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Sustainable Development and Mitigation

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EXECUTIVE SUMMARY

The concept of sustainable development was adopted by the World Commission on Environment and Development, and there is agreement that sustainable development involves a comprehensive and integrated approach to economic, social, and environmental processes. Discourses on sustainable development, however, have focused primarily on the environmental and economic dimensions. The importance of social, political, and cultural factors is only now getting more recognition. Integration is essential in order to articulate development trajectories that are sustainable, including addressing the climate change problem.

There is growing emphasis in the literature on the two-way relationship between climate change mitigation and sustainable development. The relationship may not always be mutually beneficial. In most instances, mitigation can have ancillary benefits or co-benefits that contribute to other sustainable development goals (climate first). Development that is sustainable in many other respects can create conditions in which mitigation can be effectively pursued (development first) (*high agreement, much evidence*).

Although still in early stages, there is growing use of indicators to manage and measure the sustainability of development at the macro and sectoral levels. This is driven in part by the increasing emphasis on accountability in the context of governance and strategy initiatives. At the sectoral level, progress towards sustainable development is beginning to be measured and reported by industry and governments using, for instance, green certification, monitoring tools, and emissions registries. Review of the indicators illustrates, however, that few macro-indicators include measures of progress with respect to climate change (*high agreement, much evidence*).

Climate change is influenced not only by the climate-specific policies but also by the mix of development choices and the resulting development trajectories - a point reinforced by global scenario analyses published since the Third Assessment Report (TAR). Making development more sustainable by changing development paths can thus make a significant contribution to climate goals. But changing development pathways is not about choosing a mapped-out path, but rather about navigating through an uncharted and evolving landscape (*high agreement, much evidence*).

Making decisions about sustainable development and climate change mitigation is no longer the sole purview of governments. There is increasing recognition in the literature of a shift to a more inclusive concept of governance, which includes the contributions of various levels of government, private sector, non-governmental actors, and civil society. The more climate change issues are mainstreamed as part of the planning perspective at the appropriate level of implementation, and the more all relevant parties are involved in the decision-making process in a meaningful way, the more likely they are to achieve the desired goals (*high agreement, medium evidence*).

Regarding governments, 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 problem; a national 'way of doing things'. Furthermore, the choice of policy instruments is affected by the institutional capacity of governments to implement the instrument. This implies that the preferred mix of policy decisions and their effectiveness in terms of sustainable development and climate change mitigation strongly depend on national characteristics (*high agreement, much evidence*).

The private sector is a central player in ecological and sustainability stewardship. Over the past 25 years, there has been a progressive increase in the number of companies taking steps to address sustainability issues at either the company or industry level. Although there has been progress, the private sector has the capacity to play a much greater role in making development more sustainable in the future, because such a shift is likely to benefit its performance (*medium agreement, medium evidence*).

Citizen groups have been major demanders of sustainable development and are critical actors in implementing sustainable development policy. Apart from implementing sustainable development projects themselves, they can push policy reform through awareness-raising, advocacy, and agitation. They can also pull policy action by filling the gaps and providing policy services, including in the areas of policy innovation, monitoring, and research. Interactions can take the form of partnerships or stakeholder dialogues that can provide citizens' groups with a lever for increasing pressure on both governments and industry (*high agreement, medium evidence*).

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 (*high agreement, medium evidence*).

Region- and country-specific case studies demonstrate that different paths and policies can achieve noticeable emissions reductions, depending on the capacity to realise sustainability and climate change objectives. These capacities are determined by the same set of conditions that are closely linked to the state of development. The mitigative capacity to realise low emissions can be low due to differentiated national endowments and barriers, even when significant abatement opportunities exist. The challenge of implementing sustainable development exists in both developing and industrialized countries. The nature of the challenge, however, tends to be different in the industrialized countries. (*high agreement, much evidence*).

Some general conclusions emerging from the case studies of how changes in development pathways at the sectoral level have or could lower emissions are reviewed in this chapter (*high agreement, medium evidence*):

- Greenhouse gas (GHG) emissions are influenced by but not rigidly linked to economic growth: policy choices make a difference.
- Sectors where effective production is far below the maximum feasible with the same amount of inputs - sectors far from their production frontier - have opportunities to adopt 'win-win-win' policies. These policies free up resources and bolster growth, meet other sustainable development goals, and also reduce GHG emissions relative to baseline.
- Sectors where production is close to optimal given available inputs – sectors that are closer to the production frontier - also have opportunities to reduce emissions by meeting other sustainable development goals. However, the closer to the production frontier, the more trade-offs are likely to appear.
- To truly have an effect, what matters is that not only a 'good' choice is made at a certain point, but also that the initial policy is sustained for a long period - sometimes several decades.
- It is often not one policy decision, but an array of decisions that are necessary to influence emissions. This raises the issue of coordination between policies in several sectors, and at various scales.

Mainstreaming requires that non-climate policies, programmes, and/or individual actions take climate change mitigation into consideration, in both developing and developed countries. However, merely piggybacking climate change onto an existing political agenda is unlikely to succeed. The ease or difficulty with which mainstreaming is accomplished will depend on both mitigation technologies or practices, and the underlying development path. Weighing other development benefits against climate benefits will be a key basis for choosing development sectors for mainstreaming. Decisions about fiscal policy, multilateral development bank lending, insurance practices, electricity markets, petroleum imports security, forest conservation, for example, which may seem unrelated to climate policy, can have profound impacts on emissions, the extent of mitigation required, and the resulting costs and benefits. However, in some cases, such as a shift from biomass cooking to LPG in rural areas of developing countries, it may be rational to disregard climate change considerations because of the small increase in emissions compared with its development benefits (*high agreement, medium evidence*).

There is a growing understanding of the possibilities to choose mitigation options and their implementation such that there is no conflict with other dimensions of sustainable development; or, where trade-offs are inevitable, to allow a rational choice to be made. The sustainable development benefits of mitigation options vary within a sector and over regions (*high agreement, much evidence*):

- Generally, mitigation options that improve productivity of resource use, whether energy, water, or land, yield positive benefits across all three dimensions of sustainable development. Other categories of mitigation options have a more uncertain impact and depend on the wider socioeconomic context within which the option is implemented.
- Climate-related policies, such as energy efficiency, are often economically beneficial, improve energy security, and reduce local pollutant emissions. Many energy supply mitigation options can also be designed to achieve other sustainable development benefits, such as avoided displacement of local populations, job creation, and rationalized human settlements design.
- Reducing deforestation can have significant biodiversity, soil, and water conservation benefits, but may result in loss of economic welfare for some stakeholders. Appropriately designed forestation and bioenergy plantations can lead to reclamation of degraded land, manage water runoff, retain soil carbon and benefit rural economies, but could compete with land for agriculture and may be negative for biodiversity.
- There are good possibilities for reinforcing sustainable development though mitigation actions in most sectors, but particularly in waste management, transportation, and building sectors, notably through decreased energy use and reduced pollution.

12.1 Introduction

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 was introduced in the World Conservation Strategy by the International Union for the Conservation of Nature (IUCN, 1980). The World Commission on Environment and Development adopted the concept and launched sustainability into political, public and academic discourses. The concept was defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987; Bojo *et al.*, 1992). While this definition is commonly cited, there are divergent views in academic and policy circles on the concept and how to apply it in practice (Banuri *et al.*, 2001; Cocklin, 1995; Pezzoli, 1997; Robinson and Herbert, 2001).

The discussion on sustainable development in the IPCC process has evolved since the First Assessment Report which focused on the technology and cost-effectiveness of mitigation activities. This focus was broadened in the Second Assessment Report (SAR) to include issues related to equity, both procedural and consequential, and across countries and generations, and to environmental (Hourcade *et al.*, 2001) and social considerations (IPCC, 1996). The Third Assessment Report (TAR) further broadened the treatment of sustainable development by addressing issues related to global sustainability (IPCC, 2001b, Chapter 1). The report noted three broad classes of analyses or perspectives: efficiency and cost-effectiveness; equity and sustainable development; and global sustainability and societal learning. The preparation of TAR was supported by IPCC Expert Group Meetings specially targeted at sustainable development and social dimensions of climate change. These groups noted the various ways that the TAR treatment of sustainable development could be improved (Munasinghe and Swart, 2000; Jochem *et al.*, 2001).

In light of this evolution, each chapter of this Fourth Assessment Report focuses to some extent on the links to sustainable development practices. Chapter 1 introduces the concept, Chapter 2 provides a framework for understanding the economic, environmental, and social dimensions, and Chapter 3 addresses the issue of development choices for climate change mitigation in a modelling context. The sector Chapters 4 to 10 and the cross-sectoral Chapter 11 examine the impacts of mitigation options on sustainable development goals; and Chapter 13 describes the extent to which sustainable development is addressed in international policies. Further, IPCC (2007) devotes two chapters that are linked to the mitigation discussion in this report. Chapter 17 in IPCC (2007) considers adaptation practices, options, constraints and capacity, while Chapter 18 examines the inter-relationships between adaptation and mitigation. Finally, Chapter 20 contains discussions of adaptation and sustainable development.

As in the aforementioned chapters, climate change policies can be considered in their own right ('climate first'). Most policy literature about climate change mitigation, and necessarily most of this assessment, focuses on government-driven, climate-specific measures that, through different mechanisms, directly constrain GHG emissions. Such measures will compose an essential element for managing the risks of climate change.

Nevertheless, the greater emphasis in Section 12.2 is on other approaches that may be necessary to go beyond the scope of climate specific actions. Climate change mitigation is treated as an integral element of sustainable development policies ('development first'). Decisions that may seem unrelated to climate policy can have profound impacts on emissions. This analysis does not suggest or imply that non-climate actions can displace climate-specific measures. It emphasizes what more developed and developing countries can do to alter emissions paths in the absence of direct constraints on emissions. Such indirect approaches to climate mitigation are especially relevant in developing countries where mandatory, climate-specific measures are controversial and, at best, prospective.

The relationship between economic development and climate change is of particular importance to developing countries because of where they are in their development process and also because of the particular climate challenges that many of them face. This chapter, therefore, gives particular emphasis to the notion of "making development more sustainable". Making development more sustainable recognizes that there are many ways in which societies balance the economic, social, and environmental, including climate change, dimensions of sustainable development. It also admits the possibility of conflict and trade-offs between measures that advance one aspect of sustainable development while harming another (Munasinghe, 2000).

This chapter (1) describes the evolution of the concept of sustainable development with emphasis on its two-way linkage to climate change mitigation (Section 12.1); (2) explores ways to make development more sustainable, - the role of development paths, how these can be changed, and the role that state, market, and civil society could play in mainstreaming climate change mitigation into development choices (Section 12.2); and (3) summarizes the impacts of climate mitigation on attributes of sustainable development (Section 12.3).

12.1.1 The two-way relationship between sustainable development and climate change

The growing literature on the two-way nature of the relationship between climate change and sustainable development is introduced in Chapter 2 (Metwalli *et al.*, 1998; Rayner and Malone, 1998; Munasinghe and Swart, 2000; Schneider *et al.*, 2000; Banuri *et al.*, 2001; Morita *et al.*, 2001; Smit *et al.*, 2001; Beg *et al.*, 2002; Markandya and Halsnaes, 2002; Metz *et al.*, 2002; Najam and Cleveland, 2003; Swart *et* *al.*, 2003; Wilbanks, 2003). The notion is that policies pursuing sustainable development and climate change mitigation can be mutually reinforcing. Much of this literature, as elaborated upon in Chapters 4 to 11, emphasizes the degree to which climate change mitigation can have effects. Sometimes called ancillary benefits or co-benefits, these effects 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 GHG emissions might reduce the incidence of death and illness due to air pollution and benefit ecosystem integrity, both elements of sustainable development (Beg *et al.*, 2002). The challenge then becomes ensuring that actions taken to address global environmental problems help to address regional and local development (Beg *et al.*, 2002). Section 12.3 summarizes the impacts of climate mitigation actions on economic, social and environmental aspects of sustainable development noted in Chapters 3 to 11, and 13.

A key finding of the Third Assessment Report (TAR; IPCC, 2001b) is that through climate mitigation alone, it will be extremely difficult and expensive to achieve low stabilization targets (450 ppmv CO_2) from baseline scenarios that embody high emission development paths (also see Chapter 3). Low emission baseline scenarios, however, may go a long way toward achieving low stabilization levels even before climate policy is included in the scenario (Morita *et al.*, 2001) See Section 3.1.2 for a discussion of the distinction between a baseline and stabilization or mitigation scenario. Achieving low emission baseline scenarios consistent with other principles of sustainable development, that is viewing climate change through a sustainable development lens, would illustrate the significant contribution sustainable development can make to stabilization (Metz *et al.*, 2002; Winkler *et al.*, 2002a; Davidson *et al.*, 2003; Heller and Shukla, 2003; Shukla *et al.*, 2003; Swart *et al.*, 2003; Robinson and Bradley, 2006). Section 12.2 focuses on this critical question of the link between sustainable development and ways to mainstream climate change mitigation into sustainable development actions. This is a central element since this topic is not addressed elsewhere in the Fourth Assessment Report in a similarly comprehensive manner that is accessible to a non-climate readership.

By framing the debate as a sustainable development problem rather than only as climate mitigation, the priority goals of all countries and particularly developing countries are better addressed, while acknowledging that the driving forces for emissions are linked to the underlying development path (IPCC, 2007, Chapter 17 and 18; Yohe, 2001; Metz *et al.*, 2002; Winkler *et al.*, 2002a).

Development paths underpin the baseline and stabilization emissions scenarios discussed in Chapter 3 and are used to estimate emissions, climate change and associated climate change impacts[1]. For a development path[2] to be sustainable over a long period, wealth, resources, and opportunity must be shared so that all citizens have access to minimum standards of security, human rights, and social benefits, such as food, health, education, shelter, and opportunity for self-development (Reed, 1996). This was also emphasized by the World Summit on Sustainable Development (WSSD) in Johannesburg in 2002 which introduced the Water, Energy, Health, Agriculture, and Biodiversity (WEHAB) framework.

Several strategies and measures that would advance sustainable development would also enhance adaptive and mitigative capacities. Winkler *et al.* (2006) have suggested that mitigative capacity be defined as "a country's ability to reduce anthropogenic greenhouse gases or enhance natural sinks." There is a close connection between mitigative and adaptive capacities and the underlying socio-economic and technological development paths that give rise to those capacities. In important respects, the determinants of these capacities are critical characteristics of such development paths. For instance, mitigative and adaptive capacities arise out of the more general pool of resources called response capacity, which is strongly affected by the nature of the development path in which it exists.

Prior to exploring these issues further, the evolution of the sustainable development concept is discussed in Section 12.1.2, and the growing use of indicators to measure sustainable development progress at the macro and sectoral levels is described in Section 12.1.3. This review concludes that while the use of quantitative indicators is helping to better define sustainable development, few macro sustainable development indicators explicitly take GHG emissions and climate change impacts into consideration.

12.1.2 Evolution and articulation of the concept of sustainable development

Since the 1992 Earth Summit in Rio de Janeiro, there is general agreement that sustainable development requires the adoption of a comprehensive and integrated approach to economic, social and

1 The climate change and climate change impact scenarios assessed in the Fourth Assessment Report are primarily based on the SRES family of emission scenarios. These define a spectrum of 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.

2 Development paths are defined here as a complex array of technological, economic, social, institutional, cultural, and biophysical characteristics that determines the interactions between human and natural systems, including consumption and production patterns in all countries, over time at a particular scale. In the TAR, "alternative development paths" referred to a variety of possible development paths, including a continuation of current trends, but also a variety of other paths. To avoid confusion, the word 'alternative' is avoided in the current report. Development paths will be different in scope and timing in different countries, and can be different for different regions within countries with large differences in internal regional characteristics.

environmental processes (Munasinghe, 1992; Banuri *et al.*, 1994; Najam *et al.*, 2003). 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). While the challenge of sustainable development is a common one, countries have to adopt different strategies to advance sustainable development goals – especially in the context of achieving the MDGs (Dalal-Clayton, 2003). The paths they adopt will have important implications for the mitigation of climate change (for a more extensive discussion of MDGs, see Section 2.1.6). As noted in Section 4.5.4.4 and Section 6.6, consideration of clean energy services, even though not explicitly mentioned in the MDGs, will be a vital factor in achieving both sustainable development and climate mitigation goals.

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). As Lehtonen (2004) explains, however, most 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 importance of social, political and cultural factors, for example, poverty, social equity, governance, is only now getting more recognition. In particular, there is a growing recognition of the importance of the institutional and governance dimensions (Banuri and Najam, 2002). From a climate change perspective, this integration is essential in order to define sustainable development paths. Moreover, as discussed in this chapter, understanding the institutional context in which policies are made and implemented is critical.

As noted in Chapter 2, the term 'sustainable development,' has given rise to considerable debate and concerns (Robinson, 2004). First, the variety of definitions of sustainable development (Meadowcroft, 1997; Pezzoli, 1997; Mebratu, 1998) 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). The concept of sustainable development is not unique in this respect, since its conceptual vagueness bears similarities to other norm-based meta-objectives such as 'democracy,' 'freedom,' and 'justice' (Lafferty, 1996; Meadowcroft, 2000).

Second, the term 'sustainable development' can be used to support cosmetic environmentalism, sometimes 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 verify claims about sustainable practices (Hardi and Zdan, 1997; OECD, 1998; Bell and Morse, 1999; Parris and Kates, 2003). See Section 12.1.3.

Finally, the most serious concern about sustainable development is that it is inherently delusory. Some critics have argued that because biophysical limits constrain the amount of future development that is sustainable, the term 'sustainable development' is itself an oxymoron (Dovers and Handmer, 1993; Mebratu, 1998; Sachs, 1999). This leads some to argue for a 'strong sustainability' approach in which natural capital must be preserved since it cannot be substituted by any other form of capital (Pearce *et al.*, 1989; Cabeza Gutes, 1996). Others point out that the concept of sustainable development is anthropocentric, thereby avoiding reformulation of values that may be required to pursue true sustainability (Suzuki and McConnell, 1997). 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.

Despite these criticisms, basic principles are emerging from the international sustainability discourse, which could help to establish commonly held principles of sustainable development. These include, for instance, the welfare of future generations, the maintenance of essential biophysical life support systems, ecosystem wellbeing, more universal participation in development processes and decision-making, and the achievement of an acceptable standard of human well-being (WCED, 1987; Meadowcroft, 1997; Swart *et al.*, 2003; MA, 2005).

The principles of sustainable development have progressively been internalized 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 national law. At a national level, principles of sustainable development are being implemented in various regions and countries, including New Zealand and the European Union. 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). South Africa's National Environmental Management Act provides for the development of assessment procedures that aim to ensure that environmental consequences of policies, plans and programmes are considered (RSA, 1998). India's Planning Commission makes sustainability part of the approach to providing 'Clean Water for All', noting that this requires a shift from groundwater to surface water where possible, or groundwater recharge (Government of India, 2006). Similarly, the 2000 EC Water Framework Directive is seeking to operationalize principles of sustainable use in the management of EU waters (Rieu-Clarke, 2004).

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. The UN Framework Convention on Climate Change, for example, includes in its principles the right to promote sustainable development, but does not elaborate modalities for doing so. In response to the necessity to build a framework of equitable, strong, and effective laws needed to manage humanity's interaction with the Earth and build a fair and sustainable society (Zaelke *et al.*, 2005), the International Network for Environmental Compliance and Enforcement (INECE) launched an initiative at the 2002 WSSD aimed at making a law work for environmental compliance and sustainable development.

Since the 1980s, sustainable development has moved from being an interesting but sometimes contested ideal, to now being the acknowledged goal of much of international policy, including climate change policy. It is no longer a question of whether climate change policy should be understood in the context of sustainable development goals; it is a question of how.

12.1.3 Measurement of progress towards sustainable development

As what is managed needs to be measured, managing the sustainable development process requires a much strengthened evidence base and the development and systematic use of robust sets of indicators and new ways of measuring progress. Measurement not only gauges but also spurs the implementation of sustainable development and can have a pervasive effect on decision-making (Meadows, 1998; Bossel, 1999). In the climate change context, measurement plays an essential role in setting and monitoring progress towards specific climate change related commitments both in the mitigation and adaptation context (CIESIN, 1996-2001).

Agenda 21 (Chapter 40) explicitly recognizes the need for quantitative indicators at various levels (local, provincial, national and international) of the status and trends of the planet's ecosystems, economic activities and social wellbeing (United Nations, 1993). The need for further work on indicators at national and other levels was confirmed by the Johannesburg Plan of Implementation (UNEP, 2002).

As pointed out by Meadows (1998), indicators are ubiquitous, but when poorly chosen create serious malfunctions in socio-economic and ecological systems. Recognizing the shortcomings of mainstream measures, such as GDP, in managing the sustainable development process, alternative indicator systems have been developed and used by an increasing number of entities in various spatial, thematic and organizational contexts (Moldan *et al.*, 1997; IISD, 2006).

Indicator development is also driven by the increasing emphasis on accountability in the context of sustainable development governance and strategy initiatives. In their compilation and analysis of national sustainable development strategies, Swanson *et al.* (2004) emphasize that indicators need to be tied to expected outcomes, policy priorities and implementation mechanisms. As such, the development of indicators may best be integrated with a process for setting sustainable development objectives and targets, but have an important role in all stages of the strategic policy cycle. Once priority issues are identified, SMART indicators need to be developed - indicators that are Specific, Measurable, Achievable, Relevant/Realistic and Time-bound.

Boulanger (2004) observes that 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 wellbeing, basic needs; and (4) the norms approach, which foresees sustainable development in normative terms. Each approach has its own merits and weaknesses. Despite these efforts at measuring sustainability, few offer an integrated approach to measuring environmental, economic and social parameters (Corson, 1996; Farsari and Prastacos, 2002; Swanson *et al.*, 2004). This review of indicators illustrates a significant gap in macro-indicators in that few include measures of progress with respect to climate change.

Indicator system development typically builds on a conceptual framework serving as a link between relevant world views, sustainability issues and specific indicators. Some of the more common ones include the pressure-state-impact framework and capital-based frameworks covering social, environmental and economic domains. Given the ambiguity of the concept of sustainable development and differences in socio-economic and ecological context, even the use of comparable indicator frameworks usually results in non-identical indicator sets (Parris and Kates, 2003; Pintér *et al.*, 2005).

Various alternative approaches to estimate macro progress towards sustainable development have been developed. Many of these approaches integrate, though not necessarily focus on, aspects of climate change. One approach to indicator development focused on monetary measures and involves adjustment to the GDP. These include, for example, calculation of genuine savings (Hamilton and *et al.*, 1997; Pearce, 2000), Sustainable National Income (Hueting, 1993), and efforts to develop a measure of sustainability (Yohe and Moss, 2000). In an attempt to aggregate and express resource consumption and human impact in the context of a finite earth, a number of indices based on non-monetary, physical measures were created. These indices may be based on the concepts of environmental space or ecospace, and ecological footprint (Wackernagel and Rees, 1996; Venetoulis *et al.*, 2004; Buitenkamp *et al.*, 1993; Opschoor, 1995; Rees, 1996). Vitousek *et al.* (1986) proposed the index of Human Appropriation of Net Primary Production (HANPP). This approach specifies the amount of energy that humans divert for their own use in competition with other species.

In trying to avoid shortcomings from the concept of carrying capacity applied to human societies the formula I = PAT, 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, has been commonly used in decomposing the impact of population, economic activity, and fuel use on the environment in general and on historical and future carbon emissions in particular (IEA, 2004c; Kaya, 1990; Schipper *et al.*, 1997; Schumacher and Sathaye, 2000). Other approaches include the development of a 'global entropy model' that inspects the conditions for sustainability (Ruebbelke, 1998). This is done by employing available entropy data to demonstrate the extent to which improvements in entropy efficiency should be accomplished to compensate the effects of increasing economic activity and population growth. Other sets of metrics have less precise ambitions but aim to explain to the larger public the risks of environmental change, such as the notion 'ecological footprint' [see above] used by some NGOs. In this, the aggregate indicators are noted as the number of planets Earth needed to sustain the present way of living of some regions of the World.

As Bartelmus (2001) observes, many of the aggregate indices are yet to be accepted in decision-making due, among others, to measurement, weighting and indicator selection challenges. However, besides efforts to develop aggregate indices either on a monetary or physical basis, many efforts are aimed at developing heterogeneous indicator sets. One of the commonly accepted frameworks uses a classification scheme that groups sustainability issues and indicators according to social, ecological, economic, and in some cases, also institutional categories. Several indicator systems developed at international and national level have adopted a capital-based framework following the above categories. They link indicators more closely to the System of Integrated Environmental and Economic Accounts System of National Accounts (SNA), including its environmental component, (Pintér *et al.*, 2005). At the United Nations, the Division for Sustainable Development led the work on developing a menu and methodology sheets for sustainability indicators that integrate several relevant for climate change from the mitigation and adaptation point of view (UNDSD, 2006). Also, the UNECE/Eurostat/OECD Working Group on Statistics for Sustainable Development is developing a conceptual framework for measuring sustainable development and recommendations for indicator sets. A set of climate change mitigation input and outcome indicators should be included.

While not necessarily focused on climate change per se, many of these indicator efforts include climate change as one of the key issues, on the mitigation or adaptation side. Keeping a broader perspective is essential, as climate change, including its drivers, impacts and related responses, transcend many sectors and issue categories. Indicators are needed in all in order to identify and analyze systemic risks and opportunities. In the mitigation context, quantifying emissions and their underlying driving forces is an essential component of management and accountability mechanisms. GHG emissions accounting is a major new field and is guided by increasingly detailed methodology standards and protocols in both the public and private sector (WBCSD, 2004).

Whether part of integrated indicator systems or developed separately, climate change indicators on the mitigation side may focus on absolute or efficiency measures (Herzog and Baumert, 2006). Absolute measures help track aggregate emissions, thus quantify the direct pressure of human activities on the climate system. Efficiency measures indicate the amount of energy or materials used or GHG emitted in order to produce a unit of economic output, or more generally, to achieve a degree of change in human wellbeing. Depending on the policy context, both absolute measures and efficiency measures may be useful. But from the climate system perspective, it is ultimately indicators of absolute emission levels that matter.

At the sectoral level, several initiatives are being implemented to measure and monitor progress towards sustainable development, including the reduction of greenhouse gas emissions. 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 organizations for reporting on the economic, environmental, and social dimensions of their activities, products, and services. Over 700 large industrial corporations are annually reporting their sustainable development progress using these guidelines. Industry sectors, such as cement and aluminium, which are among the most intensive energy users, have their own initiatives to track progress (For more information on sectoral indicators, see Section 12.3.1).

In essence, while tools for measuring progress towards sustainable development are still far from perfect, considerable progress in the development of such tools and considerable uptake in their use has occurred. The trend is clearly towards more refinement in the tools and an increase in their use by governments, business and civil society.

12.2 Implications of development choices for climate change mitigation

The roadmap for this section starts with the concept of development paths. National development paths do not result from integrated policy programmes. They emerge from fragmented decisions made by numerous private actors and public agencies within varied institutional frameworks of state, markets, and civil society. Decisions about the development of the most significant sectors that shape emission profiles - energy, industry, transportation and land use - are made by ministries and companies that do not regularly attend to climate risks. The same is true for even more indirect influences on these sectoral pathways, including financial, macro-economic, and trade practices and policies. The focus on development paths places new emphasis on development's impact on climate and on indirect rather than direct actions that affect climate mitigation. Section 12.2.1 reviews scenario and other literature indicating that in different nations and regions, contingent development paths are plausible and can be associated with widely disparate economic, environmental and social consequences. Section 12.2.2 provides historical evidence that lower emissions pathways are not necessarily associated with lower economic growth.

