Verhagen

Data · November 2015

2 authors:

Kirsten Halsnæs
Technical University of Denmark
68 PUBLICATIONS **2,138** CITATIONS

SEE PROFILE

Jan Verhagen
Wageningen University & Research
199 PUBLICATIONS **3,302** CITATIONS

SEE PROFILE

Springer Link

Original Article

Mitigation and Adaptation Strategies for Global Change

June 2007, Volume 12, *Issue 5,* pp 665-684

First online: 24 April 2007

Development based climate change adaptation and mitigation—conceptual issues and lessons learned in studies in developing countries

- Kirsten Halsnæs
- , Jan Verhagen

10.1007/s11027-007-9093-6

Abstract

This paper discusses the conceptual basis for linking development policies and climate change adaptation and mitigation and suggests an analytical approach that can be applied to studies in developing countries. The approach is centred on a broad set of policy evaluation criteria that merge traditional economic and sectoral goals and broader social issues related to health and income distribution. The approach is inspired by institutional economics and development paradigms that emphasise human wellbeing, resource access, empowerment, and the arrived freedoms. It is outlined how indicators of wellbeing can be used to assess policies that integrate development and climate change policy objectives, and this approach is discussed in comparison with other work that rather have been inspired by sustainable development aspects of manmade, natural, and social capital. The experiences and results from case studies of development and climate that have done a first attempt to use human wellbeing indicators are reported and discussed. The studies include work from India, China, South Africa, Brazil, Bangladesh, and Senegal. A number of policy examples in the energy-, food-, and water sectors in these studies have shown up to demonstrate numerous linkages between

development policies and climate change. Various analytical tools have been used in the studies including quantitative and qualitative scenario work as well as detailed micro-based analysis. The methodological conclusion that can be drawn from these studies, is that it is possible to apply wellbeing indicators to the more detailed policy assessment, but a link to more general national and regional scenario work is not yet established.

Keywords

Development and climate change linkages – Wellbeing indicators – Energy-, food-, and water security in developing countries

1 Introduction

In many developing countries today the issue of climate change is overshadowed by a number of immediate development priorities. These include poverty eradication, food and water security, health, natural resource management, energy access, transportation needs, and local air and water pollution. Despite not being recognised as an immediate policy priority, climate change in many cases is expected to exacerbate immediate development stresses through temperature increases, water scarcities, and through weather variability and extreme events.

Meeting current development challenges require large investments, technology transfer, as well as human and social capacity building, and resources for such initiative are scarce. However development programs will be less effective when they overlook potential synergies and tradeoffs between development and climate change. The effectiveness of development strategies may be reduced and sectoral vulnerability enhanced if climate change adaptation and mitigation are not taking into account.

The aim of this paper is to present a development oriented methodological framework for integrated assessment of climate change adaptation and mitigation policies, and to discuss the framework in relation to case studies from developing countries. The framework is inspired by the theoretical work on human wellbeing and empowerment by Armatya Sen *1999* and Partha Dasgupta *1993*.

The framework suggested here is focused on the assessment of climate policy impacts on human wellbeing dimensions given the specific institutional factors that characterise developing countries such as technological inefficiencies, implementation barriers, and market limitations. This is different from other frameworks of climate change analysis, that often are structured around a detailed representation of key vulnerable sectors like agriculture and forestry and major Greenhouse gas (GHG) emitting sectors.

2 Conceptual issues

Economic studies of climate change policies in developing countries involve a number of complex methodological issues including understanding the linkages between economic development processes, human development needs, technological innovation, and climate change adaptation and mitigation policies. In this way, climate change basically is rooted in core aspects of the economic development process as such. It is a consequence of anthropogenic GHG emissions related to resource consumption and production processes, and climate change at the same time influences the productive basis of the economy and human living conditions.

There are several key economic development issues that are directly related to climate change impacts, and to adaptation and mitigation policies including:

- Economic growth processes, capital accumulation, investments, technological change, and labour productivity.
- Natural resource consumption and environmental impacts.
- Institutional issues.
- Human wellbeing, basic needs, and equity.

A key theme in development economics is the distinction between economic growth and development. Economic growth in this context can be understood as represented by aggregate measures of economic output like GDP, while development also requires considerations about social factors. The general point is that development problems deserve a special attention going beyond what is included in traditional neoclassical economics. The following sections discuss how specific features of development processes can be reflected in development and climate change studies inspired by recent work in development economics.

The common basic foundation of most economic development theories is the neoclassical paradigm that is structured around determining the conditions for optimal resource allocation. No particular attention is given to the identification of reasons why economies like developing countries can deviate from optimal resource allocation, and the specific development policy recommendations that directly arrive from the “pure” neoclassical theoretical paradigm therefore are limited.

A key policy recommendation of the neo-classical paradigm is to remove all market distortions. Seen in a climate change policy context the neoclassical approach, first of all, recommends to internalise environmental externalities like climate change into the market mechanism and to use economic instruments such as taxes, emission trading, insurance markets, etc. in climate change mitigation or adaptation policies. More specifically energy and food security policies, in addition to the need for internalising climate change, according to this framework, will include general policy recommendations about improving markets through liberalisation policies, subsidy removal, and other measures. These policy recommendations need to be

considered cautiously, when implemented in a context, where current market structures are far from optimal resource allocation conditions.

Some of the major schools in development economics that have examined how inefficiency in the economies of developing countries and equity concerns can be addressed are institutional economics, and the work of Amartya Sen and Partha Dasgupta on development and human wellbeing. These paradigms provide different understandings about core development issues that can be recognised as providing part of the basis for proposed climate change adaptation and mitigation options in developing countries. A brief overview in the following will be given on how these paradigms consider economic development issues and the derived climate change policy implications.

Recent development research has included studies on the role of institutions as a critical component in an economy's capacity to use resources optimally. Institutions are here in a broad sense being understood as the core allocation mechanism and as the structure of society that organises markets and other interactions (Peet and Hartwich *1999*, p. 58). A weak institutional structure basically explains why an economy can be in a position that is significantly below its potential. Several economists suggest that the institutional structure can be understood as the so called "missing link" in the production function that explains differences in economy's productive capacity (Meier *2001*). Furthermore weak institutions also provide a basis for high transaction costs because frictions in economic exchange processes arrive when institutions are weak.

