the pre-existing institutions in a given nation and the local politics of reform and resistant domestic interests. Yet in almost all cases the reorganization of governance institutions will have important implications for the choice among potential national development paths in key input sectors. For example, a recent study of electricity sector reforms in five leading emerging nations—China, India, South Africa, Brazil and Mexico—found that in no cases did the changes away from power provision through state monopolies correspond closely to the orthodox designs of electricity market reforms. While all five electricity sectors did separate the ownership of generation from transmission and distribution and allow participation in the generation markets by independent, often foreign, power producers, nowhere have competitive generation markets flourished or has the state withdrawn substantially from system planning, tariff setting based on social and political criteria, infrastructure financing, or predominant ownership of major power sector firms. In particular, independent regulation has been difficult to implement, resulting in ongoing uncertainty about the rules of sectoral operations. In this face of this uncertainty, partially privatised or politically influential companies have established a comparative advantage in investment because of their greater ability to manage the political risk

remaining in the system (Victor and Heller 2006). Yet, the consequences for climate friendly energy development have varied across these emerging markets because of nationally specific characteristics. Social goals, including increasing access and renewable power development, have not been interrupted and in some cases, such as the Indian state of Gujarat, the substitution of privately developed captive for grid power has increased the rate of substitution of natural gas for coal-fired generation. (Shukla 2005). In Mexico, complex, financially problematic, government guarantees of tariffs have also encouraged gas fuel diversification from oil to gas. In other cases, including China, the ongoing flux in institutional reforms creates both risks of intensive coal-based power development and the opportunities of more climate friendly energy growth.

The choice of policies that governments seek and are able to pursue are influenced by the political culture and regulatory policy style of a country or region and the extent of public expectations that their governments will take a strong or weak lead in pursuing policy responses. Earlier efforts addressing the issues of institutional capacity for mitigation include a compendium of policy instruments (US DOE 1989), two collections of country studies (Grubb and *et al.* 1991; NIGEC (National Institute for Global Environmental Change) 1993) and a review of the relevant social science literature on institutions (O'Riordan, Cooper *et al.* 1998). However, the issue has not been widely taken up in the climate change policy literature and has been largely absent from the IPCC until now. This is surprising since the idea of differentiated capacities is explicitly recognized in the principle of differentiated responsibilities, embodied in the creation of Annex 1 and Annex 2 countries within the UNFCCC.

A substantial body of political theory identifies and explains the existence of national policy styles or political cultures. The underlying assumption of this work is that individual countries tend to process problems in a specific manner, regardless of the distinctiveness or specific features of any specific problem; a national "way of doing things". Richardson (Richardson, Gustafsson *et al.* 1982) identify national policy style as deriving from the interaction of two components "(a) the government's approach to problem solving and (b) the relationship between government and other actors in the policy process." Using a basic typology of styles, Richardson et al subdivide countries according to whether national decisionmaking is anticipatory or reactive and whether the political context is consensus based or impositional. Many studies of national differences in institutional arrangements for making and implementing environment and technology policy emphasize the essentially cooperative approach to environmental protection in Europe and the more confrontational approach that predominates in the United States (eg, (Lindquist 1980; Kelman 1981; Kunreuther and *et al.* 1982). Jasanoff (Jasanoff 1986) shows how information about established technologies, such as formaldehyde use, is interpreted differently by scientific advisory bodies in different countries. In particular, Brickman (Brickman and *et al.* 1985) argue that the decentralization of decision making in the US both increases the demand for scientific details of technological and environmental hazards and engenders competition between different explanations.

On the other hand, Europeans generally expect the national government to take the lead in all matters pertaining to environmental safety and health, as well as economic and social welfare. The contrast between the US and Europe is not so much dissemination of information or the level of concern, but the view of which institutions in society ought to take the lead in any climate response strategy. In Europe the burden clearly falls upon the national government, whereas there appears to be a widespread expectation that the appropriate agents of change in the USA are the State governments, communities, and nongovernmental/philanthropic organizations. Reviewing case studies from five countries, Rayner (Rayner 1993) concludes:

In sum, the overall picture is that there is a dynamic relationship between centralized programmes and local decentralized initiatives through which informal institutions are becoming an increasingly critical factor in shaping and implementing environmental policy…wide variations in political culture do seem to exert a significant influence on the choice of policy instruments and how legitimate targets are defined.

Recent empirical studies confirm the view that only detailed and case-specific analyses of government institutions and policies can illuminate national differences in the pursuit of environmental and other regulatory objectives. Weiner (Weiner 2002) finds that, contrary to common assertions, that the United States and Europe have not differed substantially in their use or implementation of the precautionary principle. Stewart finds that the United States has successively moved between alternative forms of environmental policies, beginning with command and control, before switching toward market instruments (permits and taxes), and later experimentation with flexible negotiated regulation and information based instruments. In these cases, what distinguishes national political and regulatory cultures are institutional factors such as the judicial doctrines of administrative review and regulatory standards of general treatment more than cultural predilections that support or restrict government action. Presumptions about the likelihood of regulatory capture by concentrated interests (or corruption) also may restrict administrative flexibility in many societies. Other dimensions of particular institutional national histories concern the distribution of government responsibilities and powers between agencies. Reliance on inter-agency task forces to coordinate policies such as climate and energy across bureaus have customarily been less effective than forecast. Given the proclivity of all organizations, including line or sectoral ministries, to protect and maintain their core technologies (Scott 1987), the introduction of new environmental or sustainable development agencies may produce only weak effective change in established policies and priorities. Finally, different governments do appear to have varied traditions of policy preferences and authority. European governments and populations appear more comfortable with lifestyle (demand) regulation than do North American, which often tend to look to longer-run technology development support in collaboration with market actors (Nelson 1993).

There are also important differences in the kinds of policy instruments available to governments. In principle there is a wide array of options (DOE (Department of Energy) 1989) varying in degree of restrictiveness from command and control regulation, through financial incentives (such as taxes and subsidies), to the development of information, including research, development, and demonstration (RD&D).

Regulation is defined as "legislation or rules, supported by actions that are designed to limit the discretion that may be exercised by public and private decision makers"(O'Riordan, Cooper *et al.* 1998). Regulatory mechanisms for forcing private firms to incorporate the social costs of their emissions are exemplified by equipment standards that stipulate the use of specific technologies or performance standards, such as effluent emissions standards with effective penalties (US DOE 1989; Hahn and Stavins 1991). Performance standards permit the regulated party greater discretion than equipment standards, but may present greater challenges of monitoring and enforcement. Equipment standards may also hinder the application of new technologies.

Fiscal incentives are designed to ensure that producers and consumers face the true costs of their decisions while permitting them a higher level of discretion about how to deal with those costs than can be achieved by straightforward regulation. Fiscal incentives include emissions fees and tradable permits, which confront emitters with the price of their actions. This has considerable political appeal in certain quarters of the world as well as widely appreciated properties of economic efficiency. However, uncertainty about costs of damages, emissions control costs, and the effectiveness

of the system to influence decisions may affect the attractiveness of emission fees. Environmental advocates may object to the idea of paying to pollute, while the sudden rearrangement of property rights can upset established manufacturing interests.

Information is a commodity that is particularly subject to problems of market failure. As a result, decision makers are often forced to make decisions with less information than could be available to them if information markets worked better. Governments can alter behaviour by improving information available to them through advertising, education, moral suasion, signalling, and support for RD&D. However, a robust finding of social science is that information alone seldom has a sustained influence on behaviour. The range of informational and RD&D instruments associated with greenhouse gas emissions mitigation range from appliance labelling requirements through prizes for technological innovation in appliance design to government sponsored research and demonstration projects.

The selection of policy instruments is likely to be influenced by the relative strength of institutional sectors in the national polity. Generally the private sector (the market) is likely to prefer carrots (subsidies) to sticks and policy instruments that set goals and leave maximum discretion to firms as to how they achieve them. Hence they are likely to lobby for fiscal instruments or, if direct regulation is unavoidable they will prefer performance standards over equipment standards. On the other hand, firms may be suspicious of informational programmes that hint at moral persuasion or jawboning, which could put firms at a competitive disadvantage.

At the other extreme, environmental organizations (civil society) often emphasize sticks rather than carrots (though they often favor subsidies to alternative energy technologies). They often favour command and control regulation, uniformly applied without the exercise of discretion by regulators or regulated firms. Such discretion violates principles of strict equality. Fiscal incentives may be acceptable, especially if linked to regulation. However, systems such as emissions permits are frequently greeted with suspicion as licenses to pollute (Mott 1990). Information programmes, particularly those designed to expose weaknesses in the compliance records of firms, are also well received here, where information can be used as a stick to beat those who are slow to comply.

Regulatory agencies (the state) may find themselves pulled in two directions. Their orderly instincts may incline them toward the predictability and ease of monitoring associated with command and control regulation. However, the need to reconcile their own agendas with those of the firms that they must regulate may lead them to favour a combination of fiscal incentives backed up by regulation. In any case, regulators are often sympathetic to demands from market constituencies for the exercise of discretion in the application of rules. Regulators' ability to exercise such discretion (e.g., by grandfathering activities of firms that were practiced prior to a rule making) is likely to be restrained in proportion to the strength of environmentalist objectors. Information is likely to be favoured by regulators to the extent that it facilitates their own regulatory tasks, although they may tend towards scepticism as to the usefulness of public information programmes. So we may expect regulators to favour policy instruments that combine carrots and sticks according to pressures from the other two constituencies.