The second segment of the road map suggests the importance of better understanding in climate policy of how nations organize sectoral and other emissions-determining policies and behaviour. Section 12.2.3 assesses literature that analyze: (1) the particular institutions, organizations, and political cultures that form the installed systems of decision-making and priority-setting from which decisions about key sectors or contexts emerge; and (2) the broader trans-national trends that are reshaping established governance processes. The description of these installed systems and the ways in which they are changing is drawn from an assessment of the social science literature on relationships between states, markets and civil society. Thus, Section 12.2.3 broadens the discourse beyond the economics and technological literature now familiar in climate analysis by incorporating history, political economy, and organization theory. The emphasis moves from government to governance. Rather than focusing on action by governments or states alone, the social science literature suggests more attention on decisions by multiple actors (Rayner and Malone, 1998; Jochem *et al.*, 2001). In some systems, change occurs primarily through actions initiated by either central governments or more federalized local jurisdictions. In others, it proceeds more through initiatives by private organizations that are then complemented by supportive governmental policies.

The final segment of road map relates in Section 12.2.4 to strategies and actions for changing development paths. It builds from the insight that changes in development paths emerge from the interactions of varied, centralized and decentralized public and private decision processes, many of which are not traditionally considered as 'climate policy'. It emphasizes that national circumstances, including endowments in primary energy resources, and the strengths of institutions matter in determining how development policies ultimately impact GHG emissions. Ensuring that key sectors evolve in a more sustainable manner depends on capability to coordinate decentralized choices and decision processes. The literature emphasizes the importance of partnerships between public, private and civil society in actions that contribute to shifts in the direction of development. However, it does not assume that the lead coordinating agency will always be the state. In different societies with different cultures of social change, the lead agent with a strong motivation, whether political or commercial, to bear the costs of organizing change may emerge from states, markets or civil societies.

In sum, Section 12.2 shows that to expand the focus of effective climate action to include development activities involves less emphasis on the search for ideal and general instruments, and involves much more attention on local and fragmented processes for more marginal changes in key sectoral decisions. When added up over time, these decisions could lead to more sustainable development paths and lower emissions.

Clearly, the reformed focus of a broadened scope for climate action raises many questions that have not been highlighted in the research agenda. These are reflected in the agenda for future research in Section 12.4.

12.2.1 Multiplicity of plausible development pathways ahead, with different economic, social and environmental content

Climate policy alone will not solve the climate problem. Making development more sustainable by changing development paths can make a major contribution to climate goals. One of the major findings of TAR in terms of sustainable development was that development choices matter (Banuri *et al.*, 2001). The literature on long-term climate scenarios (Metz *et al.*, 2002; Nakicenovic *et al.*, 2000; Swart *et al.*, 2003), and especially the SRES Report (Morita *et al.*, 2000), points to the same conclusion. Climate outcomes are influenced not only by climate specific policies but also by the mix of development choices made and the development paths that these policies lead to. There are always going to be a variety of development pathways[3] that could possibly be followed and they might lead to future outcomes at global, national, and local levels. The choice of development policies can, therefore, be as consequential to future climate stabilization as the choice of climate-specific policies.

Development pathways can be useful ways to think about possible, even plausible, future states of the world. Over the last century, for example, human health has been improved significantly in most of the world under very different socio-

3 Development paths are defined here as a complex array of technological, economic, social, institutional, cultural, and biophysical characteristics that determines the interactions between human and natural systems, including consumption and production patterns in all countries, over time at a particular scale. In the TAR, "alternative development paths" referred to a variety of possible development paths, including a continuation of current trends, but also a variety of other paths. To avoid confusion, the word 'alternative' is avoided in the current report. Development paths will be different in scope and timing in different countries, and can be different for different regions within countries with large differences in internal regional characteristics.

economic pathways and health care systems (e.g., see CGD, 2004; OECD, 2005). Countries have made different decisions with respect to health care, leading to a wide variety of different systems, with still a large divide between industrialized and developing countries (Redclift and Benton, 2006). But in general, the chosen strategies have in common that they have contributed to marked health improvements in almost all regions. Advances have been uneven and improvements are under constant pressure from new developments (e.g., AIDS, new infectious diseases). In general, the health example suggests that human choice can make a positive contribution towards reaching a common goal (Frenk *et al.*, 1993; Smith, 1997). The same could be true for sustainable development in general, and reduced GHG emissions in particular. But changing a development pathway is not about choosing a mapped out path, but rather about navigating through an uncharted and evolving landscape.

Developing scenarios depicting possible development pathways can falsely suggest that these are in some sense latent pathways or routes through the future that have been uncovered through insight or research. In reality, well-defined development pathways are not waiting to be selected. Even understanding the much smaller set of current development paths can be difficult. These are not simply the result of previous policies or decisions of governments, although these certainly affect the outcomes. As Shove *et al*. (1998) argue with respect to energy usage, the present is the result of myriad small activities and practices adopted or developed in the course of everyday life.

In reviewing the literature on development pathways, and in respecting the caveats described above, three key lessons emerge:

- Development paths as well as climate policy determine GHG emissions;
- New global scenario analyses confirm the importance of development pathways for climate change mitigation;
- Development paths can vary by regions and countries because of different priorities and conditions.

These three findings are discussed in the following section.

12.2.1.1 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 GHG emissions. The IPCC Third Assessment Report concluded that committing to alternative development paths can result in very different future GHG emissions. Development paths leading to lower emissions will require major policy changes in areas other than climate change. The development pathway pursued is an important determinant of mitigation costs and can be as important as the emissions target in determining overall costs (Hourcade *et al.*, 2001) These findings were based on an extensive analysis of 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 *et al.*, 2000) based on the IPCC SRES scenarios (Nakicenovic *et al.*, 2000).

Developing countries do not have to follow the example of developed countries in terms of energy use (UNCSD, 2006), since the early stages of infrastructure development offer opportunities to satisfy their populations' needs in different ways. Many factors that determine a country's or region's development pathway, and, closely related, its energy and GHG 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 to change development paths, because of lock-in effects (e.g., Arthur, 1989). For detailed discussion, see Section 2.7.1 and Section 3.1.3. 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. Also, climate mitigation objectives can be mainstreamed into general development choices, by taking climate mitigation objectives routinely into consideration in the pursuance of particular development pathways.

Development policies not explicitly targeting GHG emissions can influence these emissions in a major way. For example, six developing countries (Brazil, China, India, Mexico, South Africa, and Turkey) have avoided through development policy decisions approximately 300 million tons a year of carbon emissions over the past three decades. Many of these efforts were motivated by common drivers, such as economic development and poverty alleviation, energy security, and local environmental protection (Chandler *et al.*, 2002).The current state of knowledge does not allow easy quantitative attribution to specific policies with accuracy, given that other factors (as in any country) also influence these emissions. For example, autonomous technological modernization certainly has played a role. Chandler *et al*. (2002), however, also clearly identify policies that have made a definite contribution. In Brazil, these included production and use of ethanol and sugarcane bagasse, development of the natural gas industrial market, use of alternative energy sources for power generation and a set of demand-side programmes promoting conservation and efficiency in the electricity and transportation sectors (See also Box 12.1).

In China, growth in GHG emissions has been slowed to almost half the economic growth rate over the past two decades through economic reform, energy efficiency improvements, switching from coal to natural gas, renewable energy development, afforestation, and slowing population growth. In India, key factors in GHG emission reductions have been economic restructuring, local environmental protection, and technological change, mediated through economic reform, enforcement of clean air laws by the nation's highest court, renewable energy incentives and development programmes funded by the national government and foreign donors. In Mexico, expanding use of natural gas in place of more carbon-intensive fuels, promoting energy efficiency and fuel substitution by means that included energy pricing mechanisms, and abating some deforestation have played a major role. The policies in South Africa that contribute to lower growth in GHG emissions include restructuring the energy sector, stimulating economic development, increasing access to affordable energy services, managing energy-related environmental impacts, and securing energy supply through diversification. Finally, in Turkey, economic restructuring and price reform resulting from government moves to more market-oriented policies and the expectation of European integration, fuel switching, and energy efficiency measures have contributed to avoided GHG emissions (Chandler *et al.*, 2002).

There are multiple drivers for actions that reduce emissions, and they can produce multiple benefits. The most promising policy approaches are those that capitalize on natural synergies between climate protection and development priorities to simultaneously advance both objectives. Many of these synergies are in energy demand (e.g., efficiency and conservation, education and awareness) and some in energy supply (e.g., renewable options).

Capturing these potential benefits is not always easy, since there are many conflicts and trade-offs. From the perspective of energy security, for example, it can be politically and/or economically attractive to give priority to domestic coal and oil resources over more environmentally friendly imported gas (e.g., SSEB 2006). The adverse economic impact of higher oil prices on oil-importing developing countries is generally more severe than for OECD countries. This is because their economies are more dependent on imported oil and more energy-intensive, and because energy is used less efficiently. On average, oil-importing developing countries use more than twice as much oil to produce a unit of economic output as do OECD countries. Developing countries are also less able to weather the financial turmoil wrought by higher oil-import costs (IEA, 2004a). For a discussion of the role of energy security for development paths, see Section 3.3.6. 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. 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 NO_x and particulate emissions in the former case, and flooding in the latter). Conversely, abating local air pollution generally is beneficial from a global perspective. Still, there are a few exceptions. Decreasing sulphur and aerosol emissions (with the exception of black carbon) to address local air pollution problems can increase overall radiative forcing, because these aerosols have a negative radiative forcing. Thus, exploring development paths requires careful assessment of both local environmental priorities and global environmental concerns (Schaeffer and Szklo, 2001).

In developed countries too, development choices made today can lead to very different energy futures. In the TAR, Banuri *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 wellbeing from production (intermediate performance levels, regionalization avoiding long-distance transport, low-resource lifestyles). Technological mitigation options at the sectoral level are mainly

Box 12.1: Greenhouse gas emissions avoided by non-climate drivers: a 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 (Holliday *et al.*, 2002; Anderson, 2004; Geller *et al*., 2004). In Brazil, programmes and measures have been undertaken over the past two or three decades in order to mitigate economic and environmental problems. These 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 production (and create more jobs while increasing 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 programmes and measures show that, in 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, although 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 may not be pursued and may even be discontinued (Anderson, 2004; Szklo *et al.*, 2005).

discussed in Chapter 4 to 11 which also cover to some extent non-technological options that relate to different development priorities, as far as the literature allows.

The connections between development pathways and international trade are often left unexplored. International trade allows a country to partially 'de-link' its domestic economic systems from 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 economic activities in many nations affect an area much larger than within their national boundaries is the ecological footprint (see Section 12.1.3). For example, the environmental effects of soya and hardwood production for export as fodder and construction material, respectively, are well-known examples. As a consequence, in discussing the implications of development choices for climate change mitigation, it is not enough to discuss development pathways for individual countries. To fully address global emission reductions, an integrated multi-country perspective is needed (Machado *et al.*, 2001).

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

Section 3.1.5 discusses some factors that determine development paths, such as structural changes in production systems, technological patterns in sectors, such as energy, transportation, building, agriculture and forestry, geographical distribution of activities, consumption patterns and trade patterns. After publication of IPCC TAR, several new scenarios relating to climate change or global sustainability were published, making different assumptions for these factors. Most of them confirm the main findings of SRES (see also Chapter 3). It is important, however, to translate the lessons derived from scenarios (which are often global in scale) to national and even local level policy choices that can lead to the desired outcomes.

For the Millennium Ecosystems Assessment (MEA), four scenarios explored implications of development pathways for global and regional ecosystem services, loosely based on the SRES but developed and enriched further (Alcamo et *al*., 2005; Carpenter and Pingali, 2005; Cork *et al.*, 2005). For the next 50 years, all scenarios find that pressures on ecosystem 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. Quality of the services differs strongly by scenario - with the most positive scenarios finding a clear improvement in some services and the most negative scenario, finding a general decrease. The MEA scenario analysis, thus, emphasizes that development of ecosystem services, biodiversity, human wellbeing and the capacity of the population to deal with these developments is largely determined by the choice of development pathway.

The United Nations Environment Programme (UNEP, 2002), used SRES scenarios as well as the scenarios of the World Water Vision (Gallopin and Rijsberman, 2000) and the Global Scenario Group (Raskin *et al.*, 1998) as inspiration for the development of four development pathways for the third Global Environmental Outlook (UNEP/RIVM, 2004): Markets First, Security First, Policy First and Sustainability First. Again, the different development pathways reflected by these scenarios are associated with a wide range of GHG emissions similar to the range captured by the SRES scenarios.

Shell's Low Trust Globalization, Open Doors and Flags scenarios explore how different future development pathways could affect the company's business environment. In the Open Doors scenario, CO_2 emissions increase most rapidly as a result of higher economic growth and the absence of security-driven investment in indigenous renewable energy sources, even if people may be more concerned about climate change than in other scenarios. The Low Trust Globalization scenario is characterized by larger barriers to international trade and cooperation. Paradoxically, there could be faster progress towards carbon efficiency as a result of a different set of policies aimed at energy efficiency, conservation and development of renewables, notably wind and, possibly, nuclear power. Finally, the Flags scenario with a patchwork of national approaches could show positive responses to climate change because of factors such as the pursuit of self-reliance (Shell, 2005).

Several scenarios developed since the TAR have explored different development pathways, but without explicitly addressing climate change or GHG emissions. The characteristics of these pathways in terms of the rate and structure of geopolitical, economic, social and technological development, however, would result in large variations in GHG emissions. 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, 2004). The National Intelligence Council scenarios show the possible impacts of particular development pathways in some regions for other regions. Also, in several developing countries, different future development pathways have been explored in systematic scenario exercises, for example, China (Ogilvy and Schwartz, 2000); the Mont Fleur scenarios for South Africa (Kahane, 2002); the Guatemala Vision (Kahane, 2002); Destino Colombia (Cowan *et al.*, 2000); Kenya at the crossroads (SID/IEA, (Society for International Development and the Institute of Economic Affairs), 2000). Taking global climate change explicitly into account would strengthen and enrich development-oriented scenarios as the ones mentioned above.

Case studies in Tanzania (Agrawala *et al.*, 2003a), Fiji (Agrawala *et al.*, 2003c), Bangladesh (Agrawala *et al.*, 2003b), Nepal (Agrawala *et al.*, 2003a), Egypt (Agrawala *et al.*, 2004b) and Uruguay (Agrawala *et al.*, 2004a) show how climate-change adaptation can be integrated with national and local development policies, often as a no-regrets strategy. Implementation of no-regrets strategies is, however, not without challenges. 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 behaviour to align with local and global sustainability (Raskin *et al.*, 1998). Kaivo-oja *et al*. (2004) conclude that climate change as such may not be a major direct threat to Finland. However, 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.

Netherlands Environmental Assessment Agency *(*MNP, 2005) has developed the four IPCC SRES scenarios for a sustainability outlook for the Netherlands. 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 Dutch population prefer a future which would be different from the globalizing, market-oriented A1 scenario. Yet, 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, and 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 sustainability issues go beyond local or national capacity to develop and implement effective policies.

Scenarios describe different states of the world that could come about by different developments in the driving forces that are often of a geopolitical nature and are largely unaffected by national or local policy-making. These scenarios studies reveal that different pathways are possible, but also that pursuing them involves many complex challenges. Such challenges include consideration of indirect effects, and difficulties in translating the often positive attitude of the population towards sustainable futures into concrete changes. Decision-makers have to consider the robustness of alternative development pathways they pursue through their policy choices, in the face of global developments they will be confronted with.

12.2.1.3 Development paths can vary by regions and countries because of different priorities and conditions

An understanding of different regional conditions and priorities is essential for mainstreaming climate change policies into sustainable development strategies (See Section 12.2.3). Since regions and countries differ in many dimensions, it is impossible to group them in a way consistent across all dimensions. There is a diversity of regional groupings in the literature using many criteria that are specific to their purpose within the underlying context. (For regional groupings, see Section 2.8).

As noted in Section 12.1.1, the mitigative capacity of a nation is closely related to its underlying development path, which depends on the general pool of resources that may be referred to as response capacity. The response capacity including mitigative capacity of countries varies, amongst other factors, with their ability to pay for abatement costs. Winkler *et al.* (2007) analysed the mitigative capacity of different countries as shaped by two economic factors: namely average abatement cost (or mitigation potential; high cost means low potential); and ability to pay, as approximated by GDP per capita. Ability to pay, measured by GDP per capita, is an important factor in mitigative capacity, since more wealth gives countries greater capacity to reduce emissions. The cost of abatement can act as a barrier in turning mitigative capacity into actual mitigation. Examining these factors together, Winkler *et al.* (2007) found that the abatement costs are not linearly correlated with level of income. Some countries have high mitigative capacity (income) and are also able to translate this into actual mitigation due to low costs. For others, mitigative capacity is clearly low. Relatively high average abatement costs mean that this capacity can be turned into even less actual mitigation. Interestingly, there are some poorer countries with low abatement costs. Conversely, there are also countries with high mitigative capacity, as approximated by income, but high average abatement costs. However, this group of countries still has higher mitigative capacity, simply by virtue of their higher ability to pay. Low-income countries do not spend on mitigation even if they have low-cost mitigation opportunities, simply because the opportunity cost in terms of basic development needs is too high.

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 accounted for over 80% of their total emissions in 2000 with negligible amounts from land-use change (Table 12.1). These countries are also largely responsible for GHG emissions with high radiative forcing. Their population growth is projected to be low or negative (UNDP, 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, 2005). These developed countries are assessed to be least vulnerable when compared

Table 12.1: *Profiles of emissions and human development at different levels of development*

	Units	Developed/industrialized/Annex I countries[c)]		Developing/Non-Annex I countries[d)]	
		OECD	EIT	Developing	Least developed
Emissions profiles by gases, 2000[a)]		100		100	100
CO_2 (fossil fuel)	%	81		41	4
CH_4	%	11		16	22
N_2O	%	6		10	12
LUC	%	*0*		33	62
High GWP gases	%	*2*		0	0
Human development profiles[b)]					
HDI, 2003		0.892	0.802	0.694	0.518
Life expectancy at birth	years	77.7	68.1	65.0	52.2
Adult literacy	%	100.0	99.2	76.6	54.2
GDP_{ppp}/capita, 2003	US$/capita	25915	7930	4359	1328
Population growth rate (2003-2015)	%/yr	0.5	-0.2	1.3	2.3
GDP/capita growth rate (1990-2003)	%/yr	1.8	0.3	2.9	2.0
Electricity consumption per capita, 2002	kWh/capita	8615	3328	1155	106
CO_2 emissions per capita, 2002	tonnes/capita	11.2	5.9	2.0	0.2
Vulnerability assessment[e)]					
Vulnerability scores		10-15	14-22	18->40	

Notes:

a) Source: Baumert *et .al*., 2004, p. 6. FF: fossil fuel combustion; High GWP (global warming potential) gases: sulphur hexafluoride (SF6), perfluorocarbons (PFCs), and hydrofluorocartbons (HFCs).

b) Source: UNDP, 2005. HDI range: 0.00<HDI<1.00; PPP: purchasing power parity. PPP normally deflates the income level of the developed nations while inflating those in the developing world as one dollar would have larger purchasing power that it has in the developed world.

c) Annex I countries include both developed OECD and EIT countries. However, a few newly admitted OECD countries are not in Annex I list, including South Korea, Singapore, and Mexico. The group of economies in transition (EIT) countries contains several sub-groups: those that are part of the enlarged EU, central Asian Republics, and other members of the CIS. In UNDP (2005) categorization, the coverage is larger, including Central and Eastern Europe and the Commonwealth of Independent Sates (CIS).

d) In emissions profiles, these two subgroups were counted separately while in the UNDP human development profiles, least developed is a subgroup of the developing world.

e) Source: Adger et al., 2004b. Vulnerability scores range from 10 to 50, with 10 the least vulnerable and 50 the most vulnerable. These scores are derived from a series of proxy variables for vulnerability including food security, ecosystem sensitivity, settlement/infrastructure sensitivity, human health sensitivity, economic capacity, human resource capacity, governance capacity and environmental capacity. See, Baumert et al., 2004, p.17.

to other groups of countries (Adger *et al.*, 2004), with vulnerability scores lower than 15, close to the lower end of the spectrum (Table 12.1). In general, mitigative capacity in these economies is high but cost can be high. As well as marginal cost of mitigation increases with the rate of energy efficiency. Nevertheless, there are large mitigation potentials in these countries. For example, passenger vehicle economy in North America and Australia is well below that in EU and Japan, even lower than some developing countries such as China (An and Sauer, 2004). Barring a few newly industrialized countries, 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).

Notwithstanding this limited scope or need for infrastructure expansion and economic growth figures often much lower than in many developing countries, the future will look different from today and low-carbon development pathways are possible. Improving energy efficiency, modernizing production and changing consumption patterns would have a large impact on future GHG emissions (Kotov, 2002). Developed countries possess comparative advantages in technological and financial capabilities in mitigation of climate change. 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 fostering a mutually remunerative low-emissions global development path through technological and financial transfer of resources to the developing world.

In many industrialized countries (e.g., Japan and in Europe), implications of energy systems with very low carbon emissions have been explored, often jointly by governments, energy specialists and stakeholders (e.g., Kok *et al.*, 2000). However, a fundamental and broad discussion in society on the implications of development pathways for climate change in general and climate change mitigation in particular in the industrialized countries has not seriously been initiated. Low-emission pathways apply not only to energy choices. For example, in North-America and Europe, UNEP (2002) identifies land-use development, particularly infrastructure expansion, as a key variable determining future environmental stresses, including GHG emissions. Pathways that 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.

Economies in Transition: With EU enlargement, economies in transition as a single group no longer exist[4]. Nevertheless, Central and Eastern Europe and Commonwealth of Independent States share some common features in socioeconomic development (UNDP, 2005), and in climate change mitigation and sustainable development (IPCC, 2001b; Adger *et al.*, 2004). With respect to social and economic development, countries in this group fall between the developed and developing countries (Table 12.1). In terms of level of human development and vulnerability, for instance, these countries fall behind the developed countries but are well ahead of the developing countries. In certain key areas, however, they are closer to the developed countries in terms of population growth, levels of industrialization, energy consumption, and GHG emissions.. In other areas, including income levels and distribution, institutions and governance, they can 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, 2003a).

Although the 0.3 % per annum rate of economic growth in the past 15 years has been low, it is expected that in many countries, future rates could 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 through restructuring the economy (Kotov, 2002). Mitigative capacities are high as compared developing economies, but lower than those for developed economies due to a weaker financial basis. These capacities can be further enlarged through institutional reform, such as liberalization of the energy market and political determination to increase energy efficiency.

Developing Economies: Recently, interest at regional level in exploring development pathways which are consistent with lower GHG emissions has increased (Kok and de Coninck, 2004). This appears to be valid primarily for developing countries. Case studies focus on the future in the priority areas of energy supply, food security and fresh water availability in South Africa (Davidson *et al.*, 2003), Senegal (Sokona *et al.*, 2003), Bangladesh (Rahman *et al.*, 2003), Brazil (La Rovere and Romeiro, 2003), China (Jiang *et al.*, 2003) and India (Shukla *et al.*, 2003) A common finding of these studies is that it is possible to develop pathways that 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 GHG emissions, even without explicit climate policies. Enhancing soil management, avoiding deforestation, and encouraging reforestation and afforestation can increase carbon storage, while also serving the primary goals of food security and ecosystem protection.

Although the developing economies are highly diverse, their general features contrast to those of the industrialized world. Levels of human development and consumption of energy per capita are much lower than those in the developed countries and in the economies in transition (Table 12.1). GHG emissions from land-use change and agriculture are a significant proportion of their total emissions (Ravindranath and Sathaye, 2002; Baumert *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 have large opportunity cost in terms of fiscal and human capitals, and therefore not be compatible with meeting sustainable development goals. With respect to levels of human development, UNDP (2005) projects that by 2015 almost all developing regions will not be able to meet their Millennium Development Goals. With respect to access to clean water, for example, the 2015 MDG goal will be missed by 210 million people who will not have access, with 50% in South Asia, 40% in Sub-Saharan Africa, 7% in East Asia and the Pacific. Non-climate policies for sustainable development goals can be more effective in addressing climate change, such as population control, poverty eradication, pollution reductions, and energy security, as demonstrated in the People's Republic of China (Winkler *et al.*, 2002b; PRC, 2004). In order to realize the promise of leapfrogging, improvements are needed to the institutional capabilities of the recipient developing country and its energy and environmental policies in order to foster sustainable industrial development (Gallagher, 2006; Lewis and Wiser, 2007).

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

4 EITs are still recognized in international agreements, such as UNFCCC and its Kyoto Protocol.

path of development (Ott *et al.*, 2004). Emissions per capita for some developing countries, however, will continue to be lower than the industrialized countries for many decades.

For most other developing countries, adaptation to climate change takes priority over mitigation as they are more vulnerable to climate change and less carbon dependent (Hasselmann *et al.*, 2003). However, both adaptive and mitigative capacities tend to be low (Huq *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. Although climate change mitigation can be one consideration in evaluating poverty alleviation options, poverty has to be alleviated regardless of GHG emissions. Improved access to energy can lead to increasing GHG emissions, for example, where kerosene and propane use is more appropriate than biomass renewables. However, in absolute terms this is a minor increase in global GHG emissions (see also Section 12.2.4).

For most Small Island States, the key issue to sustainable development is the adoption of a comprehensive adaptation and vulnerability assessment and implementing framework with several priorities: sea level rise (high percentage 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, such as tropical hurricanes and El Niño and La Niña events, are an important threat.

In summary, different regions and types of countries have different contextual conditions to respond to, and therefore, their attempts to move towards a development path leading to sustainable development while also mitigating climate change, will vary considerably. Policy decisions will be most effective where made while recognizing these contextual conditions and where they relate and adapt to the existing regional and country realities.

12.2.2 Lower emissions pathways are not necessarily associated with lower economic growth

Section 12.2.1 has demonstrated that business-as-usual futures in countries with similar characteristics can result in very different emission profiles, depending on the development path adopted. Since economic growth figures prominently among the objectives of policy-makers worldwide, the relationship between economic growth and emissions at the national level is reviewed in Section 12.2.2. Consideration is given to whether lower emissions pathways are necessarily associated with lower economic growth The conclusion that there are degrees of freedom between economic growth and GHG emissions is further explored in Section12.2.3 and Section 12.2.4.

Economic activity is a key driver of CO_2 emissions. How economic growth translates into new emissions, however, is ambiguous. On one hand, as the economy expands, demand for and supply of energy and of energy-intensive goods also increases, pushing up CO_2 emissions.. On the other hand, economic growth may drive technological change, increase efficiency and foster the development of institutions and preferences more conducive to environmental protection and emissions mitigation (see Chapter 3). Also, economic growth may be associated with specialization in sectors high) emissions per unit of output, such as services (manufacturing and heavy industries, respectively), thus resulting in a faster strong or weak relationship between domestic emissions and GDP. Unlike technological change or efficiency, however, specialization does not affect the level of global emissions: it only modifies the distribution of emissions across countries.

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 focuses on 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. 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. The EKC hypothesis is compatible with several, and possibly joint, explanations: structural shift towards low carbon-intensity sectors; increased environmental awareness with income, policy or technology thresholds; and increasing returns to abatement (Copeland and Taylor, 2004). The EKC hypothesis was initially formulated for local pollutants in the seminal analysis of Grossman and Krueger (1991) but was quickly expanded to CO_2 emissions. Even so, it recognized that some of the theoretical explanations for local pollutants, namely that higher income individuals would be more sensitive to environmental concerns, are less relevant for GHGs that do not have local environmental or health impacts. The EKC hypothesis has generated considerable research, and the field is still very active. Recent summaries can be found in Stern (2004), Copeland and Taylor (2004) or Dasgupta *et al.* (2004). With regard to carbon dioxide, three conclusions can be drawn, as discussed below.