Seen in relation to ongoing international discussion about the potential for climate change mitigation policies with negative costs, which by many is referred to as no-regret policy options (IPCC *2001b*, Chapter 7), the precondition for the existence of such options to a large extent are the factors that are addressed by the institutional economists.

Weak institutions in developing countries have many implications for the capacity to adapt or mitigate to climate change. A review of the social capital literature and the implications for climate change mitigation policies by Olhoff *2002* concludes, that successful implementation of GHG emission reduction options in most cases will depend on additional measures to increase the potential market and the number of exchanges. This can involve strengthening the incentives for exchange (prices, capital markets, information efforts and the like), introduction of new actors (institutional and human capacity efforts), and reducing the risks of participating (legal framework, information, general policy context of market regulation). The measures all depend on the nature of the formal institutions, the social groups of society, and the interactions between them." (Olhoff *2002*, p. 76).

This understanding of institutional mechanisms has wide policy implications. The policy implication is formulated by Douglas North as there is no greater challenge than forming a dynamic theory of social change than enables an understanding of an economy's "adaptive efficiency", by which North means a flexible institutional matrix that adjusts to technical and demographic change as well as to shocks to the system (after Peet and Hartwick *1999*, p. 60). The policy recommendation that

follows is to enhance institutions like the financial sector, information and risk sharing, as well as general market development.

Some of the climate change policy recommendations that are inspired by institutional economics include general capacity building programmes, market development, and local enterprise and finance development for example in the form of soft loans and micro credits, in addition to educational and training programmes.

A group of development theories have focussed on development and human welfare. This includes i.e., work by A. Sen and P. Dasgupta. Dasgupta in his inquiry into wellbeing and destitution is concluding that "citizens achievements are the wrong things to look at. We should instead be looking at the extent to which they enjoy the freedom to achieve their ends, no matter what their ends turn out to be. The problem is that the extent of such freedoms depends upon the degree which citizens make use of income and basic needs." (Dasgupta *1993* p. 54). Following that, Dasgupta recommends to study the distribution of resources, as opposed to outcomes (which for example can be measured in terms of welfare). The access to income and basic needs are seen as a fundamental basis for human wellbeing and these needs include education, food, energy, medical care etc. that the individuals can use as inputs in meeting their individual desires. Dasgupta see the public policy role as ensuring these basic requisites of human needs.

Amartya Sen sees development in terms of the freedoms of individuals. "In focusing on evaluating development, it is not being suggested that there is some unique and precise 'criterion' of development in terms of which the different development experiences can always be ranked and compared. The motivation underlying the approach of 'development as freedom' is not so much to order all states...but to draw attention to important aspects of the process of development" (Sen *1999*, p. 33).

Returning to the previous discussions about growth and development the approaches suggested by Dasgupta and Sen can be said to capture both these dimensions at the same time. Income can be seen as a measure of economic growth including specific distributional concerns, while basic needs reflect a requirement for assuring basic access to key resources as a prerequisite for development. The basic needs are here assigned to individuals but a social responsibility element is also included through the claim that the freedom of individuals should not be infringed by the activities of other.

The theories that focus on human wellbeing are closely related to ethics in emphasising the rights of all human beings to have access to specific resources. In addition to this ethical dimension the approaches can also be understood as related to the discussion about economic growth processes. Seen in this context, human wellbeing and basic needs require the provision of resources and income that are critical in enhancing the skills of the labour force, which again support income generation and the establishment of domestic demand including demand from the poorer parts of the population. All together this can be seen as constituting important growth factors in the domestic economy. In this way human capital is highlighted as a critical growth factor.

Human wellbeing paradigms have recently been influential in development policies for the energy and food/water sectors as for example reflected in the World Banks Poverty Reduction Strategies (World Bank *2001*).

In terms of climate change policies the equity dimensions as included in the wellbeing paradigms have important implications at the global and national level. As a global environmental problem climate change is influencing the global atmosphere and thereby the climate dependent resources available for all human beings to pursue their goals. In particularly developing countries and low income groups will experience significant negative influences from climate change. Following that, it can be argued that it is the obligation of the international society to ensure that dangerous anthropogenic interference with the climate is prevented in order to ensure that development can proceed in a sustainable manner. From a national perspective the argument can be that climate change policies should be embedded in development policies in order to ensure individuals access to those resources that are directly related to climate change adaptation and mitigation policies. Such policies include land resource management, and energy and water access and affordability.

3 Conclusions: conceptual issues

The previous discussion has identified a number of climate change policy recommendations including market reform policies such as removal of subsidies and other barriers, liberalisation policies, and environmental taxes that are in line with the understanding of neoclassical economic theory. It was concluded that the performance of these policies depend on that the economies are in a state of efficient resource allocation, which is typically not the case for developing countries. This provides a case for including alternative paradigms like institutional economics and human wellbeing concepts that suggest to examine policy implementation given real market features and empowerment in developing countries.

A specific feature of institutional economics, is the high emphasis given to human, social and institutional factors and their role in reducing the transactions costs and thereby increasing the efficiency of the economy. In this way, the climate change policy recommendations arriving from institutional economics to a large extent focus on strengthening of markets and other information exchange processes including support of human and social capacities.

In the same way development paradigms that focus on human wellbeing and freedom first at all see climate change as a possible constraint to the rights of individuals to enjoy the freedom to achieve their needs including energy-, food- and water access, health services, education, political rights etc. Following this, climate change policies are to be embedded in development policies and should ensure that any individual's rights and freedom are not infringed. More specifically in relation to adaptation policies, it can be argued that the policies should compensate any climate

change losses that the individuals may experience in relation to basis needs, and mitigation policies should not imply any reduction in the access and affordability of energy, food and water resources.

4 Methodological framework issues in integrating climate change in development studies

The previous section highlighted a number of issues that are important to consider in the establishment of a methodological framework for development based climate change studies. Dependent on the applied development paradigm, a number of specific issues were identified as key conceptual issues to be addressed in climate change adaptation and mitigation studies for developing countries. These include market performance and efficiency improvements, institutional issues, industrialisation and growth processes, and human wellbeing factors. This section will present a framework for how human wellbeing dimensions can be addressed as part of climate change adaptation and mitigation studies.

