INTERGOVERNMENTAL PANEL ON climate change

Working Group III – Mitigation of Climate Change

# Chapter 4

# Sustainable Development and Equity

| | | |
|---|---|---|
| Chapter: | 4 | |
| Title: | Sustainable Development and Equity | |
| Author(s): | CLAs: | Marc Fleurbaey and Sivan Kartha |
| | LAs: | Simon Bolwig, Yoke Ling Chee, Ying Chen, Esteve Corbera, Franck Lecocq, Wolfgang Lutz, Maria Silvia Muylaert, Richard B. Norgaard, Chukwumerije Okereke, Ambuj Sagar |
| | CAs: | Paul Baer, Donald A. Brown, Josefa Francisco, Michael Zwicky Hauschild, Michael Jakob, Heike Schroeder, John Thøgersen, Kevin Urama |
| | REs: | Luiz Pinguelli Rosa, Matthias Ruth, Jayant Sathaye |

# Chapter 4: Sustainable Development and Equity

## Contents

Chapter 4: Sustainable Development and Equity .......... 2
Executive Summary .......... 4
4.1 Introduction .......... 7
4.1.1 Key messages of previous IPCC reports .......... 7
4.1.2 Narrative focus and key messages .......... 8
4.1.2.1 Consumption, disparities and well-being .......... 9
4.1.2.2 Equity at the national and international scales .......... 9
4.1.2.3 Building institutions and capacity for effective governance .......... 10
4.2 Approaches and indicators .......... 11
4.2.1 Sustainability and sustainable development (SD) .......... 11
4.2.1.1 Defining and measuring sustainability .......... 11
4.2.1.2 Links with climate change and climate policy .......... 13
4.2.2 Equity and its relation to sustainable development and climate change .......... 13
4.3 Determinants, drivers and barriers .......... 18
4.3.1 Legacy of development relations .......... 18
4.3.2 Governance and political economy .......... 19
4.3.3 Population and demography .......... 21
4.3.4 Values and behaviours .......... 23
4.3.5 Human and social capital .......... 24
4.3.6 Technology .......... 25
4.3.7 Natural resources .......... 27
4.3.8 Finance and investment .......... 28
4.4 Production, trade, consumption and waste patterns .......... 29
4.4.1 Consumption patterns, inequality and environmental impact .......... 29
4.4.1.1 Trends in resource consumption .......... 29
4.4.1.2 Consumerism and unequal consumption levels .......... 30
4.4.1.3 Effect of non-income factors on per capita carbon footprint .......... 30
4.4.2 Consumption patterns and carbon accounting .......... 31
4.4.2.1 Choice of GHG accounting method .......... 31
4.4.2.2 Carbon footprinting (consumption-based GHG emissions accounting) .......... 31
4.4.2.3 Product carbon footprinting .......... 32
4.4.2.4 Consumption-based and territorial approaches to GHG accounting .......... 32

4.4.3 Sustainable consumption and production – SCP ........ 33
4.4.3.1 Sustainable consumption and lifestyle ........ 34
4.4.3.2 Consumer sustainability attitudes and the relation to behavior ........ 35
4.4.3.3 Sustainable production ........ 36
4.4.4 Relationship between consumption and well-being ........ 37
4.5 Development pathways ........ 39
4.5.1 Definition and examples ........ 39
4.5.2 Transition between pathways ........ 40
4.5.2.1 Path dependence and lock-ins ........ 41
4.5.2.2 Examples and lessons from the technology transition literature ........ 42
4.5.2.3 Economic modeling of transitions between pathways ........ 43
4.6 Mitigative capacity and mitigation, and links to adaptive capacity and adaptation ........ 45
4.6.1 Mitigation and adaptation measures, capacities, and development pathways ........ 45
4.6.2 Equity and burden-sharing in the context of international cooperation on climate ........ 47
4.6.2.1 Equity principles pertinent to burden-sharing in an international climate regime ........ 47
4.6.2.2 Frameworks for equitable burden-sharing ........ 51
4.7 Integration of framing issues in the context of sustainable development ........ 53
4.7.1 Risk and uncertainty in sustainability evaluation ........ 53
4.7.2 Socio-economic evaluation ........ 53
4.8 Implications for subsequent chapters ........ 54
4.8.1 Three levels of analysis of sustainability consequences of climate policy options ........ 54
4.8.2 Sustainability and equity issues in subsequent chapters ........ 55
4.9 Gaps in knowledge and data ........ 60
4.10 Frequently Asked Questions ........ 62
References ........ 63

## Executive Summary

Since the first assessment report, the IPCC has considered issues of sustainable development (SD) and equity: acknowledging the importance to climate decision-making, and progressively expanding the scope to include: the co-benefits of climate actions for SD and equity, the relevance of lifestyle and behaviour, the relevance of technological choices, the relevance of procedural equity to effective decision-making, and the relevance of ethical frameworks and equitable burden-sharing in assessing climate responses. This Assessment Report further explores key dimensions of SD and equity, highlighting the significance of disparities across different regions and groups, and the ways in which designing a climate policy is a component of a wide-ranging societal choice of a development path [4.1, 4.2].

**Sustainable development, a central framing issue in this Assessment Report, is intimately connected to climate change** *(high confidence)*. SD is variably conceived as development that preserves the interests of future generations, that preserves the ecosystem services on which continued human flourishing depends, or that harmonizes the co-evolution of three pillars (economic, social, environmental) [4.2]. First, the climate threat constrains possible development paths, and sufficiently disruptive climate change could preclude any prospect for a sustainable future (*medium evidence, high agreement*). Thus, a stable climate is one component of SD. Second, there are synergies and trade-offs between climate responses and broader SD goals, because some climate responses generate co-benefits for human and economic development, while others can have adverse side-effects and generate risks (*robust evidence, high agreement*). These co-benefits and risks are studied in the sector chapters of this report, along with measures and strategies to optimize them. Options for equitable burden-sharing can reduce the potential for the costs of climate action to constrain development (*medium evidence, high agreement*). Third, at a more fundamental level, the capacities underlying an effective climate response overlap strongly with capacities for SD (*medium evidence, high agreement*) and designing an effective climate policy involves "mainstreaming" climate in the design of comprehensive SD strategies and thinking through the general orientation of development (*medium evidence, medium agreement*) [4.2, 4.5].

**Equity is an integral dimension of SD** (*high confidence*). First, intergenerational equity underlies the concept of sustainability. Intra-generational equity is also often considered an intrinsic component of SD. In the particular context of international climate policy discussions, several arguments support giving equity an important role: a moral justification that draws upon ethical principles; a legal justification that appeals to existing treaty commitments and soft law agreements to cooperate on the basis of stated equity principles; and an effectiveness justification that argues that a fair arrangement is more likely to be agreed internationally and successfully implemented domestically (*medium evidence, medium agreement*). A relatively small set of core equity principles serve as the basis for most discussions of equitable burden-sharing in a climate regime: responsibility (for GHG emissions), capacity (ability to pay for mitigation, but sometimes other dimensions of mitigative capacity), the right to development, and equality (often interpreted as an equal entitlement to emit) [4.2, 4.6].

**While it is possible to envision an evolution toward equitable and sustainable development, its underlying determinants are also deeply embedded in existing societal patterns that are unsustainable and highly inertial** (*high confidence*). A useful set of determinants from which to examine the prospects for and impediments to SD and equity are: the legacy of development relations; governance and political economy; population and demography; values and behaviour; human and social capital; technology; natural resource endowments; and finance and investment. The evolution of each of these determinants as a driver (rather than barrier) to a SD transition is conceivable, but also poses profound challenges (*medium evidence, medium agreement*) [4.3].

**Governing a transition toward an effective climate response and SD pathway is a challenge involving rethinking our relation to nature, accounting for multiple generations and interests (including those based on endowments in natural resources), overlapping environmental issues, among actors with widely unequal capacities, resources, and political power, and divergent conceptions of justice** (*high confidence*). Key debated issues include articulating top-down and bottom-up approaches, engaging participation of diverse countries and actors, creating procedurally equitable forms of decentralization and combining market mechanisms with government action, all in a particular political economic context (*robust evidence, high agreement*) [4.3].

**Technology and finance both are strong determinants of future societal paths, and while society's current systems of allocating resources and prioritizing efforts toward investment and innovation are in many ways robust and dynamic, there are also some fundamental tensions with the underlying objectives of SD** (*high confidence*). First, the technological innovation and financial systems are highly responsive to short-term motivations, and are sensitive to broader social and environmental costs and benefits only to the –often limited– extent that these costs and benefits are internalized by regulation, taxation, laws and social norms. Second, while these systems are quite responsive to market demand that is supported by purchasing power, they are only indirectly responsive to needs, particularly of those of the world's poor, and they operate with a time horizon that disregards potential needs of future generations (*medium evidence, medium agreement*) [4.3].

**Enhancing human capital based on individual knowledge and skills, and social capital based on mutually beneficial formal and informal relationships is important for facilitating a transition toward sustainable development** (*medium evidence, high agreement*). 'Social dilemmas' arise in which short-term individual interests conflict with long-term social interests, with altruistic values being favourable to SD. However, the formation of values and their translation into behaviours is mediated by many factors, including the available set of market choices and lifestyles, the tenor of dominant information sources (including advertisements and popular culture), the culture and priorities of formal and civil institutions, and prevailing governance mode (*medium evidence, medium agreement*). The demographic transition toward low fertility rates, though an ageing population creates economic and social challenges, and migrations due to climate impacts may exacerbate tensions (*medium evidence, medium agreement*) [4.3, 4.4].

**The global consumption of goods and services has increased dramatically over the last decades, in both absolute and per capita terms, and is a key driver of environmental degradation, including global warming** (*high confidence*). This trend involves the spread of high-consumption lifestyles in some countries and sub-regions, while in other parts of the world large populations continue to live in poverty. There are high disparities in consumption both between and within countries (*robust evidence, high agreement*) [4.4].

**Two basic types of decoupling often arise in the context of a transition toward sustainable development: the decoupling of material resource consumption (including fossil fuels) and environmental impact (including climate change) from economic growth, and the decoupling of economic growth from human well-being** (*high confidence*). The first type – the dematerialization of the economy, i.e. of consumption and production – is generally considered crucial for meeting SD and equity goals, including mitigation of climate change. Production-based (territorial) accounting suggests that some decoupling of impacts from economic growth has occurred, especially in industrialized countries, but its extent is significantly diminished based on a consumption-based accounting (*robust evidence, medium agreement*). Consumption-based emissions are more strongly associated with GDP than production-based emissions, because wealthier countries generally satisfy a higher share of their final consumption of products through net imports compared to poorer countries. Ultimately, absolute levels of resource use and environmental impact – including GHG emissions – generally continue to rise with GDP (*robust evidence, high agreement*), though great variations between countries highlight the importance of other factors such as geography, energy system, production methods, waste management, household size, diet and lifestyle. The second type of decoupling – of human well-being from economic growth – is a more controversial goal than the first. There are ethical controversies about the measure of well-being and the use of subjective data for this purpose (*robust evidence, medium agreement*). There are also empirical controversies about the relationship between subjective well-being and income, some recent studies across countries finding a clear relationship between average levels of life satisfaction and per capita income, while the evidence about the long-term relationship between satisfaction and income is less conclusive and quite diverse among countries (*medium evidence, medium agreement*). Studies of emotional well-being do identify clear satiation points beyond which further increases in income no longer enhance emotional well-being (*medium evidence, medium agreement*). Furthermore, income inequality has been found to have a marked negative effect on average subjective well-being, due to perceived unfairness and undermined trust of institutions among low income groups (*medium evidence, medium agreement*) [4.4].

**Understanding how development paths impact on emissions and mitigative capacity, and, more generally, how development paths can be made more sustainable and more equitable in the future requires in-depth analysis of the mechanisms that underpin these paths** (*high confidence*). Of particular importance are the processes that may generate path dependence and lock-ins, notably "increasing returns" but also use of scarce resources, switching costs, negative externalities or complementarities between outcomes (*robust evidence, high agreement*) [4.5, 4.6]. The study of transitions between pathways is an emerging field, notably in the context of technology transitions. Yet analyzing how to transition to a sustainable, low-emission pathway remains a major scientific challenge. It would be aided by models with a holistic framework encompassing the economy, society (in particular the distribution of resources and well-being), and the environment, take account of relevant technical constraints and trends, and explore a long-term horizon while simultaneously capturing processes relevant for the short-term and the key uncertainties (*medium evidence, medium agreement*) [4.5, 4.7].

**Mitigation and adaptation measures can strongly affect broader SD and equity objectives, and it is thus useful to understand their broader implications** (*high confidence*). Building both mitigative capacity and adaptive capacity relies to a profound extent on the same factors as those that are integral to equitable and sustainable development (*medium evidence, high agreement*), and equitable burden-sharing can enhance these capacities where they are most fragile [4.6]. This chapter focuses on examining ways in which the broader objectives of equitable and sustainable development provide a policy frame for an effective, robust, and long-term response to the climate problem. [4.8].

# 4.1 Introduction

## 4.1.1 Key messages of previous IPCC reports

This chapter seeks to place climate change, and climate change mitigation in particular, in the context of equity and SD. Prior IPCC assessments have sought to do this as well, progressively expanding the scope of assessment to include broader and more insightful reflections on the policy-relevant contributions of academic literature.

The IPCC *First Assessment Report* (FAR) (IPCC, 1990) underscored the relevance of equity and SD to climate policy. Mandated to identify "possible elements for inclusion in a framework convention on climate change", the IPCC prominently put forward the "endorsement and elaboration of the concept of sustainable development" for negotiators to consider as part of the Convention's Preamble. It noted as key issues "how to address equitably the consequences for all" and "whether obligations should be equitably differentiated according to countries' respective responsibilities for causing and combating climate change and their level of development". This set the stage for the ensuing UNFCCC negotiations, which ultimately included explicit appeals to equity and SD, including in its Preamble, its Principles (Art. 2), its Objective (Art. 3), and its Commitments (Art. 4).

The IPCC *Second Assessment Report* (SAR) (IPCC, 1995), published after the UNFCCC was signed, maintained this focus on equity and SD. It reflected a growing appreciation for the prospects for SD co-benefits and reiterated the policy relevance of equity and SD. It did this most visibly in a special section of the Summary for Policymakers presenting "Information Relevant to Interpreting Article 2 of the UNFCCC", including "Equity and social considerations" and "Economic development to proceed in a sustainable manner". Notably, the SAR added an emphasis on procedural equity through a legitimate process that empowers all actors to effectively participate, and on the need to build capacities and strengthen institutions, particularly in developing countries.

The IPCC *Special Report on Emission Scenarios* (SRES) (Nakicenovic et al., 2000) demonstrated that broader SD goals can contribute indirectly, yet substantially, to reducing emissions. This IPCC contribution reflected a change in the scientific literature, which had in recent years expanded its discussion of SD to encompass analyses of lifestyles, culture, and behaviour, complementing its traditional techno-economic analyses. It also reflected a recognition that economic growth (especially as currently measured) is not the sole goal of societies. The SRES thus provided insights into how policy intervention can decouple economic growth from emissions and well-being from economic growth, showing that both forms of decoupling are important elements of a transition to a world with low greenhouse gas (GHG) emissions.

The IPCC *Third Assessment Report* (TAR) (IPCC, 2001) deepened the consideration of broader SD objectives in assessing response strategies. Perhaps owing to a growing appreciation for the severity of the climate challenge, the TAR stressed the need for an ambitious and encompassing response, and was thus more attentive to the risk of climate-focused measures conflicting with basic development aspirations. It thus articulated the fundamental equity challenge of climate change as ensuring "that neither the impact of climate change nor that of mitigation policies exacerbates existing inequities both within and across nations", specifically because "restrictions on emissions will continue to be viewed by many people in developing countries as yet another constraint on the development process" (See Box 4.1 for further discussion of the relationship between climate change and development challenges in developing countries.). The TAR recognized the need to deepen the analysis of equitable burden-sharing in order to avoid undermining prospects for SD in developing countries. More generally, the TAR observed that equitable burden-sharing is not solely an ethical matter. Even from a rational-actor game-theoretic perspective, an agreement in which the burden is equitably shared is more likely to be signed by a large number of countries, and thus to be more effective and efficient.

The IPCC *Fourth Assessment Report* (AR4) (IPCC, 2007) further expanded the consideration of broader SD objectives. It stressed the importance of civil society and other non-government actors in designing climate policy and equitable SD strategies generally. The AR4 focused more strongly on the distributional implications of climate policies, noting that conventional climate policy analysis that is based too narrowly on traditional utilitarian or cost-benefit frameworks will neglect critical equity issues. These oversights include human rights implications and moral imperatives; the distribution of costs and benefits of a given set of policies, and the further distributional inequities that arise when the poor have limited scope to influence policy. This is particularly problematic, the AR4 notes, in integrated assessment model (IAM) analyses of "optimal" mitigation pathways, because climate impacts do not affect the poor exclusively through changes in incomes. Nor do they satisfactorily account for uncertainty and risk, which the poor treat differently than the rich. The poor have higher risk aversion and lower access to assets and financial mechanisms that buffer against shocks. The AR4 went on to outline alternative ethical frameworks including rights-based and capabilities-based approaches, suggesting how they can inform climate policy decisions. In particular, the AR4 discussed the implications of these different frameworks for equitable international burden-sharing.

The IPCC *Special Report on Renewable Energy Sources and Climate Change Mitigation* (SRREN) (IPCC, 2011) deepened the consideration of broader SD objectives in assessing renewable energy options, noting particularly that while synergies can arise (for example, helping to expand access to energy services, increase energy security, and reduce some environmental pressures), there can also be trade-offs (such as increased pressure on land resources, and affordability) and these must be negotiated in a manner sensitive to equity considerations.

The IPCC Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX) (IPCC 2012a) highlighted key further dimensions of SD and equity, including the distinction and interplay between incremental and transformative changes – both of which are necessary for an effective climate policy response, and emphasized the diversity of values that underlie decision-making, e.g., a human rights framework vs. utilitarian cost-benefit analysis.

### 4.1.2 Narrative focus and key messages

In keeping with the previous IPCC assessments, this chapter considers SD and equity as matters of policy relevance for climate change decision-makers. It examines the ways in which climate change is in fact inextricably linked with SD and equity. It examines these links with the aim of drawing policy-relevant conclusions regarding equitable and sustainable responses to climate change.

In one direction, the link is self-evident: an effective climate response is necessary for equitable and sustainable development to occur. The disruptions that climate change would cause in the absence of an effective societal response are sufficiently severe (see AR5 WGI and WGII) to severely compromise development, even taking into account future societies' ability to adapt (Shalizi and Lecocq, 2010). Nor is this development likely to be equitable, as an increasingly inhospitable climate will most seriously undermine the future prospects of those nations, communities, and individuals that are in greatest need of development. Without an effective response to climate change, including both timely mitigation and proactive adaptation, development can be neither sustainable nor equitable.

In recent years, the academic community has come increasingly to appreciate the extent to which SD and equity are also needed as frameworks for assessing and prioritizing climate responses: given the strong trade-offs and synergies between the options for a climate response and SD, the design of an effective climate response must accord with the objectives for development and equity and exploit the synergies. A climate strategy that does not do so runs the risk either of being ineffective for lack of consensus and earnest implementation or of jeopardizing SD just as unabated climate change would. Therefore, a shift toward more equitable and sustainable modes of development may provide the only context in which an effective climate response can be realized.

The scientific community is coming to understand that climate change is but one example of how humankind is pressing up against its planetary limits (Millennium Ecosystem Assessment, 2005; Rockström et al., 2009a). Technical measures can certainly help in the near-term to alleviate climate change. However, the comprehensive and durable strategies society needs are those that recognize climate change shares its root causes with other dimensions of the global sustainability crisis, and that without addressing these root causes, robust solutions may not be accessible.

This chapter, and many parts of this report, uncovers ways in which a broader agenda of SD and equity may support and enable an effective societal response to the climate challenge, by establishing the basis by which mitigative and adaptive capacity can be built and sustained. In examining this perspective, this chapter focuses on several broad themes.

#### *4.1.2.1 Consumption, disparities and well-being*

The first theme relates to well-being and consumption. The relationship between consumption levels and environmental pressures, including GHG emissions, has long been a key concern for SD, with a growing focus on high-consumption lifestyles in particular and consumption disparities. A significant part of the literature develops methodologies for assessing the environmental impacts across national boundaries of consumption, through consumption-based accounting and GHG footprint analysis. Important research is now also emerging on the relationship between well-being and consumption, and how to moderate consumption and its impacts without hindering well-being – and indeed, while enhancing it. More research is now available on the importance of behaviour, lifestyles and culture, and their relationship to over-consumption (Sections 4.3, 4.4).

Research is emerging to help understand "under-consumption", i.e., poverty and deprivation, and its impacts on well-being more broadly, and specifically on the means by which it undermines mitigative and adaptive capacity (WGII Chapter 20). Energy poverty is one critical example, linked directly to climate change, of under-consumption that is well-correlated with weakened livelihoods, lack of resilience, and limited mitigative and adaptive capacity. Overcoming under-consumption and reversing over-consumption, while maintaining and advancing human well-being, are fundamental dimensions of SD, and are equally critical to resolving the climate problem (Sections 4.5, 4.6).

#### *4.1.2.2 Equity at the national and international scales*

Given the disparities evident in consumption patterns, the distributional implications of climate response strategies are critically important. As recent history shows, understanding how policies affect different segments of the population is essential to designing and implementing politically acceptable and effective national climate response strategies. A transition perceived as just would attract a greater level of public support for the substantial techno-economic, institutional and lifestyle shifts needed to reduce emissions substantially and enable adaptive responses.

At the international level, an equitable regime with fair burden-sharing is likely to be a key condition for an effective global response (Sections 4.2, 4.6). Given the urgency of the climate challenge, a rather rapid transition will be required if the global temperature rise is to remain below the politically discussed targets, such as 1.5°C or 2°C over pre-industrial levels, with global emissions possibly peaking as soon as 2020 (see WGI, Figure 6.25). Particularly in a situation calling for a concerted global effort, the most promising response is a cooperative approach "that would quickly require humanity to think like a society of people, not like a collection of individual states" (Victor 1998).

While scientific assessments cannot define what equity is and how equitable burden-sharing should be implementing the Convention and climate policies in general, they can help illuminate the implications of alternative choices and their ethical basis (Section 4.6, also Sections 3.2, 3.3, 6.3.6, 13.4.3).

#### *4.1.2.3 Building institutions and capacity for effective governance*

While there is strong evidence that a transition to a sustainable and equitable path is technically feasible (see Sections 6.1.2, 6.3), charting an effective and viable course through the climate challenge is not merely a technical exercise. It will involve myriad and sequential decisions, among states and civil society actors, supported by the broadest possible constituencies (Section 4.3). Such a process benefits from the education and empowerment of diverse actors to participate in systems of decision-making that are designed and implemented with procedural equity as a deliberate objective. This applies at the national as well as international levels, where effective governance relating to global common resources, in particular, is not yet mature.

Any given approach to addressing the climate challenge has potential winners and losers. The political feasibility of that approach will depend strongly on the distribution of power, resources, and decision-making authority among the potential winners and losers. In a world characterized by profound disparities, procedurally equitable systems of engagement, decision-making and governance appear needed to enable a polity to come to equitable and sustainable solutions to the sustainable development challenge.

**Box 4.1.** Sustainable development and climate change mitigation in developing countries

The interconnectedness of climate change, sustainable development, and equity poses serious challenges for developing countries but it also presents opportunities.

Developing countries are confronted by a daunting mitigation challenge in the midst of pressing development needs. Developing country emissions comprised more than half of global emissions in 2010, and grew during the preceding decade by an amount that accounted for the total global emissions rise (JRC/PBL (2012), IEA (2012), see Annex II.8; see Section 5.3). In the absence of concerted mitigation actions, the coming decades would see this trend prolonged, with a continued growth in global emissions driven predominantly by developing countries' rising emissions (see Section 6.3). This trend is the unsurprising outcome of the recent economic growth in many developing countries. The increase in emissions coincided with a number of positive developments: Over the past decade, the overall poverty rate has declined, maternal and child mortality have fallen, the prevalence of several preventable diseases has decreased, and access to safe drinking water and sanitation has expanded, while the Human Development Index across nations has risen and its convergence has become more pronounced. This "rise of the South" has been termed "unprecedented in its speed and scale [...] affecting a hundred times as many people as the Industrial Revolution" and setting in motion a "dramatic rebalancing" of economic and geopolitical forces (United Nations, 2011a; United Nations Development Programme, 2013).

Notwithstanding these gains, further developmental progress is urgently needed throughout the developing world. More than 1.5 billion people remain in multi-dimensional poverty, energy insecurity is still widespread, inequality of income and access to social services is persistently high, and the environmental resource base on which humans rely is deteriorating in multiple ways (Millennium Ecosystem Assessment, 2005; Bazilian et al., 2010; United Nations Development Programme, 2013). Moreover, unavoidable climate change will amplify the challenges of development: climate impacts are expected to slow economic growth and exacerbate poverty, and current failures to address emerging impacts are already eroding the basis for sustainable development (WGII SPM).

Thus, the challenge confronting developing countries is to preserve and build on the developmental achievements to date, sharing them broadly and equitably across their populations, but to do so via a sustainable development pathway that does not reproduce the fossil-fuel based and emissions-intensive conventional pathway by which the developed world moved from poverty to prosperity. Faced with this dilemma, developing countries have sought evidence that such alternative development pathways exist, looking in particular to developed countries to take the lead during the two decades since the UNFCCC was negotiated. Some such evidence has emerged, in the form of a variety of incipient climate policy experiments (see Section 15.6, 15.7) that appear to have generated some innovation in low-carbon technologies (see Section 4.4) and modestly curbed emissions in some countries (see Section 5.3).

Developing countries have stepped forward with significant actions to address climate change, but will need to build mitigative and adaptive capacity if they are to respond yet more effectively (see Section 4.6). More broadly, the underlying determinants of development pathways in developing countries are often not aligned toward a sustainable pathway (see Sections 4.3, 4.5). At the same time, developing countries are in some ways well-positioned to shift toward sustainable pathways: Most developing countries are still in the process of building their urban and industrial infrastructure and can avoid lock-in (see Sections 4.5, 5.6). Many are also in the process of establishing the cultural norms and lifestyles of an emerging middle class, and can do so without reproducing the consumerist values of many developed countries (4.3, 4.4). Some barriers, such as lack of access to financial and technological resources, can be overcome through international cooperation based on principles of equity and fair burden-sharing (see Sections 4.6, 6.3).

## 4.2 Approaches and indicators

This section maps out the various conceptual approaches to the issues of SD (4.2.1), equity (4.2.2), and their linkages to climate change and climate policy.

### 4.2.1 Sustainability and sustainable development (SD)

#### *4.2.1.1 Defining and measuring sustainability*

The most frequently quoted definition of SD is "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs",* from the Brundtland Report (World Commission on Environment and Development, 1987). This definition acknowledges a tension between sustainability and development (Jabareen, 2006), and that development objectives aim at meeting basic needs for all citizens and securing them in a sustainable manner (Murdiyarso, 2010). One of the first definitions of SD (Prescott-Allen, 1980) refers to a development process that is compatible with the preservation of ecosystems and species.

A popular conceptualization of SD goes beyond securing needs and preserving the environment and involves three "pillars" or three "bottom-lines" of sustainability: environmental, economic, and social aspects (Dobson, 1991; Elkington, 1998; Flint and Danner, 2001; Pope et al., 2004; Sneddon et al., 2006; Murdiyarso, 2010; Okereke, 2011). There is some variation in the articulation of the three spheres, with some arguing for an equal appraisal of their co-evolution and mutual interactions, and others positing a hierarchy with economic activities embedded in the social matrix, which is itself grounded in the ecosphere (Levin, 2000; Fischer et al., 2007). This broad SD framework is equally relevant for rich countries concerned with growth, well-being, human development, and lifestyles.

A well-known distinction opposes weak sustainability to strong sustainability approaches (Neumayer, 2010). The former rely on the assumption that human-made capital can replace natural resources and ecosystem services with a high degree of substitutability. Strong sustainability, in contrast, takes the view that certain critical natural stocks – such as the climate system and biodiversity – cannot be replaced by human-made capital and must be maintained. Weak sustainability is often believed to be inherent to economic modeling that aggregates all forms of capital together (Dietz and Neumayer, 2007), but economic models and indicators can accommodate any degree of substitutability between different forms of capital (Fleurbaey and Blanchet, 2013). The linkage between strong sustainability and IAMs is discussed in Sathaye et al. (2011). A different but related issue is whether one should evaluate development paths only in terms of human well-being , which depends on the environment services (Millennium Ecosystem Assessment, 2005), or also account for natural systems as intrinsically valuable (McShane, 2007; Attfield, 2008).

Sustainability is closely related to resilience (AR5 WII 2.5 and 20.2-20.6, Folke et al. (2010), Gallopin (2006), Goerner et al. (2009) and vulnerability (Kates, 2001; Clark and Dickson, 2003; Intergovernmental Panel on Climate Change, 2012a). A key premise of this direction of research is that social and biophysical processes are interdependent and co-evolving (Polsky and Eakin, 2011). The biosphere itself is a complex adaptive system, the monitoring of which is still perfectible (Levin, 2000; Thuiller, 2007). Critical perspectives on these concepts, when applied to SD analysis, can be found in Turner (2010) and Cannon and Müller-Mahn (2010).

Although there are various conceptions of sustainability in the literature, there are internationally agreed principles of SD adopted by heads of states and governments at the 1992 UN Conference on Environment and Development and reaffirmed at subsequent review and implementation conferences (United Nations, 1992a, 1997, 2002, 2012a). A key guiding principle is: "The right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations" (1992 Rio Declaration Principle 3). The Rio principles were reaffirmed at the June 2012 summit level UN Conference on SD.

---

**Box 4.2**. Sustainable development indicators (SDI)

When SD became a prominent consideration in policy-making in the early 1990s, SDI initiatives flourished. Pressure-state-response (PSR) and capital accounting-based (CAB) frameworks, in particular, were widely used to assess sustainability. The PSR approach was further modified as driving force-state-response (DSR) by UNCSD (2001) and driving force-pressure-state-impact-response (DPSIR) by UNEP (UNEP, 1997, 2000, 2002). The System of Integrated Environmental-Economic Accounting (SEEA) of the United Nations offers a wealth of information about the state of ecosystems and is currently under revision and expansion.[1] The CAB approach is embodied in the Adjusted Net Savings indicator of the World Bank (2003, 2011), which is mentioned in Section 4.3 and 14.1 of this report. It is based on the economic theory of "genuine savings" (defined as the variation of all natural and man-made capital stocks, evaluated at certain specific accounting prices), which shows that on a path that maximizes the discounted utilitarian sum, a negative value for genuine savings implies that the current level of well-being is not sustainable (Hamilton and Clemens, 1999; Pezzey, 2004).

General presentations and critical assessments of SDIs can be found in a large literature (Daly, 1996; Aronsson et al., 1997; Pezzey and Toman, 2002; Lawn, 2003; Hamilton and Atkinson, 2006; Asheim, 2007; Dietz and Neumayer, 2007; Neumayer, 2010; Martinet, 2012; Mori and Christodoulou, 2012; Fleurbaey and Blanchet, 2013). This literature is pervaded by a concern for comprehensiveness – i.e., recording all important aspects of well-being, equity, and nature preservation for current and future generations – and accuracy – i.e., avoiding arbitrary or unreliable weighting of the relevant dimensions when synthesizing multidimensional information. The general conclusion of this literature is that there is currently no satisfactory empirical indicator of sustainability.

A limitation of the PSR model is that it fails to identify causal relations, and it oversimplifies the links between dimensions. It is moreover based upon aggregate indices which lose much information contained in the underlying indicators. An important limitation of the SEEA is that social and institutional issues are essentially left out, and its stock-and-flow approach is problematic with respect to environmental and social aspects that do not have a market price. Similarly, computing CAB indicators compounds the difficulty of comprehensively estimating the evolution of capital stocks with the difficulty of computing the accounting prices. Market prices do provide relevant

[1] Documentation is available at http://unstats.un.org/unsd/envaccounting/seea.asp.

information for valuing capital stocks in a perfectly managed economy (as shown by Weitzman (1976)), but may be very misleading in actual conditions (Dasgupta and Mäler, 2000; Arrow et al., 2010).

#### *4.2.1.2 Links with climate change and climate policy*

The literature on the complex relations between climate change, climate policies, and SD is large (Swart et al., 2003; Robinson et al., 2006; Bizikova et al., 2007; Sathaye et al., 2007; Thuiller, 2007; Akimoto et al., 2012; Janetos et al., 2012). The links between SD and climate issues are examined in detail in WGII Chapter 20. Mapping out these links is also important in the WGIII report; this subsection puts the relevant components of the report in perspective.

Three main linkages can be identified, each of which contains many elements. First, the climate threat constrains possible development paths, and sufficiently disruptive climate change could preclude any prospect for sustainable future (WGII Chapter 19). In this perspective, an effective climate response is necessarily an integral objective of an SD strategy.

Second, there are trade-offs between climate responses and broader SD goals, because some climate responses can impose other environmental pressures, have adverse distributional effects, draw resources away from other developmental priorities, or otherwise impose limitations on growth and development (Sections 4.6, 7.11, 8.9, 9.8, 10.10, 11.9, 12.8). Section 4.4 examines how to avoid such trade-offs by changing behavioural patterns and decoupling emissions and growth, and/or decoupling growth and well-being.

Third, there are multiple potential synergies between climate responses and broader SD objectives. Climate responses may generate co-benefits for human and economic development (Sections 3.6, 4.8, 6.6, 7.9, 8.7, 9.6, 10.8, 11.7). At a more fundamental level, capacities underlying an effective climate response overlap strongly with capacities for SD (Section 4.6, 5.3).

A key message of this report is that designing a successful climate policy may require going beyond a narrow focus on mitigation and adaptation, beyond the analysis of a few co-benefits of climate policy, and may instead require "mainstreaming" climate issues into the design of comprehensive SD strategies, including at local and regional levels. Figure 4.1 illustrates the different perspectives from which climate policy can be envisioned. In the broadest, boldest perspective, the choice of the development path (see Sections 4.5, 6.1) is at stake.

### 4.2.2 Equity and its relation to sustainable development and climate change

Equity is prominent in research and policy debates about SD and climate, both as distributive equity (distribution of resources in contexts such as burden-sharing, distribution of well-being in the broader context of social justice, see Sections 3.3, 4.4, 4.6) and procedural equity (participation in decision-making, see Section 4.3). Various aspects of the general concept, as developed in social ethics, are introduced in Section 3.2 under the name of fairness and justice. (In this chapter the terms equity, fairness, and justice are not distinguished but are used according to common usage depending on context). The aim of this subsection is to analyse the links between equity, SD, and climate issues.


**Figure 4.1.** Three frameworks for thinking about mitigation

Equity *between* generations underlies the very notion of SD. Figure 4.2, a variant of a figure from Howarth and Norgaard (1992), illustrates sustainability as the possibility for future generations to reach at least the same level of well-being as the current generation. It shows in particular that sustainability is a matter of distributive equity, not of efficiency, even if eliminating inefficiencies affecting future sustainable well-being may improve sustainability, as stressed in Grubb et al. (2013).

There has been a recent surge of research on intergenerational equity, motivated by dissatisfaction with the tradition of discounting the utility of future generations in the analysis of growth paths (see, e.g., Asheim (2007), Roemer and Suzumura (2007) for recent syntheses). The debate on discounting is reviewed in 3.6.2. Recent literature presents new arguments deriving the imperative of sustaining well-being across generations from more basic equity principles (Asheim et al., 2001, 2012).

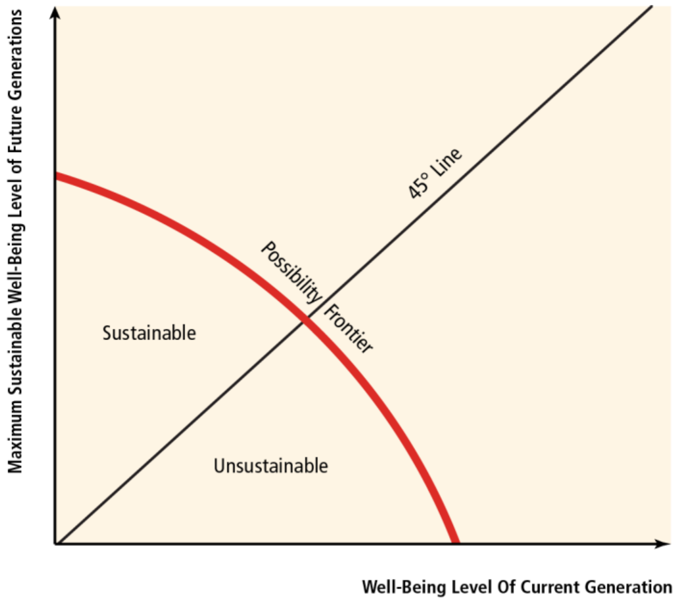


**Figure 4.2.** The well-being level of the current generation is sustainable if it does not exceed the maximum sustainable well-being level of the future generations –independently of whether one is or is not on the possibility frontier.

Equity *within* every generation is often considered an intrinsic component of SD linked to the social pillar. The Millennium Development Goals (MDGs) may be seen as one indication of a more explicit global commitment to the social pillar (United Nations, 2000). Yet, the relation between equity within generations and SD is complex. Attempting to meet the needs of the world's poor by proliferating the consumption patterns and production processes of the world's richest populations would be unsustainable (Millennium Ecosystem Assessment, 2005; Rockström et al., 2009b; Steffen et al., 2011; Intergovernmental Panel on Climate Change, 2014). Such a scenario would not likely play out well for the world's poor. Environmental issues are interwoven with the fabric of racial, social and economic injustice. Environmental costs and benefits are often distributed so that those who already suffer other socio-economic disadvantages tend to bear the greatest burden (Okereke, 2011).

Figure 4.3 illustrates the normative framework in which a SD path can be grounded on certain values (well-being, equity) and interrelated goals (development and conservation), and the synergies and trade-offs between SD and climate policy, with procedural equity and iterative learning nurturing each step, from conceptualization to implementation.

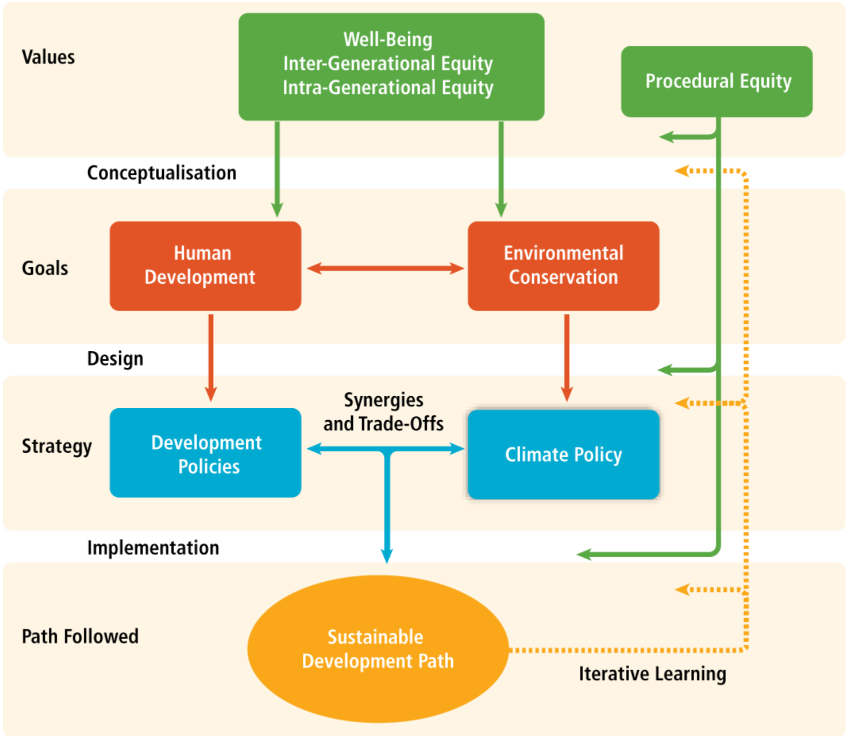


**Figure 4.3.** Links between SD, equity, and climate policy

In the rest of this section, we focus on one key dimension of equity that is of central importance to international negotiations toward an effective global response to climate change. As in many other contexts, fundamental questions of resource allocation and burden-sharing arise in climate change, and therefore equity principles are invoked and debated. Three lines of argument have been put forward to justify a reference to equity in this context (Section 4.6 examines the details of burden-sharing principles and frameworks in a climate regime.)

The first justification is the normative claim that it is morally proper to allocate burdens associated with our common global climate challenge according to ethical principles. The broad set of ethical arguments for ascribing moral obligations to individual nations has been reviewed in Section 3.3, drawing implicitly upon a cosmopolitan view of justice, which posits that some of the basic rights and duties that arise between people within nations also hold between people of different nations.

The second justification is the legal claim that countries have accepted treaty commitments to act against climate change that include the commitment to share the burden of action equitably. This claim derives from the fact that signatories to the UNFCCC have agreed that: "Parties should protect the climate system for the benefit of present and future generations of humankind, *on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities*" (UNFCCC, 2002). These commitments are consistent with a body of soft law and norms such as the no-harm rule according to which a state must prevent, reduce or control the risk of serious environmental harm to other states (Stockholm Convention (UNEP, 1972), Rio declaration (United Nations, 1992b), Stone (2004)). In addition, it has been noted that climate change adversely affects a range of human rights that are incorporated in widely ratified treaties (Aminzadeh, 2006; Humphreys, 2009; Knox, 2009; Wewerinke and Yu III, 2010; Bodansky, 2010).

The third justification is the positive claim that equitable burden-sharing will be necessary if the climate challenge is to be effectively met. This claim derives from the fact that climate change is a classic commons problem (Hardin, 1968; Soroos, 1997; Buck, 1998; Folke, 2007) (also see Section 13.2.2.4). As with any commons problem, the solution lies in collective action (Ostrom, 1990). This is true at the global scale as well as the local, only more challenging to achieve (Ostrom et al., 1999).

Inducing cooperation relies, to an important degree, on convincing others that one is doing one's fair share. This is why notions of equitable burden-sharing are considered important in motivating actors to effectively respond to climate change. They are even more important given that actors are not as equal as the proverbial "commoners," where the very name asserts homogeneity (Milanović et al., 2007). To the contrary, there are important asymmetries or inequalities between stakeholders (Okereke et al., 2009; Okereke, 2010): asymmetry in contribution to climate change (past and present), in vulnerability to the impacts of climate change, in capacity to mitigate the problem, and in power to decide on solutions. Other aspects of the relation between intragenerational equity and climate response include the gender issues noted in 4.2.1.2, and the role of virtue ethics and citizen attitudes in changing lifestyles and behaviours (Dobson, 2007; Lane, 2012), a topic analyzed in Section 4.4.

Young (2013) has identified three general conditions –which apply to the climate context– under which the successful formation and eventual effectiveness of a collective action regime may hinge on equitable burden-sharing: the absence of actors who are powerful enough to coercively impose their preferred burden-sharing arrangements; the inapplicability of standard utilitarian methods of calculating costs and benefits; the fact that regime effectiveness depends on a long-term commitment of members to implement its terms. With respect to climate change, it has long been noted that a regime that many members find unfair will be face severe challenges to its adoption or be vulnerable to festering tensions that jeopardize the its effectiveness (Harris, 1996; Müller, 1999; Young, 2012). Specifically, any attempt to protect the climate by keeping living standards low for a large part of the world population will face strong political resistance, and will almost certainly fail (Roberts and Parks, 2007; Baer et al., 2009). While costs of participation may provide incentives for non-cooperation or defection in the short-term, the climate negotiations are not a one-shot game, and they are embedded in a much broader global context; climate change is only one of many global problems – environmental, economic, and social – that will require effective cooperative global governance if development – and indeed human welfare – is to be sustained in the long term (Singer, 2004; Jasanoff, 2004; Speth and Haas, 2006; Kjellen, 2008).

Despite these three lines of justification, the question of the role that equity does or should play in the establishment of global climate policy and burden-sharing in particular is nonetheless controversial (Victor, 1998). The fact that there is no universally accepted global authority to enforce participation is taken by some to mean that sovereignty, not equity is the prevailing principle. Such a conception implies that the bottom-line criterion for a self-enforcing (Barrett, 2005) cooperative agreement would be simply that everyone is no worse off than the status quo. This has been termed "International Paretianism" (Posner and Weisbach, 2010), and its ironic, even perverse results have been pointed out: "an optimal climate treaty could well require side payments to rich countries like the United States and rising countries like China, and indeed possibly from very poor countries which are extremely vulnerable to climate change - such as Bangladesh." (Posner and Weisbach, 2010, p. 86).

However, both critics and advocates of the importance of equity in the climate negotiations acknowledge that governments can choose to act on moral rather than purely self-interested principles (DeCanio and Fremstad, 2010; Posner and Weisbach, 2010, 2012; Baer, 2013; Jamieson, 2013) (See also Section 3.10.). Whether or not states behave as rational actors, given the significant global gains to be had from cooperation, this leaves ample room for discussion of the role of equity in the distribution of those global gains, while still leaving all parties better off (Stone, 2004).

While the above discussion focuses on equity among nations, equally relevant concerns regarding equity within nations also arise, and indeed can be overriding determinants of the prospects for climate policy to be adopted. Demands for equity have been articulated by labour communities primarily in terms of a just transition (International Labour Office, 2010; Newell and Mulvaney, 2013), and often by marginalized populations and racial minorities in terms of environmental justice and just sustainability (Agyeman and Evans, 2004; Walker and Bulkeley, 2006; Shiva, 2008). While the particular demands are highly location- and context-specific, the broad concerns are procedural and distributive justice with reduced power asymmetries, as underscored throughout this chapter.

## 4.3 Determinants, drivers and barriers

This section explores the determinants of SD, emphasizing how each influences the extent to which societies can balance the economic, social and environmental pillars of SD, whilst highlighting potential synergies and trade-offs for the building of mitigative and adaptive capacity and the realisation of effective and equitable mitigation and adaptation strategies. Determinants refer to social processes, properties, and artefacts, as well as natural resources, which together condition and mediate the course of societal development, and thus the prospects for SD. When determinants facilitate SD they act drivers and when they constrain it they act as barriers.

The determinants discussed include: the legacy of development relations; governance and political economy; population and demography; human and social capital; behaviour, culture and values; technology and innovation processes; natural resources; and finance and investment. These determinants are interdependent, characterized by feedbacks that blur the distinction between cause and effect, and their relative importance depends on context -see analogous discussion in the context of GHG emission drivers in 5.3. They are not unique, and other determinants such as leadership (Jones and Olken, 2005), randomness (Holling, 1973; Arthur, 1989), or human nature (Wilson, 1978) could be added to the list, but they are less amenable to deliberate intervention by policy-makers and other decision-makers and have therefore been excluded. What follows lays the foundations for understanding concepts that recur throughout this chapter and those that follow.

### 4.3.1 Legacy of development relations

Following World War II, security, economic, and humanitarian relations between rich nations and poor nations were comingled and addressed under the umbrella of "development" (Truman, 1949; Sachs, Wolfgang, 1999). Differing perspectives on the mixed outcomes of six decades of development, and what the outcomes may indicate about underlying intentions and capabilities, inform different actors in different ways as to what will work to address climate change and the transition to SD. During the 1950s and 1960s, for example, expectations were that poverty would be reduced dramatically by the end of the century (Rist, 2003). It was widely believed that economic development could be instigated through aid from richer nations, both financial and in kind. Development was seen as a process of going through stages starting with transforming traditional agriculture through education, the introduction of new agricultural technologies, improved access to capital for farm improvements, and the construction of transportation infrastructure to facilitate markets. Improved agriculture would release workers for an industrial stage and thereby increase opportunities for education and commercial development in cities. As development proceeded, nations would increasingly acquire their own scientific capabilities and, later, sophisticated governance structures to regulate finance and industry in the public good, becoming well-rounded, well-governed economies comparable to those of rich nations.

By the 1970s, however, it was clear that development was not on a path to fulfilling these linear expectations because: 1) contributions of aid from the rich nations were not at levels anticipated; 2) technological and institutional changes were only partially successful, proved inappropriate, or had unpredicted, unfortunate consequences; 3) requests for military aid and the security and economic objectives of richer nations in the context of the Cold War were frequently given priority over poverty reduction; and 4) graft, patronage, and the favouring of special interests diverted funds from poverty reduction. Beliefs that nations naturally went through stages of development to become well-rounded economies faded by the early 1980s. Greater participation in global trade, with its implied specialization, was invoked as the path to economic growth. Diverse other efforts were made to improve how development worked, but with only modest success, leaving many in rich and poor nations concerned about development process and prospects (United Nations, 2011a).