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 (Schmalensee *et al.*, 1998; Ravallion *et al.*, 2000; Heil and Selden, 2001; Wagner and Müller-Fürstenberg, 2004). A 1% increase in GDP per capita is found to lead to an increase in CO_2 emissions per capita of 0.5% to 1.5%, depending on the study. All studies also find evidence that this coefficient, elasticity of per capita CO_2 emissions relative to per capita GDP, is not constant but decreases as per capita income rises. Until recently, empirical studies consistently found a relationship between per capita GDP and per capita CO_2 emissions such that, beyond a certain level of GDP per capita, per capita CO_2 emissions would decrease as income increases - thus confirming the EKC hypothesis for carbon dioxide. However, the reliability of these estimates has been challenged recently on technical grounds. For a general discussion, see Harbaugh *et al.* (2002) and Millimet *et al.* (2003); and for a critical review focusing on carbon dioxide, see Wagner and Müller-Fürstenberg (2004). Two main points emerge from the most recent reviews: (1) they cast doubt on the idea that the EKC hypothesis could be validated based on existing data; (2) they conclude that the relationship between GDP and emissions data is less robust than previously thought.

Second, 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, explain most of the variations in per capita emissions in OECD countries. Similarly, Coondoo and Dinda (2002) find a strong correlation between emissions and income in developed countries and in Latin America, but a weaker correlation in Africa and Asia. Recent work on the EKC (Dasgupta *et al.*, 2004) also shows 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.

Third, including trade among the explanatory variables of CO_2 emissions usually yield EKC curves peaking farther in the future (Frankel and Rose, 2002), although there are methodological issues associated with this approach (Heil and Selden, 2001). Using trade-corrected emissions data for USA, Aldy (2005) also shows that taking trade into accounts leads to curves that peak much later. Neither taking trade into account as a new explanatory variable nor correcting emissions for trade effects, however, significantly increases the robustness of the correlation between observed levels of GDP per capita and observed emission levels.

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. The monotonically increasing relationship between economic activity and CO_2 emissions emerging from the data does not appear to be econometrically very robust, especially at country level and at higher GDP per capita level. The pessimistic interpretation of the literature findings that growth and CO_2 emissions are irrevocably linked is not supported by the data. There is apparently some degree of flexibility between economic growth and CO_2 emissions. For example, CO_2 emissions from fossil-fuel combustion in China remained essentially constant between 1997 and 2001. This was despite a +30% growth in GDP (IEA, 2004a) due to the combination of closing small-scale, inefficient power plants, shift in industry ownership away from the public sector, and introduction of energy efficiency and environmental regulation (Streets *et al.*, 2001; Wu *et al.*, 2005). However, these econometric studies do not distinguish between structural emissions and emissions that result from policy decisions. Thus, limited information is provided about how future policy choices may or may not influence CO_2 emissions paths. To explore these choices, a more disaggregated approach is necessary, as discussed in the following section.

12.2.3 Changing development pathway requires working with multiple actors, at multiple scales

Over the past two decades, social scientists have observed significant changes in the role of government in relation to social and economic change. These include a shift from government defined strictly by the nation state to a more inclusive concept of governance that recognizes the contributions of various levels of government (global, trans-national, regional, local) as well as the roles of the private sector, non-governmental actors, and civil society (Rhodes, 1996; Goodwin, 1998). 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, among which global environmental risks figure prominently (Beck, 1992; Giddens, 1998; Howes, 2005). Ideology and economic globalization have also played a role in the shifting focus from government to governance. Command-and-control strategies are losing favour while market-based mechanisms, voluntary initiatives, and partnerships with non-governmental organizations have gained wider acceptance (Lewis *et al.*, 2002). However, the shift to discussions of governance does not imply a reduction in the role of government. Governments remain central actors in environmental policy. They ensure the delivery of environmental protection to citizens, and help create the rules, norms, and many organizations that ensure environmental protection (Haas *et al.*, 1993; OECD, 2001; Ostrom *et al.*, 2002).

Recognizing the difficulty and limitations of trying to directly control their domestic economies in an increasingly open and globalized economy, governments now try to pursue economic growth through strategic policies. These policies are 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). On environmental issues, a strong case has been made for the need for government policy to ensure delivery of environmental protection as a public good (e.g., Liverman, 1999; Haas *et al.*, 1993; OECD, 2001; Ostrom *et al.*, 2002).

The three key institutional sectors– 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). This is not to imply that they always or even mostly work in partnership or have synchronous priorities: it mean that they now do 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 what the state, civil society and markets do or not do (Najam *et al.*, 2004).

The more prominent roles businesses and civil society groups have 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, 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 responsibility for the environment and sustainability has become a much broader project. It is no longer primarily the preserve of governments, but involves civil society, private sector, and the state (Rayner and Malone, 2000; Najam *et al.*, 2004).

12.2.3.1 State

The transition from government to governance recognizes the changing trends among political constitutions in developed and developing countries. While varying in speed and scope in individual states, these institutional reforms 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 (Berger and Dore, 1996; Hollingworth and Boyer, 1997; Schmidt, 2002; Heller and Shukla, 2003).

The specific constellation of these reforms depends on the pre-existing institutions in a country, the local politics of reform and resistant domestic interests. Yet in almost all cases, the re-organization of governance institutions will have important implications for the choice of 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 (Box 12.2).

All five electricity sectors separate 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 (Victor and Heller, 2007). 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. In some cases, such as the Indian State of Gujarat, the substitution of public grid power by privately developed stand-alone power plants has increased the rate of substitution of coal-fired generation by natural gas (Shukla *et al.*, 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 is 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 to address the issues of institutional capacity for mitigation include a compendium of policy instruments (DOE, 1989); two collections of country studies (Grubb, 1991; Rayner, 1993) and a review of the relevant social science literature on institutions (O'Riordan *et al.*, 1998).

A substantial body of political theory identifies and explains national policy styles or political cultures. The underlying assumption 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.' The key features of prevailing 'policy styles' in various countries and regions of the world are highlighted.

Richardson *et al.* (1982) identified 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, countries are subdivided according to whether national decision-making 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

Box 12.2: Poverty tariff in South Africa

The extent to which the policy alleviates poverty depends on the energy burden (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 12.2; 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.

Table 12.2: *Mean household expenditure on electricity and other fuels and energy as a percentage of total household expenditure*

Expenditure on	Before subsidy	After subsidy	Difference	
Electricity (Rand/month)	38	31	7	18%
Fuels excluding electricity (Rand/month)	70	59	11	16%
Energy share in household expenditure (%)	18	12	6	

Source: Prasad and Ranninger, 2003.

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 the poverty tariff, a substantial rise against an average consumption ranging from 100 to 150 kWh per month (Borchers *et al.*, 2001; Holliday *et al.*, 2002). This rise is less than the full 50 kWh/month, suggesting that households make greater use of electricity, but also value some saving on their energy bills (Cowan and Mohlakoana, 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, 2000; Hawken, 1999; Anderson, 1998; Holliday *et al.*, 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 shows that poverty-alleviation and environmental objectives can be addressed simultaneously. To the extent electricity use displaces indoor fuel use, it may also provide a benefit to public health.

protection in Europe and the more confrontational approach that predominates in the United States (Lindquist, 1980; Kelman, 1981; Kunreuther *et al.*, 1982). 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 *et al.* (1985) argue that decentralization of decision-making in the USA both increases the demand for scientific details of technological and environmental hazards and engenders competition between different explanations. Europeans generally expect national government, and increasingly the European Union, to take the lead in all matters pertaining to environmental safety and health, as well as economic and social welfare.

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 (2002) finds that, contrary to common assertions, the USA and Europe have not differed substantially in their use or implementation of the precautionary principle. Stewart (2001) finds that the USA 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, national political and regulatory cultures are distinguished by 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. Finally, governments 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 governments, which often tend to look to longer-run technology development support in collaboration with market actors (Nelson, 1993).

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 (Rayner, 1993). 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 of policy instruments listed above. These attributes include (O'Riordan *et al.*, 1998):

- 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 public opinion formulation;
- a vast combined public and private annual RD&D budget for reducing uncertainties and establishing pilot programmes.

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 forest preservation and carbon management. 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 programmes resources is exacerbated by pressures to utilize natural resources to earn foreign income. This increases 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).

Less industrialized countries often have poor infrastructures, exacerbated by lack of human, financial, and technological resources. In addition, these countries are likely to focus on more basic considerations of nation building and economic development. 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 countries.

The notions of adaptive and mitigative capacity advanced in the IPCC TAR 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. They are largely synonymous with those of sustainable development. The issues and cases discussed here suggest that the challenges of capacity building 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.

As O'Riordan et al. (1998) note "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."

12.2.3.2 Market

Industry is a central player in ecological and sustainability stewardship. Accordingly, over the past 25 years or so, there has been a progressive increase in the number of companies taking steps to address sustainability issues (Holliday *et al.*, 2002; Lyon, 2003) at either the company or industry level (see Box 12.3). A number of companies have, as part of their corporate strategy, voluntarily defined goals that reflect social responsibilities and environmental concerns that go beyond traditional company obligations. Following this line of thinking, an increasing number of companies are defining targets for GHG emissions and sinks. Some of the more widely acknowledged corporate sustainability drivers include regulatory compliance, market opportunities, and reputational value. Lyon (2003) hypothesizes that voluntary action on the environment might be explained by either a recognition by companies that pollution is a symptom of production inefficiencies, or a perception that consumers are willing to pay more for products with better environmental credentials. Either explanation would signal that markets are more important than regulation as an incentive for improved environmental performance. Lyon (2003) suggests instead that "it is the opportunity to influence regulation that makes corporate environmentalism profitable".

Some companies have recognized that pursuing sustainability offers potential cost savings (Thompson, 2002; Dunphy *et al.*, 2003). For example, 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 market advantage (Hawken *et al.*, 1999; Schaltegger *et al.*, 2003). This concept of 'eco-efficiency' further acknowledges that businesses which constantly work to evaluate their environmental performance will be more innovative and responsive businesses. DuPont, for example, has sought to elevate sustainability to the strategic level, using a three-pronged strategy involving integrated science, knowledge intensity and productivity improvements (Holliday, 2001). The company has achieved financial savings in excess of US$1 billion per annum, partly through reduced energy and raw material use and less waste (Holliday, 2001).

Lyon (2003) suggests that the influence of 'green marketing' is modest in terms of shifting industry behaviour with respect to the environment. Senge and Carstedt (2001) position consumers as a key influence in shaping the 'next industrial revolution', founded on an economic system that genuinely connects industry, society and the environment. Their view is that a shift in consumer attitudes and values is an essential prerequisite to building sustainable societies. Schaefer and

Box 12.3: Role of Business

One well-known example of a corporation which has embraced sustainability is Interface Inc., a USA. manufacturer of carpets and upholstery. Since embracing the sustainability goal in 1994, Interface has reduced the carbon intensity of its products by 36% (Hawken et al., 1999; Anderson, 2004) Many of these reductions came through investments in energy efficiency and renewable energy (Holliday et al., 2002). However, Interface has also substantially reduced GHG emissions through other elements of its sustainability strategy, including reduction in raw material use and recycling materials not directly related to energy consumption (Hawken *et al*., 1999; Anderson, 2004). As most of the materials used by Interface in its production are derived from petrochemicals (Anderson, 1998; Hawken *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 ecological burden. For example, in 1994 CEMEX embarked on an eco-efficiency programmes to "optimize its consumption of raw materials and energy" (Wilson and Change, 2003), p.29). Through this and other measures, CEMEX reduced CO_2 emissions 2.7 million tons between 1994 and 2003 (Wilson and Change, 2003, p.32).

ITC Ltd, an Indian conglomerate and third largest company in terms of net profits in the country, reportedly sequestered almost a third of its CO_2 emissions in 2003-04, and plans to become a carbon positive corporation through a programmes of energy savings and CO_2 sequestration through farm and social forestry initiatives. Through programmes for rainwater harvesting, the company 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 (Das and Dutta, 2004).

Crane (2005) conclude that a change in behaviour by the majority of consumers is not imminent. They suggest that it will require a sense of crisis to bring about a sea change in consumption patterns.

Managing stakeholder relations has also been identified as a corporate environmental driver. 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 introduced purchasing guidelines that place demands on suppliers to meet environmental performance standards (Thompson, 2002). The role of trade associations is another factor - including at the international negotiations (Hamilton *et al.*, 2003).

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 an incentive for greater corporate sustainability (Thompson, 2002; Borsky *et al.*, 2006). The role of institutional investors, and the growing concern in some business circles about liability due to inaction on climate change should also be acknowledged. This has led to a growing number of stakeholder initiatives to have publicly owned companies become proactive on climate change, and a growing number of initiatives to monitor and manage GHG emissions, even in the absence of domestic legislation and mandatory requirements (see Innovest, 2005; Cogan, 2006). The Carbon Disclosure Project has emerged as an important framework internationally for company reporting on their carbon footprint. Disclosure of environmental impact is increasingly seen as a crucial element of a company's risk profile for legal liability as well as competitive position in the face of possible future regulation. For example, re-insurers, companies providing insurance to insurance companies, have shown considerable concern about how climate change could impact insurance claims. Zanetti *et al.* (2005) suggest that climate change should be a core element in a company's long term-risk management strategy. Risk and return, demand, compliance and enforcement regimes, amongst other factors, are also likely to have an impact on investment.

Notwithstanding these achievements, there is widespread debate as to whether industry's responses to environmental decline and sustainability issues more generally are sufficient (Elkington, 2001; Sharma, 2002; Doppelt, 2003; Dunphy *et al.*, 2003).

All the same, 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 to include other economic, social, and environmental concerns. The arguments in support of CSR include competitive advantage (Porter and van der Linde, 1995; Porter and Kramer, 2002), notions of corporate citizenship (Marsden, 2000; Andriof and McIntosh, 2001), and stakeholder theory (Post *et al.*, 2002; Driscoll and Starik, 2004; Windsor, 2004). Drawing on the experience of DuPont, Holliday (2001) acknowledges the importance of shareholder value, but adds that business practices focused on sustainability outcomes can generate financial gains.

Colman (2002) reported that 45% 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 (2003) suggests it is primarily sales driven. In the UK, socially responsible investment (Srivastava and Heller, 2003) grew from US$ 46 billion in 1997 to US$ 450 billion in 2001 (Sparkes, 2002). Borsky *et al.* (2006) report that the US$ 2.16 trillion of socially responsible investments held in the USA accounted for approximately 11% of the total investment assets under management in 2003. The standards used by SRI funds to evaluate firms vary widely in the issues they address (with many simply staying away from weapons, tobacco, alcohol, and gambling) and how rigorously these standards are applied. Some SRI companies emphasize diversity and labour relations, while others focus on environment. There is no set of common criteria, and thus not all companies on SRI lists can be considered sustainable. However, growing public interest in SRI has led more companies to be concerned about a variety of social and environmental issues.

In considering the role of business, a distinction between multinationals and smaller, entrepreneurial enterprises is useful. A recent UK report identifies a difference in perspectives and approaches to global climate change in these two groups of businesses, with multinationals taking a long-term view, positioning for the future based on broad policy directions (Hamilton and Kenber, 2006). By contrast, smaller businesses, entrepreneurs or venture capitalists are more sensitive to the details of immediate or shorter term policy reforms. Similarly, there may be a difference even within the multinational sector between the energy suppliers (e.g., electricity producers/distributors, oil companies, or even coal companies) and energy intensive industries (e.g., chemical or aluminium companies). The former takes a longer term, market development or pro-active view and the later a more reactive view (e.g., BIAC/OECD/IEA, 1999). Finally, some companies are likely to be ‘winners’ with any effort to advance sustainable development through clean energy policies (e.g., insulation industry, window manufacturers, energy service companies) and some are likely to be ‘losers’ (e.g., producers of energy inefficient products). It is therefore difficult to speak about ‘market’ sector preferences because there are different types of businesses with significantly different perspectives in different places.

In summary, although there has been progress, the private sector can play a much greater role in making development more sustainable. As the number of companies that operate both profitably and more sustainably increases, the view that addressing social and environmental issues is incompatible with shareholder maximization may loose ground. Opinions vary on the extent to which business can be relied upon to meet sustainability objectives. These range from business being inherently self-interested and exclusively profit-driven, to socially responsible businesses going ‘beyond compliance’ are on the forefront of the sustainability curve. Although 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.

12.2.3.3 Civil society

Civil society refers to the arena of uncoerced collective action around shared interests, purposes and values (Rayner and Malone, 2000). In theory, its institutional forms are distinct from those of the state, family and market, although in practice, the boundaries between state, civil society, family and market are often complex, blurred and negotiated. Civil society commonly embraces a diversity of spaces, actors and institutional forms, varying in their degree of formality, autonomy and power. Civil societies are often populated by organizations such as registered charities, development non-governmental organizations, community groups, women’s organizations, faith-based organizations, professional associations, trades unions, self-help groups, social movements, business associations, coalitions and advocacy groups (Najam, 1996). As this definition emphasizes, civil society is closely related to the more recent concept of ‘social capital’. As described by Putnam (1993), social capital describes the overlapping networks of associational ties that bind a society together.

During the past three decades, the mantle of civil society has been increasingly claimed by non-governmental organizations (NGOs). The NGO sector has experienced an explosion in numbers worldwide as well as a proliferation of types and functions. There is considerable debate about the extent to which NGOs claim to be or even represent civil society in the traditional sense can be maintained. Certainly, their dependence on either government or business raises questions about the extent to which they are truly independent of the state and the market. According to The Economist (2000), a quarter of Oxfam’s US$ 162 million income in 1998 was given by the British Government and the EU. World Vision US, which claims to be the world’s largest privately funded Christian relief and development organization, receives millions of dollars worth of resources from the US Government. The role of governments in supporting NGOs is not limited to financial support. At least one UK-based NGO has advised various small governments in climate negotiations and has even drafted text. Other NGOs are closely associated with the market sector, known as BINGOs (Business and Industry NGOs). A question frequently raised about NGOs is of accountability (Jordan and van Tuijl, 2006). Relatively few NGOs are directly accountable to members in the same way that governments are to voters or businesses are to shareholders, raising further questions about the extent to which their claims to the mantle of civil society are justified (Najam, 1996).

Whether they are truly 'civil society' or not, there is little doubt that NGOs can be effective in shaping development and environment. 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). Non-governmental organizations have been particularly active and often influential in shaping societal debate and policy directions on this issue (Corell and Betsill, 2001; Gough and Shackley, 2001; Newell, 2000). 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 policy services such 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 environmental protection and climate change mitigation policies is the most familiar one. There are numerous examples of civil society organizations and movements seeking to push policy reform at the global, national and even local levels. The reform desired by various interest groups within civil society can differ (Michaelowa, 1998). But common to all is the legitimate role 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, and public protests. Given the nature of the issue, civil society includes not only NGOs but also academic and other non-governmental research institutions, business groups, and broadly stated the 'epistemic' or knowledge communities that work on better understanding of the climate change problematic. 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. Governments have eventually began responding to these calls from civil society for systematic environmental protection and global climate change mitigation policies (Gough and Shackley, 2001; Najam *et al.*, 2004). In particular, studies on the negotiation processes of global climate change policy (Levy and Newell, 2000; Corell and Betsill, 2001) highlight the role of non-governmental 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 is a voluntary knowledge community seeking to organize the state of knowledge on climate change for policy-makers. It is an 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 and Cleveland, 2003). In addition, the knowledge communities as well as NGOs have been extremely active and instrumental in servicing the needs of national and sub-national climate policy. This is done in various ways: by universities and research institutions writing local and national climate change plans; by 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); by civil society and epistemic actors playing key roles in climate change policy assessments at all levels from the local to the global.

Finally, civil society plays a very significant role by 'creating spaces for champions of policy reform' and providing platforms where these champions can advance these ideas. The Pew Climate Initiative and the Millennium Ecosystem Assessment are two examples of how civil society has created forums and space for discourse by 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 cognisant of the need to broaden the participation in these forums to other institutional sectors of society.

12.2.3.4 Interactions

The shift from 'government to governance' has been accompanied by both theoretical and a practical interest in how the three main arenas of actors – state, market and civil society – interact, including how they might work in concert to achieve improved outcomes from a sustainability perspective. A variety of perspectives are offered that cast light on these questions including 'partnerships' (Najam *et al.*, 2003; Hale, 2004; Forsyth, 2005), 'deliberative democracy' (Levine, 2000; O'Riordan and Stoll-Kleeman, 2002; Gutmann and Thompson, 2004), and 'transition theory' (Geels, 2004; Elzen and Wieczorek, 2005)

Each of these studies considers issues of governance in the context of sustainable development and climate change mitigation. Partnerships considers forms of cooperative governance and action, deliberative democracy deals with issues of representation in decision-making, Transition theory seeks to explain how technological innovation occurs and how these processes might be channelled towards changing the technological composition of development pathways, for example, in support of de-carbonization.

Partnerships: Partnerships between public and private actors can maximize impact by taking advantage of each partner's unique strengths and skill sets. Partnership programmes can provide citizens groups with a lever for increasing pressure on both governments and industry to change in support of improved sustainability. From an economic development perspective, one of the potentially fruitful styles of partnership has been between governments and industry through BOT projects - Build, Operate, Transfer. Despite their promise as a means of financing large-scale capital intensive projects, there have been significant difficulties in practice (see Box 12.4).

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. Although these cooperative models allow for more stakeholder participation, it is also suggested that they fail to fully address exclusion of minority and less powerful groups, non-representative outcomes, and a failure to integrate local knowledge. An analysis of waste-to-energy projects in the Philippines and India confirms that such problems will be encountered (Forsyth, 2005).

The notion that partnerships between sectors is the wave of the future was given particular salience by the World Summit on Sustainable Development in Johannesburg, South Africa, in 2002. There, several 'Type II' partnerships were launched involving various combinations of governments, business and civil society actors (Najam and Cleveland, 2003; Hale, 2004; Bäckstrand and Lövbrand, 2006). Although too early to evaluate the impacts, these particular partnerships, represent a larger trend in the last decade with a far greater level of partnership activities between governments and NGOs, and between government and business, and now increasingly all three. Such multi-sector forums and partnerships are no longer limited to a few industrialized countries or to particular sectoral mixes. There are now cross-sectoral partnerships and the search for meaningful cross-sectoral partnerships in developing and industrialized countries alike and initiated equally by governments, business and civil society.

Box 12.4: Public Private Partnerships

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. 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 utilizing such investments for natural-gas fired turbines, and Laos is engaging in a large programme of hydropower construction to supply electricity to a regional power grid in the Greater Mekong Sub region. However, BOT projects 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. 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.

Sources: Estache and Strong, 2000; Handley, 1997; Irwin et al., 1999; Tam, 1999; Wyatt, 2002.

Deliberative Democracy: According to Pimbert and Wakeford (2001), various social and political factors have brought support to the use of deliberative processes in policy-making, planning and technology assessments. According to Levine (2000), public debate over issues such as global warming provides the public opportunity to form opinions, where otherwise such an opportunity might not exist. Additionally, deliberative processes provide decision-makers with insight into the public mood and, public deliberation provides the opportunity for the public to justify their views on matters of concern.

Notions of deliberative democracy emerge from the observed shift from 'government to governance', in that they refer to shared responsibility for the design of policy. O'Riordan and Stoll-Kleeman (2002) suggest that policy spaces are no longer characterized by hierarchical orders; opportunities have been opened for a variety of forms of public-private cooperation, policy networks, formal and informal consultation, working across scales from multinational to local. The drivers, they suggest, include a need for new approaches to decision-making, occasioned by new mixes of private, public and civic actors.

There are at least five issues that continually challenge social scientists engaged in the design and implementation of participatory mechanisms, such as consensus conferences, focus groups, citizens' juries, and community advisory boards. These are:

- *Representation* – Who and how to select. The challenge is achieving representativeness of a community and establishing the legitimacy of those participating to speak on behalf of others;
- *Resources* – Participatory decision-making requires substantial investment by all parties, chiefly, funding and logistical support on the part of governments and business and time on the part of citizens;
- *Agenda framing* – Too narrow a framing prejudges the issues, but overly broad framing frustrates closure;
- *Effectiveness* – Does citizen involvement have impact on decisions. Disaffection deepens when citizen deliberations are not seen to have traction and people think their time has been wasted;
- *Evaluation* – This is seldom done, and when done, is usually self-evaluation of process rather than of outcomes.

Transition Theory: What can loosely be referred to as 'transition theory' (Elzen and Wieczorek, 2005) offers another perspective on 'society – market – state' relations, but importantly also presents some insights into how societies can shift onto more sustainable paths. Berkhout (2002) observed that energy and climate change policy communities are confronted with a major challenge in the form of shaping a substantially de-carbonized future**.** This necessitates a better understanding of the links between technologies and the institutions in which they are imbedded (Geels, 2004).

The important questions refer to the factors that impede transitions and, of particular interest to policy communities, how transitions could be induced. Socio-technical systems are often characterized by technological lock-in and path dependency. Actors and organizations become imbedded in interdependent networks and mutual dependencies (Walker, 2000; Berkhout, 2002; Geels, 2004). Elzen and Wieczorek (2005) outline options for inducing innovation under different governance paradigms – the top-down, command-and-control approach (state) a market model, or through policy networks (processes, interactions, networks). Geels (2004) and Smith (2003) approach the same question from a different perspective, both concluding that radical innovations are nurtured in 'niches'. Thus: "Climate change, for instance, is currently putting pressure on energy and transport sectors, triggering changes in technical search heuristics and public policies" (Geels, 2004). Berkhout (2002) offers that substantial commitment is required from governments and businesses to invoke transitions.

While the literature on transition theory is vague on how to induce innovations, such as those that might bring about a shift onto a more sustainable development path. It usefully emphasizes the importance of interactions among actors/organizations, technology, and institutions. For a shift to a more sustainable path, Smith (2003) provides an important reminder that technical change has traditionally occurred in the context of economic growth. Sustainable development, he suggests, implies that "the problem ordering shifts subtly yet profoundly", which will establish new challenges in achieving "publicly managed transitions towards environmentally sustainable technological regimes" (Smith, 2003). In the context of climate change, acknowledged in the literature on transition theory as an impetus for technological innovation, this challenge needs to be addressed; this will require new approaches to the governance of technological change and innovation (Berkhout, 2002; Elzen and Wieczorek, 2005).

12.2.3.5 Policy implications

The discussion above implies that actors and actor coalitions are important and that there is increasing evidence of multi-level patterns of governance and transnational networks of influence on climate change and other global environmental issues. These networks join actors across organizational boundaries; business representatives and environmental non-governmental organization activists may join shareholders, government policy communities and scientists to promote (or stall) action (Haas, 1990; Levy and Newell, 2000; Fairhead and Leach, 2003; Paterson *et al.*, 2003; Biermann and Dingwerth, 2004; Haas, 2004; Levy and Newell, 2005). Also, local and regional governments are increasingly active and may provide an invaluable testing ground and experience with mitigation policy in key areas, such as transportation (Betsill and Bulkeley, 2004; Lindseth, 2004; Bulkeley and Betsill, 2005). This suggests that policy-makers could do a number of things differently to promote understanding of climate change and agreement on policy responses to climate change:

- Create 'policy spaces' for non-state actors, scientists, and experts to interact with government actors; actively facilitate interactions between experts and other stakeholders to build trust, understanding and support for action across a wide range of actors (Ostrom, 1990; Ostrom, 2000; Stern, 2000; Banuri and Najam, 2002; Ostrom *et al.*, 2002). Such activity would provide benefits if built from the bottom-up (building on experience and viewpoints from an increasingly active municipal and community level set of response) and from the top-down (working across elites in government or in scientific/expert and other NGO circles).
- Institutionalize opportunities for public debate and wider interactions within the public sphere on environmental issues (Renn, 2001; Bulkeley and Mol, 2003; De Marchi, 2003; Liberatore and Funtowicz, 2003). By creating the means for dialogue and collaboration to construct understanding about global environmental change, participants have the opportunity to formulate views – talk leads to value formation – which can ultimately generate public support for political action (Dietz and Stern, 1995; Dietz, 2003).
- Encourage and facilitate local action and experimentation – where local communities have the potential to work more closely with affected stakeholders and tailor response strategies to the community's values and norms (Cash and Moser, 2000). Local action on climate change interacts with governance and action taken at different scales (e.g., at national and international levels; Bulkeley and Betsill, 2005).