4.1 Human wellbeing as a policy goal for development and climate change policies

Climate change adaptation and mitigation policies have a number of implications on resources that are considered to be important factors in human wellbeing including economic impacts, equity, natural resources, energy-, food- and water access, health and education. Methodological approaches that until now have been used to study adaptation and mitigation policies have not included most of these factors, but have predominantly reflected traditional energy and land use sector issues and have included various economic and technology oriented aspects with a lot of details.

Approaches that take the starting point in human wellbeing and development can be structured around an evaluation of climate change policy goals in relation to a broad range of the described development aspects. One way to structure such an analytical approach will be to define an overall goal function for the climate change policy evaluation that include arguments in terms of wellbeing indices. These for example can be based on indicators that reflect:

- Total income generation and income distribution related to income levels, geographical structure, and gender.
- Energy access and affordability for different income groups.
- Water access and affordability for different income groups.
- Food access and affordability for different income groups.

- Health status and access to health services.
- Educational status and access to education.
- Governance and local participation in policy implementation.

It is to a large extent possible to define quantitative or qualitative indicators that reflect these human wellbeing dimensions that can be used to access specific policies. Obviously, it is most easy to apply well being indicators to the evaluation of individual policy options like adaptation or mitigation projects in the agricultural and energy sectors, rather than to integrate wellbeing indicators in general national or regional analysis. This is the case, because the wellbeing issues addressed here by definition as mentioned earlier reflect the freedom and rights of individuals. A meaning full representation of these therefore requires rather detailed information that is most easy to cover in micro-oriented or sectoral studies.

Table *1* provides more detailed examples of wellbeing indicators that can be used to assess climate change adaptation and mitigation policy options in the energy and

food production sectors.

Table 1

Examples of wellbeing Indicators that be applied to the evaluation of energy and food sector policies

	Themes	Sector and project level indicators
Energy, food and water supply and consumption	Supply and demand including structure, efficiency, and costs	Energy balance
		Efficiency of conversion and end use
		Food products
		Essential nutrients
		Water balance
		Profit
		Costs
		Employment
Environmental impacts	Climate change	Climate change vulnerability
	Air pollution	GHG emissions
	Water	Air pollution
	Waste	Water pollution
	Biodiversity	Toxic compounds and organisms
		Soil degradation
		Flora and fauna
Accessibility	Supply to business and households	Energy balance
	Transmission	Transmission systems
	Other infrastructure	Supply structure, coverage, efficiency including income

	Themes	Sector and project level indicators
	Other infrastructure	Supply structure, coverage, efficiency including income segment structure and gender issues
	Markets	Traditional fuels
Affordability	Costs	Cost measures
	Investments	Capital requirements and costs
	Income distribution	Energy expenditures relative to total production costs
		Energy expenditures relative to household expenditures for different income segments
		Food expenditures relative to total production costs
		Food expenditures relative to household expenditures for different income segments
		Time spent on energy and food provision
Health	Life expectancy	Life expectancy
	Nutrition	Infant mortality
	Energy for health services	Indoor air quality
		Nutrition
		Energy supply

The wellbeing dimensions that are suggested in Table *1* include energy and food supply and consumption, environmental impacts, accessibility and affordability, health, and education, and a number of quantitative and qualitative indicators are suggested as measurement standards in these areas. The indicators in addition to more traditional economic and environmental standard measures also include rather detailed information about income distribution, health and educational issues. The assessment of such impacts requires the inclusion of nationally specific

social data, which for example are available in a number of countries in so called household income expenditure surveys.

It is worth recognising that the well being indicators that are suggested in Table *1* include many of the dimensions that are covered in the Millenium Development Goals, MDG that was adopted by the World Summit on Sustainable Development in Johannesburg in August 2003 (UNDP 2003). Some of the major MDG's are to decrease poverty, to reduce hunger and to improve education and health. Environmental issues are only directly referred to in the MDG's in relation to air pollution impacts on health and to degradation of natural resources. However, there are several strong linkages between the top priorities of the MDG's as for example poverty alleviation and issues like improved energy access and increased food/water supply and climate change policy objectives. Supply of high quality and clean energy offers income generation opportunities for business as well as for households and may allow time for educational activities. At the same time access to clean energy improves health conditions and energy is needed for health clinics and educational activities.

Agriculture provides a livelihood for the majority of people living in rural areas in developing countries. Agriculture is of critical importance to the rural poor as it in many cases is the only strategy that provides access to food and income. Food security is related to the current access to an adequate diet and to the probability of having access to this diet in the future. It depends on economic and social factors, such as markets, financial institutions, property rights and other institutional issues as well as on climate variability including short-term fluctuations as well as more permanent climatic changes. The core of these rural development policies is to increase market access and to increase the effectiveness and the outputs of agricultural production systems without compromising the natural capital.

Agriculture will in most countries not be able to provide work and income for the increasing population, so the joint development of other sectors, industries and services is important. In cases where agricultural goods provide the materials for industry and other economic sectors, changes in agricultural production systems will go hand in hand with changes in industry. Industrial transitions in the developing countries will be strongly linked to changes in agriculture. In some cases besides the more traditional functions of food and fiber production, work and income provision facilitated by agricultural development, are supplemented with other functions like nature protection, biodiversity, landscape, water supply and carbon sequestration.

A number of multilateral agencies and overseas development programmes including The African Development Bank, The Asian Development Bank, UNDP, the World Bank, UNEP, and the governments of the UK and Germany have developed a special report that discuss the linkages between development and poverty alleviation policies, and this report focus on a number of the same issues as the ones addressed in the discussion about wellbeing indicators. The first output is the Interagency Poverty and Climate Change report (African Development Bank et al. *2003*). The report concludes that low-income countries and poor people are in particularly vulnerable to climate change. It is emphasised that the adaptive capacity generally is

socially constructed being conditioned and sometimes constrained by cultural, religious and political structures in addition to economic resources, technology, information, infrastructure, and institutions. Poor countries are in general least endowed with these factors and their vulnerability to climate change is therefore high.