An important, though often neglected issue in the choice of policy instruments is the institutional capacity of governments to implement the instrument on the ground. This is often a matter of what countries with highly constrained resources think that they can afford. However, even industrialized nations exhibit significant variation with respect to the characteristics that would be considered ideal for the successful application of the complete suite policy instruments listed above. These attributes include:

- a well developed institutional infrastructure to implement regulation
- an economy that is likely to respond well to fiscal policy instruments because it possesses certain characteristics of the economic models of the free market
- a highly developed information industry and mass communications infrastructure for educating, advertising, and jawboning
- a vast combined public and private annual RD&D budget for reducing uncertainties and establishing pilot programmes (O'Riordan, Cooper *et al.* 1998).

To the extent that these close to ideal conditions for conventional policy instruments are missing policy makers are likely to encounter obstacles to their effectiveness. For example, both Brazil and Indonesia (Petrich 1993) have carefully crafted forest protection laws that could be used to secure carbon sequestration goals. However, neither country is able to allocate sufficient resources to monitoring and compliance with those laws to ensure that they are effective. Even in industrialized countries, competition for resources among state agencies responsible for promoting economic development and those responsible for environmental protection are almost universally resolved in favour of the former. In much of the developing world, the shortage of programme resources is exacerbated by pressures to exploit natural resources to earn foreign income, increasing demands of population for energy, and pressures to convert forest land to human habitation. As a result, legislative initiatives often seem to "leave more marks on paper than on the landscape" (Rayner and Richards 1994).

Administrative resources are not merely an issue for command and control regulation. Fiscal policy instruments, such as taxes, subsidies, and emissions trading systems also require substantial investments of time, personnel and money to implement and monitor. The complexities of designing and implementing greenhouse gas emissions trading in countries that do approximate the list of ideal conditions outlined above should not be underestimated.

Less industrialized countries often have poor infrastructures to begin with, exacerbated by lack of human, financial, and technological resources. In addition, these countries are likely to be focused on more basic considerations of nation building and economic development. In principle, the economic conditions of less-industrialized countries also present opportunities to achieve both sustainable development goals and emissions reductions measures at lower cost than in the industrialized nations that have already made capital intensive commitments to fossil fuel technologies and may lack the land resources available for carbon sequestration programmes. This is the basis for the Joint Implementation provisions of the FCCC that permit countries to share credit for emissions reductions outside their territorial boundaries. However, both Joint Implementation and its complementary programme, the Clean Development Mechanism, have been controversial from the viewpoints of both industrialized and less-industrialized countries.

A comprehensive review of the social science pertaining to "institutional frameworks for political action" on climate change concludes that "Effective actions designed to mitigate or respond opportunistically or adaptively to climate change are likely to be those that are most fully integrated into more general policy strategies for economic and social development" (O'Riordan, Cooper *et al.* 1998). The notions of adaptive and mitigative capacity advanced in the IPCC Third Assessment Report appear to reinforce the idea that the capacity to develop and implement climate response strategies are essentially the same as those required to develop and implement policies across a wide variety of domains. In other words, they are largely synonymous with those of sustainable development. The issues and cases discussed in this section suggest that the challenges of building the capacity for sustainable development is not confined to the less industrialized countries, but that

industrialized countries also fall short of the capacity to respond to climate mitigation challenges in a sustainable fashion.

The more that climate change issues are routinized as part of the planning perspective at the appropriate level of implementation, the national and local government, the firm, the community, the more likely they are to achieve desired goals. Climate policies per se are hard to implement meaningfully. However, merely piggybacking climate change onto an existing political agenda is unlikely to succeed.

12.2.2.2.3 Market

Industry is a central player in environmental stewardship. Increasingly, the private sector has been recognized not only as a partner in implementation, but also as a stakeholder in policy design. Over the past 25 years, there has also been a progressive increase in the number of companies that are taking voluntary steps to address sustainability issues (Holliday, Schmidheiny *et al.* 2002) at either the firm or industry level. Some of the more widely acknowledged corporate sustainability drivers are summarised below.

Regulatory compliance
Compliance with regulations is one of the reasons most frequently cited by companies for improving their environmental and social performance. Firms work to avoid fines, liability, and other costs of non-compliance.

Markets
There is a perception that companies can increase their market share by producing less environmentally harmful good and services than their competitors Additionally, some businesses are positioning themselves to exploit new markets for environmental products and services.

Reputational value
Businesses are taking steps to implement sustainability in order to protect the company brand otherwise employee perceptions of the company, customer loyalty and investor attitudes may be adversely affected.

Cost savings
Some companies have recognised that pursuing sustainability offers the potential for the company to make cost savings (Thompson 2002; Dunphy, A.Griffiths *et al.* 2003). By increasing energy and material efficiency in production and by reducing wastes, companies can reduce costs per unit of production and thereby gain a competitive advantage in the market (Hawken, Lovins *et al.* 1999; Schaltegger, Burritt *et al.* 2003). This is the concept of "eco-efficiency." A related theory suggests that businesses which constantly work to evaluate their environmental performance will be more innovative and responsive businesses as well (add reference to WBCSD, etc.)

Stakeholder relations
Many companies seek to improve relations with government, NGOs and local communities, because this can offer benefits such as faster approvals for projects or products, (Thompson 2002), a continuing 'licence to operate', and greater scope for self-regulation. In regard to NGOs, improved relations can reduce or eliminate protests, such as consumer boycotts and direct lobbying, (Thompson 2002). Companies are also improving their environmental and social performance in response to demands from their corporate clients. Many large corporations, in particular, have in-

troduced purchasing guidelines that place demands on suppliers to meet environmental performance standards (Thompson 2002).

Finance sector drivers

Demands of investors, insurers and other financial institutions are providing further incentives in relation to sustainability. Through improved sustainability performance, companies can potentially increase the attractiveness of their shares in the market, reduce insurance premiums and obtain better loan terms (Thompson 2002). For example, the rapid growth of socially responsible investment funds (SRIs) in the last decade is providing incentives for greater corporate sustainability (Thompson 2002; Borsky, Arbelaez-Ruiz *et al.* 2005). Disclosure of environmental impact is increasingly seen as a crucial element of a firm's risk profile, for legal liability as well as competitive position in the face of possible future regulation. For example, Reinsurers, companies providing insurance to insurance companies, have shown considerable concern about how climate change could impact insurance claims.

Ideological commitments

It is acknowledged that some changes are being driven by beliefs among senior executives and other employees that promoting sustainability is the 'right thing to do' (Dunphy and Benveniste 2000; Thompson 2002). The pursuit of sustainability by companies has substantial implications for climate change mitigation, both through programs oriented directly towards GHG emissions reductions and indirectly through the promotion of "eco-efficiency" and other holistic management approaches.

One well-known example of a corporation which has embraced sustainability is Interface Inc, a U.S. manufacturer of carpets and upholstery. Since embracing sustainability in 1994, Interface has reduced the carbon intensity of its products by 36% (Hawken, Lovins *et al.* 1999; Anderson 2004) Many of these reductions came through investments in energy efficiency and renewable energy (Anderson 1998; Holliday, Schmidheiny *et al.* 2002; Anderson 2004). However, it is also important to note that Interface has also substantially reduced GHG emissions through other elements of its sustainability strategy, including reduction in use of raw materials and recycling of materials that do not relate directly to energy consumption (Hawken, Lovins *et al.* 1999; Suzuki and Dressel 2002; Anderson 2004). As most of the materials used by Interface in its production are derived from petrochemicals (Anderson 1998; Hawken, Lovins *et al.* 1999), these strategies have led to substantial reductions in the company's carbon footprint.

CEMEX, a Mexican-based cement manufacturer, was able to achieve similar emissions results through adoption of sustainability-oriented business model. One of the major environmental issues facing cement manufacturers is energy use (Wilson and Change 2003). As part of its sustainability strategy, Cemex has focused intently on its energy use in an effort to reduce its environmental burden. For example, in 1994 CEMEX embarked on an eco-efficiency program to "optimize its consumption of raw materials and energy" (Wilson and Change 2003), p29). Through this and other measures, CEMEX has been able to reduce its emissions of carbon dioxide by 2.7 millions tons between 1994-2003 (Wilson and Change 2003), p32).

ITC Limited, an Indian conglomerate and third-largest company in terms of net profits in the country, reportedly sequestered almost a third of its carbon dioxide emissions in 2003-04, and plans to become a carbon positive corporation through a program of energy savings and sequestration of carbon dioxide through its farm and social forestry initiatives. Through programs for rainwater har-

vesting it plans to become a water-positive corporation as well. Its "e-Choupal" intervention has eliminated the need for brokers and helped 2.4 million farmers across six Indian states participate in global sourcing and marketing of products.

There is widespread debate as to whether the responses of industry to environmental decline and sustainability issues more generally is sufficient. Luke (Luke 1999): 132), for example, talks of sustainability in this context as a 'remoulded economic growth ideology'. Initiatives taken by business to reduce waste, improve resource efficiencies, and prevent pollution satisfy a public desire for environmental protection, but at the same time usually work within the mainstream business model. Even business scholars and academics have questioned whether existing business models are up to the challenge of implementing sustainability (Elkington 2001; Sharma 2002; Doppelt 2003; Dunphy, A.Griffiths *et al.* 2003). According to (Doppelt 2003): 17): 'Because they do not understand that sustainability often entails whole new business models, few organizations institute meaningful cultural change efforts'

At the most fundamental level, the presiding view in western economies is that businesses do not have a responsibility, beyond regulatory compliance, to internalize sustainability issues. Following the thinking of Friedman and the Chicago School, the only responsibility of firms is to their shareholders, leading Stormer (Stormer 2003): 281) to comment that '…the conceptualization of business as more than a profit-maximising system has not permeated the business system itself'.