Layering the goal of environmental sustainability onto the goal of poverty reduction further compounded the legacy of unmet expectations (World Commission on Environment and Development, 1987). There have been difficulties determining, shifting to, and governing for sustainable pathways (Sanwal, 2010) -see 4.3.2 below. The negotiation of new rules for the mobility of private capital and the drive for globalization of the economy also came with new expectations for development (Stiglitz, 2002). The Millennium Development Goals (MDG) established in 2000 to be met by 2015 are an example of how such expectations were thought to be realizable in the rapidly evolving times of the global financial economy. In retrospect and after the 2008 financial sector induced recession, significant improvements are largely in China and India where economic growth accelerated through private capital flows independent of the MDG process. Excluding these countries, the record is mixed at best and still poor in most of Africa (Keyzer and Wesenbeeck, 2007; Easterly, 2009; United Nations, 2011a). Additionally, since the 1990s, greenhouse gas emissions became another focus of contention (Roberts and Parks, 2007; Penetrante, 2011; Dryzek et al., 2011). The developed nations became rich through the early use of fossil fuels and land transformations that put GHGs in the atmosphere, imposing costs on all people, rich and poor, through climate impacts that will persist over centuries (Srinivasan et al., 2008). Connections between causal and moral responsibility arose, complicating the legacy of development.

Such legacy of unmet development and sustainability expectations is open to multiple interpretations. In richer nations, the evidence can be interpreted to support the views of fiscal conservatives who oppose aid, libertarians who oppose humanitarian and environmental interventions, progressives who urge that more needs to be done to reach social and environmental goals, and some environmentalists who urge dematerialization and degrowth among the rich as necessary to meet the needs of the poor. In poorer nations, the legacy similarly supports various views including a distrust of rich nations for not delivering development and environmental assistance as promised, cynicism toward the intentions and conceptual rationales when it is provided, and also a wariness of development's unpredicted outcomes.

In both developed and developing nations these diverse sentiments among the public, policy makers, and climate negotiators contribute to what philosopher Gardiner (2011b) refers to as the "perfect moral storm" of climate policy. Some analysts argue that the legacy of development and interrelated issues of equity so cloud global climate negotiations that *ad hoc* agreements and voluntary pledges are the most that can be achieved (Victor, 2004) and considerations of development and equity are better left aside (Posner and Weisbach, 2010), although this leaves open whether such arrangements could provide an adequately ambitious climate response consistent with the UNFCCC's objectives. (See Section 4.6.2 for further discussion of perspectives on equity in a climate regime, and Section 13.4.3 for further discussion of regime architectures).

### 4.3.2 Governance and political economy

Governance and political economy are critical determinants for SD, equity and climate mitigation because they circumscribe the process through which these goals and how to attain them are articulated and contested. The quest for equity and climate mitigation in the context of SD thus necessitates an improved understanding and practice of governance (Biermann et al., 2009; Okereke et al., 2009). Governance in the broadest sense refers to the processes of interaction and decision-making among actors involved in a common problem (Kooiman, 2003; Hufty, 2011). It goes beyond notions of formal government or political authority and integrates other actors, networks, informal institutions and incentive structures operating at various levels of social organization (Rosenau, 1990; Chotray and Stoker, 2009). In turn, climate governance has been defined as the mechanisms and measures "aimed at steering social systems towards preventing, mitigating or adapting to the risks posed by climate change" (Jagers and Stripple, 2003). From this definition, it can be seen as a broad phenomenon encompassing not only formal policy-making by states but all the processes through which authority is generated and exerted to affect climate change and sustainability. This includes policy-making by states but also by many other actors -NGOs, TNCs, municipalities, for example- operating across various scales (Okereke et al., 2009).

Many scholars have highlighted the challenges associated with governing for SD and climate change (Adger and Jordan, 2009; Levin et al., 2012). First, it involves rethinking the ways society relates to nature and the underlying biophysical systems. This is relevant in the context of the growing evidence of the impact of human activity on the planet and the understanding that extraordinary degrees of irreversible damage and harm are distinct possibilities if the right measures are not taken within adequate timescale (Millennium Ecosystem Assessment, 2005; Rockström et al., 2009a). Second, governing climate change involves complex intergenerational considerations. On the one hand, cause and effect of some environmental impacts and climate change are separated by decades, often generations, and on the other hand, those who bear the costs of remediation and mitigation may not be the ones to reap the benefits of avoided harm (Biermann, 2007).

Third, effective response to climate change may require a fundamental restructuring of the global economic and social systems which in turn would involve overcoming vested multiple interests and the inertia associated with behavioural patterns and crafting new institutions that promote sustainability (Meadows et al., 2004; Millennium Ecosystem Assessment, 2005). This challenge is exacerbated by the huge mismatch between the planning horizon needed to address global environmental problems and climate change and the tenure of decision makers (Hovi et al., 2009). Fourth, and finally, SD governance cuts across several realms of policy and organisation. Particularly, the governance of climate mitigation and adaptation is an element of a complex and evolving arena of global environmental governance, which deals with other, and often overlapping, issues such as biodiversity loss, desertification, water management, trade, energy security, and health, among others (Adger and Jordan, 2009; Brown, 2009; Bell et al., 2010; Balsiger and Debarbieux, 2011; da Fonseca et al., 2012; Bark et al., 2012). Sites of climate change governance and policy-making are thus multiple and are not confined to the UNFCCC and national rule-making processes, a situation which raises challenges in relation to coordination, linkages and synergies (Ostrom, 2010; Zelli, 2011; Jinnah, 2011) – see Sections 13.4, 13.13, 14.1, 15.2, notably Figure 13.1 for a visual summary.

These considerations explain why climate governance has attracted more political controversy than any other issue in relation to global sustainability and its equity considerations. Some of the main aspects of this controversy include: who should participate in decision making; how to modulate power asymmetry among stakeholders; how to share responsibility among actors; what ideas and institutions should govern response measures, and where should interventions most focus? Questions of justice are embedded in these five domains, aggravated by the high stakes involved and the stark asymmetry among states and others actors in terms of cause, effect, and capability to respond to the problem (Okereke and Dooley, 2010; Okereke, 2010; Schroeder et al., 2012).

Scholars have long analysed climate governance focusing on the above key controversies with a multitude of possible solutions being volunteered. Concerning participation, a departure from the top-down approach implied in the Kyoto Protocol towards a more voluntary and bottom-up approach has been suggested (Rayner, 2010). Some argue that limiting participation to the "most capable, responsible and vulnerable" countries can foster progress toward more stringent mitigation policy (Eckersley, 2012). However, the latter has been opposed on the basis that it would further exacerbate issues of inequity (Aitken, 2012; Stevenson and Dryzek, 2012). Others have discussed the need to create spaces for collaborative learning to debate, legitimize and potentially overcome knowledge divides between experts and lay people in sectoral climate policy development (Swanson et al., 2010; Armitage et al., 2011; Colfer, 2011; Larsen et al., 2012) -see Section 13.13 for further detail. On allocation of responsibility, a global agreement has been elusive not merely because parties and other key actors have differing conceptions of a fair allocation (Okereke, 2008), but because the pertinent policies are highly contentious given the combination of factors at play, prominent among which are finance, politics, ineffective institutions and vested interests.

Precisely, a defining image of the climate governance landscape is that key actors have vastly disproportionate capacities and resources, including the political, financial and cognitive resources that are necessary to steer the behaviour of the collective within and across territorial boundaries (Dingwerth and Pattberg, 2009). A central element of governance therefore relates to huge asymmetry in such resources and the ability to exercise power or influence outcomes. Some actors, including governments, make use of negotiation power and/or lobbying activities to influence policy decisions at multiple scales and, by doing so, affect the design and the subsequent allocation and distribution of benefits and costs resulting from such decisions (Markussen and Svendsen, 2005; Benvenisti and Downs, 2007; Schäfer, 2009; Sandler, 2010) -see e.g. Section 15.5.2. The problem, however, also resides in the fact that those that wield the greatest power either consider it against their interest to facilitate rapid progress towards a global low carbon economy or insist that the accepted solutions must be aligned to increase their power and material gains (Sæverud and Skjærseth, 2007; Giddens, 2009; Hulme, 2009; Lohmann, 2009, 2010; Okereke and McDaniels, 2012; Wittneben et al., 2012). The most notable effect of this is that despite some exceptions, the prevailing organizing of the global economy which confers significant power on actors associated with fossil fuel interests and with the financial sector has provided the context for the sorts of governance practices of climate change that have dominated to date (Newell and Paterson, 2010).

Many specific governance initiatives described in Sections 13.13 and 15.3, whether organized by states or among novel configurations of actors, have focused on creating new markets or investment opportunities. This applies, for example, to carbon markets (Paterson, 2009), carbon offsetting (Bumpus and Liverman, 2008; Lovell et al., 2009; Corbera and Schroeder, 2011; Corbera, 2012), investor-led governance initiatives such as the Carbon Disclosure Project (Kolk et al., 2008) or partnerships such as the Renewable Energy and Energy Efficiency Partnership (Parthan et al., 2010). Some scholars find that carbon markets can contribute to achieving a low fossil carbon transition, but require careful designs to achieve environmental and welfare gains (Wood and Jotzo, 2011; Pezzey and Jotzo, 2012; Springmann, 2012; Bakam et al., 2012). Others note that such mechanisms are vulnerable to “capture” by special interests and against the original purposes for which they are conceived. Several authors have discussed this problem in the context of the Clean Development Mechanism (CDM) and the European Union Emissions Trading Scheme (EU-ETS) (Lohmann, 2008; Clò, 2010; Okereke and McDaniels, 2012; Böhm et al., 2012).

Governing for SD and climate change requires close attention to some key questions. There is a need to understand current governance as encompassing more than the actors within formal government structures, and to understand their choices as being driven by more than optimal decision-making theory. It requires understanding the dynamics that determine whether and how policy options are legitimized, and then formally deliberated and adopted (or not). It is necessary to examine how these modes of governance are defined and established in the first place, by whom and for whose benefit, illuminating the relationship and tensions between effective governance and existing trends in political economy. There is a need to explore how different modes of governance translate into outcomes, affecting the decisions and actions of actors at multiple scales, and to draw lessons about their environmental effectiveness and distributional implications. While some argue that states should still be regarded as key agents in steering such transitions (Eckersley, 2004; Weale, 2009), most decision-making relevant to SD and climate remains fundamentally decentralized. A key challenge of governance is thus to recognize the political economy context of these decision-makers, to ensure procedurally equitable processes that address the allocation of responsibilities and ensure transparency and accountability in any transition towards SD.

### 4.3.3 Population and demography

Population variables, including size, density, growth rate as well as age, sex, education and settlement structures, play a determinant role in countries’ SD trajectories. Their drivers, in particular fertility, mortality and migration, are reciprocally influenced by development pathways, including evolving policies, socio-cultural trends, as well as by changes in the economy (Bloom, 2011). In the climate change context, population trends have been shown to matter both for mitigation efforts as well as for societies' adaptive capacities to climate change (O'Neill et al., 2001).

Current demographic trends show distinct patterns in different parts of the world. While population sizes are on a declining trajectory in Eastern Europe and Japan, they are set for significant further increase in many developing countries (particularly in Africa and south-western Asia) due to a very young population age structure and continued high levels of fertility. As most recent projections show, the world's population is almost certain to increase to between 8 and 10 billion by mid-century. After that period, uncertainty increases significantly, with the future trend in birth rates being the key determinant but also amplified by the uncertainty about future infectious disease mortality and the still uncertain consequences of climate change on future mortality trajectories (O'Neill et al., 2001; Lutz and KC, 2010; United Nations, 2011b; Lee, 2011; Scherbov et al., 2011). The population of Sub-Saharan Africa will almost certainly double and could still increase by a factor of three or more depending on the course of fertility over the coming decades, which depends primarily on progress in female education and the availability of reproductive health services (Bongaarts, 2009; Bloom, 2011; Bongaarts and Sinding, 2011).

Declining fertility rates together with continued increases in life expectancy result in significant population ageing around the world, with the current low fertility countries being most advanced in this process. Population ageing is considered a major challenge for the solvency of social security systems. For populations still in the process of fertility decline, the expected burden of ageing is a more distant prospect, and the declining birth rates are expected to bring some near term benefits. This phase in the universal process of any demographic transition, when the ratio of children to adults is already declining and the proportion of elderly has not yet increased, is considered a window of opportunity for economic development, which may also result in an economic rebound effect leading to higher per capita consumption and emissions (Bloom and Canning, 2000).

Low development is widely understood to contribute to high population growth, which declines only after the appearance of widespread access to key developmental needs such as perinatal and maternal healthcare, and female education and empowerment. Conversely, high population growth is widely regarded as an obstacle to SD, because it tends to make efforts such as the provision of clean drinking water and agricultural goods and the expansion of health services and school enrolment rates difficult (Dyson, 2006; Potts, 2007; Pimentel and Paoletti, 2009). This has given rise to the fear of a vicious circle of underdevelopment and gender inequity yielding high population growth and environmental degradation, in turn inhibiting the development necessary to bring down fertility (Caole and Hoover, 1958; Ehrlich and Holdren, 1971; Dasgupta, 1993). However, history shows that countries can break this vicious circle with the right social policies, with an early emphasis on education and family planning, prominent examples being South Korea and Mauritius, used in the 1950s as textbook examples of countries trapped in such a vicious circle (Meade, 1967).

With respect to adaptation to climate change, the literature on population and environment has begun to explore more closely people's vulnerability to climate stressors, including variability and extreme events, and to analyse their adaptive capacity and reliance on environmental resources to cope with adversities and adapt to gradual changes and shocks (Bankoff et al., 2004; Adger et al., 2009) -see also 4.6.1 and AR5 WGII. Generally speaking, not only the number of people matters, but also their composition by age, gender, place of residence and level of education, as well as the institutional context that influences people's decision-making and development opportunities (Dyson, 2006). One widely and controversially discussed form of adaptation can be international migration induced by climate change. There is often public concern that massive migration of this sort could contribute to political instability and possibly conflict. However, a major recent review of our knowledge in this field has concluded that much environmentally induced migration is likely to be internal migration and there is very little science-based evidence for assessing possible consequences of environmental change on large international migration streams (UK Government Office for Science, 2011).

### 4.3.4 Values and behaviours

Research has identified a range of individual and contextual predictors of behaviours in favour or against climate mitigation, ranging from individuals' psychological needs to cultural and social orientations towards time and nature (Swim et al., 2009) -see Sections 2.4, 3.10, and 5.5. Below we discuss some of these factors, focusing on human values that influence individual and collective behaviours and affect our priorities and actions concerning the pursuit of SD, equity goals and climate mitigation. Values have been defined as ”enduring beliefs that pertain to desirable end states or behaviours, transcend specific situations, guide selection or evaluation of behaviour and events and are ordered by importance” (citing Schwartz and Bilsky, 1987, p. 551; Pepper et al., 2009, p. 127). Values provide ”guides for living the best way possible for individuals, social groups and cultures” (citing Rohan, 2000, p. 263; Pepper et al., 2009, p. 127) and so influence actions at all levels of society –including the individual, the household, the firm, civil society, and government. Individuals acquire values through socialization and learning experience (Pepper et al., 2009) and values thus relate to many of the other determinants discussed in this section. Values may be rooted in cultural, religious and other belief systems, which may sometimes conflict with scientific understandings of environmental risks. In particular, distinct values may influence perceptions and interpretations of climate impacts and hence climate responses (Wolf et al., 2013).

The relevance of values to SD and, particularly, to ecologically conscious (consumer) behaviour, is related to 'the nature of environmental issues as ‘social dilemmas’, where short-term narrow individual interests conflict with the longer term social interest' (Pepper et al., 2009). Researchers have highlighted the role of non-selfish values that promote the welfare of others (including nature), noting that some but not all indigenous societies are known to focus on 'collective' as opposed to 'individual' interests and values, which often result in positive resource conservation strategies and wellbeing (Gadgil et al., 1993; Sobrevila, 2008; Watson et al., 2011). However, it is well known that a range of factors also mediate the impact of values on behaviour such that the link from values to ecologically conscious behaviour is often loose (Pepper et al., 2009).

In fact, this ‘value-action’ gap suggests that pursuing climate mitigation and SD globally may require substantial changes in behaviour in the short term along with a transformation of human values in the long term, e.g. progressively changing conceptions and attitudes toward biophysical systems and human interaction (Gladwin et al., 1995; Leiserowitz et al., 2005; Vlek and Steg, 2007; Folke et al., 2011a). Changing human values would require a better understanding of cross-cultural behavioural differences that in turn relate to environmental, economic and political histories (Norenzayan, 2011).

Behavioural change can be induced by changes in formal and civil institutions and governance, human values (Jackson, 2005a; Folke et al., 2011a; Fischer et al., 2012), perceptions of risk and causality, and economic incentives. Removing perverse subsidies for environmentally harmful products, favouring greener consumption and technologies, adopting more comprehensive forms of biophysical and economic accounting, and providing safer working conditions are considered central for achieving pro-SD behavioural change (Lebel and Lorek, 2008; Le Blanc, 2010; Thøgersen, 2010). Yet behaviour experiments (Osbaldiston and Schott, 2012) suggest there is no 'silver bullet' for fostering ecologically conscious behaviour, as favourable actions (e.g. to conserve energy) are triggered by different stimuli, including information, regulation or economic rewards, and influenced by the nature of the issue itself. Furthermore, people are able to 'express both relatively high levels of environmental concern and relatively high levels of materialism simultaneously' (Gatersleben et al., 2010). This suggests the need to be issue, context and culturally aware when designing specific actions to foster pro-SD behaviour, as both environmental and materialistic concerns must be addressed. These complexities underscore the challenges in changing beliefs, preferences, habits and routines (Southerton, 2012) -see Sections 4.4 and 5.5.2.

### 4.3.5 Human and social capital

Levels of human and social capital also critically influence a transition toward SD and the design and implementation of mitigation and adaptation strategies. Human capital results from individual and collective investments in acquiring knowledge and skills that become useful for improving wellbeing (Iyer, 2006). Such knowledge and skills can be acquired through formal schooling and training, as well as informally through customary practices and institutions, including communities and families. Human capital can thus be viewed as a critical component of a broader-encompassing human capability, i.e. a person's ability to achieve a given list of "functionings" or achievements, which depend on a range of personal and social factors, including education, age, gender, health, income, nutritional knowledge and environmental conditions, among others (Sen, 1997, 2001). See Clark (2009) and Schokkaert (2009) for a review of Sen's capability approach and its critiques.

Economists have long considered improvements in human capital a key explanatory reason behind the evolution of economic systems, in terms of growth and constant innovation (Schultz, 1961; Healy and Cote, 2001). Macro-economic research shows a strong correlation between levels of economic development and levels of human capital and vice versa (Schultz, 2003; Iyer, 2006), whilst micro-economic studies reveal a positive relationship between increases in the quantity and quality of formal education and future earnings (Duflo, 2001). Gains in human capital can be positively correlated to economic growth and efficiency, but also to nutritional, health and education standards (Schultz, 1995). As such, improvements in human capital provide a basis for SD, as they shape countries' socio-economic systems and influence people's ability to make informed choices. Seemingly, human capital often also explains the development and survival of business ventures (Colombo and Grilli, 2005; Patzelt, 2010; Gimmon and Levie, 2010), which are an important source of innovation and diffusion of principles and technologies that can contribute to SD and to ambitious climate mitigation and adaptation goals (Marvel and Lumpkin, 2007; Terjesen, 2007).

However, a growing body of literature in economics, geography and psychology (reviewed in Sections 2.4, 2.6.6 and 3.10 as well as in WGII Chapter 2) has shown that the diversity of environmental, socio-economic, educational and cultural contexts in which individuals make decisions shape their willingness and/or ability to engage in mitigation and adaptation action (Lorenzoni et al., 2007). It is important to distinguish between formally acquired knowledge on climate change -often based on scientific developments- and traditional knowledge on climate-related issues (Smith and Sharp, 2012), as well as to recognize that the relative validity of both types of knowledge to different audiences, and the meaning and relevance of personal engagement, will be influenced by individual perceptions, preferences, values and beliefs. Therefore, knowledge on climate issues does not alone explain individual and collective responses to the climate challenge (Whitmarsh, 2009; Sarewitz, 2011; Wolf and Moser, 2011; Berkhout, 2012). There is evidence of cognitive dissonance and strategic behaviour in both mitigation and adaptation. Denial mechanisms that overrate the costs of changing lifestyles, blame others, and that cast doubt on the effectiveness of individual action or the soundness of scientific knowledge are well documented (Stoll-Kleemann et al., 2001; Norgaard, 2011; McCright and Dunlap, 2011), as is the concerted effort by opponents of climate action to seed and amplify those doubts (Jacques et al., 2008; Kolmes, 2011; Conway and Oreskes, 2011).

Among the different definitions of social capital, one of the most influential was proposed by Fukuyama (2002): the shared norms or values that promote social cooperation, which are founded in turn on actual social relationships, including trust and reciprocity. Social capital appears in the form of family bonds, friendship and collective networks, associations, and other more or less institutionalized forms of collective action. Social capital is thus generally perceived as an asset for both the individuals that recognize and participate in such norms and networks and for the respective group/society, insofar as they derive benefits from information, participating in decision-making and belonging to the group. Social capital can be linked to successful outcomes in education, employment, family relationships, and health (Gamarnikow and Green, 1999), as well as to economic development and participatory, democratic governance (Woolcock, 1998; Fukuyama, 2002; Doh and McNeely, 2012). Indeed, social capital can also be sustained on unfair social norms and institutions that perpetuate an inequitable access to the benefits provided by social organisation (Woolcock and Narayan, 2000), through social networks of corruption or criminal organisations, for example, that perpetuate the uneven distribution of public resources, and undermine societies' cohesion and physical security.

Scholarship suggests that social capital is supportive for SD (Rudd, 2000; Bridger and Luloff, 2001; Tsai, 2008; Ostrom, 2008; Jones et al., 2011), having shown that it can be instrumental to address collective action problems (Ostrom, 1998; Rothstein, 2005), combat injustices and conditions of poverty and vulnerability (Woolcock and Narayan, 2000), and benefit from resources (Bebbington, 1999; Diaz et al., 2002), and to foster mitigation and adaptation (Adger, 2003; Wolf et al., 2010).

### 4.3.6 Technology

Technology has been a central element of human, social, and economic development since ancient times (Jonas, 1985; Mokyr, 1992). It can be a means to achieving equitable SD, by enabling economic and social development whilst using environmental resources more efficiently. The development and deployment of the overwhelming majority of technologies is mediated by markets, responding to effective demand of purchasers (Baumol, 2002), and carried out by private firms, where the pre-requisites of technological capacity and investment resources tend to be found. However, this process does not necessarily address the basic needs of those members of society with insufficient market demand to influence the decisions of innovators and investors, nor does it provide an incentive to reduce externalized costs, such as the costs of GHG pollution (Jaffe et al., 2005).

Fundamental objectives of equity and SD are still unmet. For example, the basic energy and nutritional needs of large parts of the world's population remain unfulfilled. An estimated 1.4 billion people lacked access to electricity in 2010 and about 3 billion people worldwide relied on highly-polluting and unhealthy traditional solid fuels for household cooking and heating (Pachauri et al., 2012; IEA, 2013) (see Section 14.3.2.1). Similarly, the Food and Agricultural Organization indicates that almost 870 million people (mostly in developing countries) were chronically undernourished in 2010–12 (FAO, 2012). Achieving the objectives of equitable SD demands the fulfilment of such basic and other developmental needs. The challenge is therefore to design, implement, and provide support for technology innovation and diffusion processes that respond to social and environmental goals, which at present do not receive adequate incentives through conventional markets.

Scholars of technological change have, in recent years, begun to highlight the 'systemic' nature of innovation processes as well as the fundamental importance of social and technical interactions in shaping technological change (see Section 4.5.2.2). Accordingly, as a first step toward understanding how innovation could help meet social and environmental goals, a systematic assessment of the adequacy and performance of the relevant innovation systems would be helpful, including an examination of the scale of innovation investments, the allocation among various objectives and options, the efficiency by which investments yield outputs, and how effectively the outputs are utilized for meeting the diffusion objectives (Sagar and Holdren, 2002; Sanwal, 2011; Aitken, 2012). For example, many reports and analyses have suggested that investments in innovation for public goods such as clean energy and energy access are not commensurate with the nature and scale of these challenges (Nemet and Kammen, 2007; AEIC, 2010; Bazilian et al., 2010). Innovation in and diffusion of new technologies also require skills and knowledge from both developers and users, as well as different combinations of enabling policies, institutions, markets, social capital and financial means depending on the type of technology and the application being considered (Bretschger, 2005; Dinica, 2009; Blalock and Gertler, 2009; Rao and Kishore, 2010; Weyant, 2011; Jänicke, 2012). Appropriately harnessing these kinds of capabilities and processes may themselves require novel mechanisms and institutional forms (Bonvillian and Weiss, 2009; Sagar et al., 2009).

At the same time, the role of public policy in creating demand for technologies that have a public goods nature cannot be overstated (see also 3.11), although these policies need to be designed carefully to be effective. In the case of renewables, for example, it has been shown that intermittent policy subsidies, governments' changing R&D support, misalignments between policy levels, sectors and institutions can greatly impede the diffusion of these technologies (Negro et al., 2012). Similarly, in agriculture, while there are many intersections between mitigation and SD through options such as 'sustainable agriculture', the potential for leveraging these synergies is contingent on appropriate and effective policies (Smith et al., 2007) -see also Sections 4.6.1 and 11.3.

Sometimes there may be a clear alignment between achieving equitable SD benefits and meeting climate goals such as the provision of clean energy to the rural poor. But in meeting multiple objectives, potential for conflicts and trade-offs can also arise. For example, our likely continued reliance on fossil fuels (IEA 2012) underlies the current exploration of new or well-established GHG mitigation options, such as biofuels or nuclear power, and other approaches like carbon capture and storage (CCS) and geo-engineering, including solar radiation management techniques, to avoid a dangerous increase of the Earth's temperature (Crutzen, 2006; Rasch et al., 2008; Intergovernmental Panel on Climate Change, 2012b). While such technological options may help mitigate global warming, they also pose potential adverse environmental and social risks, and thus give rise to concerns about their regulation and governance (Mitchell, 2008; Pimentel et al., 2009; de Paula Gomes and Muylaert de Araujo, 2011; Shrader-Frechette, 2011; Jackson, 2011b; Scheidel and Sorman, 2012; Scott, 2013; Diaz-Maurin and Giampietro, 2013) -see Sections 7.5 and 11.3.

The public perception and acceptability of technologies is country and context-specific, mediated by age, gender, knowledge, attitudes towards environmental risks and climate change, and policy procedures (Shackley et al., 2005; Pidgeon et al., 2008; Wallquist et al., 2010; Corner et al., 2011; Poumadere et al., 2011; Visschers and Siegrist, 2012) and therefore resolution of these kinds of trade-offs and conflicts may not be easy. Yet the trade-offs and synergies between the three dimensions of SD, as well as the impacts on socio-ecological systems across geographical scales will need to be systematically considered, which in turn will require the acknowledgement of multiple stakeholder perspectives. Assessment of energy technology options, for example, will need to include impact on landscapes' ecological and social dimensions –accounting for multiple values– and on energy distribution and access (Wolsink, 2007; Zografos and Martinez-Alier, 2009).

Lastly, there are some crosscutting issues, such as regimes for technology transfer (TT) and intellectual property (IP) that are particularly relevant to international cooperation in meeting the global challenge of pursuing equitable SD and mitigation, although progress under the UNFCCC has been incomplete. For example, TT under the CDM has been limited to selective conditions and mainly to a few countries (Dechezleprêtre et al., 2009; Seres et al., 2009; Wang, 2010). IP rights and patent laws have been shown as promoting innovation in some countries (Khan, 2005), although recent work suggests a more nuanced picture (Moser, 2013; Hudson and Minea, 2013). In fact, IP protection has also been regarded as a precondition for technology transfer but, again, reality has proven more complex (United Nations Environment Programme et al., 2010). A recent study shows that in the wind sector, there are "patent thickets", which might restrain the extent and scope of dissemination of wind power technologies (Wang et al., 2013). In part, there are such divergent views on this issue since IP and TT also touch upon economic competitiveness (Ockwell et al., 2010). As earlier, perspectives are shaped by perceived national circumstances, capabilities, and needs, yet these issues do need to be resolved – in fact, there may be no single approach that will meet all needs. Different IP regimes, for example, are required to meet development objectives at different stages of development (Correa, 2011). The importance of this issue and the lack of consensus provide impetus for further analysis of the evidence and for exploration to develop IP and TT regimes that further international cooperation to meet climate, SD, and equity objectives.

### 4.3.7 Natural resources

Countries' level of endowment with renewable and/or non-renewable resources influences but does not determine their development paths. The location, types, quantities, long-term availability and the rates of exploitation of non-renewable resources, including fossil fuels and minerals, and renewable resources such as fertile land, forests, or freshwater affect national economies (e.g. in terms of GDP, trade balance and rent potential), agricultural and industrial production systems, the potential for civil conflict, and countries' role in global geo-political and trade systems (Krausmann et al., 2009; Muradian et al., 2012; Collier and Goderis, 2012). Economies can evolve to reflect changes in economic trends, in policies or in consumption patterns, both nationally and internationally. In the context of climate change, natural resource endowments affect the level and profile of GHG emissions, the relative cost of mitigation, and the level of political commitment to climate action.

Resource-rich countries characterized by governance problems, including rent-seeking behaviour and weak judiciary and political institutions, have more limited capacity to distribute resource extraction rents and increase incomes (Mehlum et al., 2006; Pendergast et al., 2011; Bjorvatn et al., 2012). Some have negative genuine savings, i.e. they do not fully reinvest their resource rents in foreign assets or productive capital, which in turn impoverishes present and future generations and undermines both natural capital and human development prospects (Mehlum et al., 2006; van der Ploeg, 2011). Furthermore, these countries also face risks associated with an over-specialization on agriculture and resource-based exports that can undermine other productive sectors, e.g. through increases in exchange rates and a reliance on importing countries economic growth trajectories (Muradian et al., 2012). In some countries, an increase in primary commodity exports can lead to the rise of socio-environmental conflicts due to the increasing exploitation of land, mineral and other resources (Martinez-Alier et al., 2010; Mitchell and Thies, 2012; Muradian et al., 2012).

Scholars have not reached definitive conclusions on the inter-relationships between resource endowment and development paths, including impacts on social welfare and conflict, and prospects for SD. Recent reviews, for example, note the need to continue investigating current resource booms and busts and documenting the latter's effect on national economies, policies, and social well-being, and to draw historical comparisons across countries and different institutional contexts (Wick and Bulte, 2009; Deacon, 2011; van der Ploeg, 2011). It is clear though that the state and those actors involved in natural resources use play a determining role in ensuring a fair distribution of any benefits and costs (Banai et al., 2011). Further, economic valuation studies have noted that systematic valuations of both positive and negative externalities can inform policy-making relating to resource exploitation, in some cases showing that the exploitation of land and mineral resources may not always be socially optimal, i.e. the social and environmental costs of action may be higher than the economic benefits of exploitation (de Groot, 2006; Thampapillai, 2011).

These considerations are relevant for climate mitigation policy for at least three reasons. First, they raise questions about if and how countries invest resource rents across economic, social and environmental sectors for SD (see Section 4.3.8). Second, they suggest that nations or sub-national actors with abundant fossil fuel reserves have, in principle, strong economic interest in exploiting them, and thus in opposing the adoption of policies that constrain such exploitation. The timeliness of this issue is underscored by the growing financial sector attention (although not yet academic attention) to the potential impact of a global carbon constraint on the fossil sector (Grantham Institute and CTI 2013; HSBC Global Research, 2013; Standard & Poor's, 2013). This raises the issue of how to compensate resource-rich countries for forgone benefits if necessary to win their participation in international mitigation efforts (Rival, 2010; Waisman et al., 2013). It similarly raises the issue of compensating (or circumventing) sub-national actors who are political powerful enough to impede domestic climate efforts. And third, they suggest that, if any given resource-rich country faces increased exposure to climate variability and extreme events, the forgone benefits of resource rents may undermine its ability to absorb increasing adaptation costs. In this regard, a recent analysis of the relationship between countries' adoption of mitigation policies and their vulnerability to climate change confirms that countries that may suffer considerable impacts of climate change in the future, which include many resource-rich developing countries, do not show a strong commitment to either mitigation or adaptation, whilst countries exhibiting strong political commitment and action towards mitigation are also active in promoting adaptation policies (Tubi et al., 2012).

### 4.3.8 Finance and investment

The financial system, comprising a large set of private and public institutions and actors, is the medium by which households, firms, and collectivities manage insurable risks and fund investments to secure future returns, thereby laying the foundations for future well-being. As such, it is a key determinant of society's development pathway and thus its prospects for an SD transition.

The financial system is characterized by several structural tensions with the ideals of SD. First, its dominant private component (banks and financial markets) is focused on commercial returns and cannot spontaneously internalize environmental and social spillovers, even if some investors' interest in "sustainable investment" is growing (UNPRI, 2012). Climate change, identified as the "greatest and widest-ranging market failure ever seen" (Stern and Treasury, 2007), is but one obvious example of a large societally important cost that is neglected by capital markets. Second, the private component of the financial system is also largely unattuned to distributive issues and particularly insensitive to "the essential needs of the world's poor, to which overriding priority should be given" (World Commission on Environment and Development, 1987), even if foreign direct investments have contributed to overall growth in emerging economies. Third, the interests of future generations may be neglected (although over-investment is also possible –see Gollier Gollier, 2013), and within a generation, there are various governance, organizational and sociological mechanisms contributing to short-termism (Tonello, 2006; Marginson and McAulay, 2008). Fourth, the recent crisis has led some to analyze that the financial system itself is a source of economic instability (Farmer et al., 2012), an issue reinforced by the recent financialization of the global economy, with accelerated growth of the financial sector relative to the "real" economy, and an increasing role of the financial system in mediating short-term speculation as distinct from long-term investment (Epstein, 2005; Krippner, 2005; Palley, 2007; Dore, 2008).
These inherent problems in the financial system are sometimes compounded by hurdles in the economic and institutional environment. The challenges are felt especially in many developing countries, which face several investment barriers that affect their capacity to mobilize private sector capital toward SD objectives and climate change mitigation and adaptation. These barriers include the comparatively high overall cost of doing business; market distortionary policies such as subsidies for conventional fuels; absence of credit-worthy off-takers; low access to early-stage financing; lower public R&D spending; too few wealthy consumers willing to pay a premium for "green products"; social and political instability; poor market infrastructure, and weak enforcement of the regulatory frameworks. Establishing better mechanisms for leveraging private sector finance through innovative financing can help (EGTT, 2008), but there are also risks in relying on the private sector as market-based finance focuses on short term lending, and private financing during episodes of abundant liquidity may not constitute a source of stable long-term climate finance (Akyuz, 2012) - see Section 16.4 for further discussion and references on barriers, risks, and innovative mechanisms.

While some developing countries are able to mobilize domestic resources to finance efforts toward SD, the needs for many developing countries exceed their financial capacity. Consequently, their ability to pursue SD, and climate change mitigation and adaptation actions in particular, can be severely constrained by lack of finance. The international provision of finance, alongside technology transfer, can help to alleviate this problem, as well as accord with principles of equity, international commitments, and arguments of effectiveness -see Sections 4.2.2 and 4.6.2. Under international agreements, in particular Agenda 21 and the Rio Conventions of 1992, and reaffirmed in subsequent UN resolutions and programs including the 2012 UN Conference on Sustainable Development

(United Nations, 2012a), developed countries have committed to provide financial resources to developing countries that are new and additional to conventional development assistance.

## 4.4 Production, trade, consumption and waste patterns

The previous section has highlighted the role of behaviors and lifestyles and the complex interaction of the values, goals and interests of many actors in the political economy of SD and equity. In order to better understand the possibilities and difficulties to equitably sustain well-being in the future, this section examines the consumption of goods and services by households, consumption trends and disparities, and the relationship between consumption and GHG emissions. It also discusses the components and drivers of consumption, efforts to make consumption (and production) more sustainable, and how consumption affects well-being. In order to shed light on important debates about equity in mitigation, we also review approaches to consumption-based accounting of GHG emissions (carbon footprinting) and their relationship to territorial approaches. So while subsequent chapters analyze GHG emissions associated with specific sectors and transformation pathways, we focus here on a particular group (consumers) and examine their emissions in an integrated way.

The possibility of a SD pathway for the world hinges on “decoupling” (von Weizsäcker et al., 1997, 2009; Jackson, 2005b, 2009). We consider two types of decoupling at the global scale and in the long term: the decoupling of material resource consumption (including fossil carbon) and environmental impact (including climate change) from economic growth (“dematerialization”); and the decoupling of human well-being from economic growth and consumption. The first type (see Sections 4.4.1 and 4.4.3) involves an increased material efficiency and environmental efficiency of production and is generally considered crucial for meeting SD and equity goals (UNEP, 2011); yet while some dematerialization has occurred, absolute levels of resource use and environmental impact have continued to rise, highlighting the important distinction between relative and absolute decoupling (Krausmann et al., 2009). This has inspired examination of the second type of decoupling (Jackson, 2005b, 2009; Assadourian, 2010), including the reduction of consumption levels in wealthier countries. We address this topic (in Section 4.4.4) by examining how income and income inequality affect dimensions of well-being. While the second type of decoupling represents a “stronger” form than the first, it is also a more controversial goal, even though the unsustainability of excessive consumption was highlighted by Chapter 4 of Agenda 21 (United Nations, 1992c).

### 4.4.1 Consumption patterns, inequality and environmental impact

#### *4.4.1.1 Trends in resource consumption*

Global levels of resource consumption and GHG emissions show strong historical trends, driven primarily by developments in industrialized countries and emerging economies (see Sections 5.2 and 14.3). The global annual use (extraction) of material resources – i.e., ores and industrial minerals, construction materials, biomass, and fossil energy carriers – increased eightfold during the 20th century, reaching about 55 Gt in 2000, while the average resource use per capita (the metabolic rate) doubled, reaching 8.5-9.2 tonnes per capita per year in 2005 (Krausmann et al., 2009; UNEP, 2011). The value of the global consumption of goods and services (the global GDP) has increased six-fold since 1960 while consumption expenditures per capita has almost tripled (Assadourian, 2010). Consumption-based GHG emissions ("carbon footprints" – see Section 4.4.2.2) increased between 1990 and 2009 in the world’s major economies, except the Russian Federation, ranging from 0.1-0.2% per year in the EU27, to 4.8-6.0% per year in China (Peters et al., 2012) (see Section 5.2.1).

Global resource consumption has risen slower than GDP, especially after around 1970, indicating some decoupling of economic development and resource use, and signifying an aggregate increase in resource productivity of about 1-2% annually (Krausmann et al., 2009; UNEP, 2011). While dematerialization of economic activity has been most noticeable in the industrialized countries, metabolic rates across countries remain highly unequal, varying by a factor of 10 or more due largely to differences in level of development, although there is also significant cross-country variation in the relation between GDP and resource use (Krausmann et al., 2009; UNEP, 2011).

#### *4.4.1.2 Consumerism and unequal consumption levels*

The spread of material consumption with rising incomes is one of the "mega-drivers" of global resource use and environmental degradation (Assadourian, 2010). While for the world's many poor people, consumption is driven mainly by the need to satisfy basic human needs, it is increasingly common across cultures that people seek meaning, contentment and acceptance in consumption. This pattern is often referred to as "consumerism", defined as a cultural paradigm where "the possession and use of an increasing number and variety of goods and services is the principal cultural aspiration and the surest perceived route to personal happiness, social status and national success" (Assadourian, 2010, p. 187).

Consumerist lifestyles in industrialized countries seem to be imitated by the growing elites (Pow, 2011) and middle-class populations in developing countries (Cleveland and Laroche, 2007; Gupta, 2011), exemplified by the increased demand for space cooling in emerging economies (Isaac and van Vuuren, 2009). Together with the unequal distribution of income in the world, the spread of consumerism means that a large share of goods and services produced are "luxuries" that only the wealthy can afford, while the poor are unable to afford even basic goods and services (Khor, 2011).

A disproportionate part of the GHG emissions arising from production are linked to the consumption of products by a relatively small portion of the world's population, illustrated by the great variation in the per capita carbon footprint between countries and regions at different income levels (Hertwich and Peters, 2009; Davis and Caldeira, 2010; Peters et al., 2011) (See Section 14.3.1). The carbon footprint is strongly correlated with consumption expenditure. Across countries, Hertwich and Peters (2009) found an expenditure elasticity of 0.57 for all GHGs: as nations become wealthier, the per capita carbon footprint increases by 57% for each doubling of consumption. Within countries, similar relationships have been found between household expenditure and carbon footprint (Druckman and Jackson, 2009; Hertwich, 2011). Because wealthier countries meet a higher share of their final demand from (net) imports than do less wealthy countries, consumption-based emissions are more closely associated with GDP than are territorial emissions, the difference being the emissions embodied in trade (see Section 4.4.2 as well as 5.2 and 14.3).

#### *4.4.1.3 Effect of non-income factors on per capita carbon footprint*

Non-income factors such as geography, energy system, production methods, waste management (GAIA, 2012; Corsten et al., 2013), household size, diet and lifestyle also affect per capita carbon footprints and other environmental impacts (Tukker et al., 2010a) so that the effects of increasing income varies considerably between regions and countries (Lenzen et al., 2006; Hertwich, 2011; Homma et al., 2012), cities (Jones and Kammen, 2011) and between rural and urban areas (Lenzen and Peters, 2010). In this regard, the environmental impact of specific consumption patterns has been studied intensely in recent years (Druckman and Jackson, 2009; Davis and Caldeira, 2010; Tukker et al., 2010a; Hertwich, 2011). At the global level, Hertwich and Peters (2009) found that food is the consumption category with the greatest climate impact, accounting for nearly 20% of GHG emissions, followed by housing/shelter, mobility, services, manufactured products, and construction (See Sections 8.2, 9.2, 10.3, 11.2, 12.2). Food and services were a larger share in poor countries, while at high expenditure levels, mobility and the consumption of manufactured goods caused the largest GHG emissions (Hertwich and Peters, 2009). The factors responsible for variations in carbon footprints across households at different scales are further discussed in Sections 5.3, 5.5, 12.2 and 14.3.4.

## 4.4.2 Consumption patterns and carbon accounting

### 4.4.2.1 Choice of GHG accounting method

New GHG accounting methods have emerged and proliferated in the last decade, in response to interest in 1) determining whether nations are reducing emissions (Bows and Barrett, 2010; Peters et al., 2011, 2012), 2) allocating GHG responsibility (Peters and Hertwich, 2008a; b; Bows and Barrett, 2010), 3) assuring the accountability of carbon markets (Stechemesser and Guenther, 2012), 4) determining the full implications of alternative energy technologies (von Blottnitz and Curran, 2007; Martínez et al., 2009; Cherubini et al., 2009; Soimakallio et al., 2011) and of outsourcing of industrial production (See Section 4.4.3.3) helping corporations become greener (Wiedmann et al., 2009), and 6) encouraging consumers to reduce their carbon footprints (Bolwig and Gibbon, 2010; Jones and Kammen, 2011). Methods differ on whether consumers or producers of products are responsible; whether emissions embedded in past or potential replacement of capital investments are included; and whether indirect emissions, for example, through global land-use change resulting from changing product prices, are included (Finkbeiner, 2009; Plevin et al., 2010; Plassmann et al., 2010). These methodological differences have normative implications.

Systems of GHG emissions accounting are constructed according to certain conventions and purposes (Davis and Caldeira, 2010). Better ways may be excessively expensive given the plausible importance of the value of better information in the decision process. Some interests will plead for standardized techniques based on past data because it favors them. Others will argue for tailored approaches that make their technologies or products look good. Producers favor responsibility being assigned to consumers, as do nations that are net exporters of industrial goods. Controversies over GHG emissions accounting approaches play into the broader issue of climate mitigation governance (see Section 4.4.2.4). And whether carbon markets are effective or not depends on good accounting and enforcement – but what will be enforced will depend on the accounting measures agreed upon. The next section discusses consumption-based GHG emissions accounting.

### 4.4.2.2 Carbon footprinting (consumption-based GHG emissions accounting)

Carbon (or GHG) accounting refers to the calculation of the GHG emissions associated with economic activities at a given scale or with respect to a given functional unit – including products, households, firms, cities, and nations (Peters, 2010; Pandey et al., 2011). GHG accounting has traditionally focused on emission sources, but recent years have seen a growing interest in analyzing the drivers of emissions by calculating the GHG emissions that occur along the supply chain of different functional units such as those just mentioned (Peters, 2010). The result of this consumption-based emissions accounting is often referred to as "carbon footprint" even if it involves other GHGs along with $CO_2$. Carbon footprinting starts from the premise that the GHG emissions associated with economic activity are generated at least partly as a result of people's attempts to satisfy certain functional needs and desires (Lenzen et al., 2007; Druckman and Jackson, 2009; Bows and Barrett, 2010). These needs and desires carry the consumer demand for goods and services, and thereby the production processes that consume resources and energy and release pollutants. Emission drivers are not limited to individuals' consumption behavior, however, but include also the wider contexts of consumption such as transport infrastructure, production and waste systems, and energy systems (see below and Sections 7.3, 8.2, 9.2, 10.3, 11.2, 12.2).

There is no single accepted carbon footprinting methodology (Pandey et al., 2011), nor is there one widely accepted definition of carbon footprint. Peters (2010) proposes this definition, which allows for all possible applications across scales: "The 'carbon footprint' of a functional unit is the climate impact under a specific metric that considers all relevant emission sources, sinks and storage in both consumption and production within the specified spatial and temporal system boundary" (p. 245). The emissions associated with the functional unit (but physically not part of the unit) are referred to as "embodied carbon", "carbon flows" or similar terms. (Annex II of this report discusses different carbon footprint methodologies, including Life Cycle Assessment (LCA) and environmentally-extended input-output (EIO) models.) Carbon footprints have been estimated with respect to different functional units at different scales. Most relevant to the analysis of consumption patterns and mitigation linkages are the carbon footprints of products and nations, discussed in turn.

#### 4.4.2.3 Product carbon footprinting

A product carbon footprint includes all emissions generated during the life-cycle of a good or service – from production and distribution to end-use and disposal or recycling. Carbon footprinting of products (and firms) can enable a range of climate mitigation actions and can have co-benefits (Sinden, 2009; Bolwig and Gibbon, 2010). Informing consumers about the climate impact of products through labeling or other means can influence purchasing decisions in a more climate-friendly direction and at the same time enable product differentiation (Edwards-Jones et al., 2009; Weber and Johnson, 2012). Carbon footprinting can also help companies reduce GHG emissions cost-effectively by identifying the various emission sources within the company and along the supply chain (Sinden, 2009; Sundarakani et al., 2010; Lee, 2012). Those emissions can be reduced directly, or by purchasing offsets in carbon markets. There is both theoretical and empirical evidence of a positive relationship between a company's environmental and financial performance (Delmas and Nairn-Birch, 2011; Griffin et al., 2012). The specific effect of carbon footprinting on company financial performance and investor valuation is not well researched, however, and the results are ambiguous: In the United Kingdom, Sullivan and Gouldson (2012) found limited investor interest in the climate change-related data provided by retailers, while a study from North America concludes that investors do care about companies' GHG emission disclosures, whether these occur through a voluntary scheme or informal estimates (Griffin et al., 2012).[2] (See also Section 15.5.5)

There are also risks associated with product carbon footprinting. It can affect competitiveness and trade by increasing costs and reduce demand for products made abroad, including in developing countries, and it may violate WTO trade rules (Brenton et al., 2009; Edwards-Jones et al., 2009; Erickson et al., 2012). A one-sided focus on GHG emissions in product development and consumer choice could also involve trade-offs with other sustainability dimensions (Finkbeiner, 2009; Laurent et al., 2012). So there are reasons to adopt more broadly encompassing concepts and tools to assess and manage sustainability in relation to the consumption of goods and services.