The report provides a number of examples on linkages between Millennium Development Goals and climate change vulnerability and adaptation (African Development Bank et al. *2003*, Table *2*). It is here demonstrated that there are numerous linkages between climate change impacts and the MDG's starting with the influence from climate change on livelihood assets and economic growth, and continuing with a number of serious health impacts including heat-related mortality, vector-borne diseases, and water and nutrition. Specific gender and educational issues are also identified as areas that indirectly will be impacted. The table finally includes a number of global sustainability issues related to ecosystems, biodiversity,

and the need for international collaboration.

Table 2

Development and climate linkages—national case examples

Policy	Development impacts	Climate change mitigation/adaptation
India		
South Asia energy-electricity market integration: gas electricity, water	Energy supply savings of 60 EJ from 2010 to 2030. Cost savings $180 bill. SO_2 emission reductions of 50 mill. t	1.4 Bill. TC saved over 30 years
Local air pollution control : CNG taxis and buses	Reduced local air pollution	CO_2 reductions
Climate change causing flooding and erosion of Konkan railway	Railway opened in 1998, today 20% of repair and maintenance costs due to climate conditions (rainfall and landslides). Future climate variability will increase costs.	Adaptation options could have been to integrate climate change impacts in the railway planning (location, tunnels etc.)
Improved irrigation systems for agriculture including energy efficiency measures for pumping	Improved water management and decreased consumption. Reduced costs of pumping systems	60% energy efficiency improvements in end use technologies. GHG emission reductions in power production systems.
China		
Energy efficiency certification system in industry and power production	Local air pollution control. Energy cost savings in efficiency cases	Energy and GHG emissions savings that e.g., related to household refrigerators provide savings of 1.1 bill. Kwh, 0.4 mill. T. C, and 0.67 bill. RMB
Increased gas, nuclear power, small scale hydro power, wind and solar energy	Improved energy access	Total SD scenario for the energy sector offers CO_2 reductions of 1,5 bill. T C in 2030
Restructuring of the agricultural sector	Increase or maintain grain production levels via sustainable agriculture	Reduce vulnerability to climate related stresses
Protection of ecosystems and return of land with low fertility	Decreased land degradation, desertification, and water stress	Increased forest area and carbon sequestration. Adaptation to decreased precipitation

Policy	Development impacts	Climate change mitigation/adaptation
Protection of ecosystems and return of land with low fertility to forest	Decreased land degradation, desertification, and water stress	Increased forest area and carbon sequestration. Adaptation to decreased precipitation
South Africa		
DSM programme on tariff induced load shifting	Cost savings from reduced capacity needs	DSM Eskom programme on tariff-induced load shifting
Clean energy generation mix: gas, hydro, nuclear, renewables	Energy security benefits, local environmental improvements	Annual CO_2 savings in 2025: 70 mill. T CO_2
Industrial energy efficiency in three major companies	Energy cost savings, local environmental improvements	Annual CO_2 savings of about 0.07 mill. T CO_2
Management of water supply and demand Including water recycling, demand savings, and groundwater and reservoir management	Improved water access for households and economic sectors	Offset decreased precipitation and droughts
Brazil		
Ethanol: 22% blend with gasoline in cars, sugarcane	Employment, foreign exchange savings, local air pollution reduction.	9.45 mill. T C saved from 1990–91 (17% of energy sector emissions). Profitable at oil price of $30
Procel energy savings programme (demand and supply side):	Procel investments R$ mill. 33.5 1986–94. Avoided investments 1986–94: R$mill. 600 and fuel saving benefits.	CO_2 reduction 5,4 mill T CO_2, or 16 % of baseline in 2000
Zero tillage to ensure higher content of organics matters in soil		60–90 mill. T CO_2 not released in 1999, 70% reduction in diesel consumption
Climate change vulnerability	Increased use of herbicides, energy cost savings	

Policy	Development impacts	Climate change mitigation/adaptation
Senegal		
Expansion of LPG to substitute woodfuel	Decreased deforestation. Decreased negative social impacts from woodfuel consumption. Improved energy access	Savings of 700,000 m3 wood a year from 1974–2000
Electricity reform including efficiency improvements and supply to rural areas	Reduced electricity supply costs	Reduced GHG emission intensity of power production
Promotion of drought resistant crop species	Improved agricultural development	Adaptation to decreased precipitation
Concessional credit lines to support agricultural equipment	Strengthen productive capacity of agriculture	Reduce climate change vulnerability in agriculture
Bangladesh		
Decentralised small NG power, biomass, solar home systems and other renewables, DSM	Supply electricity at minimum 540 kwh/capita/year	Decreased GHG emission intensity of energy supply
Natural gas, oil and gas exploitation, biomass supply, switching from petroleum to NG, energy efficiency in industry.	Supply primary fuel at minimum 4 mill. BTU/cap/year	Offset threats from climate change in terms of droughts, flooding, salinity, decreased crops, and erosion. Adaptation options include land reforms, improved production practices and quality seeds
Agricultural credits, improved fertiliser management and crops, and knowledge transfer	Increased food production to minimum daily requirements for the growing population	
Disaster management systems		

The actual application of a broad policy evaluation framework that includes the many well being dimensions that are shown in Table *1*, will involve a number of practical and methodological complexities. Few studies will be able to collect appropriate information about all dimensions, and the result of policy evaluations will take the form of multiple indicators that can represent synergies as well as tradeoffs between various dimensions. The actual treatment and interpretation of such study outputs depend on the methodological approaches applied to the policy evaluation and for decision-making processes. Some of the alternative approaches that can be used to such policy evaluations are discussed by Halsnæs and Markandya *2002* and IPCC *2001a*, Chapter 10.

The following sections in more detail presents the outcome of recent case studies on development based climate change policies based on case studies for Bangladesh, Brazil, China, India, Senegal, and South Africa, and returns from this back to the discussion about methodological approaches that can be used for such policy evaluations.

5 Experiences with development based climate change approaches

As already said, few international studies have addressed climate change policies in a development context. However, there is an emerging international literature about more conceptual issues regarding how sustainable development and climate change adaptation and mitigation policies can be linked.