Despite the preeminence of the "shareholder" thesis, notions of corporate social responsibility (CSR) have gained a wider hold. The essence of the CSR perspective is that there is a clear basis for businesses to widen their focus from simply profit maximization (the "shareholder" view) to include other economic, social and environmental concerns. The arguments in support of CSR include, inter alia, competitive advantage (e.g., (Porter and C. van der Linde 1995; Porter and Kramer 2002), notions of corporate citizenship (Marsden 2000; Andriof and McIntosh 2001), and stakeholder theory (Post, Sauter-Sachs *et al.* 2002; Driscoll and Starik 2004; Windsor 2004). The ecological modernization thesis (e.g., (Christoff 1996; Mol and Spaargaren 2000; Dobson 2003a) proposes a reform of the growth ethic, to give greater recognition to social wellbeing, equity, and ecological limits.

While the theoretical and ideological debates continue, there is no question that firms are doing more in support of the environment and sustainability issues. Colman (Colman 2002) reported that forty-five percent of the Fortune Global Top 250 companies have issued environmental, social or sustainability reports.

Similarly, CSR would seem to have become a more serious concern to European companies, though Pharaoh (Pharaoh 2003) suggests it is primarily sales driven. In the UK, socially responsible investment (SRI) grew from £23 billion in 1997 to £225 billion in 2001 (Sparkes 2002), while Borsky et al (Borsky, Arbelaez-Ruiz *et al.* 2005) report that the $2.16 trillion of socially responsible investments held in the US accounted for approximately 11 percent of the total investment assets under management in 2003. It is important to recognize that the standards used by SRI firms to evaluate firms vary widely in what issues they address (with many simply staying away from weapons, tobacco, alcohol, and gambling) and how rigorously these standards are applied. Some SRI firms emphasize diversity and labor relations, while others focus on environment; there is no set of common criteria, and thus not all firms listed on SRI lists can be considered sustainable. However, growing public interest in SRI has led more firms to be concerned about a variety of social and environmental issues.

From the perspective of firms, there are both internal and external barriers to change. Internal barriers include an absence of commitment and leadership at senior levels, corporate culture, organizational structure, and the specific characteristics of plant and operations (Howes 2005). External impediments to change in support of sustainability include a persistent emphasis in the markets on short-term profit, accountability systems that ignore social and environmental performance, the inability to adequately influence supply chain relationships, and the risks to the individual firm of enacting fundamental change while the mainstream remains locked into the neo-classical growth model. Additionally: "Regulatory barriers include: regimes that do not encourage firms to go beyond compliance, that do not provide a constant long-term direction for change or are not backed up with a consistent political will of enforcement' (Howes 2005): 163). There is also the fact that social and environmental costs are largely externalized by firms (Sharma and Starik 2004), a situation that could be redressed, in part at least, by full-cost accounting of the environmental and social impacts of firms.

Though there has been progress, the private sector can play a much greater role in making development more sustainable. As the number of companies which operate both profitably and more sustainably increases, the view that addressing social and environmental issues is incompatible with shareholder maximization may loose ground. There are many opinions on the extent to which business can be relied upon to meet sustainability objectives, ranging from those who feel that business is inherently self-interested and exclusively profit-driven, to those who feel that socially-responsible businesses going "beyond compliance" are on the forefront of the sustainability curve. Though the issues are complicated, there can be no question that the shift towards improved sustainability is fundamentally connected to the social, economic and environmental performance of the private sector. This is especially true in relation to the issue of climate change.

12.2.2.2.4 Civil Society

A multitude of interest groups, including civil society in its various manifestations, seek to influence the direction of national and global climate change mitigation policy (Michaelowa, 1998). Nongovernmental organizations (NGOs) have been particularly active and often influential in shaping the societal debates and policy directions on this issue (Newell, 2000; Gough and Shackley, 2001; Corell and Betsill, 2001). The literature on the various ways in which civil society, and especially NGOs, influence global environmental policy in general and climate policy in particular, points out that civil society employs 'civic will' to the policy discourse and that it can motivate policy in three distinct but related ways (Banuri and Najam, 2002). First, it can push policy reform through awareness-raising, advocacy and agitation. Second, it can pull policy action by filling the gaps and providing such policy services as policy research, policy advice and, in a few cases, actual policy development. Third, it can create spaces for champions of reform within policy systems so that they can assume a salience and create constituencies for change that could not be mobilized otherwise.

The image of civil society 'pushing' for climate change mitigation policies is the most familiar one. At the global, national and even local levels, one finds numerous examples of civil society organizations and movements seeking to push policy reform. The reform various interest groups within civil society desire can differ (Michaelowa, 1998) but what is common is the legitimate role that civil society has in articulating and seeking their visions of change through a multitude of mechanisms that include public advocacy, voter education, lobbying decision-makers, research, public protests, etc. Given the nature of the issue, civil society includes not just NGOs but also academic and other non-governmental research institutions, business groups, and broadly stated the 'epistemic' or knowledge communities that work on understanding the climate change problematique

better. Some have argued that civil society has been the critical element in putting global climate change into the policy arena and relentlessly advocating its importance so that governments eventually began responding to these calls from civil society for systematic global climate change mitigation policies (Gough and Shackley, 2001; Najam, Christoupoulou and Moomaw, 2004). In particular, studies of the negotiation processes of global climate change policy (Newell, 2000; Corell and Betsill, 2001) highlight the role of nongovernmental and civil society actors in advancing the cause of global climate change mitigation.

The role of civil society in 'pulling' climate change mitigation policy is no less important. In fact, the IPCC assessment process itself, as a voluntary knowledge community seeking to organize the state of knowledge on climate change for policy-makers is an ideal example of how civil society, and particularly how 'epistemic' or knowledge communities can directly add to or 'pull' the global climate policy debate (Siebenhuner, 2002; Najam, Rahman, *et al.*, 2003). In addition, the knowledge communities as well as NGOs have been extremely active and instrumental in actually servicing the needs of national and sub-national climate policy. This is done by universities and research institutions writing local and national climate change plans (add reference), NGOs helping in the preparation of national climate change positions for international negotiations and increasingly being part of the national negotiation delegations (Corell and Betsill, 2001), in civil society and epistemic actors playing key roles in climate change policy assessments at all levels from the local to the global, etc.

Finally, we find civil society playing a very significant role by 'creating spaces for champions of policy reform' and providing platforms where these champions can advance these ideas. For example, the Pew Climate Initiative and Millennium Environmental Assessment are just two examples of how civil society has created forums and space for discourse amongst different actors, and not just civil society actors, to interact and advance the discussion on where climate change mitigation and sustainable development policy should be heading. Increasingly, civil society forums such as these are very cognizant of the need to broaden the participation in these forums to those from other institutional sectors of society.

12.2.2.2.5 Partnerships

Partnerships between public and private actors can maximize impact by taking advantage of each partners' unique strengths and skill sets. However, as "boundaries between and within public and private sectors have become blurred" (Stoker 1998): 17), questions have arisen about the authority, responsibility and accountability of different actors (Jessop 1995).

The strategies of partnership, self-help and community empowerment have been used to encourage participation and to promote the idea that environmental problems are best addressed through communities working together and with government and industry. Partnership programmes can provided citizens groups with a lever for increasing pressure on both governments and industry to change in support of improved sustainability.

One of the best known examples of a partnership for sustainability is the Australian Landcare programme, designed to rehabilitate degraded rural land. Landcare originated as a partnership between the Australian Conservation Foundation, Australia's largest environmental NGO, and the National Farmers Federation. Subsequently, the partnership was joined by the Commonwealth Government. Landcare was constructed in a way which appealed to both the farming and environmental sectors (Higgins and Lockie 2002). Many evaluations of Landcare and allied partnership programs indicate that they are well accepted by the community and have high participation rates (Curtis 1998). They

have also enabled the development of programs that are locally meaningful and have increased awareness of sustainability issues (Cocklin 2004). On the other hand, Landcare and other partnership programs have been criticized for their excessive expectations of volunteers and their inability to demonstrate meaningful environmental outcomes (Wilson 2004).

From an economic development perspective, one of the potentially fruitful styles of partnership has been between governments and industry through what is known as BOT projects – Build, Operate, Transfer. As Box 12.1c shows, however, that despite their promise as a means of financing large-scale capital intensive projects, there have been significant difficulties in practice.

Closely related to the idea of partnerships is the idea of stakeholder dialogue and input. Forsyth (Forsyth 2005) suggests that local involvement in public-private partnerships may help resolve the stand-offs over global environmental agreements like the UNFCC. Cooperative environmental governance models offer advantages such as a more structured framework for pluralist contributions to policy, consensus-building, more stable policy outcomes, and social learning. Though these cooperative models do allow for more stakeholder participation, it can be argued that they fail to fully address exclusion of minority and less powerful groups, non-representative outcomes, and a failure to integrate local knowledge. Forsyth's analysis of waste-to-energy projects in the Philippines and India confirms that such problems will be encountered. He concludes that "deliberative public-private partnerships work most effectively when investors, local governments and citizen groups are willing to work together to implement new technologies, and produce arenas to discuss these technologies that are locally inclusive" (Forsyth 2005). Further:

"Building capacity for deliberative partnerships that address both global concerns such as climate change policy and local environment and livelihood concerns does not simply mean educating local people about predefined institutional structures or environmental risks. Instead, it means creating a deliberative space between investors and citizen groups that allow open communication between all parties, an act that frequently requires actors to define their own spaces (or negotiating arenas) rather than accept usual models such as public consultations with the local government".