#### 4.4.2.4 Consumption-based and territorial approaches to GHG accounting

Consumption-based accounting of GHG emissions (carbon footprinting) at national level differs from the production-based or territorial framework because of imports and exports of goods and services that, directly or indirectly, involve GHG emissions (Davis and Caldeira, 2010; Peters et al., 2011, 2012). The territorial framework allocates to a nation (or other jurisdiction) those emissions that are physically produced within its territorial boundaries. The consumption-based framework assigns the emissions released through the supply chain of goods and services consumed within a nation irrespective of their territorial origin. The difference in inventories calculated based on the two frameworks are the emissions embodied in trade (Peters and Hertwich, 2008b; Bows and Barrett, 2010). We emphasize that territorial and consumption-based accounting of emissions as such represent pure accounting identities measuring the emissions embodied in goods and services that are produced or consumed, respectively, by an individual, firm, country, region, etc. Responsibility for these emissions only arises once it is assigned within a normative or legal framework, such as a climate agreement, specifying rights to emit or obligations to reduce emission based on one of these metrics. As detailed below, the two approaches function differently in a global versus a fragmented climate policy regime.

[2] In the United States, increasing carbon emissions was found to positively impact the financial performance of firms when using accounting-based measures, while the impact was negative when using market-based performance measures (Delmas and Nairn-Birch, 2011).

Steckel et al. (2010) show that within a global regime that internalizes a cost of GHG emissions, the two approaches are theoretically equivalent in terms of their efficiency in inducing mitigation. For example, with a global cap-and-trade system with full coverage (i.e., an efficient global carbon market) and given initial emission allocations, countries exporting goods benefit from export revenues, with costs related to GHG emissions and any other negative impacts of production of those goods priced in, such that the choice of accounting system has no influence on the efficiency of production. Nor will it influence the welfare of countries, irrespective of being net exporters or importers of emissions, since costs associated with these emissions are fully internalized in product prices and will ultimately be borne by consumers. In practice, considerations such as transaction costs and information asymmetries would influence the relative effectiveness and choice of accounting system.

In the case of a fragmented climate policy regime, one argument put in favor of a consumption-based framework is that, unlike the territorial approach, they do not allow current emission inventories to be reduced by outsourcing production or relying more on imports to meet final demand. Hence, some authors (e.g. Peters and Hertwich, 2008b; Bows and Barrett, 2010) argue that this approach gives a fairer illustration of responsibility for current emissions. Carbon footprinting also increases the range of mitigation options by identifying the distribution of GHG emissions among different activities, final uses, locations, household types, etc. This enables a better targeting of policies and voluntary actions (Bows and Barrett, 2010; Jones and Kammen, 2011).
On the other hand, reducing emissions at the "consumption end" of supply chains requires changing deeply entrenched lifestyle patterns and specific behaviours among many actors with diverse characteristics and preferences, as opposed to among the much fewer actors emitting GHGs at the source. It has also been pointed out that – identical to the accounting of production-based emissions – there is no direct one-to-one relationship between changes in consumption-based and global emissions (Jakob and Marschinski, 2012). That is, if some goods or services were not consumed in a given country, global emissions would not necessarily decrease by the same amount of emissions generated for their production, as this country's trade partners would adjust their consumption – as well as production – patterns in response to price changes resulting from its changed demand profile. This has been shown for China (Peters et al., 2007) and India (Dietzenbacher and Mukhopadhyay, 2007): while these countries are large net exporters of embodied carbon, territorial emissions would remain roughly constant or even increase if they were to withdraw from international trade (and produce their entire current consumption domestically instead). Hence, without international trade, consumption-based emissions of these countries' trade partners would likely be reduced, but not global emissions.

It is for this reason that Jakob and Marschinski (2012) argue that a more detailed understanding of the underlying determinants of emissions is needed than what is currently provided by either territorial or consumption-based accounts, in order to guide policies that will effectively reduce global emissions in a fragmented climate policy regime. In particular, a better understanding of system interrelationships in a global economy is required in order to be able to attribute how, e.g., policy choices in one region affect global emissions by transmission via world market prices and associated changes in production and consumption patterns in other regions. Furthermore, as market dynamics and resource use are driven by both demand and supply, it is conceivable to rely on climate policies that target the consumption as well as the production side of emissions, as is done in some other policy areas

### 4.4.3 Sustainable consumption and production – SCP

The concepts of "sustainable consumption" and "sustainable production" represent, respectively, demand- and supply-side perspectives on sustainability. The efforts by producers to improve the environmental or social impact of a product are futile if consumers do not buy the good or service (Moisander et al., 2010). Conversely, sustainable consumption behavior depends on the availability and affordability of such products in the marketplace. The idea of sustainable consumption and production (SCP) was first placed high on the international policy agenda at the 1992 UN Conference on Environment and Development and was made part of Agenda 21. In 2003, a 10-year Framework of Programmes on SCP was initiated, which was formalized in a document adopted by the 2012 UN Conference on Sustainable Development (United Nations, 2012b, p. 2). A great variety of public and private SCP policies and initiatives have developed alongside the UN-led initiatives (see Section 10.11.3), as has a large body of research that we report on below.

#### *4.4.3.1 Sustainable consumption and lifestyle*

A rich research literature on sustainable consumption has developed over the past decade, including several special issues of international journals (Tukker et al., 2010b; Le Blanc, 2010; Kilbourne, 2010; Black, 2010; Schrader and Thøgersen, 2011). Several books, such as *Prosperity without Growth* (Jackson, 2009), discuss the unsustainable nature of current lifestyles, development trajectories, and economic systems, and how these could be changed in more sustainable directions. Several definitions of sustainable consumption have been proposed within policy, business and academia (Pogutz and Micale, 2011). At a meeting in Oslo in 2005, a group of scientists agreed on the following broad and integrating conceptualization of sustainable consumption:

> *"The future course of the world depends on humanity's ability to provide a high quality of life for a prospective nine billion people without exhausting the Earth's resources or irreparably damaging its natural systems … In this context, sustainable consumption focuses on formulating strategies that foster the highest quality of life, the efficient use of natural resources, and the effective satisfaction of human needs while simultaneously promoting equitable social development, economic competitiveness, and technological innovation" (Tukker et al., 2006, p. 10) (p.10)*

This perspective encompasses both demand-side and production issues, and addresses all three pillars of SD (social, economic and environmental) as well as equity and well-being, illustrating the complexity of sustainable consumption and its connections to other issues.

Research has demonstrated that consumption practices and patterns are influenced by a range of economic, informational, psychological, sociological, and cultural factors, operating at different levels or spheres in society – including the individual, the family, the locality, the market, and the work place (Thøgersen, 2010). Furthermore, consumers' preferences are often constructed in the situation (rather than pre-existing) and their decisions are highly contextual (Weber and Johnson, 2009) and often inconsistent with values, attitudes, and perceptions of themselves as responsible and green consumers and citizens (Barr, 2006; de Barcellos et al., 2011) (see below, as well as Sections 2.6.6 and 3.10).

The sustainable consumption of goods and services can be viewed in the broader context of lifestyle and everyday life. Conversely, sustainable consumption practices are bound up with perceptions of identity, ideas of good life, and so on, and considered alongside other concerns such as affordability and health. Ethical consumption choices are also negotiated among family members with divergent priorities and interpretations of sustainability. Choosing a simpler lifestyle ("voluntary simplifying") seems to be related to environmental concern (Shaw and Newholm, 2002; Huneke, 2005), but frugality, as a more general trait or disposition, is not (Lastovicka et al., 1999; Pepper et al., 2009).

Other research draws attention to the constraints placed on consumption and lifestyle choices by factors beyond the influence of the individual, family or community, which tends to lock consumption into unsustainable patterns by reducing "green agency" at the micro level (Thøgersen, 2005; Pogutz and Micale, 2011). These structural issues include product availability, cultural norms and beliefs, and working conditions which favor a "work-and-spend" lifestyle (Sanne, 2002). Brulle and Young (2007) found that the growth in personal consumption in the USA during the $20^{th}$ century is partly explained by the increase in advertising. According to this study, the effect of advertising on spending is concentrated on luxury goods (household appliances and supplies and automobiles) while it is nonexistent in the field of basic necessities (food and clothes), while Druckman and Jackson (2010) found that in the UK, expenditures on food and clothes clearly exceeded 'necessary' levels..

The strength and pervasiveness of political economy factors such as those just mentioned, and the inadequate attention to them by policy, is an important cause of the lack of real progress towards more sustainable consumption patterns (Thøgersen, 2005; Tukker et al., 2006; Le Blanc, 2010). Furthermore, the unsustainable lifestyles in industrialized countries are being replicated by the growing elites (Pow, 2011) and middle-class populations in developing countries (Cleveland and Laroche, 2007; Gupta, 2011). Finally, most SC studies are done in a consumer culture context, which limits discussion of instances where sustainable consumption has pre-empted consumerism.

#### *4.4.3.2 Consumer sustainability attitudes and the relation to behavior*

Despite the overwhelming impact of structural factors on consumer practices, choices and behavior, it is widely agreed that the achievement of more sustainable consumption patterns also depends on how consumers value environmental quality and other dimensions of sustainability (Jackson, 2005a; Thøgersen, 2005; Bamberg and Möser, 2007). It also depends on whether people believe that their consumption practices make a difference to sustainability (Frantz and Mayer, 2009; Hanss and Böhm, 2010), which in turn is influenced by their value priorities and how much they trust the environmental information provided to them by scientists, companies, and public authorities (Kellstedt et al., 2008). The motivational roots of sustainable consumer choices seem to be substantially the same, although not equally salient in different national and cultural contexts (Thøgersen, 2009; Thøgersen and Zhou, 2012).

In a survey of European attitudes towards sustainable consumption and production (Gallup Organisation, 2008a), 84% of EU citizens said that the product's impact on the environment is "very important" or "rather important" when making purchasing decisions. This attitude is rarely reflected in behavior, however. There is plenty of evidence demonstrating the presence of an "attitude-behavior" or "values-action" gap whereby consumers expressing "green" attitudes fail to adopt sustainable consumption patterns and lifestyles (Barr, 2006; Young et al., 2010; de Barcellos et al., 2011). To a large measure, this gap can be attributed to many other goals and concerns competing for the person's limited attention (Weber and Johnson, 2009). This observation is reflected in the substantial difference in the level of environmental concern that Europeans express in opinion polls when the issue is treated in isolation, and when the environment is assessed in the context of other important societal issues. For example, in 2008, 64% of Europeans said protecting the environment was "very important" to them personally when the issue was presented in isolation (Gallup Organisation, 2008b) while only 4% pointed at environmental pollution as one of the two most important issues facing their country at the moment (Gallup Organisation, 2008a). When there are many important issues competing for the person's limited attention and resources, those that appear most pressing in everyday life are likely to prevail.

The likelihood that a person will act on his or her environmental concern is further diminished by factors affecting everyday decisions and behavior, including the structural factors mentioned above, but also more specific factors such as habit, high transactions costs (i.e., time for information search and processing and product search), availability, affordability, and the influence of non-green criteria such as quality, size, brand, and discounts (Young et al., 2010). Some of these factors vary across different product categories and within sectors (McDonald et al., 2009). The impact of all of these impeding factors is substantial, calling into question the capacity of "the green consumer" to effectively advance sustainable consumption and production (Csutora, 2012) and, more generally, the individualistic view of the consumer as a powerful market actor (Moisander et al., 2010).

Third-party eco-labels and declarations have proven to be an effective tool to transform consumer sustainability attitudes into behavior in many cases (Thøgersen, 2002). One of the reasons is that a trusted label can function as a choice heuristic in the decision situation, allowing the experienced consumer to make sustainable choices in a fast and frugal way (see Section 2.6.5 and Thøgersen et al., 2012). Labeling products with their carbon footprint may help to create new goals (e.g., to reduce $CO_2$ emissions) and to attract and keep attention on those goals, in the competition between goals (Weber and Johnson, 2012). In Europe, 72% of EU citizens thought that carbon labeling should be mandatory (Gallup Organisation, 2008a). In Australia, Vanclay et al. (2010) found a strong purchasing response of 20% when a green-labeled product (indicating relatively low life-cycle $CO_2$ emissions) was also the cheapest, and a much weaker response when green-labeled products were not the cheapest. Hence, consumers, at least in developed countries, show interest in product carbon footprint information and many consumers would prefer carbon-labeled products and firms over others, other things being equal (Bolwig and Gibbon, 2010). Yet the impeding factors and the related "attitude-behavior" gap limit how far one can get towards sustainable consumption with labeling and other information-based means alone.

Research on these topics in the developing world is lacking. Considering the notion of a hierarchy of needs (Maslow, 1970; Chai and Moneta, 2012) and the challenges facing consumers in developing countries, carbon footprints and other environmental declarations might be seen as a luxury concern that only developed countries can afford. Countering this view, Kvaløy et al. (2012) find environmental concern in developing countries at the same level as in developed countries. Furthermore, eco-labeled products increasingly appear at retail level in developing countries (Roitner-Schobesberger et al., 2008; Thøgersen and Zhou, 2012).

#### *4.4.3.3 Sustainable production*

Research and initiatives on sustainable production have been concerned with increasing the resource efficiency of, and reducing the pollution and waste from, the production of goods and services through technological innovations in process and product design at the plant and product levels, and, more lately, through system-wide innovations across value chains or production networks (Pogutz and Micale, 2011). Policies that incentivize certain product choices have also been developed (see Section 10.11.3). Eco-efficiency (Schmidheiny and WBSCD, 1992) is the main management philosophy guiding sustainable production initiatives among companies (Pogutz and Micale, 2011) and is expressed as created value or provided functionality per caused environmental impact. Moving towards a more eco-efficient production thus means creating the same or higher value or functionality while causing a lower environmental impact (relative or even absolute decoupling). This involves consideration of multiple impacts across scales, ranging from global impacts like climate change over regional impacts associated with air and water pollution, to local impacts caused by use of land or water.

A strong increase in the eco-efficiency of production is a pre-requisite for developing a sustainable society (Pogutz and Micale, 2011). The I=PAT equation expresses the environmental impact I as a product of the population number P, the affluence A (value created or consumed per capita), and a technology factor T perceived as the reciprocal of eco-efficiency. Considering the foreseeable growth in P and A, and the current unsustainable level of I for many environmental impacts it is clear that the eco-efficiency (1/T) must increase many times (a factor 4 to 20)[3] to ensure a sustainable production. While a prerequisite, even this kind of increases in eco-efficiency may not be sufficient since A and T are not mutually independent due to the presence of rebound – including market effects; indeed, sometimes a reduction in T (increased eco-efficiency) is accompanied by an even greater growth in A, thereby increasing the overall environmental impact I (Pogutz and Micale, 2011). (A related concept to I=PAT is the Kaya identity, see Section 5.3)

With its focus on the provided function and its broad coverage of environmental impacts, LCA is frequently used for evaluation of the eco-efficiency of products or production activities (Hauschild,

[3] Factor 4 to factor 20 increases can be calculated depending on the expected increases in P and A and the needed reduction in I (von Weizsäcker et al., 1997; Schmidt-Bleek, 2008).

2005; Finnveden et al., 2009) (see Annex II.4.2). LCA has been standardized by the International Organization for Standardization (ISO 14040 and ISO 14044) and is a key methodology underlying standards for eco-labeling and environmental product declarations. LCA is also the analytical tool underlying DFE (design for environment) methods (Bhander et al., 2003; Hauschild et al., 2004).

With the globalization and outsourcing of industrial production, analyzing the entire product life cycle (or product chain) – from resource extraction to end-of-life – gains increased relevance when optimizing the energy and material efficiency of production. A life-cycle approach will reveal the potential problem shifting that is inherent in outsourcing and that may lead to increased overall resource consumption and GHG emissions of the product over its life cycle in spite of reduced impacts of the mother company (Shui and Harriss, 2006; Li and Hewitt, 2008; Herrmann and Hauschild, 2009). This is why a life cycle perspective is applied when calculating the carbon footprint. Indeed, a life cycle-based assessment is generally needed to achieve resource and emissions optimization across the product chain. Especially the use stage can be very important for products that use electricity or fuels to function (Wenzel et al., 1997; Samaras and Meisterling, 2008; Yung et al., 2011; Sharma et al., 2011). Improvement potentials along product chains can be large, in particular when companies shift from selling only products to delivering product-service systems, often increasing the number of uses of the individual product (Manzini and Vezzoli, 2003). Exchange of flows of waste materials or energy can also contribute to increasing eco-efficiency. Under the heading of "industrial symbiosis", such mutually beneficial relationships between independent industries have emerged at multiple locations, generally leading to savings of energy and sometimes also materials and resources (Chertow and Lombardi, 2005; Chertow, 2007; Sokka et al., 2011) (See Section 10.5).

While the broad coverage of environmental impacts supported by LCA is required to avoid unnoticed problem shifting between impacts, a narrower focus on climate mitigation in relation to production would be supported by considering energy efficiency, which can be addressed at different levels: the individual process, the production facility, the product chain, and the industrial system (industrial symbiosis). At the process level, the operation of the individual process and consideration of the use-stage energy efficiency in the design of the machine tools and production equipment would be addressed (see Section 10.4). Improvements in energy efficiency in manufacturing have focused on both the design and operation of a variety of processes (Gutowski et al., 2009; Duflou et al., 2010; Herrmann et al., 2011; Kara and Li, 2011), finding improvement potentials at the individual process level of up to 70% (Duflou et al., 2012), and at the plant level by re-using e.g. waste heat from one process for heating in another (Hayakawa et al., 1999). Exergy analysis and energy pinch analysis are used to identify potentials for reutilization of energy flows in other processes (Creyts and Carey, 1999; Bejan, 2002).

Research on the social dimensions of production systems have addressed such issues as worker conditions (Riisgaard, 2009), farm income (Bolwig et al., 2009), small producer inclusion into markets and value chains (Bolwig et al., 2010; Mitchell and Coles, 2011) and the role of standards in fostering sustainability (Gibbon et al., 2010; Bolwig et al., 2013). Recently, the LCA methodology has been elaborated to include assessment of social impacts such as labor rights (Dreyer et al., 2010), in order to support the assessment of problem shifting and trade-offs between environmental and social dimensions (Hauschild et al., 2008).

### 4.4.4 Relationship between consumption and well-being

As noted earlier, global material resource consumption continues to increase despite substantial gains in resource productivity or eco-efficiency, causing further increases in GHG emissions and overall environmental degradation. In this light it is relevant to discuss whether human well-being or happiness can be decoupled from consumption or growth (Ahuvia and Friedman, 1998; Jackson, 2005b; Tukker et al., 2006). We do this here by examining the relationship between different dimensions of well-being and income (and income inequality) across populations and over time.

Happiness is an ambiguous concept that is often used as a catchword for subjective well-being (SWB). SWB is multidimensional and includes both cognitive and affective components (Kahneman et al., 2003). Cognitive well-being refers to the evaluative judgments individuals make when they think about their life and is what is reported in life satisfaction or ladder-of-life data, whereas affective or emotional well-being refers to the emotional quality of an individual's everyday experience as captured by surveys about the intensity and prevalence of feelings along the day (Kahneman and Deaton, 2010). Emotional well-being has been defined as "the frequency and intensity of experiences of joy, fascination, anxiety, sadness, anger, and affection that makes one's life pleasant or unpleasant" (Kahneman and Deaton, 2010, p. 16489). Camfield and Skevington (2008) examine the relationship between SWB and quality of life (QoL) as used in the literature. They find that SWB and QoL are virtually synonymous; that they both contain a substantial element of life satisfaction, and that health and income are key determinants of SWB or QoL, while low income and high inequality are both associated with poor health and high morbidity.

The "Easterlin paradox" refers to an emerging body of literature suggesting that while there is little or no relationship between SWB and the aggregate income of countries or long-term GDP growth, *within* countries people with more income are happier (Easterlin, 1973, 1995). Absolute income is, it is argued, only important for happiness when income is very low, while relative income (or income equality) is important for happiness at a wide range of income levels (Layard, 2005; Clark et al., 2008). These insights have been used to question whether economic growth should be a primary goal of government policy (for rich countries), instead of, for example, focusing on reducing inequality within countries and globally, and on maximizing subjective well-being. For instance, Assadourian (2010) argues against consumerism on the grounds that increased material wealth above a certain threshold does not contribute to subjective well-being.

The Easterlin paradox has been contested in comparisons across countries (Deaton, 2008) and over time (Stevenson and Wolfers, 2008; Sacks et al., 2010), on the basis of the World Gallup survey of well-being. These works establish a clear linear relationship between average levels of ladder-of-life satisfaction and the logarithm of GDP per capita across countries, and find no satiation threshold beyond which affluence no longer enhances subjective well-being. Their time series analysis also suggests that economic growth is on average associated with rising happiness over time. On this basis they picture a strong role for absolute income and less for relative income comparisons in determining happiness.

These results contrast with studies of emotional well-being, which generally find a weak relationship between income and well-being at higher income levels. In the US, for example, Kahneman and Deaton (2010) find a clear satiation effect: beyond around $75,000 annual household income (just above the mean US household income) "further increases in income no longer improve individuals' emotional well-being (including aspects such as spending time with people they like, avoiding pain and disease, and enjoying leisure)" (p. 16492).[4] But even for life satisfaction, there is contrasting evidence. In particular, in Deaton (2008) there is a lot of variation of SWB between countries at the same level of development, and in Sacks et al. (2010) the long term positive relationship between income and life satisfaction is weakly significant and sensitive to the sample of countries (see also Graham (2009), Easterlin et al. (2010), Di Tella and MacCulloch (2010)). An important phenomenon is that all components of SWB, in various degrees, adapt to most changes in objective conditions of life, except a few things, such as physical pain (Kahneman et al., 2003; Layard, 2005; Clark et al., 2008; Graham, 2009; Di Tella and MacCulloch, 2010).

The great variability of SWB data across individuals and countries and the adaptation phenomenon suggest that these data do not provide indices of well-being that are comparable across individuals and over time. Respondents have different standards when they answer satisfaction questions at

[4] This result is based on cross-sectional data and do not refer to the effects of a *change* in a person's income.

different times or in different circumstances. Therefore, the weakness of the observed link between growth and SWB is not only debated, but it is quite compatible with a strong and firm desire in the population for ever-growing material consumption (Fleurbaey, 2009). Decoupling growth and well-being may be more complicated than suggested by raw SWB indicators.

Decoupling individual well-being from consumption may be fraught with controversies, but decoupling social welfare from average consumption might be possible via inequality reduction. It has been found that inequality in society has a marked negative effect on average SWB. For example, Oishi et al. (2011) found that over a 37-year period, Americans were less happy on average during years with greater income inequality. This was explained by the fact that lower-income respondents "trusted other people less and perceived other people to be less fair in the years with more national income inequality" (Oishi et al., 2011, p. 1095). The potential decoupling of social welfare from average consumption is even more obvious if social welfare is defined in a way that gives priority to those who are less well-off (Atkinson, 1970).

## 4.5 Development pathways

Sustainable development provides a framework for the evaluation of climate policies. This is particularly useful in view of the fact that a given concentration pathway or climate objective can typically be achieved through various policies and development pathways inducing different impacts on the economy, the society, and other aspects of the environment. Integrated Assessment Models (IAM) provide valuable tools for the analysis of pathways, though most models suffer from limitations analysed in this section.

### 4.5.1 Definition and examples

Though widely used in the literature, the concept of development pathway has rarely been defined.[5] According to AR4, a development path is “an evolution based on an array of technological, economic, social, institutional, cultural, and biophysical characteristics that determine the interactions between human and natural systems, including consumption and production patterns in all countries, over time at a particular scale” (IPCC, 2007, Glossary, p. 813). AR4 also indicates that “alternative development paths refer to different possible trajectories of development, the continuation of current trends being just one of the many paths”. Though AR4 defines development pathways as global, the concept has also been used at regional (e.g., Li and Zhang, 2008), national (e.g.,Poteete, 2009) and subnational scales (e.g. Dusyk et al., 2009) at provincial scale and (Yigitcanlar and Velibeyoglu, 2008) at city scale. In the present report, a development pathway characterizes all the interactions between human and natural systems in a particular territory, regardless of scale.

The concept of development pathway is holistic. It is broader than the development trajectory of a particular sector, or of a particular group of people within a society. Thus, a wide range of economic, social and environmental indicators are necessary to describe a development pathway, not all of which may be amenable to quantitative representation. As defined by AR4, however, a “pathway” is not a random collection of indicators. It has an internal narrative and causal consistency that can be captured by the *determinants* of the interactions between human and natural systems. The underlying assumption is that the observed development trajectory—as recorded by various economic, social and environmental indicators—can be explained by identifiable drivers. This roots the concept of development pathway in the (dominant) intellectual tradition according to which history has some degree of intelligibility (while another tradition holds that history is a chaotic set of events that is essentially not intelligible (Schopenhauer, 1819).

[5] Development path and development pathway are synonymous.

The literature on development pathways has two main branches. A “backward-looking” body of work describes past and present development trajectories for given territories and explores their determinants. For example, most of the growth literature as well as a large part of the (macro) development literature fall into this category.[6] This body of work is discussed in Section 4.3 as well as in several other chapters. In particular, Section 5.3.1 reviews the determinants of GHG emissions, Section 12.2 reviews past trajectories of human settlements, and Section 14.3 discusses past trajectories of development at regional scale. In addition, “forward-looking” studies construct plausible development pathways for the future and examine the ways by which development might be steered towards one pathway or another. Box 4.3 briefly reviews the main forward-looking development pathways published since AR4. Most of Chapter 6 is devoted to “forward-looking” studies.

---

**Box 4.3.** Forward-Looking Development Pathways: new developments since AR4

Forward-looking development pathways aim at illuminating possible futures, and at providing a sense of how these futures might be reached (or avoided). Forward-looking pathways can be constructed using various techniques, ranging from simulations with numerical models to qualitative scenario construction or group forecasting exercises (van Notten et al., 2003).

New sets of forward-looking development pathways have been proposed since the AR4 review (in Sathaye et al. (2007), Section 12.2.1.2). At the global scale, they include, inter alia, the climate smart pathway (World Bank, 2010), the Tellus Institute scenarios (Raskin et al. (2010)), and degrowth strategies (Martínez-Alier et al., 2010) or the scenarios developed under the Integrated Assessment Modelling Consortium umbrella (Moss et al., 2010) to update the 2000 SRES scenarios (Nakicenovic and Swart, 2000). Pathways have also been proposed for specific sectors, such as health (Etienne and Asamoa-Baah, 2010), agriculture (Paillard et al., 2010), biodiversity (Leadley et al., 2010; Pereira et al., 2010), and energy (Ayres and Ayres, 2009) .

At the national and regional levels, the emergence of the “green growth” agenda (OECD, 2011) has spurred the development of many short- to medium-term exercises (e.g. Republic of Korea, 2009; Jaeger et al., 2011); as well as renewed discussions on SD trajectories (e.g. Jupesta et al., 2011). Similarly, there is growing research on the ways by which societies can transition towards a “low carbon economy”, considering not only mitigation and adaptation to climate change, but also the need for social, economic and technological (Shukla et al., 2008) (see 6.6.2 for a broader review). For instance, studies in China show that controlling emissions without proper policies to counteract the negative effects will have an adverse impact on the country’s economic development, reducing its per capita income and the living standards of both urban and rural residents (Wang Can et al., 2005; Wang Ke, 2008). China is developing indicators for low-carbon development and low-carbon society (UN (2010), with many citations) with specific indicators tested on selected cities and provinces (Fu, Jiafeng et al., 2010), providing useful data on challenges and gaps as well as the need for clearly defined goals and definitions of “low-carbon” and its SD context.

---

### 4.5.2 Transition between pathways

Backward-looking studies reveal that past development pathways have differed in many respects, notably in terms of GHG emissions because of differences in, inter alia, fuel supply mix, location

[6] This literature can itself be divided in two main groups: papers aimed at identifying individual mechanisms that drive development trajectories, and papers aimed at identifying broad patterns of development. One example of the former is the literature on the relationships between GDP and emissions, discussed in Chapter 5, section 4.1. One example of the latter is the so-called “investment development path” literature, which, following Dunning (1981), identifies stages of development for countries based on the direction of foreign direct investment flows and the competitiveness of domestic firms on international markets.

patterns, structure of economic activity, composition of household demand, etc.—even across countries with otherwise very similar economic characteristics. Similarly, forward-looking studies point to very contrasted, yet equally plausible, futures in terms of GHG emissions. Shifting from a high- to a low-emissions development pathway require modifying the trajectory of the system that generates (among others) GHG emissions. It thus requires time as well as action over multiple dimensions of development (location, technology, lifestyles, etc.). Yet, shifting from a high- to a low-emissions development pathway could potentially be as important for climate mitigation as implementing “climate” policies (Halsnaes et al., 2011).

A central theme of the present report is to explore the conditions of a transition towards development pathways with lower emissions, globally (Chapter 6), sectorally (Chapters 7-12) and regionally (Chapters 13-15). To frame these subsequent discussions, the present section does two things. First, it discusses the obstacles to changing course by introducing the key notions of path dependence and lock-ins (4.5.2.1 ). Second, examples and lessons from the technology transition literature are discussed (4.5.2.2 ). The policy and institutional aspects of building strategies to transition between pathways are discussed in the subsequent chapters.[7]

#### 4.5.2.1 Path dependence and lock-ins

Path dependence is the tendency for past decisions and events to self-reinforce, thereby diminishing and possibly excluding the prospects for alternatives to emerge. Path dependence is important for analyzing transitions between development pathways. For example, development of inter-city highways may make further extension of the road network more likely (if only for feeder roads) but also make further extension of rail networks less cost-effective by drawing out traffic and investment financing (see Section 12.5), thereby diminishing the prospects for alternative transportation investments.

Chief among the mechanisms that underlie path-dependence are “increasing returns” mechanisms (Page, 2006) –in which an outcome in one period increases the probability of generating that same outcome in the next period. Increasing returns is a large group which comprises, inter alia, increasing returns to scale, learning by doing, induced technological change, or agglomeration economies. As (Shalizi and Lecocq, 2013) note, the concept of increasing returns has a long tradition in economic history, and the implications of increasing returns mechanisms have been systematically explored over the past three decades or so, notably around issues of monopolistic competition (Dixit and Stiglitz, 1977), international trade (Krugman, 1979), economic geography (Fujita et al., 1999), economic growth (Romer, 1990), industrial organizations or adoption of technologies (Arthur, 1989).

Yet increasing returns are neither sufficient nor necessary to generate path-dependence. They are not sufficient because competing increasing returns can cancel out. And they are not necessary because other mechanisms might generate path-dependence. For example, decisions that involve the use of scarce resources, such as land, labour or exhaustible natural resources constrain future agents’ options, either temporarily (for labour) or permanently (for exhaustible resources). Similarly, in the presence of switching costs – e.g., costs attached to premature replacement of long-lived capital stock – decisions made at one point in time can partially or totally lock-in decision-makers’ subsequent choices (Farrell and Klemperer, 2007). Also, path-dependence can emerge from coordination failures in complex systems that require high degree of articulation between actors (Yarime, 2009). The key message is that it is essential to look broadly for mechanisms that may generate path-dependence when analyzing the determinants of pathways (past or anticipated) (Shalizi and Lecocq, 2013).

[7] The key point, as emphasized in AR4, is that a development pathway results from the interactions of decisions by multiple agents, at all levels. Thus in general public policies[7] alone cannot trigger changes in pathways, and cooperation between governments, markets and civil societies are necessary (Sathaye et al., 2007).

Lock-in is the most extreme manifestation of path dependence, when it becomes extremely costly or impossible to shift away from the current pathway. Lock-ins can emerge in many domains, with examples ranging from end-use technology standards (cf. the competition between the AZERTY and the QWERTY keyboards, or between the VHS and BETAMAX video standards), energy supply networks to expansion pathways of regions once initial choices are made (Fujita et al., 1999). Lock-ins are not “good” or “bad” per se (Shalizi and Lecocq, 2013), but identifying risks of “bad” lock-ins and taking advantage of possible “good” lock-ins matters for policy-making, so that ex ante decisions are not regretted ex post (Liebowitz and Margolis (1995)). The literature, however, underlines that lock-ins do not stem only for lack of information. There are also many cases in which rational agents might make decisions based only on part of the information available, because of, inter alia, differences between local and global optimum, time and resource constraints on the decision-making process or information symmetry (Foray, 1997); which points to the process of decision-making (See 4.3.2 on Governance and Political Economy).

#### *4.5.2.2 Examples and lessons from the technology transition literature*

Part of the literature on innovation (reviewed in Sections 3.11 and 4.3.6; technological change is reviewed in Section 5.6) adopts a broad, systemic perspective to try to explain how new technologies emerge. It thus provides examples of, and insights on how transition between pathways can occur. In fact, changes in technologies, their causes, and their implications for societies have been actively studied in social sciences since the late 18th century by historians, economists and sociologists. A common starting point is the observation that “technological change is not a haphazard process, but proceeds in certain directions” (Kemp, 1994). For example, processors tend to become faster, planes to become lighter, etc. To characterize these regularities, scholars have developed the concepts of *technological regime* (Nelson and Winter, 2002) and *technological paradigms* (Dosi, 1982; Dosi and Nelson, 1994). Technological regimes refer to shared beliefs among technicians about what is feasible. Technological paradigms refer to the *selected* set of objects engineers are working on, and to the *selected* set of problems they choose to address. How technological regimes may change (such as with the development of information technologies) is a subject of intense research. Radical innovations (e.g., the steam engine) are seen as a necessary condition. But the drivers of radical innovation themselves are not clearly understood. In addition, once an innovation is present, the shift in technological regime is not a straightforward process: The forces that maintain technological regimes (e.g., increasing returns to scale, vested interests, network externalities) are not easy to overcome – all the more so that new technologies are often less efficient, in many respects, than existing ones, and competing technologies may coexist for a while. History thus suggests that the diffusion of new technologies is a slow process (Kemp, 1994; Fouquet, 2010).

More recent research over the past 20 years has yielded two major perspectives on technology transitions (Truffer and Coenen, 2012): the multi-level perspective on socio-technical systems (Geels, 2002) and concept of technological innovations systems (Bergek et al., 2008). The multi-level perspective distinguishes three levels of analysis: niche innovations, socio-technical regimes, and socio-technical landscape (Geels, 2002). A technological niche is the micro-level where radical innovations emerge. Socio-technical regimes correspond to an extended version of the technological regime discussed above. And the socio-technical landscape corresponds to the regulatory, institutional, physical and behavioural environment within which innovations emerge. There is considerable inertia at this third level. Changes in socio-technical regimes emerge from the interactions between these three levels. According to Geels and Schot’s typology (2007), changes in socio-technical regimes can follow four different paths. *Transformation* corresponds to cases in which moderate changes in the landscape occur at a time when niche innovations are not yet developed, thus resulting in a relatively small change of direction of the development pathway. An example of transformation occurred when municipal sewer systems were implemented in Dutch cities (Geels, 2006). *De-alignment* and *realignment* correspond to sudden changes in the landscape that cause actors to lose faith in the regime. If no clear replacement is ready yet, a large range of technologies may compete until one finally dominates and a new equilibrium is reached. One example is the transition from horse-powered vehicles to cars. If new technologies are already available, on the other hand, a *transition substitution* might occur, as in the case of the replacement of sailing ships by steamships between 1850 and 1920. Finally, a *reconfiguration* occurs when innovations initially adopted as part of the current regime progressively subvert it into a new one, an example of which is the transition from traditional factories to mass production in the United States.

The technological innovation systems approach (Bergek et al., 2008) adopts a systemic perspective by considering all relevant actors, their interactions and the institutions relevant for innovation. Early work in this approach argues that beside market failures, "system failures" such as, inter alia, actor deficiencies, coordination deficits or conflicts with existing institutional structures (institutional deficits) can explain unsuccessful innovation (Jacobsson and Bergek, 2011). More recent analysis focus on core processes critical for innovation, such as presence of entrepreneurial activities, learning, knowledge diffusion through networks, etc. The technological innovation systems concept was developed to inform public policy on how to better support technologies deemed sustainable with an increasing focus on "system innovations" as opposed to innovation in single technologies or products (Truffer and Coenen, 2012).

#### 4.5.2.3 Economic modeling of transitions between pathways

As noted above (4.5.1), economic modeling is a major tool for analyzing future development pathways. Depending on their features and on how they are used, models do not provide the same type of information about transition. This is what the present sub-section reviews. See Section 6.2 for a review of modeling tools for integrated assessment.

There are four, increasingly complex ways of using economic models to analyze transitions between development pathways. The first option consists of building plausible images of the future at a given date and comparing them (comparative statics). The focus is on the internal consistency of each image, and on the distance between them. Models without explicit representation of time (e.g., input-output, partial equilibrium or static general equilibrium models) are sufficient. Static models can provide insights on the sustainable character of the long-term images, to the extent that the model captures critical variables for sustainability such as natural resources use or impact of economic activity on the environment (e.g., GHG emissions). However, national accounts typically add up multiple products with very different material content, very different energy contents, and very different prices. Thus, constructing robust relationships between aggregate monetary indicators and physical flows requires in-depth analysis. Similarly, static models can provide insights on the social components of sustainability to the extent they include some form of representation of the *distribution* of economic activity within the society, notably across income groups (see Section 4.4.1). Again, the associated data challenge is significant. By construction, on the other hand, static models do not provide insights on the pathways from the present on to each possible future, let alone on the transitions between pathways.

Thus one needs dynamic models to depict the pathway towards desirable (or undesirable) long-term futures. Still, the relevance of dynamic models for discussing transitions depends on their structure, content, and way they are used. A large part of the modelling literature on climate mitigation relies on neoclassical growth models with exogenous (Swan, 1956; Solow, 1956) or endogenous (Koopmans, 1965; Cass, 1965) savings rate. In those, long-term growth is ultimately driven by the sum of population growth and exogenous total factor productivity growth (exogenous technical change). In the simplest version of the neoclassical model, there is thus only one "pathway" to speak of, as determined by human fertility and human ingenuity. Any departure from this pathway resorbs itself endogenously through adjustment of the relative weights of capital and labor in the production function, and through adjustment of the savings rate (when endogenous). Empirically, neoclassical growth models have limited ability to explain observed short-term growth patterns (e.g. Easterly (2002)).

Discussions about transitions are richer when models differentiate short-term economic processes from long-term ones. The general point is that the technical, economic and social processes often exhibit more rigidities in the short- than in the long-run. As Solow (2000) suggests, at short-term scales, "*something sort of 'Keynesian' is a good approximation, and surely better than anything straight 'neoclassical'. At very long time scales, the interesting questions are best studied in a neoclassical framework and attention to the Keynesian side of things would be a minor distraction*" (p. 158). There is a long tradition of debates in economics on the degree to which production technologies and wages should be considered flexible or rigid in the short- and medium-run, with potentially very different results for the assessment of climate mitigation policies (Rezai et al., 2013), (Guivarch et al., 2011). Other important rigidities include, inter alia, long-lived physical capital, the premature replacement of which is typically very costly, and the dynamics of which have important implications for the costs, timing and direction of climate policies (e.g. Lecocq et al., 1998; Wing, 1999); rigidities associated with the location of households and firms, changes of which take time; or rigidities associated with preferences of individuals and with institutions. Presence of may also lead to bifurcations towards different long-term outcome (i.e., equilibrium-dependence and not just path-dependence as in section 4.5.2) (See e.g. Hallegatte et al., 2007).

A second key element for the analysis of transitions is to relax the full information hypothesis under which many models are run. If information increases over time, there is a rationale for a sequential decision-making framework (Arrow et al., 1996), in which choices made at one point can be re-considered in light of new information. Thus, the issue is no longer to select a pathway once and for all, but to make the best first-step (or short-term) decision, given the structure of uncertainties and the potential for increasing information over time – factors which are especially relevant in the context of climate change. Inertia plays an especially important role in this context, as the more choices made at one point constrain future opportunity sets, the more difficult it becomes to make advantage of new information (e.g.,Ha-Duong et al., 1997). Another way by which uncertainty can be captured in models is to abandon the intertemporal optimization objective altogether and use simulation models instead, with decisions made at any time based on imperfect expectations (Scrieciu et al., 2013). Such shift has major implications for the transition pathway (Sassi et al., 2010), but results strongly depend on how expectations and decisions under uncertainty are represented.

Ideally, models that produce development pathways should thus (i) be framed in a consistent macroeconomic framework (since a pathway is holistic), (ii) impose relevant technical constraints in each sector, such as assumptions about the process of technical change, (iii) capture the key relationships between economic activity and the environment, e.g., energy and natural resources consumption or greenhouse gases emissions, (iv) have a horizon long enough to assess "sustainability" – a long-term horizon which also implies, incidentally, that the model must be able to represent structural and technical change – yet (v) recognize short-term economic processes critical for assessing transition pathways, such as market imbalance and rigidities, all this while (vi) providing an explicit representation of how economic activity is distributed within the society, and how this retrofits into the growth pattern, and (vii) representing key uncertainties.

No model today meets all these specifications. Current models can be classified along two major fault lines: bottom-up vs. top-down, and long-term vs. short-term. By design, computable general equilibrium (CGE) models provide a comprehensive macroeconomic framework, and they can be harnessed to analyze distributional issues, at least amongst income groups, but they typically fail to incorporate key technical constraints. Conversely, bottom-up engineering models provide a detailed account of technical potentials and limitations, but their macro-engine, if at all, is most often rudimentary. Emerging "hybrid" models developed in the context of climate policy assessment are steps towards closing this gap (Hourcade et al., 2006). A similar rift occurs with regard to time horizon. Growth models like Solow's are designed to capture key features of long-term development pathways, but they do not include short- or medium-term economic processes such as market rigidities. On the other hand, short-term models (econometric or structural) will meet requirement but are not designed to look deep in the future. Again, emerging models include short-/medium-term processes into analysis of growth in the long-run (see e.g., (Barker and Serban Scrieciu, 2010), but this pretty much remains an open research field.

**Box 4.4**. Characterizing the sustainability of development pathways

Constructing and modelling forward-looking development pathways is one thing, evaluating how they fare in terms of sustainability within and beyond the time horizon of the modelling is another. Two questions can actually be distinguished (Asheim, 2007). One is to predict whether the current situation (welfare, environment) will be preserved in the future: Are we on a sustained development pathway, i.e., a pathway without downturn in welfare or environmental objectives? This question is answered by looking at the evolution of the target variables within the time horizon of the scenario, and what happens beyond the horizon remains undetermined. Another question is to determine whether the current generation's decisions leave it possible for future generations to achieve a sustained pathway: Is a sustained development pathway possible given what the current generation does? Unlike the former question, the latter does not require predicting the future generations' decisions, only their future constraints and opportunities. Showing the existence of a sustained pathway is then an argument in favour of the compatibility of current decisions with future sustainability. Some indicators of sustainability such as genuine savings (see Box 4.2) are meant to provide an answer based on the current evolution of (economic, social, environmental) capital stocks and can also be used for the evaluation of scenarios which depict these stocks. In practice, sustainability analysis (of either type) is not frequent in the scenario-building community, though multi-criteria analysis of scenarios has been gaining ground in recent years (See e.g.,GEA, 2012).

## 4.6 Mitigative capacity and mitigation, and links to adaptive capacity and adaptation

### 4.6.1 Mitigation and adaptation measures, capacities, and development pathways

Even though adaptation and mitigation are generally approached as distinct domains of scientific research and practice (Biesbroek et al., 2009) (as reflected, for example, in the IPCC separate Working Groups II and III), a recognition of the deep linkages between mitigation and adaptation has gradually emerged. Initially, mitigation and adaptation were analyzed primarily in terms of techno-economic considerations. But growing attention has been directed at the underlying capacities, first with respect to adaptation, and later -and less fully- with respect to mitigation, (Grothmann and Patt, 2005; Burch and Robinson, 2007; Winkler et al., 2007; Goklany, 2007; Pelling, 2010).

This attention has necessitated a broadening of the scope of analysis well beyond narrow techno-economic considerations, to the social, political, economic and cultural domains, as ultimately, this is where the underlying determinants of mitigative and adaptive capacity lie. Following the literature enumerated above, a non-exhaustive list of these underlying determinants include: the level and distribution of wealth, robustness and legitimacy of institutions, availability of credible information, existence and reliability of infrastructure, access to and adequacy of technologies and systems of innovation, effective governance, social cohesion and security, distribution of decision-making power among actors, conditions of equity and empowerment among citizens, the opportunity costs of action, as well as individual cognitive factors, including relevant skills, knowledge and cultural framings. The fact that mitigative and adaptive capacities share and are similarly affected by these underlying determinants highlights their similarity, blurring the distinction between them and leading some scholars to argue that there is simply "response capacity" (Tompkins and Adger, 2005; Wilbanks, 2005; Burch and Robinson, 2007). Because response capacity is directly shaped by these underlying technological, economic, institutional, socio-cultural and political determinants, it is in other words directly shaped by the overall development pathway, which is the combined product of those same inter-related determinants. This dependence of response capacity on development pathway is underscored by the strong parallel between its determinants (outlined above) and the defining dimensions of a development pathway (discussed in Sections 4.3 and 4.5). Indeed, response capacity is determined much more by the overall development pathway than by targeted climate-specific policies. The academic consensus on this point has been clearly reflected in the IPCC AR4 (2007), in WGI Chapter 12 in the case of mitigative capacity, and WGII Chapter 18 in the case of adaptive capacity. Of course, more nuanced and site-specific assessments of the determinants of such capacity can provide further useful insight; see e.g. (Keskitalo et al., 2011).

Moreover, there is consensus that an effective transition toward a SD pathway in particular can more effectively foster response capacity (Intergovernmental Panel on Climate Change, 2007; Matthew and Hammill, 2009; Parry, 2009; Halsnaes et al., 2011; Harry and Morad, 2013). There are various elements of fostering a transition toward SD that naturally accord with the creation of mitigative and adaptive capacity, including, for example, the establishment of innovation systems that are supportive of environmental and social priorities, the support for adaptive ecosystem management and conservation, the strengthening of institutions and assets to support food and water security and public health, and the support for procedurally equitable systems of governance (Banuri, 2009; Barbier, 2011; Bowen et al., 2011; Bowen and Friel, 2012). Mitigation and adaptation outcomes can of course still be expected to depend on the extent to which explicit efforts are taken to implement and mainstream climate change policies and measures, as well as on the manner in which a particular SD approach may evolve -with more or less emphasis on economic, social or environmental objectives- (Giddings et al., 2002; Beg et al., 2002; Grist, 2008; Halsnæs et al., 2008).

The centrality of mitigative and adaptive capacity to SD is highlighted by the growing attention to idea that the Earth system has moved from the Holocene into the Anthropocene (Steffen et al., 2011), where societies are the most important drivers of the Earth's dynamics. Mitigative and adaptive capacity can be seen in general terms, i.e., not just with respect to GHG emissions and climate impacts, but all anthropogenic environmental pressures and impacts from ecosystem degradation. In this view, mitigative and adaptive capacity are central to sustainable ecosystem management (Holling, 1978; Walters and Holling, 1990; McFadden et al., 2011; Williams, 2011), and thus fundamental to SD (Chapin et al., 2010; Folke et al., 2011b; Polasky et al., 2011; Biermann et al., 2012). Some scholars interpret this as a fundamental redefinition of development calling for transformational shifts based on re-imagining possibilities for future development pathways (Pelling, 2010; Jackson, 2011a; Kates et al., 2012; Ehrlich et al., 2012).

Scholarship exploring the links between mitigation, adaptation, socio-ecological resilience and SD more generally, has generally pointed toward the existence of (potential) synergies and trade-offs within and across policy sectors and across implementation measures (Gallopín, 2006; Rosenzweig and Tubiello, 2007; Vogel et al., 2007; Boyd et al., 2009; Thornton and Gerber, 2010; Adger et al., 2011; Warren, 2011; Lal et al., 2011; Vermeulen et al., 2012; Denton and Wilbanks, 2012; Hill, 2013). These studies show that, in spite of mitigative and adaptive *capacities* being so closely intertwined with each other and with SD, the relationship between mitigation and adaptation *measures* is more ambiguous and, in line with the IPCC AR4, suggest that outcomes are highly dependent on the measures and the context in which they are undertaken, with some policy sectors being more conducive to synergies than others.