A number of the conceptual discussions were initiated by the Third Assessment Report of IPCC. The IPCC Synthesis report (IPCC *2002*) recognised the importance of understanding the relationship between sustainable development and climate change and concludes on this background that “the climate change issue is part of the larger challenge of sustainable development”. As a result, climate policies can be more effective when consistently embedded within broader strategies designed to make national and regional development paths more sustainable. This occurs because the impact of climate variability and change, climate policy responses, and associated socio-economic development will affect the ability of countries to achieve sustainable development goals. Conversely, the pursuit of those goals will in turn affect the opportunities for, and success of, climate policies. In particular, the socio-economic and technological characteristics of different development paths will strongly affect emissions, the rate and magnitude of climate change, climate change impacts, the capability to adapt, and the capacity to mitigate.” The major findings of IPCC at the more conceptual level accordingly were, that sustainable development can be used as a framework for understanding society’s ability to respond to climate change impacts, but more work is needed to understand and assess the capacity for policy implementation.

In line with this understanding, IPCC WGII and WGIII concluded that the capacity for implementing climate change adaptation and mitigation policies depends on various aspects related to manmade-, natural-, human-, and social capital, and these capitals at the same time at a more general level constitute the basis for sustainable development (IPCC *2001a*, Chapter 18; IPCC *2001b*, Chapter 1). In accordance with this framework, a more specific definition of adaptive capacity was given by Yohe and Moss *2000*. The adaptive capacity to climate change impacts is here determined by:

- The availability of resources and their distribution across the population.
- The structure of critical institutions and the derivative allocation of decision-making authority.
- The stock of human capital, including education and personal security.
- The stock of social capital including the definition of property rights.
- The systems access to risk spreading processes.
- The ability of decision makers to manage information, the process by which these decision makers determine which information is credible, and the credibility of the decision makers themselves.
- Public perception of attribution.

It is important to notice that these elements of adaptive capacity put a high emphasis on institutional issues and on social capital differently from work on climate change adaptation measures that focuses on specific policies and measures such as building dikes and water supply systems, new crops, cooling systems etc.

Yohe and Tol (*2002*) defines mitigative capacity as the mirror image of adaptive capacity on the emission side. The mitigative capacity here for a decision unit, such as a nation, depends on:

- The range of viable technical options for reducing emissions.
- The range of viable policy instruments with which it might effect the adoption of these options.
- The structure of critical institutions and the derivative allocation of decision-making authority.
- The availability and distribution of resources required to underwrite their adoption and the associated, broadly defined opportunity cost of devoting those resources to mitigation.
- The stock of human capital, including education and personal security.
- The stock of social capital including the definition of property rights, the country's access to risk spreading processes.

- The ability of decision-makers to manage information, the process by which these decision-makers determine which information is credible, and the credibility of decision-makers themselves.

The similarities between the definitions of adaptive and mitigative capacity of Yohe and Moss (*2000*) and Yohe and Tol (*2002*) are obvious. Both definitions emphasise social- and human capital and the ability of decision-makers to mange information. It is here important to recognise that these aspects of adaptive and mitigative capacities draw on general "public goods" and social resources, which are common for a broad range of climate change policies. This means, that the basis for a nations adaptive and mitigative capacity is very similar, and that there are many over-laps between the aspects and policies that enhance the capacities. Examples of such common capacity areas can be:

- Land property rights and capital access for rural farmers are key framework conditions for investments in irrigation, use of fertilisers and crop switching and are thereby key elements in adaptation. GHG emissions and carbon sequestration similarly are influenced by these conditions.
- Electricity markets and capital access influence the structure of future power supply and thereby GHG emissions. The same factors influence the energy sectors vulnerability to climate change impacts for example arriving from changing hydropower resources.
- Implementation of adaptation and mitigation policies in developing countries require financial transfers, and the ability of a country to attract such resources depends on local governance and decision-makers management of information.

The only areas, where the definitions of adaptive and mitigative capacity show major differences are in relation to the range of technical options and policy instruments that apply to adaptation and mitigation respectively. The assessment of the efficiency and implementability of these options, however, depend on local institutions, including markets and human and social capital. A country with well functioning capital markets and information sharing systems can implement energy efficiency measures and introduce new power production technologies. In the same way, food security policies, based on improved land management and mechanisation of agricultural production, work better, when supported by capital access, education and information systems.

In this way the concepts of adaptive and mitigative capacity in particularly focus on the institutional basis for a country's capacity to implement climate policies rather than on the specific financial- or other economic resources that are required to investment in particular technologies or other projects.

It is here important to recognise that it is complicated to conduct empirical studies of the institutional and social capital aspects of climate change policies[1] This is the case because these aspects on one hand are major determinants for the costs and effectiveness of policy implementation, but on the other hand only manifest

themselves in relation to the implementation process as such. Another complexity in relation to addressing institutional capacity is that the “public good” character of the capacity. Social and human capitals render general benefits to the whole society, and cannot be singled out as a separate component that can be measured as a cost in relation to the implementation of specific policies.

As yet, the concepts of adaptive and mitigative capacity have not been implemented in case study work in developing countries, so no empirical conclusions can be drawn.

6 Study results

An international network of institutions from developing countries and industrialised countries have conducted a study of linkages between current development programmes and local and global environmental impacts that have been based on a more pragmatic methodological approach as part of the Development and Climate programme[2] The programme includes country studies for India, China, South Africa, Brazil, Senegal, and Bangladesh (Halsnæs *2003*; Davidson et al. *2003*a).

The Development and Climate studies take the starting point in current development programmes of the participating countries with a major focus on the energy-, food-, and water sectors and then discuss these plans in the context of a broader sustainable development agenda that in addition to other environmental and social goals include climate change adaptation and mitigation policy goals. The idea is to compare a reference case that is defined to reflect a continuation of current development trends with a sustainable development policy case and assess synergies and tradeoffs between integrated development and climate change policies and specific goals that are considered to represent important aspects of human well being. The wellbeing aspects that have been considered in the studies include areas like energy-, food-, and water supply, access of low income groups, local and global air emissions, employment impacts, and a number of cost indicators related to GDP and project costs.