The notion that partnerships between sectors is the wave of the future was given particular credibility by the World Summit on Sustainable Development in Johannesburg, South Africa, in 2002 where a set of 'Type II' partnerships were launched involving various combinations of governments, business and civil society actors (Najam and Cleveland, 2003; Hale, 2004). Although it is too early to evaluate the impacts of these particular partnerships, they do represent a larger trend whereby the last decade has seen a far greater level of partnership activities between governments and NGOs on the one hand, between government and business on the others, and now increasingly all three. Such multi-sector forums and partnerships are no longer a phenomenon limited to a few industrialized countries nor to particular sectoral mixes. One finds cross-sectoral partnerships and the search for meaningful cross-sectoral partnerships in developing and industrialized countries alike and one finds them being initiated equally by governments, business and civil society.

Box 12.1c: *Public- Private-Partnerships (PPPs)*

Globally, public-private-partnerships (PPPs) are an increasingly popular tool governments use to fund large-scale infrastructure projects. Broadly, PPPs involve the investment of private capital and the use of private sector expertise to deliver public infrastructure and services. There are various forms of PPPs. In the power generation sector, popular examples of PPPs are Build-Operate-Transfer (BOT) projects. In a BOT project, private partners (investors) provide the financing and

technology, they build, and they operate the power generation facility for a concessionary period of up to 35 years. During the concession, a government partner provides the investor with ownership rights and gradually buys back the project by providing the developer with the right to charge consumers a fee for its product. At the end of the concession period, the facility is transferred to government ownership at no further cost to the government.

BOT projects have enabled developing country governments with growing energy needs to access new financial capital for green or intermediate fuel technologies for power generation. For example, Vietnam is utilising such investments for natural-gas fired turbines, and Laos is engaging in a large program of hydropower construction to supply electricity to a regional power grid in the Greater Mekong Subregion. However, they have also enabled governments to bring on-line more conventional fossil-fuel powered generating capacity in regions where alternative fuels are not available - heavy oils in some regions of China and coal in Thailand.

While PPPs have assisted governments with access to new financial capital and expertise to invest in cleaner power generating capacity, care needs to be taken in evaluating their costs, benefits and risks to governments and consumers. In uncertain investment environments such as that in developing countries, private partners require a range of onerous guarantees from governments to reduce their investment risks over the life of the projects. These include take-or-pay guarantees where governments commit to purchase a minimum level of production, guarantees to cover currency exchange risks, fuel supply price guarantees, political risk guarantees to protect against government regulatory change, etc.. In the aftermath of the East Asian financial crisis that began in 1997, governments such as the Philippines and Indonesia paid a high price for guaranteed power purchases that were denominated in US dollars as their currencies devalued respectively and power demand from industry dropped.

12.2.2.3 Sustainable development and climate change mitigation: issues and opportunities

In this subsection, issues and opportunities for promoting more sustainable development are presented with the purpose of evaluating the way choices for promoting sustainable development overtime can impact climate change.

12.2.2.3.1 Energy and Economic Development

Development programs for rural areas/poor urban communities in developing countries provide the most evident and unquestionable proofs of the benefits from modern energy and its end-use technologies access and usage on sustainable development. Those changes in traditional rural life usually lead to higher productivity, income increases, job creation and economic development. And, depending upon the choices made for energy production and use, it may or may not increase GHG emissions (Geller, Schaeffer *et al.* 2004).

Yet, while accessing and using modern energy and end-use technologies are fundamental to promote economic development, larger modern energy use (let alone traditional) will not always result in higher well being, neither in higher economic development, and nor in lower GHG emissions. As a matter of fact, energy services, rather than energy use, are the ones that really lead to higher well-being. Also, the purpose for which energy services are allocated is what will determine, to a great extent, the level of economic development achieved, and, as a consequence, how sustainable development will be (Karekezi and Majoro 2002; Spalding-Fecher, Clark *et al.* 2002).

In a more strict sense, the supply of modern energy sources is also needed to support economic development in contemporary societies, since most of their production activities rely on, or even demand, modern energy sources. Thus, shortage of modern energy supply affects economic growth, as well as uncertainty about future availability of modern energy to support higher level of activity discourages expansion in production capacity by corporations, reinforcing negatives impacts on current economic growth, constraining the potential economic growth in the future and a more sustainable development (Machado and Schaeffer 2005).

12.2.2.3.2 Enhancing Sustainable Development

The promotion of a more sustainable future is not a simple task. Economic growth will not lead by itself to sustainable development. On the contrary, in addition to provide a good environment to economic growth (macroeconomic stability, appropriate and stable market regulations, adequate long-run funding for infra-structure investments and satisfactory human capital), enhancing sustainable development requires a broad set of measures and policies in place.

While enhancing sustainable development demands considerable efforts from all social actors, governments play a fundamental role in this process; particularly in developing countries. National governments have to pursue multiple objectives, including devising climate change mitigation policies, to facilitate a more sustainable future. They have to promote an enabling environment to economic growth; promote efficiency and competitiveness in the markets, removing both market and previous government failures; guarantee that low-income people have access to modern energy services at affordable prices; assure long-run investments in modern infra-structure (either by providing attractive market environment or through state-owned companies) to satisfy future modern demands; support technology innovations and new and/or more dynamic markets to stimulate structural changes in the economies and to leapfrog various technologies; and become catalysts of the process of enhancing sustainable development, coordinating actions of different social and economic actors in order to seek some synergies (Machado and Schaeffer 2005).

Boxes 12.2, 12.3 and 12.4 below present the interesting cases of South Africa and China, where recent developments in the energy area are helping these countries move towards a more sustainable development future.

Box 12.2: *Poverty tariff in South Africa*

South Africa undertook a national electrification programme that increased electrification rates from roughly one-third to two-thirds by 2002 (NER (National Electricity Regulator) 2002). However, consumption levels of electricity remained lower than expected, since poor households often can afford only limited use of the electricity. In an attempt to address the question of affordability, the South African government committed itself to implementing a free supply of electricity for basic needs (DME, 2004). The 'poverty tariff'[13] stipulates a uniform electricity basic support services tariff (EBSST) of 50 kWh at zero cost to all grid-connected poor customers. This is considered sufficient for lighting, ironing, water heating, TV and radio (National Treasury 2003), and could make cooking and heating more attractive. By subsidising the use of electricity for some basic needs, government is seeking to increase the social benefits of electrification. (Gaunt 2005)

[13] Official names include electricity basic support services tariff (EBSST). The national policy indicates 50kWh, although some municipal distributors are providing lower amounts, 20-50 kWh / household / month. Households in Eskom distribution areas receive 50 kWh.

The extent to which the policy alleviates poverty depends on the energy burden (the percentage of the total household budget spent on energy). The energy burden of poor households in remote rural villages can be up to 18% of the total household budget, according to data from a case study reported in Table 12-1; see also (UCT 2002). The 50 kWh provided by the poverty tariff would reduce the energy burden by two-thirds (6 percentage points). Monthly expenditure on electricity and other fuels decline by 18% and 16% respectively, due to the poverty tariff.

[INSERT **Table 12-1** here]

A recent study in the poor areas of Cape Town showed that monthly electricity consumption has risen by 30 – 35 kWh/month per customer since the introduction of poverty tariff, a substantial rise against an average consumption ranging from 100 to 150 kWh per month (Borchers, Qase *et al.* 2001). This rise is less than the full 50 kWh/month, suggesting that households both make greater use of electricity, but also value some saving on their energy bills (Cowan and Mohla-koana 2005).

The impacts on climate change mitigation have been broadly scoped. If extended to all customers in a broad-based approach, the poverty tariff might at most increase emissions by 0.146 $MtCO_2$ under the assumption that all the free electricity would be additional to existing energy use (UCT 2002). In practice, it is likely that electricity might displace existing use of paraffin, coal, wood, candles, batteries and other fuels to some extent. This upper-bound estimate represents 0.04% of total GHG emissions, but about 2% of residential sector emissions in 1994. This example from South Africa show that poverty-alleviation and environmental objectives can be simultaneously addressed.

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Box 12.3: Poverty alleviation, electricity access and climate change in South Africa

An example a development policy impacting on mitigation is electrification. Using South Africa again as a case study, it is clear that - in the context of coal-fired electricity – increased levels of electricity consumption will increase GHG emissions. Yet electricity helps make local development more sustainable – it provides important social services, it can act as a catalyst for economic development, and avoids local air pollution. Electricity displaces multiple fuels, although use of fuels such as wood, coal and paraffin continues in electrified households.

Universal access to modern energy services is a key development objective for the South African government (ANC (African National Congress) 1994). At the beginning of the 1990s, about one-third (31%) of all households were connected to the electricity grid. By the end of the decade, this had increased to about two-thirds (63%), and an off-grid concessions programme seeking to address electrification by solar home systems in remote rural areas (Borchers, Qase *et al.* 2001).

Access to an important service has thus increased dramatically, although affordability of electricity use remains a major issue (see box on poverty tariff). Considering the impacts for local and global sustainable development, the question arises what the net impact of electricity provision is.

[INSERT Table 12-2 here]

The results from a case study for SA are shown in Table 12-2. The study estimated the avoided health costs of electrification by combining previous analysis on the external costs of household fuels with a simple model of the impact of electrification on fuel consumption, taking into account continued multiple

fuel use. It found that the benefits of avoided health costs are of the same order of magnitude as the local air pollution damages from the power stations that produce electricity given by previous studies. They are, however, significantly less than the damages caused by greenhouse gas emissions from power stations (Spalding-Fecher 2005)

The implications are that electrification in a carbon-intensive grid has significant local sustainable development benefits, but increases greenhouse gas emissions. To mitigate GHG emissions, electrification would need to be accompanied by policies that reduce the carbon-intensity of electricity generation. Access, affordability and cleaner fuel use need to be combined (Spalding-Fecher 2005).