Domestic policy processes influence international policy opportunities and constraints on climate change (Fisher, 2004). Any domestic policy process will necessarily be working to develop a position with input across the range of actors, for example, market, state, civil society and science/expert communities (Hajer, 1995; SLG, 2001; Fisher, 2004). How this plays out will, to some extent, be influenced by different cultural and social biases in governance at the domestic level (e.g., whether science and business have a privileged role in the policy process; the access and influence of environmental organizations; how coalitions of actors across these groups interact with the policy process). On issues of global environmental change, scientists and other experts necessarily play a privileged role to advise governments (Jasanoff, 1990; Giddens, 1991; Beck, 1992; Yearley, 1994; Jasanoff and Wynne, 1998), forming what Haas (1990; 2004) has referred to as transnational epistemic communities or networks of influence. Given large uncertainties, global environmental change science argues for policy processes that give a central role to public deliberation about the issues – to facilitate common framings about the problem and eventual agreement on responses (Funtowicz and Ravetz, 1993; Hajer and Wagenaar, 2003; Stern and Fineberg, 1996).

Ultimately, devising effective climate change mitigation strategies depends on good governance practices, which is the essence of sustainable development, for example, whole-of-government decision-making; synergies among economic, environmental and social policies; coalition-building; political leadership; integrated approaches; and policy coherence.

12.2.4 Opportunities at the sectoral level to change development pathways towards lower emissions through development policies

The multiplicity of plausible development paths ahead are underlined in Section 12.2.1, in which low emissions are not necessarily associated with low economic growth (Section 12.2.2). However, the vast literature on governance indicates that changing development pathways can rarely be imposed from the top: it requires the coordination of multiple actors, at multiple scales (Section 12.2.3).

On this basis, examples of opportunities to change development pathways towards lower emissions at the sectoral level are presented in Section 12.2.4. Firstly, opportunities in major sectors are reviewed: energy (Section 12.2.4.1); transportation and urban planning (Section 12.2.4.2); rural development (Section 12.2.4.3); and macro-economy and trade (Section 12.2.4.4). Some general lessons are drawn in Section 12.2.4.5. The potential for action on non-climate policies in major sectors is summarized in Section 12.2.4.4, and some insights on how climate considerations could be mainstreamed into non-climate policies in Section 12.2.4.7.

In reviewing how individual policies not intended for climate mitigation impact GHG emissions, examples are drawn from policies already adopted and implemented, and from forward-looking analysis to estimate the impact of future non-climate policies on emissions. However, few case studies directly analyze the link between a given policy and GHG emissions, and these are mostly in the energy sector.

In fact, assessing the impact of specific policies on GHG emissions, even ex post, is difficult for at least four reasons. 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 (see also Section 12.2.3). Third, indirect effects of policies on emissions, such as increased demand induced by energy efficiency programmes, are even more difficult to evaluate. And last, there is rarely a control group on the basis of which carbon savings can be evaluated.

To make up for the scarce literature on the relationships between policies and emissions, studies of the relationships between policies and proxies and/or key determinants of GHG emissions are also included in the review, for example, studies linking land-use policies with deforestation rate. This allows examples to be drawn from a wider range of sectors, namely energy, transportation and construction, rural development, as well as from macro-economic and trade policies. The depth of the literature, however, is variable across sectors. Finally, the examples below are intended to discuss the relationships between given policies and GHG emissions, and not the pros and cons of each policy.

12.2.4.1 Energy

The implications of four broad categories of energy policies on emissions are discussed: provision of affordable energy services to the poor; liberalization; energy efficiency; and energy security. Policies that support the penetration of renewable energy - which are often introduced for non-climate reasons, but are also obvious tools for climate mitigation in the energy sector - are discussed in Section 4.5.

***Access to Energy**:* Access to energy is critical for the provision of basic services such as lighting, cooking, refrigeration, telecommunication, education, transportation or mechanical power (Najam *et al.*, 2003). Yet, an estimated 2.4 billion people rely on wood, charcoal or dung for cooking, and 1.6 billion are without access to electricity (IEA, 2004c). Providing access to commercial fuel and efficient stoves would have highly positive impacts on human development by reducing child mortality, improving maternal health, and freeing up time used to collect fuel wood, especially for women and girls (Najam and Cleveland, 2003; Modi *et al.*, 2006). For example, indoor air pollution, mainly from cooking and heating from solid fuels, is responsible for 36% of all lower respiratory infections and 22% of chronic obstructive pulmonary disease (WHO, 2002). See also Chapter 4 and Chapter 6. It is estimated that a shift from crop residues to LPG, kerosene, ethanol gel, or biogas could decrease indoor air pollution by approximately 95% (Smith *et al.*, 2000). The impact on GHG emissions depends on the nature of the biomass resources and the carbon intensity of the replacement. Providing reliable access to electricity would also have highly positive impacts on human development, by providing preconditions for the development of new economic and social activities, for example, allowing for education activities at night and employment generating business initiatives (World Bank, 1994; Karekezi and Majoro, 2002; Spalding-Fecher *et al.*, 2002; Toman and Jemelkova, 2003).

The implications of improved access to commercial fuels for cooking on GHG emissions are ambiguous. On the one hand, emissions increase, albeit by a small amount globally. Smith (2002) estimates that providing LPG as fuel for roughly two billion households would increase global GHG emissions by about 2%. On the other hand, unsustainable use of fuelwood and related deforestation decreases. For example, the 'butanization' programmes adopted in Senegal in 1974 to support LPG use through a combination of subsidies to LPG, support for the development for stoves suitable for local conditions and removal of tax on imported equipment, is estimated to have resulted in a 33-fold increase in LPG use, and in a 15% drop of charcoal consumption (Davidson and Sokona, 2002). Similarly, the implications of electrification programmes for GHG emissions are ambiguous. Energy demand is likely to increase as a result of easier access and induced economic benefits. However, emissions per unit of energy consumed might decrease, depending on the relative carbon content of the fuel used in the baseline (typically kerosene) and of the electricity 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 where 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 technology choices.

One example of such indirect impact is documented by Colombier and Hourcade (1989). They found 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 costs to accommodate increased demand from rural households and companies – much higher than would have occurred had decentralized solutions been implemented at the onset. The implications for GHG emissions (not studied in the paper) are probably limited given the share of nuclear power in France. But similar dynamics could have more important GHG emissions implications in countries with fossil-fuel dominated power grids.

Liberalization: Many countries have embarked on liberalization of their energy sector over the past two decades. These programmes with the objective to reduce costs and improve efficiency of energy services include privatization of the energy producers, separation between production and transmission activities, liberalization of energy markets, and lifting restrictions on capital flows in the sector. Overall, liberalization programmes aim at improving the efficiency of the energy sector, and should, therefore, lead to reduced emissions per unit of output. Effective privatization programmes, however, differ markedly from country to country (Kessides, 2004), depending on prior institutional arrangements. In addition, privatization programmes are often sequentia. See, for example, Jannuzzi (2005) for a discussion on how the Brazilian regulator progressively adapted policies to elicit sufficient resources for energy efficiency and R&D from private utilities. These policies are often 'incomplete', in the sense that former public power generators remain dominant by combining features from both the public and private sector, an outcome very different from the ideal private energy markets (Victor and Heller, 2007: see also Section 12.2.3.1). It may, therefore, not be surprising that there is little literature drawing general lessons on the implications of privatization programmes on GHG emissions.

A great deal of literature, however, deals with the emission implications of some components of privatization programmes, particularly removal of energy subsidies. Energy subsidies removal may also be adopted as a stand-alone policy, independent from privatization. Conversely, subsidies may remain even within competitive markets. Government subsidies in the global energy sector are in the order of US$ 250-300 billion per year, of which around 2-3% support renewable energy (De Moor, 2001). Removing subsidies on energy has well-documented economic benefits. It frees up financial resources for other uses and discourages overuse of natural resources (UNEP, 2004). But, 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 in most cases, as higher prices trigger lower demand for energy and induce energy conservation. For example, econometric analyses have shown that price liberalization in Eastern Europe during the period 1992-1999 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 *et al.*, 2002). Overall, an OECD study showed global CO_2emissions could be reduced by more than 6% and real income increased by 0.1% by 2010, if support mechanisms on fossil fuels used by industry and the power generation sector were removed (OECD, 2002). Yet subsidies removal may actually result in increased emissions in cases where poor consumers are forced off-grid and back to highly carbon intensive fuels, such as non-sustainable charcoal or diesel generators. For example, removal of the subsidies for LPG in Senegal under the 'butanization' programmes discussed above is expected to increase charcoal and unsustainable fuelwood use (Deme, 2003). For additional discussion on energy subsidies, see Section 4.5.1 and Section 6.8.3.2 and Section 13.2.1.5.

Energy Efficiency: 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. This is the case even though some of the direct efficiency gains might be offset by increased demand due to lower energy costs per unit of output. Efficiency also increases competitiveness, relaxes supply constraints and, therefore, enhances the range of policy options and space, and lowers expenditure on energy thereby freeing up more resources for other development goals. The impact on CO_2 emissions, in turn, tends to be positive, but depends 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 R$ 2.6 billion from 1986 to 1997. This is 25 times as much as the amount invested in the programmes, while reducing emissions by an estimated 3.6 Mt CO_2 over the same period of time (La Rovere and Americano, 1999; Szklo *et al.*, 2005). Similarly, Palmer *et al. (*2004) estimate that the annual energy savings generated by all current Demand-Side Management programmes (DSM) in the USA represent about 6% of the country's non-transportation energy consumption. This leads to reductions in CO_2 emissions equivalent to (at most) 3.5% of the country's total. DSM programmes are also discussed in Section 6.8.3.1 and Section 5.5.1.Over the period 1973-1998, the International Energy Agency (IEA, 2004b) estimates that energy efficiency - driven both by policies and by autonomous technical improvements - have resulted in energy savings corresponding to almost 50% of 1998 energy consumption levels. Without these savings, energy use (and CO_2 emissions) in 1998 would have been almost 50% higher than observed.

Energy Security: Energy security is broadly defined as ensuring long-term security of energy supply at reasonable prices to support the domestic economy. This is a major concern for Governments worldwide, and it has taken new prominence in recent years with the political instability in the Middle East, increased oil prices, and tensions over gas in Europe (Dorian *et al.*, 2006; Turton and Barreto, 2006). Energy security concerns, however, can translate into very different policies depending on national and historical circumstances (Helm, 2002). Their impact on carbon emissions is ambiguous, depending on the nature of the policies and, in particular, on the fuel sources being favoured. 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[5]. The programmes resulted in reduction of oil imports and expenditure of foreign currency and job creation, as well as in large emission reductions, estimated at 1.5 Mt CO_2/yr (Szklo *et al.*, 2005). Brazil also provides an example where emissions actually increased as a result of energy security considerations. During the 1990s, 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 install and run emergency fossil-fuel plants, which led to a substantial increase in GHG emissions from the power sector in 2001 (Geller *et al.*, 2004). Hourcade and Kostopoulo (1994) show how reactions to the first oil shock by France, Italy, Germany, and Japan led to very different emissions with relatively similar economic outcomes (see Box 12.5).

5 PRO-ALCOOL was also a way of assisting the domestic sugar industry at times of low international sugar prices.

Box 12.5: Differentiated reactions to the first oil shock in France, Italy, Germany and Japan

An example of how different development paths can unfold in relatively similar countries is given by Hourcade and Kostopoulou (1994) for France, Italy, Germany, and Japan - countries with similar levels of GDP per capita in 1973 – in their response to the first oil shock. France moved aggressively to develop domestic supply of nuclear energy and a new building code. 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. Germany built 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 (Figure 12.1 left). Yet, while this indicator diminished by half in France, by a third in Japan, and 'only' by a quarter in Germany (IEA 2004b).

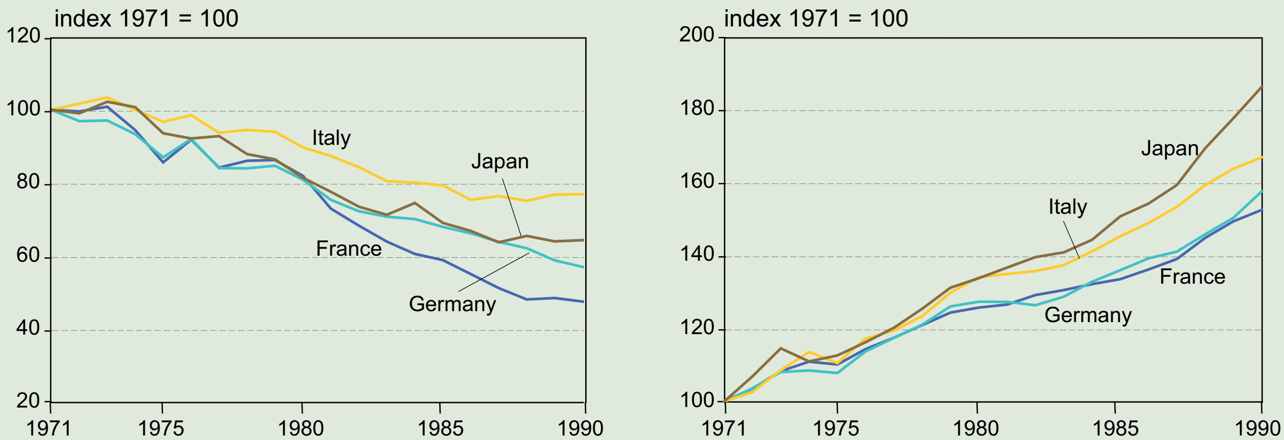

Figure 12.1: *(left) CO_2 emissions from fossil-fuel combustion per unit of GDP; (right) Evolution of GDP per capita*

Note: GDP in US$ in constant prices at market exchange rates.

Source: IEA, 2004a

Hourcade and Kostopoulou (1994) also observe that the macro-economic performance of these countries was relatively comparable between 1973 and 1990 (Figure 12.1 right), 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 (thus providing an illustration of the general observations about decision-making made in Section 12.2.3.1).

12.2.4.2 Transportation and urban planning

Transportation is a key development issue. Transportation is also one of the fastest growing end-use sectors in terms of CO_2 emissions in both the developed and the developing world. The level of these emissions results from the combination of the distances travelled by goods and people, and the set of technologies used to make these journeys. Demand for and supply of transportation are largely inelastic in the short-term, but become elastic in the longer run as people and activities change location, as new infrastructure is developed and as preferences evolve. A very wide array of policies affects these long-term dynamics. The set of transportation technologies available at time, and their relative costs, are also influenced by public policies.

Three examples of how public policy choices affect transportation supply, transportation demand, technology, and ultimately emissions from the transport sector are discussed in this section: one of congestion policy, one of urban planning at city level, and the other of national policy driving urban planning. The first example is from the City of London, where a congestion charge was introduced in February 2003 to reduce congestion. Simultaneously, investment in public transport was increased. Early results suggest that congestion in the charging zone has reduced by 30% during the charging hours, that CO_2 emissions have been reduced by 20%, and that primary emissions of NO_x and PM_{10} have been reduced by 16% (Transport for London, 2005). However, the cost-benefit ratio of the operation is questioned (Prud'homme and Bocarejo, 2005; Santos and Fraser, 2006). Other examples of how non-climate transportation policies can impact on emissions are given in Section 5.5.

The second example is the development and steady implementation of an integrated urban planning programme in the city of Curitiba (Brazil) from 1965 onwards. This has allowed the city to grow eight-fold from 1950 to 1990, while maintaining 75% of commute travel 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 and socio-economic characteristics. Two characteristics of the programmes seem to have contributed particularly to its success: (i) integration of 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 third example concerns urban planning in the United States and Europe (and Japan), the latter being on average rather compact while the former exhibit important sprawl. Nivola (1999) notes that this difference cannot be explained only by differences in demography, geography, technology or income. He argues that the combination of public choices is responsible for most of the differences in urban sprawl between the USA and Europe. Such policies include: (1) a bias towards public financing of roads to the detriment of other modes of transportation in the USA - against a more balanced approach in Europe; (2) dedicated revenues for highway construction in the USA - against funds drawn from general revenues in Europe; (3) lower taxes on gasoline in the USA than in Europe; (4) housing policies more geared towards supporting new homes: (5) a tax system more in favour of homeowners in the USA; (6) lower support from the federal government to local governments in the USA than in Europe; and (7) the quasi-absence of regulations favouring small in-city outlets against shopping malls in the USA. In turn, this difference in urban planning generates widely different transport demand, energy consumption (Newman and Kenworthy, 1991), and CO_2 emissions. Per capita CO_2 emissions from travel in the USA are nearly three times as high as in major European countries, due mostly to a larger number of journeys per capita and a higher energy intensity (Schipper *et al.*, 2001). A key point in the analysis made by Nivola (1999) is that most of these consequences were totally unintended, as these policies were adopted for non-transportation reasons (let alone for emissions reasons).

12.2.4.3 Agriculture and forestry

Vast arrays of policies affect the emissions of the agriculture and forestry sectors, and the emissions or the sequestration rate from biomass and soils. An extensive list of non-climate policies that impact on CO_2, CH_4 and N_2O emissions from the agriculture sector are presented in Chapter 8 (Tables 8.10 and 8.11). The list includes sectoral policies designed to reach environmental goals other than climate change, such as biodiversity conservation or watershed protections; agricultural policies designed to reach non-environmental goals, such as increasing exports of agricultural products or securing farmers' income; and non-agricultural policies with impact on the agriculture sector, such as energy price reforms. For example, the 2003 EU Common Agricultural Policies reform, by decoupling subsidies from production targets, is likely to lead to reduced on-farm CO_2 and N_2O emissions (see Table 8.10). In fact, changes in the Common Agricultural Policy from 1997 to 2001 (in intervention prices, in per-hectare support to grains and oilseeds, as in milk quotas and livestock subsidies) are estimated to have resulted in a 4% decline of agricultural sector emissions in Europe over that period (De Cara *et al.*, 2005).

If the direct emissions of the forestry sector are small, the emissions/uptake related to land conversion from/to forests are extremely large (see Chapter 9). In addition, emissions/uptake related to changes in the quality of existing forests, to the use of forest products in carbon stocks, and to bioenergy are very large. Policies affecting land use and land-use change, policies affecting the substitution between wood-based and other products, and policies related to bioenergy are thus likely to have strong implications for the net emissions from forests and forest products.

The causes of deforestation have been studied specifically. They differ from regions to regions and depend on the interaction of cultural, demographic, economic, technological, political and institutional issues (e.g., Angelsen and Kaimowitz, 1999; Geist and Lambim, 2002). In all cases, the drivers of deforestation are strongly affected by policy decisions. For example, rural road construction or improvement tend to encourage future deforestation (Chomitz and Gray, 1996; Chomitz, 2007), yet may have positive economic implications by providing better access to markets and basic services for remote population in developing countries (Jacoby, 2000). Similarly, agriculture intensification policies have potentially important but ambiguous effects on deforestation. On the one hand, intensification increases the productivity of existing agricultural land and lowers the pressure on forests. On the other, it could also trigger migration and 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).

A third example concerns a macro-economic policy decision: the devaluation of Brazil currency in 1999, which fell by 50% against the US dollar. Coupled with an increase of soybean prices on the international market, increased the value of soybean and beef production in the country - notably in the state of Mato Grosso – triggered massive increase in production and massive deforestation of cerrado forests. In fact, a third of total deforestation in the Brazilian Amazon between 1999 and 2003 occurred in Mato Grosso (Chomitz, 2007).

12.2.4.4 Macro-economy and trade

Macro-economic policies such as exchange rate policies, fiscal policies, government budget deficits, or trade policies may have profound impacts on the environment, even though they are designed for other purposes. This link has been extensively studied in the past decades, notably in the context of the evaluation of structural adjustment programmes in developing countries. A key finding from this literature is that the relationship between macro-economic policies and the environment are often complex and country-specific, and depend on whether or not other market or institutional imperfections persist (Munasinghe and Cruz, 1995; Gueorguieva and Bolt, 2003). No case studies discuss the impact of structural adjustment on GHG emissions, but some discuss the relationship between structural adjustment and deforestation and thus, by extension, GHG emissions from land-use change. Again, the effects depend on the mix of policies adopted as part of the structural adjustment programmes, and of country-specific characteristics. For example, Kaimovitz *et al*. (1999) report that the structural adjustment programmes implemented in Bolivia in 1985 strongly increased profitability of soybean production, and led to massive deforestation in soybean producing areas. Symmetrically, Benhin and Barbier (2004) find that a structural adjustment programmes implemented in Ghana in 1983 led to a reduction of deforestation linked to extension of cocoa culture because, among others, of increased producer price for cocoa, higher availability of inputs, and other measures aimed at rehabilitating existing cocoa farms. Another channel through which structural adjustment programmes could impact on deforestation is through the timber market. Pandey and Wheeler (2001) analyse cross-country data on the markets for wood products in countries where World Bank supported adjustment programmes were implemented. They find that these programmes greatly affect imports, exports, consumption and production in many forest product sectors, but that the impacts on deforestation tend to cancel out. If domestic deforestation does not increase, however, imports of wood products do, suggesting increased pressures on forest in other countries. Finally, as also noted above, Pandey and Wheeler (2001) find that currency devaluation strongly increases the exploitation of forest resources.

Among macro-economic policies, trade policies have attracted particular attention in recent years, due to the fact that international trade has increased dramatically over the past decades. There is a general consensus that, in the long-run, openness to trade is beneficial for economic growth. However, the pace of openness, and how to cope with social consequences of trade policies are subject to much controversy (Winters *et al.*, 2004). Trade has multiple implications for GHG emissions. First, increased demand for transportation of goods and people generates emissions. For example, freight transport now represents more than a third of the total energy use in the transportation sector (see Section 5.2.1). Secondly, trade allows countries to partially 'de-link' consumption from emissions, since some goods and services are produced abroad, with opposite implications for the importing and exporting countries. For example, 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 decrease in emissions intensity of West Germany over the period 1985-1990. At the other end, Machado *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% and 14%, respectively, of the total carbon emissions from energy use of the Brazilian economy in 1995. And the game is often not zero-sum, when production technologies are less carbon-efficient in the exporting country than in the importing one. For example, Shui and Harriss (2006) estimate that USA-China trade represents between 7% and 14% of China's total CO_2 emissions, and that USA-China trade increases world emissions by an average of 100 $MtCO_2$-eq per year over the period 1997-2003 because of higher emissions per kWh and less efficient manufacturing technologies in China. Finally, policies favourable to trade have been accused of favouring the relocation of companies to 'pollution heavens' where environmental constraint would be lower. Empirical analysis, however, do not confirm the 'race to the bottom' hypothesis (Wheeler, 2001). See also Section 11.7.

12.2.4.5 Some general insights on the opportunities to change development pathways at the sectoral level

Although the examples discussed above are very diverse, some general patterns emerge. First, in any given country, sectors where effective production is far below the maximum feasible production with the same amount of inputs – sectors that are far away from their production frontier – have opportunities to adopt 'win-win-win' policies. Such policies free up resources and bolster growth, meet other sustainable development goals, and also, incidentally, reduce GHG emissions relative to baseline. Among the examples discussed above, the removal of energy subsidies in economies in transition, or the mitigation of urban pollution in highly polluted cities in the developing world pertain to the 'win-win-win' category. Of course, these policies may have winners and losers, but compensation mechanisms can be designed to make no-one worse off in the process.

Conversely, sectors where production is close to the optimal given available inputs – sectors that are closer to the production frontier – also have opportunities to reduce emissions by meeting other sustainable development goals. However, the closer to the production frontier, the more trade-offs are likely to appear. For example, as discussed above, diversifying energy supply sources in a country where the energy system is already cost-efficient might be desirable for energy security reasons and/or for local or global environmental reasons. But it might come at a cost to the country if, for example, diversification involves more expensive technologies or more risky investments (Dorian *et al.*, 2006).

Third, in many of the examples reviewed above, what matters is not only that a 'good' choice is made at a certain time, but also that the initial policy has persisted for a long period – sometimes several decades – to truly have effects. The comparison between the development of European and USA cities since the end of World War II is a case in point. 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 re-oriented. This raises deep institutional questions about the possibility of governments to make credible long-term commitments, particularly in democratic societies where policy-makers are in place only for short spans of time (Stiglitz, 1998).

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

Fifth, as already emphasized in Section 12.2.3, institutions are significant in determining how a given policy or a given set of policies ultimately impact on GHG emissions (World Bank, 2003). For example, the differentiated reactions of Japan, Italy, Germany and France to the first oil shock can be traced to differences in institutions, relative power of different influence groups, and political cultures (Hourcade and Kostopoulou, 1994).

12.2.4.6 Mainstreaming climate change into development choices: Setting priorities

As highlighted in Sections 12.2.4.1 to 12.2.4.5, development policies in various sectors can have strong impacts on GHG emissions. The operational question is how to harness that potential. How can climate change mitigation considerations be mainstreamed into development policies.

Mainstreaming means that development policies, programmes and/or individual actions that otherwise would not have taken climate change mitigation into consideration explicitly include these when making development choices. This makes development more sustainable.

The ease or difficulty with which mainstreaming is accomplished will depend on both the mitigation technology or practice, and the underlying development path. No-regrets energy efficiency options, for instance, are likely to be easier to implement (and labelled as climate change mitigation actions) than others that have higher direct cost, require coordination among stakeholders, and/or require a trade-off against other environmental, and social and economic benefits. Weighing other development benefits against climate benefits will be a key basis for choosing development sectors for mainstreaming climate change considerations. In some cases, it may even be rational to disregard climate change considerations because of an action's other development benefits (Smith, 2002).

Development policies, such as electricity privatization, can increase emissions if they result in construction of natural gas power plants in place of hydroelectric power for instance, but they can reduce emissions if coal power plants are not built. Judicious and informed choices will be needed when pursuing development policies in order to ensure that GHG emissions are reduced and not increased (see above). This section considers which sectors should receive priority for mainstreaming climate change mitigation into development choices; what sectors are better off not pursuing mainstreaming; and which stakeholders might have a bigger stake and voice in mainstreaming. The next section considers concrete ways to mainstream mitigation considerations into development choices.

Prioritizing requires that the current and future associated emissions of the targeted sector and the mitigation potential of the non-climate sustainable development action be estimated. Policy-makers can then weigh the emissions reduction potential against other sustainability aspects of the action in choosing the appropriate policy to implement. In order to implement such an approach, empirical analyses are needed to estimate future associated emissions and current and future mitigation potential of development actions. Few, if any, global analyses provide complete guidance of this type. In light of the lack of empirical analyses, associated emissions for selected sectors in which development actions may be pursued are presented. This provides an initial guide in ranking sustainable development actions. A more complete analysis is needed, however, which would require the estimation of future associated emissions, and current and future mitigation potential of sustainable development actions.