In the agricultural sector, for example, scholars have for many years highlighted the potential of fostering both mitigation and adaptation by supporting traditional and biodiverse agro-ecological systems around the world (Campbell, 2011; Altieri and Nicholls, 2013, and see Sec 11.5)(and see Section 11.5). A recent modelling exercise suggests that investing substantially in adapting agriculture to climate change in some regions -Asia and North America- can result in substantial mitigation co-benefits, whilst the latter may be insignificant in Africa (Lobell et al., 2013). There are empirical studies where interventions in agricultural systems have led to positive mitigation and adaptation outcomes -or vice versa- (Kenny, 2011; Wollenberg, 2012; Bryan et al., 2012), or where synergies between adaptation and mitigation have not materialized due to, for example, limited scientific and policy knowledge, as well as institutional and farmers' own financial and cognitive constraints (Haden et al., 2012; Arbuckle Jr. et al., 2013; Bryan et al., 2013). In forestry, the links between fostering mitigation strategies, e.g. through planting trees, developing agro-forestry systems or conserving diverse ecosystems, and the adaptation of both forests and people to climate change have been widely acknowledged and the possibility of effective linkages in policy and action have also been identified (Locatelli et al., 2011; Schoeneberger et al., 2012; Mori et al., 2013). Methods for identifying trade-offs between mitigation and adaptation at policy and implementation levels and to foster legitimate decision-making have also been recently developed (Laukkonen et al., 2009; Janetos et al., 2012).

This evolving literature highlights the need to examine adaptation and mitigation for their SD implications, and ultimately to mainstream them in broader development policy. It also explains the parallel emergence of environmental governance research about reforming existing or developing institutions in different policy domains to meet this need (Folke et al., 2005; Folke, 2007; Brunner and Lynch, 2010). Recent studies highlight the organisational, institutional, financial and knowledge barriers to the development of effective governance for climate mitigation and adaptation in general government policy (Picketts et al., 2012), as well as in particular policy sectors, e.g. in forestry (Johnston and Hesseln, 2012); in health (Bowen et al., 2013); or in urban planning (Barton, 2013). Others identify the multi-scale, inter-connected and dynamic nature of many climate issues and their associated responses as a key barrier to action, particularly at local level (Romero-Lankao, 2012). Analyses of the effectiveness of public-private partnerships and other forms of multi-actor cooperation to mainstream both mitigation and adaptation measures in a given sector and context also reveal the challenging nature of such endeavour (Pattberg, 2010; Pinkse and Kolk, 2012).

There is ample scope to improve response capacity in nations and communities by putting SD at the core of development priorities, despite the considerable governance challenges to mainstreaming mitigation and adaptation measures across policy sectors, collective and individual behaviour and to exploit possible synergies and confront trade-offs. Nonetheless, it remains the case that the variation of mitigative and adaptive capacity between different nations -and communities within them- is a function of the vast disparities in the determinants of such capacity. These differences in capacity are in turn driven to a significant degree by differences in development pathways and, specifically, level of development. This is a primary reason why the issue of burden sharing among nations features so prominently in consideration of international cooperation on climate change generally, and the UNFCCC in particular, as discussed further in the following section.

### 4.6.2 Equity and burden-sharing in the context of international cooperation on climate

Chapter 3 (Sections 3.2 to 3.5) introduced the general equity principles in the philosophical literature and their relevance to climate change including burden-sharing. This section briefly reviews the extensive literature regarding burden-sharing in a global climate regime. If focuses first on the equity principles as they are invoked in the literature, which emphasises those laid out in the UNFCCC. It then reviews several categories of burden-sharing frameworks. While the academic literature uses the term “burden-sharing,” it is understood that mitigation action entails not only burdens but also benefits.

#### *4.6.2.1 Equity principles pertinent to burden-sharing in an international climate regime*

The UNFCCC clearly invokes the vision of equitable burden-sharing among Parties toward achieving the Convention’s objective. While Parties had not articulated a specific burden-sharing arrangement in quantified detail, they had established an initial allocation of obligations among countries with explicit references to the need for equitable contributions. All Parties adopted general commitments to mitigate, adapt and undertake other climate-related actions, but distinct categories of countries reflecting level of development were identified and assigned specific obligations. Developed countries (listed in Annex I) were distinguished from developing countries and obliged to "take the lead on combating climate change and the adverse effects thereof" (Art 3.1), noting "the need for equitable and appropriate contributions by each of these Parties to the global effort regarding [the UNFCCC] objective" (Art 4.2(a)). A subset of Annex I countries consisting of the wealthier developed countries (listed in Annex II) were further obliged to provide financial and technological support "to developing countries to enable them to effectively implement their UNFCCC commitments" (Art. 4.7), noting that they "shall take into account … the importance of appropriate burden sharing among the developed country Parties".

While Parties' equitable contributions are elaborated further in subsequent UNFCCC decisions and under the Durban Platform for Enhanced Action, an explicit arrangement for equitable burden-sharing remains unspecified. Because there is no absolute standard of equity, countries (like people) will tend to advocate interpretations which tend to favour their (often short term) interests (Heyward, 2007; Lange et al., 2010; Kals and Maes, 2011). It is thus tempting to say that no reasoned resolution is possible and to advocate a purely procedural resolution (Müller, 1999). However, there is a basic set of shared ethical premises and precedents that apply to the climate problem, and impartial reasoning (as behind a Rawlsian (Rawls, 2000) "veil of ignorance") can help put bounds on the plausible interpretations of equity in the burden sharing context. Even in the absence of a formal, globally agreed burden-sharing framework, such principles are important in establishing expectations of what may be reasonably required of different actors. They influence the nature of the public discourse, the concessions individuals are willing to grant, the demands citizens are inclined to impose on their own governments, and the terms in which governments represent their negotiating positions both to other countries and to their own citizens. From the perspective of an international climate regime, many analysts have considered principles for equitable burden-sharing, (Rose 1990; Hayes and Smith 1993; Baer et al. 2000; B. Metz et al. 2002; Ringius, Torvanger, and Underdal 2002; Aldy, Barrett, and Stavins 2003; Ghersi, Hourcade, and Criqui 2003; Gardiner 2004; Caney 2005; Caney 2009; Caney 2010; Heyward 2007; E. A. Page 2008; Vanderheiden 2008; Klinsky and Dowlatabadi 2009; Winkler et al. 2011). Equitable burden-sharing has been most frequently applied to costs of mitigation, though similar issues arise with regard to adaptation (Baer, 2006; Paavola and Adger, 2006; Adger, 2006; Jagers and Duus-Otterstrom, 2008; Dellink et al., 2009; Grasso, 2010; Hartzell-Nichols, 2011). Here these equity principles are given along four key dimensions – responsibility, capacity, equality, and the right to sustainable development, expanding on the philosophical arguments in Sections 3.2-3.4.

### *Responsibility*

In the climate context, responsibility is widely taken as a fundamental principle relating responsibility for contributing to climate change (via emissions of GHGs) to the responsibility for solving the problem. The literature extensively discusses it, distinguishing moral responsibility from causal responsibility, and considering the moral significance of knowledge of harmful effects (Neumayer, 2000; Caney, 2005; Müller et al., 2009). Common sense ethics (and legal practice) hold persons responsible for harms or risks they knowingly impose or could have reasonably foreseen, and, in certain cases, regardless of whether they could have been foreseen. The notion of responsibility is thus closely connected to the Polluter Pays principle, and burden-sharing principles which derive from it hold that countries should be accountable for their greenhouse gas emissions. This is a common interpretation of the UNFCCC phrase "*common but differentiated responsibilities"* (Harris, 1999; Rajamani, 2000), given its similarity to the more explicit Rio Declaration (see sec 4.1).

Responsibility is taken by some to include present and past emissions (Grübler and Fujii, 1991; Smith, 1991; Neumayer, 2000; Rive et al., 2006; Wei et al., 2012). This has been justified on three main grounds. First, climate change results from the stock of accumulated historic emissions. Second, the total amount of greenhouse gases that can be emitted to the atmosphere must be constrained (to a level determined by society's choice of global climate stabilization goal (see IPCC

AR5 WGI), and thus constitutes a finite common resource (often loosely referred to as the "atmospheric space" or the "carbon budget"). Users of this resource -whether current or historical- should be accountable for depleting the resource and precluding the access of others. Third, historical emissions reflect the use of a resource from which benefits have been derived, i.e., wealth, fixed capital, infrastructure, and other assets. These benefits constitute a legacy based in part on consuming a common resource that (a) should be paid for, and (b) provides a basis for mitigative capacity (Shue, 1999; Caney, 2006, 2010). The latter argument carries the notion of responsibility further back in time, assigning responsibility for the emissions of previous generations, to the extent that present generations have inherited benefits. This argument links responsibility with the capacity principle discussed below (Meyer and Roser, 2010; Gardiner, 2011a; Meyer, 2012). If conventional development continues, the relative responsibility of some nations that currently have relatively low cumulative emissions would match and exceed by mid-century the relative responsibility of some nations who currently have high responsibility (Höhne and Blok, 2005; Botzen et al., 2008), on an aggregate – if not per capita – basis. Such projections illustrate that the relative distribution of responsibility among countries can vary substantially over time, and that a burden-sharing framework must dynamically reflect evolving realities if they are to faithfully reflect ethical principles. They also may provide a basis for understanding *where* mitigation might productively be undertaken, though not necessarily *who* should be obliged to bear the costs.

Each nation's responsibility for emissions is typically defined (as in IPCC inventory methodologies) in terms of emissions within the nation's territorial boundary. An alternative interpretation (Fermann, 1994) which has become more salient as international trade has grown more important, is to include emissions embodied in internationally traded goods consumed by a given nation. Recent studies (Lenzen et al., 2007; Pan et al., 2008; Peters et al., 2011) have provided a quantitative basis for better understanding the implications of a consumption-based approach to assessing responsibility. In general, at the aggregate level, developed countries are net importers of emissions, and developing countries are net exporters (see Sections 5.3.3.2 and 14.3.4). The relevance of this to burden-sharing may depend on further factors, such as the distribution between the exporting and importing countries of the benefits of carbon-intensive production, and the presence of other climate policies such as border carbon tariffs (see Section 13.8.1 and 14.4.1), as well as the development of the relevant data sources (see also Sections 3.9 and 4.4). Many analysts have suggested that all emissions are not equivalent in how they translate to responsibility, distinguishing the categories of "survival emissions", "development emissions", and "luxury" emissions (Agarwal and Narain, 1991; Shue, 1993; Baer et al., 2009; Rao and Baer, 2012).

Determining responsibility for emissions in order to allocate responsibility raises methodological questions. In addition to the standard questions about data availability and reliability, there are also equity-related questions. For instance, there are various rationales for determining how far in the past to include historical emissions. One rationale is that the 1990s should be the earliest date, reflecting the timing of the First IPCC Assessment Report and the creation of a global regime that imposed obligations to curb emissions (Posner and Sunstein, 2007). Some argue that the date should be earlier, corresponding to the time that climate change became reasonably suspected of being a problem, and greenhouse gas emissions thus identfiable as a pollutant worthy of policy action. For example, one might argue for the 1970s or 1960s, based on the published warnings issued by scientific advisory panels to the United States presidents Johnson (U.S. National Research Council Committee on Atmospheric Sciences, 1966; MacDonald et al., 1979) and Carter (MacDonald et al., 1979), and the first G7 Summit Declaration highlighting climate change as a problem and seeking to prevent further increases of carbon dioxide in the atmosphere (Group of 7 Heads of State, 1979). Others argue that a still earlier date is appropriate because the damage is still caused, the stock depleted, and the benefits derived, regardless of whether there is a legal requirement or knowledge.

Another issue is the question of accounting for the residence time of emissions into the atmosphere, as an alternative to simply considering cumulative emissions over time. In the case of carbon dioxide, responsibility could include past emissions even when they are no longer resident in the atmosphere, on the grounds that those emissions (a) have contributed to the warming and climate damages experienced so far, and upon which further warming and damages will be additive, and (b) have been removed from the atmosphere predominantly to the oceans, where they are now causing ocean acidification, which is itself an environmental problem (See AR5 WGI, Chapters 3 and 6).

### *Capacity (or, Ability to Pay)*

A second principle for allocating effort arises from the capacity to contribute to solving the climate problem (Shue, 1999; Caney, 2010). Generally, it is interpreted to mean that the more one can afford to contribute, the more one should, just as societies tend to distribute the costs of preserving or generating societal public goods; i.e., most societies have progressive income taxation. This view can be apply at the level of countries, or at a lower level, recognizing inequalities between individuals. Smith et al. (1993) suggested GDP as an income based measure of ability-to-pay, subject to a threshold value, determined by an indicator of quality of life. This was developed in Kartha et al. (2009) and Baer et al. (2010), taking into account intra-national disparities.

As discussed in Section 4.6.1, response capacity refers to more than just financial wherewithal, encompassing also other characteristics that affect a nation's ability to contribute to solving the climate problem. It recognizes that effective responses require not only financial resources, but also technological, institutional, and human capacity. This issue has been treated by Winkler, Letete and Marquard (2011) by considering Human Development Index as a complement to income in considering capacity. Capacity, even in this broader sense, can be distinguished from mitigation potential, which refers to the presence of techno-economic opportunities for reducing emissions due to, for example, having renewable energy resources that can be exploited, a legacy of high-carbon infrastructure that can be replaced, or a rapidly growing capital stock that can be built based on low-carbon investments. Mitigation potential is a useful characteristic for determining where emissions reductions can be located geographically for reasons of cost-effectiveness, but this can be distinguished from burden-sharing *per se*, in the sense of determining on normative grounds which country should pay for those reductions. This distinction is reflected in the economist's notion that economic efficiency can be decoupled from equity (Coase, 1960; Manne and Stephan, 2005).

### *Equality*

Equality means many things, but a common understanding in international law is that each human being has equal moral worth and thus should have equal rights. Some argue this applies to access to common global resources, expressed in the perspective that each person should have an equal right to emit (Grubb, 1989; Agarwal and Narain, 1991). This equal right is applied by some to current and future flows, and by some to the cumulative stock as well. (See further below.)

Some analysts (Caney, 2009) have noted, however, that a commitment to equality does not necessarily translate into an equal right to emit. Egalitarians generally call for equality of a total package of "resources" (or "capabilities" or "opportunities for welfare") and thus may support inequalities in one good to compensate for inequalities in other goods (Starkey, 2011). For example, one might argue that poor people who are disadvantaged with respect to access to a resources such as food or drinking water may be entitled to a greater than per capita share of emissions rights. Second, some individuals may have greater needs than others. For example, poorer people may have less access to alternatives to fossil fuels (or unsustainably harvested wood fuel) because of higher cost or less available technologies, and thus be entitled to a larger share of emission rights.

Others have suggested that equality can be interpreted as requiring equal sacrifices, either by all parties, or by parties who are equal along some relevant dimension. Then, to the extent that parties are not equal, more responsibility (Gonzalez Miguez and Santhiago de Oliveira, 2011) or capacity (Jacoby et al., 2009) would imply more obligation, all else being equal.

### *Right to development*

The right to development appears in international law in the UN Declaration on the Right to Development, the Rio Declaration, and the Vienna Declaration, and is closely related to the notion of *need* as an equity principle, in that it posits that the interests of poor people and poor countries in meeting basic needs are a global priority (Andreassen and Marks, 2007). The UNFCCC acknowledges a right to promote sustainable development, and "the legitimate priority needs of developing countries for the achievement of sustained economic growth and the eradication of poverty" (UNFCCC, 2002) and recognizes that "economic and social development and poverty eradication are the first and overriding priorities of the developing country Parties" (p. 3).

In the context of equitable burden-sharing, a minimalist interpretation of a right to development is a right to an exemption from obligations for poor Parties (Ringius et al., 2002) on the basis that meeting basic needs has clear moral precedence over the need to solve the climate problem, or, at the very least, it should not be hindered by measures taken to address climate change.

### *4.6.2.2 Frameworks for equitable burden-sharing*

There are various ways of interpreting the above equity principles and applying them to the design of burden-sharing frameworks. It is helpful to categorize them into two broad classes. "Resource-sharing" frameworks are aimed at applying ethical principles to establish a basis for sharing the agreed global "carbon budget". "Effort-sharing" frameworks are aimed at sharing the costs of the global climate response. The resource-sharing frame is the natural point of departure if climate change is posed as a tragedy of the commons type of collective action problem; if it is posed as a free-rider type of collective action problem, the effort-sharing perspective is more natural. Neither of these framings is objectively the "correct" one, just as neither collective action framing of the climate change problem is correct. Both can inform policymakers judgments in different ways. Indeed, the two approaches are complementary: any given resource-sharing framework implies a particular distribution of the effort, and conversely. In either case, burden-sharing frameworks are typically formulated as emission entitlements to be used in trading system or global climate fund, which enables a cost-effective distribution of the actual mitigation efforts. Through such mechanism, countries with obligations greater than their domestic mitigation potential can fund reductions in countries with obligations that are less than their domestic mitigation potential (see Sections 6.3.6 and 13.4.3).

One important dimension along which both resource-sharing and effort-sharing proposals can be compared is the number of categories into which countries are grouped. The UNFCCC in fact had three categories – Annex I, Annex II (the OECD countries within Annex I), and non-Annex I. Many of the proposals discussed below reproduce these distinctions. Others increase the number of "bins," to as many as six (Winkler et al., 2006). Finally, many others eliminate any qualitative categories, instead allocating emissions rights or obligations on the basis of a continuous index.

### *Resource sharing approaches*

The resource-sharing approach starts by acknowledging that the global "carbon budget" is bounded, with its size defined by the agreed climate stabilization target. The most straightforward resource-sharing approach is an equal per capita approach (Grubb, 1990; Agarwal and Narain, 1991; Jamieson, 2001), which is premised on the equal rights to the atmospheric commons to all individuals, and allocates emission allowances to each country in proportion to its population. In response to the concern that an equal per capita allocation would provide an incentive for more rapid population growth, some analysts have argued that the effect would be negligible in comparison to other factors affecting population, and others have proposed solutions such as holding population constant as of some agreed date (Jamieson, 2001), establishing standardized growth expectations (Cline, 1992), or allocating emission in proportion only to adult population (Grubb, 1990).

In response to the concern that unrealistically rapid reductions would be required in those countries whose current emissions are far above the global average, some have proposed a period of transition from grandfathered emission rights (i.e., allocated in proportion to current emissions) to equal per capita emission rights (Grubb and Sebenius, 1992; Welsch, 1993; Meyer, 2004). This rationale applies specifically to a framework intended to determine actual emission pathways, in which case an immediate per capita distribution would impose unrealistically abrupt changes from present emission levels. For a framework intended to assign transferable rights to emit, rather than actual emissions, the rationale is questionable: the opportunity to acquire additional allocations through emissions trading or some other transfer system would allow a cost-effective transition and lessen, though not eliminate, the political challenges of an immediate equal per capita allocation.

A variant on the above that aims to address the concern that many developing countries would have to reduce their emissions from already very low levels is “Common but Differentiated Convergence” (Höhne et al., 2006), under which a developing country is required to begin converging only once its per capita emissions exceed a specified (and progressively declining) threshold. Chakravarty et al. (2009) put forward a variant that looked beyond average national indicators of emissions by examining the distribution of emissions across individuals at different income levels within countries.

Extending the concept of equal per capita rights to include both the historical and future carbon budget gives the “equal cumulative per capita emission rights” family of frameworks (Bode, 2004; den Elzen et al., 2005; German Advisory Council on Global Change, 2009; Oberheitmann, 2010; Höhne et al., 2011; CASS/DRC Joint Project Team, 2011; Jayaraman et al., 2011; Pan et al., 2013). These frameworks vary, for example, in their choice of the initial date for historical emissions, the way they deal with growing populations, their treatment of luxury versus survival emissions, and their way of distributing a budget over time. As some countries (which tend to be higher income countries that industrialized earlier) have consumed more than their equal per capita share of the historical global budget, this excess use is offered as an argument for obliging them to provide financial and technological resources to other countries that have used less than their historical share. This obligation has been linked to the notion of a “carbon debt” or “climate debt” (Pickering and Barry, 2012), and framed as a subset of a larger “ecological debt” (Roberts and Parks, 2009; Goeminne and Paredis, 2010), which some analyses have attempted to quantify (Smith, 1991; Srinivasan et al., 2008; Cranston et al., 2010).

### *Effort sharing approaches*

“Effort sharing” frameworks seek to fairly divide the costs of reducing emissions to an agreed level. (Effort sharing approaches can also be applied to adaptation costs whereas resource sharing approaches cannot.) Many of the philosophers engaged with the question of burden-sharing in the climate regime have argued that obligations should be proportional in some fashion to responsibility and capacity (see, for example the analyses of Shue (1993); or Caney (2005)).

An early effort-sharing approach was the Brazilian proposal using historic responsibility for emissions and thus global temperature rise as a basis for setting Kyoto targets. This approach has been quantitatively analyzed (Höhne and Blok, 2005) and discussed in the global political context recently (Gonzalez Miguez and Santhiago de Oliveira, 2011). Other approaches have used capacity based on indicators such as GDP per capita (Wada et al., 2012) as a basis for effort-sharing, or have combined capacity and responsibility (Winkler et al., 2006). Some have included minimal form of a right to development by identifying a threshold of development below which income and emissions are not included in a nation’s capacity or responsibility (Cao, 2008; Kartha et al., 2009; Yue and Wang, 2012).

The quantitative implications of a number of burden-sharing frameworks are presented for several regions in Section 6.3.6.6. The frameworks are grouped into six categories, corresponding either to one of the underlying burden-sharing principles (responsibility, capability, equality, right to development), or a combination of them. It is important to note that several of the approaches are based on considerations other than equity principles. For example, several allocate allowances based on grandfathered emissions levels, with a transition to an equity-based allocation only over several decades or in some cases with no such transition. Others allocate allowances in proportion to GDP, while others include mitigation potential as one basis in addition to equity principles.

## 4.7 Integration of framing issues in the context of sustainable development

Chapters 2 and 3 of this report review the framing issues related to risk and uncertainty (Chapter 2) and social, economic and ethical considerations guiding policy (Chapter 3). They examine how these issues bear on climate policy, both on the mitigation and on the adaptation side of our response to the challenge of climate change. Their general analysis is also directly relevant to the understanding of SD and equity goals. This section briefly examines how the concepts reviewed in these chapters shed light on the topic of the present chapter.

### 4.7.1 Risk and uncertainty in sustainability evaluation

The sustainability ideal seeks to minimize risks that compromise future human development (Sections 4.2 and 4.5). This objective is less ambitious than maximizing an expected value of social welfare over the whole future. It focuses on avoiding setbacks on development, and is therefore well in line with Chapter 2 (Section 2.5.1) highlighting the difficulty of applying the standard decision model based on expected utility in the context of climate policy. It is directly akin to the methods of risk management listed there (Sections 2.5.2-2.5.7), in particular those focusing on worst-case scenarios. The literature on adaptation has similarly emphasized the concept of resilience, which is the ability of a system to preserve its functions in a risky and changing environment (WGII Section 2.5 and Sections 20.2-20.6, Folke et al. (2010), Gallopin (2006)).

This chapter has reviewed the actors and determinants of support for policies addressing the climate challenge (Sections 4.3 and 4.6). Among the relevant considerations, one must include how risk perceptions shape the actors' understanding of threats to sustainability and willingness to take action. Chapter 2 (Section 2.4) has described how framing and affective associations can be effective and manipulative, how absence or presence of a direct experience of climate extremes makes individuals distort probabilities, and how gradual changes are easy to underestimate.

Risk and uncertainty are also relevant to the dimension of equity, in relation to sustainability, because various regions of the world and communities within those regions experience unequal degrees of climate risk and uncertainty. Better information about the distribution of risks between regions and countries would affect the policy response and negotiations. Lecocq and Shalizi (2007) argue that the absence of information about the location and extent of impacts raises incentives for mitigation, and Lecocq and Hourcade (2012) show that the optimal level of mitigation may also increase.

Incorporating risk in the evaluation of sustainability of a development pathway is challenging and has been analysed in a small literature. In particular, Baumgärtner and Quaas (2009) and Martinet (2011) propose to define thresholds for well-being or for various natural or man-made stocks and to assess sustainability by the probability that thresholds will be crossed in the foreseeable future. However, a decision-maker may not find it sufficient to check that the risk of unsustainability is below a given threshold, and may also want to know the likelihood of the bad scenarios and the harm incurred by the population in these scenarios.

### 4.7.2 Socio-economic evaluation

Chapter 3 has reviewed the principles of social and economic evaluation and equity in a general way. In 3.6.1 it recalls that there is now a consensus that methods of cost-benefit analysis that simply add up monetary-equivalent gains and losses are consistent and applicable only under very specific assumptions (constant marginal utility of income and absence of priority for the worse off) which are empirically dubious and ethically controversial. It is thus necessary to introduce weights in such summations (see Eq. 3.6.2) that embody suitable ethical concerns and restore consistency of the evaluation. Adler (2011) makes a detailed argument in favour of this "social welfare function" approach to cost-benefit analysis. This approach is followed by Anthoff et al. (2009), refining previous use of equity weights by Fankhauser et al. (1997) and Tol (1999). An advantage of a well-specified methodology for the choice of equity weights is the ability to reach more precise conclusions than when all possible weights are spanned. It also makes it possible to transparently relate conclusions to ethical assumptions such as the degree of priority to the worse off.

Chapter 3 (Sections 3.2-3.4) describes the general concepts of social welfare and individual well-being. In applications to the assessment of development paths and sustainability, empirical measures are needed. Several methods are discussed in Stiglitz et al. (2009) and Adler (2011). In particular, the capability approach (Sen, 2001, 2009) is well known for its broad measure of well-being that synthesizes multiple dimensions of human life and incorporates considerations of autonomy and freedom. Most applications of it do not directly rely on individual preferences (Alkire, 2010). Fleurbaey and Blanchet (2013) defend an approach that relies on individual preferences, in a similar fashion as money-metric utilities. Some authors (e.g., Layard et al. (2008)) even propose to use satisfaction levels obtained from happiness surveys directly as utility numbers. This is controversial because different individuals use different standards when they answer questions about their satisfaction with life (Graham, 2009).

One reason why well-being may be useful as a guiding principle in the assessment of sustainability, as opposed to a more piecemeal analysis of each pillar, is that it helps evaluate the weak versus strong sustainability distinction. As explained in Section 4.2, weak sustainability assumes that produced capital can replace natural capital, whereas strong sustainability requires natural capital to be preserved. From the standpoint of well-being, the possibility to substitute produced capital for natural capital depends on the consequences on living beings. If the well-being of humans depends directly on natural capital, if there is option value in preserving natural capital because it may have useful properties that have yet to be discovered, or if non-human living beings depend on natural capital for their flourishing, this gives powerful reasons to support a form of strong sustainability.

Additionally, Chapter 3 (in particular Sections 3.3 and 3.5) mentions other aspects of equity that are relevant to policy debates and international negotiations on climate responses. Chapter 3 discusses these issues at the level of ethical principles, and given the importance of such issues in policy debates about mitigation efforts, Section 4.6 develops how these principles have been applied to the issue of burden-sharing in climate regime.

## 4.8 Implications for subsequent chapters

The primary implication of this chapter as a framing for subsequent chapters is to underscore the importance of explicitly scrutinizing the candidate mitigation technologies, measures and policies for their broader equity and sustainability implications. Indeed, the relevant stakeholders and decision-makers have various priorities, in particular regarding economic and human development, which may align or conflict with prospective climate actions. Equitable and sustainable development provides a broader overarching framework within which to examine climate strategies as one of the multiple interacting challenges confronting society. Ultimately, it is a framework within which society can consider the fundamental question of its development pathway.

### 4.8.1 Three levels of analysis of sustainability consequences of climate policy options

Various definitions and indicators of SD have been introduced in this chapter (in particular in 4.2,.4.5). This subsection offers a simple taxonomy of approaches for the assessment of sustainability.

**Long-term evolution of the three pillars.** The outcomes of climate policy options can generally be observed in the three spheres related to the three pillars of SD: the economic, the social, and the environmental sphere. Sustainability in the economy refers to the preservation of standards of living and the convergence of developing economies toward the level of developed countries. Sustainability in the social sphere refers to fostering the quality of social relations and reducing causes of conflicts and instability, such as excessive inequalities and poverty, lack of access to basic resources and facilities, and discriminations. Sustainability in the environmental sphere refers to the conservation of biodiversity, habitat, natural resources, and to the minimization of ecosystem impacts more generally.

**Long-term evolution of well-being.** The way the three spheres (and pillars) flourish can be viewed as contributing to sustaining well-being for humans as well as for other living creatures. Human well-being depends on economic, social, and natural goods, and the other living beings depend on the quality of the ecological system. It may therefore be convenient to summarize the multiple relevant considerations by saying that the ultimate end result, for sustainability assessment, is the well-being of all living beings. Measuring well-being is considered difficult for humans because there are controversies about how best to depict individual well-being, and about how to aggregate over the whole population. However, as explained in Sections 3.4 and 4.7, many of the difficulties have been exaggerated in the literature, and practical methodologies have been developed. Truly enough, it still remains difficult to assess the well-being of all living beings, humans and non-humans together.

But, even if current methodologies fall short of operationalizing comprehensive measures of well-being of that sort, it is useful for experts who study particular sectors to bear in mind that a narrow notion of living standards for humans does not cover all the aspects of well-being for the purposes of assessing sustainability. It is also useful to try to assess how various interactions between the three spheres can impact on well-being. When there are trade-offs between different aspects of the economic, social, and ecological dimensions, one has to make an assessment of their relative priorities. Well-being is the overarching notion that helps thinking about such issues.

**Current evolution of capacities.** Sustainability can also be assessed in terms of capital or capacities, as suggested by some indicators such as genuine savings (Section 4.2). Preserving the resources transmitted to the future generation is a key step in guaranteeing a sustainable path. Again, it is useful to think of the capacities underlying the functioning of the three spheres: economic, social, environmental. The economic sphere needs various forms of productive capital and raw materials, infrastructures and a propitious environment, but also human capital, institutions, governance, and knowledge. The social sphere needs various forms of institutions and resources for sharing goods and connecting people, which involve certain patterns of distribution of economic resources, transmission of knowledge, and forms of interaction, coordination and cooperation. The ecological sphere needs to keep the bases of its health, including habitat, climate, and biological integrity. In general, climate policy options can affect capacities in all of these spheres, to varying degrees.

### 4.8.2 Sustainability and equity issues in subsequent chapters

As discussed in this chapter (Sections 4.2 and 4.5), sustainability is a property of a development pathway as a whole. And some of the literature reviewed in the subsequent chapters (6 to 16) actually discusses development pathways and the sustainability thereof. In addition, chapters 6 to 16 discuss individual issues relevant to SD and equity. Based on a detailed description of SD and equity issues (rooted in the “three pillars” approach for SD, see Section 4.8.1), this section provides a map and a reader’s guide for the report from the SD and equity perspective. Table 4.1 shows where those issues are addressed throughout the report. It is supplemented in this section by a brief outline of how each chapter from 6 to 16 deals with them.

The present section is broader than, and a complement to, Section 6.6 and Table 6.5, which sum up and discuss key co-benefits and adverse side-effects in chapters 7-12. It is broader in two ways. First, the present section covers all chapters, not just the sectoral ones. Second, the present section reviews not only where co-benefits and adverse side-effects are discussed (the "development in the climate lens" approach as in Sathaye et al. (2007)), but also where the implications of key development policies for mitigation and mitigative capacity are discussed ("climate in the development lens"), and where integrated development paths, including but not limited to climate mitigation, are analysed. On the other hand, Section 6.6 and Table 6.5 provide a more detailed description of many sorts of co-benefits and adverse side-effects (not all of which directly bear on SD).

The review conducted in the present section leads to three key messages. First, SD and equity issues are pervasive throughout the chapters, reflecting growing literature and attention paid to the topic. Second, a large part of the discussion remains framed within the framework of co-benefits and adverse side-effects. Although extremely important and useful, it has been noted above (Section 4.2) that co-benefits and adverse side-effects are only a building block towards a full SD assessment—which is about integrating the different dimensions in a comprehensive pathway framework. Third, while some topics, such as health co-benefits and adverse side-effects associated with mitigation policies, appear already well covered in the literature, others remain scarcely addressed. In particular, distributional issues (both distributional implications of mitigation policies and implications of different distributional settings for climate policies), employment, and social cohesiveness, have limited coverage—despite being among the key SD goals that policymakers will consider.

The following paragraphs briefly describe how each chapter (from 5 to 16) deals with SD and equity issues. Chapter 5 analyzes the drivers of GHG emissions, and many of these drivers have to do with basic characteristics of the development pathway (population, economic growth, behaviors, technology) that impact sustainability perspectives (5.3, 5.5, 5.6). It also provides a brief overview of co-benefits (in particular in health) and adverse side-effects (5.7) and takes a system perspective to understand the linkages between emissions and the various drivers (5.8) –such a systemic view is congenial to the comprehensive approach to SD discussed in 4.2.

Chapter 6 analyses distributional consequences of different international burden-sharing regimes (6.3.6.6). This chapter also highlights the contrast between the literature suggesting that mitigation might increase the rural-urban gap and deteriorate the living standards of large sections of the population in developing countries, and the SD literature stating that policy and measures aligned to 'development' and 'climate' objectives can deliver substantial co-benefits [Box 6.2]. Section. 6.5.2 discusses underlying factors that enable or prevent mitigation. Section 6.6.1 summarizes Ch. 7-12 information on co-benefits and adverse side-effects, while 6.6.2 attempts to link transformation pathway studies with other key development priorities, including air pollution and health (6.6.2.1), energy security (6.6.2.2), energy access (6.6.2.3), employment (6.6.2.4), biodiversity (6.6.2.5), water use (6.6.2.6). Section 6.6.2.7 reviews scenario studies analysing the interactions between mitigation, air quality and energy security objecitves.

**Table 4.1:** Overview of SD and equity issues as addressed in Chapters 5-16 of the WGIII AR5 report.

| | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **EQUITY** | | | | | | | | | | | | |
| •Distribution (within and between countries and generations) | 5.3.3 | 6.3.6.6 | 7.9.1 | 8.10.1 | 9.7.1 | | 11.7.1 | 12.6 | 13.2.2.3<br>13.4.2.4<br>13.13.1.2 | 14.1.3 | 15.5.2.3<br>15.5.2.4 | |
| •Procedural equity (Participation / involvement, including institutional issues) | | 6.3.6.6 | | | | | 11.7.1<br>11.8.2<br>11.9.3 | 12.5.2.3<br>12.6.1 | 13.2.2.4 | | 15.2.1 | |
| **ECONOMIC** | | | | | | | | | | | | |
| –Employment | 5.7.2 | 6.6.2.4 | 7.9.1 | 8.7.1 | 9.7.2.1 | 10.8.1 | 11.7.1<br>11.13.6 | 12.4.2<br>12.5.2.1 | | 14.1.3 | | |
| –Standards of living | 5.3.3 | 6.3.1.2 | 7.10.2 | 8.2.2.1 | 9.7.2.5 | 10.8.1 | 11.7.1 | 12.5.2.1 | | | | |
| –Financing | | | 7.10.2 | | 9.10.3.3 | | 11.7.1 | 12.6.2 | 13.11.1 | 14.3.7<br>14.4.4 | | 16.8 |
| –Innovation | 5.6.1 | 6.5.1 | 7.9.1 | 8.7.3 | | 10.8.4 | 11.3.1<br>11.13.6 | 12.2.1.3 | 13.9 | 14.3.6 | 15.6 | |
| –Path-dependence and lock-ins | 5.6.3 | 6.3.6.4<br>6.4.3 | 7.9,1<br>7.10.5 | 8.4 | 9.4.3 | | 11.3.2 | 12.3.2.1<br>12.4.1 | | 14.3.2 | | |
| –Energy Security | 5.3.4 | 6.6.2.2 | 7.9.1 | 8.7.1 | 9.7.2.2 | 10.8.1 | 11.13.6 | 12.8.2 | | 14.4.3 | | |
| **SOCIAL** | | | | | | | | | | | | |
| –Poverty (alleviation) | | 6.6.2.3 | 7.9,1<br>7.10.3 | 8.7.1 | 9.7.2.5 | | 11.7.1<br>11.8.1<br>11.13.6 | | | 14.1.3 | | |
| –Access to and affordability of basic services | | 6.6.2.3 | 7.9.1 | 8.7.1 | 9.7.1 | | 11.A.6 | 12.4.2.4<br>12.5.2.1 | | 14.3.2.1 | | |
| –Food security | 5.3.5<br>5.7.2 | 6.3.5 | 7.9.4 | | | | 11.7.1<br>11.13.6/7 | | | | | |
| –Education and learning | | | 7.9.1 | | | | | | 13.10 | | 15.10 | 16.3 |
| –Health | 5.7.1 | 6.6.2.1 | 7.9.2 ; 7.9.3 | 8.7.1 | 9.7.3.1<br>9.7.3.2 | 10.8.1 | 11.7.1<br>11.13.6 | 12.8.1<br>12.8.3/4 | | | | |
| –Displacements | | | 7.9.4 | | | 10.8.1 | 11.7.1<br>11.13.6 | | | | | |
| –Quality of life | | | 7.9.4 | 8.7.1 | 9.7.1 | 10.8.1 | 11.A.6 | 12.8.2/3 | | | | |
| –Gender Impacts | | | 7.9.1 (Box) | | 9.7.1 | | 11.7<br>11.13.5 | | | | | |
| ENVIRONMENTAL | | | | | | | | | | | | |
| –Ecosystem impacts and biodiversity conservation | 5.7.2 | 6.6.2.6 | 7.9.2 | 8.7.1 | 9.7.1 | 10.8.1 | 11.7.2<br>11.13.6/7 | 12.5.1<br>12.8.1/4 | | 14.3.5 | 15.5.6 | |

| | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| –Water, soils and other natural resources | 5.5.2 | 6.6.2.5 | 7.9.2 ;7.9.3 | 8.7.2 | 9.7.3.3 | 10.8.1 | 11.7.2<br>11.8.3<br>11.13.6 | 12.6.1<br>12.8.4 | | | | |

Chapter 7 reviews the literature on the co-benefits, risks and spillovers of mitigation in the energy sector, with emphasis on employment, energy security and energy access (7.9.1), and health and environmental issues (7.9.2 and 7.9.3). It also puts energy mitigation options into a broader development context, notably by examining how special mechanisms such as microfinance can help lifting rural populations out of the energy poverty trap and increase the deployment of low carbon energy technologies (7.10.2). It stresses that poverty itself is shaping energy systems in LDCs and creating obstacles (e.g., legal barriers, or vandalism, in informal settlements) to the distribution of electricity (7.10.3). It also highlights the implications of the long life duration of energy supply fixed capital stock (7.10.5).

Chapter 8 emphasizes the importance of the transport sector both for human development and for mitigation (8.1.1). There are many potential co-benefits associated with mitigation actions in the transport sector, with respect to equitable mobility access, health and local air pollution, traffic congestion, energy security, and road safety (8.7.1). But it is difficult to assess the social value of such benefits, and there are risks and uncertainties (8.7.2). The chapter analyzes the special uncertainties and concerns of developing countries, where efforts are made to develop or improve institutional effectiveness to support integrated planning (involving transportation, land use, energy, agriculture and public health authorities) that uses transportation as a driver for developing economic and social resilience (8.9.3). Finally, Chapter 8 mentions the concerns with market-based policies having differential impacts across population groups (8.10.1).

Chapter 9 lists the co-benefits and adverse side-effects associated with buildings, notably in terms of employment (9.7.2.1), energy security (9.7.2.2), fuel poverty alleviation (9.7.2.5) and health (9.7.3.1 and 9.7.3.2). Detailed analysis is also conducted on path dependence and lock-in effects associated with the building stock (9.4.2) and with financing issues, as they relate to the particular situations of developing countries (9.10.3).

Chapter 10 discusses the co-benefits and adverse side-effects associated with mitigation actions in the industry sector, focusing mostly on macroeconomic and health benefits (10.8.1). The chapter also focuses on employment impacts of eco-innovation and investment, noting that substantial impacts require job support mechanisms, and that the distributional effects of these policies and across different countries remain unclear (10.10.2).

Chapter 11 frames the discussion of mitigation options in the AFOLU sector within a systemic development context (11.4.1). It thoroughly examines the socio-economic impacts of changes in land use (11.7.1). Increasing land rents and food prices due to a reduction in land availability for agriculture, and increasing inequity and land conflicts are serious concerns (11.7.1). Special care for small holders and equity issues, including gender, should accompany mitigation projects (Box 11.5). Bioenergy deployment can have strong distributional impacts, mediated by global market dynamics, including policy regulations and incentives, the production model and deployment scale, and place-specific factors such as land tenure security, labour and financial capabilities. It can raise and diversify farm incomes and increase rural employment, but can also cause smallholders, tenants and herders to lose access to productive land, while other social groups such as workers, investors, company owners, biofuels consumers, would benefit (bioenergy appendix).

Chapter 12 naturally adopts a systemic perspective in dealing with human settlements (12.1, 12.4, 12.5.1), and discusses procedural equity issues in the context of city governance (12.6). It notes that a high-density city, depending heavily upon land-based public-private financing, faces issues of real estate speculation and housing affordability (12.6.2). Adapted tax policies can help integrate market incentives with policy objectives such as sustainable transit financing, affordable housing, and environmental protection. Section 12.8 focuses more specifically on the co-benefits of mitigation options in human settlements, notably in terms of improved health, but also regarding quality of life (noise, urban heat island effect) and energy security and efficiency.

Chapter 13 provides a detailed examination of various international agreements and mechanisms through the lens of distributional impacts, noting the complex interaction between equity and participation in voluntary cooperation processes (13.2). The chapter discusses the distributional impacts of the Kyoto Protocol as well as various proposals for multilateral systems (global permit market, global tax, technology-oriented schemes) (13.13.2), linkages (13.7.2), and more decentralized initiatives such as trade sanctions (13.8) and geo-engineering (13.4.4).Chapter 13 further discusses advantages and limitations of linking negotiations on mitigation and negotiations on other development objectives (13.3.3). Links with policies and institutions related to other development goals are not discussed, except for relationships between mitigation and international trade regulation (13.8). Finally, human rights and rights of nature are discussed in so far as they might support legal challenges to greenhouse gases emissions (13.5.2.2).

Chapter 14 firmly embeds its analysis of climate policies at the regional level within the context of possible development paths, highlighting significant regional differences (14.1.2, 14.1.3). Given heterogeneity of capacities between countries, it argues that regional cooperation on climate change can help to foster mitigation that considers distributional aspects. In particular, high inequalities in poor regions raise difficult distributional questions regarding the costs and benefits of mitigation policies (14.1.3). Mitigation opportunities are discussed in the context of the broader development objectives, with regard to energy access (14.3.2), urbanization (14.3.3), consumption patterns (14.3.4), agriculture and land-use (14.3.5) and technological development (14.3.6). Relationships between mitigation options and regional trade agreements—not a development objective per se but an instrument for achieving economic growth—are also examined (14.4.2). Finally, Chapter 14 examines the geographical concentration of CDM projects (14.3.7).

In analyzing policies at the national and subnational level, Chapter 15 provides a detailed analysis of the relationships between climate mitigation and other development goals. While it notes the practical importance of co-benefits in the design of climate policies (15.2.2), it also shows that certain measures set up with primarily other development objectives have important implications for climate mitigation, either directly in terms of emission reductions, or indirectly in terms of provision of public goods necessary for mitigation policies to be effective (15.3.4, 15.5.2, 15.5.6). In addition, the chapter highlights the importance of designing policy packages that jointly address different development objectives, and discusses in depth the opportunities but also the difficulties of such association (15.7.2, 15.11.3). Finally, Chapter 15 insists on the fact that whether a policy is adopted or not, and what outcome it finally has strongly depends on local circumstances (notably institutions), and on the process by which the decision is made (15.8.2, 15.9). Finally, this chapter notes that while the distributional incidence of taxes has been studied quite extensively, much less is known about the distributional incidence of other policies (15.13).

Availability of resources for investment is critical for supporting any development path. The literature reviewed in Chapter 16 notes that there are barriers to investment in many countries, not specific to mitigation – although mitigation activities have specific characteristics (size, perceived risks, etc.) that make their financing even more difficult (16.8). However, Chapter 16 notes that the literature on financing remains limited, and focuses quite narrowly on energy mitigation policies. There is very little evaluation, both at the micro and macro level, of how investment flows in other sectors (such as transportation or housing), could be redirected in relation with climate mitigation.

## 4.9 Gaps in knowledge and data

- The relationship between countries' human capital levels and their national and international engagement in climate change policy would benefit from additional studies.
- There are many open questions about how developing countries can best pull together the resources and capabilities to achieve SD and climate mitigation objectives and how to leverage international cooperation to support this process.

- Not much is known about the desirability and feasibility of various economic and policy frameworks for the compensation of foregone benefits from exploiting fossil fuels in resource-rich countries.
- In the efforts made toward an evaluation of funding necessary to implement UNFCCC mitigation and adaptation activities, harmonized and clear methodologies and processes are still missing as a basis for accurate estimates.
- It is still difficult to assess the unrealized potential for reducing the environmental impact of economic activity and to understand how this potential can be realized.
- For technology transitions, knowledge remains insufficient for a comparative assessment of alternative innovation and diffusion systems and an assessment of the interplay between property rights, markets and government action, taking account of local circumstances and constraints.
- The relative importance in a SD transition of changes in values, as opposed to standard economic instruments influencing behaviors and economic activity, remains hard to assess.
- Not much is known about the relative potential of frugality (life-styles and consumption patterns involving lower expenditures on goods and services) versus ecologically-conscious behaviour (lifestyles and consumption patterns involving fewer material resources and less environmental harm without necessarily reducing expenditure) for promoting SD and equity.
- We still have an imperfect understanding of the non-economic motivations for climate-friendly behaviours, particularly regarding the respective role of social considerations or values (e.g. universalism regarding fellow human beings) versus ecological considerations (universalism regarding the environment), and the extent to which these drivers can be separated.
- The predictive power of values regarding ecologically conscious consumer behaviour is often low, typically less than 20%, due to a range of factors operating at different levels. The causes of this 'value-action gap' regarding especially behaviours that increase or limit GHG emissions are not well understood.
- The measurement of well-being, for the purpose of public policy, remains a controversial field, which suggests further exploring the potential uses of subjective data, and also seeking ways to improve the quality of data on well-being.
- The empirical economic models used in the context of climate policy could substantially improve by integrating transition issues (short-medium term) into long-term analysis, and also by adopting a sequential structure compatible with the resolution of uncertainty over time.
- The current methodologies for the construction of scenarios do not yet deliver sufficiently detailed and sufficiently long-term data in order to assess development paths at the bar of sustainability and equity. The studies of SD impacts of sectoral measures in terms of co-benefits are seldom integrated into a comprehensive assessment of sustainability of the general development path.
- A better understanding of the distributional impacts of prospective climate policies would provide guidance for designing equitable policies, and insight into the present political economic landscape wherein some actors support climate action and others oppose it.

## 4.10 Frequently Asked Questions

### *FAQ 4.1 Why does the IPCC need to think about sustainable development?*

Climate change is one among many (some of them longstanding) threats to SD, such as the depletion of natural resources, pollution hazards, inequalities, or geopolitical tensions. As policymakers are concerned with the broader issues of SD, it is important to reflect on how climate risks and policies fit in the general outlook. This report studies the interdependence between policy objectives via the analysis of co-benefits and adverse side-effects. More broadly, it examines how climate policy can be conceived as a component of the transition of nations toward SD pathways (Sections 4.2, 4.6, 4.8). Many factors determine the development pathway. Among the main factors that can be influenced by policy decisions, one can list governance, human and social capital, technology, and finance. Population size, behaviours and values are also important factors. Managing the transition toward SD also requires taking account of path dependence and potential favourable or unfavourable lock-ins (e.g. via infrastructures), and attention to the political economy in which all of these factors are embedded (Sections 4.3, 4.4, 4.5).

### *FAQ 4.2 The IPCC and UNFCCC focus primarily on GHG emissions within countries. How can we properly account for all emissions related to consumption activities, even if these emissions occur in other countries?*

For any given country, it is possible to compute the emissions embodied in its consumption or those emitted in its productive sector. The consumption-based framework for GHG emission accounting allocates the emissions released during the production and distribution (i.e. along the supply chain) of goods and services to the final consumer and the nation (or another territorial unit) in which she resides, irrespective of the geographical origin of these products. The territorial or production-based framework allocates the emissions physically produced within a nation's territorial boundary to that nation. The difference in emissions inventories calculated based on the two frameworks are the emissions embodied in trade. Consumption-based emissions are more strongly associated with GDP than are territorial emissions. This is because wealthier countries satisfy a higher share of their final consumption of products through net imports compared to poorer countries. (Section 4.4)

### *FAQ 4.3 What kind of consumption has the greatest environmental impact?*

The relationship between consumer behaviours and their associated environmental impacts is well understood. Generally, higher consumption lifestyles have greater environmental impact, which connects distributive equity issues with the environment. Beyond that, research has shown that food accounts for the largest share of consumption-based GHG emissions (carbon footprints) with nearly 20% of the global carbon footprint, followed by housing, mobility, services, manufactured products, and construction. Food and services are more important in poor countries, while mobility and manufactured goods account for the highest carbon footprints in rich countries. (Section 4.4)

### *FAQ 4.4 Why is equity relevant in climate negotiations?*

The international climate negotiations under the UNFCCC are working toward a collective global response to the common threat of climate change. As with any cooperative undertaking, the total required effort will be allocated in some way among countries, including both domestic action and international financial support. At least three lines of reasoning have been put forward to explain the relevance of equity in allocating this effort: (i) a *moral* justification that draws upon widely applied ethical principles, (ii) a *legal* justification that appeals to existing treaty commitments and soft law agreements to cooperate on the basis of stated equity principles, and (iii) an *effectiveness* justification that argues that an international collective arrangement that is perceived to be fair has greater legitimacy and is more likely to be internationally agreed and domestically implemented, reducing the risks of defection and a cooperative collapse. (Sections 4.2, 4.6)

## References

**Adger W.N. (2003).** Social capital, collective action, and adaptation to climate change. *Economic Geography* **79**, 387–404.

