

ADAPTATION TO CLIMATE VARIABILITY AND CHANGE: WHAT IS OPTIMAL AND APPROPRIATE?¹

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Abstract. Adaptation is intricately linked with non-climatic developments and takes place in a dynamic societal context. The identification of optimal and appropriate adaptation strategies is therefore fraught with difficulties. Particularly the identification and quantification of adaptation benefits faces a number of uncertainty-related and methodological caveats. This paper explores these caveats and discusses their implications for policy and funding. It concludes that the quantitative assessment of future adaptation costs and benefits should play a less significant part in determining the optimality or appropriateness of adaptation options and hence in the allocation of adaptation funds. Instead, one could assess the economic value of an adaptation project to today's society and identify no-regret adaptation options, which would help to reduce vulnerability to both contemporary climate variability and anticipated climate change. Moreover, strengthening adaptive capacity and raising awareness should serve to create an enabling environment for adaptation.

Key words: climate change, climate variability, impacts, adaptation, adaptive capacity, vulnerability, benefits, costs, policy, funding.

1. Introduction

Adaptation is increasingly recognised as an appropriate and necessary response option to climate change, especially since it has been established that humans are—at least in part—responsible for climate change and that some impacts can no longer be avoided. The Intergovernmental Panel on Climate Change (IPCC) Workshop on Adaptation to Climate Variability and Change (San José, Costa Rica, 1998) provided a strong impetus to the increasing recognition of the importance of adaptation. The workshop aimed to assess and improve the current understanding of both the theory and practice of climate adaptation. It also served to produce materials for consideration by the IPCC for its Third Assessment Report, which has recently been finalised. The Working Group II contribution to the IPCC Third Assessment Report features adaptation more strongly than before in its discussions of vulnerable sectors and regions. In addition, it contains a chapter devoted entirely to adaptation in the context of sustainable development and equity (Smit *et al.*, 2001). It re-emphasises the need for adaptation and stresses the importance of enhancing the adaptive capacity of developing countries.

From an international policy perspective the importance of adaptation was first confirmed at the third Conference of the Parties (COP-3, 1997) to the United Nations Framework Convention on Climate Change (UNFCCC) in Kyoto. The Kyoto Protocol defines a Clean Development Mechanism (CDM) that explicitly mentions adaptation as

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an expenditure goal. At COP-4 in Buenos Aires (1998) governments decided that funding could be made available to developing countries for preparatory (so-called “Stage II”) adaptation activities. At COP-5 and COP-6 (Bonn, 1999 and The Hague, 2000, respectively) governments subsequently discussed how the CDM and the aforementioned decision made at COP-4 could be made operational. The initial failure at COP-6 to reach agreement amongst Parties on the implementation of the Kyoto Protocol and the functioning of the CDM seemed likely to delay its implementation and thereby the availability of adaptation funding from this source. However, COP-6bis in Bonn (2001) and COP-7 in Marrakech (2001) responded to the increasing need for adaptation. Agreement was reached on the establishment of three funds from which adaptation activities in developing countries can be financed.

Adaptation has not always been considered as important or relevant within climate science or policy. Despite the fact that the UNFCCC refers to both mitigation and adaptation, national and international climate policies to date have mainly focused on mitigation (*i.e.*, all human activities aimed at limiting climate change by reducing the emissions or enhancing the sinks of greenhouse gases). In part this reflects the uncertainty about climate change being caused by human activity, which existed until the publication of the IPCC Second Assessment Report in 1996. It also reflects the lack of theoretical and practical knowledge about adaptation to climate change, which in turn resulted from the limited attention given to adaptation by the scientific community. In his review of the IPCC Second Assessment Report, Kates (1997) suggested the reason for this limited attention lies in the existence of two distinct schools of thought about climate change, both of which chose not to engage in adaptation research.