Selected examples of CO_2 emissions associated with sectors where sustainable development actions could be implemented are presented in Table 12.3. These are described below:

Emissions associated with selected sectors:

- *Macro-economy:* Through fiscal tax and subsidy policies, public finance can play an important role in reducing emissions. Rational energy pricing based on long-run-marginal-cost principle can level the playing field for renewables, increase the spread of energy efficient and renewable energy technologies, improve the economic viability of utility companies, and can reduce GHG emissions. Non-climate taxes/subsidies and other fiscal instruments can impact the entire global fossil fuel emissions of CO_2, which amounted to about 51 $GtCO_2$-eq in 2004. Those that directly reduce fossil fuel use could be easily relabelled and mainstreamed as climate taxes, but others, for example a tax on water use, would need to be evaluated for their fossil fuel impacts and climate benefits.
- *Forestry:* Adoption of forest conservation and sustainable forest management practices can contribute to conservation of biodiversity, watershed protection, rural employment generation, increased incomes to forest dwellers and carbon sink enhancement. The forestry sector emissions show a high and low range to signal the uncertainty in estimates of deforestation. A best estimate value is about 7% of global emissions in 2004 (see Table 12.3). There are many country-

Table: 12.3: *Mainstreaming climate change into development choices - selected examples*

Selected sectors	Non-climate policy instruments and actions that are candidates for mainstreaming	Primary decision-makers and actors	Global greenhouse gas emissions by sector that could be addressed by non-climate policies (% of global GHG emissions)[a,d]		Comments
Macro-economy	Implement non-climate taxes/subsidies and/or other fiscal and regulatory policies that promote sustainable development	State (governments at all levels)	100	Total global GHG emissions	Combination of economic, regulatory, and infrastructure non-climate policies could be used to address total global emissions
Forestry	Adoption of forest conservation and sustainable management practices	State (governments at all levels) and civil society (NGOs)	7	GHG emissions from deforestation	Legislation/regulations to halt deforestation, improve forest management, and provide alternative livelihoods can reduce GHG emissions and provide other environmental benefits
Electricity	Adoption of cost-effective renewables, demand-side management programmes, and transmission and distribution loss reduction	State (regulatory commissions), market (utility companies) and, civil society (NGOs, consumer groups)	20[b]	Electricity sector CO_2 emissions (excluding auto producers)	Rising share of GHG-intensive electricity generation is a global concern that can be addressed through non-climate policies
Petroleum imports	Diversifying imported and domestic fuel mix and reducing economy's energy intensity to improve energy security	State and market (fossil fuel industry)	20[b]	CO_2 emissions associated with global crude oil and product imports	Diversification of energy sources to address oil security concerns could be achieved such that GHG emissions are not increased
Rural energy in developing countries	Policies to promote rural LPG, kerosene and electricity for cooking	State and market (utilities and petroleum companies), civil society (NGOs)	<2[c]	GHG emissions from biomass fuel use, not including aerosols	Biomass used for rural cooking causes health impacts due to indoor air pollution, and releases aerosols that add to global warming. Displacing all biomass used for rural cooking in developing countries with LPG would emit 0.70 $GtCO_2$-eq., a relatively modest amount compared to 2004 total global GHG emissions
Insurance for building and transport sectors	Differentiated premiums, liability insurance exclusions, improved terms for green products	State and market (insurance companies)	20	Transport and building sector GHG emissions	Escalating damages due to climate change are a source of concern to insurance industry. Insurance industry could address these through the types of policies noted here
International finance	Country and sector strategies and project lending that reduces emissions	State (international Financial Institutions) and market (commercial banks)	25[b]	CO_2 emissions from developing countries (non-Annex 1)	IFIs can adopt practices so that loans for GHG-intensive projects in developing countries that lock-in future emissions are avoided

Notes:
a. Data from Chapter 1 unless noted otherwise.
b. CO_2 emissions from fossil fuel combustion only; source: IEA, 2006.
c. CO_2 emissions only. Authors estimate, see text.
d. Emissions indicate the relative importance of sectors in 2004. Sectoral emissions are not mutually exclusive and may overlap.

specific studies of the potential to reduce deforestation (Chapter 9).

- *Electricity:* Adoption of cost-effective energy efficiency technologies in electricity generation, transmission distribution, and end-use reduce costs and local pollution in addition to reduction of greenhouse gas emissions. Electricity deregulation or privatization can be practised in any country and can impact the global electricity-related emissions which amounted to about 20% of global emissions.
- *Oil import security:* Oil import security is important to ensure reliable supply of fuels and electricity. Diversification of oil imports, through increasing imported and domestic sources oil and other energy carriers is an approach adopted by countries concerned about energy security. The percentage of net oil imports serves as one indicator of a country's energy security. The CO_2 emissions associated with net oil imports amounted to about 20% of global emissions (see Table 12.3). Reducing oil imports as a strategy to improve energy security thus offers a significant global opportunity to reduce emissions. Minimizing the use of coal as a substitute, and increasing use of less-carbon-intensive energy sources and reducing energy intensity of the economy are options that could be pursued to achieve this goal (IEA, 2004b). However, heavy use of biomass as a fossil fuel substitute may compete with other societal goals such as food security, alleviation of hunger and conservation of biodiversity.

Example of a sector where other benefits outweigh mainstreaming:

- *Rural household energy use:* Development of rural regions, better irrigation and water management, rural schools, better cook stoves in developing countries can promote sustainable development. The emissions associated with rural household activities, mostly derived from energy needed for cooking and some heating, are relatively small, however. These emissions are estimated to be between 10% and 15% of developing-country residential sector emissions or less than 0.5% of global emissions. Rural areas of developing countries rely primarily on traditional bioenergy[6] and consume comparatively small amounts of fossil fuels. The use of improved cook stoves is one way to reduce biomass and fossil fuel use. The worldwide amount estimated by Smith (2002) for provision of LPG as fuel for roughly two billion households is about 2% of global GHG emissions. From a global perspective, Table 12.3 suggests that smaller sectors with significant other welfare benefits need not be burdened with having to reduce CO_2 emissions since larger gains from sustainable development actions that address climate change mitigation are to be had elsewhere.

Emissions that key stakeholders can influence:

- *International finance:* While climate change mitigation is an important component of the multilateral bank (MDB) strategies, in practice climate change issues are not systematically incorporated into lending for all sectors. MDBs 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 *et al.*, 2005). MDBs can directly influence their own lending and indirectly influence the emissions of borrowing countries. The annual emissions from World Bank-funded energy activities alone, for instance, were estimated to range from 0.27 to 0.32 $GtCO_2$ (World Bank, 1999). MDBs could directly influence more than the aforementioned amounts once emissions associated with all lending activities of all MDBs are counted. Indirectly, through policy dialogue and conditionality, MDBs could influence additional emissions from developing countries, which amounted to about 25% of global emissions in 2004 (Table 12.3).
- *Insurance:* Buildings and transport vehicles form the bulk of the insured activities. Emissions from these sectors and from all international marine vessels and aircraft are estimated to be about 20% of global emissions, giving insurers a significant potential role in controlling emissions. Some insurers are beginning to recognize climate-change risks to their business (Vellinga *et al.*, 2001; Mills, 2005). Examples of actions may include premiums differentiated to reflect vehicle fuel economy (this is not unique to the buildings and/or transport sector or distance driven); liability insurance exclusions for large emitters; improved terms to recognize the lower risks associated with green buildings; or new insurance products to help manage technical, regulatory, and financial risks associated with emissions trading (Mills, 2003).

12.2.4.7 Operationalization of mainstreaming

Though there is a considerable amount of literature on how development policies are made (see Section12.2.3), there is currently very limited literature on how climate mitigation considerations could be mainstreamed into development policies. Based on a number of Indian case studies on integrating climate change mitigation in local development, Heller and Shukla (2003) note operational guidelines which can integrate development and climate policies into the future development pathways of developing countries. In developing countries, which by and large have not yet enacted domestic GHG legislation, the Clean Development Mechanism can play a role as one component of national GHG reduction strategies and sustainable development.

6 Bioenergy use is assumed to be GHG emissions neutral.

Based on a United States Environmental Protection Agency (US EPA, 2006) report on best practices for implementation of clean energy policies and programmes, Sathaye *et al.* (2006) conclude that following best practices would benefit the operationalization process: (a) commitment of publicly elected and/or regulatory bodies; (b) involvement and support of key stakeholders; (c) sound economic and environmental analyses conducted using simple and transparent tools; (d) longer time frames for programmes so that they can overcome market and funding cycles; (e) setting annual and cumulative targets to gage progress of mainstreaming; (f) ensuring additionality over and above existing and other planned programmes; (g) selection of an effective entity for implementation; (h) education and regular training of key participants; (i) monitoring and evaluation of mainstreaming results; and (j) maintenance of a functional database on a project's or programme's sustainable development performance.

A study of the Baltic region explores a sustainable development pathway addressing broad environmental, economic and social development goals, including low GHG emissions. 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 *et al.*, 1998). Kaivo-oja (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.

12.3 Implications of mitigation choices for sustainable development goals

The evolution of the concept of sustainable development with emphasis on its two-way linkage to climate change mitigation is discussed in Section 12.1, and the link between the role of development paths and actors or stakeholders that could make development more sustainable by taking climate change into consideration is explored in Section 12.2.The reverse linkages are summarized in Section 12.3, and the literature on impacts of climate mitigation on attributes of sustainable development is assessed.

The sectoral chapters (Chapters 4–11) provide an overview of the impacts of the implementation of many mitigation technologies and practices that are being or may be deployed at various scales in the world. In this section, the information from the sectoral chapters is summarized and supplemented with findings from the sustainable development literature. Synergies with local sustainable development goals, conditions for their successful implementation, and trade-offs where the climate mitigation and local sustainable development may be at odds with each other are discussed (see overview Table 12.4). In addition, the implications of policy instruments on sustainable development goals are described in Section 12.3.5, with the focus on the Clean Development Mechanism (CDM).

As documented in the sectoral chapters, mitigation options often have positive effects on aspects of sustainability, but may not always be sustainable with respect to all three dimensions of sustainable development - economic, environmental and social. For example, removing subsidies for coal increases its price and creates unemployment of coal mine workers, independently of the actual mitigation (IPCC, 2001). In some cases, the positive effects on sustainability are more indirect, because they are the results of side-effects of reducing GHG emissions. Therefore, it is not always possible to assess the net outcome of the various effects.

The sustainable development benefits of mitigation options vary over sectors and 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 8.8), for instance, improved management practices for rice cultivation and grazing land, and use of bioenergy and efficient cooking stoves enhance productivity, and promote social harmony and gender equality. Other categories of mitigation options have a more uncertain impact and depend on the wider socio-economic context within which the option is being implemented.

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 over years and/or across landscapes, which too limit the equilibrium amount of carbon that can be sequestered. Thus, the incremental sustainable development gains would reach an equilibrium condition after some decades, unless the land yields biofuel that is used as a substitute for fossil fuels.

The sectoral discussion below focuses on the three aspects of sustainable development - economic, environmental, and social. Economic implications include costs and overall welfare. Sectoral costs of various mitigation policies have been 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 4 to 10. Yet, mitigation costs are just one part of the broader economic impacts of sustainable development . 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.

Table 12.4: *Sectoral mitigation options and sustainable development (economic, local environmental and social) considerations: synergies and trade-offs* [a)]

Sector and mitigation options	Potential sustainable development synergies and conditions for implementation	Potential sustainable development trade-offs
Energy Supply and Use: Chapters 4-7		
Energy efficiency improvement in all sectors (buildings, transportation, industry, and energy supply: Chapters 4-7)	- Almost always cost-effective, reduces or eliminates local pollutant emissions and consequent health impacts, improves indoor comfort and reduces indoor noise level, creates business opportunity and jobs, and improves energy security - Government and industry programmes can help overcome lack of information and principal agent problems - Programmes can be implemented at all levels of government and industry - Important to ensure that low-income household energy needs are given due consideration, and that the process and consequences of implementing mitigation options are, or the result is, gender-neutral	- Indoor air pollution and health impacts of improving biomass cook stove thermal efficiency in developing country rural areas are uncertain
Fuel switching and other options in the transportation and buildings sectors (Chapters 5 and 6)	- CO_2 reduction costs may be offset by increased health benefits - Promotion of public transport and non-motorized transport has large and consistent social benefits - Switching from solid fuels to modern fuels for cooking and heating indoors can reduce indoor air pollution and increase free time for women in developing countries - Institutionalizing planning systems for CO_2 reduction through coordination between national and local governments is important for drawing up common strategies for sustainable transportation systems	- Diesel engines are generally more fuel-efficient than gasoline engines and thus have lower CO_2 emissions, but increase particle emissions - Other measures (CNG buses, hybrid diesel-electric buses and taxi renovation) may provide little climate benefits
Replacing imported fossil fuel with domestic alternative energy sources (DAES: Chapter 4)	- Important to ensure that DAES is cost-effective - Reduces local air pollutant emissions. - Can create new indigenous industries (e.g., Brazil ethanol programme) and hence generate employment	- Balance of trade improvement is traded off against increased capital required for investment - Fossil-fuel-exporting countries may face reduced exports - Hydropower plants may displace local populations and cause environmental damages to water bodies and biodiversity
Replacing domestic fossil fuel with imported alternative energy sources (IAES: Chapter 4)	- Almost always reduces local pollutant emissions - Implementation may be more rapid than DAES - Important to ensure that IAES is cost-effective - Economies and societies of energy-exporting countries would benefit	- Could reduce energy security - Balance of trade may worsen but capital needs may decline
Forestry Sector: Chapter 9		
Afforestation	- Can reduce wasteland, arrest soil degradation, and manage water runoff - Can retain soil carbon stocks if soil disturbance at planting and harvesting is minimized - Can be implemented as agro-forestry plantations that enhance food production - Can generate rural employment and create rural industry - Clear delineation of property rights would expedite implementation of forestation programmes	- Use of scarce land could compete with agricultural land and diminish food security while increasing food costs - Monoculture plantations can reduce biodiversity and are more vulnerable to diseases - Conversion of floodplain and wetland could hamper ecological functions
Avoided deforestation	- Can retain biodiversity, water and soil management benefits, and local rainfall patterns - Reduce local haze and air pollution from forest fires - If suitably managed, it can bring revenue from ecotourism and from sustainably harvested timber sales - Successful implementation requires involving local dwellers in land management and/or providing them alternative livelihoods, enforcing laws to prevent migrants from encroaching on forest land	- Can result in loss of economic welfare for certain stakeholders in forest exploitation (land owners, migrant workers) - Reduced timber supply may lead to reduced timber exports and increased use of GHG-intensive construction materials - Can result in deforestation with consequent sustainable development implications elsewhere
Forest Management	- See afforestation	- Fertilizer application can increase N_2O production and nitrate runoff degrading local (ground)water quality - Prevention of fires and pests has short term benefits but can increase fuel stock for later fires unless managed properly

Table 12.4. Continued.

Sector and mitigation options	Potential sustainable development synergies and conditions for implementation	Potential sustainable development trade-offs
Bioenergy (Chapter 8 and 9)		
Bioenergy production	- Mostly positive when practised with crop residues (shells, husks, bagasse, and/or tree trimmings) - Creates rural employment - Planting crops/trees exclusively for bioenergy requires that adequate agricultural land and labour is available to avoid competition with food production	- Can have negative environmental consequences if practised unsustainably - biodiversity loss, water resource competition, increased use of fertilizer and pesticides - Potential problem with food security (location specific) and increased food costs
Agriculture: Chapter 8		
Cropland management (management of nutrients, tillage, residues, and agro-forestry) Cropland management (water, rice, and set-aside)	- Improved nutrient management can improve ground water quality and environmental health of the cultivated ecosystem	- Changes in water policies could lead to clash of interests and threaten social cohesiveness - Could lead to water overuse
Grazing land management	- Improves livestock productivity, reduces desertification, and provide social security to the poor - Requires laws and enforcement to ban free grazing	
Livestock management	- Mix of traditional rice cultivation and livestock management would enhance incomes even in semi arid and arid regions	
Waste Management: Chapter 10		
Engineered sanitary landfilling with landfill gas recovery	- Can eliminate uncontrolled dumping and open burning of waste, improving health and safety for workers and residents - Sites can provide local energy benefits and public spaces for recreation and other social purposes within the urban infrastructure	- When done unsustainably can cause leaching that leads to soil and groundwater contamination with potentially negative health impacts
Biological processes for waste and wastewater (composting, anaerobic digestion, aerobic and anaerobic wastewater processes)	- Can destroy pathogens and provide useful soil amendments if properly implemented using source-separated organic waste or collected wastewater - Can generate employment - Anaerobic processes can provide energy benefits from CH_4 recovery and use	- A source of odours and water pollution if not properly controlled and monitored
Incineration and other thermal processes	- Obtain the most energy benefit from waste	- Expensive relative to controlled landfilling and composting - Unsustainable in developing countries if technical infrastructure not present - Additional investment for air pollution controls and source separation needed to prevent emissions of heavy metals and other air toxics
Recycling, reuse, and waste minimization	- Provide local employment as well as reductions in energy and raw materials for recycled products - Can be aided by NGO efforts, private capital for recycling industries, enforcement of environmental regulations, and urban planning to segregate waste treatment and disposal activities from community life.	- Uncontrolled waste scavenging results in severe health and safety problems for those who make their living from waste - Development of local recycling industries requires capital.

Note:
a) Material drawn from Chapters 4 to 11. New material is referenced in the accompanying text below that describes the sustainable development implications of mitigation options in each sector.

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. GHG emissions are often directly related to the emissions of other pollutants, either airborne, for example, sulphur dioxide from burning coal which causes local or indoor air pollution, or waterborne, for example, from leaching of nitrates from fertilizer application in intensive agriculture.

The social dimension includes issues such as gender equality, governance, equitable income distribution, housing and education opportunity, health impacts, and corruption. Most mitigation options will impact one or more of these issues, and both benefits and trade-offs are likely.

12.3.1 Energy supply and use

Mitigation options in the energy sector may be classified into those that improve energy efficiency and those that reduce the use of carbon-intensive fuels. The latter may be further classified into domestic and imported fuels. The synergies and trade-offs of these options with economic, local environmental, and social sustainable development goals are presented in Table 12.4. In the case of energy efficiency, it is generally thought to be cost effective and its use reduces or eliminates local pollutant emissions. Improving energy efficiency is thus a desirable option in every energy demand and supply sector.

As noted in Section 12.1.3, over the last decade, quantification of progress towards sustainable development has gained ground. In the industrial sector, several trade associations provide platforms for organizing and implementing GHG mitigation programmes. Chapter 7 notes that performance indicators are being used by the aluminium, semiconductor, and cement industry to measure and report progress towards sustainable development. 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 sustainable development achievements. Industrial sectors with high environmental impacts lead in reporting and 85% of the reports address progress on climate change (GRI, 2005), and (KPMG Global Sustainability Services, 2005). Another example is in the buildings sector. Several thousand commercial buildings have been certified by the USA Green Building Council's programme on Leadership in Energy and Environmental Design (LEED), which uses 69 criteria to award certificates at various levels of achievement. The certification ensures that a building meets largely quantitative criteria related to energy use, indoor air quality, materials and resource use, water efficiency, and innovation and design process (USGBC, 2005). Economic and ethical considerations are the most cited reasons by businesses in the use of these two guidelines.

12.3.1.1 Energy demand sectors – Transport, Buildings and Industry

In the buildings sector, energy efficiency options may be characterized as integrated and efficient designs and siting, including passive solar technologies and designs and urban planning to limit heat island effect. Considering energy efficiency as the guiding principle during the construction of new homes results in both reduced energy bills -enhancing the affordability of increased energy services- and GHG abatement (see Section 6.6). Policies that actively promote integrated building solutions for both mitigating and adapting to climate change are especially important for the buildings sector. Good urban planning, including increasing green areas as well as cool roofs in cities, has proven to be an efficient way to limit the heat island effect, which also reduces cooling needs. Mitigation and adaptation can, therefore, be addressed simultaneously by these energy efficiency measures.

In developing countries, efficient cooking stoves that use clean biomass fuels are an important option. These can have significant health benefits including reduction in eye diseases. The incident is disproportionately high amongst rural women in many developing countries where fuelwood and other biomass materials are 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). A move to a more reliable and cleaner fuel not only has benefits in terms of carbon emission and health, it has also the effect of freeing up significant amount of time for women and children, which can be applied to more socially beneficial activities, including going to schools in the case of children. The air pollution benefit of improved stoves, however, is controversial; other studies have noted that efficiency was improved at the expense of higher emissions of harmful pollutants (see Section 4.5.4.1).

In the transport sector, the energy efficiency measures may be categorized into those that are vehicle specific and those that address transportation planning. Vehicle-specific programmes focus on improvement to the technology and vehicle operations. Planning programmes are targeted to street layouts, pavement improvements, lane segregation, and infrastructural measures that improve vehicle movement and facilitate walking, biking and the use of mass transport. Cost-effective mitigation measures of both types have been identified that result in higher vehicle and/or trip fuel economy and reduce local air pollution. Institutionalizing planning systems for CO_2 reduction through coordinated interaction between national and local governments is important for drawing up common strategies for sustainable transportation systems (see Section 5.5.1). While there are many synergies in emission controls for air pollution and climate change, there are also trade-offs (see Section 5.5.4). Promotion of bicycling, walking, and other non-motorized modes of transportation has large and consistent co-benefits of GHG reduction, air quality, and people health improvement (see Section 5.2.1 and 5.5.4). Diesel engines are generally more fuel efficient than gasoline engines and thus have lower CO_2 emissions, but increase particle emissions. Air quality driven measures, such as obligatory particle matter and NO_x filters and in-engine measures, mostly result in higher fuel use and consequently, higher GHG emissions.

In the industrial sector, energy efficiency options may be classified as those aimed at mass-produced products and systems, and those that are process-specific. The potential for cost-effective measures is significant in this sector. Measures in both categories would have a positive impact on the environment. To the extent the measures improve productivity, they would increase economic output and hence add to government tax revenue. Higher tax revenue would benefit national, state and local government fiscal balance sheets (see Section 7.7; Nadel *et al.*, 1997; Barrett *et al.*, 2002; Phadke *et al.*, 2005).

Since energy efficiency improvement reduces reliance on energy supply, it is likely to improve a nation's energy security. Using prices as an instrument to promote energy efficiency mitigation options is often difficult due to the many barriers that impede their progress. Lack of information about such mitigation options and the principal agent problem have been documented to be particularly significant barriers in the residential sector, but these also prevail in the small and medium scale industries sectors (Sathaye and Murtishaw, 2005). Programmes that can overcome such barriers would increase energy efficiency penetration.

12.3.1.2 Energy supply[7]

Switching to low carbon energy supply sources is the other mitigation category in the energy sector with significant GHG benefits. This can be achieved through either increased reliance on imported or indigenous alternative fuels. Using a higher proportion of low carbon imported fuels will almost always reduce local air pollution. Its direct impact will be to increase payment for fuel imports that may result in worsened balance of payments, unless these are utilized to increase a nation's exports (Sathaye *et al.*, 1996). The higher fuel imports will increase dependence on international fuel supply that may result in reduced energy security unless diversification of supply mitigates concerns about increased dependence. Economies and societies of low carbon fuel exporting countries would benefit from the higher trade.

Increased reliance on most indigenous low carbon energy sources[8] would also reduce local air pollution, but the local environmental benefits in certain solid bioenergy applications appear to be uncertain (see Section 4.5.4.1). While indigenous low carbon fuels can reduce fuel imports, these have to be balanced against higher capital requirements for investment in fuel extraction, processing and delivery (Sathaye *et al.*, 1996). The development of large hydro sources can displace local populations and put their livelihood in jeopardy, and in reservoirs with large surface area, the resulting methane emissions may reduce their net GHG benefit substantially. For example, although hydroelectric plants have the potential to reduce GHG emissions significantly, a large amount of literature points to important environmental costs (McCully, 2001; Dudhani *et al.*, 2005), highlights the social disruptions and dislocations (Sarkar and Karagoz 1995; Kaygusuz, 2002), and questions the long-term economic benefits of major hydropower development. Increased use of indigenous low-carbon fuels can reduce export of fuels from other countries to the extent the latter are substituted away. These may adversely affect the trade balance of exporting countries (Sathaye *et al.,* 1996).

At the same time, low carbon fuels can have other environmental benefits. For example, a move away from coal to cleaner fuels will reduce ecosystem pressures that often accompany mining operations (Azapagic, 2004). Similarly, a move away from charcoal and fuelwood as a source of energy will have the attendant environmental benefits of reducing the pressures of deforestation (Masera *et al.*, 2000; Najam and Cleveland, 2003). This points towards the need to optimize technology choice decisions not only along the dimension of carbon emissions but also other environmental costs.

Wind power 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 (see Chapter 4). Trade-offs 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.

Several examples of corruption that either increases the price of electricity and/or prevent the proceeds from extracted resources to meet development needs are provided in Section 4.5.4.3. This suggests that corruption may reduce the sustainable development benefits of new mitigation technologies and/or low carbon fuels that require a significant modification of social systems.

12.3.1.3 Cross-sectoral sustainable development impacts

Implementation of mitigation options often creates new industries, for example, for energy efficient products such as cooking stoves, efficient lamps, insulation materials, heat pumps, and efficient motors, or for solar panels, windmills, and biogas installations. The success of these new industries depends on various factors, such as the degree of information, costs, the image of the product and its traditional competitors or its attributes other energy efficient. New industries can create new jobs and income, and might be pioneers in new market with significant competitive advantage. Ethanol production from sugar waste has created a new industry and generated employment opportunities and tax revenue for the Government of Brazil. However, the older, outpaced industry may lose jobs. Besides the uncertainty on the overall net effect, this may lead to regional loss of employment. For example, the increased production of biofuels for transportation, or energy production

7 Carbon capture and storage (CCS) is an emerging GHG mitigation option that is described in Chapter 4. Its sustainable development impacts would be similar to those described in this section for the siting of power plants.
8 Low carbon energy sources include hydro, biomass, wind, natural gas and other similar energy carriers.

in rural areas, is expected to protect existing employment and to create new jobs in rural areas (Sims, 2003). Renewable energy systems are more labour intensive than fossil fuel systems and a higher proportion of 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, labour intensity decreases over time, the long-term effect on jobs might be less pronounced than originally anticipated.

12.3.2 Forestry sector

Mitigation options in the forestry sector may be categorized as those that (1) avoid emissions from deforestation or forest degradation; (2) sequester carbon through forestation; and (3) substitute for energy intensive materials or fossil fuels.

Reducing or avoiding deforestation has considerable environmental benefits. It can retain biodiversity, ecosystem functions, and in cases of large land areas, affect local weather patterns (see Section 9.7.2). Reduction of forest fires improves local air quality. Many deforesting countries have laws that promote conservation of forest areas. 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 (Boer, 2001) and Brazil (Boer, 2001; Fearnside, 2001). Avoiding deforestation is relatively expensive, since the opportunity cost of deforested land is high due to its high timber and land values. Stakeholders such as land owners, migrant workers, and local saw mills would be negatively affected.

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 Programme 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). Successful implementation requires that alternative livelihood be provided to the deforesters, programmes to promote forest management jointly with the local population be pursued, and that enforcement be stricter.

Afforestation can provide carbon benefits by increasing carbon stocks on land and in products. Trees planted on wasteland can arrest soil degradation and help manage water runoff. Soil carbon can be increased to the extent soil disturbance during planting and harvesting is minimized. Planting in conjunction with agricultural crops (agro-forestry) enhances economic benefits while increasing food security. Afforestation activities are generally undertaken in rural areas and benefit the rural economy and generate employment for rural dwellers. Clear delineation of property rights would expedite the implementation of forestation programmes. A major concern is that forestation may diminish food security if it were to occur primarily on rich agricultural land, and that monoculture plantations would reduce biodiversity and increase the risk of catastrophic failure due to diseases. Conversion of floodplains and wetlands to forest plantations could hamper ecological functions.

Afforestation activities can also yield biomass fuel that may be used as a fossil fuel substitute in power plants or as a liquid fuel substitute. Palm-tree plantations are also a rich source of bio-diesel fuel. These sustainable development benefits and potential trade-offs also apply to bioenergy plantations. In regions, where crop residues (rice husks, sugarcane bagasse, nut shells, and/or tree trimmings) are available, these can be harvested synergistically with the crops and pose less potential sustainable development trade-offs.

Forest management activities include sustainable management of native forests, prevention of fires and pests, longer rotation periods, minimizing soil disturbance, reduced harvesting, promoting understory diversity, fertilizer application, and selective and reduced logging. Most of these activities bring positive social and environmental benefits. Minimizing soil disturbance may result in less use of fossil fuels, less emissions from biomass burning, and more employment if less machinery is used. The prevention of fires may result in larger fire events later due to excessive accumulation of fuel. Therefore, such practice should be linked to other practices such as sustainable wood fuel production. Theoretically, N fertilizer application increases net primary productivity (NPP) (and CO_2 removals), but there is a trade-off since at the same time it increases N_2O emissions and may contaminate waters with nitrates.

Some of the social benefits of mitigation policies come through education, training, participation as an integral part of a policy. Participatory approaches to forest management can be more successful than traditional, hierarchical programmes (Stoll, 2003). These participatory programmes can also help to strengthen civil society and democratization. Participatory approaches can create social capital (Dasgupta, 1993): networks and social relations which allow humans to cope better with their livelihoods.

12.3.3 Agriculture sector

Table 12.4 also summarizes the impact of different mitigation activities in agriculture sector on the constituents and determinants of sustainable development (see also Section 8.4.5 and Table 8.8). The table provides a description and tentative direction of impact but the exact magnitude of impact would depend upon the scale and intensity of the activities in the context where they are undertaken.