When considering the environmental impacts of electrification, it must be borne in mind that electricity enters a situation of multiple fuel use. While some shifts in fuels occur, there is not a linear movement to another 'modern' fuel (Yamba, E.Matsika *et al.* 2002), with multiple fuel use continuing for several years after households receive electricity services (Mehlwana 1998). Both for local environmental impacts – such as indoor air pollution – and global emissions, the impacts of electricity need to be compared to those of the fuels it displaces.

In a study for South African households, it was found that coal use is 80 per cent lower in electrified communities, while paraffin use is almost 90 per cent lower. Reductions in LPG and candles varied by region, but were consistently higher than 50 per cent (Spalding-Fecher 2005).

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Box 12.4: *Chinese electricity development*

The development of China's electricity sector has been the most rapid and substantial of any historical experience. It has grown from 1.2 GW installed capacity in 1949 to more than 415 GW today, with a capacity addition of more than 40 GW in 2004 alone (Zhang, May, *et al.* 2004). It has also contributed more to afford access to users to electric services than any other nation. However, the history of Chinese electrification has been overwhelming the story of coal-fired power. More than 70% of total Chinese capacity and a similar or even higher proportion of the most recent capacity vintage is operated on good standard, but still sub-critical coal technologies (Zhang and Heller 2006). The most common assumption is that, for reasons of coal costs relative to those of other fuels capable of supplying the needed expansion of capacity that will allow continuing high economic growth, coal will remain the fuel of choice in coming years in spite of its impacts on global climate change.

The potential to reduce carbon emissions, and improve air quality, through increasing the rate of substitution of natural gas for coal fired power is enormous. The first natural gas plants, some powered by piped gas from the West-East China pipeline and some by imported LNG in South China, are now under construction. The International Energy Agency forecasts that, given these trends, in 2020 there will be 560 GW of coal power and 67 GW gas power in China. If we imagine a switch of 80 GW from coal to natural gas combined cycle (CCGT) during this same period, you would save 105 million tons CO_2 annually thereafter[14] (This figure of 80 GW can be compared to the US capacity additions of 110 GW of CCGT capacity between 2000 and 2003.). The GHG saving is equal to about 20% of the UK annual emissions in 2000; about 50% of California's automobile emissions in that year; and more than 10 times the combined mitigation potential of the ten largest CDM proposals that have been put forward. As the relative price of coal rose in the 2004 summer, especially in the fast-growing coastal provinces with high rail transportation costs for delivered coal and easy sea-access for falling-price LNG supplies, in some areas alternative development options have become more realistic.

Which development path will China follow: the high or low gas substitution scenario? It is unlikely that

[14] Footnote should be introduced here presenting the assumptions behind the calculations provided.

China will have national or sectoral mandatory emissions targets under an international agreement that would favor the high gas scenario. A first focal point for a development led climate strategy might logically be the sectoral policy reforms such as competitive electricity markets, private ownership of generation, integration of a national transmission grid, or independent regulation. In fact, the impact of any of these reforms on fuel choice by themselves would not necessarily produce an increase in gas' shares of the fuel mix. However, other policies, both within the electricity sector and outside it, would shift the mix toward gas at the margin. These might include the exchange rate, financial sector reforms, decentralization of decision making in energy policy, peak-load pricing, and the rules for incorporating distributed power within the electricity system. Most importantly, there are empowered actors who have strong interests who would favor the high gas scenario, including the Chinese state oil and gas giants, national and international gas equipment manufacturers and shippers, and international oil and gas firms. Whether cooperative strategies can be conceived and implemented to bring these coalitions together with Chinese policy makers to design and build a policy and investment environment that will make gas markets expand more rapidly may determine the speed of gas penetration without any specific reference to climate goals. A focus of international assistance or crediting on the infrastructure costs of this gas-friendly context might produce development and climate results far in excess of current cooperation mechanisms.

12.2.2.3.3 Seeking Synergies

Enhancing sustainable development requires a broad set of measures and policies devoted to such aim, demanding considerable efforts of all social actors. In spite of that, governments have the additional task of coordinating the actions of different social and economic actors. This is a fundamental role to be played by governments because, frequently, market and government failures, transaction costs or information asymmetries prevent stakeholders to act in benefit of sustainable development (Machado and Schaeffer 2005).

For instance, the removal of price distortions (including for environmental externalities) will contribute to encourage improvements in economic efficiency, changes in personal patterns of energy use, restructuring in transportation systems and in spatial organization, structural changes towards higher value added activities and new consumption patterns. Sustainable development has at least three pillars (economic, social and environmental). Climate change mitigation is an important part to give consistence to any one of these components, and is affected by any of them (Winkler, Spalding-Fecher *et al.* 2002).

12.2.3 Mainstreaming climate change into development choices

How can the concept of alternative development pathways be used to bring about more sustainable development? Based on a number of Indian case studies, Heller and Shukla (Heller and Shukla 2003) propose operational guidelines which can integrate development and climate policies into the future development pathways of developing countries. It is possible and advisable to mainstream climate concerns into the evolving political and economic decisions. Concerns about climate change can and should be mainstreamed into other political and economic policies. By recognizing the negative externalities associated with climate change, policies can steer commercial actors to more sustainable activities. In developing countries, which by and large have not yet enacted domestic GHG legislation, the CDM can play a role as one component of national GHG reduction strategies and sustainable development.

Case studies in Tanzania (Agrawala, Moehner *et al.* 2003), Fiji (Agrawala, Ota *et al.* 2003), Bangladesh (Agrawala, Ota *et al.* 2003), Nepal (Agrawala, Raksakulthai *et al.* 2003), Egypt (Agrawala,

Moehner *et al.* 2004) and Uruguay (Agrawala, Moehner *et al.* 2004) show how climate change adaptation can be integrated with national and local development policies, often as a no-regrets strategy. Implementation of such no-regrets strategies is however, not without challenges.

The previous IPCC assessment highlighted the vulnerability of the poor to the impacts of climate change, and the need to focus on adaptation. Still, mainstreaming climate change mitigation into development policies is also important and involves major challenges. While climate change mitigation is an important component of the World Bank's strategy, in practice climate change issues are not systematically incorporated into lending in the energy sector. Multilateral development banks could explicitly integrate climate change considerations into their guidelines for country and sector strategies, and apply a greenhouse gas accounting framework in their operations (Sohn, Nakhooda *et al.* 2005).

Mainstreaming climate change mitigation into development policies appears to be discussed mainly in multilateral development cooperation circles (see above). In industrialized countries, climate change continues to be regarded mainly as a separate, environmental problem that is to be addressed through specific climate change policies. One example is the Sustainable Development Strategy proposed by the European Commission (European Commission 2001). The strategy addresses climate change, but only through dedicated climate change policies, rather than more holistic changes. While the Strategy suggests policies should be coordinated, the strategy does not propose mainstreaming climate change impacts into economic, financial and other policies. This appears to be typical for the approach many developed countries take.

This approach fails to recognize that climate change and development paths are mutually dependent, and that climate change will have negative impacts in the future which should encourage policies to avoid harm in the future. For example, a study of the Baltic region explores a sustainable development pathway addressing broad environmental, economic and social development goals, including low GHG emissions. It points out that a majority of the population could favour — or at least tolerate - a set of measures that change individual and corporate behaviours to align with local and global sustainability (Raskin, Gallopin *et al.* 1998). Kaivo-oja *et al.* (Kaivo-oja, Luukkanen *et al.* 2004) concludes that climate change as such may not be a major direct threat to Finland, but the effects of climate change on the world's socio-economic system and the related consequences for the Finnish system may be considerable. The Finnish scenario analysis, which is based on intensive expert and stakeholder involvement, suggests that such indirect consequences have to be taken into account in developing strategic views of possible future development paths for administrative and business sectors.

MNP (MNP (Netherlands Environmental Assessment Agency) 2005) has developed the four IPCC SRES scenarios into more elaborate for a sustainability outlook for the Netherlands, noting that the four scenarios represent four world perspectives with four different views on future priorities for action to make development more sustainable. This outlook points at several dilemmas. Surveys showed that 90% of the population prefers a future which would be different from the globalizing, market -oriented A1 scenario, while A1 appears to be the future they are heading for. A majority of the population also thinks that something has to be done about unsustainable production and consumption patterns, but suggest that the government should do more.

The study suggests that the regional (European) level may be the most appropriate level to address sustainability issues: global political, economic and cultural differences make effective global policy difficult, while many of the sustainability issues go beyond the local or national capacity to develop and implement effective policies.

12.3 Implications of Mitigation Choices for Sustainable Development Goals[15]

12.3.1 Sectoral Policies and Choices

As documented in the TAR, the current array of commercially available technologies and practices, if deployed on a wider scale, can be adequate to stabilize climate change. Many or most of these technologies and practices are being deployed at various scales in the world today. The use of renewable energy and energy efficiency technologies, for instance, is growing worldwide as countries pursue pathways to reduce deleterious impacts and improve energy productivity. Carbon sequestration is being enhanced by the annual planting of tens of millions of ha of land, and landfill methane gas capture is spreading quickly worldwide. The sectoral chapters provide an overview of the impacts of the implementation of such technologies and practices. In this section, we summarize the current impacts on sustainable development, and draw conclusions about their impact on alternative future development paths.