On the one extreme Kates identified the “preventionist” school, which argues that the ongoing increase of atmospheric greenhouse-gas concentrations could be catastrophic and that drastic action is required to reduce emissions. Preventionists fear that increased emphasis on adaptation will weaken society’s willingness to reduce emissions and thus delay or diminish mitigation efforts. On the other extreme one finds what Kates referred to as the “adaptationist” school, which sees no need to focus on either adaptation or mitigation. Adaptationists argue that natural and human systems have a long history of adapting naturally to changing circumstances and that active adaptation would constitute interference with these systems, bringing with it high social costs.

Following the publication of the IPCC Second Assessment Report a distinct third school of thought has emerged, which has been labelled the “realist” school by Klein and MacIver (1999). The realist school positions itself in between the two extreme views of the preventionists and adaptationists. Realists regard climate change as a fact but acknowledge that impacts are still uncertain. Furthermore, realists appreciate that the planning and implementation of effective adaptation options takes time. Therefore, they understand that a process must be set in motion to consider adaptation as a crucial and realistic response option along with mitigation (*e.g.*, Parry *et al.*, 1998; Pielke, 1998). The establishment of the three funds from which adaptation activities in developing countries can be financed is a reflection of this understanding.

However, the limited theoretical and practical understanding of adaptation to climate change, combined with the considerable uncertainties that remain concerning the

location and magnitude of impacts, threatens to be an impediment to adaptation investment. Adaptation is intricately linked with non-climatic developments and takes place in a dynamic societal context, in which many different actors pursue many different interests. The identification of optimal and appropriate adaptation strategies, in part based on the balancing of their costs and benefits, is therefore fraught with difficulties.

For a variety of reasons assessing the financial costs and, especially, benefits of available adaptation options is considerably more complicated than determining those of most mitigation options. Most importantly, the performance of adaptation options is more difficult to measure and express in a single metric, which constrains the comparison of alternative options. This paper analyses the role of adaptation in reducing a system's vulnerability to adverse impacts of climate change and argues that the use of economic decision tools alone should not form the basis of international adaptation decisions. The next section discusses the various types of adaptation and how they can help to reduce impacts to climate change. Section 3 provides an overview of current international funding arrangements for adaptation, whilst Section 4 discusses uncertainty-related and methodological caveats to assessing adaptation benefits. Section 5 draws conclusions and places them in a broader policy context.

2. Types of Adaptation

There are various ways to classify or distinguish between adaptation options. First, depending on the timing, goal and motive of its implementation, adaptation can be either reactive or anticipatory. Reactive adaptation occurs after the initial impacts of climate change have become manifest, whilst anticipatory (or proactive) adaptation takes place before impacts are apparent. A second distinction can be based on the system in which the adaptation takes place: the natural system (in which adaptation is by definition reactive) or the human system (in which both reactive and anticipatory adaptation are observed). Within the human system a third distinction can be based on whether the adaptation decision is motivated by private or public interests. Private decision-makers include both individual households and commercial companies, whilst public interests are served by governments at all levels. Figure 1 shows examples of adaptation activities for each of the five types of adaptation that have thus been defined.

In addition to the ones made above, other adaptation distinctions are discussed by Smit *et al.* (2000). A useful distinction that is often made is the one between planned and autonomous adaptation (Carter *et al.*, 1994). Planned adaptation is the result of a deliberate policy decision that is based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain or achieve a desired state. Autonomous adaptation involves the changes that natural and most human systems will undergo in response to changing conditions irrespective of any policy plan or decision. Instead, autonomous adaptation will be triggered by market or welfare changes induced by climate change. Autonomous adaptation in human systems would therefore be in the actor's rational self-interest, whilst the focus of planned adaptation is on

collective needs (Leary, 1999). Thus defined, autonomous and planned adaptation largely correspond with private and public adaptation, respectively (see Figure 1).