Several mitigation activities are explored in Chapter 8, ranging from crop, tillage/residue, nutrient, rice, water, manure/biosolid, grazing lands, organic soils, livestock and manure management practice, to land cover change, agro-forestry, land restoration, bioenergy, enhanced energy efficiency and increased carbon storage in agricultural products. It is shown that appropriate adoption of these mitigation measures is likely to help achieve social, economic and environmental goals, although sometimes trade-offs may also occur. Interesting enough, these trade-offs, when and if they occur, seem to be most visible in the short term, as in the long-term synergy amongst the aspects of sustainable development seems to be dominant.

An appropriate and optimal mix of rice cultivation with livestock known as integrated annual crop-animal system and traditionally found in West Africa, India and Indonesia and Vietnam would enhance the net income, improve the condition of cultivated ecosystems and over all human well being (MA, 2005). Such combinations of livestock and crop farming especially for rice would prove effective in income generation even in semi arid and arid areas of the world.

Ground water quality may be enhanced and the loss of biodiversity slowed by greater use of farmyard manure and more targeted pesticides. The impact on social and economic aspects of this mitigation measure remains uncertain. Better nutrient management can improve environmental sustainability.

Controlling overgrazing through pasture improvement has a favourable impact on livestock productivity (greater income from the same number of livestock) and slows/halts desertification (environmental aspect). It also provides social security to the poorest people during extreme events such as drought and other crisis (especially in Sub-Saharan Africa). One effective strategy to control overgrazing is the prohibition of free grazing, as was done in China (Rao, 1994).

This critical sector of the world economy is the biggest, user of the water. In low-income countries, agriculture uses almost 90% of the total extracted water (World Bank, 2000). Policies on free or very cheap energy (electricity, petroleum) as present is some areas for political reasons, contribute to misuse of water as the true economic cost inclusive of environmental and social costs are not reflected in the pricing and other incentive structures. Rationalization of electricity tariffs would aid in improving water allocation across users and over time. Through proper institutions and effective functioning of markets, water management can be operationalized with favourable impact on environmental and economic goals. In the short term, social cohesiveness might come under stress due to a clash of divergent interests.

Land cover and tillage management could encourage favourable impacts on environmental goals. A mix of horticulture with optimal crop rotations would promote carbon sequestration and could also improve agro-ecosystem function. Societal well-being would also be enhanced through provisioning of water and enhanced productivity. Whilst the environmental benefits of tillage/residue management are clear, other impacts are less certain. Land restoration will have positive environmental impacts, but conversion of floodplains and wetlands to agriculture could hamper ecological function (reduced water recharge, bioremediation, and nutrient cycling) and therefore, could have an adverse impact on sustainable development goals (Kumar, 2001).

Livestock management and manure management mitigation measures are context and location specific in there influence on sustainable development. Appropriate adoption of mitigation measures is likely to help achieve environmental goals, but farmers may incur additional costs, reducing their returns and income.

12.3.4 Waste and wastewater management sector

Better waste and wastewater management is an important sustainable development goal because it can lead directly to improved health, productivity of human resources, and better living conditions. It can also have direct economic benefits in terms of higher value of property due to improved living conditions. The 2002 Johannesburg World Summit on Sustainable Development added a new goal on sanitation, calling for the reduction by 50% of the number of people living without access to safe sanitation by 2015.

Chapter 10 emphasizes that environmentally-responsible waste management to reduce GHG emissions at an appropriate level of technology can promote sustainable development. In many developing countries, uncontrolled open dumpsites, open burning of waste, and poor sewerage practices result in major public health hazards due to vermin, pathogens, safety concerns, air pollution, and contamination of water resources. Often, waste in rural areas is neither collected nor properly managed.

The challenge is to develop improved waste and wastewater management using low to medium-technology strategies that can provide significant public health benefits and GHG mitigation at affordable cost. Some of these strategies include small-scale wastewater management such as septic tanks and recycling of grey water, construction of medium-technology landfills with controlled waste placement and use of daily cover, composting of organic waste, and implementation of landfill bio covers to optimize microbial CH_4 oxidation.

The major impediment in developing countries is the lack of capital. Another challenge is the lack of urban planning so that waste treatment and disposal activities are segregated from community life. A third challenge is often the lack of environmental regulations enforced within urban infrastructure. In many developing countries, waste recycling occurs through the scavenging activities of informal recycling networks. Sustainable development includes a higher standard for these recycling activities so that safety and health concerns are reduced via lower technology solutions that are effective, affordable, and sustainable.

In some cases, landfill gas might be used to provide heating fuel for a factory or commercial venture that can be an alternative source of local employment. Also, compost can be used for agriculture or horticulture applications, and closed re-vegetated landfills can become public parks or recreational areas.

12.3.5 Implications of climate policies for sustainable development

A major policy development since the TAR is the implementation of a large range of climate policies at the international level (e.g., Kyoto Protocol), regional level (e.g., EU Emissions Trading Scheme), national and sub-national level (see the review in Section 13.3.3.4).

The implications of these policies for sustainable development are not assessed in the literature, except for those of the Clean Development Mechanism (CDM) (Michaelowa, 2003; Spalding-Fecher and Simmonds, 2005; Sutter, 2003; UNEP, 2004; Winkler, 2004; Winkler and Thorne, 2002). For extensive discussion, see Section 13.3.3.4.2. The sustainable development implications of particular mitigation activities that can be implemented under the CDM are discussed further in Section 12.3. This section focuses on the sustainable development implications of CDM as a policy. Key findings from this literature that relate to the implications of climate policies on sustainable development are as follows:

- The CDM channels non-trivial amounts of money towards developing countries. In 2005, the CDM channelled about US$2.5 billion to purchase carbon credits in developing countries (Capoor and Ambrosi, 2006), or 0.75% of the (record) net foreign direct investment (FDI) inflow in developing countries for that year (UNCTAD, 2006). In addition, it can be argued that the CDM leverages new private capital to developing countries.
- Since carbon payments are payable in strong currencies, and usually originate from buyers with strong credit ratings, they provide the seller with additional opportunities to raise additional capital and debt from banks and other finance institutions (Mathy *et al.*, 2001; Lecocq and Capoor, 2005).
- The geographical distribution of CDM projects tends to follow FDI flows with most of the financial flows towards large middle-income countries (Fenhann, 2006), and very little financial flows towards least developed countries, notably in Sub-Saharan Africa (Capoor and Ambrosi, 2006).
- Projects mitigating non-CO_2 gases (HFC23, N_2O and CH_4) represent the bulk of the volume of emission reductions exchanged under the CDM. However, projects with the highest direct benefits for local communities deliver fewer emission reductions and are in general accompanied by higher transaction costs. Resolving the tension between global emission reductions and local benefits is a key challenge for the future of climate change regime (Ellisa *et al.*, 2007).

12.4 Gaps in knowledge and future research needs

As noted in Section 12.1, changing development paths will be critical to addressing mitigation and the scale of effort required is unlikely to be forthcoming from the environmental sector on its own. If climate policy on its own will not solve the climate problem, future research on climate change mitigation and sustainable development will need to focus increasingly on development sectors. A better understanding is needed of how countries might get from current development trajectories onto lower-carbon development paths – how to make development more sustainable.

The global GHG emissions reduction potential of such actions varies from a few tens to million tons of carbon, and empirical research is needed to identify and quantify actions that will yield the most emissions savings.

A fundamental yet important step would be to identify relevant non-climate policies affecting GHG emissions/sinks, including trade, finance, rural and urban development, water, energy, health, agriculture, forestry, insurance, and transport among others. Future research will also need to access and use local knowledge. More case studies would help illustrate the link between sustainable development and climate mitigation in developed, developing and transition countries. A particular challenge in this regard is that such policies will necessarily be context specific and will work only when structured within local and national realities. This means that a lot of the research required is at the local and national levels to identify policy options and choices that might best work within the contexts of specific regions, countries and localities.

This chapter has noted that development-oriented scenarios could be enriched by taking global climate change explicitly into account. Future research might develop and analyse scenarios for development paths at different scales and their implications for reducing or avoiding GHG emissions. This may require broadening and deepening the current set of models to better analyse the GHG implications of non-climate scenarios. This also applies to industrialized countries on their development paths and choices.

This chapter has suggested that the capacity to mitigate is rooted in development paths. Considerable research must be carried out to further investigate how mitigation capacity can be turned into actual mitigation, and its connection with components of the underlying development path. Paradoxically, the reviewed literature suggests that a fundamental discussion on the implications of 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. 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.

Section 12.1.3 cites several macro-indicators of sustainable development that are being used to track its progress at the national and international level. Few of these take climate change mitigation directly into consideration. Inclusion of this aspect in the use of macro-indicators is identified as an important area of research.

Changing development pathways involves multiple actors, at multiple scales. The roles of different actors and joint actions in changing development pathways need further research, particularly the private sector and civil society (and how they relate to government). A key question revolves around the complex process of decision-making, theories of which need to be applied to sustainable development and mitigation. A particular focus in this area might be identifying patterns of investment and their implications for GHG emissions. Again, much of this research will have to be contextually specific and related to specific local and national contexts.

While future research must focus on multiple sectors, actors and scales, a key area of investigation will remain the role for international agreements. Reconciling the role for international coordination mechanisms with decentralized policy approaches is challenging and requires further evaluation. An area of particular importance in this context is international agreements that are not specific to climate change but whose structure and implementation can affect development paths. These include voluntary international agreements, such as those on the implementation of the Millennium Development Goals (MDGs) to specific Multilateral Environmental Agreements (MEAs), such as those on desertification, on biodiversity, to the related provisions of international policy instruments within the World Trade Organization (WTO). All these agreements, including the WTO, now claim sustainable development as their ultimate goal.

Future research will continue to examine the implications of climate change mitigation for sustainable development. Understanding of the sustainable development implications in each of many sectors is growing, but further analysis will be needed for key sectors and where least information is available. Synergies beyond those in air pollution require more attention, including water, soil management; forest management and others. Apart from investigating synergies, the question of trade-offs between sustainable development and mitigation (and also adaptation) requires further analysis.

REFERENCES

Adger, W.N., N. Brooks, M. Kelly, S. Bentham, S. Eriksen (eds.), 2004: New indicators of vulnerability and adaptive capacity. Centre for Climate Research.

Agrawala, S., A. Moehner, A. Hemp, M. van Aalst, S. Hitz, J. Smith, H. Meena, S.M. Mwakifwamba, T. Hyera and O.U. Mwaipopo, 2003a: *Development and Climate Change in Tanzania: focus on Mount Kilimanjaro.* OECD, Paris.

Agrawala, S., A. Moehner, M. El Raey, D. Conway, M. van Aalst, M. Hagenstad and J. Smith, 2004b: *Development and Climate Change in Egypt: Focus on Coastal resources and the Nile.* OECD, Paris.

Agrawala, S., T. Ota, T., Ahmed, A.U., Smith, J. and M. van Aalst, 2003b: *Development and Climate Change in Bangladesh: Focus on coastal flooding and the Sundarbans.* OECD, Paris.

Agrawala, S., T. Ota, J. Risbey, M. Hagenstad, J. Smith, M. van Aalst, K. Koshy and B. Prasad, 2003c: *Development and Climate Change in Fiji: Focus on coastal mangroves.* OECD, Paris.

Alcamo, J., D. van Vuuren, C. Ringler, W. Cramer, T. Masui, J. Alder, and K. Schulze, *2005:* Changes in nature's balance sheet: Model-based estimates of future worldwide ecosystem services. *Ecology and Society,* **10**(2), pp.19.

Aldy, J.E., 2005: *An environmental Kuznets Curve analysis of U.S. state-level carbon dioxide emissions. Journal of Environment and Development,* pp. 48-72.

An, F. and A. Sauer, 2004. *Comparison of passenger vehicles fuel economy and greenhouse gas emission standards around the world.* Pew Center on Global Climate Change, Washington D.C., US, pp. 36.

Anderson, R., 1998: *Mid-Course Correction.* The Peregrinzilla Press, Atlanta.

Anderson, R., 2004: Climbing Mount Sustainability. Q*uality Progress*, February 2004, pp. 32.

Andriof, J. and M. McIntosh, 2001: *Perspectives on Corporate Citizenship.* Greenleaf Publishing Ltd, Sheffield.

Angelsen, A. and D. Kaimowitz, 1999: Rethinking the causes of deforestation: lessons from economic models. *The World Bank Research Observer,* **14**(1), pp. 73-98. <http://www.worldbank.org/research/journals/wbro/obsfeb99/pdf/article4.pdf> accessed 06/07/07.

Angelsen, A. and D. Kaimowitz (eds.), 2001: *Agricultural technologies and tropical deforestation.* CABI Publishing, New York, USA, 422 pp.

Arthur, W.B., 1989: Competing technologies, increasing returns, and lock-in by historical events. *The Economic Journal*, **99,** pp. 116-131.

Athanasiou, T., 1996: The age of greenwashing. In *Divided planet: The ecology of rich and poor.* University of Georgia Press, Athens, GA, pp. 227-297.

Azapagic, A., 2004: Developing a framework for sustainable development indicators for the mining and minerals industry. *Journal of Cleaner Production,* **12**(6), pp. 639-662.

Bäckstrand, K. and E. Lövbrand, 2006: Planting trees to mitigate climate change: Contested discourses of ecological modernisation, green governmentality and civic environmentalism. *Global Environmental Politics,* **6**(1), pp. 50-75.

Banuri, T., G. Hyden, Banuri, T., C. Juma, M. Rivera, 1994: Sustainable human development: from concept to operation. United Nations Development Programme, New York.

Banuri, T. and A. Najam, 2002: *Civic Entrepreneurship - A Civil Society Perspective on Sustainable Development.* Gandhara Academy Press, Islamabad,<http://www.tellus.org/seib/publications/civic/VOLUME1.pdf> accessed 06/07/07.

Banuri, T., J. Weyant, G. Akumu, A.Najam, L. Pinguelli Rosa, S. Rayner, W. Sachs, R. Sharma, G. Yohe, 2001: Setting the stage: Climate change and sustainable development. In *Climate Change 2001: Mitigation, Report of working group III, Intergovernmental Panel On Climate Change (IPCC) [*Metz, B., O. Davidson, R. Swart, and J. Pan (ed.)], Cambridge University Press, Cambridge.

Barnett, J., 2001: *The meaning of environmental security, ecological politics and policy in the new security era.* Zed Books, London.

Barrett, J., J.A. Hoerner, S. Bernow, B.Dougherty, 2002: *Clean energy and jobs: A comprehensive approach to climate change and energy policy.* Economic Policy Institute and Center for a Sustainable Economy, Washington D.C.

Bartelmus, P., 2001: Accounting for sustainability: greening the national accounts. In *Our Fragile World, Forerunner to the Encyclopaedia of Life Support System*. Tolba, M.K. (ed.), pp. 1721-1735.

Baumert, K. and J. Pershing, *T. Herzog, M. Markoff*, 2004: *Climate data: insights and observations*. Pew Centre on Climate Change, Washington, D.C.

Beck, U., 1992: *Risk Society: Towards a New Modernity*. Sage, London.

Beg, N., J.C. Morlot, O. Davidson, Y. Afrane-Okesse, L. Tyani, F. Denton, Y. Sokona, J.P. Thomasc, E.L. La Rovere, J.K. Parikh, K. Parikh, A.A. Rahman, 2002: Linkages between climate change and sustainable development. *Climate Policy*, **2**, pp. 129-144.

Behera, B. and S. Engel, 2005: Institutional analysis of evolution of joint forest management in India: A new institutional economics approach. *Forest Policy and Economics,* **(8)**4, pp. 350-362.

Bell, S. and S. Morse, 1999: *Sustainability Indicators: Measuring the Immeasurable*. Earthscan, London.

Benhin, J.K.A. and E.B. Barbier, 2004: Structural Adjustment Programme, deforestation and biodiversity loss in Ghana. *Environment and Resources Economic,* **27**, pp. 337-366.

Berger, S. and R. Dore, 1996: *National diversity and global capitalism.* Cornell Press.

Berkhout, F., 2002: Technological regimes, path dependency and the environment. *Global Environmental Change,* **12**, pp. 1-4.

Betsill, M.M. and H. Bulkeley, 2004: Transnational networks and global environmental governance: The cities for climate protection program. *International Studies Quarterly,* **48,** pp. 471-493.

BIAC/OECD/IEA, 1999: *Workshop on Climate Change: Industry view on the Climate Change challenge with special emphasis on the Kyoto Mechanisms - Industry Sector Reports.* OECD/IEA, Paris, 54 pp.

Biermann, F. and K. Dingwerth, 2004: Global environmental change and the nation state. *Global Environmental Politics*, **4**, pp. 1-22.

Boer, R., 2001: Economic assessment of mitigation options for enhancing and maintaining carbon sink capacity in Indonesia. *Mitigation and Adaptation Strategies for Global Change*, **6**, pp. 257-290.

Bojo, J., K.-G. Mäler, L. Unemo, 1992: *Environment and development: An economic approach.* Second Revised Edition. Kluwer Academic Publishers, 211 pp.

Borchers, M., N. Qase, *C.T. Gaunt, J. Mavhungu, H. Winkler, Y. Afrane-Okese, C. Thom,* 2001: *National Electrification Programme evaluation: Summary report.* Evaluation commissioned by the Department of Minerals & Energy and the Development Bank of Southern Africa. Energy & Development Research Centre, University of Cape Town, Cape Town.

Borsky, S., D. Arbelaez-Ruiz, C. Cocklin, D. Holmes, 2006: International trends in socially-responsible investment: implications for corporate managers. In *International Handbook on Environmental Technology Management.* D. Annadale, D. Marinova, and J. Phillimore (ed.), Edward Elgar, London.

Bossel, H., 1999: Indicators for sustainable development: Theory, methods, applications. International Institute for Sustainable Development, Winnipeg, MB, <http://www.iisd.org/pdf/balatonreport.pdf> accessed 06/07/07.

Boulanger, P.-M., 2004: *Les indicateurs du développement durable: un défi scientifique, un enjeu démocratique.* IDDRI, Paris.

Boyle, A. and D. Freestone, 1999: *International law and sustainable development: past achievements and future challenges.* Oxford University Press, Oxford.

Brickman, R., S. Jasanoff, T. Ilgen, 1985: Controlling chemicals: the *politics of regulation in Europe and the United States.* Cornell University Press, Ithaca, New York.

Brown, L., 1981*: Building a sustainable society.* Worldwatch Institute, Washington, D.C.

Buitenkamp, M., H. Venner, T. Wams, 1993: *Action Plan Sustainable Netherlands.* Dutch Friends of the Earth, Amsterdam.

Bulkeley, H. and M.M. Betsill, 2005: Rethinking sustainable cities: Multilevel governance and the 'urban' politics of Climate Change. *Environmental Politics,* **14**, pp. 42-63.

Bulkeley, H. and A.P.J. Mol, 2003: Participation and environmental governance: Consensus, ambivalence and debate. *Environmental Values,* **12,** pp. 143-154.

Cabeza Gutes, M., 1996: The concept of weak sustainability. *Ecological Economics*, **17**(3), pp. 147-156.

Capoor, K. and P. Ambrosi, 2006: *State and trends of the carbon market 2006.* Prototype Carbon Fund and International Emissions Trading Association, Washington D.C.

Carpenter, S., P.L. Pingali, E.M. Bennett, M.B. Zurek, 2005: *Ecosystems and human well-being: Scenarios. Findings of the Scenarios Working Group v. 2* (Millennium Ecosystem Assessment S.), Island Press.

Cash, D.W. and S.C. Moser, 2000: Linking global and local scales: designing dynamic assessment and management processes. *Global Environmental Change,* **10,** pp. 109-120.

CGD, 2004: *Millions saved: Proven successes in global health.* Centre for Global Development.

Chandler, W., R. Schaeffer, D. Zhou, P.R. Shukla, F. Tudela, O. Davidson, S. Alpan-Atamer, 2002: *Climate change mitigation in developing countries: Brazil, China, India, Mexico, South Africa, and Turkey.* Pew Center on Global Climate Change, Washington D.C.

Chomitz, K., 2007: *At Loggerheads? Agricultural expansion, poverty reduction, and environment in the tropical forests.* World Bank: Washington D.C.

Chomitz, K. and D. Gray, 1996: Roads, land use, and deforestation: A spatial model applied to Belize. *The World Bank Economic Review*, **10,** pp. 487-512.

CIESIN, 1996-2001: *Environmental Treaties and Resource Indicators.* Center for International Earth Science Information Network (CIESIN), Palisades, NY, <http://sedac.ciesin.columbia.edu/entri/> accessed 06/07/07.

Cocklin, C., 1995: Agriculture, society, and environment: discourses on sustainability. *International Journal of Sustainable Development and World Ecology*, **2**, pp. 240-256.

Cogan, 2006: *Corporate Governance and Climate Change: Making the Connection.* CERES, Boston, MA, 300 pp.

Metwalli, A.A.M., H.H.J de Jongh, M.A.J.S. van Boekel, S. Cohen, D. Demeritt, J. Robinson, D. Rothman, 1998: Climate Change and Sustainable Development: Towards Dialogue. *Global Environment Change*, **8**(4), pp. 341-371.

Colman, R., 2002: Corporate sustainability a hot commodity. *CMA Management*, **76**(Sep), 9 pp.

Colombier, M. and J.C. Hourcade, 1989: Développement des réseaux et modulations spatio-temporelles des tarifs: l'équité territoriale revisitée. *Revue Economique*, **40**(July), pp. 649-676.

Coondoo, D. and S. Dinda, 2002: Causality between income and emission: a country group-specific econometric analysis. *Ecological Economics,* **40**, pp. 351-367.

Copeland, B.R. and M.S. Taylor, 2004: Trade, growth, and the environment. *Journal of Economic Literature,* **42**(March), pp. 7-71.

Corell, E. and M. Betsill, 2001: A comparative look at NGO influence on international environmental negotiations: Desertification and Climate Change. *Global Environmental Politics*, **2**(1), pp. 86-107.

Cork, S., G. Peterson, G. Petschel-Held, J. Alcamo, J. Alder, E. M. Bennett, E. Carr, D. Deane, G. Nelson, and T. Ribeiro, 2005: Four scenarios. In *Ecosystems and Human Well-being: Scenarios, Volume 2. Findings of the Scenarios Working Group of the Millennium Ecosystems Assessment.* S.R. Carpenter, P.L. Pingali, E.M. Bennett, M.B. Zurek, (eds.), Island Press.

Cornillie, J. and S. Fankhauser, 2002: *The energy intensity of transition countries.* Working Paper N.72 EBRD, London, U.K., 25 pp.

Corson, W. (ed.), 1996: *Measuring sustainability: indicators, trends, and performance.* M.E. Sharpe, Armonk, NY, pp. 325-352.

Cowan, B. and N. Mohlakoana, 2005: *Barriers to access modern fuels in low-income households: Khayelitsha.* Energy Research Centre, University of Cape Town, Cape Town.

Cowan, J., E. Eidinow, *Laura Likely,* 2000: A scenario-planning process for the new millennium. *Deeper News*, **9**(1).

Dalal-Clayton, B. (ed.), 2003: *The MDGs and sustainable development: the need for a strategic approach.* IIED, London, pp. 73-91.

Das, A.K and C. Dutta, 2004: Strengthening rural information infrastructure through E-Choupals. In *Proceedings 21st IASLIC National Seminar*, S.B. Ghosh (ed) Kolkata, India.

Dasgupta, P., 1993: *An Inquiry into Well-being and Destitution.* Clarendon Press, Oxford.

Dasgupta, S., K. Hamilton, K. Pandey, D. Wheeler, 2004: *Air pollution during growth: accounting for governance and vulnerability.* Policy Research Working Paper No.3383, World Bank, Washington D.C, USA, 30 pp.

Davidson, O., K. Halsnaes, S. *Huq, M. Kok, B. Metz, Y. Sokona, J. Verhagen*, 2003: The development and climate nexus: the case of sub-Saharan Africa. *Climate Policy,* **3**(S1), pp. S97-S113.

Davidson, O. and Y. Sokona, 2002: *Think bigger, act faster: a new sustainable energy path for African development.* Energy & Development Research Centre, University of Cape Town & ENDA Tiers Monde, Cape Town and Dakar.

Davis, T.S., 1999: Reflecting on voluntary environmental partnerships: Lessons for the next century. *Corporate Environmental Strategy*, **6**(1), pp. 55-59.

De Cara, S., M. Houzé, P.-A. Jayet, 2005: Methane and nitrous oxide emissions from agriculture in the EU: A spatial assessment of sources and abatement costs. *Environmental and Resource Economics*, **32**, pp. 551-583.

De Gouvello, C. and Y. Maigne (eds.), 2000: *L'Electrification Rurale Décentralisée à l'heure des négociations sur le changement climatique.* Systèmes Solaires, Paris, France, pp. 35-60.

De Marchi, B., 2003: Public participation and risk governance. *Science and Public Policy*, **30**(171-176).

De Moor, A., 2001: Towards a grand deal on subsidies and climate change. *Journal Natural Resources Forum,* **25**(2).

Decleris, M., 2000: *The law of sustainable development - General principles*. European Commission.

Deme, P.A., 2003: Le cas du GPL au Sénégal. *In ESMAP: Énergies modernes et réduction de la pauvreté: Un atelier multi-sectoriel. Actes de l'atelier Régional,* Dakar, Sénégal, 4-6 February 2003, 22 pp.

Dietz, T., 2003: The Darwinian trope in the drama of the commons: Variations on some themes by the Ostroms. In *Academic Conference in Honor of the Work of Elinor and Vincent Ostrom*, George Mason University, Arlington, Virginia.

Dietz, T. and P.C. Stern, 1995: Toward a theory of choice: Socially embedded preference construction. *The Journal of Socio-Economics,* **24**, pp. 261-279.

DOE,1989: *Compendium of options for government policy to encourage private sector responses to potential climate change*. US Department of Energy, Washington D.C.

Doppelt, B., 2003: *Leading change toward sustainability: A change-management guide for business, government and civil society.* Greenleaf Publishing Ltd., Sheffield.

Dorian, J.P., H.T. Franssen, *D.R. Simbeck*, 2006: Global challenges in energy. *Energy Policy*, **34**(15), pp. 1984-1991.

Dovers, S. and J. Handmer, 1993: Contradictions in sustainability. *Environmental Conservation,* **20**(3), pp. 217-222.

Dow, R.M. and C.R. Dow, 1998: using solar cookers and gardens to improve health in urban and rural areas. *Journal of American Dietetic Association*, **99**(9), pp. A58.

Driscoll, C. and M. Starik, 2004: The primordial stakeholder: Advancing the conceptual consideration of stakeholder status for the natural environment. *Journal of Business Ethics,* **49**(1), pp. 55-73.

Dryzek, J., 1990: Designs for environmental discourse: The greening of the administrative state. In *Managing Leviathan: Environmental Politics and the Administrative State*. R. Paehlke and D. Torgerson (ed.), Belhaven Press, London, pp. 97-111.

Dryzek, J., 1997: *The politics of the earth: Environmental discourse.* Oxford University Press, Oxford.

Dudhani, S., A.K. Sinha, *S.S. Inamdar*, 2006: Assessment of small hydropower potential using remote sensing data for sustainable development in India. *Energy Policy* **34**(17), pp. 3195-3205.

Dunphy, D., A.Griffiths, S. Benn, 2003: *Organizational change for corporate sustainability: A guide for leaders and change agents of the future.* Routledge, London.

Elkington, J., 2001: *The Chrysalis Economy: How citizen CEOs and corporations can fuse values and value creation.* Capstone, Oxford.

Ellisa, J., H. Winkler, *J. Corfee-Morlot, F, Gagnon-Lebrun*, 2007: CDM: Taking stock and looking forward. *Energy Policy*, **35**(1), pp. 15-28.

Elzen, B. and A. Wieczorek, 2005: Transitions towards sustainability through system innovation. *Technological Forecasting and Social Change*, **72**, pp. 651-661.