As documented in the sectoral chapters current development paths may not always be sustainable with respect to all three dimensions of SD -- economic, environmental and social. Some pathways are not directly related to the generation process of greenhouse gases themselves, but induced by shifts in the technical and socio-economic background. For example, removing subsidies for coal, thus increasing prices for energy production (IPCC (Intergovernmental Panel on Climate Change) 2001) will create unemployment of former coal mine workers, independently of the actual mitigation. Other pathways are more indirect by creating side-effects of reducing the GHG-emissions. For example, an increase in energy efficiency in heating or cooking, in particular in developing countries, will also reduce the emission of pollutants like SO_2 or particulate-carbon matter. This has beneficial effects for local or indoor air quality and on the longer term also on human health.

Possible side effects of mitigation policies can either be positive or negative with respect to the promotion of sustainable development. For the time being, uncertainties on the different SD impacts are high and often only qualitative information or individual case studies exist. Therefore, it is not always possible to assess the net outcome of the various effects.

The sustainable development benefits of mitigation options vary within a sector and over regions. Generally, mitigation options that improve productivity of resource use, whether it is energy, water, or land, yield positive benefits across all three dimensions of sustainable development. In the agricultural sector (Table 8.4.4) for instance, improved management practices for rice cultivation and grazing land, and use of bioenergy and efficient cookstoves enhance productivity, and promote social harmony and gender equality. Other categories of mitigation options have a more uncertain impact and depend on the wider socioeconomic context within which the option is being implemented. Nuclear and large hydro forms of energy supply reduce carbon emissions but can have other environmental and social impacts that are not beneficial.

Some mitigation activities, particularly in the land use sector, have GHG benefits that may be of limited duration. A finite amount of land area is available for forestation, for instance, which limits the amount of carbon that a region can sequester. And, certain practices are carried out in rotation

[15] This section (including Sections 3.1 and 3.2) is based on findings of other chapters as reported in late October 2005. More material will be added as it appears in the sectoral (4-10) and cross-cutting (11 and 13) chapters. Therefore, it is preliminary, and is intended to provide the reader with the type of information that will be prepared.

over years and/or across landscapes, which too limit the equilibrium amount of carbon that can be sequestered. The incremental sustainable development gains to be had would thus reach an equilibrium condition after some decades.

Over the last decade, quantification of the progress towards sustainable development has gained ground. In the industrial sector, several trade associations provide platforms for organizing and implementing GHG mitigation programs. Chapter 7 in this AR4 report, notes that performance indicators are being used by the aluminum, semiconductor, and cement industry to measure and report progress towards SD. The Global Reporting Initiative (GRI) a UNEP Collaborating Centre initiative, for example, reports that over 700 companies worldwide make voluntary use of its Sustainability Reporting Guidelines for reporting their SD achievements. Industrial sectors with high environmental impacts lead in reporting and 85% of the reports address progress on climate change (GRI (Global Reporting Initiative) 2005, and KPMG Global Sustainability Services 2005). Another example is in the buildings sector, where several thousand commercial buildings have been certified by the US Green Building Council's program on Leadership in Energy and Environmental Design (LEED), which uses a 69 criteria to award certificates at various levels of achievement. The certification ensures that a building meets largely quantitative criteria related to energy, indoor air quality, materials and resource use, energy use, water efficiency, and innovation and design process (www.usgbc.org) (USGBC (U.S. Green Building Council) 2005). Economic and ethical considerations are the most cited reasons by businesses in the use of these two guidelines.

12.3.1.1 The Economic Dimension

Sectoral costs of various mitigation policies are widely studied and a range of cost estimates are reported for each sector at both the global and country-specific levels in the sectoral chapters. Among the various sectors the costs of mitigation in the energy supply sector have been studied most often. Yet the costs of mitigation for the entire national or global economy are just part of the SD impacts. Other impacts include growth and distribution of income, employment and availability of jobs, government fiscal budgets, and competitiveness of the economy or sector within a globalizing market.

Many of the sectoral policies and choices represent significant opportunities for promoting economic development with respect to these issues. Nevertheless, careful analyses are required to assess the potential risks of these policies. For example, the increased production of biofuels for transportation, or energy production in rural areas, is expected to protect existing employment and to create new jobs in rural areas (Sims 2003). Renewable energy systems are more labor intensive than fossil fuel systems and a higher proportion of the jobs are relatively highly skilled. Thus an increase in employment of the rural people can only be achieved, if corresponding learning opportunities are created. If, however, labor intensity decreases over time, the long-term effect on jobs might be less pronounced than originally anticipated.

The lack of adequate infrastructure for power supply, oil and gas extraction and refining, road networks, enforcement of laws, etc. is a theme that is echoed in both industrialized and developing countries. The IEA estimates $5 trillion to meet electricity demand in developing countries by 2030. Yet, access to finance for investment has been declining due to high transaction costs imposed by lack of accessibility and affordability to clean fuels. The high transaction costs are caused by not only a country's or utility's inability to payback borrowed funds, but also because of institutional constraints that limit competition in the marketplace, and corruption.

Electricity shortages are common phenomena in many developing countries. Removal of electricity shortages through cost-effective energy efficiency mitigation options has the potential to increase

production from affected businesses. The increased production means that industry is able to hire more workers. It also leads to higher income and sales tax revenue for the government. An analysis of the potential for end-use energy efficiency options by Phadke *et al.* (Phadke, Sathaye *et al.* 2005) show that for the state of Maharashtra, India, the increased production translates into several million new jobs, and increased tax revenue that can offset at least 15% of the state's revenue deficit (Phadke, Sathaye *et al.* 2005). Earlier analyses of energy efficiency options and alternative climate change policies nationally and for several US regions showed similar potential for increases in jobs (Nadel, S. *et al.* 1997) and (Barrett, Hoerner *et al.* 2002).

While in the above example, energy efficiency mitigation measures are estimated to increase productivity, economic growth, competitiveness and jobs, this may not always be the case. Privatization of electricity systems is a common theme worldwide. As noted in Section 4.8.4.3, privatization of many systems in Latin America and Africa is likely to increase competitiveness at the cost of new and existing jobs. A prioritization of mitigation options on the basis of these attributes will be essential to ensure that other sustainable development objectives are not compromised for the sake of rapid economic growth.

The realization of mitigation options often creates new industries, e.g. for energy efficient products like cookstoves, efficient lamps, or higher-fuel-economy automobiles. The success of these new industries depends on various factors, which determine the demand for the alternative products. The degree of information, costs, the image of the product and its traditional competitors or its traits besides being energy efficient are some of those factors. New industries can create new jobs and income, and might be a pioneer in the new market with significant competitive advantage. There is, however, the danger that jobs in the older, outpaced industry might be lost. Besides the uncertainty on the overall net effect, major regional distortion might be created with high unemployment rates in traditional regions.

Indirect price effects might also have impacts on other sectors. For example, the reduction of oil consumption for energy production will reduce the oil price with beneficial effects for the chemical industry.

12.3.1.2 The Social Dimension

The social dimension includes issues such gender equality, governance, equitable income distribution, housing and education opportunity, energy security, health impacts, and corruption. All forms of development paths, including those that pursue climate mitigation, impact these issues. Since there are lessons to be learned about the impacts of all development paths, the discussion below is not confined to the implementation of mitigation options alone.

Effects of mitigation policies on the social dimension of sustainable development might be induced directly through the policy itself or also indirectly via environmental and/or economic side effects. In many instances, the reduction of greenhouse gas emissions will also reduce the emission of other pollutants with final benefits for human health. The creation of new jobs and income opportunities by biofuel production in rural areas, particularly in the developing countries, might strengthen the sense of pride of indigenous people (Sims, 2003). Due to this higher degree of indirectness of the effects, the net outcomes in terms of individual sustainability goals are mediated by a large variety of factors. For example, jobs in new industries are often relatively high skilled. Then the distributional consequence of these new jobs depends on who actually has access to education. This question lies outside the scope of climate politics.

Some of the social effects of mitigation policies are more directly induced, in particular if measures like education, training, participation, etc. are an integral part of a policy. It has turned out, for example, that participatory approaches to forest management can be more successful than traditional, hierarchical programs (Stoll 2003). These participatory programs can also help to strengthen civil society and democratization. This shows that the social effects of sectoral mitigation policies depend on factors which are not directly related to the sector itself, i.e. in the example just given this relates to the way participation is carried out which in turn depends on the legal and institutional framework.

In some instances, a mitigation choice might increase the opportunities and capacities for actions promoting sustainable development. Experiences on how to design effective policies and institution made within the climate regime might be transferred to other regimes like biodiversity or desertification. Participatory approaches can create social capital (Dasgupta 1993), i.e. networks and social relations which allow humans to better to cope with their livelihoods. Social networks have also been credited as a means for the rapid transfer of energy efficient cookstoves to rural areas (ESMAP 2002).

Section 4.8.4.3 provides several examples of corruption that either increases the price of electricity and/or prevents the proceeds from extracted resources to meet development needs. It also denies government from receiving tax revenue and can allow shareholders to reap higher profits than legally warranted. Absence and poor implementation of legal frameworks has been documented to deny the transfer of revenue from resource extraction to local governments in Peru, Nigeria, Gabon, and other countries. Similarly, the lack of enforcement of laws that ban or limit deforestation or timber extraction has allowed illegal extraction of logs and the burning of forests in Indonesia and Brazil (Boer 2001), and (Fearnside 2001).

Transparency and participatory approaches have played a key role in reducing communal tensions and allowed communities to reap the same or larger benefits within an organized legal framework. The Joint Forest Management Program in India has created a community-based approach to manage forest fringe areas to reduce forest logging for fuelwood and encroachment on forest lands for agriculture (Behera and Engel 2005). BP's reporting of its tax, and other financial, payments to the Angolan government has reduced the potential for corruption in these transactions (Section 4.8.4.3).