**Adger W.N. (2006).** *Fairness in Adaptation to Climate Change*. MIT Press, 337 pp., (ISBN: 9780262012270).

**Adger W.N., K. Brown, D.R. Nelson, F. Berkes, H. Eakin, C. Folke, K. Galvin, L. Gunderson, M. Goulden, K. O'Brien, J. Ruitenbeek, and E.L. Tompkins (2011).** Resilience implications of policy responses to climate change. *Wiley Interdisciplinary Reviews: Climate Change* **2**, 757–766. (DOI: 10.1002/wcc.133).

**Adger W.N., and A. Jordan (2009).** Sustainability: exploring the processes and outcomes of governance. In: *Governing Sustainability*. Cambridge University Press, Cambridge pp.3–31, (ISBN: 9780521732437).

**Adger W.N., I. Lorenzoni, and K. O'Brien (2009).** *Adapting to Climate Change. Thresholds, Values, Governance*. Cambridge University Press, Cambridge (GBR), 514 pp., (ISBN: 9780521764858).

**Adler M. (2011).** *Well-being and fair distribution : beyond cost-benefit analysis*. Oxford University Press, New York, (ISBN: 9780195384994).

**AEIC (2010).** *A Business Plan for Americas Energy Future*. American Energy Innovation Council.

**Agarwal A., and S. Narain (1991).** Global Warming in an Unequal World: A Case of Environmental Colonialism. Centre for Science and the Environment.

**Agyeman J., and B. Evans (2004).** "Just sustainability": the emerging discourse of environmental justice in Britain? *Geographical Journal* **170**, 155–164. (DOI: 10.1111/j.0016-7398.2004.00117.x). Available at: http://onlinelibrary.wiley.com/doi/10.1111/j.0016-7398.2004.00117.x/abstract.

**Ahuvia A.C., and D.C. Friedman (1998).** Income, Consumption, and Subjective Well-Being: Toward a Composite Macromarketing Model. *Journal of Macromarketing* **18**, 153 –168. (DOI: 10.1177/027614679801800207). Available at: http://jmk.sagepub.com/content/18/2/153.abstract.

**Aitken M. (2012).** Changing climate, changing democracy: a cautionary tale. *Environmental Politics* **21**, 211–229.

**Akimoto K., F. Sano, A. Hayashi, T. Homma, J. Oda, K. Wada, M. Nagashima, K. Tokushige, and T. Tomoda (2012).** Consistent assessments of pathways toward sustainable development and climate stabilization. *Natural Resources Forum*, n/a–n/a. (DOI: 10.1111/j.1477-8947.2012.01460.x). Available at: http://onlinelibrary.wiley.com/doi/10.1111/j.1477-8947.2012.01460.x/abstract.

**Akyuz Y. (2012).** *Key Issues in the Organisation of and Government Intervention in Finance to Developing Countries: Lessons from Recent Experiences, South Centre Policy Brief Number 14*. Available at: http://www.southcentre.org/index.php?option=com_content&view=article&id=1902%3Akey-issues-in-the-organization-of-and-government-intervention-in-finance-in-developing-countries-lessons-from-recent-experience&catid=142%3Aglobal-financial-and-economic-crisis&Itemid=67&lang=en.

**Alkire S. (2010).** *Human Development: Definitions, Critiques, and Related Concepts*. UNDP. Available at: http://ideas.repec.org/p/hdr/papers/hdrp-2010-01.html.

**Altieri M.A., and C.I. Nicholls (2013).** The adaptation and mitigation potential of traditional agriculture in a changing climate. 1 pp.

**Aminzadeh S.C. (2006).** Moral Imperative: The Human Rights Implications of Climate Change, A. *Hastings International and Comparative Law Review* **30**, 231. Available at: http://heinonline.org/HOL/Page?handle=hein.journals/hasint30&id=243&div=&collection=journals.

**Andreassen B.A., and S.P. Marks** (Eds.) **(2007).** *Development As a Human Right: Legal, Political, and Economic Dimensions*. FXB Center for Health and Human Rights, 350 pp., (ISBN: 0674021215).

**Anthoff D., C. Hepburn, and R.S.J. Tol (2009).** Equity weighting and the marginal damage costs of climate change. *Ecological Economics* **68**, 836–849. (DOI: 10.1016/j.ecolecon.2008.06.017). Available at: http://linkinghub.elsevier.com/retrieve/pii/S0921800908002991.

**Arbuckle Jr. J.G., L.W. Morton, and J. Hobbs (2013).** Farmer beliefs and concerns about climate change and attitudes toward adaptation and mitigation: Evidence from Iowa. *Climatic Change* **118**, 551–563. (DOI: 10.1007/s10584-013-0700-0).

**Armitage D., F. Berkes, A. Dale, E. Kocho-Schellenberg, and E. Patton (2011).** Co-management and the co-production of knowledge: Learning to adapt in Canada's Arctic. *Global Environmental Change* **21**, 995–1004. (DOI: 10.1016/j.gloenvcha.2011.04.006). Available at: http://www.sciencedirect.com/science/article/pii/S0959378011000665.

**Aronsson T., P.-O. Johansson, and K.-G. Löfgren (1997).** *Welfare measurement, sustainability, and green national accounting : a growth theoretical approach*. Edward Elgar Pub., Cheltenham UK ;Brookfield Vt. US, (ISBN: 9781858984858).

**Arrow K.J., P. Dasgupta, L.H. Goulder, K.J. Mumford, and K. Oleson (2010).** Sustainability and the measurement of wealth. NBER.

**Arrow K.J., William R. Cline, Karl-Goran Maler, Mohan Munasinghe, R. Squitieri, and Joseph E. Stiglitz (1996).** Intertemporal Equity, Discounting, and Economic Efficiency. In: *Climate Change 1995: Economic and Social Dimensions of Climate Change, Contribution of Working Group III to the Second Assessment Report of the Intergovernmental Panel on Climate Change*. James P. Bruce, Hoesung Lee, Erik F. Haites, (eds.), Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA pp.125–144, .Available at: http://www.ipcc.ch/ipccreports/sar/wg_III/ipcc_sar_wg_III_full_report.pdf.

**Arthur W.B. (1989).** Competing Technologies, Increasing Returns, and Lock-In by Historical Events. *The Economic Journal* **99**, 116–131. Available at: http://www.jstor.org/stable/2234208.

**Asheim G. (2007).** *Justifying, characterizing, and indicating sustainability*. Springer, Dordrecht, the Netherlands, (ISBN: 9781402061998).

**Asheim G.B., W. Buchholz, and B. Tungodden (2001).** Justifying Sustainability. *Journal of Environmental Economics and Management* **41**, 252–268. (DOI: 10.1006/jeem.2000.1137). Available at: http://www.sciencedirect.com/science/article/pii/S0095069600911379.

**Asheim G., T. Mitra, and B. Tungodden (2012).** Sustainable recursive social welfare functions. *Economic Theory* **49**, 267–292.

**Assadourian E. (2010).** Transforming Cultures: From Consumerism to Sustainability. *Journal of Macromarketing* **30**, 186 –191. (DOI: 10.1177/0276146710361932). Available at: http://jmk.sagepub.com/content/30/2/186.short.

**Atkinson A.B. (1970).** On the measurement of inequality. *Journal of Economic Theory* **2**, 244–263.

**Attfield R.** (Ed.) **(2008).** *The ethics of the environment*. Ashgate, Farnham, England ; Burlington, VT, 620 pp., (ISBN: 9780754627869).

**Ayres R.U., and E.H. Ayres (2009).** *Crossing the Energy Divide: Moving from Fossil Fuel Dependence to a Clean-Energy Future*. Pearson Prentice Hall, 254 pp., (ISBN: 9780137039012).

**Baer P. (2006).** Adaptation: Who Pays Whom? In: *Fairness in Adaptation to Climate Change*. W.N. Adger, (ed.), MIT Press, .

**Baer P. (2013).** Who should pay for climate change? "Not me." *Chicago Journal of International Law* **13**.

**Baer P., T. Athanasiou, S. Kartha, and E. Kemp-Benedict (2010).** Greenhouse Development Rights: A Framework for Climate Protection that is "More Fair" than Equal per Capita Emissions Rights. In: *Climate Ethics: Essential Readings*. S.M. Gardiner, S. Caney, D. Jamieson, H. Shue, (eds.), Oxford University Press, New York pp.215–230, (ISBN: 9780195399622). Available at: http://www.oup.com/us/catalog/general/subject/Philosophy/EthicsMoralPhilosophy/EnvironmentalEthics/?view=usa&sf=toc&ci=9780195399622.

**Baer P., S. Kartha, T. Athanasiou, and E. Kemp-Benedict (2009).** The Greenhouse Development Rights Framework: Drawing Attention to Inequality within Nations in the Global Climate Policy Debate. *Development and Change* **40**, 1121–1138. (DOI: 10.1111/j.1467-7660.2009.01614.x). Available at: http://onlinelibrary.wiley.com.ezproxy.library.tufts.edu/doi/10.1111/j.1467-7660.2009.01614.x/abstract.

**Bakam I., B.B. Balana, and R. Matthews (2012).** Cost-effectiveness analysis of policy instruments for greenhouse gas emission mitigation in the agricultural sector. *Journal of Environmental Management* **112**, 33–44. (DOI: 10.1016/j.jenvman.2012.07.001). Available at: http://www.sciencedirect.com/science/article/pii/S0301479712003611.

**Balsiger J., and B. Debarbieux (2011).** Major challenges in regional environmental governance research and practice. *Procedia - Social and Behavioral Sciences* **14**, 1–8. (DOI: 10.1016/j.sbspro.2011.03.010). Available at: http://www.sciencedirect.com/science/article/pii/S1877042811001807.

**Bamberg S., and G. Möser (2007).** Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behaviour. *Journal of Environmental Psychology* **27**, 14–25. (DOI: 10.1016/j.jenvp.2006.12.002). Available at: http://www.sciencedirect.com/science/article/pii/S0272494406000909.

**Banai A., M. Ronzoni, and C. Schemmel (2011).** *Social Justice, Global Dynamics. Theoretical and empirical perspectives*. Routledge, Oxon.

**Bankoff G., G. Frerks, and D. Hilhorst (2004).** *Mapping Vulnerability. Disastres, Development & People*. Earthscan, London, 236 pp., (ISBN: 1853839647).

**Banuri T. (2009).** Climate change and sustainable development. *Natural Resources Forum* **33**, 257–258. (DOI: 10.1111/j.1477-8947.2009.01270.x).

**Barbier E. (2011).** The policy challenges for green economy and sustainable economic development. *Natural Resources Forum* **35**, 233–245. (DOI: 10.1111/j.1477-8947.2011.01397.x). Available at: http://doi.wiley.com/10.1111/j.1477-8947.2011.01397.x.

**De Barcellos M.D., A. Krystallis, M.S. de Melo Saab, J.O. Kügler, and K.G. Grunert (2011).** Investigating the gap between citizens' sustainability attitudes and food purchasing behaviour: empirical evidence from Brazilian pork consumers. *International Journal of Consumer Studies* **35**, 391–402. (DOI: 10.1111/j.1470-6431.2010.00978.x). Available at: http://onlinelibrary.wiley.com.globalproxy.cvt.dk/doi/10.1111/j.1470-6431.2010.00978.x/abstract.

**Bark R.H., D.E. Garrick, C.J. Robinson, and S. Jackson (2012).** Adaptive basin governance and the prospects for meeting Indigenous water claims. *Environmental Science & Policy* **19–20**, 169–177. (DOI: 10.1016/j.envsci.2012.03.005). Available at: http://www.sciencedirect.com/science/article/pii/S1462901112000421.

**Barker T., and S. Serban Scrieciu (2010).** Modeling Low Climate Stabilization with E3MG: Towards a "New Economics" Approach to Simulating Energy-Environment-Economy System Dynamics. *The Energy Journal* **31**. (DOI: 10.5547/ISSN0195-6574-EJ-Vol31-NoSI-6). Available at: http://www.iaee.org/en/publications/ejarticle.aspx?id=2371.

**Barr S. (2006).** Environmental action in the home: Investigating the "value-action" gap. *Geography* **91**, 43–54. Available at: http://www.jstor.org.globalproxy.cvt.dk/discover/10.2307/40574132?uid=23002&uid=18273808&uid=3737880&uid=2134&uid=18273416&uid=2&uid=70&uid=3&uid=5910136&uid=67&uid=62&uid=22998&sid=21101457590453.

**Barrett S. (2005).** *Environment And Statecraft: The Strategy of Environmental Treaty-making*. Oxford University Press, 460 pp., (ISBN: 9780199286096).

**Barton J.R. (2013).** Climate Change Adaptive Capacity in Santiago de Chile: Creating a Governance Regime for Sustainability Planning.

**Baumgärtner S., and M.F. Quaas (2009).** Ecological-economic viability as a criterion of strong sustainability under uncertainty. *Ecological Economics* **68**, 2008–2020. (DOI: 10.1016/j.ecolecon.2009.01.016). Available at: http://linkinghub.elsevier.com/retrieve/pii/S0921800909000342.

**Baumol W.J. (2002).** *The Free Market Innovation Machine: Analyzing the Growth Miracle of Capitalism*. Princeton University Press, 348 pp., (ISBN: 9780691096155).

**Bazilian M., P. Nussbaumer, E. Haites, M.I. Levi, M. Howells, and K.K. Yumkella (2010).** Understanding the Scale of Investment for Universal Energy Access. *Geopolitics of Energy* **32**, 21–42.

**Bebbington A. (1999).** Capitals and capabilities: A framework for analyzing peasant viability, rural livelihoods and poverty. *World Development* **27**, 2021–2044. (DOI: 10.1016/S0305-750X(99)00104-7).

**Beg N., J.C. Morlot, O. Davidson, Y. Afrane-Okesse, L. Tyani, F. Denton, Y. Sokona, J.P. Thomas, E.L. La Rovere, J.K. Parikh, K. Parikh, and A. Atiq Rahman (2002).** Linkages between climate change and sustainable development. *Climate Policy* **2**, 129–144. (DOI: 10.1016/S1469-3062(02)00028-1). Available at: http://www.sciencedirect.com/science/article/pii/S1469306202000281.

**Bejan A. (2002).** Fundamentals of exergy analysis, entropy generation minimization, and the generation of flow architecture. *International Journal of Energy Research* **26**, 0–43. (DOI: 10.1002/er.804). Available at: http://onlinelibrary.wiley.com.globalproxy.cvt.dk/doi/10.1002/er.804/abstract.

**Bell R., S. Taylor, and M. Marmot (2010).** Global Health Governance: Commission on Social Determinants of Health and the Imperative for Change. *The Journal of Law, Medicine & Ethics* **38**, 470–485. (DOI: 10.1111/j.1748-720X.2010.00506.x). Available at: http://onlinelibrary.wiley.com.globalproxy.cvt.dk/doi/10.1111/j.1748-720X.2010.00506.x/abstract.

**Benvenisti E., and G.W. Downs (2007).** The Empire's New Clothes: Political Economy and the Fragmentation of International Law. *Stanford Law Review* **60**, 595–631. Available at: http://papers.ssrn.com/abstract=976930.

**Bergek A., S. Jacobsson, B. Carlsson, S. Lindmark, and A. Rickne (2008).** Analyzing the functional dynamics of technological innovation systems: A scheme of analysis. *Research Policy* **37**, 407–429. (DOI: 10.1016/j.respol.2007.12.003). Available at: http://www.sciencedirect.com/science/article/pii/S004873330700248X.

**Berkhout F. (2012).** Adaptation to climate change by organizations. *Wiley Interdisciplinary Reviews: Climate Change* **3**, 91–106. (DOI: 10.1002/wcc.154). Available at: http://doi.wiley.com/10.1002/wcc.154.

**Bhander G.S., M. Hauschild, and T. McAloone (2003).** Implementing life cycle assessment in product development. *Environmental Progress* **22**, 255–267. (DOI: 10.1002/ep.670220414). Available at: http://onlinelibrary.wiley.com.globalproxy.cvt.dk/doi/10.1002/ep.670220414/abstract.

**Biermann F. (2007).** "Earth system governance" as a crosscutting theme of global change research. *Global Environmental Change-Human and Policy Dimensions* **17**, 326–337. (DOI: 10.1016/j.gloenvcha.2006.11.010).

**Biermann F., K. Abbott, S. Andresen, K. Backstrand, S. Bernstein, M.M. Betsill, H. Bulkeley, B. Cashore, J. Clapp, C. Folke, A. Gupta, J. Gupta, P.M. Haas, A. Jordan, N. Kanie, T. Kluvankova-Oravska, L. Lebel, D. Liverman, J. Meadowcroft, R.B. Mitchell, P. Newell, S. Oberthur, L. Olsson, P. Pattberg, R. Sanchez-Rodriguez, H. Schroeder, A. Underdal, S. Camargo Vieira, C. Vogel, O.R. Young, A. Brock, and R. Zondervan (2012).** Navigating the Anthropocene: Improving Earth System Governance. *Science* **335**, 1306–1307. (DOI: 10.1126/science.1217255).

**Biermann F., M.M. Betsill, J. Gupta, N. Kanie, L. Lebel, D. Liverman, H. Schroeder, and B. Siebenhüner (2009).** *Earth System Governance: People, Places and the Planet. Science and Implementation Plan of the Earth System Governance Project. Earth System Governance Report 1*. International Human Dimensions Programme, Bonn.

**Biesbroek G.R., R.J. Swart, and W.G.M. van der Knaap (2009).** The mitigation–adaptation dichotomy and the role of spatial planning. *Habitat International* **33**, 230–237. (DOI: 10.1016/j.habitatint.2008.10.001). Available at: http://www.sciencedirect.com/science/article/pii/S019739750800060X.

**Bizikova L., J. Robinson, and S. Cohen (2007).** Linking climate change and sustainable development at the local level. *Climate Policy* **7**, 271–277.

**Bjorvatn K., M.R. Farzanegan, and F. Schneider (2012).** Resource Curse and Power Balance: Evidence from Oil-Rich Countries. *World Development* **40**, 1308–1316. (DOI: 10.1016/j.worlddev.2012.03.003).

**Black I. (2010).** Sustainability through anti-consumption. *Journal of Consumer Behaviour* **9**, 403–411. (DOI: 10.1002/cb.340). Available at: http://onlinelibrary.wiley.com.globalproxy.cvt.dk/doi/10.1002/cb.340/abstract.

**Blalock G., and P.J. Gertler (2009).** How firm capabilities affect who benefits from foreign technology. *Journal of Development Economics* **90**, 192–199. (DOI: 10.1016/j.jdeveco.2008.11.011). Available at: http://www.sciencedirect.com/science/article/pii/S0304387808001272.

**Le Blanc D. (2010).** Sustainable consumption and production: Policy efforts and challenges. *Natural Resources Forum* **34**, 1–3. (DOI: 10.1111/j.1477-8947.2010.01292.x). Available at: http://onlinelibrary.wiley.com/doi/10.1111/j.1477-8947.2010.01292.x/abstract.

**Bloom D.E. (2011).** Seven billion and counting. *Science* **333**, 562–569.

**Bloom D.E., and D. Canning (2000).** Public health - The health and wealth of nations. *Science* **287**, 1207–+. (DOI: 10.1126/science.287.5456.1207).

**Von Blottnitz H., and M.A. Curran (2007).** A review of assessments conducted on bio-ethanol as a transportation fuel from a net energy, greenhouse gas, and environmental life cycle perspective. *Journal of Cleaner Production* **15**, 607–619. (DOI: 10.1016/j.jclepro.2006.03.002). Available at: http://www.sciencedirect.com/science/article/pii/S0959652606001016.

**Bodansky D. (2010).** *Climate Change and Human Rights: Unpacking the Issues*. Social Science Research Network, Rochester, NY. Available at: http://papers.ssrn.com/abstract=1581555.

**Bode S. (2004).** Equal emissions per capita over time – a proposal to combine responsibility and equity of rights for post-2012 GHG emission entitlement allocation. *European Environment* **14**, 300–316. (DOI: 10.1002/eet.359). Available at: http://onlinelibrary.wiley.com/doi/10.1002/eet.359/abstract.

**Böhm S., M.C. Misoczky, and S. Moog (2012).** Greening Capitalism? A Marxist Critique of Carbon Markets. *Organization Studies* **33**, 1617–1638. (DOI: 10.1177/0170840612463326). Available at: http://oss.sagepub.com/content/33/11/1617.

**Bolwig S., and P. Gibbon (2010).** Counting Carbon in The Marketplace: Part 1 - Overview Paper. In: *Counting Carbon in the Market Place*. OECD, Paris. Available at: http://www.oecd.org/dataoecd/29/40/42886201.pdf.

**Bolwig S., P. Gibbon, and S. Jones (2009).** The Economics of Smallholder Organic Contract Farming in Tropical Africa. *World Development* **37**, 1094–1104. (DOI: 10.1016/j.worlddev.2008.09.012). Available at: http://www.sciencedirect.com/science/article/pii/S0305750X08003148.

**Bolwig S., S. Ponte, A. Du Toit, L. Riisgaard, and N. Halberg (2010).** Integrating Poverty and Environmental Concerns into Value-Chain Analysis: A Conceptual Framework. *Development Policy Review* **28**, 173–194. (DOI: 10.1111/j.1467-7679.2010.00480.x). Available at: http://onlinelibrary.wiley.com.globalproxy.cvt.dk/doi/10.1111/j.1467-7679.2010.00480.x/abstract.

**Bolwig S., L. Riisgaard, P. Gibbon, and S. Ponte (2013).** Challenges of Agro-Food Standards Conformity: Lessons from East Africa and Policy Implications. *European Journal of Development*

*Research* **25**, 408–427. (DOI: 10.1057/ejdr.2013.8). Available at: http://www.palgrave-journals.com/ejdr/journal/v25/n3/abs/ejdr20138a.html.

**Bongaarts J. (2009).** Human population growth and the demographic transition. *Philosophical Transactions of the Royal Society B-Biological Sciences* **364**, 2985–2990. (DOI: 10.1098/rstb.2009.0137).

**Bongaarts J., and S. Sinding (2011).** Population Policy in Transition in the Developing World. *Science* **333**, 574–576. (DOI: 10.1126/science.1207558).

**Bonvillian W.B., and C. Weiss (2009).** Stimulating Innovation in Energy Technology. *Issues in Science and Technology* **26**, 51–56.

**Botzen W.J.W., J.M. Gowdy, and J.C.J.M. van den Bergh (2008).** Cumulative CO2 emissions: shifting international responsibilities for climate debt. *Climate Policy* **8**, 569–576. (DOI: 10.3763/cpol.2008.0539).

**Bowen K.J., K. Ebi, and S. Friel (2013).** Climate change adaptation and mitigation: next steps for cross-sectoral action to protect global health. 1 pp.

**Bowen K.J., and S. Friel (2012).** Climate change adaptation: Where does global health fit in the agenda? *Globalization and Health* **8**, 10. (DOI: 10.1186/1744-8603-8-10). Available at: https://xpv.uab.cat/,DanaInfo=.aaqrvD1kiwouy09zttxwSw98+full_record.do?product=UA&search_mode=Refine&qid=13&SID=S2x4u3rKsOCbxxaPf7S&page=1&doc=3.

**Bowen K.J., S. Friel, K. Ebi, C.D. Butler, F. Miller, and A.J. McMichael (2011).** Governing for a Healthy Population: Towards an Understanding of How Decision-Making Will Determine Our Global Health in a Changing Climate. *International Journal of Environmental Research and Public Health* **9**, 55–72. (DOI: 10.3390/ijerph9010055). Available at: https://xpv.uab.cat/,DanaInfo=.aaqrvD1kiwouy09zttxwSw98+full_record.do?product=UA&search_mode=Refine&qid=13&SID=S2x4u3rKsOCbxxaPf7S&page=1&doc=7.

**Bows A., and J. Barrett (2010).** Cumulative emission scenarios using a consumption-based approach: a glimmer of hope? *Carbon Management* **1**, 161–175. (DOI: 10.4155/cmt.10.17). Available at: http://www.future-science.com/doi/abs/10.4155/cmt.10.17.

**Boyd E., N. Hultman, J.T. Roberts, E. Corbera, J. Cole, A. Bozmoski, J. Ebeling, R. Tippman, P. Mann, K. Brown, and D.M. Liverman (2009).** Reforming the CDM for sustainable development: lessons learned and policy futures. *Environmental Science & Policy* **12**, 820–831. (DOI: 10.1016/j.envsci.2009.06.007).

**Brenton P., G. Edwards-Jones, and M.F. Jensen (2009).** Carbon Labelling and Low-income Country Exports: A Review of the Development Issues. *Development Policy Review* **27**, 243–267. (DOI: 10.1111/j.1467-7679.2009.00445.x). Available at: http://onlinelibrary.wiley.com.globalproxy.cvt.dk/doi/10.1111/j.1467-7679.2009.00445.x/abstract.

**Bretschger L. (2005).** Economics of technological change and the natural environment: How effective are innovations as a remedy for resource scarcity? *Ecological Economics* **54**, 148–163. (DOI: 10.1016/j.ecolecon.2004.12.026).

**Bridger J.C., and A.E. Luloff (2001).** Building the Sustainable Community: Is Social Capital the Answer? *Sociological Inquiry* **71**, 458–472. (DOI: 10.1111/j.1475-682X.2001.tb01127.x). Available at:

http://onlinelibrary.wiley.com.ezproxy.library.tufts.edu/doi/10.1111/j.1475-682X.2001.tb01127.x/abstract.

**Brown K. (2009).** Human development and environmental governance: a reality check. In: *Governing Sustainability*. Cambridge University Press, Cambridge pp.32–52, (ISBN: 9780521732437).

**Brulle R.J., and L.E. Young (2007).** Advertising, Individual Consumption Levels, and the Natural Environment, 1900–2000. *Sociological Inquiry* **77**, 522–542. (DOI: 10.1111/j.1475-682X.2007.00208.x). Available at: http://onlinelibrary.wiley.com.globalproxy.cvt.dk/doi/10.1111/j.1475-682X.2007.00208.x/abstract.

**Brunner R., and A. Lynch (2010).** *Adaptive governance and climate change*. American Meteorological Society, Boston, Mass., xix, 404 pp., (ISBN: 9781878220974).

**Bryan E., C. Ringler, B. Okoba, J. Koo, M. Herrero, and S. Silvestri (2012).** Can agriculture support climate change adaptation, greenhouse gas mitigation and rural livelihoods? insights from Kenya. *Climatic Change* **118**, 151–165. (DOI: 10.1007/s10584-012-0640-0). Available at: https://xpv.uab.cat/,DanaInfo=.aaqrvD1kiwouy09zttxwSw98+full_record.do?product=UA&search_mode=GeneralSearch&qid=16&SID=S2x4u3rKsOCbxxaPf7S&page=1&doc=2.

**Bryan E., C. Ringler, B. Okoba, C. Roncoli, S. Silvestri, and M. Herrero (2013).** Adapting agriculture to climate change in Kenya: Household strategies and determinants. *Journal of Environmental Management* **114**, 26–35. (DOI: 10.1016/j.jenvman.2012.10.036).

**Buck S.J. (1998).** *The Global Commons: An Introduction*. Island Press, 244 pp., (ISBN: 9781559635516).

**Bumpus A.G., and D.M. Liverman (2008).** Accumulation by decarbonization and the governance of carbon offsets. *Economic Geography* **84**, 127–155.

**Burch S., and J. Robinson (2007).** A framework for explaining the links between capacity and action in response to global climate change. *Climate Policy* **7**, 304–316.

**Camfield L., and S.M. Skevington (2008).** On Subjective Well-being and Quality of Life. *Journal of Health Psychology* **13**, 764 –775. (DOI: 10.1177/1359105308093860). Available at: http://hpq.sagepub.com/content/13/6/764.abstract.

**Campbell E. (2011).** The agroecosystem role in climate change mitigation and adaptation. *Carbon Management* **2**, 501–503. (DOI: 10.4155/cmt.11.51).

**Caney S. (2005).** Cosmopolitan Justice, Responsibility, and Global Climate Change. *Leiden Journal of International Law* **18**, 747–775. Available at: http://search.proquest.com.ezproxy.library.tufts.edu/docview/219604455/abstract/137A36D074062596F0B/1?accountid=14434.

**Caney S. (2006).** Environmental Degradation, Reparations, and the Moral Significance of History. *Journal of Social Philosophy* **37**, 464–482. (DOI: 10.1111/j.1467-9833.2006.00348.x). Available at: http://onlinelibrary.wiley.com/doi/10.1111/j.1467-9833.2006.00348.x/abstract.

**Caney S. (2009).** Justice and the distribution of greenhouse gas emissions. *Journal of Global Ethics* **5**, 125–146. (DOI: 10.1080/17449620903110300). Available at: http://www.tandfonline.com/doi/abs/10.1080/17449620903110300.

**Caney S. (2010).** Climate change and the duties of the advantaged. *Critical Review of International Social and Political Philosophy* **13**, 203–228. (DOI: 10.1080/13698230903326331). Available at: http://www.tandfonline.com/doi/abs/10.1080/13698230903326331.

**Cannon T., and D. Müller-Mahn (2010).** Vulnerability, resilience and development discourses in context of climate change. *Natural Hazards* **55**, 621–635. (DOI: 10.1007/s11069-010-9499-4). Available at: http://link.springer.com/10.1007/s11069-010-9499-4.

**Cao J. (2008).** *Reconciling Human Development and Climate Protection: Perspectives from Developing Countries on Post-2012 International Climate Change Policy*. Belfer Center for Science and International Affairs, Kennedy School of Government, Harvard University, Cambridge, MA. Available at: http://belfercenter.ksg.harvard.edu/publication/18685/reconciling_human_development_and_climate_protection.html.

**Caole A.J., and E.M. Hoover (1958).** *Population Growth and Economic Development in Low Income Countries*. Princeton University Press, Princeton.

**Cass D. (1965).** Optimum Growth in an Aggregative Model of Capital Accumulation. *The Review of Economic Studies* **32**, 233–240. (DOI: 10.2307/2295827). Available at: http://restud.oxfordjournals.org/content/32/3/233.

**CASS/DRC Joint Project Team (2011).** Equitable access to sustainable development: Carbon budget account proposal. In: *Equitable access to sustainable development: Contribution to the body of scientific knowledge*. BASIC expert group, Beijing, Brasilia, Cape Town and Mumbai pp.35–58, .Available at: http://www.erc.uct.ac.za/Basic_Experts_Paper.pdf.

**Chai A., and A. Moneta (2012).** Back to Engel? Some evidence for the hierarchy of needs. *Journal of Evolutionary Economics* **22**, 649–676. (DOI: 10.1007/s00191-012-0283-3). Available at: http://link.springer.com.globalproxy.cvt.dk/article/10.1007/s00191-012-0283-3.

**Chakravarty S., A. Chikkatur, H. de Coninck, S. Pacala, R. Socolow, and M. Tavoni (2009).** Sharing global CO2 emission reductions among one billion high emitters. *Proceedings of the National Academy of Sciences* **106**, 11884–11888. (DOI: 10.1073/pnas.0905232106). Available at: http://www.pnas.org/cgi/doi/10.1073/pnas.0905232106.

**Chapin F.S., S.R. Carpenter, G.P. Kofinas, C. Folke, N. Abel, W.C. Clark, P. Olsson, D.M.S. Smith, B. Walker, O.R. Young, F. Berkes, R. Biggs, J.M. Grove, R.L. Naylor, E. Pinkerton, W. Steffen, and F.J. Swanson (2010).** Ecosystem stewardship: sustainability strategies for a rapidly changing planet. *Trends in Ecology & Evolution* **25**, 241–249. (DOI: 10.1016/j.tree.2009.10.008). Available at: http://www.sciencedirect.com/science/article/pii/S0169534709003255.

**Chertow M.R. (2007).** “Uncovering” Industrial Symbiosis. *Journal of Industrial Ecology* **11**, 11–30. (DOI: 10.1162/jiec.2007.1110). Available at: http://onlinelibrary.wiley.com.globalproxy.cvt.dk/doi/10.1162/jiec.2007.1110/abstract.

**Chertow M.R., and D.R. Lombardi (2005).** Quantifying Economic and Environmental Benefits of Co-Located Firms. *Environmental Science and Technology* **39**, 6535–6541.

**Cherubini F., N.D. Bird, A. Cowie, G. Jungmeier, B. Schlamadinger, and S. Woess-Gallasch (2009).** Energy- and greenhouse gas-based LCA of biofuel and bioenergy systems: Key issues, ranges and recommendations. *Resources, Conservation and Recycling* **53**, 434–447. (DOI:

10.1016/j.resconrec.2009.03.013). Available at: http://www.sciencedirect.com/science/article/pii/S0921344909000500.

**Chotray V., and G. Stoker (2009).** *Governance theory and practice: A cross-disciplinary approach*. Palgrave Macmillan, London.

**Clark D.A. (2009).** Capability Approach. In: *The Elgar Companion to Development Studies*. Edward Elgar, pp.32–44, (ISBN: 9781843764755).

**Clark W.C., and N.M. Dickson (2003).** Sustainability science: The emerging research program. *Proceedings of the National Academy of Sciences* **100**, 8059–8061. (DOI: 10.1073/pnas.1231333100). Available at: http://www.pnas.org/cgi/doi/10.1073/pnas.1231333100.

**Clark A.E., P. Frijters, and M.A. Shields (2008).** Relative income, happiness, and utility: An explanation for the Easterlin paradox and other puzzles. *Journal of Economic Literature* **46**, 95–144.

**Cleveland M., and M. Laroche (2007).** Acculturaton to the global consumer culture: Scale development and research paradigm. *Journal of Business Research* **60**, 249–259. (DOI: 10.1016/j.jbusres.2006.11.006). Available at: http://www.sciencedirect.com/science/article/pii/S0148296306001949.

**Cline W.R. (1992).** *The Economics of Global Warming*. Institute for International Economics, Washington, D.C.

**Clò S. (2010).** Grandfathering, auctioning and Carbon Leakage: Assessing the inconsistencies of the new ETS Directive. *Energy Policy* **38**, 2420–2430. (DOI: 10.1016/j.enpol.2009.12.035). Available at: http://www.sciencedirect.com/science/article/pii/S0301421509009914.

**Coase R.H. (1960).** The problem of social cost. *Journal of Law and Economics* **3**, 1–44. Available at: http://onlinelibrary.wiley.com/doi/10.1002/9780470752135.ch1/summary.

**Colfer C.J.P. (2011).** Marginalized Forest Peoples' Perceptions of the Legitimacy of Governance: An Exploration. *World Development* **39**, 2147–2164. (DOI: 10.1016/j.worlddev.2011.04.012). Available at: http://www.sciencedirect.com/science/article/pii/S0305750X11000829.

**Collier P., and B. Goderis (2012).** Commodity prices and growth: An empirical investigation. *European Economic Review* **56**, 1241–1260. (DOI: 10.1016/j.euroecorev.2012.04.002). Available at: http://www.sciencedirect.com/science/article/pii/S0014292112000505.

**Colombo M.G., and L. Grilli (2005).** Founders' human capital and the growth of new technology-based firms: A competence-based view. *Research Policy* **34**, 795–816. (DOI: 10.1016/j.respol.2005.03.010). Available at: http://www.sciencedirect.com/science/article/pii/S0048733305000776.

**Conway E.M., and N. Oreskes (2011).** *Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming*. Bloomsbury, 457 pp., (ISBN: 9781408828779).

**Corbera E. (2012).** Problematizing REDD+ as an experiment in payments for ecosystem services. *Current Opinion in Environmental Sustainability* **4**, 612–619. (DOI: 10.1016/j.cosust.2012.09.010). Available at: http://www.sciencedirect.com/science/article/pii/S1877343512001170.

**Corbera E., and H. Schroeder (2011).** Governing and implementing REDD+. *Environmental Science & Policy* **14**, 89–99. (DOI: 10.1016/j.envsci.2010.11.002).

**Corner A., D. Venables, A. Spence, W. Poortinga, C. Demski, and N. Pidgeon (2011).** Nuclear power, climate change and energy security: Exploring British public attitudes. *Energy Policy* **39**, 4823–4833. (DOI: 10.1016/j.enpol.2011.06.037).

**Correa C. (2011).** *The Role of Intellectual Property Rights in Global Economic Governance*. Initiative for Policy Dialogue Working Paper Series, Columbia University and UNDP.

**Corsten M., E. Worrell, M. Rouw, and A. van Duin (2013).** The potential contribution of sustainable waste management to energy use and greenhouse gas emission reduction in the Netherlands. *Resources, Conservation and Recycling* **77**, 13–21. (DOI: 10.1016/j.resconrec.2013.04.002). Available at: http://www.sciencedirect.com/science/article/pii/S0921344913000888.

**Cranston G.R., G.P. Hammond, and R.C. Johnson (2010).** Ecological Debt: Exploring the Factors that Affect National Footprints. *Journal of Environmental Policy & Planning* **12**, 121–140. (DOI: 10.1080/15239081003719193). Available at: http://www.tandfonline.com/doi/abs/10.1080/15239081003719193.

**Creyts J.C., and V.P. Carey (1999).** Use of extended exergy analysis to evaluate the environmental performance of machining processes. *Proceedings of the Institution of Mechanical Engineers, Part E: Journal of Process Mechanical Engineering* **213**, 247–264. (DOI: 10.1243/0954408991529861). Available at: http://pie.sagepub.com/content/213/4/247.

**Crutzen P.J. (2006).** Albedo enhancement by stratospheric sulfur injections: A contribution to resolve a policy dilemma? *Climatic Change* **77**, 211–219. (DOI: 10.1007/s10584-006-9101-y).

**Csutora M. (2012).** One More Awareness Gap? The Behaviour–Impact Gap Problem. *Journal of Consumer Policy* **35**, 145–163. (DOI: 10.1007/s10603-012-9187-8). Available at: http://www.springerlink.com.globalproxy.cvt.dk/content/r241112640w6m231/abstract/.

**Daly H.E. (1996).** *Beyond growth : the economics of sustainable environment*. Beacon Press, Boston, Mass., (ISBN: 0807047090 9780807047095 0807047082 9780807047088).

**Dasgupta P. (1993).** *An Inquiry into Well-being and Destitution*. Oxford University Press, Oxford.

**Dasgupta P., and K.-G. Mäler (2000).** Net national product, wealth, and social well-being. *Environment and Development Economics* **5**, 69–93. Available at: http://www.esaim-m2an.org/action/displayAbstract?fromPage=online&aid=49643&fulltextType=RA&fileId=S1355770X00000061.

**Davis S.J., and K. Caldeira (2010).** Consumption-based accounting of CO2 emissions. *Proceedings of the National Academy of Sciences* **107**, 5687–5692.

**Deacon R. (2011).** The Political Economy of the Natural Resources Curse: A Survey of Theory and Evidence. *Foundations and Trends® in Microeconomics* **7**, 111–208. (DOI: 10.1561/0700000042). Available at: http://www.nowpublishers.com/product.aspx?product=MIC&doi=0700000042.

**Deaton A.S. (2008).** Income, Health, and Well-Being around the World: Evidence from the Gallup World Poll. *Journal of Economic Perspectives* **22**, 53–72.

**DeCanio S.J., and A. Fremstad (2010).** *Game Theory and Climate Diplomacy*. E3 Network. Available at: http://www.e3network.org/papers/Basic_Game_Anlaysis.pdf.

**Dechezleprêtre A., M. Glachant, and Y. Ménière (2009).** Technology transfer by CDM projects: A comparison of Brazil, China, India and Mexico. *Energy Policy* **37**, 703–711. (DOI: 10.1016/j.enpol.2008.10.007). Available at: http://www.sciencedirect.com/science/article/pii/S0301421508005727.

**Dellink R., M. den Elzen, H. Aiking, E. Bergsma, F. Berkhout, T. Dekker, and J. Gupta (2009).** Sharing the burden of financing adaptation to climate change. *Global Environmental Change* **19**, 411–421. (DOI: 10.1016/j.gloenvcha.2009.07.009). Available at: http://www.sciencedirect.com/science/article/pii/S095937800900065X.

**Delmas M.A., and N. Nairn-Birch (2011).** Is the tail wagging the dog? An empirical analysis of corporate carbon footprints and financial performance. Institute of the Environment and Sustainability, University of California. Available at: http://escholarship.org/uc/item/3k89n5b7.

**Denton F., and T. Wilbanks (2012).** Climate-Resilient Pathways: Adaptation, Mitigation, and Sustainable Development. IPCC WGII AR5 Chapter 20.

**Diaz H.L., R.D. Drumm, J. Ramirez-Johnson, and H. Oidjarv (2002).** Social capital, economic development and food security in Peru's mountain region. *International Social Work* **45**, 481–+.

**Diaz-Maurin F., and M. Giampietro (2013).** A "Grammar" for assessing the performance of power-supply systems: Comparing nuclear energy to fossil energy. *Energy* **49**, 162–177. (DOI: 10.1016/j.energy.2012.11.014). Available at: http://icta.uab.es/divulgacion/articulos.jsp?id=1305&id_idioma=2.

**Dietz S., and E. Neumayer (2007).** Weak and strong sustainability in the SEEA: Concepts and measurement. *Ecological Economics* **61**, 617–626. (DOI: 10.1016/j.ecolecon.2006.09.007). Available at: http://linkinghub.elsevier.com/retrieve/pii/S092180090600454X.

**Dietzenbacher E., and K. Mukhopadhyay (2007).** An Empirical Examination of the Pollution Haven Hypothesis for India: Towards a Green Leontief Paradox? *Environmental and Resource Economics* **36**, 427–449. (DOI: 10.1007/s10640-006-9036-9). Available at: http://link.springer.com.globalproxy.cvt.dk/article/10.1007/s10640-006-9036-9.

**Dingwerth K., and P. Pattberg (2009).** World Politics and Organizational Fields: The Case of Transnational Sustainability Governance. *European Journal of International Relations* **15**, 707–743. (DOI: 10.1177/1354066109345056).

**Dinica V. (2009).** Biomass power: Exploring the diffusion challenges in Spain. *Renewable and Sustainable Energy Reviews* **13**, 1551–1559. (DOI: 10.1016/j.rser.2008.10.002). Available at: http://www.sciencedirect.com/science/article/pii/S1364032108001706.

**Dixit A.K., and J.E. Stiglitz (1977).** Monopolistic Competition and Optimum Product Diversity. *The American Economic Review* **67**, 297–308. Available at: http://www.jstor.org/stable/1831401.

**Dobson A. (1991).** *The Green reader: essays toward a sustainable society*. Mercury House, San Francisco, 280 pp., (ISBN: 1562790102).

**Dobson A. (2007).** Environmental citizenship: towards sustainable development. *Sustainable Development* **15**, 276–285. (DOI: 10.1002/sd.344). Available at: http://doi.wiley.com/10.1002/sd.344.

**Doh S., and C.L. McNeely (2012).** A multi-dimensional perspective on social capital and economic development: an exploratory analysis. *Annals of Regional Science* **49**, 821–843. (DOI: 10.1007/s00168-011-0449-1).

**Dore R. (2008).** Financialization of the global economy. *Industrial and Corporate Change* **17**, 1097–1112. (DOI: 10.1093/icc/dtn041). Available at: http://icc.oxfordjournals.org/content/17/6/1097.

**Dosi G. (1982).** Technological paradigms and technological trajectories: A suggested interpretation of the determinants and directions of technical change. *Research Policy* **11**, 147–162. (DOI: 10.1016/0048-7333(82)90016-6). Available at: http://www.sciencedirect.com/science/article/pii/0048733382900166.

**Dosi G., and R.R. Nelson (1994).** An introduction to evolutionary theories in economics. *Journal of Evolutionary Economics* **4**, 153–172. (DOI: 10.1007/BF01236366). Available at: http://www.springerlink.com.gate3.inist.fr/content/u234h48k3q800813/.

**Dreyer L., M. Hauschild, and J. Schierbeck (2010).** Characterisation of social impacts in LCA. *The International Journal of Life Cycle Assessment* **15**, 247–259. (DOI: 10.1007/s11367-009-0148-7). Available at: http://www.springerlink.com.globalproxy.cvt.dk/content/v605u06666453772/abstract/.

**Druckman A., and T. Jackson (2009).** The carbon footprint of UK households 1990–2004: A socio-economically disaggregated, quasi-multi-regional input–output model. *Ecological Economics* **68**, 2066–2077. (DOI: 10.1016/j.ecolecon.2009.01.013). Available at: http://www.sciencedirect.com/science/article/pii/S0921800909000366.

**Druckman A., and T. Jackson (2010).** The bare necessities: How much household carbon do we really need? *Ecological Economics* **69**, 1794–1804. (DOI: 10.1016/j.ecolecon.2010.04.018). Available at: http://www.sciencedirect.com/science/article/pii/S0921800910001618.

**Dryzek J.S., R.B. Norgaard, and D. Schlosberg (2011).** *The Oxford Handbook of Climate Change and Society*. Oxford University Press, 743 pp., (ISBN: 9780199566600).

**Duflo E. (2001).** Schooling and labour market consequences of school construction in Indonesia. *American Economic Review* **91**, 795–813.

**Duflou J.R., K. Kellens, T. Devoldere, W. Deprez, and Wim Dewulf (2010).** Energy related environmental impact reduction opportunities in machine design: case study of a laser cutting machine. *International Journal of Sustainable Manufacturing* **2**, 80–98. (DOI: 10.1504/IJSM.2010.031621). Available at: http://dx.doi.org/10.1504/IJSM.2010.031621.

**Duflou J.R., J.W. Sutherland, D. Dornfeld, C. Herrmann, J. Jeswiet, S. Kara, M. Hauschild, and K. Kellens (2012).** Towards energy and resource efficient manufacturing: A processes and systems approach. *CIRP Annals - Manufacturing Technology* **61**, 587–609. (DOI: 10.1016/j.cirp.2012.05.002). Available at: http://www.sciencedirect.com/science/article/pii/S0007850612002016.

**Dunning J.H. (1981).** Explaining the international position of countries towards a dynamic or developmental approach. *Weltwirtshaftliches Archiv*, 30–64.

**Dusyk N., T. Berkhout, S. Burch, S. Coleman, and J. Robinson (2009).** Transformative energy efficiency and conservation: a sustainable development path approach in British Columbia, Canada. *Energy Efficiency* **2**, 387–400. (DOI: 10.1007/s12053-009-9048-8). Available at: http://www.springerlink.com.gate3.inist.fr/content/q33487333r52608g/.

**Dyson T. (2006).** Population and Development. In: *The Elgar Companion to Development Studies*. Edward Elgar, Cheltenham pp.436–441, (ISBN: 978 1 84376475 5).

**Easterlin R.A. (1973).** Does Money Buy Happiness? *The Public Interest* **30**, 3–10.

**Easterlin R.A. (1995).** Will raising the incomes of all increase the happiness of all? *Journal of Economic Behavior & Organization* **27**, 35–47. (DOI: 10.1016/0167-2681(95)00003-B). Available at: http://www.sciencedirect.com/science/article/pii/016726819500003B.

**Easterlin R.A., L.A. McVey, M. Switek, O. Sawangfa, and J.S. Zweig (2010).** The happiness-income paradox revisited. *Proceedings of the National Academy of Sciences* **107**, 22463–22468. (DOI: 10.1073/pnas.1015962107). Available at: http://www.pnas.org/cgi/doi/10.1073/pnas.1015962107.

**Easterly W. (2002).** *The Elusive Quest for Growth: Economists' Adventures and Misadventures in the Tropics*. The MIT Press. Available at: http://ideas.repec.org/b/mtp/titles/0262550423.html.