Estache, A. and J. Strong, 2000: The rise, the fall, and the emerging recovery of project finance in transport, private sector development. Working Paper 2385, Washington: World Bank Institute.

ESMAP, 2002: *Energy strategies for rural India: Evidence from six states.* World Bank, Washington D.C. Report 258/02.

Fairhead, J. and M. Leach, 2003: *Science, society and power: Environmental knowledge and policy in West Africa and the Carribbean*. Cambridge, Cambridge University Press.

Farsari, Y. and P. Prastacos, 2002: Sustainable development indicators: an overview. Foundation for the Research and Technology Hellas.

Fearnside, P., 2001: The potential for Brazil's forest sector for mitigating global warming under the Kyoto Protocol. *Mitigation and Adaptation Strategies for Global Change*, **6**, pp. 355-372.

Fenhann, J., 2006: *Overview of the CDM Pipeline,* version 09-08-2006. CD4CDM, UNEP-Risoe Centre, Denmark.

Fisher, D.R., 2004: *National governance and the global Climate Change regime*. Rowman and Littlefield Publishers, Inc., Lanham MD.

Forsyth, T., 2005: Building deliberative public-private partnerships for waste management in Asia. *Geoforum*, **36**(4), pp. 429-439.

Frankel, J.A. and A.K. Rose, 2002: *Is trade good or bad for the environment? Sorting out the causality.* National Bureau of Economic Research Working Paper 9201, Cambridge, MA.

Frenk, J., J.L. Bobadilla, *C. Stern, T. Frejka, R. Lozano,* 1993: Elements for a theory of the health transition. In *Health and social change in international perspective*. L.C. Chen, A. Kleinman, and N.C. Ware (eds.), Harvard University Press, Boston.

Funtowicz, S. and J. Ravetz, 1993: Science for a post-normal age. *Futures*, **25**(739-755).

Furuseth, O. and C. Cocklin, 1995: An institutional framework for sustainable resource management: the New Zealand model. *Natural Resources Journal*, **35**(2), pp. 243-273.

Gallagher, K.S., 2006: Limits to leapfrogging in energy technologies? Evidence from the Chinese automobile industry. *Energy Policy*, **34**(383-394).

Gallopin, G.C. and F. Rijsberman, 2000: Three global water scenarios. *International Journal of Water,* **1**(1), pp. 16-40.

Geels, F., 2004: From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory. *Research Policy*, **33**, pp. 897-920.

Geist, H.J. and E.F. Lambim, 2002: Proximate causes and underlying driving forces of tropical deforestation. *Bioscience*, **52**(2), pp. 142-150.

Geller, H., R. Schaeffer, *A. Szklo, M. Tolmasquim,* 2004: Policies for advancing energy efficiency and renewable energy use in Brazil. *Energy Policy*, **32**, pp. 1437-1450.

Giddens, A., 1991: *Modernity and self-identity: Self and society in the late modern age.* Stanford, Stanford University Press.

Giddens, A., 1998: Risk society: The context of British politics. In *The Politics of Risk Society*, J. Franklin, ed., Polity Press, Cambridge, pp. 23-34.

Goklany, I.M., 2006: *Integrated Strategies to Reduce Vulnerability and Advance Adaptation, Mitigation, and Sustainable Development*. <http://members.cox.net/igoklany/Goklany-Integrating_A&M_preprint.pdf> accessed 09/07/07.

Goodwin, M., 1998: The governance of rural areas: some emerging research issues and agendas. *Journal of Rural Studies,* **14**(1), pp. 5-12.

Gough, C. and S. Shackley, 2001: The respectable politics of Climate Change: The Epistemic Communities and NGOs. *International Affairs,* **77**(2).

Government of India, 2006: *Towards faster and more inclusive growth: An approach to the 11th Five Year Plan.* Planning Commission, Government of India.

GRI, 2005: Global Reporting Initiative. <http://www.globalreporting.org> accessed 06/07/07.

Grossman, G.M. and A.B. Krueger, 1991: *Environmental impacts of a North American Free Trade Agreement.* National Bureau of Economic Research Working Paper 3914, NBER, Cambridge, MA.

Grubb, M., 1991: *Energy policies and the greenhouse effect.* Energy and environmental programme, Dartmouth for The Royal Institute of International Affairs, Aldershot.

Gueorguieva, A. and K. Bolt, 2003: *A critical review of the literature on structural adjustment and the environment.* World Bank Environmental Economics Series Paper 90, Washington, D.C.

Gutmann, A. and D. Thompson, 2004: *Why Deliberative Democracy?* Princeton University Press, Princeton.

Haas, P., 1990: *Saving the Mediterranean: the politics of international environmental cooperation.* Columbia University Press, New York City.

Haas, P., R.O. Keohane, *M.A. Levy* (eds.), 1993: *Institutions for the earth*. The MIT Press, Cambridge, MA.

Haas, P.M., 2004: When does power listen to truth? A constructivist approach to the policy process. *Journal of European Public Policy*, **(11)**, pp. 569-592.

Hajer, M., 1995: *The politics of environmental discourse.* Oxford University Press, Oxford.

Hajer, M. and H. Wagenaar (eds.), 2003: *Deliberative policy analysis: Understanding governance in the network society.* Cambridge University Press, Cambridge.

Hale, T., 2004: Thinking globally and acting locally: Can the Johannesburg Partnerships coordinate action on sustainable development? *Journal of Environment and Development*, **3**, pp. 220-239.

Hamilton, K., G. Anderson*, D. Pearce*, 1997: *Genuine savings as an indicator of sustainability.* CSERGE Working Paper GEC 97-03, Centre for Social and Economic Research and the World Bank

Hamilton, K., T.L Brewer, T. Aiba, T. Sugiyama, J. Drexhage, 2003: Module 2: Corporate engagement in US, Canada, the EU and Japan and the influence on domestic and international policy. In *The Kyoto-Marrakech System: A Strategic Assessment.* M. Grubb, T. Brewer, B. Müller, J. Drexhage, K. Hamilton, T. Sugiyama, T. Aiba, <http://www.iccept.ic.ac.uk/a5-1.html> accessed 06/07/07.

Hamilton, K. and M. Kenber, 2006: *Business views on international climate and energy*. The Climate Group, UK, 56 pp.

Handley, P., 1997: A critical view of the Build-Operate-Transfer privatisation process in Asia. *Asian Journal of Public Administration*, **19**(2), 203-243.

Harbaugh, W.T., A. Levinson, D. Wilson, 2002: Reexamining the empirical evidence for an environmental Kuznets curve. *The Review of Economics and Statistics*, **84**(3), pp. 541-551.

Hardi, P. and T. Zdan (eds.), 1997: *Assessing Sustainable Development: Principles in practice.* International Institute for Sustainable Development, Winnipeg.

Hasselmann, K., M. Latif, G. Hooss, C. Azar, O. Edenhofer, C. C. Jaeger, 2003: The challenge of long-term climate change. *Science,* **302**, pp. 1923-1925.

Hawken, P., A. Lovins, L. Hunter, 1999: *Natural capitalism: The next industrial revolution.* Earthscan, London.

Heil, M.T. and T.M. Selden, 2001: Carbon emissions and economic development: future trajectories based on historical experience. *Environment and Development Economics*, **6**(1), pp. 63-83.

Heller, T.C. and P.R. Shukla (eds.), 2003: *Development and climate: Engaging developing countries.* Pew Center on Global Climate Change, Arlington, 111 pp.

Helm, D., 2002: Energy policy: security of supply, sustainability and competition. *Energy Policy*, **30**, pp. 173-184.

Herzog, T., K.A. Baumert, J. Pershing, 2006: *Target: Intensity. An analysis of greenhouse gas intensity targets.* World Resources Institute, Washington D.C. <http://www.wri.org/climate/pubs_description.cfm?pid=4195> accessed 06/07/07.

Holliday, C., 2001: Sustainable growth, the DuPont Way. *Harvard Business Review,* September, pp. 129-134.

Holliday, C., S. Schmidheiny, P. Watts, 2002: *Walking the talk: The business case for sustainable development.* Greenleaf Publishing, San Francisco.

Hollingworth, J.R. and R. Boyer, 1997: *Contemporary Capitalism: The embeddedness of institutions,* Cambridge Press.

Hourcade, J.C. and M. Kostopoulou, 1994: Quelles politiques face aux chocs énergétiques. France, Italie, Japon, RFA: quatre modes de résorption des déséquilibres. *Futuribles,* **189,** pp. 7-27.

Hourcade, J.C., P. Shukla, L. Cifuentes, D. Davis, J. Edmonds, B. Fisher, E. Fortin, A. Golub, O. Hohmeyer, A. Krupnick, S. Kverndokk, R. Loulou, R. Richels, H. Segenovic, K.Yamaji , 2001: Global, Regional and National Costs and Ancillary Benefits. In *2001 Climate Change 2001: Mitigation,* B. Metz, O. Davidson, R. Swart, and J. Pan (ed.), Cambridge University Press, Cambridge.

Howes, M., 2005: *Politics and the environment: Risk and the role of government and industry.* Allen and Unwin, Sydney.

Hueting, R. (ed.), 1993: *Calculating a sustainable national income. A practical solution for a theoretical dilemma.* Nagard, Milan.

Hulme, D. and M. Edwards, 1997: NGOs, states and donors: An overview. In *NGOs, States and Donors: Too Close for Comfort?* D. Hulme and M. Edwards (ed.), St. Martin's Press, New York.

Huq, S., H. Reid, L. Murray, 2003: *Mainstreaming adaptation to Climate Change in least developed countries.* Working Paper 1: Country by Country Vulnerability to Climate Change, IIED, <http://www.iied.org/pubs/pdf/full/10002IIED.pdf> accessed 09/07/07.

IEA, 2003a: Energy balance of OECD Countries. International Energy Agency/OECD, Paris. <www.iea.org> accessed 06/07/07.

IEA, 2003b: *Key World Energy Statistics from the IEA.* International Energy Agency/OECD, Paris.

IEA, 2004a: *Analysis of the impact of high oil prices on the global economy.* International Energy Agency, Paris, 15 pp.

IEA, 2004b: *CO_2 emissions from fuel combustion 1971-2002*. International Energy Agency, Paris, France.

IEA, 2004c: *Oil Crises and Climate Challenges: 30 Years of Energy Use in IEA Countries.* International Energy Agency, Paris.

IEA, 2005: *World Energy Outlook. International Energy Agency, Paris*.

IEA, 2006: CO_2 emissions from Fuel Combustion, 1971-2004. *International Energy Agency, Paris*.

IISD, 2006: *Compendium of Sustainable Development Indicator Initiatives*. International Institute for Sustainable Development, Winnipeg, MB, Canada, <http://www.iisd.org/measure/compendium/> accessed 06/07/07.

Innovest, 2005: *Carbon Disclosure Project 2005.* Carbon Disclosure Project, London, 154 pp.

IPCC, 1996: *Estimating the costs of mitigating greenhouse gases.* Intergovernmental Panel on Climate Change (IPCC), Cambridge University Press, Cambridge, UK., pp. 263-296.

IPCC, 2000: *Special Report on Emissions Scenarios.* Intergovernmental Panel on Climate Change (IPCC), Cambridge University Press, Cambridge, UK.

IPCC, 2001: *Setting the stage: climate change and sustainable development.* Intergovernmental Panel on Climate Change (IPCC), Cambridge University Press, Cambridge, UK.

IPCC, 2001b: *Climate Change 2001: Mitigation* - Contribution of Working Group III to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) [Metz, B., O. Davidson, R. Swart, and J. Pan (eds.)]. Cambridge University Press, Cambridge, 700 pp.

IPCC, 2007: *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, C.E. Hanson (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Irwin, T., M. Klein, G.E. Perry, M. Thobani, 1999: Managing government exposure to private infrastructure risks. World Bank Research Observer., **14**, pp. 229-245.

IUCN, 1980: *World conservation strategy: Living resources conservation for sustainable development.* International Union for the Conservation of Nature, United Nations Environment Programme, Worldwide Fund for Nature, Switzerland.

Jacoby, H.G., 2000: Access to markets and the benefits of rural roads. *Economic Journal,* **110**, pp. 713-737. <http://europa.sim.ucm.es/compludoc/GetSumario?r=/W/10001/00130133_7.htm&zfr=0> accessed 06/07/07.

Jahan, S. and A. Umana, 2003: The environment-poverty nexus. *Development Policy Journal*, **3,** pp. 53-70.

Jannuzzi, G.M., 2005: Power sector reforms in Brazil and its impacts on energy efficiency and research and development activities. *Energy Policy*, **33**, pp. 1753-1762.

Jasanoff, S., 1986: *Risk management and political culture: a comparative study of science in the policy context.* Russell Sage Foundation, New York.

Jasanoff, S., 1990: *The fifth branch: Science advisers as policymakers.* Cambridge, Mass.

Jasanoff, S. and B. Wynne, 1998: Science and decisionmaking. In *Human Choice and Climate Change,* S. Rayner and E.L. Malone (ed.), Battelle Press., Columbus, OH, pp. 1-87.

Jessop, R., 1997: Capitalism and its future: Remarks on regulation, government and governance. *Review of International Political Economy,* **4**, pp. 561-581.

Jiang, K., Z. Dadajie, J. Hui, L. Eda, 2003: *Country Study: China.* Energy Research Institute and Academy for Agriculture Science, Beijing, China.

Jochem, E., J. Sathaye, D. Bouille, 2001: *Society, behaviour, and climate change mitigation.* Kluwer Academic Publishers, The Netherlands.

Jordan, L. and P. van Tuijl (eds.), 2006: *NGO Accountability: politics, principles and innovations.* Earthscan, London.

Kahane, A., 2002: *An overview of multi-stakeholder civic scenario work. Global Business Network,* <http://www.generonconsulting.com/publications/> accessed 06/07/07.

Kaimowitz, D., G. Thiele, P. Pacheco, 1999: The effects of structural adjustment on deforestation and forest degradation in lowland Bolivia. *World Development,* **27**(3), pp. 505-520.

Kaivo-oja, J., J. Luukkanen, M. Wilenius, 2004: Defining alternative national-scale socio-economic and technological futures up to 2100: SRES scenarios for the case of Finland. *Boreal Environment Research,* **9**, pp. 109-125.

Karekezi, S. and L. Majoro, 2002: Improving modern energy services for Africa's urban poor. *Energy Policy*, **30**(Special Issue), pp. 1015-1028.

Kaya, Y., 1990: Impact of Carbon Dioxide Emission Control on GNP Growth: Interpretation of Proposed Scenarios. Paper presented to the IPCC Energy and Industry Subgroup, Response Strategies Working Group, Paris.

Kaygusuz, K., 2002 Sustainable development of hydropower and biomass energy in Turkey. *Energy Conversion and Management,* **43**(8), pp. 1099-1120.

Kelman, S., 1981: *Regulating America, regulating Sweden: a comparative study of occupational safety and health policy.* MIT Press, Cambridge, Mass.

Kessides, I.N., 2004: *Reforming infrastructure: privatization, regulation and competition.* Washington D.C, World Bank, 306 pp.

Kok, M., W. Vermeulen, W.J.V. Vermeulen, A.P.C. Faaij, D. de Jager, 2000: *Global warming and social innovation: The challenge of a climate-neutral society.* Earthscan, United Kingdom, 242 pp.

Kok, M.J.T. and H.C. de Coninck, 2004: *Beyond climate: Options for broadening climate policy.* RIVM report 500019001, Bilthoven, The Netherlands.

Kotov, V., 2002: *Policy in transition: New framework for Russia's climate policy.* Fondazione Eni Enrico Mattei (FEEM), Milano, Italy, Report-58.2002.

KPMG Global Sustainability Services, 2005: *KPMG International Survey of Corporate Responsibility Reporting 2005.*

Kumar, P., 2001: *Valuation of ecological services of wetland ecosystems: A case study of Yamuna flood plains in the corridors of Del*hi. Mimeograph, Institute of Economic Growth, Delhi.

Kunreuther, H., J. Linnerooth, R. Starnes, (eds.), 1982: *Liquified energy gas facility siting: International comparisons.* IIASA, Laxenburg, Austria.

La Rovere, E.L. and B. Americano, 1999: *Assessment of global environmental impacts of PROCEL: GHG emissions avoided by PROCEL 1990-2020.* Final Report to Electrobrás, Rio de Janeiro, Brazil.

La Rovere, E.L. and A.R. Romeiro, 2003: *Country study: Brazil.* Centroclima - COPPE/UFRJ and UNICAMP/EMBRAPA, Rio de Janeiro, Brazil.

Lafferty, W., 1996: The politics of sustainable development: global norms for national development. *Environmental Politics*, **5,** pp. 185-208.

Lecocq, F. and K. Capoor, 2005: *State and trends of the carbon market 2005.* Prototype Carbon Fund and International Emissions Trading Association, Washington D.C.

Lehtonen, M., 2004: The environmental-social interface of sustainable development: capabilities, social capital, institutions. *Ecological Economics*, **49**(2), pp. 199-214.

Levi-Faur, D., 2005: The global diffusion of regulatory capitalism. *Annals of the American Academy of Political and Social Sciences*, **598,** pp. 12-32.

Levine, P., 2000: The new progressive era: Toward a fair and deliberative democracy. Rowman & Littlefield Pub. Inc.

Levy, D. and P. Newell, 2000: Oceans apart? Business responses to global environmental issues in Europe and the United States. *Environment*, **42**(9), pp. 9-20.

Levy, D.L. and P.J. Newell, 2005: *The Business of Global Environmental Governance.* MIT Press, Cambridge, MA and London.

Lewis, J.L. and R.H. Wiser, 2007: Fostering a renewable energy technology industry: An international comparison of wind industry policy support mechanism. *Energy Policy* **35,** pp. 1844-1857.

Lewis, N., W. Moran, C. Cocklin, 2002: Restructuring, regulation and sustainability. In *The Sustainability of Rural Systems: Geographical Interpretations*. I. Bowler, C. Bryant, and C. Cocklin (ed.), Kluwer Academic, Dordrecht, pp. 97-121.

Liberatore, A., and S. Funtowicz, 2003: 'Democratising' expertise, 'expertising' democracy: what does this mean, and why bother? *Science and Public Policy,* **30**, pp. 146-155.

Lindquist, L., 1980: *The hare and the tortoise: Clean air policies in the United States and Sweden.* University of Michigan Press, Ann Arbor.

Lindseth, G., 2004: The cities for climate protection campaign (CCPC) and the framing of local climate policy. *Local Environment,* **9**, pp. 325-336.
Liverman, D.M., 1999: Geography and the global environment. *Annals of the Association of American Geographers*, **89**.
Lyon, T., 2003: 'Green' firms bearing gifts. *Regulation*, Fall, pp. 36-40.
MA, 2005: *Current state and trends.* Millenium Ecosystems Assessment, Island Press, Washington D.C.
Machado, G., R. Schaeffer, E. Worrell, 2001: Energy and carbon embodied in the international trade of Brazil: an input-output approach. *Ecological Economics*, **39,** pp. 409-424.
Markandya, A. and K. Halsnaes (eds.), 2002: *Climate change and sustainable development: prospects for developing countries.* Earthscan Publications, London.
Marsden, C., 2000: The new corporate citizenship of big business: Part of the solution to sustainability? *Business and Society Review*, **105**(1), pp. 9.
Masera, O.R., B.D. Saatkamp, D.M. Kammen, 2000: From linear fuel switching to multiple cooking strategies: A critique and alternative to the energy ladder model. *World Development*, **28**(12), pp. 2083-2103.
Mathy, S., J.-C. Hourcade, C. de Gouvello, 2001: Clean development mechanism: leverage for development? *Climate Policy*, **1**, pp. 251-268.
McCully, P., 2001: *Silenced rivers: The ecology and politics of large dams*. Zed Books, London.
Meadowcroft, J., 1997: Planning for sustainable development: Insights from the literatures of political science. *European Journal of Political Research,* **31,** pp. 427-454.
Meadowcroft, J., 2000: Sustainable development: a new(ish) idea for a new century. *Political Studies*, **48**(2), pp. 370-387.
Meadows, D.H., 1998: *Indicators and information systems for sustainable development.* A Report to the Balaton Group. The Sustainability Institute, Hartland Four Corners, VT, <http://sustainabilityinstitute.org/pubs/Indicators&Information.pdf> accessed 06/07/07.
Mebratu, D., 1998: Sustainability and sustainable development: historical and conceptual review. *Environmental Impact Assessment Review*, **18**, pp. 493-520.
Metz, B., M. Berk, M. den Elzen, B. de Vries, D. van Vuuren, 2002: Towards an equitable climate change regime: compatibility with Article 2 of the climate change convention and the link with sustainable development. *Climate Policy*, **2**, pp. 211-230.
Metz, B., O. Davidson, H. de Coninck, M. Loos, L.A. Meyer, (eds.), 2005: *Special Report on Carbon Dioxide Capture and Storage Special Report of the Intergovernmental Panel on Climate Change (IPCC),* Cambridge University Press, Cambridge.
Michaelowa, A., 1998: Climate policy and interest groups: A public choice analysis. *Intereconomics,* **33**(6), pp. 251-259.
Michaelowa, A., 2003: CDM host country institution building. *Mitigation and Adaptation Strategies for Global Change*, **8**, pp. 201-220.
Millimet, D.L., J.A. List, T. Stengos, 2003: The environmental Kuznets curve: Real progress or misspecified models? *Review of Economics and Statistics*, **85**(4), pp. 1038-1047.
Mills, E., 2003: The insurance and risk management industries: New players in the delivery of energy-efficient products and services. *Energy Policy*, **31**, pp. 1257-1272.
Mills, E., 2005: Insurance in a climate of change. In *Science*, **12**(August), pp. 1040-1044.
MNP, 2005: *Quality and the future. Sustainability outlook.* Netherlands Environmental Assessment Agency, Bilthoven, Netherlands, 500013010, 28 pp.
Modi, V., S. McDade, L. Lallement, J. Saghir, 2006: *Energy Services for the Millenium Development Goals.* Energy Sector Management Assistance Program, United Nations Development Programme, UN Millennium Project, World Bank, New York, USA, 109 pp.
Moldan, B., S. Billharz, R. Matravers (eds.), 1997: *Sustainability indicators: A report on the project on indicators of sustainable development.* SCOPE Report no. 58. Wiley, Chicester, UK.
Moomaw, W.R. and G.C. Unruh, 1997: Are environmental Kuznets curves misleading us? The case of CO_2 emissions. *Environment and Development Economics*, **2,** pp. 451-463, <http://ase.tufts.edu/gdae/publications/archives/moomawpaper.pdf> accessed 06/07/07.
Morita, T. and H. Lee, 1998: IPCC Scenario Database. *Mitigation and Adaptation Strategies for Global Change*, **3**(2-4), pp. 121-131.
Morita, T., N. Nakicenovic, J. Robinson, 2000: Overview of Mitigation Scenarios for Global Climate Stabilization Scenarios based on the new IPCC Emissions Scenarios (SRES). *Environmental Economics and Policy Studies*, **3**(2).
Morita, T., J. Robinson, *A. Adegbulugbe, J. Alcamo, D. Herbert, E.L. La Rovere, N. Nakicenovic, H. Pitcher, P. Raskin, K. Riahi, A. Sankovski, V. Sokolov, B. de Vries, D. Zhou,* 2001: Greenhouse gas emission mitigation scenarios and implications (Chapter 2). In *Climate Change 2001 - Mitigation.* Report of working group III of the Intergovernmental Panel on Climate Change (IPCC). B. Metz, O. Davidson, R. Swart, and J. Pan (ed.), Cambridge University Press, Cambridge, pp. 115-166.
Munasinghe, M., 1992: *Environmental economics and sustainable development.* The World Bank, Washington D.C.
Munasinghe, M. and W. Cruz (eds.), 1995: *Economy wide policies and the environment: Lessons from experience.* World Bank Environment Paper, Washington D.C, USA, 86 pp.
Munasinghe, M. and R. Swart (eds.), 2000: *Climate change and its linkages with development, equity and sustainability.* Intergovernmental Panel on Climate Change, Geneva.
Munasinghe, M., 2000, Development, equity and sustainability (DES) in the context of Climate Change. In *Climate Change and its linkages with development, equity and sustainability,* M. Munasinghe and R. Swart (eds.), Intergovernmental Panel on Climate Change, Geneva.
Nadel, S., 1997: *Energy efficiency and economic development in New York, New Jersey, and Pennsylvania.* American Council for an Energy Efficient Economy, Washington D.C.
Najam, A., 1996: Understanding the Third Sector: Revisiting the prince, the merchant and the citizen. *Nonprofit Management and Leadership,* **7**(2), pp. 203-19.
Najam, A., 1999: World business council for sustainable development: The greening of business or a greenwash? In *Yearbook of International Co-operation on Environment and Development 1999/2000,* H.O. Bergesen, G. Parmann, and Ø.B. Thommessen ed. Earthscan Publications, London, pp. 65-75.
Najam, A., 2000: The four C's of third sector-government relations: Cooperation, confrontation, complementarity, and co-optation. *Nonprofit Management and Leadership,* **10**(4), pp. 375-396.
Najam, A., I. Christopoulou, W.R. Moomaw, 2004: The emergent 'system' of global environmental governance. *Global Environmental Politics*, **4**(23-35).
Najam, A. and C. Cleveland, 2003: Energy and sustainable development at global environmental summits: An evolving agenda. *Environment, Development and Sustainability*, **5**(2), pp. 117-138.
Najam, A. and T. Page, 1998: The Climate Convention: Deciphering the Kyoto Convention. *Environmental Conservation*, **25**(3), pp. 187-194.
Najam, A., A. Rahman, S. Huq, Y. Sokona, 2003: Integrating sustainable development into the fourth IPCC assessment. *Climate Policy*, Special Issue on Climate Change and Sustainable Development, **3**(Supplement 1), pp. S9-S17.
Nakicenovic, N. and R. Swart (eds), 2000: *Emissions Scenarios*. *Special Report of the Intergovernmental Panel on Climate Change (IPCC)*. Cambridge University Press, London.
Nelson, R.R. (ed.), 1993: *National innovation systems. A comparative analysis.* Oxford, New York.
Newell, P., 2000: *Climate for change: Nonstate actors and the global politics of the greenhouse.* Cambridge University Press, Cambridge, UK.
Newman, P.W.G. and J.R. Kenworthy, 1991: *Cities and automobile dependence, an international sourcebook.* Avebury Technical Publishing, Aldershot, UK.

NIC, 2004: *Mapping the global future.* National Intelligence Council, Washington, D.C.

Nivola, P.S., 1999: *Laws of the landscape: How policies shape cities in Europe and America.* Brookings Institution Press, Washington, D.C., USA, 126 pp.

O'Riordan, T., C.L. Cooper, A. Jordan, S. Rayner, K. Richards, P. Runci, and S. Yoffe, 1998: *Institutional frameworks for political action. Human Choice and Climate Change.* Battelle Press, Ohio, 345-370 pp.

O'Riordan, T. and S. Stoll-Kleeman, 2002: Deliberative democracy and participatory biodiversity. In *Biodiversity, Sustainability and Human Communities: Protecting Beyond the Protected.* T. O'Riordan, and S.S.-K. (eds.) ed. Cambridge University Press, Cambridge, pp. 87-112.

OECD, 1998: Sustainable development indicators. In *OECD Expert Workshop*, Organization of Economic Co-operation and Development (OECD), Paris.

OECD, 2001: *Sustainable development: Critical issues.* Organization of Economic Co-operation and Development (OECD), Paris.

OECD, 2005: *Health at a Glance, OECD Indicators*. Organization of Economic Co-operation and Development (OECD), Paris.

OECD, 2002: *Reforming energy subsidies. UN Environmental Programme and Organisation for Economic Cooperation and Development.* OECD/IEA, Oxford, UK, 31 pp.

Ogilvy, J. and P. Schwartz, 2000: *China's futures: Scenarios for the world's fastest growing economy, ecology, and society.* Jossey-Bass, San Francisco.