Health impacts of energy extraction and use can affect local communities and households. A community may be willing to allow oil extraction that generates tax revenue even when its households suffer higher health costs, largely because the tax benefit accrues to local authorities while households bear the health costs (Chapter 4).

12.3.1.3 The Environmental Dimension

Environmental impacts include those occurring in local areas on air, water, and land, including the loss of biodiversity. Virtually all forms of energy supply and use, and land-use change activity cause some level of environmental damage. The emission of greenhouse gases (GHG) is often directly related to the emissions of other pollutants, either airborne, e.g. sulfur dioxide from burning coal which causes local or indoor air pollution, or waterborne, e.g. from leaching of nitrates from fertilizer application in intensive agriculture

Therefore many of the policies targeting the reduction of GHG emissions also help to reduce these pollutants with benefits for the local environment and by secondary effects on human health and well-being in general. Also, the reduction will help to reduce the overall consumption of valuable

non-renewable resources. Increased use of renewable energy and energy efficiency measures generally reduces environmental impacts. Nevertheless, some renewable energy sources, wind power for example, can cause harm to bird populations, and may not be aesthetically appealing. Increased use of biomass is viewed as a renewable alternative, but indoor air pollution from solid fuels has been ranked as the fourth most important health risk factor in least developed countries (Chapter 4). Tradeoffs among pollutants are inevitable in the use of some mitigation options, and need to be resolved in the specific context in which the option is to be implemented.

There is, however, the risk that some of the new technologies will create new environmental problems, e.g. due to the need for new materials or to an increase in emissions of other pollutants. For example, according to present technologies the long-term option of a hydrogen based energy production will need a large amount of platinum, which is expensive and might cause problems in terms of waste disposal on the longer term. Another example is the burning of biofuels, where some evidence exists that this brings about emissions of particulate matter with potentially harmful impacts on the local environment and on human health (Wierzbicka, Lillieblad *et al.* 2005).

More basic policies like a change of urban planning to reduce the need for transportation can bring about environmental benefits not related to the emissions of pollutants, such as in the case of urban planning, the effects of urban sprawl and infrastructure construction on biodiversity by habitat fragmentation. A shift in consumption to more energy efficient products might also lead to more environmental awareness with benefits for other sectors.

12.3.2 Cross-sectoral and economy-wide choices

One of the many important conclusions of the IPCC Special Report on Emission Scenarios (IPCC (Intergovernmental Panel on Climate Change) 2000) was that cross-sectoral and economy-wide choices not directly related to climate change mitigation could nonetheless have significant, and sometimes even critical, impacts on GHG emissions. Similarly, cross-sectoral and economy-wide choices made as part of the larger portfolio of climate choices can have significant impact on sustainable development. Although the literature pertaining to the sustainable development impacts of climate choices is still nascent and qualitative, it does begin to identify possible consequences.

We will focus here on two types of important cross-sectoral choices.

12.3.2.1 Technology Choices

Technology innovation is considered a central component of climate mitigation policies (IPCC (Intergovernmental Panel on Climate Change) 2000) (IPCC (Intergovernmental Panel on Climate Change) 2001). The literature on sustainable development has similarly highlighted the importance of technology innovation as one of the key means to achieve sustainable development goals (Banuri, Hyden *et al.* 1994; Najam and Sagar 1998; Ravindranath and Sathaye 2002). Both literatures conclude that while technology may not in itself be a sufficient instrument, it is a key instrument in the menu of choices that might lead to climate mitigation on the one hand and sustainable development on the other.

In terms of environmental impacts, technology choices made for climate mitigation will have the obvious impact of reducing greenhouse emissions, which is a net environmental benefit. However, not every possible technological innovation that benefits climate mitigation is likely to have equal environmental benefits and, therefore, sustainable development benefits. For example, although hydroelectric plants have the potential of reducing greenhouse emissions significantly, there is a

large environmental literature that points to the important environmental costs of hydropower development (McCully 2001; Dudhani, Sinha *et al.* 2005), highlights the social disruptions and dislocations that can be caused by major hydropower development (Sarkar and Karagoz 1995) (Kaygusus 2002), and also questions the long-term economic benefits of such development. Similarly, nuclear power generation might have benefits in terms of curbing carbon emissions but the larger environmental literature points towards the risk posed by such technology to human health, security, and accidental calamities. At the same time many technological innovations can also have incidental environmental benefits along other dimensions. For example, a move away from coal to cleaner fuels will also have the impact of reducing the ecosystem pressures that often accompany mining operations (Azapagic 2004). Similarly, a move away from charcoal and fuel wood as a source of energy will have the attendant environmental benefits of reducing the pressures of deforestation (Masera and B. D. Saatkamp 2000; Najam, Rahman *et al.* 2003). This points towards the need to optimize technology choice decisions not only along the dimension of carbon emissions but also other environmental costs.

In terms of economics, technological innovation can spur greater economic activity, create new employment opportunities, and allow for productivity growth. At the level of national economies, technological innovation for mitigation can often provide the opportunity to developing countries to leap-frog to cleaner and more productive technologies (add case examples; possibly China). This can create new synergies and opportunities for macroeconomic development (Brazil, biofuels?). However, macro-effeciencies of new technologies can sometimes come with micro-displacements of livelihoods and employment (Smith and Scherr 2003). The emergence of new technologies can come with, for example, displacement of livelihoods related to the older technology. This can cause significant economic stress for communities whose employment has been displaced. Such stress is particularly important from a sustainable development perspectives when it falls on the poorest populations which may be least likely to make a quick switch to alternate livelihoods (Banuri and Najam 2002; Gundimeda 2004). On the other hand, new technologies can also enhance the skills of communities and can induce new skills and new livelihoods.

In terms of the social impacts of technological innovation for climate mitigation, many potential technological innovations promise to have significant benefits in terms of sustainable development. A key area in this regard is health where not only will avoided climate change have important health benefits but cleaner energy options can have significant health benefits ranging from disease like asthma and its links to urban air pollution to eye-diseases, the incident of which is disproportionately high amongst rural women in many development countries where fuel wood is a principal source of energy (Porritt 2005). It has also been shown, for example, that the availability of cleaner burning cookers and solar cookers in developing countries not only has important health benefits but also significant social benefit in the lives of women in particular (Dow and Dow 1998). For example, in many cases a dependence on fuel wood also means the investment of time and effort in gathering fuel wood. A move to a more reliable and cleaner fuel not only has benefits in terms of carbon emission and health it also has the effect of freeing up significant amount of time for women and children which can then be applied to more socially beneficial activities, including going to schools in the case of children.

12.3.2.2 Policy Choices

The recognition that climate policy can, and should, be integrated with larger sustainable development goals is best exemplified in the structure of the Clean Development Mechanism (CDM). As Chapter 13 in AR4 details, the CDM is one of the key implementation mechanisms within the Kyoto Protocol and is designed specifically to provide developing countries with sustainable devel-

opment benefits while allowing Annex I countries with a means to use the cheaper emission reduction opportunities available within developing countries. The CDM is a fairly recent mechanism and there are important debates concerning its effectiveness and efficacy as a sustainable development tool, including those related to its links to international trade and WTO rules, impacts on and of foreign direct investment, problems with ensuring investment additionality, leakage and baseline problems, etc. which are detailed further in Chapter 13 of AR4-WGIII (Kartha, Lazarus *et al.* 2004, Najam and Sagar 1998, Eckersley 2004, Najam, Huq *et al.* 2003). These challenges have will continue to be a focus of debate as CDM projects are put into place and as we learn more about these issues. However, what is central to the structure of the CDM as a policy choice is that sustainable development goals can be enhanced through climate policy.

A number of emission trading mechanisms are also discussed in Chapter 13. Tradable permit systems can be designed to include entire economies or only selected sectors. In addition to the climate policy benefits of such mechanisms, tradable permit schemes also serve to create efficient markets which turn emissions into a tradable commodity and give an incentive to low emitters to keep their emissions low. By rewarding low emitters such mechanisms can encourage investment of this reward into the wider economy and possibly towards the goal of sustainable development. Other policy options discussed in Chapter 13 also have the potential of positive integrated into the larger economy and society. For example, Chapter 13 of TAR WGIII provides the example fo Denmark where the successful societal investment in and deployment of wind turbines has created a set of domestic industries for the design, finance, manufacture, installation and maintenance of this renewable energy source and has had a net positive impact on the national economy, on employment generation, and in giving Denmark a competitive advantage in the international wind turbine market.

Effective climate policy can also be an impetus for economic competitiveness through technological leapfrogging. Investment in emerging renewable technologies can sometimes provide countries and companies with competitive advantages over the long term. There is also an emerging trend of voluntary climate investments by large corporations, sometimes in partnership with NGOs and/or government (Hoffman 2005). Some companies attribute such forward thinking investment to sustainable development goals or environmental stewardship policies (Margolick and Russell 2001) but the economic motives are also central (Kolk and Pinske 2004) and it is increasingly felt that such investments create future financial value in one for or the other (Lyon and Maxwell 2000).

Adaptation policies when designed appropriately can be particularly geared towards sustainable development goals. For example, positive synergies can be had in areas including water management, farm practices, forest management, and residential building standards. In many cases, particularly in the least developed countries, these are directly linked to livelihoods and, therefore, to sustainable development. Climate policy can also create sustainable development benefits by enhancing non-climate-related environmental quality. For example, effective climate policy – particularly in highly polluted urban centers can have significant impacts on urban air pollution leading to health and quality of life benefits. Land use policy related to climate change can have positive impacts on forests and on biodiversity (Van Vliet, Faaj *et al.* 2003).