Climate change adaptation and mitigation are built into the analytical framework of the studies in the following way. Development priorities are considered initially as the basis for an analysis of climate change impacts recognising that these impacts are yet another stress factor that increases the vulnerability of resource dependent sectors and the livelihood of people. Given current development constraints of the countries including technological inefficiencies, market limitations, and weak institutions, the studies examine the well being impacts of implementing examples of climate change adaptation and mitigation policies. In the case, where climate change adaptation and mitigation policies can help to improve the efficiency of the economies by for example strengthening local institutions and introducing new technologies there might be synergies between development and climate policy

objectives even assessed in relation to a baseline case without climate change impacts. In other cases, climate change will be a net loss to a country because its impacts on vulnerable sectors cannot be by management improvements or other adaptation policies even when supported by international technology and financial transfers.

In this way climate change vulnerability and adaptation and mitigation activities are considered as having two different sorts of impacts on development opportunities. On one hand, climate change in most cases will reduce the production potential of the economy. The magnitude of this impact depends on vulnerability, efficiency and institutional capacity to adapt. On the other hand climate change adaptation as well as mitigation can include policies like financial and technology transfer, institutional strengthening and market improvements that enhance the productive capacity of the country. These different effects will be illustrated by a number of case examples from the country studies in the following (Table *2*).

The country study for India included an assessment of a wide range of adaptation and mitigation policies for the energy sector, transportation and water sectors (IIM *2003*). The study included and assessment of a large and very economically attractive option namely the establishment of electricity and energy market collaboration in South Asia between Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka. The collaboration involves natural gas pipelines, hydro power, and power transmission lines to support energy market development. The Indian Institute of Management estimated that as much as energy savings of up to 60 EJ could be achieved in total in the period 2010–2030, offering $180 bill. of energy cost savings, and 1.4 bill. T. of carbon savings (IIM *2003*). The energy market collaboration will offer increased energy access and the costs of primary energy and electricity can be reduced with an average of 5% in the region from 2010 to 2030. The implementation of the project is also expected to support employment and trade and to imply significant foreign exchange savings in the region due to decreased imports of oil and gas.

The energy market cooperation will also have an impact on water system management through enhanced water supply and flood control related to hydro power projects. The study examined the energy–water sector nexus in India in more detail. Decreased future water availability can be somehow offset by better agricultural management practices, but more intensive water pumping and transition systems might also be needed. Already today energy consumption for water pumping are a major GHG emission source in India. Energy consumption for pumping in agriculture contributes as much as one third of total power consumption, and the systems are characterised by large inefficiencies, which have been assessed to be as high as 60% loss in pumping technologies (IIM *2003*, Chapter 7).

The Indian study also included an assessment of climate change vulnerability of infrastructure based on the Konkan railway that was established in 1998 along the west Indian coastline without taking these impacts into consideration. It is expected that future heavy rainfalls will cause accidents and soil erosion that both can be very

risky and expensive in terms of increased repair and maintenance costs. The study has identified more than 200 vulnerable spots of the railway lines where adaptive measures already now have been taken including speed adjustment, land erosion protection measures, and adjustment of cutting slopes (Government of India 2004). Many of such vulnerable spots could have been avoided if climate change impact scenarios had been part of the railway planning basis.

The Chinese study concluded that energy efficiency improvements in power production, industry, and the building sector at the same time can offer economic benefits, reduced local air pollution, and GHG emission reductions (Jiang *2003*). It will also be possible further to reduce GHG emissions and local air pollution from the Chinese energy system by substituting coal with natural gas, nuclear power, and renewable energy. These energy options, however, will be more costly than coal based systems.

Agricultural production in China needs to increase in order to keep in pace with the growing population. Plans to restructure, stabilise and strengthen the agricultural sector in a sustainable way are being developed. In some parts of China, especially the northern areas, water availability is a major constraint for grain production. Climate change is expected to have serious consequences for ecosystems and agricultural resources in China and consequently for the restructuring of the agricultural sector. Adaptation options include improved soil, crop and water management practices in order to reduce the vulnerability to e.g., water stress. Besides the importance of maintaining and increasing grain yields, improvement of the agricultural market system by the establishment of links to the food processing industry is important. When taking into account emissions of greenhouse gasses, the restructuring of the food industry and markets can contribute to the development of a climate safe and friendly agricultural sector in China.

There are a lot of similarities between these Chinese energy system options and the cases that have been examined in the South African study (Davidson et al. *2003b*). Energy efficiency measures will constitute a major economic and environmentally attractive policy package in South Africa, and with a coal based energy system, the country has a large potential for reducing GHG emissions by increasing the share of gas, hydro power, nuclear energy, and renewables in the energy system. Like in the case of China, a decreased contribution of coal to the energy supply will imply increased costs and will also decrease the activity and the employment in the coal-mining sector, and these impacts might need to be offset by other initiatives or compensation measures. South Africa is expecting an increased stress on water resources arriving from climate change, and integrated water supply and demand planning and adaptation measures are therefore part of the sustainable development policies.

The Brazilian country study offers a number of examples that are somehow different from the energy sector options included in the other country studies (La Rovere et al. *2003*). These include the ethanol transportation programme, and a number of landuse policies including zero tillage, afforestation, and other land management options that aim at reducing the vulnerability to water stress and erosion. At the

same time these options also have a carbon sequestration potential. The ethanol programme has been assessed to contribute to a net CO_2 reduction that in 1990 –1991 amounted to 9.5 mill. t C in addition to foreign exchange savings, employment opportunities, and local air pollution benefits.

The Senegal country study is a good example of development and climate issues as they arise in the energy system development of least developed countries, LDC's (Sokona et al. *2003*). Introduction of modern energy forms like LPG for cooking and lighting will both increase the energy access and may reduce the pressure on forest and land resources. At the same time, increased electricity access in rural areas that is a major development priority includes efficiency measures and cleaner energy sources that can ensure that the GHG emission intensity of the power system is not increasing. However, the increased electricity access might well increase the GHG emissions in absolute terms because the access implies a large expansion of the power supply as such.