**Easterly W. (2009).** How the Millennium Development Goals are Unfair to Africa. *World Development* **37**, 26–35. (DOI: 10.1016/j.worlddev.2008.02.009). Available at: http://www.sciencedirect.com/science/article/pii/S0305750X08001022.

**Eckersley R. (2004).** *The Green State. Rethinking Democracy and Sovereignty*. MIT Press, Masschussets.

**Eckersley R. (2012).** Moving Forward in the Climate Negotiations: Multilateralism or Minilateralism? *Global Environmental Politics* **12**, 24–42. (DOI: 10.1162/GLEP_a_00107). Available at: http://dx.doi.org/10.1162/GLEP_a_00107.

**Edwards-Jones G., K. Plassmann, E.H. York, B. Hounsome, D.L. Jones, and L. Milà i Canals (2009).** Vulnerability of exporting nations to the development of a carbon label in the United Kingdom. *Environmental Science & Policy* **12**, 479–490. (DOI: 10.1016/j.envsci.2008.10.005). Available at: http://www.sciencedirect.com/science/article/pii/S1462901108001184.

**EGTT (2008).** *UNFCCC Guidebook on Preparing Technology Transfer Projects for Financing*. Expert Group on Technology Transfer, United Nations Framework Convention on Climate Change, Bonn. Available at: http://unfccc.int/ttclear/jsp/Guidebook.jsp.

**Ehrlich P.R., and J. Holdren (1971).** Impact of population growth. *Science* **171**, 1212–1217.

**Ehrlich P.R., P.M. Kareiva, and G.C. Daily (2012).** Securing natural capital and expanding equity to rescale civilization. *Nature* **486**, 68–73. (DOI: 10.1038/nature11157).

**Elkington J. (1998).** *Cannibals with forks : the triple bottom line of 21st century business*. New Society Publishers, Gabriola Island, BC; Stony Creek, CT, (ISBN: 0865713928 9780865713925).

**Den Elzen M.G.J., J. Fuglestvedt, N. Höhne, C. Trudinger, J. Lowe, B. Matthews, B. Romstad, C.P. de Campos, and N. Andronova (2005).** Analysing countries' contribution to climate change: scientific and policy-related choices. *Environmental Science & Policy* **8**, 614–636. (DOI:

10.1016/j.envsci.2005.06.007). Available at: http://www.sciencedirect.com/science/article/pii/S1462901105001103.

**Epstein G.A. (2005).** *Financialization and the World Economy*. Edward Elgar Publishing, 472 pp., (ISBN: 9781781008263).

**Erickson P., A. Owen, and E. Dawkins (2012).** Low-Greenhouse-Gas Consumption Strategies and Impacts on Developing Countries. *Stockholm Environment Institute Working Papers* **2012-01**. Available at: http://www.sei-international.org/publications?pid=2082.

**Etienne C., and A. Asamoa-Baah (2010).** *WHO The world health report - health systems financing: the path to universal coverage.* Available at: http://www.cabdirect.org/abstracts/20113115509.html;jsessionid=A44C51F9AD7E7857E3633E1481 27D338.

**Fankhauser S., R.S.J. Tol, and D.W. Pearce (1997).** The aggregation of climate change damages: a welfare theoretic approach. *Environmental and Resource Economics* **10**, 249–266.

**FAO (2012).** *The State of Food Insecurity in the World 2012*. Food and Agriculture Organisation, Rome, Italy.

**Farmer R., C. Nourry, and A. Venditti (2012).** *The Inefficient Markets Hypothesis: Why Financial Markets Do Not Work Well in the Real World*. NBER.

**Farrell J., and P. Klemperer (2007).** Chapter 31 Coordination and Lock-In: Competition with Switching Costs and Network Effects. In: *Handbook of Industrial Organization*. Elsevier, pp.1967–2072, (ISBN: 1573-448X). Available at: http://www.sciencedirect.com/science/article/pii/S1573448X06030317.

**Fermann G. (1994).** Climate Change, Burden-sharing Criteria, and Competing Conceptions of Responsibility. *International Challenges* **13**, 28–34.

**Finkbeiner M. (2009).** Carbon footprinting—opportunities and threats. *The International Journal of Life Cycle Assessment* **14**, 91–94. (DOI: 10.1007/s11367-009-0064-x). Available at: http://www.springerlink.com.globalproxy.cvt.dk/content/5106170g43854187/.

**Finnveden G., M.Z. Hauschild, T. Ekvall, J. Guinée, R. Heijungs, S. Hellweg, A. Koehler, D. Pennington, and S. Suh (2009).** Recent developments in Life Cycle Assessment. *Journal of Environmental Management* **91**, 1–21. (DOI: 10.1016/j.jenvman.2009.06.018). Available at: http://www.sciencedirect.com/science/article/pii/S0301479709002345.

**Fischer J., R. Dyball, I. Fazey, C. Gross, S. Dovers, P.R. Ehrlich, R.J. Brulle, C. Christensen, and R.J. Borden (2012).** Human behavior and sustainability. *Frontiers in Ecology and the Environment* **10**, 153–160. (DOI: 10.1890/110079).

**Fischer J., A.D. Manning, W. Steffen, D.B. Rose, K. Daniell, A. Felton, S. Garnett, B. Gilna, R. Heinsohn, D.B. Lindenmayer, B. MacDonald, F. Mills, B. Newell, J. Reid, L. Robin, K. Sherren, and A. Wade (2007).** Mind the sustainability gap. *Trends in Ecology & Evolution* **22**, 621–624. (DOI: 10.1016/j.tree.2007.08.016). Available at: http://linkinghub.elsevier.com/retrieve/pii/S0169534707002820.

**Fleurbaey M. (2009).** Beyond GDP: The quest for a measure of social welfare. *Journal of Economic Literature* **47**, 1029–1075.

**Fleurbaey M., and D. Blanchet (2013).** *Beyond GDP: measuring welfare and assessing sustainability*. Oxford University Press, Oxford ; New York, (ISBN: 9780199767199).

**Flint R.W., and M.J.E. Danner (2001).** The nexus of sustainability & social equity: Virginia's Eastern Shore as a local example of global issues. *International Journal of Economic Development*. Available at: http://findarticles.com/p/articles/mi_qa5479/is_2_3/ai_n28892986/?tag=content;col1.

**Folke C. (2007).** Social–ecological systems and adaptive governance of the commons. *Ecological Research* **22**, 14–15. (DOI: 10.1007/s11284-006-0074-0). Available at: http://link.springer.com/article/10.1007/s11284-006-0074-0.

**Folke C., S.R. Carpenter, B. Walker, M. Scheffer, F.S. Chapin, and J. Rockström (2010).** Resilience thinking: integrating resilience, adaptability and transformability. *Ecology and Society* **15**, 20. Available at: https://www.ivey.uwo.ca:444/cmsmedia/222506/Resilience_thinking_IntegratingResilience__Adaptability_and_Transformability.pdf.

**Folke C., T. Hahn, P. Olsson, and J. Norberg (2005).** ADAPTIVE GOVERNANCE OF SOCIAL-ECOLOGICAL SYSTEMS. *Annual Review of Environment and Resources* **30**, 441–473. (DOI: 10.1146/annurev.energy.30.050504.144511). Available at: http://www.annualreviews.org/doi/abs/10.1146/annurev.energy.30.050504.144511.

**Folke C., A. Jansson, J. Rockstrom, P. Olsson, S.R. Carpenter, F.S. Chapin, A.-S. Crepin, G. Daily, K. Danell, J. Ebbesson, T. Elmqvist, V. Galaz, F. Moberg, M. Nilsson, H. Osterblom, E. Ostrom, A. Persson, G. Peterson, S. Polasky, W. Steffen, B. Walker, and F. Westley (2011a).** Reconnecting to the Biosphere. *Ambio* **40**, 719–738. (DOI: 10.1007/s13280-011-0184-y).

**Folke C., Å. Jansson, J. Rockström, P. Olsson, S.R. Carpenter, F. Stuart Chapin, A.-S. Crépin, G. Daily, K. Danell, J. Ebbesson, T. Elmqvist, V. Galaz, F. Moberg, M. Nilsson, H. Österblom, E. Ostrom, Å. Persson, G. Peterson, S. Polasky, W. Steffen, B. Walker, and F. Westley (2011b).** Reconnecting to the Biosphere. *AMBIO: A Journal of the Human Environment* **40**, 719–738. (DOI: 10.1007/s13280-011-0184-y).

**Da Fonseca I.F., M. Bursztyn, and B.S. Allen (2012).** Trivializing sustainability: Environmental governance and rhetorical free-riders in the Brazilian Amazon. *Natural Resources Forum* **36**, 28–37. (DOI: 10.1111/j.1477-8947.2012.01441.x). Available at: http://onlinelibrary.wiley.com/doi/10.1111/j.1477-8947.2012.01441.x/abstract.

**Foray D. (1997).** The dynamic implications of increasing returns: Technological change and path dependent inefficiency. *International Journal of Industrial Organization* **15**, 733–752. (DOI: 10.1016/S0167-7187(97)00009-X). Available at: http://www.sciencedirect.com/science/article/pii/S016771879700009X.

**Fouquet R. (2010).** The slow search for solutions: Lessons from historical energy transitions by sector and service. *Energy Policy* **38**, 6586–6596. (DOI: 10.1016/j.enpol.2010.06.029). Available at: http://www.sciencedirect.com/science/article/pii/S0301421510004921.

**Frantz C.M., and F.S. Mayer (2009).** The Emergency of Climate Change: Why Are We Failing to Take Action? *Analyses of Social Issues and Public Policy* **9**, 205–222. (DOI: 10.1111/j.1530-2415.2009.01180.x). Available at: http://onlinelibrary.wiley.com.globalproxy.cvt.dk/doi/10.1111/j.1530-2415.2009.01180.x/abstract.

**Fu, Jiafeng, Zhuang, Guiyang, and Gao, Qingxian (2010).** Clarification on the concept of “low-carbon economy” and construction of evaluation indicator system. *China Population, Resources and Environment* **20**.

**Fujita M., P. Krugman, and A.J. Venables (1999).** *The Spatial Economy*. MIT Press, Cambridge, Mass.

**Fukuyama F. (2002).** Social Capital and Development: The Coming Agenda. *The SAIS Review of International Affairs* **22**, 23–37.

**Gadgil M., F. Berkes, and C. Folke (1993).** Indigenous Knowledge for Biodiversity Conservation. *AMBIO: A Journal of the Human Environment* **22**, 151–156.

**GAIA (2012).** *On the road to zero waste: Successes and lessons from around the World*. GAIA - Global Alliance for Incinerator Alternatives, Quezon City, Phillipines. 88 pp. Available at: www.no-burn.org.

**Gallopín G.C. (2006).** Linkages between vulnerability, resilience, and adaptive capacity. *Global Environmental Change* **16**, 293–303. (DOI: 10.1016/j.gloenvcha.2006.02.004). Available at: http://linkinghub.elsevier.com/retrieve/pii/S0959378006000409.

**Gallup Organisation (2008a).** *Public opinion in the European union*. European Commission, Brussels.

**Gallup Organisation (2008b).** *Attitudes of European citizens towards the environment*. European Commission, Brussels. Available at: http://ec.europa.eu/public_opinion/archives/ebs/ebs_295_en.pdf.

**Gamarnikow E., and A. Green (1999).** Social Capital and the Educated Citizen. *The School Field* **10**, 103–126.

**Gardiner S.M. (2011a).** Climate Justice. In: *Climate Change and Society*. J.S. Dryzek, R.B. Norgaard, D. Schlosberg, (eds.), Oxford University Press, pp.309–322, .

**Gardiner S.M. (2011b).** *A Perfect Moral Storm: The Ethical Tragedy of Climate Change*. Oxford University Press, 509 pp., (ISBN: 9780195379440).

**Gatersleben B., E. White, W. Abrahamse, T. Jackson, and D. Uzzell (2010).** Values and sustainable lifestyles. *Architectural Science Review* **53**, 37–50. (DOI: 10.3763/asre.2009.0101). Available at: http://www.tandfonline.com/doi/abs/10.3763/asre.2009.0101.

**GEA (2012).** *Global Energy Assessment - Toward a Sustainable Future*. Cambridge University Press, Cambridge, UK and New York, NY, USA and the International Institute for Applied Systems Analysis, Laxenburg, Austria, (ISBN: 9781 10700 5198 hardback 9780 52118 2935 paperback). Available at: www.globalenergyassessment.org.

**Geels F. (2002).** Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Research Policy* **31**, 1257–1274. (DOI: 10.1016/S0048-7333(02)00062-8).

**Geels F.W. (2006).** The hygienic transition from cesspools to sewer systems (1840–1930): The dynamics of regime transformation. *Research Policy* **35**, 1069–1082. (DOI: 10.1016/j.respol.2006.06.001). Available at: http://www.sciencedirect.com/science/article/pii/S0048733306001168.

**Geels F.W., and J. Schot (2007).** Typology of sociotechnical transition pathways. *Research Policy* **36**, 399–417. (DOI: 10.1016/j.respol.2007.01.003). Available at: http://www.sciencedirect.com/science/article/pii/S0048733307000248.

**German Advisory Council on Global Change (2009).** *Solving the climate dilemma: The budget approach special report* (C. Hay and T. Cullen, Trans.). WBGU, Berlin, Germany. Available at: http://www.wbgu.de/en/special-reports/sr-2009-budget-approach/.

**Gibbon P., S. Ponte, and E. Lazaro** (Eds.) **(2010).** *Global agro-food trade and standards*. Palgrave Macmillan, London.

**Giddens A. (2009).** *The Politics of Climate Change*. Polity Press, Cambridge.

**Giddings B., B. Hopwood, and G. O'Brien (2002).** Environment, economy and society: fitting them together into sustainable development. *Sustainable Development* **10**, 187–196. (DOI: 10.1002/sd.199). Available at: http://onlinelibrary.wiley.com/doi/10.1002/sd.199/abstract.

**Gimmon E., and J. Levie (2010).** Founder's human capital, external investment, and the survival of new high-technology ventures. *Research Policy* **39**, 1214–1226. (DOI: 10.1016/j.respol.2010.05.017). Available at: http://www.sciencedirect.com/science/article/pii/S0048733310001411.

**Gladwin T.N., J.J. Kennelly, and T.-S. Ause (1995).** Shifting paradigms for sustainable development: Implications for management theory and research. *Academy of Management Review* **20**, 874–907.

**Goeminne G., and E. Paredis (2010).** The concept of ecological debt: some steps towards an enriched sustainability paradigm. *Environment, Development and Sustainability* **12**, 691–712. (DOI: 10.1007/s10668-009-9219-y). Available at: http://link.springer.com/article/10.1007/s10668-009-9219-y.

**Goerner S.J., B. Lietaer, and R.E. Ulanowicz (2009).** Quantifying economic sustainability: Implications for free-enterprise theory, policy and practice. *Ecological Economics* **69**, 76–81. (DOI: 10.1016/j.ecolecon.2009.07.018). Available at: http://linkinghub.elsevier.com/retrieve/pii/S0921800909003085.

**Goklany I.M. (2007).** Integrated strategies to reduce vulnerability and advance adaptation, mitigation, and sustainable development. *Mitigation and Adaptation Strategies for Global Change* **12**, 755–786. (DOI: 10.1007/s11027-007-9098-1). Available at: http://www.springerlink.com/content/4223136v69221w74/.

**Gollier C. (2013).** The Debate on Discounting: Reconciling Positivists and Ethicists. *Chicago Journal of International Law* **13**, 551–566.

**Gonzalez Miguez J.D., and A. Santhiago de Oliveira (2011).** The importance of historical responsibility in the context of the international regime on climate change. In: *Equitable access to sustainable development: Contribution to the body of scientific knowledge*. BASIC expert group, Beijing, Brasilia, Cape Town and Mumbai pp.23–34, .Available at: http://www.erc.uct.ac.za/Basic_Experts_Paper.pdf.

**Graham C. (2009).** *Happiness around the World: The Paradox of Happy Peasants and Miserable Millionaires*. Oxford University Press, Oxford.

**Grantham Institute, and Carbon Tracker Initiative (2013).** *Unburnable Carbon 2013: Wasted capital and stranded assets*. Available at: http://carbontracker.live.kiln.it/Unburnable-Carbon-2-Web-Version.pdf.

**Grasso M. (2010).** An ethical approach to climate adaptation finance. *Global Environmental Change* **20**, 74–81. (DOI: 10.1016/j.gloenvcha.2009.10.006). Available at: http://www.sciencedirect.com/science/article/pii/S0959378009000910.

**Griffin P.A., D.H. Lont, and Y. Sun (2012).** The Relevance to Investors of Greenhouse Gas Emission Disclosures. *UC Davis Graduate School of Management Research Papers* **11**, 1–58. Available at: http://ssrn.com/abstract=1735555 or http://dx.doi.org/10.2139/ssrn.1735555.

**Grist N. (2008).** Positioning climate change in sustainable development discourse. *Journal of International Development* **20**, 783–803. (DOI: 10.1002/jid.1496).

**De Groot R. (2006).** Function-analysis and valuation as a tool to assess land use conflicts in planning for sustainable, multi-functional landscapes. *Landscape and Urban Planning* **75**, 175–186. (DOI: 10.1016/j.landurbplan.2005.02.016). Available at: http://www.sciencedirect.com/science/article/pii/S0169204605000575.

**Grothmann T., and A. Patt (2005).** Adaptive capacity and human cognition: The process of individual adaptation to climate change. *Global Environmental Change Part A* **15**, 199–213. (DOI: doi: 10.1016/j.gloenvcha.2005.01.002). Available at: http://www.sciencedirect.com/science/article/pii/S095937800500004X.

**Group of 7 Heads of State (1979).** G7 Economic Summit Declaration, Tokyo, 1979. Available at: http://www.g8.utoronto.ca/summit/1979tokyo/communique.html.

**Grubb M. (1989).** *The greenhouse effect: negotiating targets*. Royal Institute of International Affairs, 70 pp., (ISBN: 9780905031309).

**Grubb M. (1990).** The Greenhouse Effect : Negotiating Targets. *International Affairs* **66**, 67–89.

**Grubb M. (2013).** *Planetary economics: energy, climate change and the three domains of sustainable development*. Routledge, New York, (ISBN: 9780415518826).

**Grubb M.J., and J. Sebenius (1992).** Participation, allocation, and adaptability in international tradeable emission permit systems for greenhouse gas control. In: *Climate Change: Designing a Tradeable Permit System*. Organization for Economic Co-operation and Development, Paris, France.

**Grübler A., and Y. Fujii (1991).** Intergenerational and spatial equity issues of carbon accounts. *Energy for Sustainable Development*, 1397–1416.

**Guivarch C., R. Crassous, O. Sassi, and S. Hallegate (2011).** The costs of climate policies in a second-best world with labour market imperfections. *Climate Policy* **11**, 768–788. (DOI: 10.3763/cpol.2009.0012). Available at: http://www.tandfonline.com/doi/abs/10.3763/cpol.2009.0012.

**Gupta N. (2011).** Globalization does lead to change in consumer behavior: An empirical evidence of impact of globalization on changing materialistic values in Indian consumers and its aftereffects. *Asia Pacific Journal of Marketing and Logistics* **23**, 251–269. (DOI: 10.1108/13555851111143204).

**Gutowski T.G., M.S. Branham, J.B. Dahmus, A.J. Jones, A. Thiriez, and D.P. Sekulic (2009).** Thermodynamic Analysis of Resources Used in Manufacturing Processes. *Environmental Science & Technology* **43**, 1584–1590. (DOI: 10.1021/es8016655). Available at: http://dx.doi.org/10.1021/es8016655.

**Haden V.R., M.T. Niles, M. Lubell, J. Perlman, and L.E. Jackson (2012).** Global and Local Concerns: What Attitudes and Beliefs Motivate Farmers to Mitigate and Adapt to Climate Change? *PLoS ONE* **7**. (DOI: 10.1371/journal.pone.0052882).

**Ha-Duong M., M.J. Grubb, and J.-C. Hourcade (1997).** Influence of socioeconomic inertia and uncertainty on optimal CO2-emission abatement. *Nature* **390**, 270–273. (DOI: 10.1038/36825). Available at: http://dx.doi.org/10.1038/36825.

**Hallegatte S., J.-C. Hourcade, and P. Dumas (2007).** Why economic dynamics matter in assessing climate change damages: Illustration on extreme events. *Ecological Economics* **62**, 330–340. (DOI: 10.1016/j.ecolecon.2006.06.006). Available at: http://www.sciencedirect.com/science/article/B6VDY-4KF1HRR-2/1/6d4cbc2883f2191f6098b2c7f968c6d8.

**Halsnaes K., A. Markandya, and P. Shukla (2011).** Introduction: Sustainable Development, Energy, and Climate Change. *World Development* **39**, 983–986. (DOI: 10.1016/j.worlddev.2010.01.006). Available at: http://www.sciencedirect.com/science/article/pii/S0305750X11000702.

**Halsnæs K., P.R. Shukla, and A. Garg (2008).** Sustainable development and climate change: Lessons from country studies. *Climate Policy* **8**, 202–219. (DOI: 10.3763/cpol.2007.0475.8.2.202).

**Hamilton K., and G. Atkinson (2006).** *Wealth, welfare and sustainability : advances in measuring sustainable development*. Edward Elgar, Cheltenham, (ISBN: 9781848441750).

**Hamilton K., and M. Clemens (1999).** Genuine Savings Rates in Developing Countries. *The World Bank Economic Review* **13**, 333 –356. (DOI: 10.1093/wber/13.2.333). Available at: http://wber.oxfordjournals.org/content/13/2/333.abstract.

**Hanss D., and G. Böhm (2010).** Can I make a difference? The role of general and domain-specific self-efficacy in sustainable consumption decisions. *Umweltpsychologie* **14**, 46–74. Available at: http://www.academia.edu/2021220/Can_I_make_a_difference_The_role_of_general_and_domain-specific_self-efficacy_in_sustainable_consumption_decisions.

**Hardin G. (1968).** The Tragedy of the Commons. *Science* **162**, 1243–1248. (DOI: 10.1126/science.162.3859.1243). Available at: http://www.sciencemag.org.ezproxy.library.tufts.edu/content/162/3859/1243.

**Harris P.G. (1996).** Considerations of equity and international environmental institutions. *Environmental Politics* **5**, 274–301. (DOI: 10.1080/09644019608414265). Available at: http://www.tandfonline.com/doi/abs/10.1080/09644019608414265.

**Harris P.G. (1999).** Common But Differentiated Responsibility: The Kyoto Protocol and United States Policy. *New York University Environmental Law Journal* **7**, 28. Available at: http://heinonline.org.ezproxy.library.tufts.edu/HOL/Page?handle=hein.journals/nyuev7&id=36&div=&collection=journals.

**Harry S., and M. Morad (2013).** Sustainable development and climate change: Beyond mitigation and adaptation. *Local Economy* **28**, 358–368. (DOI: 10.1177/0269094213476663).

**Hartzell-Nichols L. (2011).** Responsibility for meeting the costs of adaptation. *Wiley Interdisciplinary Reviews: Climate Change* **2**, 687–700. (DOI: 10.1002/wcc.132). Available at: http://onlinelibrary.wiley.com/doi/10.1002/wcc.132/abstract.

**Hauschild (2005).** Assessing Environmental Impacts in a Life-Cycle Perspective. *Environmental Science & Technology* **39**, 81A–88A. (DOI: 10.1021/es053190s). Available at: http://dx.doi.org/10.1021/es053190s.

**Hauschild M.Z., L.C. Dreyer, and A. Jørgensen (2008).** Assessing social impacts in a life cycle perspective—Lessons learned. *CIRP Annals - Manufacturing Technology* **57**, 21–24. (DOI: 10.1016/j.cirp.2008.03.002). Available at: http://www.sciencedirect.com/science/article/pii/S0007850608000048.

**Hauschild M.Z., J. Jeswiet, and L. Alting (2004).** Design for Environment — Do We Get the Focus Right? *CIRP Annals - Manufacturing Technology* **53**, 1–4. (DOI: 10.1016/S0007-8506(07)60631-3). Available at: http://www.sciencedirect.com/science/article/pii/S0007850607606313.

**Hayakawa N., Y. Wakazono, T. Kato, Y. Suzuoki, and Y. Kaya (1999).** Minimizing Energy Consumption in Industry by Cascade Use of Waste Energy. *IEEE Transactions on Energy Conversion* **14**, 795–801.

**Healy T., and S. Cote (2001).** *The Well-Being of Nations: The Role of Human and Social Capital. Education and Skills.* Organisation for Economic Cooperation and Development, 2 rue Andre Pascal, F-75775 Paris Cedex 16, France ($25); Tel: +33 1-45-24-82-00; Web site: http://www.oecd.org; Web site: http://www.oecdwash.org/PUBS/pubshome.htm. Available at: http://www.eric.ed.gov/ERICWebPortal/detail?accno=ED453111.

**Herrmann I.T., and M.Z. Hauschild (2009).** Effects of globalisation on carbon footprints of products. *CIRP Annals - Manufacturing Technology* **58**, 13–16. (DOI: 10.1016/j.cirp.2009.03.078). Available at: http://www.sciencedirect.com/science/article/pii/S0007850609000316.

**Herrmann C., S. Thiede, S. Kara, and J. Hesselbach (2011).** Energy oriented simulation of manufacturing systems – Concept and application. *CIRP Annals - Manufacturing Technology* **60**, 45–48. (DOI: 10.1016/j.cirp.2011.03.127). Available at: http://www.sciencedirect.com/science/article/pii/S0007850611001284.

**Hertwich E.G. (2011).** THE LIFE CYCLE ENVIRONMENTAL IMPACTS OF CONSUMPTION. *Economic Systems Research* **23**, 27–47. (DOI: 10.1080/09535314.2010.536905). Available at: http://www.tandfonline.com/doi/abs/10.1080/09535314.2010.536905.

**Hertwich E.G., and G.P. Peters (2009).** Carbon Footprint of Nations: A Global, Trade-Linked Analysis. *Environ. Sci. Technol.* **43**, 6414–6420. (DOI: 10.1021/es803496a). Available at: http://dx.doi.org/10.1021/es803496a.

**Heyward C. (2007).** Equity and international climate change negotiations: a matter of perspective. *Climate Policy* **7**, 518–534.

**Hill M. (2013).** Adaptive Capacity, Adaptive Governance and Resilience. Advances in Global Change Research. In: *Climate Change and Water Governance*. Springer Netherlands, pp.29–51, (ISBN: 978-94-007-5795-0, 978-94-007-5796-7). Available at: http://link.springer.com/chapter/10.1007/978-94-007-5796-7_3.

**Höhne N., and K. Blok (2005).** Calculating Historical Contributions To Climate Change--Discussing The "Brazilian Proposal." *Climatic Change* **71**, 141–173. (DOI: 10.1007/s10584-005-5929-9). Available at: http://search.proquest.com/docview/198509983/abstract/1379FAB43992DBB99ED/1?accountid=14434.

**Höhne N., H. Blum, J. Fuglestvedt, R.B. Skeie, A. Kurosawa, G. Hu, J. Lowe, L. Gohar, B. Matthews, A.C.N. de Salles, and C. Ellermann (2011).** Contributions of individual countries' emissions to climate change and their uncertainty. *Climatic Change* **106**, 359–391. (DOI: 10.1007/s10584-010-9930-6). Available at: http://link.springer.com.ezproxy.library.tufts.edu/article/10.1007/s10584-010-9930-6.

**Höhne N., M.G.J. den Elzen, and M. Weiss (2006).** Common but differentiated convergence (CDC): A new conceptual approach to long-term climate policy. *Climate Policy* **6**, 181–199. (DOI: 10.1080/14693062.2006.9685594). Available at: http://www.tandfonline.com/doi/abs/10.1080/14693062.2006.9685594.

**Holling C.S. (1973).** Resilience and Stability of Ecological Systems. *Annual Review of Ecology and Systematics* **4**, 1–23. (DOI: 10.2307/2096802). Available at: http://www.jstor.org/stable/2096802.

**Holling C.S.** (Ed.) **(1978).** Adaptive environmental assessment and management. , xviii + 377.

**Homma T., K. Akimoto, and T. Tomoda (2012).** Quantitative evaluation of time-series GHG emissions by sector and region using consumption-based accounting. *Energy Policy* **51**, 816–827. (DOI: 10.1016/j.enpol.2012.09.031). Available at: http://www.sciencedirect.com/science/article/pii/S0301421512008063.

**Hourcade J.C., M. Jaccard, C. Bataille, and F. Ghersi (2006).** Hybrid Modeling: New Answers to Old Challenges. *The Energy Journal* **2**, 1–12. Available at: http://halshs.archives-ouvertes.fr/halshs-00471234.

**Hovi J., D.F. Sprinz, and A. Underdal (2009).** Implementing Long-Term Climate Policy: Time Inconsistency, Domestic Politics, International Anarchy. *Global Environmental Politics* **9**, 20–39. (DOI: 10.1162/glep.2009.9.3.20). Available at: http://dx.doi.org/10.1162/glep.2009.9.3.20.

**Howarth R.B., and R.B. Norgaard (1992).** Environmental Valuation Under Sustainable Development. *American Economic Review* **82**, 473–477.

**HSBC Global Research (2013).** *Oil & carbon revisited: Value at risk from '"unburnable'" reserves*. HSBC Bank PLC, London, UK. Available at: http://gofossilfree.org/files/2013/02/HSBCOilJan13.pdf.

**Hudson J., and A. Minea (2013).** Innovation, Intellectual Property Rights, and Economic Development: A Unified Empirical Investigation. *World Development* **46**, 66–78. (DOI: 10.1016/j.worlddev.2013.01.023). Available at: https://xpv.uab.cat/,DanaInfo=.aaqrvD1kiwouy09zttxwSw98+full_record.do?product=UA&search_mode=GeneralSearch&qid=16&SID=Z27Ehm8N3cUXFd7hQ8D&page=1&doc=1.

**Hufty M. (2011).** Investigating Policy Processes: The Governance Analytical Framework (GAF). *Research Sustainable Development: Foundations, Experiences, and Perspectives*, 403–424.

**Hulme M. (2009).** *Why we disagree about climate change*. Cambridge University Press, Cambridge.

**Humphreys S.** (Ed.) **(2009).** *Human Rights and Climate Change*. Available at: http://www.cambridge.org/gb/knowledge/isbn/item2713745/?site_locale=en_GB.

**Huneke M.E. (2005).** The face of the un-consumer: An empirical examination of the practice of voluntary simplicity in the United States. *Psychology and Marketing* **22**, 527–550. (DOI: 10.1002/mar.20072). Available at: http://onlinelibrary.wiley.com.globalproxy.cvt.dk/doi/10.1002/mar.20072/abstract.

**IEA (2012).** CO2 Emissions from Fuel Combustion. Beyond 2020 Online Database. 2012 Edition. Available at: http://data.iea.org/IEASTORE/DEFAULT.ASP.

**IEA (2013).** *World Energy Outlook 2013.* International Energy Agency, Paris. Available at: http://www.worldenergyoutlook.org/publications/weo-2013/.

**Intergovernmental Panel on Climate Change (1990).** *Climate Change: First Assessment Report*. Cambridge University Press, Cambridge, UK; New York, USA, and Melbourne, Australia.

**Intergovernmental Panel on Climate Change (1995).** *Climate Change 1995: IPCC Second Assessment*. Cambridge University Press, Cambridge, UK; New York, USA, and Melbourne, Australia.

**Intergovernmental Panel on Climate Change (2001).** *Climate Change 2001: IPCC Third Assessment Report*. Cambridge University Press, Cambridge, UK. Available at: http://www.grida.no/publications/other/ipcc_tar/.

**Intergovernmental Panel on Climate Change (2007).** *Climate Change 2007: IPCC Fourth Assessment Report*. Cambridge University Press, Cambridge, UK.

**Intergovernmental Panel on Climate Change (2011).** *IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation* (O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. (coordinating lead authors) Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, and C. von Stechow, Eds.). Cambridge University Press, Cambridge, U.K., and New York. Available at: http://srren.ipcc-wg3.de/report.

**Intergovernmental Panel on Climate Change (2012a).** *Managing the risks of extreme events and disasters to advance climate change adaption: special report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, New York, NY, 582 pp., (ISBN: 9781107025066).

**Intergovernmental Panel on Climate Change (2012b).** *Meeting Report of the Intergovernmental Panel on Climate Change Expert Meeting on Geoengineering [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, C. Field, V. Barros, T.F. Stocker, Q. Dahe, J. Minx, K. Mach, G.-K. Plattner, S. Schlömer, G. Hansen, M. Mastrandrea (eds.)]. IPCC Working Group III Technical Support Unit, Potsdam Institute for Climate Impact Research, Potsdam, Germany, pp. 99.* Potsdam, Germany.

**Intergovernmental Panel on Climate Change (2014).** *IPCC Fifth Assessment Report, Working Group Two*.

**International Energy Agency (2012).** *World Energy Outlook 2012*. IEA, Paris, France.

**International Labour Office (2010).** *Climate Change and Labour: The Need for a "Just Transition."* Geneva, Switzerland. Available at: http://www.ilo.org/actrav/what/pubs/WCMS_153352/lang--en/index.htm.

**Isaac M., and D.P. van Vuuren (2009).** Modeling global residential sector energy demand for heating and air conditioning in the context of climate change. *Energy Policy* **37**, 507–521. (DOI: 10.1016/j.enpol.2008.09.051). Available at: http://www.sciencedirect.com/science/article/pii/S0301421508005168.

**Iyer S. (2006).** Human Capital. In: *The Elgar Companion to Development Studies*. Edward Elgar, Cheltenham pp.240–245, (ISBN: 978 1 84376 475 5).

**Jabareen Y. (2006).** A New Conceptual Framework for Sustainable Development. *Environment, Development and Sustainability* **10**, 179–192. (DOI: 10.1007/s10668-006-9058-z). Available at: http://www.springerlink.com/index/10.1007/s10668-006-9058-z.

**Jackson T. (2005a).** *Motivating sustainable consumption: A review of evidence on consumer behaviour and behavioural change. A report to the Sustainable Development Research Network*. University of Surrey, Centre for Environmental Strategies, Surrey. Available at: http://www3.surrey.ac.uk/eng/data/staff/rp/JacksonSDRN-review.pdf.

**Jackson T. (2005b).** Live Better by Consuming Less?: Is There a "Double Dividend" in Sustainable Consumption? *Journal of Industrial Ecology* **9**, 19–36. (DOI: 10.1162/1088198054084734). Available at: http://onlinelibrary.wiley.com.globalproxy.cvt.dk/doi/10.1162/1088198054084734/abstract.

**Jackson T. (2009).** *Prosperity without Growth? – The Transition to a Sustainable Economy*. Sustainable Development Commission, London. Available at: http://www.earthscan.co.uk/ProsperityWithoutGrowth/tabid/102098/Default.aspx.

**Jackson T. (2011a).** Societal transformations for a sustainable economy. *Natural Resources Forum* **35**, 155–164. (DOI: 10.1111/j.1477-8947.2011.01395.x). Available at: http://onlinelibrary.wiley.com/doi/10.1111/j.1477-8947.2011.01395.x/abstract.

**Jackson A.L.R. (2011b).** Renewable energy vs. biodiversity: Policy conflicts and the future of nature conservation. *Global Environmental Change* **21**, 1195–1208. (DOI: 10.1016/j.gloenvcha.2011.07.001). Available at: http://www.sciencedirect.com/science/article/pii/S0959378011001063.

**Jacobsson S., and A. Bergek (2011).** Innovation system analyses and sustainability transitions: Contributions and suggestions for research. *Environmental Innovation and Societal Transitions* **1**, 41–57. (DOI: 10.1016/j.eist.2011.04.006). Available at: http://www.sciencedirect.com/science/article/pii/S2210422411000177.

**Jacoby H., M. Babiker, S. Paltsev, and J. Reilly (2009).** Sharing the burden of GHG reductions. In: *Post-Kyoto international climate policy : implementing architectures for agreement*. J.E. Aldy, R.N. Stavins, (eds.), Cambridge University Press, Cambridge(ISBN: 9780521137850 0521137853 9780521129527 0521129524).

**Jacques P.J., R.E. Dunlap, and M. Freeman (2008).** The organisation of denial: Conservative think tanks and environmental scepticism. *Environmental Politics* **17**, 349–385. (DOI: 10.1080/09644010802055576). Available at: http://www.tandfonline.com/doi/abs/10.1080/09644010802055576.

**Jaeger C.C., L. Paroussos, D. Mangalagiu, R. Kupers, A. Mandel, and J.D. Tabara (2011).** *A New Growth Path for Europe: Generating Prosperity and Jobs in the Low-Carbon Economy (Synthesis Report)*. Postdam, (ISBN: 978-3-941663-09-1).

**Jaffe A.B., R.G. Newell, and R.N. Stavins (2005).** A tale of two market failures: Technology and environmental policy. *Ecological Economics* **54**, 164–174. (DOI: 10.1016/j.ecolecon.2004.12.027).

**Jagers S., and G. Duus-Otterstrom (2008).** Dual climate change responsibility: on moral divergences between mitigation and adaptation. *Environmental Politics* **17**, 576–591. (DOI:

10.1080/09644010802193443). Available at: http://www.tandfonline.com/doi/abs/10.1080/09644010802193443.

**Jagers S.C., and J. Stripple (2003).** Climate governance beyond the state. *Global Governance* **9**, 385–399.

**Jakob M., and R. Marschinski (2012).** Interpreting trade-related CO2 emission transfers. *Nature Climate Change* **3**, 19–23. (DOI: 10.1038/nclimate1630). Available at: http://www.nature.com/doifinder/10.1038/nclimate1630.

**Jamieson D. (2001).** Climate Change and Global Environmental Justice. In: *Changing the Atmosphere: Expert Knowledge and Environmental Governance*. The MIT Press, Cambridge, MA pp.287–308, .

**Jamieson D. (2013).** Climate change, consequentialism and the road ahead. *Chicago Journal of International Law* **13**.

**Janetos A.C., E. Malone, E. Mastrangelo, K. Hardee, and A. de Bremond (2012).** Linking climate change and development goals: framing, integrating, and measuring. *Climate and Development* **4**, 141–156. (DOI: 10.1080/17565529.2012.726195). Available at: http://www.tandfonline.com/doi/abs/10.1080/17565529.2012.726195.

**Jänicke M. (2012).** Dynamic governance of clean-energy markets: how technical innovation could accelerate climate policies. *Journal of Cleaner Production* **22**, 50–59. (DOI: 10.1016/j.jclepro.2011.09.006). Available at: http://www.sciencedirect.com/science/article/pii/S0959652611003374.

**Jasanoff S. (2004).** *Earthly Politics: Local and Global in Environmental Governance*. MIT Press, 372 pp., (ISBN: 9780262600590).

**Jayaraman T., T. Kaniktar, and M. D'Souza (2011).** Equitable access to sustainable development: An Indian approach. In: *Equitable access to sustainable development: Contribution to the body of scientific knowledge*. BASIC expert group, Beijing, Brasilia, Cape Town and Mumbai pp.59–77, .Available at: http://www.erc.uct.ac.za/Basic_Experts_Paper.pdf.

**Jinnah S. (2011).** Climate Change Bandwagoning: The Impacts of Strategic Linkages on Regime Design, Maintenance, and Death. *Global Environmental Politics* **11**, 1–9. (DOI: 10.1162/GLEP_a_00065). Available at: http://dx.doi.org/10.1162/GLEP_a_00065.

**Johnston M., and H. Hesseln (2012).** Climate change adaptive capacity of the Canadian forest sector. *Forest Policy and Economics* **24**, 29–34. (DOI: 10.1016/j.forpol.2012.06.001).

**Jonas H. (1985).** *The Imperative of Responsibility: In Search of an Ethics for the Technological Age*. University of Chicago Press, 267 pp., (ISBN: 9780226405971).

**Jones N., C.P. Halvadakis, and C.M. Sophoulis (2011).** Social capital and household solid waste management policies: a case study in Mytilene, Greece. *Environmental Politics* **20**, 264–283. (DOI: 10.1080/09644016.2011.551032). Available at: https://xpv.uab.cat/,DanaInfo=.aaqrvD1kiwouy09zttxwSw98+full_record.do?product=UA&search_mode=GeneralSearch&qid=1&SID=R21KP3JD4HmjO2Be8Mp&page=1&doc=1.

**Jones C.M., and D.M. Kammen (2011).** Quantifying Carbon Footprint Reduction Opportunities for U.S. Households and Communities. *Environ. Sci. Technol.* **45**, 4088–4095. (DOI: 10.1021/es102221h). Available at: http://pubs.acs.org/doi/abs/10.1021/es102221h.

**Jones B.F., and B.A. Olken (2005).** Do Leaders Matter? National Leadership and Growth Since World War II. *The Quarterly Journal of Economics* **120**, 835–864. (DOI: 10.1093/qje/120.3.835). Available at: http://qje.oxfordjournals.org/content/120/3/835.

**JRC/PBL (2012).** European Commission, Joint Research Centre (JRC)/PBL Netherlands Environmental Assessment Agency. Emission Database for Global Atmospheric Research (EDGAR), release version 4.2 FT2010. Available at: http://edgar.jrc.ec.europa.eu.

**Jupesta J., R. Boer, G. Parayil, Y. Harayama, M. Yarime, J.A.P. de Oliveira, and S.M. Subramanian (2011).** Managing the transition to sustainability in an emerging economy: Evaluating green growth policies in Indonesia. *Environmental Innovation and Societal Transitions* **1**, 187–191. (DOI: 10.1016/j.eist.2011.08.001). Available at: http://www.sciencedirect.com/science/article/pii/S2210422411000311.

**Kahneman D., and A. Deaton (2010).** High income improves evaluation of life but not emotional well-being. *Proceedings of the National Academy of Sciences* **107**, 16489–16493. (DOI: 10.1073/pnas.1011492107). Available at: http://www.pnas.org/cgi/doi/10.1073/pnas.1011492107.

**Kahneman D., E. Diener, and N. Schwarz (2003).** *Well-being : the foundations of hedonic psychology*. Russell Sage Foundation, New York, (ISBN: 9780871544230).

**Kals E., and J. Maes (2011).** *Justice and conflicts*. Springer, New York, (ISBN: 9783642190346).

**Kara S., and W. Li (2011).** Unit process energy consumption models for material removal processes. *CIRP Annals - Manufacturing Technology* **60**, 37–40. (DOI: 10.1016/j.cirp.2011.03.018). Available at: http://www.sciencedirect.com/science/article/pii/S0007850611000199.

**Kartha S., P. Baer, T. Athanasiou, and E. Kemp-Benedict (2009).** The Greenhouse Development Rights framework. *Climate and Development* **1**, 147–165. (DOI: 10.3763/cdev.2009.0010). Available at: http://www.tandfonline.com/doi/abs/10.3763/cdev.2009.0010.

**Kates R.W. (2001).** Sustainability Science. *Science* **292**, 641–642. (DOI: 10.1126/science.1059386). Available at: http://www.sciencemag.org/cgi/doi/10.1126/science.1059386.

**Kates R.W., W.R. Travis, and T.J. Wilbanks (2012).** Transformational adaptation when incremental adaptations to climate change are insufficient. *Proceedings of the National Academy of Sciences* **109**, 7156–7161. (DOI: 10.1073/pnas.1115521109). Available at: http://www.pnas.org/content/109/19/7156.

**Kellstedt P.M., S. Zahran, and A. Vedlitz (2008).** Personal Efficacy, the Information Environment, and Attitudes Toward Global Warming and Climate Change in the United States. *Risk Analysis* **28**, 113–126. (DOI: 10.1111/j.1539-6924.2008.01010.x). Available at: http://onlinelibrary.wiley.com.globalproxy.cvt.dk/doi/10.1111/j.1539-6924.2008.01010.x/abstract.

**Kemp R. (1994).** Technology and the transition to environmental sustainability: The problem of technological regime shifts. *Futures* **26**, 1023–1046. (DOI: 10.1016/0016-3287(94)90071-X). Available at: http://www.sciencedirect.com/science/article/pii/001632879490071X.

**Kenny G. (2011).** Adaptation in agriculture: Lessons for resilience from eastern regions of New Zealand. *Climatic Change* **106**, 441–462. (DOI: 10.1007/s10584-010-9948-9).

**Keskitalo E.C.H., H. Dannevig, G.K. Hovelsrud, J.J. West, and A.G. Swartling (2011).** Adaptive capacity determinants in developed states: Examples from the Nordic countries and Russia. *Regional Environmental Change* **11**, 579–592. (DOI: 10.1007/s10113-010-0182-9).

**Keyzer M., and L. Wesenbeeck (2007).** The Millennium Development Goals, How Realistic are They? *De Economist* **155**, 139–139. (DOI: 10.1007/s10645-006-9039-5). Available at: http://www.springerlink.com/index/10.1007/s10645-006-9039-5.

**Khan B.Z. (2005).** *The Democratization of invention: patents and copyrights in American economic development, 1790-1920*. Cambridge University Press, Cambridge; New York, (ISBN: 052181135X 9780521811354 9780521747202 0521747201).

**Khor M. (2011).** Risks and uses of the green economy concept in the context of sustainable development, poverty and equity. *South Centre Research Paper*. Available at: http://www.twnside.org.sg/title2/uncsd2012/RP40_GreenEcon_concept_MKJul11.pdf.

**Kilbourne W.E. (2010).** Facing the Challenge of Sustainability in a Changing World: An Introduction to the Special Issue. *Journal of Macromarketing* **30**, 109 –111. (DOI: 10.1177/0276146710363726). Available at: http://jmk.sagepub.com/content/30/2/109.short.

**Kjellen B. (2008).** *A new diplomacy for sustainable development*. Routledge, London.

**Knox J.H. (2009).** Linking Human Rights and Climate Change at the United Nations. *Harvard Environmental Law Review* **33**, 477. Available at: http://heinonline.org/HOL/Page?handle=hein.journals/helr33&id=481&div=&collection=journals.

**Kolk A., D. Levy, and J. Pinkse (2008).** Corporate Responses in an Emerging Climate Regime: The Institutionalization and Commensuration of Carbon Disclosure. *European Accounting Review* **17**, 719–745. (DOI: 10.1080/09638180802489121).

**Kolmes S.A. (2011).** Climate Change: A Disinformation Campaign. *Environment: Science and Policy for Sustainable Development* **53**, 33–37. (DOI: 10.1080/00139157.2011.588553). Available at: http://www.tandfonline.com/doi/abs/10.1080/00139157.2011.588553.

**Kooiman J. (2003).** *Governing as Governance*. Sage Publications, Inc, London, Thousand Oaks, New Delhi.

**Koopmans T.C. (1965).** On the Concept of Optimal Economic Growth. *Pontificiae Academiae Scientiarum Scripta Varia* **28**. Available at: http://econpapers.repec.org/paper/cwlcwldpp/163.htm.

**Krausmann F., S. Gingrich, N. Eisenmenger, K.-H. Erb, H. Haberl, and M. Fischer-Kowalski (2009).** Growth in global materials use, GDP and population during the 20th century. *Ecological Economics* **68**, 2696–2705. (DOI: 10.1016/j.ecolecon.2009.05.007). Available at: http://www.sciencedirect.com/science/article/pii/S0921800909002158.

**Krippner G.R. (2005).** The financialization of the American economy. *Socio-Economic Review* **3**, 173–208. (DOI: 10.1093/SER/mwi008). Available at: http://ser.oxfordjournals.org/content/3/2/173.

**Krugman P.R. (1979).** Increasing returns, monopolistic competition, and international trade. *Journal of International Economics* **9**, 469–479. (DOI: 10.1016/0022-1996(79)90017-5). Available at: http://www.sciencedirect.com/science/article/pii/0022199679900175.

**Kvaløy B., H. Finseraas, and O. Listhaug (2012).** The publics' concern for global warming: A cross-national study of 47 countries. *Journal of Peace Research* **49**, 11–22. (DOI: 10.1177/0022343311425841). Available at: http://jpr.sagepub.com/content/49/1/11.

**Lal R., J.A. Delgado, P.M. Groffman, N. Millar, C. Dell, and A. Rotz (2011).** Management to mitigate and adapt to climate change. *Journal of Soil and Water Conservation* **66**, 276–282. (DOI: 10.2489/jswc.66.4.276).

**Lane M.S. (2012).** *Eco-republic: what the ancients can teach us about ethics, virtue, and sustainable living*. Princeton University Press, Princeton, NJ, 245 pp., (ISBN: 9780691151243).