As Chapter 13 notes, climate change considerations provide both developing and developed countries with an opportunity to look at their respective development strategies from a new perspective. Climate policy can become a contributor to sustainable development in areas such as energy efficiency, renewable energy, sustainable land use or agriculture. Local benefits can also be derived in the areas related to technology and other resource transfers.

12.4 Regional variations and priorities

In a heterogeneous world, an understanding of regional variations and priorities is essential for mainstreaming climate change policies into sustainable development strategies. With a brief look at the definition of regions, the review will focus on variations and priorities for sustainable development goals at regional level.

12.4.1 Regional groupings

There is a diversity of regional groupings in the literature using many criteria that are specific to their purpose within the underlying context. In the development literature (e.g., (UNDP 2005), (World Bank 2004), and (IPCC (Intergovernmental Panel on Climate Change) 2000), income levels are often used to differentiate country groups. However, as oft-used in UN statistics and the academic literature, geography is a natural basis for grouping regions. Stages of industrialization are another relevant criteria for reporting energy consumption and emissions of greenhouse gases (Ott, Winkler *et al.* 2004), (Pan 2004). Examples include post-industrializing, industrialized, newly industrialized and industrializing regions. Baumert and Pershing (Baumert, Pershing *et al.* 2004) single out top 25 emitters using aggregate amount of emissions by political entities.

In the context of UNFCCC, international politics has been a rationale for country groupings (Yamin and Depledge 2005), and (Metz, Davidson *et al.* 2005). Negotiating blocks in the UNFCCC process are highlighted in the mitigation literature, such as Annex I, non-Annex I, and Annex B countries, and those with economies in transition. In the IPCC SRES, two indicators are used to group countries: levels of economic development and geographic location. IPCC Working Group III TAR investigates regional variations from geo-political and socio-economic dimensions.

Nevertheless, all the country groupings can overlap one another. Some EIT and developing countries are members of the OECD, and some developing countries have income level higher than developed nations (Baumert, Pershing *et al.* 2004; Ott, Winkler *et al.* 2004). Given the complexities of the criteria used in country groupings, Table 12.3 follows Baumert and Pershing (Baumert, Pershing *et al.* 2004) and UNDP (UNEP (United Nations Environment Programme) 2004)and adopts a combination of income and political considerations. As mitigation choices are normally at a given point in time, regional variations and priorities are viewed on the basis of geo-political and socio-economic indicators.

12.4.2 Developed economies

Developed economies are included in Annex I to the UNFCCC and are members of the OECD. CO_2 emissions from fossil fuel combustion account for over 80% of their total emissions with negligible amounts from land use change (Table 12.3). These countries also account for GHGs with high radiative forcing. Their population growth is projected to be low or negative (United Nations 2004), income and level of human development are in the upper middle and high end of the spectrum (UNDP 2004), and energy consumption and GHG emissions per capita are above the world average (IEA (International Energy Agency) 2003). These developed countries are assessed to be least vulnerable when compared to other groups of countries (Adger, Brooks *et al.* 2004), with vulnerability scores lower than 15, close to the lower end of the spectrum (Table 12.3). In general, mitigative capacity in these economies is high but mitigation potentials vary. For instance, passenger vehicle fuel economy is the lowest in the United States, even lower than the recent standards adopted by China (An and Sauer 2004). While a few newly industrialized countries require some consolidation, most

are highly industrialized with limited scope or need for large scale expansion of the physical infrastructure such as public utilities, physical transport infrastructure, and buildings (Pan 2003).

Developed nations possess comparative advantages in technological and financial capabilities in mitigation of climate change. Most of the developed nations commit themselves to taking a leading role in emissions reductions and to financial support to the developing nations for climate actions. The US, Norway, Japan and a few other developed nations are focusing more of their efforts on sinks and carbon sequestration (IPCC 2005). As the impacts of climate change in these countries are manageable, priority mitigation areas for countries in this group may lie in improving energy efficiency, building new and renewable energy and carbon capture and storage facilities, and to foster a mutually remunerative low-emissions global development path through technological and financial transfer of resources to the developing world.

12.4.3 Economies in transition

With the enlargement of the EU, economies in transition as a single group do not exist. Nevertheless, central and eastern Europe and Commonwealth of Independent States do share some common features in socioeconomic development (UNDP 2005) and in climate change mitigation and sustainable development (IPCC TAR; Adger, Brooks *et al.* 2004). With respect to social and economic development, countries in this group fall in between the developed and developing countries (Table 12.3). In terms of level of human development and vulnerability for instance, these countries fall behind the developed nations but are well ahead of the developing countries. In certain key areas, however, they are closer to the developed nations in terms of population growth, levels of industrialization, consumption of energy, and emissions of greenhouse gases. In other areas, they show features similar to the developing world. GDP per capita level in some of these EIT countries is as low as that in the lower middle income developing countries (World Bank 2003) and energy intensity is in general high (IEA (International Energy Agency) 2003).

Although the 0.3 percent per annum rate of economic growth in the past 15 years has been low, it is expected that in many countries future rates would be high, which would contribute to an upward trend in GHG emissions. Measures to decouple economic and emissions growth might be especially important for this group (Kotov 2002). This would suggest a large potential for emissions reductions through institutional reform and increase in energy efficiency. Unlike developed nations, they are not required to commit financial resources to the developing world for mitigation.

12.4.4 Developing economies

Although the developing economies are highly diverse, their general features stand in contrast to those of the industrialized world. Levels of human development, and consumption of energy per capita, are much lower than in the developed countries and in the economies in transition (Table 12.3). GHG emissions from land use change and agriculture are a significant proportion of their total emissions (Ravindranath and Sathaye 2002; Baumert, Pershing *et al.* 2004).

Given the fact that energy consumption and emission per capita are low in the developing world, focus on climate mitigation alone may not be compatible with meeting sustainable development goals. With respect to levels of human development, UNDP (UNDP 2005) projects that by 2015 almost all developing regions would not be able to meet their Millennium Development Goals. With respect to access to clean water, for example, by 2015 some 210 million people on earth will not have access, with half of them in South Asia, 40% in Sub-Saharan Africa, 7% in East Asia and the Pacific. Non-climate policies for sustainable development goals, on the other hand, can be more

effective in addressing climate change, such as population control, poverty eradication, pollution reductions, and energy security, as demonstrated in China (GOC (Government of China) 2004)and (Winkler, Spalding-Fecher *et al.* 2002).

In aggregate terms, some large developing countries are included in the list of top 25 emitters (Baumert, Pershing *et al.* 2004). These handful of developing countries are projected to increase their emissions at a faster rate than the industrialized world and the rest of developing nations as they are in the stage of rapid industrialization (Pan 2004). For these countries, climate change mitigation and sustainable development policies can reinforce one another, however, financial and technological assistance can be of help for these countries to pursue a low carbon path of development (Ott, Winkler *et al.* 2004).

For most other developing countries, adaptation to climate change takes priority to mitigation as they are more vulnerable to climate change and less carbon dependent (Hasselmann, Latif *et al.* 2003). As both adaptive and mitigative capacities are low, development aid is required to reduce vulnerability to climate change and to keep/increase carbon storage in forest and soils through CDM and poverty eradication (Huq, Reid, *et al.* 2003). OPEC countries are unique in a sense that they may be hurt by development paths that reduce the demand for fossil fuels. Diversification of their economy is high on their agenda.

For most Small Island States, the key issue to SD is the adoption of a comprehensive adaptation and vulnerability assessment and implementing framework with several priorities: sea level rise (high percent of the population located in coastal areas), coastal zone management (including specially coral reefs and mangroves), water supply (including fresh water catchments), management of upland forest ecosystem, and food and energy security. For some islands, extreme events like tropical hurricanes, and El Niño and La Niña events are an important threat.

12.4.5 Conclusions

In meeting the climate change challenge to sustainable development, the developed nations have the resources to pull together the mitigative capacity for implementing lead in GHG emission reductions and of financial and technological assistance to the developing world to enable them for low carbon development. As countries with economies in transition have been fully industrialized, physical expansion of their economy is rather limited and the scope for increase in energy efficiency can result in large amount of GHG emissions reductions. As many of the central and eastern European countries are part of the EU, it is the CIS countries that require specific attention for climate change mitigation.

Some of the developing countries are among the top in terms of aggregate or per capita emissions. Some may be able to take more responsibilities for climate change mitigation, meeting the millennium development goals constitute a challenge for them. Along the path to industrialization, emissions by the industrializing developing nations will continue to grow but pursuit to sustainable and low carbon development can generate great potential for climate change mitigation.

12.5 Future research needs

A better understanding is needed of how countries might get from current development trajectories onto lower-carbon development paths – i.e., how to make development more sustainable. What is the role of mitigative capacity, internal and external resources, technologies, and lifestyles in achieving the transition to sustainable development pathways?

Although the adaptive and mitigative capacity literature does not claim that building capacity will necessarily lead to improved responses to the climate change risk, little work has been done to explicate the widely noted variation in response to climate change among communities and nations with similar capacities. It is apparent, therefore, that capacity is a necessary, but not sufficient, condition for mitigative action. Phenomena such as risk perception, science/policy interactions, and relationships between industry and regulators, for instance, may play some role in determining whether or not capacity is turned into action in response to the climate change risk.

Considerable research must be carried out to further investigate the nature of the capacity/action link, and its connection with components of the underlying development path. Paradoxically, the reviewed literature suggests that a fundamental discussion on the implications of alternative development pathways for climate change in general and climate change mitigation in particular has been and is being explored more extensively for the developing countries than for the industrialized countries.

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