Increased food access is an important development priority in Senegal, and this objective will be harder to meet with emerging climate change. The natural variability of rainfall is the main factor influencing variability in agricultural production and climate change is expected to aggravate the already high variability. Adaptation policies therefore put a high emphasis on reducing vulnerability and strengthening of the productive capacity of agriculture for example through improved credit systems and new crops and farming systems. Improving soil fertility via increased inputs of organic matter will not only improve the nutrient status and water holding capacity of the soil but can also reduce soil erosion and sequester carbon. Similar conclusions can be drawn from the Bangladesh study, where major development priorities are to expand energy access of the poor including electricity as well as other energy forms, and increased food production and adaptive measures against flooding, erosion, salinity, and droughts (BCAS *2003*).

All together, the Development and Climate studies show a number of vulnerabilities in land use sectors and infrastructure that will add stress and risks to future development prospects of the countries. However, a number of policy options were identified that could help to mitigate these impacts and to reduce GHG emissions. In some cases, the options were assessed to be both economically attractive and climate friendly, and in other cases they would require additional resources—like with the introduction of coal substituting fuels—but would still offer attractive side-benefits on the local environment and in most cases also on employment.

Climate change impacts as well as the costs of implementing adaptation and mitigation policies to a large depend on institutional and social factors in the countries. Current production practices and technology use are often very inefficient and studies therefore tend to conclude that new practises will be economically attractive without really being able to address the institutional conditions for policy implementation. It is here important to recognise that since many of the policy options that have been assessed in the studies for India, China, Brazil, South Africa, Senegal, and Bangladesh will have several co-benefits on human wellbeing indicators reflecting energy-, food-, and water access, health and educational issues,

there is also a case for linking the policy implementation to local institutions and development agencies.

7 Methodological lessons from development based climate change studies

The limited available experiences from development based climate change studies demonstrate that it is possible to identify a number of linkages between national development policies and climate change vulnerability, adaptation and mitigation. Some of the areas that were identified in the first phase of the Development and Climate studies include energy-, food-, and water issues related to poverty reduction. The energy-, food- and water sector policies were assessed to have numerous linkages to climate change adaptation and mitigation policies. On one hand, climate change impacts tend to exacerbate existing development problems and therefore create a need for revisiting the development goals and to consider consistency with sustainable development patterns. On the other hand, climate change adaptation and mitigation policies in many cases can support more general sustainable development goals.

The suggested analytical approach that is constructed around the assessment of well being indicators that were illustrated in Table *1* can be used to focus on a number of linkages between development and climate change policies. Many of the suggested indicators, in particular those that are related to the energy sector, land use, water, and environmental issues, are not to different from what usually is included in national plans, and access to data for these sectors is possible.

However, the social indicators add a number of new equity, health, and educational aspects to the traditional sectoral planning themes that require data collection and further development of the approaches of traditional energy system and land use models. It is possible to generate relevant social data based on national statistics, social programmes and/or on household income expenditure surveys that can supplement the sectoral models. In this way, the integration of sectoral and social information in the well being indicators can facilitate the establishment of cross-cutting social and sectoral planning perspectives, and this can help to broaden the perspective existing poverty alleviation goals as they for example are described in the Millenium Development Goals.

Analytical methods for development based climate change studies have shown up to be limited. The country studies of the Development and Climate project have used various national scenario methods and models and have tried to update these with new data and indicators in order to capture some of the new social and equity aspects of the well being approach. Some studies as for example the cases of India and China have included very general scenario work, where alternative national sustainable development and business as usual scenarios have been used to assess the policies. The studies have included alternative assumptions about development

policies related to energy technologies and fuels and land use patterns and have based on these generated a wide variety of future projections of economic development and environmental impacts. The approach has been to capture this variety by constructing scenarios around different assumptions about global and national economic structures, population growth, technological development, local and global environmental policy priorities, as well as on governance perspectives.

An example of this scenario work is the Indian scenarios that are inspired by IPCC's emission scenarios for the Third Assessment, SRES (IPCC *2000*). The Indian study includes four scenario cases namely High Growth, Business as Usual, Sustainable Development, and Regional Development.

The High Growth scenario assumes that India is well integrated in the global economy, domestic market forces are strong and there is high access to finance and technologies. Conversely, the Business as Usual scenario assumes less integration in global markets and a more conventional technology use. The Sustainable Development- and the Regional Development scenarios assume a higher priority of environmental issues than the two other scenarios with a particular high priority of global and local environmental issues and non-material lifestyles in the Sustainable Development scenarios. The Regional Development scenario, in contrast, gives higher emphasis to local issues and self reliance.

Similarly, the country study of China has included scenarios that are inspired by the IPCC SRES work (Jiang *2003*). The scenarios included a Catch-up case that describes a rapid and successful integration of China into the global economy, a Domestic supply scenario that assumes that the economic development will rely on domestic Chinese economic and technological resources, a Short-cut case with high priority of environmental values and equity assuming that China will go to this state by a shortcut compared with the high emission intensity level of OECD countries today, and finally a Regional equity case that reflects regional and regional balance between economic development and environmental concerns.

The outcome of the scenario work has been a qualitative description of a number of issues related to sustainable development together with quantitative data on economic growth, population, technology choice, GHG emissions, energy system structure, and costs. The more specific social and equity related well being dimensions have not been addressed in depth in the scenario work, but have been covered in more detail in related policy case work.

The country studies for Bangladesh, Brazil, Senegal, and South Africa similarly have addressed a number of equity and other social aspects in relation to policy cases in particularly by assessing how energy, food and water access can include low income groups and the rural population. In this way, micro-based and to some extent sectoral studies have addressed a number of new well being aspects of development based climate studies, but a direct link is not yet established between the policy cases and more general national and regional scenario projections.

8 Conclusions: methodological issues

Studying climate change adaptation and mitigation in developing countries involves a number of complex methodological aspects since the climate issues are deeply rooted in core economic development issues. Developing countries experience a number of limitations in managing investments, technological change, natural resources, institutional issues, equity and other human well being dimensions. Inefficiencies or constraints in any of these areas will enhance the vulnerability to climate change impacts, and at the same time will tend to generate energy systems and consumption patterns that are costly and GHG emission intensive. There is therefore a scope for exploring linkages between development and climate change policies. The use of well being indicators to assess policies and development paths seems promising, but is not yet fully explored.