**Lange A., A. Löschel, C. Vogt, and A. Ziegler (2010).** On the self-interested use of equity in international climate negotiations. *European Economic Review* **54**, 359–375. (DOI: 10.1016/j.euroecorev.2009.08.006). Available at: http://www.sciencedirect.com/science/article/pii/S0014292109000944.

**Larsen R.K., Å.G. Swartling, N. Powell, B. May, R. Plummer, L. Simonsson, and M. Osbeck (2012).** A framework for facilitating dialogue between policy planners and local climate change adaptation professionals: Cases from Sweden, Canada and Indonesia. *Environmental Science & Policy* **23**, 12–23. (DOI: 10.1016/j.envsci.2012.06.014). Available at: http://www.sciencedirect.com/science/article/pii/S1462901112000949.

**Lastovicka J.L., L.A. Bettencourt, R.S. Hughner, and R.J. Kuntze (1999).** Lifestyle of the Tight and Frugal: Theory and Measurement. *Journal of Consumer Research* **26**, 85–98. (DOI: 10.1086/209552). Available at: http://www.jstor.org.globalproxy.cvt.dk/discover/10.1086/209552?uid=23002&uid=18273808&uid=3737880&uid=2134&uid=18273416&uid=2&uid=70&uid=3&uid=5910136&uid=67&uid=62&uid=22998&sid=21101214139453.

**Laukkonen J., P.K. Blanco, J. Lenhart, M. Keiner, B. Cavric, and C. Kinuthia-Njenga (2009).** Combining climate change adaptation and mitigation measures at the local level. *Habitat International* **33**, 287–292. (DOI: 10.1016/j.habitatint.2008.10.003).

**Laurent A., S.I. Olsen, and M.Z. Hauschild (2012).** Limitations of Carbon Footprint as Indicator of Environmental Sustainability. *Environ. Sci. Technol.* **46**, 4100–4108. (DOI: 10.1021/es204163f). Available at: http://dx.doi.org/10.1021/es204163f.

**Lawn P.A. (2003).** A theoretical foundation to support the Index of Sustainable Economic Welfare (ISEW), Genuine Progress Indicator (GPI), and other related indexes. *Ecological Economics* **44**, 105–118. (DOI: 10.1016/S0921-8009(02)00258-6). Available at: http://linkinghub.elsevier.com/retrieve/pii/S0921800902002586.

**Layard R. (2005).** *Happiness: Lessons from a New Science*. Penguin, London.

**Layard R., G. Mayraz, and S. Nickell (2008).** The marginal utility of income. *Journal of Public Economics* **92**, 1846–1857.

**Leadley P., H.M. Pereira, R. Alkemade, J.F. Fernandez-Manjarrés, V. Proença, J.P.W. Scharlemann, and M.J. Walpole (2010).** *Biodiversity Scenarios: Projections of 21st Century Change in Biodiversity and Associated Ecosystem Services : a Technical Report for the Global Biodiversity Outlook 3*. UNEP/Earthprint, 136 pp., (ISBN: 9789292252182).

**Lebel L., and S. Lorek (2008).** Enabling Sustainable Production-Consumption Systems. *Annual Review of Environment and Resources* **33**, 241–275. (DOI: 10.1146/annurev.environ.33.022007.145734). Available at: http://www.annualreviews.org/doi/abs/10.1146/annurev.environ.33.022007.145734.

**Lecocq F., and J.-C. Hourcade (2012).** Unspoken ethical issues in the climate affair: Insights from a theoretical analysis of negotiation mandates. *Economic Theory* **49**, 445–471. (DOI: 10.1007/s00199-010-0589-z). Available at: http://link.springer.com.ezproxy.library.tufts.edu/article/10.1007/s00199-010-0589-z.

**Lecocq F., J.-C. Hourcade, and M. Ha Duong (1998).** Decision making under uncertainty and inertia constraints: sectoral implications of the when flexibility. *Energy Economics* **20**, 539–555. (DOI: 10.1016/S0140-9883(98)00012-7). Available at: http://www.sciencedirect.com/science/article/B6V7G-3VB9DM5-5/1/f9f59b7667b8bd1d8bd84e4b02bd8c71.

**Lecocq F., and Z. Shalizi (2007).** Balancing Expenditures on Mitigation of and Adaptation to Climate Change—An Exploration of Issues Relevant to Developing Countries. World Bank.

**Lee R. (2011).** The Outlook for Population Growth. *Science* **333**, 569–573. (DOI: 10.1126/science.1208859).

**Lee K.-H. (2012).** Carbon accounting for supply chain management in the automobile industry. *Journal of Cleaner Production*. (DOI: 10.1016/j.jclepro.2012.02.023). Available at: http://www.sciencedirect.com/science/article/pii/S0959652612000996.

**Leiserowitz A., R.W. Kates, and T.M. Parris (2005).** Do Global Attitudes and Behaviors Support Sustainable Development? By ANTHONY A. LEISEROWITZ, ROBERT W. KATES, AND THOMAS M. PARRIS. *Environment* **47**, 22–38.

**Lenzen M., J. Murray, F. Sack, and T. Wiedmann (2007).** Shared producer and consumer responsibility — Theory and practice. *Ecological Economics* **61**, 27–42. (DOI: 10.1016/j.ecolecon.2006.05.018). Available at: http://www.sciencedirect.com/science/article/pii/S0921800906002953.

**Lenzen M., and G.M. Peters (2010).** How City Dwellers Affect Their Resource Hinterland. *Journal of Industrial Ecology* **14**, 73–90. (DOI: 10.1111/j.1530-9290.2009.00190.x). Available at: http://onlinelibrary.wiley.com/doi/10.1111/j.1530-9290.2009.00190.x/abstract.

**Lenzen M., M. Wier, C. Cohen, H. Hayami, S. Pachauri, and R. Schaeffer (2006).** A comparative multivariate analysis of household energy requirements in Australia, Brazil, Denmark, India and Japan. *Energy* **31**, 181–207. (DOI: 10.1016/j.energy.2005.01.009). Available at: http://www.sciencedirect.com/science/article/pii/S0360544205000113.

**Levin S.A. (2000).** *Fragile dominion : complexity and the commons*. Perseus, Cambridge, Mass.; [Oxford], (ISBN: 073820319X 9780738203195 0738201111 9780738201115).

**Levin K., B. Cashore, S. Bernstein, and G. Auld (2012).** Overcoming the tragedy of super wicked problems: constraining our future selves to ameliorate global climate change. *Policy Sciences* **45**, 123–152. (DOI: 10.1007/s11077-012-9151-0). Available at: http://link.springer.com/article/10.1007/s11077-012-9151-0.

**Li Y., and C.N. Hewitt (2008).** The effect of trade between China and the UK on national and global carbon dioxide emissions. *Energy Policy* **36**, 1907–1914. (DOI: 10.1016/j.enpol.2008.02.005). Available at: http://www.sciencedirect.com/science/article/pii/S0301421508000694.

**Li Y., and B. Zhang (2008).** Development Path of China and India and the Challenges for their Sustainable Growth. *The World Economy* **31**, 1277–1291. (DOI: 10.1111/j.1467-9701.2008.01128.x). Available at: http://onlinelibrary.wiley.com/doi/10.1111/j.1467-9701.2008.01128.x/abstract.

**Liebowitz S.J., and S.E. Margolis (1995).** Path Dependence, Lock-in, and History. *Journal of Law, Economics, & Organization* **11**, 205–226. Available at: http://www.jstor.org/stable/765077.

**Lobell D.B., U.L.C. Baldos, and T.W. Hertel (2013).** Climate adaptation as mitigation: The case of agricultural investments. *Environmental Research Letters* **8**. (DOI: 10.1088/1748-9326/8/1/015012).

**Locatelli B., V. Evans, A. Wardell, A. Andrade, and R. Vignola (2011).** Forests and climate change in latin America: Linking adaptation and mitigation. *Forests* **2**, 431–450. (DOI: 10.3390/f2010431).

**Lohmann L. (2008).** Carbon Trading, Climate Justice and the Production of Ignorance: Ten examples. *Development* **51**, 359–365. Available at: http://econpapers.repec.org/article/paldevelp/v_3a51_3ay_3a2008_3ai_3a3_3ap_3a359-365.htm.

**Lohmann L. (2009).** Climate as Investment. *Development and Change* **40**, 1063–1083. (DOI: 10.1111/j.1467-7660.2009.01612.x).

**Lohmann L. (2010).** Uncertainty Markets and Carbon Markets: Variations on Polanyian Themes. *New Political Economy* **15**, 225–254. (DOI: 10.1080/13563460903290946).

**Lorenzoni I., S. Nicholson-Cole, and L. Whitmarsh (2007).** Barriers perceived to engaging with climate change among the UK public and their policy implications. *Global Environmental Change* **17**, 445–459. (DOI: 10.1016/j.gloenvcha.2007.01.004). Available at: http://www.sciencedirect.com/science/article/pii/S0959378007000209.

**Lovell H., H. Bulkeley, and D. Liverman (2009).** Carbon offsetting: sustaining consumption? *Environment and Planning A* **41**, 2357–2379. (DOI: 10.1068/a40345).

**Lutz W., and S. KC (2010).** Dimensions of global population projections: what do we know about future population trends and structures? *Philosophical Transactions of the Royal Society B-Biological Sciences* **365**, 2779–2791. (DOI: 10.1098/rstb.2010.0133).

**MacDonald G., H. Abarbanel, and P. Carruthers (1979).** *JASON. Long term impact of atmospheric carbon dioxide on climate. Technical report*. SRI International, Arlington, VA, US. Available at: http://www.osti.gov/energycitations/product.biblio.jsp?osti_id=5829641.

**Manne A.S., and G. Stephan (2005).** Global climate change and the equity–efficiency puzzle. *Energy* **30**, 2525–2536. (DOI: 10.1016/j.energy.2004.07.007). Available at: http://www.sciencedirect.com/science/article/pii/S0360544204003202.

**Manzini E., and C. Vezzoli (2003).** *Product-service Systems and Sustainability: Opportunities for Sustainable Solutions*. United Nations Environment Programme, Division of Technology Industry and Economics, Paris. Available at: http://www.unep.fr/scp/design/pdf/pss-imp-7.pdf.

**Marginson D., and L. McAulay (2008).** Exploring the debate on short-termism: a theoretical and empirical analysis. *Strategic Management Journal* **29**, 273–292. (DOI: 10.1002/smj.657). Available at: http://onlinelibrary.wiley.com.ezproxy.library.tufts.edu/doi/10.1002/smj.657/abstract.

**Markussen P., and G.T. Svendsen (2005).** Industry lobbying and the political economy of GHG trade in the European Union. *Energy Policy* **33**, 245–255. (DOI: 10.1016/S0301-4215(03)00238-6). Available at: http://www.sciencedirect.com/science/article/pii/S0301421503002386.

**Martinet V. (2011).** A characterization of sustainability with indicators. *Journal of Environmental Economics and Management* **61**, 183–197. (DOI: 10.1016/j.jeem.2010.10.002). Available at: http://linkinghub.elsevier.com/retrieve/pii/S009506961000104X.

**Martinet V. (2012).** *Economic theory and sustainable development: what can we preserve for future generations?* Routledge, London ; New York, 203 pp., (ISBN: 9780415544771).

**Martínez E., F. Sanz, S. Pellegrini, E. Jiménez, and J. Blanco (2009).** Life cycle assessment of a multi-megawatt wind turbine. *Renewable Energy* **34**, 667–673. (DOI: 10.1016/j.renene.2008.05.020). Available at: http://www.sciencedirect.com/science/article/pii/S0960148108002218.

**Martinez-Alier J., G. Kallis, S. Veuthey, M. Walter, and L. Temper (2010).** Social Metabolism, Ecological Distribution Conflicts, and Valuation Languages Joan Martinez-Alier a, Giorgos Kallis b,⍰, Sandra Veuthey a, Mariana Walter a, Leah Temper. *Ecological Economics* **70**, 153–158.

**Martínez-Alier J., U. Pascual, F.-D. Vivien, and E. Zaccai (2010).** Sustainable de-growth: Mapping the context, criticisms and future prospects of an emergent paradigm. *Ecological Economics* **69**, 1741–1747. (DOI: 10.1016/j.ecolecon.2010.04.017). Available at: http://www.sciencedirect.com/science/article/pii/S0921800910001606.

**Marvel M.R., and G.T. Lumpkin (2007).** Technology entrepreneurs' human capital and its effects on innovation radicalness. *Entrepreneurship Theory and Practice* **31**, 807–828. (DOI: 10.1111/j.1540-6520.2007.00209.x).

**Maslow A.H. (1970).** *Motivation and personality*. Harper & Row, New York.

**Matthew R.A., and A. Hammill (2009).** Sustainable development and climate change. *International Affairs* **85**, 1117–1128. (DOI: 10.1111/j.1468-2346.2009.00852.x). Available at: http://onlinelibrary.wiley.com/doi/10.1111/j.1468-2346.2009.00852.x/abstract.

**McCright A.M., and R.E. Dunlap (2011).** Cool dudes: The denial of climate change among conservative white males in the United States. *Global Environmental Change* **21**, 1163–1172. (DOI: 10.1016/j.gloenvcha.2011.06.003). Available at: http://www.sciencedirect.com/science/article/pii/S095937801100104X.

**McDonald S., C. Oates, M. Thyne, P. Alevizou, and L.-A. McMorland (2009).** Comparing sustainable consumption patterns across product sectors. *International Journal of Consumer Studies* **33**, 137–145. (DOI: 10.1111/j.1470-6431.2009.00755.x). Available at: http://onlinelibrary.wiley.com.globalproxy.cvt.dk/doi/10.1111/j.1470-6431.2009.00755.x/abstract.

**McFadden J.E., T.L. Hiller, and A.J. Tyre (2011).** Evaluating the efficacy of adaptive management approaches: Is there a formula for success? *Journal of Environmental Management* **92**, 1354–1359. (DOI: 10.1016/j.jenvman.2010.10.038). Available at: http://www.sciencedirect.com/science/article/pii/S0301479710003701.

**McShane K. (2007).** Why Environmental Ethics Shouldn't Give Up on Intrinsic Value. *Environmental Ethics* **29**, 43–61.

**Meade J.E. (1967).** Population explosion, the standard of living and social conflict. *The Economic Journal* **77**, 233–255.

**Meadows D.H., J. Randers, and D. Meadows (2004).** *Limits to Growth: The 30-Year Update*. Chelsea Green, (ISBN: 1931498857).

**Mehlum H., K. Moene, and R. Torvik (2006).** Cursed by resources or institutions? *World Economy* **29**, 1117–1131. (DOI: 10.1111/j.1467-9701.2006.00808.x).

**Meyer A. (2004).** Briefing: Contraction and convergence. *Proceedings of the ICE - Engineering Sustainability* **157**, 189–192. (DOI: 10.1680/ensu.2004.157.4.189). Available at: http://www.icevirtuallibrary.com.ezproxy.library.tufts.edu/content/article/10.1680/ensu.2004.157.4.189.

**Meyer L.H. (2012).** Why Historical Emissions Should Count. *Chicago Journal of International Law* **13**, 597. Available at: http://heinonline.org.ezproxy.library.tufts.edu/HOL/Page?handle=hein.journals/cjil13&id=603&div=&collection=journals.

**Meyer L.H., and D. Roser (2010).** Climate justice and historical emissions. *Critical Review of International Social and Political Philosophy* **13**, 229–253. (DOI: 10.1080/13698230903326349). Available at: http://www.tandfonline.com/doi/abs/10.1080/13698230903326349.

**Milanović B., P.H. Lindert, and J.G. Williamson (2007).** *Measuring Ancient Inequality*. National Bureau of Economic Research.

**Millennium Ecosystem Assessment (2005).** *Ecosystems and human well-being: synthesis*. Island Press, Washington, DC, 137 pp., (ISBN: 1597260401).

**Mitchell D. (2008).** *A Note on Rising Food Prices*. Available at: http://papers.ssrn.com/abstract=1233058.

**Mitchell J., and C. Coles** (Eds.) **(2011).** *Markets and rural poverty: upgrading in value chains*. Taylor & Francis UK, London.

**Mitchell S.M., and C.G. Thies (2012).** Resource Curse in Reverse: How Civil Wars Influence Natural Resource Production. *International Interactions* **38**, 218–242. (DOI: 10.1080/03050629.2012.658326).

**Moisander J., A. Markkula, and K. Eräranta (2010).** Construction of consumer choice in the market: challenges for environmental policy. *International Journal of Consumer Studies* **34**, 73–79. (DOI: 10.1111/j.1470-6431.2009.00821.x). Available at: http://onlinelibrary.wiley.com.globalproxy.cvt.dk/doi/10.1111/j.1470-6431.2009.00821.x/abstract.

**Mokyr J. (1992).** *The Lever of Riches: Technological Creativity and Economic Progress*. Oxford University Press, Oxford.

**Mori K., and A. Christodoulou (2012).** Review of sustainability indices and indicators: Towards a new City Sustainability Index (CSI). *Environmental Impact Assessment Review* **32**, 94–106. (DOI:

10.1016/j.eiar.2011.06.001). Available at: http://linkinghub.elsevier.com/retrieve/pii/S0195925511000758.

**Mori A.S., T.A. Spies, K. Sudmeier-Rieux, and A. Andrade (2013).** Reframing ecosystem management in the era of climate change: Issues and knowledge from forests. *Biological Conservation* **165**, 115–127. (DOI: 10.1016/j.biocon.2013.05.020).

**Moser P. (2013).** Patents and Innovation: Evidence from Economic History. *Journal of Economic Perspectives* **27**, 23–44. (DOI: 10.1257/jep.27.1.23). Available at: https://xpv.uab.cat/,DanaInfo=.aaqrvD1kiwouy09zttxwSw98+full_record.do?product=UA&search_mode=GeneralSearch&qid=1&SID=Z27Ehm8N3cUXFd7hQ8D&page=1&doc=1.

**Moss R.H., J.A. Edmonds, K.A. Hibbard, M.R. Manning, S.K. Rose, D.P. van Vuuren, T.R. Carter, S. Emori, M. Kainuma, T. Kram, G.A. Meehl, J.F.B. Mitchell, N. Nakicenovic, K. Riahi, S.J. Smith, R.J. Stouffer, A.M. Thomson, J.P. Weyant, and T.J. Wilbanks (2010).** The next generation of scenarios for climate change research and assessment. *Nature* **463**, 747–756. (DOI: 10.1038/nature08823). Available at: http://dx.doi.org/10.1038/nature08823.

**Müller B. (1999).** *Justice in Global Warming Negotiations: How to Obtain a Procedurally Fair Compromise*. Oxford Institute for Energy Studies, Oxford, UK. Available at: http://www.oxfordenergy.org/1998/03/justice-in-global-warming-negotiations-how-to-obtain-a-procedurally-fair-compromise/.

**Müller B., N. Höhne, and C. Ellermann (2009).** Differentiating (historic) responsibilities for climate change. *Climate Policy* **9**, 593–611. (DOI: 10.3763/cpol.2008.0570). Available at: http://www.tandfonline.com/doi/abs/10.3763/cpol.2008.0570.

**Muradian R., M. Walter, and J. Martinez-Alier (2012).** Hegemonic transitions and global shifts in social metabolism: Implications for resource-rich countries. Introduction to the special section. *Global Environmental Change*. (DOI: 10.1016/j.gloenvcha.2012.03.004). Available at: http://www.sciencedirect.com/science/article/pii/S0959378012000283.

**Murdiyarso D. (2010).** Climate and development - the challenges in delivering the promises: an editorial essay. *Wiley Interdisciplinary Reviews: Climate Change* **1**, 765–769. (DOI: 10.1002/wcc.19). Available at: http://wires.wiley.com/WileyCDA/WiresArticle/wisId-WCC19.html.

**Nakicenovic N., J. Alcamo, G. Davis, B. de Vries, J. Fenhann, S. Gaffin, K. Gregory, A. Grübler, T.Y. Jung, T. Kram, E.L. La Rovere, L. Michaelis, S. Mori, T. Morita, W. Pepper, H. Pitcher, L. Price, K. Riahi, A. Roehrl, H.-H. Rogner, A. Sankovski, M. Schlesinger, P. Shukla, S. Smith, R. Swart, S. van Rooijen, N. Victor, and Z. Dadi (2000).** *Special Report on Emissions Scenarios* (N. Nakicenovic and R. Swart, Eds.). Intergovernmental Panel on Climate Change, The Hague. Available at: http://www.grida.no/publications/other/ipcc_sr/?src=/climate/ipcc/emission.

**Nakicenovic N., and R. Swart** (Eds.) **(2000).** *Emissions Scenarios*. Cambridge University Press, UK, Cambridge, UK, 570 pp. Available at: http://www.ipcc.ch/ipccreports/sres/emission/index.php?idp=0.

**Negro S.O., F. Alkemade, and M.P. Hekkert (2012).** Why does renewable energy diffuse so slowly? A review of innovation system problems. *Renewable and Sustainable Energy Reviews* **16**, 3836–3846. (DOI: 10.1016/j.rser.2012.03.043). Available at: http://www.sciencedirect.com/science/article/pii/S1364032112002262.

**Nelson R.R., and S.G. Winter (2002).** Evolutionary Theorizing in Economics. *The Journal of Economic Perspectives* **16**, 23–46. Available at: http://www.jstor.org/stable/2696495.

**Nemet G.F., and D.M. Kammen (2007).** US energy research and development: Declining investment, increasing need, and the feasibility of expansion. *Energy Policy* **35**, 746–755. (DOI: 10.1016/j.enpol.2005.12.012).

**Neumayer E. (2000).** In defence of historical accountability for greenhouse gas emissions. *Ecological Economics* **33**, 185–192. (DOI: 10.1016/S0921-8009(00)00135-X). Available at: http://www.sciencedirect.com/science/article/pii/S092180090000135X.

**Neumayer E. (2010).** *Weak versus strong sustainability: exploring the limits of two opposing paradigms*. Edward Elgar, Cheltenham, UK ; Northhampton, MA, 272 pp., (ISBN: 9781848448728).

**Newell P., and D. Mulvaney (2013).** The political economy of the “just transition.” *The Geographical Journal* **179**, 132–140. (DOI: 10.1111/geoj.12008). Available at: http://onlinelibrary.wiley.com/doi/10.1111/geoj.12008/abstract.

**Newell P., and M. Paterson (2010).** *Climate Capitalism. Global Warming and the Transformation of the Global Economy*. Cambridge University Press, Cambridge.

**Norenzayan A. (2011).** Explaining Human Behavioral Diversity. *Science* **332**, 1041–1042. (DOI: 10.1126/science.1207050). Available at: http://www.sciencemag.org/content/332/6033/1041.

**Norgaard K.M. (2011).** *Living in Denial: Climate Change, Emotions, and Everyday Life*. MIT Press, 300 pp., (ISBN: 9780262515856).

**Van Notten P.W.., J. Rotmans, M.B.. van Asselt, and D.S. Rothman (2003).** An updated scenario typology. *Futures* **35**, 423–443. (DOI: 10.1016/S0016-3287(02)00090-3). Available at: http://www.sciencedirect.com/science/article/pii/S0016328702000903.

**O’Neill B.C., L.F. MacKellar, and W. Lutz (2001).** *Population and Climate Change*. Cambridge University Press, Cambridge.

**Oberheitmann A. (2010).** A new post-Kyoto climate regime based on per-capita cumulative CO2-emission rights—rationale, architecture and quantitative assessment of the implication for the CO2-emissions from China, India and the Annex-I countries by 2050. *Mitigation and Adaptation Strategies for Global Change* **15**, 137–168. (DOI: 10.1007/s11027-009-9207-4). Available at: http://link.springer.com/article/10.1007/s11027-009-9207-4.

**Ockwell D.G., R. Haum, A. Mallett, and J. Watson (2010).** Intellectual property rights and low carbon technology transfer: Conflicting discourses of diffusion and development. *Global Environmental Change* **20**, 729–738. (DOI: 10.1016/j.gloenvcha.2010.04.009). Available at: http://www.sciencedirect.com/science/article/pii/S0959378010000385.

**OECD (2011).** *Towards Green Growth*. OECD Publishing, Paris, 142 pp., (ISBN: 9789264094970). Available at: http://www.oecd.org/document/10/0,3746,en_2649_37465_47983690_1_1_1_37465,00.html.

**Oishi S., S. Kesebir, and E. Diener (2011).** Income Inequality and Happiness. *Psychlogical Science* **22**, 1095–1100. (DOI: 10.1177/0956797611417262).

**Okereke C. (2008).** *Global justice and neoliberal environmental governance*. Routledge, London.

**Okereke C. (2010).** Climate justice and the international regime. *Wiley Interdisciplinary Reviews-Climate Change* **1**, 462–474. (DOI: 10.1002/wcc.52).

**Okereke C. (2011).** Moral Foundations for Global Environmental and Climate Justice. *Royal Institute of Philosophy Supplements* **69**, 117–135. (DOI: 10.1017/S1358246111000245).

**Okereke C., H. Bulkeley, and H. Schroeder (2009).** Conceptualizing Climate Governance Beyond the International Regime. *Global Environmental Politics* **9**, 58–+. (DOI: 10.1162/glep.2009.9.1.58).

**Okereke C., and K. Dooley (2010).** Principles of justice in proposals and policy approaches to avoided deforestation: Towards a post-Kyoto climate agreement. *Global Environmental Change-Human and Policy Dimensions* **20**, 82–95. (DOI: 10.1016/j.gloenvcha.2009.08.004).

**Okereke C., and D. McDaniels (2012).** To what extent are EU steel companies susceptible to competitive loss due to climate policy? *Energy Policy* **46**, 203–215. (DOI: 10.1016/j.enpol.2012.03.052).

**Osbaldiston R., and J.P. Schott (2012).** Environmental Sustainability and Behavioral Science: Meta-Analysis of Proenvironmental Behavior Experiments. *Environment and Behavior* **44**, 257–299. (DOI: 10.1177/0013916511402673).

**Ostrom E. (1990).** *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge University Press, 302 pp., (ISBN: 9780521405997).

**Ostrom E. (1998).** A Behavioral Approach to the Rational Choice Theory of Collective Action: Presidential Address, American Political Science Association, 1997. *The American Political Science Review* **92**, 1–22. (DOI: 10.2307/2585925). Available at: http://www.jstor.org/stable/2585925.

**Ostrom E. (2008).** Frameworks and theories of environmental change. *Global Environmental Change* **18**, 249–252. (DOI: 10.1016/j.gloenvcha.2008.01.001). Available at: http://www.sciencedirect.com.ezproxy.library.tufts.edu/science/article/B6VFV-4S0R6N9-2/2/1867c32c2af7afda9b026ae7f5c1fc25.

**Ostrom E. (2010).** Polycentric systems for coping with collective action and global environmental change. *Global Environmental Change* **20**, 550–557. Available at: http://www.sciencedirect.com/science/article/pii/S0959378010000634.

**Ostrom E., J. Burger, C.B. Field, R.B. Norgaard, and D. Policansky (1999).** Revisiting the Commons: Local Lessons, Global Challenges. *Science* **284**, 278–282. (DOI: 10.1126/science.284.5412.278). Available at: http://www.sciencemag.org/content/284/5412/278.

**Paavola J., and W.N. Adger (2006).** Fair adaptation to climate change. *Ecological Economics* **56**, 594–609. (DOI: 10.1016/j.ecolecon.2005.03.015). Available at: http://www.sciencedirect.com/science/article/pii/S0921800905001187.

**Pachauri S., A. Brew-Hammond, D.F. Barnes, D.H. Bouille, S. Gitonga, V. Modi, G. Prasad, A. Rath, and H. Zerriffi (2012).** Chapter 19 - Energy Access for Development. In: *Global Energy Assessment - Toward a Sustainable Future*.Cambridge University Press, Cambridge, UK and New York, NY, USA and the International Institute for Applied Systems Analysis, Laxenburg, Austria pp.1401–1458, (ISBN: 9781 10700 5198 hardback 9780 52118 2935 paperback). Available at: www.globalenergyassessment.org.

**Page S.E. (2006).** Path Dependence. *Quarterly Journal of Political Science* **1**, 87–115. (DOI: 10.1561/100.00000006).

**Paillard S., S. Treyer, and B. Dorin (2010).** *Agrimonde: Scénarios et défis pour nourrir le monde en 2050*. Editions Quae, 298 pp., (ISBN: 9782759208883).

**Palley T. (2007).** Financialization: What it is and Why it Matters. *PERI Working Papers*. Available at: http://scholarworks.umass.edu/peri_workingpapers/135.

**Pan J., J. Phillips, and Y. Chen (2008).** China's balance of emissions embodied in trade: approaches to measurement and allocating international responsibility. *Oxford Review of Economic Policy* **24**, 354–376. (DOI: 10.1093/oxrep/grn016). Available at: http://oxrep.oxfordjournals.org/content/24/2/354.abstract.

**Pan X., F. Teng, and G. Wang (2013).** Sharing emission space at an equitable basis: Allocation scheme based on the equal cumulative emission per capita principle. *Applied Energy*. (DOI: 10.1016/j.apenergy.2013.07.021). Available at: http://www.sciencedirect.com/science/article/pii/S0306261913005874.

**Pandey D., M. Agrawal, and J. Pandey (2011).** Carbon footprint: current methods of estimation. *Environmental Monitoring and Assessment* **178**, 135–160. (DOI: 10.1007/s10661-010-1678-y). Available at: http://www.springerlink.com.globalproxy.cvt.dk/content/g531t74mvh500125/abstract/.

**Parry M. (2009).** Climate change is a development issue, and only sustainable development can confront the challenge. *Climate and Development* **1**, 5–9. (DOI: 10.3763/cdev.2009.0012).

**Parthan B., M. Osterkorn, M. Kennedy, S.J. Hoskyns, M. Bazilian, and P. Monga (2010).** Lessons for low-carbon energy transition: Experience from the Renewable Energy and Energy Efficiency Partnership (REEEP). *Energy for Sustainable Development* **14**, 83–93. (DOI: 10.1016/j.esd.2010.04.003).

**Paterson M. (2009).** Global governance for sustainable capitalism? The political economy of global environmental governance. In: *Governing Sustainability*. Cambridge University Press, Cambridge pp.99–122, (ISBN: 9780521732437).

**Pattberg P. (2010).** Public-private partnerships in global climate governance. *Wiley Interdisciplinary Reviews-Climate Change* **1**, 279–287. (DOI: 10.1002/wcc.38).

**Patzelt H. (2010).** CEO human capital, top management teams, and the acquisition of venture capital in new technology ventures: An empirical analysis. *Journal of Engineering and Technology Management* **27**, 131–147. (DOI: 10.1016/j.jengtecman.2010.06.001). Available at: http://www.sciencedirect.com/science/article/pii/S0923474810000196.

**De Paula Gomes M.S., and M.S. Muylaert de Araujo (2011).** Artificial cooling of the atmosphere-A discussion on the environmental effects. *Renewable & Sustainable Energy Reviews* **15**, 780–786. (DOI: 10.1016/j.rser.2010.07.045).

**Pelling M. (2010).** *Adaptation to Climate Change: From Resilience to Transformation*. Taylor & Francis US, 220 pp., (ISBN: 9780415477505).

**Pendergast S.M., J.A. Clarke, and G.C. van Kooten (2011).** Corruption, Development and the Curse of Natural Resources. *Canadian Journal of Political Science-Revue Canadienne De Science Politique* **44**, 411–437. (DOI: 10.1017/S0008423911000114).

**Penetrante A.M. (2011).** Politics of Equity and Justice in Climate Change Negotiations in North-South Relations. Hexagon Series on Human and Environmental Security and Peace. In: *Coping with Global Environmental Change, Disasters and Security*. H.G. Brauch, Ú.O. Spring, C. Mesjasz, J. Grin, P. Kameri-Mbote, B. Chourou, P. Dunay, J. Birkmann, (eds.), Springer Berlin Heidelberg, pp.1355–1366, (ISBN: 978-3-642-17775-0, 978-3-642-17776-7). Available at: http://link.springer.com/chapter/10.1007/978-3-642-17776-7_86.

**Pepper M., T. Jackson, and D. Uzzell (2009).** An examination of the values that motivate socially conscious and frugal consumer behaviours. *International Journal of Consumer Studies* **33**, 126–136. (DOI: 10.1111/j.1470-6431.2009.00753.x). Available at: http://onlinelibrary.wiley.com.globalproxy.cvt.dk/doi/10.1111/j.1470-6431.2009.00753.x/abstract.

**Pereira H.M., P.W. Leadley, V. Proença, R. Alkemade, J.P.W. Scharlemann, J.F. Fernandez-Manjarrés, M.B. Araújo, P. Balvanera, R. Biggs, W.W.L. Cheung, L. Chini, H.D. Cooper, E.L. Gilman, S. Guénette, G.C. Hurtt, H.P. Huntington, G.M. Mace, T. Oberdorff, C. Revenga, P. Rodrigues, R.J. Scholes, U.R. Sumaila, and M. Walpole (2010).** Scenarios for Global Biodiversity in the 21st Century. *Science* **330**, 1496–1501. (DOI: 10.1126/science.1196624). Available at: http://www.sciencemag.org/content/330/6010/1496.

**Peters G.P. (2010).** Carbon footprints and embodied carbon at multiple scales. *Current Opinion in Environmental Sustainability* **2**, 245–250. (DOI: 10.1016/j.cosust.2010.05.004). Available at: http://www.sciencedirect.com/science/article/pii/S1877343510000369.

**Peters G.P., S.J. Davis, and R. Andrew (2012).** A synthesis of carbon in international trade. *Biogeosciences* **9**, 3247–3276. (DOI: 10.5194/bg-9-3247-2012). Available at: http://www.biogeosciences.net/9/3247/2012/.

**Peters G.P., and E.G. Hertwich (2008a).** CO2 Embodied in International Trade with Implications for Global Climate Policy. *Environ. Sci. Technol.* **42**, 1401–1407. (DOI: 10.1021/es072023k). Available at: http://dx.doi.org/10.1021/es072023k.

**Peters G.P., and E.G. Hertwich (2008b).** Post-Kyoto greenhouse gas inventories: production versus consumption RID B-1012-2008. *Climatic Change* **86**, 51–66. (DOI: 10.1007/s10584-007-9280-1).

**Peters G.P., J.C. Minx, C.L. Weber, and O. Edenhofer (2011).** Growth in emission transfers via international trade from 1990 to 2008. *Proceedings of the National Academy of Sciences* **108**, 8903–8908. (DOI: 10.1073/pnas.1006388108). Available at: http://www.pnas.org/content/108/21/8903.

**Peters G.P., C.L. Weber, D. Guan, and K. Hubacek (2007).** China’s Growing CO2 EmissionsA Race between Increasing Consumption and Efficiency Gains. *Environmental Science & Technology* **41**, 5939–5944. (DOI: 10.1021/es070108f). Available at: http://dx.doi.org/10.1021/es070108f.

**Pezzey J.C.V. (2004).** One-sided sustainability tests with amenities, and changes in technology, trade and population. *Journal of Environmental Economics and Management* **48**, 613–631. (DOI: 10.1016/j.jeem.2003.10.002). Available at: http://www.sciencedirect.com/science/article/pii/S0095069603001219.

**Pezzey J.C.V., and F. Jotzo (2012).** Tax-versus-trading and efficient revenue recycling as issues for greenhouse gas abatement. *Journal of Environmental Economics and Management* **64**, 230–236.

(DOI: 10.1016/j.jeem.2012.02.006). Available at: http://www.sciencedirect.com/science/article/pii/S0095069612000423.

**Pezzey J.C.V., and M. Toman (2002).** Progress and problems in the economics of sustainability. In: *International Yearbook of Environmental and Resource Economics 2002/2003*. Edward Elgar Publishing, .

**Pickering J., and C. Barry (2012).** On the concept of climate debt: its moral and political value. *Critical Review of International Social and Political Philosophy* **15**, 667–685. (DOI: 10.1080/13698230.2012.727311). Available at: http://www.tandfonline.com/doi/abs/10.1080/13698230.2012.727311.

**Picketts I.M., J. Curry, and E. Rapaport (2012).** Community Adaptation to Climate Change: Environmental Planners' Knowledge and Experiences in British Columbia, Canada. *Journal of Environmental Policy and Planning* **14**, 119–137. (DOI: 10.1080/1523908X.2012.659847).

**Pidgeon N.F., I. Lorenzoni, and W. Poortinga (2008).** Climate change or nuclear power - No thanks! A quantitative study of public perceptions and risk framing in Britain. *Global Environmental Change-Human and Policy Dimensions* **18**, 69–85. (DOI: 10.1016/j.gloenvcha.2007.09.005).

**Pimentel D., A. Marklein, M.A. Toth, M.N. Karpoff, G.S. Paul, R. McCormack, J. Kyriazis, and T. Krueger (2009).** Food Versus Biofuels: Environmental and Economic Costs. *Human Ecology* **37**, 1–12. (DOI: 10.1007/s10745-009-9215-8).

**Pimentel D., and M.G. Paoletti (2009).** *Developing a 21st Century View of Agriculture and the Environment* (N. Ferry and A.M.R. Gatehouse, Eds.). Cabi Publishing-C a B Int, Wallingford, (ISBN: 978-1-84593-409-5).

**Pinkse J., and A. Kolk (2012).** Addressing the climate change-sustainable development nexus: The role of multistakeholder partnerships. *Business and Society* **51**, 176–210. (DOI: 10.1177/0007650311427426).

**Plassmann K., A. Norton, N. Attarzadeh, M.P. Jensen, P. Brenton, and G. Edwards-Jones (2010).** Methodological complexities of product carbon footprinting: a sensitivity analysis of key variables in a developing country context. *Environmental Science & Policy* **13**, 393–404. (DOI: 10.1016/j.envsci.2010.03.013). Available at: http://www.sciencedirect.com/science/article/pii/S1462901110000316.

**Plevin R.J., M. O'Hare, A.D. Jones, M.S. Torn, and H.K. Gibbs (2010).** Greenhouse Gas Emissions from Biofuels' Indirect Land Use Change Are Uncertain but May Be Much Greater than Previously Estimated. *Environ. Sci. Technol.* **44**, 8015–8021. (DOI: 10.1021/es101946t). Available at: http://dx.doi.org/10.1021/es101946t.

**Van der Ploeg F. (2011).** Natural Resources: Curse or Blessing? *Journal of Economic Literature* **49**, 366–420. (DOI: 10.1257/jel.49.2.366).

**Pogutz S., and V. Micale (2011).** Sustainable consumption and production. *Society and Economy* **33**, 29–50. (DOI: 10.1556/SocEc.33.2011.1.5). Available at: http://www.akademiai.com/content/j2826827174686k1/.

**Polasky S., S.R. Carpenter, C. Folke, and B. Keeler (2011).** Decision-making under great uncertainty: environmental management in an era of global change. *Trends in Ecology & Evolution* **26**, 398–404. (DOI: 10.1016/j.tree.2011.04.007).

**Polsky C., and H. Eakin (2011).** Global change vulnerability assessments: Definitions, challenges, and opportunities. In: *The Oxford Handbook of Climate Change and Society*. Oxford University Press, (ISBN: 9780199566600).

**Pope J., D. Annandale, and A. Morrison-Saunders (2004).** Conceptualising sustainability assessment. *Environmental Impact Assessment Review* **24**, 595–616. (DOI: 10.1016/j.eiar.2004.03.001). Available at: http://linkinghub.elsevier.com/retrieve/pii/S0195925504000447.

**Posner E.A., and C.R. Sunstein (2007).** Climate Change Justice. *Georgetown Law Journal* **96**, 1565. Available at: http://heinonline.org/HOL/Page?handle=hein.journals/glj96&id=1571&div=&collection=journals.

**Posner E.A., and D. Weisbach (2010).** *Climate Change Justice*. Princeton University Press, 231 pp., (ISBN: 9780691137759).

**Posner E.A., and D. Weisbach (2012).** International Paretianism: A Defense. Available at: http://papers.ssrn.com/abstract=2120650.

**Poteete A.R. (2009).** Is Development Path Dependent or Political? A Reinterpretation of Mineral-Dependent Development in Botswana. *Journal of Development Studies* **45**, 544–571. (DOI: 10.1080/00220380802265488). Available at: http://www.tandfonline.com/doi/abs/10.1080/00220380802265488.

**Potts M. (2007).** Population and environment in the twenty-first century. *Population and Environment* **28**, 204–211. (DOI: 10.1007/s11111-007-0045-6).

**Poumadere M., R. Bertoldo, and J. Samadi (2011).** Public perceptions and governance of controversial technologies to tackle climate change: nuclear power, carbon capture and storage, wind, and geoengineering. *Wiley Interdisciplinary Reviews-Climate Change* **2**, 712–727. (DOI: 10.1002/wcc.134).

**Pow C.-P. (2011).** Living it up: Super-rich enclave and transnational elite urbanism in Singapore. *Geoforum* **42**, 382–393. (DOI: 10.1016/j.geoforum.2011.01.009). Available at: http://www.sciencedirect.com/science/article/pii/S001671851100011X.

**Prescott-Allen R. (1980).** *How to save the world : strategy for world conservation*. Barnes and Noble Books, Totowa, N.J., (ISBN: 0389200115 9780389200116).

**Rajamani L. (2000).** The Principle of Common but Differentiated Responsibility and the Balance of Commitments under the Climate Regime. *Review of European Community & International Environmental Law* **9**, 120–131. (DOI: 10.1111/1467-9388.00243). Available at: http://onlinelibrary.wiley.com/doi/10.1111/1467-9388.00243/abstract.

**Rao N., and P. Baer (2012).** “Decent Living” Emissions: A Conceptual Framework. *Sustainability* **4**, 656–681. (DOI: 10.3390/su4040656). Available at: http://www.mdpi.com/2071-1050/4/4/656.

**Rao K.U., and V.V.N. Kishore (2010).** A review of technology diffusion models with special reference to renewable energy technologies. *Renewable and Sustainable Energy Reviews* **14**, 1070–1078. (DOI: 10.1016/j.rser.2009.11.007). Available at: http://www.sciencedirect.com/science/article/pii/S136403210900269X.

**Rasch P.J., P.J. Crutzen, and D.B. Coleman (2008).** Exploring the geoengineering of climate using stratospheric sulfate aerosols: The role of particle size. *Geophysical Research Letters* **35**. (DOI: 10.1029/2007GL032179).

**Raskin P.D., C. Electris, and R.A. Rosen (2010).** The Century Ahead: Searching for Sustainability. *Sustainability* **2**, 2626–2651. (DOI: 10.3390/su2082626). Available at: http://www.mdpi.com/2071-1050/2/8/2626/.

**Rawls J. (2000).** *A theory of justice.* Belknap, Cambridge Mass., (ISBN: 9780674000773).

**Rayner S. (2010).** How to eat an elephant: a bottom-up approach to climate policy. *Climate Policy* **10**, 615–621. (DOI: 10.3763/cpol.2010.0138). Available at: http://www.tandfonline.com/doi/abs/10.3763/cpol.2010.0138.

**Republic of Korea (2009).** *Road to Our Future: Green Growth, National Strategy and the Five-Year Plan (2009-2013)*. Presidential commission on green growth, Seoul. Available at: http://www.greengrowth.go.kr/english/en_information/en_report/userBbs/bbsView.do.

**Rezai A., L. Taylor, and R. Mechler (2013).** Ecological macroeconomics: An application to climate change. *Ecological Economics* **85**, 69–76. (DOI: 10.1016/j.ecolecon.2012.10.008). Available at: http://www.sciencedirect.com/science/article/pii/S0921800912004120.

**Riisgaard L. (2009).** Global Value Chains, Labor Organization and Private Social Standards: Lessons from East African Cut Flower Industries. *World Development* **37**, 326–340. (DOI: 10.1016/j.worlddev.2008.03.003). Available at: http://www.sciencedirect.com/science/article/pii/S0305750X08001228.

**Ringius L., A. Torvanger, and A. Underdal (2002).** Burden Sharing and Fairness Principles in International Climate Policy. *International Environmental Agreements: Politics, Law and Economics* **2**, 1–22. (DOI: 10.1023/A:1015041613785). Available at: http://www.springerlink.com/content/xn6cb7v5bv2gc4c4/.

**Rist G. (2003).** *The History of Development: From Western Origins to Global Faith*. Zed Books, 308 pp., (ISBN: 9781842771815).

**Rival L. (2010).** Ecuador's Yasuni-ITT Initiative The old and new values of petroleum. *Ecological Economics* **70**, 358–365. (DOI: 10.1016/j.ecolecon.2010.09.007).

**Rive N., A. Torvanger, and J.S. Fuglestvedt (2006).** Climate agreements based on responsibility for global warming: Periodic updating, policy choices, and regional costs. *Global Environmental Change* **16**, 182–194. (DOI: 10.1016/j.gloenvcha.2006.01.002). Available at: http://www.sciencedirect.com/science/article/pii/S0959378006000148.

**Roberts J.T., and B.C. Parks (2007).** *A Climate of Injustice. Global Inequality, North-South Politics, and Climate Policy*. MIT Press, Cambridge Mass., 404 pp.

**Roberts J.T., and B.C. Parks (2009).** Ecologically Unequal Exchange, Ecological Debt, and Climate Justice The History and Implications of Three Related Ideas for a New Social Movement. *International Journal of Comparative Sociology* **50**, 385–409. (DOI: 10.1177/0020715209105147). Available at: http://cos.sagepub.com/content/50/3-4/385.

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

**Rockström J., W. Steffen, K. Noone, A. Persson, F.S. Chapin, E.F. Lambin, T.M. Lenton, M. Scheffer, C. Folke, H.J. Schellnhuber, B. Nykvist, C.A. de Wit, T. Hughes, S. van der Leeuw, H. Rodhe, S. Sorlin, P.K. Snyder, R. Costanza, U. Svedin, M. Falkenmark, L. Karlberg, R.W. Corell, V.J. Fabry, J. Hansen, B. Walker, D. Liverman, K. Richardson, P. Crutzen, and J.A. Foley (2009a).** A safe operating space for humanity. *Nature* **461**, 472–475. (DOI: 10.1038/461472a). Available at: http://dx.doi.org/10.1038/461472a.

**Rockström J., W. Steffen, K. Noone, A. Persson, F.S. Chapin, E.F. Lambin, T.M. Lenton, M. Scheffer, C. Folke, H.J. Schellnhuber, B. Nykvist, C.A. de Wit, T. Hughes, S. van der Leeuw, H. Rodhe, S. Sorlin, P.K. Snyder, R. Costanza, U. Svedin, M. Falkenmark, L. Karlberg, R.W. Corell, V.J. Fabry, J. Hansen, B. Walker, D. Liverman, K. Richardson, P. Crutzen, and J.A. Foley (2009b).** Planetary Boundaries: Exploring the safe operating space for humanity. *Ecology and Society* **14**.

**Roemer J., and K. Suzumura (2007).** *Intergenerational equity and sustainability*. Palgrave Macmillan, Basingstoke ;New York, (ISBN: 9780230007864).

**Rohan M.J. (2000).** A Rose by Any Name? The Values Construct. *Personality and Social Psychology Review* **4**, 255–277. (DOI: 10.1207/S15327957PSPR0403_4). Available at: http://psr.sagepub.com/content/4/3/255.

**Roitner-Schobesberger B., I. Darnhofer, S. Somsook, and C.R. Vogl (2008).** Consumer perceptions of organic foods in Bangkok, Thailand. *Food Policy* **33**, 112–121. (DOI: 10.1016/j.foodpol.2007.09.004). Available at: http://www.sciencedirect.com/science/article/pii/S0306919207000516.

**Romer P.M. (1990).** Endogenous Technological Change. *Journal of Political Economy* **98**, S71–S102. Available at: http://www.jstor.org/stable/2937632.

**Romero-Lankao P. (2012).** Governing Carbon and Climate in the Cities: An Overview of Policy and Planning Challenges and Options. *European Planning Studies* **20**, 7–26. (DOI: 10.1080/09654313.2011.638496).

**Rosenau J.N. (1990).** *Turbulence in World Politics: A Theory of Change and Continuity*. Princeton University Press, Princeton.

**Rosenzweig C., and F.N. Tubiello (2007).** Adaptation and mitigation strategies in agriculture: an analysis of potential synergies. *Mitigation and Adaptation Strategies for Global Change* **12**, 855–873. (DOI: 10.1007/s11027-007-9103-8). Available at: http://link.springer.com/10.1007/s11027-007-9103-8.

**Rothstein B. (2005).** *Social Traps and the Problem of Trust*. Cambridge University Press, Cambridge, UK, 244 pp., (ISBN: 0521848296).