Opschoor, J.B., 1995: Ecospace and the fall and rise of throughput intensity. *Ecological Economics*, **15**, pp. 137-141.

Ostrom, E., 1990: *Governing the commons: The evolution of institutions for collective action.* Cambridge University Press, Cambridge.

Ostrom, E., 2000: Collective actions and the evolution of norms. *Journal of Economic Perspectives*, **14**, pp. 137-158.

Ostrom, E., T. Dietz, N. Dolsak, P.C. Stern, S. Stonich, E.U. Weber (eds.), 2002: *The drama of the commons.* National Academy Press, Washington, D.C.

Ott, H.E., H. Winkler, B. Brouns, S. Kartha, M. Mace, S. Huq, Y. Kameyama, A.P. Sari, J. Pan, Y. Sokona, P.M. Bhandari, A. Kassenberg, E.L. La Rovere, A. Rahman, 2004: *South-North dialogue on equity in the greenhouse. A proposal for an adequate and equitable global climate agreement.* Eschborn, GTZ.

Palmer, K. and R. Newell, K. Gillingham, 2004: *Retrospective Examination of Demand-side Energy-efficiency Policies*, Discussion Papers dp-04-19, Resources for the Future. <http://www.rff.org/documents/RFF-DP-04-19REV.pdf> accessed 06/07/07.

Pan, J., 2003: Emissions rights and their transferability: equity concerns over climate change mitigation, International Environmental Agreements. *Politics, Law and Economics*, **3**(1), pp. 1-16.

Pan, J., 2004a: China's industrialization and reduction of greenhouse emissions. *China and the World Economy* **12**, no.3. <old.iwep.org.cn/wec/**2004**_5-6/**china**'**s**%20**industrialization**.pdf> accessed 31/05/07.

Pan, J., 2004b: Meeting human development needs: emissions reductions from a developing country perspective. *IDS Bulletin on Climate Change and Development,* July 2004, **35**(3), pp. 90-97.

Pan, J. 2004: Industrialisation and emissions reductions: challenges and opportunities. *China and World Economy*, **3,** pp. 1-16.

Pandey, K.D. and D. Wheeler, 2001: *Structural adjustment and forest resources: The impact of World Bank operations.* World Bank Policy Research Working Paper 2584, Washington, D.C.

Parris, T. and R. Kates, 2003: Characterizing and measuring sustainable development. *Annual Review of Energy & the Environment,* **28**, pp. 559-586.

Paterson, M., D. Humphreys, l. Pettiford, 2003: Conceptualizing global environmental governance: from interstate regimes to counter-hegemonic struggles. *Global Environmental Politics*, **3,** pp. 1-10.

Pearce, D., 2000: The policy relevance and use of aggregate indicators: Genuine savings. In *OECD Proceedings, Frameworks to Measure Sustainable Development. An OECD Expert Workshop*. OECD, Paris.

Pearce, D., A. Markandya, E.B. Barbier, 1989: *Blueprint for a green economy*. Earthscan, London.

Petrich, C.H., 1993: Indonesia and global climate change negotiations: potential opportunities and constraints for participation, leadership, and commitment. *Global and Environmental Change,* **3**(1), pp. 53-77.

Pezzoli, K., 1997: Sustainable development: A transdisciplinary overview of the literature. *Journal of Environmental Planning and Management*, **40**(5), pp. 549-574.

Phadke, A., J. Sathaye, S. Padmanabhan, 2005: *Economic benefits of reducing Maharashtra's electricity shortage through end-use efficiency improvement.* LBNL-57053.

Pharaoh, A., 2003: Corporate reputation: the boardroom challenge. Corporate Governance, *International Journal of Business in Society*, **3**(4), pp. 46-51.

Pimbert, M. and T. Wakeford, 2001: Overview - deliberative democracy and citizen empowerment. *PLA Notes*, **40**(February), pp. 23-28.

Pintér, L., P. Hardi, B. Bartelmus, 2005: *Sustainable Development Indicators - The way forward. December 15-17, 2005* Expert Group Meeting of the United Nations Division for Sustainable Development, Winnipeg, IISD for the UN-DSD, <http://www.iisd.org/pdf/2005/measure_indicators_sd_way_forward.pdf> accessed 06/07/07.

Porritt, J., 2005: Healthy environment-healthy people: The links between sustainable development and health. *Public Health*, **119**(11), pp. 952-953.

Porter, M. and M. Kramer, 2002: The competitive advantage of corporate philanthropy. *Harvard Business Review*, **80**(12), pp. 56-68.

Porter, M. and C. van der Linde, 1995: Green and competitive: Ending the stalemate. *Harvard Business Review*, **73**(5), pp. 120-133.

Post, J., L.E. Preston S. Sauter-Sachs, 2002: *Redefining the corporation: Stakeholder management and organizational wealth.* Stanford Business Books, Stanford.

Prasad, G. and H. Ranninger, 2003: *The social impact of the basic electricity support tariff (BEST). Domestic use of energy.* Cape Technikon, pp. 17-22, Cape Town.

PRC, 2004: *Initial National Communication on Climate Change.* China Planning Press, Beijing, People's Republic of China, 80 pp.

Prud'homme, R. and J.P. Bocarejo, 2005: The London congestion charge: a tentative economic appraisal. *Transport Policy*, **12**, pp. 279-287.

Putnam, R., 1993: *Making democracy work: Civic traditions in modern Italy.* Princeton University Press, Princeton.

Rabinovitch, J. and J. Leitman, 1993: *Environmental innovation and management in Curitiba, Brasil.* UNDP/UNCHS/World Bank, Washington, D.C, 62 pp.

Rahman, A., M. Alam, Z. Karim, K. Islam, 2003: *Bangladesh country case study*. Bangladesh Centre for Advanced Studies, Dhaka, Bangladesh.

Rao, C.H., 1994: *Agricultural growth, rural poverty and environmental degradation in India.* Oxford University Press, Delhi.

Raskin, P., G. Gallopin, P. Gutman, A. Hammond, R. Swart, 1998: *Bending the curve: Toward global sustainability. A* Report of the Global Scenario Group. Stockholm Environment Institute, Boston.

Ravallion, M., M. Heil, J. Jalan, 2000: Carbon emissions and income inequality. *Oxford Economic Papers,* **52**, pp. 651-669.

Ravindranath, N.H. and J.A. Sathaye, 2002: *Climate Change and Developing Countries.* Kluwer, 300 pp.

Rayner, S. and E. Malone (eds.), 1998*: Human choice and climate change* (4 volumes). Batelle Press, Columbus, Ohio.

Rayner, S. and E. Malone, 2000: Security, governance and the environment. In: *Environment and Security: Discourses and Practices.* Lowi, M. and B. Shaw (ed.) Macmillan, Basingstoke.

Rayner, S. and K.R. Richards, 1994: *I think that I shall never see ... a lovely forestry policy. Land use programs for conservation of forests.* In Workshop of IPCC WGIII, Tsukuba.

Rayner, S., 1993: National case studies of institutional capabilities to implement greenhouse gas reductions. *Global Environmental Change*, **3**(Special issue), pp. 7-11.

Redclift, M. and T. Benton (eds.), 2006: *Social movements and environmental change.* WHO (World Health Organization), 2006. London and New York: Routledge, pp. 150-168.

Reed, D. (ed.), 1996: *Structural adjustment, the environment, and sustainable development.* Earthscan, London.

Rees, W.E., 1996: Revisiting carrying capacity: Area based indicators of sustainability. Population and Environment. *A Journal of interdisciplinary Studies*, **17**(39).

Renn, O., 2001: The role of social science in environmental policy making: experiences and outlook. *Science and Public Policy* **28**, pp. 427-437.

Rhodes, R., 1996: The new governance: Governing without government. *Political Studies*, **XLIV**, pp. 652-657.

Richardson, J., G. Gustafsson, G. Jordan (eds.), 1982: *The concept of policy style.* George Allen & Unwin, London.

Rieu-Clarke, A.S., 2004: Sustainable use and the EC Water Framework Directive: From principle to practice? In *International Law and Sustainable Development.* N. Schrijver and F. Weiss (ed.), Martinus Nijhoff Publishers, The Netherlands, pp. 714.

Robinson, J., M. Bradley, P. Busby, D. Connor, A. Murray, B. Sampson, W. Soper, 2006: Climate change and sustainable development: Realizing the opportunity. *Ambio*, **35**(1), pp. 2-8.

Robinson, J., 2004: Squaring the circle? Some thoughts on the idea of sustainable development. *Ecological Economics*, **48**, pp. 369-384.

Robinson, J. and D. Herbert, 2001: Integrating climate change and sustainable development. *International Journal of Global Environmental Issues,* **1**(2), pp. 130-148.

RSA, 1998: National Environmental Management Act (Act 107 of 1998). Republic of South Africa, Department of Environmental Affairs and Tourism, Pretoria.

Ruebbelke, D., 1998: Entropic limits of irreversible processes and possible adaptation mechanism for a sustainble development. *World Resources Review,* **10**(2).

Sachs, W., 1999: Sustainable development and the crisis of nature: On the political anatomy of an oxymoron. In *Living with Nature*. F. Fischer and M. Hajer (ed.), Oxford Scholarship Online, Oxford, pp. 23-42.

Santos, G. and G. Fraser, 2006: Road pricing: Lessons from London. *Economic Policy* (April), pp. 263-310.

Sarkar, A.U. and S. Karagoz, 1995: Sustainable development of Hydroelectric Power. *Energy* **20**(10), pp. 977-981.

Sathaye, J., S. de la Rue du Can, S. Kumar, M. Iyer, C. Galitsky, A. Phadke, M. M'cNeill, L. Price, R. Bharvirkar, 2006: *Implementing end-use efficiency improvements in India: Drawing from experience in the US and other countries.* LBNL-60035.

Sathaye, J., P. Monahan, A. Sanstad, 1996: Costs of reducing carbon emissions from the energy sector: China, India, and Brazil, *AMBIO*, **25**(4).

Sathaye, J. and S. Murtishaw, 2005: *Market failures, consumer preferences, and transaction costs in energy efficiency purchase decisions. Lawrence Berkeley National Laboratory for the California Energy Commission,* PIER Energy-Related Environmental Research. CEC-500-2005-020/ LBNL-57318.

Schaefer, A. and A. Crane, 2005: Addressing sustainability and consumption. *Journal of Macromarketing,* **1**, pp 76-92.

Schaeffer, R. and A. Szklo, 2001: Future electric power technology choices of Brazil: a possible conflict between local pollution and global climate change. *Energy Policy*, **29**(5), pp. 355-369.

Schaltegger, S., R. Burritt, H. Petersen, 2003: *An introduction to corporate environmental management: Striving for sustainability.* Greenleaf Publishing, UK.

Schipper, L., M. Ting, M. Khrushch, W. Golove, 1997: The evolution of carbon dioxide emissions from energy use in industrialized countries: An end-use analysis. *Energy Policy,* **25**, pp. 651-672.

Schipper, L., S. Murtishaw, F. Unander, 2001: International comparisons of sectoral carbon dioxide emissions using a cross-country decomposition technique. *The Energy Journal,* **22**(2), pp. 35-75.

Schmalensee, R., T.M. Stoker, R.A. Judson, 1998: World carbon dioxide emissions 1950-2050. *Review of Economics and Statistics*, **80**(1), pp. 15-27.

Schmidt, V., 2002: *The Futures of European Capitalism.* Oxford University Press.

Schneider, S.H., W. Easterlig, L.O. Mearns, 2000: Adaptation: Sensitivity to natural variability, agent assumptions and dynamic climate changes. *Climatic Change*, **45**(1), pp. 203-221.

Schumacher, K. and J. Sathaye, 2000: Carbon emissions trends for developing countries and countries with economies in transition. LBNL-44546. *Quarterly Journal of Economic Research*, **4**(Special Issue: Energy Structures Past 2000).

Senge, P. and G. Carstedt, 2001: Innovating our way to the next industrial revolution. *MIT Sloan Management Review*, **Winter,** pp. 24-38.

Sharma, S., 2002: Research in corporate sustainability: What really matters? In *Research in Corporate Sustainability: The Evolving Theory and Practice of Organisations in the Natural Environment*. S. Sharma and M. Starik (ed.), Edward Elgar, Cheltenham, pp. 1-22.

Shell, 2005: *The Shell Global Scenarios to 2025: The business environment: trends, trade-offs and choices.* Shell, London.

Shove, E., L. Lutzenhiser, S. Guy, B. Hackett, H. Wilhite, 1998: Energy and social systems. In *Human Choice and Climate Change, Vol. 2 Resources and Technology*. S. Rayner and E.L. Malone (ed.), Battelle Press, Columbus, OH.

Shui, B. and R.C. Harriss, 2006: The role of CO_2 embodiment in US-China trade. <http://www.globalchange.umd.edu/publications/94/> accessed 06/07/07.

Shukla, P., R. Nair, M. Kapshe, A. Garg, S. Balasubramaniam, D. Menon, K.K. Sharma, 2003: *Development and climate: An assessment for India.* Indian Institute of Management, Ahmedabad.

Shukla, P.K., T. Heller, D.G. Victor, D. Biswas, T. Nag, A. Yajnik, 2005: *Electricity reforms in India: Firm choices and emerging generation markets.* Tata McGraw Hill, New Delhi.

SID/IEA, 2000: *Kenya at the crossroads: scenarios for our future.* Society for International Development and the Institute of Economic Affairs, Nairobi, Kenya.

Siebenhuner, B., 2002: How do scientific assessments learn? Conceptual Framework and Case Study of the IPCC. *Environmental Science and Policy*, **5**(5), pp. 411-420.

Sims, R.E.H., 2003: Bioenergy to mitigate for climate change and meet the needs of the society, the economy and the environment. *Adaptation and Mitigation Strategies for Global Change*, **8**(4), pp. 349-370. <http://www.springerlink.com/app/home/contribution.asp?wasp=23tl pnyvqm1j502g9m7j&referrer=parent&backto=issue,2,7;journal,5,31; searchpublicationsresults,1,2;> acessed 06/07/07.

SLG, 2001: *Learning to manage global environmental risks: A comparative history of climate change, ozone depletion and acid precipitation.* Social Learning Group, MIT Press, Cambridge, MA.

Smit, B., O. Pilifosova, I. Burton, B. Challenger, S. Huq, R.J.T. Klein, G. Yohe, 2001: Adaptation to climate change in the context of sustainable development and equity. I *Climate Change 2001: Impacts, Adaptation and Vulnerability.* J. McCarthy, O. Canziani, N. Leary, D. Dokken, and K. White (ed.), Cambridge University Press, Cambridge.

Smith, A., 2003: Transforming technological regimes for sustainable development: a role for alternative technology niches? *Science and Public Policy,* **2,** pp. 127-135.

Smith, K., 2002: In praise of petroleum? *Science*, **298**, pp. 1847.

Smith, K.R., 1997: Development, health, and the environmental risk transition. In *International Perspectives in Environment, Development, and Health.* G. Shahi, B.S. Levy, A. Binger, T. Kjellstrom, and R. Lawrence (ed.), Springer, New York, pp. 51-62.

Smith, K.R., J.M. Samet, I. Romieu, N. Bruce, 2000: Indoor air pollution in developing countries and acute lower respiratory infections in children. *Thorax,* **55**, pp. 518-532.

Sohn, J., S. Nakhooda, K. Baumert, 2005: *Mainstreaming climate change considerations at the multilateral development banks.* World Resources Institute, Washington, D.C.

Sohngen, B. and R. Sedjo, 2001: Forest set-asides and carbon sequestration. In *World Forests, Markets and Policies*. M. Palo, J. Uusivuori, and G. Mery (ed.), Kluwer Academic.
Sokona, Y., J.-P. Thomas, O. Touré, 2003: *Development and climate: Sengal country study.* Environnement et Développement du Tiers Monde (ENDA-TM), Dakar, Senegal.
Spalding-Fecher, R., A. Clark, M. Davis, G. Simmonds, 2002: The economics of energy efficiency for the poor - a South African case study. Energy*: The International Journal*, **27**(12), pp. 1099-1117.
Spalding-Fecher, R. and G. Simmonds (eds.), 2005: *Sustainable energy development and the Clean Development Mechanism: African Priorities.* Cambridge University Press, Cambridge, 124-135 pp.
Sparkes, R., 2002: *Socially responsible investment: A global revolution.* John Wiley, Chichester.
Srivastava, L. and T. Heller, 2003: *Integrating sustainable development and climate change in AR4 (AR4 SCOP-2/Doc. 8, 12.VIII.2003).* Intergovernmental Panel on Climate Change (IPCC).
SSEB, 2006: *American energy security: Building a bridge to energy independence and to a sustainable energy future.* Southern States Energy Board, Northcross, USA.
Stern, D.I., 2004: The rise and fall of the environmental Kuznets Curve. *World Development*, **32**(8), pp. 1419-1439.
Stern, P.C., 2000: Toward a coherent theory of environmentally significant behavior. *Journal of Social Issues,* **56**, pp. 407-424.
Stern, P.C. and H.V. Fineberg (eds.), 1996: *Understanding risk: Informing decisions in a democratic society.* National Academy Press, Washington D.C.
Stewart, R., 2001: A New generation of environmental regulation? *Capital Law Review,* **21**, pp. 182.
Stiglitz, J.E., 1998: Distinguished lecture on economics in government: the private uses of public interests: incentives and institutions. *Journal of Economic Perspective*, **12**(2), pp. 3-22.
Stoll, S., 2003: Participatory Research.
Streets, D.G., K.J. Jiang, X. Hu, J.E. Sinton, X.-Q. Zhang, D. Xu, M.Z. Jacobson, J.E. Hansen, 2001: Recent reductions in China's greenhouse gas emissions. *Science*, **294**, pp. 1835-1837.
Sutter, C., 2003: *Sustainability check-up for CDM projects: How to assess the sustainability of international projects under the Kyoto Protocol.* Wissenschaftlicher Verlag, Berlin.
Suzuki, D. and A. McConnell, 1997: The *sacred balance: Rediscovering our place in nature.* David Suzuki Foundation and Greystone Books, Vancouver.
Swanson, D.A., L. Pinter, F. Bregha, A. Volkery, K. Jacob, 2004: *National strategies for sustainable development: challenges, approaches and innovations in strategic and co-ordinated action.* IIED-GTZ.
Swart, R., J. Robinson, S. Cohen, 2003: Climate change and sustainable development: expanding the options. *Climate Policy*, Special Issue on Climate Change and Sustainable Development, **3**(S1), pp. S19-S40.
Szklo, A.S., R. Schaeffer, M.E. Schuller, W. Chandler, W., 2005: Brazilian energy policies side-effects on CO_2 emissions reduction. *Energy Policy*, **33**(3), pp. 349-364.
Tam, C.M., 1999: Build-Operate-Transfer model of infrastructure developments in Asia: Reasons for successes and failures. *International Journal of Project Management*, December 1999, pp. 377-382.
The Economist, 2000: Sins of the secular missionaries. January 29, 2000.
Thompson, D., 2002: *Tools for environmental management: A practical introduction and guide.* New Society Publishers, Gabriola, British Columbia.
Toman, M.A. and B. Jemelkova, 2003: Energy and economic development: an assessment of the state of knowledge. *Energy Journal*, **24**(4), pp. 93-112.
Transport for London, 2005: *Central London congestion charging, Impacts monitoring.* Third 45 annual report, April 2005.
Turton, H. and L. Barreto, 2006: Long-term security of energy supply and climate change. *Energy Policy,* **34**(15).
UCT, 2002: *Options for a basic electricity support tariff: Analysis, issues and recommendations for the Department of Minerals & Energy and Eskom.* Cape Town.
UNCSD, 2006: *Johannesburg Plan of Implementation.* United Nations Commission for Sustainable Development, New York.
UNCTAD, 2006: *World Investment Report 2006: FDI from developing and transition economies: Implications for development.* United Nations Conference on Trade and Development, UN, New York and Geneva.
UNDP, 2004: *Human Development Report,* 2004. United Nations Development Programme, Oxford University Press.
UNDP, 2005: *Human Development Report* 2005. United Nations Development Programme Oxford, University Press Oxford.
UNDSD, 2006: United Nations Division for Sustainable Development. <http://www.un.org/esa/sustdev/natlinfo/indicators/egmIndicators/egm.htm> accessed 09/07/07.
UNEP, 2002: *Global Environmental Outlook 3.* United Nations Environment Programme (UNEP), Nairobi, Earthscan, London.
UNEP, 2004: *Energy subsidies: Lessons learned in assessing their impact and designing policy reforms.* Economic and Trade Branch, United Nations Environment Programme (UNEP), Geneva, Switzerland.
UNEP/RIVM, 2004: *The GEO-3 scenarios 2020-2032: quantification and analysis of environmental impacts.* UNEP/DEWA/RS.03-4, RIVM Report 402001022.
United Nations, 1993: *Agenda 21: Earth Summit- The United Nations Programme of Action from Rio.* New York, United Nations, <http://www.springerlink.com/app/home/contribution.asp?wasp=23tlpnyvqm1j502g9m7j&referrer=parent&backto=issue,2,7;journal,5,31;searchpublicationsresults,1,2;> accessed 06/07/07.
US EPA, 2006: *Clean energy-environment guide to action: Policies, best practices, and action steps for states.* United States Environmental Protection Agency, EPA430-R-06-001.
USGBC, 2005: U.S. Green Building Council, <http://www.usgbc.org/> accessed 10/07/07.
Vellinga, P.V., E. Mills, G. Berz, L. Bouwer, S. Huq, L.A. Kozak, J. Palutikof, B. Schanzenbächer, G. Soler, 2001: Insurance and other financial services. Chapter 8: *Climate Change 2001: Impacts, Vulnerability, and Adaptation.* Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK.
Venetoulis, J., D. Chazan, C. Gaudet, 2004: The ecological footprint of nations. Redefining Progress, <http://www.redefiningprogress.org/> accessed 06/07/07.
Vennemo, H., K. Aunan, J. Fang, P. Holtedahl, T. Hu, H.M. Seip, 2006: Domestic environmental benefits of China's energy related CDM potential. *Climatic Change*, **75**(1-2), pp. 215-239.
Victor, D. and T.C. Heller, 2007: *The political economy of power sector reform: The experience of five major developing countries,* Cambridge University Press, Cambridge.
Vitousek, P., P.R. Ehrlich, A.H. Ehrlich, P. Matson, 1986: Human appropriation of the products of photosynthesis. *Bioscience*, **34**(6), pp. 368-373.
Wackernagel, M. and W.E. Rees, 1996: *Our ecological footprint: reducing human impact on the earth.* New Society Publishers, Gabriola Island, BC. Philadelphia, PA. ISBN 086571312X.
Wagner, M. and G. Müller-Fürstenberg, 2004: *The Carbon Kuznets Curve: A cloudy picture emitted by lousy econometrics?* Discussion Paper 04-18. University of Bern, 36 pp.
Walker, W., 2000: Entrapment in large technology systems: institutional commitment and power relations. *Research Policy*, **29**, pp. 833-846.
WBCSD, 2004: *The Greenhouse Gas Protocol: A corporate accounting and reporting standard.* (Revised edition), World Business Council for Sustainable Development (WBCSD)/WRI.
WCED, 1987: *Our common future.* World Commission on Environment and Development. Oxford University Press, Oxford.
Weiner, J., 2002: Comparing precaution in the United States and Europe. *Journal of Risk Research*, **5**(4), pp. 317-349.

Welsch, H., 2001: The determinants of production-related carbon emissions in West Germany 1985-1990: assessing the role of technology and trade. *Structural Change and Economic Dynamics*, **12,** pp. 425-455.

Wheeler, D., 2001: *Racing to the bottom? Foreign investment and air pollution in developing countries.* World Bank, Policy Research Working Paper 2524, Washington D.C, USA, 24 pp.

WHO, 2002: The world health report 2002 - reducing risks, promoting healthy life. World Health Organisation, Geneva, Switzerland, 248 pp.

Wilbanks, T., 2003: Integrating climate change and sustainable development in a place-based context. *Climate Policy*, **3**(S1), pp. S147-S154.

Wilson, D. and C. Change, 2003: CEMEX promotes a sustainable approach with manufacturing excellence. *Environmental Quality Management,* **12**(4).

Windsor, D., 2004: Stakeholder influence strategies for smarter growth. In *Research in Corporate Sustainability: The Evolving Theory and Practice of Organisations in the Natural Environment.* S. Sharma and M. Starik, *et al.* (eds), Edward Elgar, Cheltenham, pp. 93-116.

Winkler, H., 2004: National policies and the CDM: Avoiding perverse incentives. *Journal of Energy in Southern Africa*, **15**(4), pp. 118-122.

Winkler, H., K.A. Baumert, O. Blanchard, S. Burch, J. Robinson, 2007: What factors influence mitigative capacity? *Energy Policy*, **35**(1), pp. 692-703.

Winkler, H., B. Brouns, S. Kartha, 2006: Future mitigation commitments: Differentiating among non-Annex I countries. *Climate Policy*, **5**(5), pp. 469-486.

Winkler, H., R. Spalding-Fecher, S. Mwakasonda, O. Davidson, 2002a: *Sustainable development policies and measures: starting from development to tackle climate change.* World Resources Institute, Washington, D.C, pp. 61-87.

Winkler, H., R. Spalding-Fecher, L.Tyani, 2002b: Comparing developing countries under potential carbon allocation schemes. *Climate Policy*, **2**(4), pp. 303-318.

Winkler, H. and S. Thorne, 2003: Baselines for suppressed demand: CDM projects contribution to poverty alleviation. *South African Journal of Economic and Management Sciences,* **5**(2), pp. 413-429.

Winters, L.A., N. McCullough, A. McKay, 2004: Trade liberalization and poverty, the evidence so far. *Journal of Economic Literature,* **42**(March), pp. 72-115.

World Bank, 1994: *World development report 1994, infrastructures for development.* Washington D.C., USA.

World Bank, 1999: *The effect of a shadow price on carbon emission in the energy portfolio of the World Bank: A carbon backcasting exercise.* Report No. ESM 212/99.

World Bank, 2000: *World Development Report.* World Bank.

World Bank, 2003: *World Development Report. Sustainable development in a dynamic world: Transforming institutions, growth, and quality of life.* World Bank, Washington, D.C, 250 pp.

World Bank, 2004: *World Development Report*. Oxford University Press, Oxford.

Wu, L., S. Kaneko, S. Matsuoka, 2005: Driving forces behind the stagnancy of China's energy-related CO_2 emissions from 1996 to 1999: the relative importance of structural change, intensity change and scale change. *Energy Policy*, **33**, pp. 319-335.

Wyatt, A.B., 2002: The privatisation of public infrastructure in transitional Southeast Asian economies: The case of build-own-operate-transfer projects in Vietnam and Laos. In *Collective Goods, Collective Futures in Asia*, S. Sargeson (ed.), London: Routledge.

Yamin, F. and J. Depledge, 2004: *The international Climate Change regime: A guide to rules, institutions and procedures.* Cambridge University Press.

Yearley, S., 1994: Social movements and environmental change. In *Social Theory and the Global Environment*. M. Redclift, and T. Benton (eds.), Routledge, London and New York, pp. 150-168.

Yohe, G., 2001: Mitigative capacity - the mirror image of adaptive capacity on the emissions side: An editorial. *Climatic Change*, **49**, pp. 247-262.

Yohe, G. and R. Moss, 2000: *Economic sustainability, indicators and climate change. In Climate Change and its linkages with development, equity and sustainability.* Proceedings of the IPCC Expert Meeting [Munasinghe, M. and R. Swart (eds.)]. IPCC and World Meteorological Organization, Geneva (2000), Colombo, Sri Lanka (27-29 April, 1999).

Zaelke, D., D. Kaniaru, E. Kružíková (eds), 2005: *Making Law Work: Environmental Compliance & Sustainable Development. Vol. 1 & 2.* INECE.

Zanetti, A., S. Schwartz, R. Enz, 2005: *Natural catastrophes and man-made disasters in 2004: more than 300,000 fatalities, record insured losses.* Swiss Reinsurance Company, Vol. sigma 1/2005.