Given the current inefficiencies in technology and resource utilisation in developing countries and the inherit institutional weaknesses, one of the major conditions for climate change adaptation and mitigation policies will be to understand how policy implementation can be integrated with local development efforts and partnerships.

Institutional economics and recent work on human well being by A. Sen and P. Dasgupta consider development challenges in terms of human freedom, which can be used as a basis for an analytical approach that links human well being indicators and climate policy evaluation. The idea is to assess how policies that both influence development patterns and climate change adaptation and mitigation influence cost effectiveness, employment generation, equity, energy-, food- and water security, health standards, and school attendance. Some of these aspects are already included in sectoral plans and data access in this case is possible but inclusion of the social data will require a special effort. Nevertheless, an integrated sectoral and social policy evaluation facilitates a better integration between economic programmes and poverty alleviation efforts as for example initiated by the Millenium Development Goals.

The experience with development based climate change studies are currently limited, but the international literature have included a number of conceptual discussions and also a preliminary case study work with examples from India, China, South Africa, Brazil, Senegal, and Bangladesh. The studies show a range of development and climate options that in some cases are both economically attractive and climate friendly, and in other cases requires additional economic resources compared with the use of domestic energy resources as for example coal, but still offer attractive side-benefits related to the local environment and in most cases also on employment. Many examples have also been given on how climate change impacts can exacerbate existing food- and water sector stress, which will make it more difficult to meet high priority development goals. Climate change adaptation policies in these areas should be intrinsic elements of development policies, in order to ensure effectiveness of policies and to avoid wrong investments. Examples of synergies between e.g., management of soil organic matter and reduced vulnerability and reduced emissions have been given in the country studies.

The assessment of human well being implications of development and climate change policies is in a preliminary state seen from a methodological point of view. In particularly micro-based policy studies have been able to address an integrated view on economic policies and social issues. Some national and regional experiences on potential alternative development pathways have been gained in scenario studies, and a qualitative and partly quantitative discussion about key sustainable development issues is provided. However, this work has not yet established a direct linked to detailed policy studies of well being dimensions, so more work is needed before more general conclusions can be drawn about synergies between sustainable development patterns and climate change.

Footnotes

1 The same limitations characterise the more general literature on sustainable development, where studies of social and human capital are still not as well developed and operational as studies of manmade and natural capital.

2 The Development and Climate studies are carried out by a network of 12 institutions from developing countries and industrialised countries. For more information, please see http://www.developmentfirst.org

References

African Development Bank et al (2003) Poverty and climate change. Reducing the vulnerability of the poor

BCAS (2003) Bangladesh country case study. Accessed 05.01.2006 at *http://www.developmentfirst.org* *(http://www.developmentfirst.org)*

Dasgupta P (1993) An Inquiry into wellbeing and destitution. Oxford University Press, New York

Davidson O, Halsnæs K, Huq S, Kok M, Metz B, Sokona Y, Verhagen J (2003a) In: Munasinghe M, Downing TE (eds) The development and climate Nexus: the case of sub-Saharan Africa, Climate policy, vol 3, Supplement 1, p 97–113. Special Supplement on Climate Change and Sustainable Development

Davidson O et al (2003b) 'South African energy futures: visions, driving factors and sustainable development indicators.' Internal project report for Phase I of the sustainable development and climate change project. Energy & Development Research Centre, University of Cape Town, South Africa

Jiang K et al (2003) The development and climate. Country Study, China, forthcoming

Indian Institute of Management, IIM (2003) Development and climate. An assessment for India, Ahmedabad, India. Accessed 04.14.2006 at *http://www.developmentfirst.org* *(http://www.developmentfirst.org)*

Indian Government (2004) Vulnerability assessment and adaptation, Chapter 3. In: India's Initial National Communication to the United Nations Framework Convention on Climate Change, Ministry of Environment and Forests, Government of India

IPCC (2000) Special report on emission scenarios. Cambridge University Press

IPCC (2001a) Climate change 2001: Vulnerability and Adaptation. Contribution of working group II to the third assessment report of the intergovernmental panel on climate change, Cambridge University Press

IPCC (2001b) Climate change 2001: Mitigation. Contribution of working group III to the third assessment report of the intergovernmental panel on climate change, Cambridge University Press

IPCC (2002) Climate change 2001: Synthesis report. Cambridge University Press

Halsnæs K, Markandya A (2002) Analytical approaches for decision-making, sustainable development and greenhouse gas emission-reduction policies. In: Markandya A, Halsnæs K (eds) Climate change and sustainable development. Prospects for developing countries. Earthscan Publications Ltd., London, pp 129–162

HalsnæsK, Verhagen J, La Rovere E, Klein R, Huq S (2003) Linkages between development and climate change, development and climate project

Meier GM (2001) The old generation of development economists and the new. In: Meier GM, Stiglitz JE (eds) Frontiers of development economics. The future in perspective. The World Bank and Oxford University Press

Olhoff A (2002) Assessing social capital aspects of climate change projects, chapter 4. In: Markandya A, Halsnæs K (eds) Climate change and sustainable development. Prospects for developing countries. Earthscan Publications Ltd., London, pp 129–162

Peet R, Harwick E (1999) Theories of development. The Guilford Press, New York

Rovere ELL et al (2003) The development and climate project. Phase 1. Country Study: Brazil. Zero Draft, Centre of Integrated Studies on Environment and Climate Change

Sen A (1999) Development as freedom. Oxford University Press

Sokona Y et al (2003) The development and climate. Country study: Senegal. Third Draft, Environnement et Développement du Tiers Monde, Senegal

World Bank (2001) Poverty reduction source book, overview p. 2. Accesssed at http://poverty.worldbank.org/library/view.php?topic = 3438&id = 8124

Yohe G, Moss R (2000) Economic sustainability, indicators and climate change. In: Munasinghe M, Swart R (eds) Climate change and its linkages with development, equity and sustainability. Proceedings of the IPCC Expert Meeting in Columbo, Sri Lanka 27–29 April 1999, IPCC and WMO Geneva

Yohe G, Tol R (2002) Indicators for social and economic coping capacity—moving toward a working definition of adaptive capacity. Glob Environ Change 12:25–40
CrossRef *(http://dx.doi.org/10.1016/S0959-3780(01)00026-7)*

Copyright information