**Rudd M.A. (2000).** Live long and prosper: collective action, social capital and social vision. *Ecological Economics* **34**, 131–144. (DOI: 10.1016/S0921-8009(00)00152-X). Available at: http://www.sciencedirect.com/science/article/pii/S092180090000152X.

**Sachs, Wolfgang (1999).** *Planet Dialectics: Explorations in Environment and Development*. Zed Books Ltd., London, UK and New York, NY, 230 pp., (ISBN: 1 85649 700 3). Available at: http://books.google.com/books?hl=en&lr=&id=0rBPM3qkHncC&oi=fnd&pg=PR8&dq=Sachs,+Wolfgang&ots=Fm8LFgapAl&sig=RVtUCjJ5MbNCePdI5tj9N82ezR4.

**Sacks D.W., B. Stevenson, and J. Wolfers (2010).** *SUBJECTIVE WELL-BEING, INCOME, ECONOMIC DEVELOPMENT AND GROWTH*. NBER. Available at: http://www.nber.org/papers/w16441.

**Sæverud I.A., and J.B. Skjærseth (2007).** Oil Companies and Climate Change: Inconsistencies between Strategy Formulation and Implementation? *Global Environmental Politics* **7**, 42–62. (DOI: 10.1162/glep.2007.7.3.42). Available at: http://dx.doi.org/10.1162/glep.2007.7.3.42.

**Sagar A.D., C. Bremner, and M.J. Grubb (2009).** Climate Innovation Centres: A partnership approach to meeting energy and climate challenges. *Natural Resources Forum* **33**, 274–284.

**Sagar A.D., and J.P. Holdren (2002).** Assessing the global energy innovation system: some key issues. *Energy Policy* **30**, 465–469. (DOI: 10.1016/S0301-4215(01)00117-3).

**Samaras C., and K. Meisterling (2008).** Life Cycle Assessment of Greenhouse Gas Emissions from Plug-in Hybrid Vehicles: Implications for Policy. *Environmental Science & Technology* **42**, 3170–3176. (DOI: 10.1021/es702178s). Available at: http://dx.doi.org/10.1021/es702178s.

**Sandler T. (2010).** Overcoming Global and Regional Collective Action Impediments. *Global Policy* **1**, 40–50. (DOI: 10.1111/j.1758-5899.2009.00002.x). Available at: https://xpv.uab.cat/,DanaInfo=.aaqrvD1kiwouy09zttxwSw98+full_record.do?product=UA&search_mode=GeneralSearch&qid=1&SID=T2GcChMb5e4Lng9hG6f&page=1&doc=1.

**Sanne C. (2002).** Willing consumers—or locked-in? Policies for a sustainable consumption. *Ecological Economics* **42**, 273–287. (DOI: 10.1016/S0921-8009(02)00086-1). Available at: http://www.sciencedirect.com/science/article/pii/S0921800902000861.

**Sanwal M. (2010).** Climate change and global sustainability: The need for a new paradigm for international cooperation. *Climate and Development* **2**, 3–8. (DOI: 10.3763/cdev.2010.0030). Available at: http://www.tandfonline.com/doi/abs/10.3763/cdev.2010.0030.

**Sanwal M. (2011).** Climate change and the Rio +20 summit: A developing country perspective. *Climate and Development* **3**, 89–93. (DOI: 10.1080/17565529.2011.582274). Available at: http://www.tandfonline.com/doi/abs/10.1080/17565529.2011.582274.

**Sarewitz D. (2011).** Does climate change knowledge really matter? *Wiley Interdisciplinary Reviews: Climate Change* **2**, 475–481. (DOI: 10.1002/wcc.126). Available at: http://wires.wiley.com/WileyCDA/WiresArticle/wisId-WCC126.html.

**Sassi O., R. Crassous, J.C. Hourcade, V. Gitz, H. Waisman, and C. Guivarch (2010).** IMACLIM-R: a modelling framework to simulate sustainable development pathways. *International Journal of Global Environmental Issues* **10**, 5. (DOI: 10.1504/IJGENVI.2010.030566). Available at: http://inderscience.metapress.com/app/home/contribution.asp?referrer=parent&backto=issue,1,9;journal,4,29;linkingpublicationresults,1:110856,1.

**Sathaye J., O. Lucon, A. Rahman, J. Christensen, F. Denton, J. Fujino, G. Heath, S. Kadner, M. Mirza, H. Rudnik, A. Schlaepfer, and A. Shmakin (2011).** Renewable Energy in the Context of Sustainable Development. In: *IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation*. O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Shlömer, C. von Stechow, (eds.), Cambridge University Press, .

**Sathaye J., A. Najam, J. Robinson, R. Schaeffer, Y. Sokona, R. Swart, H. Winkler, C. Cocklin, T. Heller, F. Lecocq, J. Llanes-Regueiro, J. Pan, G. Petschel-Held, and S. Rayner (2007).** Sustainable development and mitigation. In: *Climate Change 2007 : Mitigation of Climate Change. Contribution of Working Group III to the Fourth Assessment Report of the IPCC*. B. Metz, O.R. Davidson, P.R. Bosh, R. Dave, L.A. Meyer, (eds.), Cambridge University Press, Cambridge (GBR) pp.692–743, .Available at: http://www.brookings.edu/press/Books/2008/climatechangeandforests.aspx.

**Schäfer W. (2009).** Some Talk, No Action (Yet): Interdependence, Domestic Interests and Hierarchical EU Governance in Climate Policy. *Swiss Political Science Review* **15**, 683–713. (DOI: 10.1002/j.1662-6370.2009.tb00150.x). Available at: http://doi.wiley.com/10.1002/j.1662-6370.2009.tb00150.x.

**Scheidel A., and A.H. Sorman (2012).** Energy transitions and the global land rush: Ultimate drivers and persistent consequences. *Global Environmental Change*. (DOI: 10.1016/j.gloenvcha.2011.12.005). Available at: http://www.sciencedirect.com/science/article/pii/S0959378011002068.

**Scherbov S., W. Lutz, and W.C. Sanderson (2011).** The Uncertain Timing of Reaching 8 Billion, Peak World Population, and Other Demographic Milestones. *Population and Development Review* **37**, 571–+. (DOI: 10.1111/j.1728-4457.2011.00435.x).

**Schmidheiny S., and WBSCD (1992).** *Changing Course: A Global Business Perspective on Development and the Environment*. MIT Press.

**Schmidt-Bleek F. (2008).** Factor 10: The future of stuff. *Sustainability: Science, Practice, & Policy* **4**. Available at: http://sspp.proquest.com/archives/vol4iss1/editorial.schmidt-bleek.html.

**Schoeneberger M., G. Bentrup, H. De Gooijer, R. Soolanayakanahally, T. Sauer, J. Brandle, X. Zhou, and D. Current (2012).** Branching out: Agroforestry as a climate change mitigation and adaptation tool for agriculture. *Journal of Soil and Water Conservation* **67**, 128A–136A. (DOI: 10.2489/jswc.67.5.128A).

**Schokkaert E. (2009).** The capabilities approach. In: *The Handbook of Rational and Social Choice*. P. Anand, P.K. Pattanaik, C. Puppe, (eds.), Oxford University Press, pp.542–566, .

**Schopenhauer A. (1819).** *Le monde comme volonté et comme représentation (Die Welt als Wille und Vorstellung) trad. A. Bureau, 1966*. Presses Universitaires de France, Paris.

**Schrader U., and J. Thøgersen (2011).** Putting Sustainable Consumption into Practice. *Journal of Consumer Policy* **34**, 3–8. (DOI: 10.1007/s10603-011-9154-9). Available at: http://www.springerlink.com/content/vv73448j23087460/.

**Schroeder H., M.T. Boykoff, and L. Spiers (2012).** Equity and state representations in climate negotiations. *Nature Climate Change* **2**, 834–836. (DOI: 10.1038/nclimate1742). Available at: http://www.nature.com/nclimate/journal/v2/n12/full/nclimate1742.html.

**Schultz T.W. (1961).** Investment in Human Capital. *The American Economic Review* **51**, 1–17.

**Schultz T.P. (1995).** *Investment in Women's Human Capital*. The University of Chicago Press, Chicago, (ISBN: 0226740889).

**Schultz T.P. (2003).** Human capital, schooling and health. *Economics and Human Biology* **1**, 207–221.

**Schwartz S.H., and W. Bilsky (1987).** Toward a universal psychological structure of human values. *Journal of Personality and Social Psychology* **53**, 550–562. (DOI: 10.1037/0022-3514.53.3.550).

**Scott K.N. (2013).** International Law in the Anthropocene: Responding to the Geoengineering Challenge. *Michigan Journal of International Law* **35**.

**Scrieciu S., A. Rezai, and R. Mechler (2013).** On the economic foundations of green growth discourses: the case of climate change mitigation and macroeconomic dynamics in economic modeling. *Wiley Interdisciplinary Reviews: Energy and Environment* **2**, 251–268. (DOI: 10.1002/wene.57). Available at: http://onlinelibrary.wiley.com/doi/10.1002/wene.57/abstract.

**Sen A. (1997).** Editorial: Human Capital and Human Capability. *World Development* **25**, 1959–1961.

**Sen A. (2001).** *Development as freedom*. Oxford University Press, Oxford; New York, (ISBN: 0192893300 9780192893307).

**Sen A.K. (2009).** *The idea of justice*. Belknap Press of Harvard University Press, Cambridge, Mass., (ISBN: 9780674036130 0674036131).

**Seres S., E. Haites, and K. Murphy (2009).** Analysis of technology transfer in CDM projects: An update. *Energy Policy* **37**, 4919–4926. (DOI: 10.1016/j.enpol.2009.06.052).

**Shackley S., C. McLachlan, and C. Gough (2005).** The public perception of carbon dioxide capture and storage in the UK: results from focus groups and a survey. *Climate Policy* **4**, 377–398.

**Shalizi Z., and F. Lecocq (2009).** *Climate Change and the Economics of Targeted Mitigation in Sectors with Long-Lived Capital Stock*. World Bank, Washington, D.C. 41 pp. Available at: http://www-wds.worldbank.org/external/default/WDSContentServer/IW3P/IB/2009/09/23/000158349_20090923161232/Rendered/PDF/WPS5063.pdf.

**Shalizi Z., and F. Lecocq (2010).** To Mitigate or to Adapt: Is that the Question? Observations on an Appropriate Response to the Climate Change Challenge to Development Strategies. *The World Bank Research Observer* **25**, 295 –321. (DOI: 10.1093/wbro/lkp012). Available at: http://wbro.oxfordjournals.org/content/25/2/295.abstract.

**Shalizi Z., and F. Lecocq (2013).** The economics of targeted mitigation in infrastructure. *Climate Policy* **(accepted)**.

**Sharma A., A. Saxena, M. Sethi, V. Shree, and Varun (2011).** Life cycle assessment of buildings: A review. *Renewable and Sustainable Energy Reviews* **15**, 871–875. (DOI: 10.1016/j.rser.2010.09.008). Available at: http://www.sciencedirect.com/science/article/pii/S1364032110002959.

**Shaw D., and T. Newholm (2002).** Voluntary simplicity and the ethics of consumption. *Psychology and Marketing* **19**, 167–185. (DOI: 10.1002/mar.10008). Available at: http://onlinelibrary.wiley.com.globalproxy.cvt.dk/doi/10.1002/mar.10008/abstract.

**Shiva V. (2008).** Soil not oil: environmental justice in a time of climate crisis. , 145 pp.

**Shrader-Frechette K. (2011).** Climate Change, Nuclear Economics, and Conflicts of Interest. *Science and Engineering Ethics* **17**, 75–107. (DOI: 10.1007/s11948-009-9181-y).

**Shue H. (1993).** Subsistence Emissions and Luxury Emissions. *Law & Policy* **15**, 39–60. (DOI: 10.1111/j.1467-9930.1993.tb00093.x). Available at: http://onlinelibrary.wiley.com/doi/10.1111/j.1467-9930.1993.tb00093.x/abstract.

**Shue H. (1999).** Global Environment and International Inequality, Global Environment and International Inequality. *International Affairs, International Affairs* **75**, 531–545. (DOI: 10.1111/1468-2346.00092, 10.1111/1468-2346.00092). Available at: http://onlinelibrary.wiley.com.ezproxy.library.tufts.edu/doi/10.1111/1468-2346.00092/abstract.

**Shui B., and R.C. Harriss (2006).** The role of CO2 embodiment in US–China trade. *Energy Policy* **34**, 4063–4068. (DOI: 10.1016/j.enpol.2005.09.010). Available at: http://www.sciencedirect.com/science/article/pii/S0301421505002478.

**Shukla P.R., S. Dhar, and D. Mahapatra (2008).** Low-carbon society scenarios for India. *Climate Policy* **8**, S156–S176. (DOI: 10.3763/cpol.2007.0498). Available at: http://www.tandfonline.com/doi/abs/10.3763/cpol.2007.0498.

**Sinden G. (2009).** The contribution of PAS 2050 to the evolution of international greenhouse gas emission standards. *The International Journal of Life Cycle Assessment* **14**, 195–203. (DOI: 10.1007/s11367-009-0079-3). Available at: http://www.springerlink.com/content/h5t355676273k01w/.

**Singer P. (2004).** *One World: The Ethics of Globalization*. Yale University Press, 264 pp., (ISBN: 9780300103052).

**Smith K.R. (1991).** Allocating Responsibility for Global Warming: The Natural Debt Index. *Ambio* **20**, 95–96. Available at: http://www.jstor.org/stable/4313785.

**Smith P., D. Martino, Z. Cai, D. Gwary, H. Janzen, P. Kumar, B. McCarl, S. Ogle, F. O'Mara, C. Rice, B. Scholes, O. Sirotenko, M. Howden, T. McAllister, G. Pan, V. Romanenkov, U. Schneider, and S. Towprayoon (2007).** Policy and technological constraints to implementation of greenhouse gas mitigation options in agriculture. *Agriculture Ecosystems & Environment* **118**, 6–28. (DOI: 10.1016/j.agee.2006.06.006).

**Smith H.A., and K. Sharp (2012).** Indigenous climate knowledges. *Wiley Interdisciplinary Reviews: Climate Change* **3**, 467–476. (DOI: 10.1002/wcc.185). Available at: http://wires.wiley.com/WileyCDA/WiresArticle/wisId-WCC185.html.

**Smith K.R., J. Swisher, and D. Ahuja (1993).** Who pays to solve the problem and how much? also Working Paper No. 1991-22, World Bank Environment Department. In: *The Global Greenhouse Regime: Who Pays?* P. Hayes, K.R. Smith, (eds.), Earthscan, Oxford, UK pp.70–98, (ISBN: 9781853831362).

**Sneddon C., R.B. Howarth, and R.B. Norgaard (2006).** Sustainable development in a post-Brundtland world. *Ecological Economics* **57**, 253–268. (DOI: 10.1016/j.ecolecon.2005.04.013). Available at: http://www.sciencedirect.com/science/article/pii/S0921800905002053.

**Sobrevila C. (2008).** *The Role of Indigenous Peoples in Biodiversity Conservation: The role of Natural but Often Forgotten Partners*. The World Bank, Washington D.C. 84 pp.

**Soimakallio S., J. Kiviluoma, and L. Saikku (2011).** The complexity and challenges of determining GHG (greenhouse gas) emissions from grid electricity consumption and conservation in LCA (life cycle assessment) – A methodological review. *Energy* **36**, 6705–6713. (DOI: 10.1016/j.energy.2011.10.028). Available at: http://www.sciencedirect.com/science/article/pii/S0360544211006876.

**Sokka L., S. Pakarinen, and M. Melanen (2011).** Industrial symbiosis contributing to more sustainable energy use – an example from the forest industry in Kymenlaakso, Finland. *Journal of Cleaner Production* **19**, 285–293. (DOI: 10.1016/j.jclepro.2009.08.014). Available at: http://www.sciencedirect.com/science/article/pii/S0959652609002868.

**Solow R.M. (1956).** A Contribution to the Theory of Economic Growth. *The Quarterly Journal of Economics* **70**, 65–94. Available at: http://www.jstor.org/stable/1884513.

**Solow R.M. (2000).** Toward a Macroeconomics of the Medium Run. *The Journal of Economic Perspectives* **14**, 151–158. Available at: http://www.jstor.org/stable/2647058.

**Soroos M.S. (1997).** *The Endangered Atmosphere: Preserving a Global Commons*. Univ of South Carolina Pr, 339 pp., (ISBN: 1570031606).

**Southerton D. (2012).** Habits, routines and temporalities of consumption: From individual behaviours to the reproduction of everyday practices. *Time & Society*. (DOI: 10.1177/0961463X12464228). Available at: http://tas.sagepub.com/content/early/2012/12/10/0961463X12464228.

**Speth J.G., and P. Haas (2006).** *Global Environmental Governance: Foundations of Contemporary Environmental Studies*. Island Press, 192 pp., (ISBN: 1597260819).

**Springmann M. (2012).** A look inwards: Carbon tariffs versus internal improvements in emissions-trading systems. *Energy Economics* **34, Supplement 2**, S228–S239. (DOI: 10.1016/j.eneco.2012.08.039). Available at: http://www.sciencedirect.com/science/article/pii/S0140988312002095.

**Srinivasan U.T., S.P. Carey, E. Hallstein, P.A.T. Higgins, A.C. Kerr, L.E. Koteen, A.B. Smith, R. Watson, J. Harte, and R.B. Norgaard (2008).** The debt of nations and the distribution of ecological impacts from human activities. *Proceedings of the National Academy of Sciences* **105**, 1768 –1773. (DOI: 10.1073/pnas.0709562104). Available at: http://www.pnas.org/content/105/5/1768.abstract.

**Standard & Poor's (2013).** *What A Carbon-Constrained Future Could Mean For Oil Companies' Creditworthiness*. Standard & Poor's Financial Services LLC. Available at: http://www.carbontracker.org/wp-content/uploads/downloads/2013/03/SnPCT-report-on-oil-sector-carbon-constraints_Mar0420133.pdf.

**Starkey R. (2011).** Assessing common(s) arguments for an equal per capita allocation. *The Geographical Journal* **177**, 112–126. (DOI: 10.1111/j.1475-4959.2010.00359.x). Available at: http://onlinelibrary.wiley.com.ezproxy.library.tufts.edu/doi/10.1111/j.1475-4959.2010.00359.x/abstract.

**Stechemesser K., and E. Guenther (2012).** Carbon accounting: a systematic literature review. *Journal of Cleaner Production*. (DOI: 10.1016/j.jclepro.2012.02.021). Available at: http://www.sciencedirect.com/science/article/pii/S0959652612000972.

**Steckel J.C., M. Kalkuhl, and R. Marschinski (2010).** Should carbon-exporting countries strive for consumption-based accounting in a global cap-and-trade regime? *Climatic Change* **100**, 779–786. (DOI: 10.1007/s10584-010-9825-6). Available at: http://www.springerlink.com/index/10.1007/s10584-010-9825-6.

**Steffen W., J. Grinevald, P. Crutzen, and J. McNeill (2011).** The Anthropocene: conceptual and historical perspectives. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* **369**, 842–867. (DOI: 10.1098/rsta.2010.0327). Available at: http://rsta.royalsocietypublishing.org/content/369/1938/842.

**Stern N.H., and G.B. Treasury (2007).** *The economics of climate change: the Stern review*. Cambridge University Press, 713 pp., (ISBN: 9780521700801).

**Stevenson H., and J.S. Dryzek (2012).** The discursive democratisation of global climate governance. *Environmental Politics* **21**, 189–210. (DOI: 10.1080/09644016.2012.651898).

**Stevenson B., and J. Wolfers (2008).** Economic growth and subjective well-being: reassessing the Easterlin Paradox. In: *Brookings Papers on Economic Activity: Spring 2008*. Brookings Institution Press, Washington, D.C. pp.1–102, .

**Stiglitz J.E. (2002).** *Globalization And Its Discontents*. W.W. Norton, New York and London, 282 pp., (ISBN: 0-393-05124-2).

**Stiglitz J.E., A. Sen, and J.-P. Fitoussi (2009).** *Report by the Commission on the Measurement of Economic Performance and Social Progress*. Paris. 2632–2637 pp. Available at: http://www.stiglitz-sen-fitoussi.fr/documents/rapport_anglais.pdf.

**Stoll-Kleemann S., T. O'Riordan, and C.C. Jaeger (2001).** The psychology of denial concerning climate mitigation measures: evidence from Swiss focus groups. *Global Environmental Change-Human and Policy Dimensions* **11**, 107–117. (DOI: 10.1016/S0959-3780(00)00061-3).

**Stone C. (2004).** Common but Differentiated Responsibilities in International Law. *American Journal of International Law* **98**, 276–301. Available at: http://www.jstor.org/stable/10.2307/3176729.

**Sullivan R., and A. Gouldson (2012).** Does voluntary carbon reporting meet investors' needs? *Journal of Cleaner Production*. (DOI: 10.1016/j.jclepro.2012.02.020). Available at: http://www.sciencedirect.com/science/article/pii/S0959652612000960.

**Sundarakani B., R. de Souza, M. Goh, S.M. Wagner, and S. Manikandan (2010).** Modeling carbon footprints across the supply chain. *International Journal of Production Economics* **128**, 43–50. (DOI: 10.1016/j.ijpe.2010.01.018). Available at: http://www.sciencedirect.com/science/article/pii/S0925527310000289.

**Swan T.W. (1956).** ECONOMIC GROWTH and CAPITAL ACCUMULATION. *Economic Record* **32**, 334–361. (DOI: 10.1111/j.1475-4932.1956.tb00434.x). Available at: http://onlinelibrary.wiley.com/doi/10.1111/j.1475-4932.1956.tb00434.x/abstract.

**Swanson D., S. Barg, S. Tyler, H. Venema, S. Tomar, S. Bhadwal, S. Nair, D. Roy, and J. Drexhage (2010).** Seven tools for creating adaptive policies. *Technological Forecasting and Social Change* **77**, 924–939. (DOI: 10.1016/j.techfore.2010.04.005). Available at: http://www.sciencedirect.com/science/article/pii/S0040162510000727.

**Swart R., J. Robinson, and S. Cohen (2003).** Climate change and sustainable development: expanding the options. *Climate Policy* **3**, S19–S40. (DOI: 10.1016/j.clipol.2003.10.010). Available at: http://linkinghub.elsevier.com/retrieve/pii/S1469306203001013.

**Swim J., S. Clayton, T. Doherty, R. Gifford, G. Howard, J. Reser, P. Stern, and E.U. Weber (2009).** Psychology and Global Climate Change: Addressing a Multi-faceted Phenomenon and Set of Challenges. Available at: http://www.apa.org/science/about/publications/climate-change.aspx.

**Di Tella R., and R. MacCulloch (2010).** Happiness Adaption to Income beyond "Basic Needs." In: *International Differences in Well-Being*. E. Diener, J. Helliwell, D.M. Kahneman, (eds.), Oxford University Press, New York.

**Terjesen S. (2007).** Building a better rat trap: Technological innovation, human capital, and the irula. *Entrepreneurship Theory and Practice* **31**, 953–963. (DOI: 10.1111/j.1540-6520.2007.00204.x).

**Thampapillai D.J. (2011).** Value of sensitive in-situ environmental assets in energy resource extraction. *Energy Policy* **39**, 7695–7701. (DOI: 10.1016/j.enpol.2011.09.006). Available at: http://www.sciencedirect.com/science/article/pii/S0301421511006951.

**Thøgersen J. (2002).** Promoting green consumer behavior with eco-labels. In: *New Tools for Environmental Protection: Education, Information, and Voluntary Measures*. T. Dietz, P.C. Stern, (eds.), National Academies Press, Washington, D.C. pp.83–104, (ISBN: 9780309084222).

**Thøgersen J. (2005).** How May Consumer Policy Empower Consumers for Sustainable Lifestyles? *Journal of Consumer Policy* **28**, 143–177. (DOI: 10.1007/s10603-005-2982-8). Available at: http://link.springer.com.globalproxy.cvt.dk/article/10.1007/s10603-005-2982-8.

**Thøgersen J. (2009).** Consumer decision-making with regard to organic food products. In: *Traditional Food Production and Rural Sustainable Development: A European Challenge*. M.T. de N. Vaz, P. Nijkamp, J.L. Rastoin, (eds.), Ashgate Publishing, Farnham pp.173–194, (ISBN: 9780754674627).

**Thøgersen J. (2010).** Country Differences in Sustainable Consumption: The Case of Organic Food. *Journal of Macromarketing* **30**, 171–185. (DOI: 10.1177/0276146710361926). Available at: http://jmk.sagepub.com.globalproxy.cvt.dk/content/30/2/171.

**Thøgersen J., A.-K. Jørgensen, and S. Sandager (2012).** Consumer Decision Making Regarding a "Green" Everyday Product. *Psychology and Marketing* **29**, 187–197. (DOI: 10.1002/mar.20514). Available at: http://onlinelibrary.wiley.com.globalproxy.cvt.dk/doi/10.1002/mar.20514/abstract.

**Thøgersen J., and Y. Zhou (2012).** Chinese consumers' adoption of a "green" innovation – The case of organic food. *Journal of Marketing Management* **28**, 313–333. (DOI: 10.1080/0267257X.2012.658834). Available at: http://www.tandfonline.com/doi/abs/10.1080/0267257X.2012.658834.

**Thornton P.K., and P.J. Gerber (2010).** Climate change and the growth of the livestock sector in developing countries. *Mitigation and Adaptation Strategies for Global Change* **15**, 169–184. (DOI: 10.1007/s11027-009-9210-9).

**Thuiller W. (2007).** Biodiversity: Climate change and the ecologist. *Nature* **448**, 550–552. (DOI: 10.1038/448550a). Available at: http://www.nature.com/doifinder/10.1038/448550a.

**Tol R.S.J. (1999).** The marginal costs of greenhouse gas emissions. *Energy Journal* **20**, 61–81.

**Tompkins E.L., and W.N. Adger (2005).** Defining response capacity to enhance climate change policy. *Environmental Science & Policy* **8**, 562–571. (DOI: 10.1016/j.envsci.2005.06.012). Available at: http://www.sciencedirect.com/science/article/pii/S146290110500105X.

**Tonello M. (2006).** *Revisiting Stock Market Short-Termism*. Social Science Research Network, Rochester, NY. Available at: http://papers.ssrn.com/abstract=938466.

**Truffer B., and L. Coenen (2012).** Environmental Innovation and Sustainability Transitions in Regional Studies. *Regional Studies* **46**, 1–21. (DOI: 10.1080/00343404.2012.646164). Available at: http://www.tandfonline.com/doi/abs/10.1080/00343404.2012.646164.

**Truman H.S. (1949).** Inaugural Address, Thursday, January 20, 1949. Available at: http://www.bartleby.com/124/pres53.html.

**Tsai T. (2008).** The impact of social capital on regional waste recycling. *Sustainable Development* **16**, 44–55. (DOI: 10.1002/sd.326). Available at: https://xpv.uab.cat/,DanaInfo=.aaqrvD1kiwouy09zttxwSw98+full_record.do?product=UA&search_mode=GeneralSearch&qid=1&SID=R21KP3JD4HmjO2Be8Mp&page=1&doc=2.

**Tubi A., I. Fischhendler, and E. Feitelson (2012).** The effect of vulnerability on climate change mitigation policies. *Global Environmental Change-Human and Policy Dimensions* **22**, 472–482. (DOI: 10.1016/j.gloenvcha.2012.02.004).

**Tukker A., M.J. Cohen, K. Hubacek, and O. Mont (2010a).** The Impacts of Household Consumption and Options for Change. *Journal of Industrial Ecology* **14**, 13–30. (DOI: 10.1111/j.1530-9290.2009.00208.x). Available at: http://onlinelibrary.wiley.com/doi/10.1111/j.1530-9290.2009.00208.x/abstract.

**Tukker A., M.J. Cohen, K. Hubacek, and O. Mont (2010b).** Sustainable Consumption and Production. *Journal of Industrial Ecology* **14**, 1–3. (DOI: 10.1111/j.1530-9290.2009.00214.x). Available at: http://onlinelibrary.wiley.com/doi/10.1111/j.1530-9290.2009.00214.x/abstract.

**Tukker A., M.J. Cohen, U. Zoysa, E. Hertwich, P. Hofstetter, A. Inaba, S. Lorek, and E. Stø (2006).** The Oslo Declaration on Sustainable Consumption. *Journal of Industrial Ecology* **10**, 9–14. (DOI: 10.1162/108819806775545303). Available at: http://onlinelibrary.wiley.com.globalproxy.cvt.dk/doi/10.1162/108819806775545303/abstract.

**Turner II B.L. (2010).** Vulnerability and resilience: Coalescing or paralleling approaches for sustainability science? *Global Environmental Change* **20**, 570–576. (DOI: 10.1016/j.gloenvcha.2010.07.003). Available at: http://linkinghub.elsevier.com/retrieve/pii/S0959378010000622.

**U.S. National Research Council Committee on Atmospheric Sciences (1966).** *Weather and climate modification problems and prospects: Final report of the Panel on Weather and Climate Modification*. National Academy of Sciences, Washington, DC.

**UK Government Office for Science (2011).** *Foresight: Migration and Global Environmental Change (2011) Final Project Report*. London. Available at: http://www.bis.gov.uk/foresight/our-work/projects/published-projects/global-migration/reports-publications.

**UN (2010).** *China and a sustainable future: towards a low carbon economy and society*. China Translation and Publishing Corporation, Beijin. Available at: http://planipolis.iiep.unesco.org/upload/China/China_HDR_2009_2010.pdf.

**UNCSD (2001).** *Indicators of Sustainable Development: Framework and Methodologies*. United Nations Commission on Sustainable Development, New York.

**UNEP (1972).** *Report of the United Nations Conference on Human Environment*. UNEP.

**UNEP (1997).** *Environment Outlook-1*. UNEP and Oxford University Press, New York and Oxford, UK.

**UNEP (2000).** *Global Environment Outlook*. UNEP and Earthscan, London.

**UNEP (2002).** *Global Environment Outlook-3*. UNEP and Earthscan, London and Sterling, VA, US.

**UNEP (2011).** *Decoupling natural resource use and environmental impacts from economic growth*. United Nations Environment Programme. Available at: http://www.unep.org/resourcepanel/decoupling/files/pdf/Decoupling_Report_English.pdf.

**UNFCCC (2002).** *Report of the Conference of the Parties on its seventh session, held at Marrakech from 29 October to 10 November 2001*. UNFCCC.

**United Nations (1992a).** *United Nations Framework Convention on Climate Change*. Rio de Janeiro. Available at: http://unfccc.int.

**United Nations (1992b).** *Rio Declaration on Environment and Development*. Available at: https://www.google.com/search?q=rio+declaration+1992&ie=utf-8&oe=utf-8&aq=t&rls=org.mozilla:en-US:official&client=firefox-a.

**United Nations (1992c).** Agenda 21. United Nations Conference on Environment & Development. Available at: http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=52&ArticleID=52&l=en.

**United Nations (1997).** *Programme for Further Implementation of Agenda 21 and the Commitments to the Rio Declaration principles*.

**United Nations (2000).** *United Nations Millennium Declaration*. New York. Available at: http://www.un.org/millennium/declaration/ares552e.htm.

**United Nations (2002).** *Plan of Implementation*. Johannesburg.

**United Nations (2011a).** Millennium Development Goals Report 2011. United Nations, New York. Available at: http://www.un.org/millenniumgoals/pdf/(2011_E)%20MDG%20Report%202011_Book%20LR.pdf.

**United Nations (2011b).** *World population prospects, the 2010 revision*. Available at: http://esa.un.org/undp/wpp/index.htm.

**United Nations (2012a).** *The Future We Want*. Available at: http://uncsd2012.org/thefuturewewant.html.

**United Nations (2012b).** A 10-year framework of programmes on sustainable consumption and production patterns. A/CONF.216/5. Available at: http://www.unep.org/resourceefficiency/Policy/SCPPoliciesandthe10YFP/The10YearFrameworkProgrammesonSCP/tabid/102563/Default.aspx.

**United Nations Development Programme (2013).** *Human development report 2013: the rise of the South : human progress in a diverse world.* (ISBN: 9211263409 9789211263404 9211263468 9789211263466).

**United Nations Environment Programme, European Patents Office, and International Centre for Trade and Sustainable Development (2010).** *Patents and clean energy: bridging the gap between evidence and policy*. Munich.

**UNPRI (2012).** *Investing in the sustainable economy*. United Nations Principles for Responsible Investment, London.

**Vanclay J.K., J. Shortiss, S. Aulsebrook, A.M. Gillespie, B.C. Howell, R. Johanni, M.J. Maher, K.M. Mitchell, M.D. Stewart, and J. Yates (2010).** Customer Response to Carbon Labelling of Groceries. *Journal of Consumer Policy* **34**, 153–160. (DOI: 10.1007/s10603-010-9140-7). Available at: http://www.springerlink.com/content/1lw15301384j31u2/.

**Vermeulen S.J., P.K. Aggarwal, A. Ainslie, C. Angelone, B.M. Campbell, A.J. Challinor, J.W. Hansen, J.S.I. Ingram, A. Jarvis, P. Kristjanson, C. Lau, G.C. Nelson, P.K. Thornton, and E. Wollenberg (2012).** Options for support to agriculture and food security under climate change. *Environmental Science and Policy* **15**, 136–144. (DOI: 10.1016/j.envsci.2011.09.003).

**Victor D. (1998).** The Regulation of Greenhouse Gases: Does Fairness Matter? In: *Fair weather? Equity concerns in climate change*. F.L. Tóth, (ed.), Earthscan, London(ISBN: 1853835579 9781853835575 1853835587 9781853835582).

**Victor D.G. (2004).** *The Collapse Of The Kyoto Protocol And The Struggle To Slow Global Warming*. Princeton University Press, 219 pp., (ISBN: 9780691120263).

**Visschers V.H.M., and M. Siegrist (2012).** Fair play in energy policy decisions: Procedural fairness, outcome fairness and acceptance of the decision to rebuild nuclear power plants. *Energy Policy* **46**, 292–300. (DOI: 10.1016/j.enpol.2012.03.062).

**Vlek C., and L. Steg (2007).** Human behavior and environmental sustainability: Problems, driving forces, and research topics. *Journal of Social Issues* **63**, 1–19. (DOI: 10.1111/j.1540-4560.2007.00493.x).

**Vogel C., S.C. Moser, R.E. Kasperson, and G.D. Dabelko (2007).** Linking vulnerability, adaptation, and resilience science to practice: Pathways, players, and partnerships. *Global Environmental Change* **17**, 349–364. (DOI: 10.1016/j.gloenvcha.2007.05.002). Available at: http://www.sciencedirect.com/science/article/pii/S0959378007000374.

**Wada K., F. Sano, K. Akimoto, and T. Homma (2012).** Assessment of Copenhagen pledges with long-term implications. *Energy Economics* **34, Supplement 3**, S481–S486. (DOI: 10.1016/j.eneco.2012.01.001). Available at: http://www.sciencedirect.com/science/article/pii/S0140988312000023.

**Waisman H., J. Rozenberg, and J.C. Hourcade (2013).** Monetary compensations in climate policy through the lens of a general equilibrium assessment: The case of oil-exporting countries. *Energy Policy*. (DOI: 10.1016/j.enpol.2013.08.055). Available at: http://www.sciencedirect.com/science/article/pii/S0301421513008598.

**Walker G., and H. Bulkeley (2006).** Geographies of environmental justice. *Geoforum* **37**, 655–659. (DOI: 10.1016/j.geoforum.2005.12.002). Available at: http://www.sciencedirect.com/science/article/pii/S0016718505001399.

**Wallquist L., V.H.M. Visschers, and M. Siegrist (2010).** Impact of Knowledge and Misconceptions on Benefit and Risk Perception of CCS. *Environmental Science & Technology* **44**, 6557–6562. (DOI: 10.1021/es1005412).

**Walters C.J., and C.S. Holling (1990).** Large-Scale Management Experiments and Learning by Doing. *Ecology* **71**, 2060–2068. (DOI: 10.2307/1938620). Available at: http://www.esajournals.org/doi/abs/10.2307/1938620.

**Wang B. (2010).** Can CDM bring technology transfer to China?—An empirical study of technology transfer in China's CDM projects. *Energy Policy* **38**, 2572–2585. (DOI: 10.1016/j.enpol.2009.12.052). Available at: http://www.sciencedirect.com/science/article/pii/S030142151000008X.

**Wang Can, Chen Jining, and Zou Ji (2005).** Impact assessment of CO_2 mitigation on China economy based on a CGE model. *Journal of Tsinghua University (Science and Technology)* **12**.

**Wang Ke (2008).** Technological Change Simulation and Its Application in Climate Change Policy Analysis Based on a CGE Model. Tsinghua University.

**Wang S., C. Wang, and Y. Xu (2013).** *Intellectual Property Rights and Climate Change*. Social Sciences Academic Press.

**Warren R. (2011).** The role of interactions in a world implementing adaptation and mitigation solutions to climate change. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* **369**, 217–241. (DOI: 10.1098/rsta.2010.0271).

**Watson A., R. Matt, K. Knotek, D. Williams, and L. Yung (2011).** Traditional wisdom: protecting relationships with wilderness as a cultural landscape. *Ecology and Society* **16**, 36–.

**Weale A. (2009).** Governance, government and the pursuit of sustainability. In: *Governing Sustainability*. Cambridge University Press, Cambridge pp.55–75, .

**Weber E.U., and E.J. Johnson (2009).** Mindful Judgment and Decision Making. *Annual Review of Psychology* **60**, 53–85. (DOI: 10.1146/annurev.psych.60.110707.163633). Available at: http://www.annualreviews.org/doi/abs/10.1146/annurev.psych.60.110707.163633.

**Weber E.U., and E.J. Johnson (2012).** Psychology and behavioral economics. Lessons for the design of a green growth strategy. *Policy Research Working Paper, The World Bank*, 1–47.

**Wei T., S. Yang, J.C. Moore, P. Shi, X. Cui, Q. Duan, B. Xu, Y. Dai, W. Yuan, X. Wei, Z. Yang, T. Wen, F. Teng, Y. Gao, J. Chou, X. Yan, Z. Wei, Y. Guo, Y. Jiang, X. Gao, K. Wang, X. Zheng, F. Ren, S. Lv, Y. Yu, B. Liu, Y. Luo, W. Li, D. Ji, J. Feng, Q. Wu, H. Cheng, J. He, C. Fu, D. Ye, G. Xu, and W. Dong (2012).** Developed and developing world responsibilities for historical climate change and CO2 mitigation. *Proceedings of the National Academy of Sciences* **109**, 12911–12915. (DOI: 10.1073/pnas.1203282109). Available at: http://www.pnas.org/content/109/32/12911.

**Weitzman M.L. (1976).** On the Welfare Significance of National Product in a Dynamic Economy. *The Quarterly Journal of Economics* **90**, 156 –162. (DOI: 10.2307/1886092). Available at: http://qje.oxfordjournals.org/content/90/1/156.abstract.

**Von Weizsäcker E., K. Hargroves, M.H. Smith, C. Desha, and P. Stasinopoulos (2009).** *Factor Five: Transforming the Global Economy through 80% Improvements in Resource Productivity*. Earthscan/The Natural Edge Project, London and Sterling, VA, US, (ISBN: 9781844075911).

**Von Weizsäcker E., A.B. Lovins, and L.H. Lovins (1997).** *Factor Four: Doubling Wealth, Halving Resource Use - A Report to the Club of Rome*. Earthscan, London, (ISBN: 9781864484380).

**Welsch H. (1993).** A CO2 agreement proposal with flexible quotas. *Energy Policy* **21**, 748–756. (DOI: 10.1016/0301-4215(93)90145-6). Available at: http://www.sciencedirect.com/science/article/pii/0301421593901456.

**Wenzel H., M.Z. Hauschild, and L. Alting (1997).** *Environmental Assessment of Products: Volume 1: Methodology, Tools and Case Studies in Product Development*. Springer, 568 pp., (ISBN: 9780792378594).

**Wewerinke M., and V.P. Yu III (2010).** *ADDRESSING CLIMATE CHANGE THROUGH SUSTAINABLE DEVELOPMENT AND THE PROMOTION OF HUMAN RIGHTS*. South Centre.

**Weyant J.P. (2011).** Accelerating the development and diffusion of new energy technologies: Beyond the "valley of death." *Energy Economics* **33**, 674–682. (DOI: 10.1016/j.eneco.2010.08.008). Available at: http://www.sciencedirect.com/science/article/pii/S0140988310001295.

**Whitmarsh L. (2009).** Behavioural responses to climate change: Asymmetry of intentions and impacts. *Journal of Environmental Psychology* **29**, 13–23.

**Wick K., and E. Bulte (2009).** The Curse of Natural Resources. In: *Annual Review of Resource Economics*. Annual Reviews, Palo Alto pp.139–155, (ISBN: 978-0-8243-4701-7).

**Wiedmann T.O., M. Lenzen, and J.R. Barrett (2009).** Companies on the Scale. *Journal of Industrial Ecology* **13**, 361–383. (DOI: 10.1111/j.1530-9290.2009.00125.x). Available at: http://onlinelibrary.wiley.com/doi/10.1111/j.1530-9290.2009.00125.x/abstract.

**Wilbanks T.J. (2005).** Issues in developing a capacity for integrated analysis of mitigation and adaptation. *Environmental Science & Policy* **8**, 541–547. (DOI: 10.1016/j.envsci.2005.06.014). Available at: http://www.sciencedirect.com/science/article/pii/S1462901105001036.

**Williams B.K. (2011).** Adaptive management of natural resources—framework and issues. *Journal of Environmental Management* **92**, 1346–1353. (DOI: 10.1016/j.jenvman.2010.10.041). Available at: http://www.sciencedirect.com/science/article/pii/S0301479710003737.

**Wilson E.O. (1978).** *On Human Nature*. Harvard University Press, 292 pp., (ISBN: 9780674016385).

**Wing H.D.J.I.S. (1999).** Adjustment Time, Capital Malleability and Policy Cost. *The Energy Journal* **20**. (DOI: 10.5547/ISSN0195-6574-EJ-Vol20-NoSI-4). Available at: http://www.iaee.org/en/publications/ejarticle.aspx?id=1043.

**Winkler H., K. Baumert, O. Blanchard, S. Burch, and J. Robinson (2007).** What factors influence mitigative capacity? *Energy Policy* **35**, 692–703. (DOI: 10.1016/j.enpol.2006.01.009). Available at: http://www.sciencedirect.com/science/article/pii/S0301421506000437.

**Winkler H., B. Brouns, and S. Kartha (2006).** Future mitigation commitments: differentiating among non-Annex I countries. *Climate Policy* **5**, 469–486. (DOI: 10.1080/14693062.2006.9685572). Available at: http://www.tandfonline.com/doi/abs/10.1080/14693062.2006.9685572.

**Winkler H., T. Letete, and A. Marquard (2011).** A South African approach – responsibility, capability and sustainable development. In: *Equitable access to sustainable development: Contribution to the body of scientific knowledge*. BASIC expert group, Beijing, Brasilia, Cape Town and Mumbai pp.78–91, .Available at: http://www.erc.uct.ac.za/Basic_Experts_Paper.pdf.

**Wittneben B.B.F., C. Okereke, S.B. Banerjee, and D.L. Levy (2012).** Climate Change and the Emergence of New Organizational Landscapes. *Organization Studies* **33**, 1431–1450. (DOI: 10.1177/0170840612464612).

**Wolf J., W.N. Adger, I. Lorenzoni, V. Abrahamson, and R. Raine (2010).** Social capital, individual responses to heat waves and climate change adaptation: An empirical study of two UK cities. *Global Environmental Change-Human and Policy Dimensions* **20**, 44–52. (DOI: 10.1016/j.gloenvcha.2009.09.004).

**Wolf J., I. Allice, and T. Bell (2013).** Values, climate change, and implications for adaptation: Evidence from two communities in Labrador, Canada. *Global Environmental Change* **23**, 548–562. (DOI: 10.1016/j.gloenvcha.2012.11.007). Available at: http://www.sciencedirect.com/science/article/pii/S0959378012001380.

**Wolf J., and S.C. Moser (2011).** Individual understandings, perceptions, and engagement with climate change: insights from in-depth studies across the world. *Wiley Interdisciplinary Reviews: Climate Change* **2**, 547–569. (DOI: 10.1002/wcc.120). Available at: http://wires.wiley.com/WileyCDA/WiresArticle/wisId-WCC120.html.

**Wollenberg E. (2012).** *Climate change mitigation and agriculture*. Earthscan, London; New York, (ISBN: 9781849713924 1849713928 9781849713931 1849713936 9780203144510 0203144511).

**Wolsink M. (2007).** Planning of renewables schemes: Deliberative and fair decision-making on landscape issues instead of reproachful accusations of non-cooperation. *Energy Policy* **35**, 2692–2704. (DOI: 10.1016/j.enpol.2006.12.002). Available at: http://www.sciencedirect.com/science/article/pii/S0301421506004836.

**Wood P.J., and F. Jotzo (2011).** Price floors for emissions trading. *Energy Policy* **39**, 1746–1753. (DOI: 10.1016/j.enpol.2011.01.004). Available at: http://www.sciencedirect.com/science/article/pii/S0301421511000140.

**Woolcock M. (1998).** Social capital and economic development: Toward a theoretical synthesis and policy framework. *Theory and Society* **27**, 151–208. (DOI: 10.1023/A:1006884930135).

**Woolcock M., and D. Narayan (2000).** Social Capital: Implications for Development Theory, Research, and Policy. *The World Bank Research Observer* **15**, 225–249. (DOI: 10.1093/wbro/15.2.225). Available at: http://wbro.oxfordjournals.org/content/15/2/225.

**World Bank (2003).** *World Development Report 2003: Sustainable Development in a dynamic World*. World Bank, Washington, D.C.

**World Bank (2010).** *World Development Report 2010: Development and Climate Change*. World Bank, Washington, D.C., 424 pp., (ISBN: 978-0-8213-7987-5). Available at: http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/EXTWDRS/EXTWDR2010/0,,menuPK:5287748~pagePK:64167702~piPK:64167676~theSitePK:5287741,00.html.

**World Bank (2011).** *The Changing Wealth of Nations. Measuring Sustainable Development in the New Millenium*. World Bank, Washington DC.

**World Commission on Environment and Development (1987).** *Our common future*. Oxford University Press, Oxford.

**Yarime M. (2009).** Public coordination for escaping from technological lock-in: its possibilities and limits in replacing diesel vehicles with compressed natural gas vehicles in Tokyo. *Journal of Cleaner Production* **17**, 1281–1288. (DOI: 10.1016/j.jclepro.2009.03.010). Available at: http://www.sciencedirect.com/science/article/pii/S0959652609001115.

**Yigitcanlar T., and K. Velibeyoglu (2008).** Knowledge-Based Urban Development: The Local Economic Development Path of Brisbane, Australia. *Local Economy* **23**, 195–207. (DOI: 10.1080/02690940802197358). Available at: http://www.tandfonline.com/doi/abs/10.1080/02690940802197358.

**Young O.R. (2012).** *On Environmental Governance: Sustainability, Efficiency, and Equity*. Paradigm Publishers, 192 pp., (ISBN: 1612051324).

**Young O.R. (2013).** Does Fairness Matter in International Environmental Governance? Creating an Effective and Equitable Climate Regime. In: *Toward a New Climate Agreement: Conflict, Resolution and Governance*. C. Todd, J. Hovi, D. McEvoy, (eds.),.

**Young W., K. Hwang, S. McDonald, and C.J. Oates (2010).** Sustainable consumption: green consumer behaviour when purchasing products. *Sustainable Development* **18**, 20–31. (DOI: 10.1002/sd.394). Available at: http://onlinelibrary.wiley.com.globalproxy.cvt.dk/doi/10.1002/sd.394/abstract.

**Yue C., and S. Wang (2012).** The National Development Rights Framework Bridging the gap between developed and developing countries.

**Yung W.K.C., H.K. Chan, J.H.T. So, D.W.C. Wong, A.C.K. Choi, and T.M. Yue (2011).** A life-cycle assessment for eco-redesign of a consumer electronic product. *Journal of Engineering Design* **22**, 69–85. (DOI: 10.1080/09544820902916597). Available at: http://www.tandfonline.com/doi/abs/10.1080/09544820902916597.

**Zelli F. (2011).** The fragmentation of the global climate governance architecture. *Wiley Interdisciplinary Reviews-Climate Change* **2**, 255–270. (DOI: 10.1002/wcc.104).

**Zografos C., and J. Martinez-Alier (2009).** The politics of landscape value: a case study of wind farm conflict in rural Catalonia. *Environment and Planning A* **41**, 1726–1744. (DOI: 10.1068/a41208).