		Anticipatory	Reactive
Natural Systems		X	<ul style="list-style-type: none"> · Changes in length of growing season · Changes in ecosystem composition · Wetland migration
	Human Systems	Private	<ul style="list-style-type: none"> · Purchase of insurance · Construction of house on stilts · Redesign of oil-rigs
Public		<ul style="list-style-type: none"> · Early-warning systems · New building codes, design standards · Incentives for relocation 	<ul style="list-style-type: none"> · Compensatory payments, subsidies · Enforcement of building codes · Beach nourishment

Figure 1. Matrix showing the five prevalent types of adaptation to climate change, including examples (based on Klein, 1998).

The extent to which society can rely on autonomous adaptation to reduce the potential impacts of climate change to an acceptable level is an issue of great academic and policy interest. Autonomous adaptation forms a baseline with which the need for planned anticipatory adaptation can be evaluated. Some studies assume considerable faith in market mechanisms and thus in the capacity of private human systems to adapt autonomously (e.g., Mendelsohn *et al.*, 1996; Yohe *et al.*, 1996). Other studies highlight the constraints for such autonomous adaptation, such as limited information, knowledge and access to resources, and emphasise the need for anticipatory planned adaptation (e.g., Tol *et al.*, 1996; Fankhauser *et al.*, 1999).

Article 3.3 of the UNFCCC suggests that anticipatory planned adaptation (as well as mitigation) deserves particular attention from the international climate change community:

“The Parties should take precautionary measures to anticipate, prevent or minimise the causes of climate change and mitigate its adverse effects. Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures, taking into account that policies and measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost. (...)”

Anticipatory adaptation is aimed at reducing a system’s vulnerability by either minimising risk or maximising adaptive capacity. Five generic objectives of anticipatory adaptation can be identified (cf. Klein and Tol, 1997):

- *Increasing robustness of infrastructural designs and long-term investments*—for example by extending the range of temperature or precipitation a system can withstand without failure and/or changing a system’s tolerance of loss or failure (e.g., by increasing economic reserves or insurance);

- *Increasing flexibility of vulnerable managed systems*—for example by allowing mid-term adjustments (including change of activities or location) and/or reducing economic lifetimes (including increasing depreciation);
- *Enhancing adaptability of vulnerable natural systems*—for example by reducing other (non-climatic) stresses and/or removing barriers to migration (such as establishing eco-corridors);
- *Reversing trends that increase vulnerability (“maladaptation”)*—for example by introducing setbacks for development in vulnerable areas such as floodplains and coastal zones;
- *Improving societal awareness and preparedness*—for example by informing the public of the risks and possible consequences of climate change and/or setting up early-warning systems.

3. International Funding Arrangements for Adaptation

The identification of human-induced climate change as an actual rather than a theoretical phenomenon has led to increased recognition of the need to prepare for adaptation (Parry *et al.*, 1998; Pielke, 1998). In fact, Article 4.1(b) of the UNFCCC already commits Parties to:

“Formulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures (...) to facilitate adequate adaptation to climate change.”

The financing of adaptation measures is addressed in Article 4.3, which states that:

“The developed country Parties and other developed Parties included in Annex II² shall provide new and additional financial resources (...) needed by the developing country Parties to meet the agreed full incremental costs of implementing measures that are covered by paragraph 1 of this Article (...).”

For developing countries that are particularly vulnerable, Article 4.4 of the UNFCCC contains another, more explicit, commitment to financing adaptation measures:

“The developed country Parties and other developed Parties included in Annex II shall also assist the developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation to those adverse effects.”

The Global Environment Facility (GEF) is the international entity entrusted with the operation of the financial mechanism of the UNFCCC. Until recently, the focus of the GEF has been primarily on mitigation of climate change but following COP-3 and COP-4 adaptation has risen on the priority ladder. The types of adaptation activities to be considered by the GEF were already classified at the tenth session of the Intergovernmental Negotiating Committee of the UNFCCC. Its decision was endorsed at COP-1

² The Annex II Parties are Australia, Austria, Belgium, Canada, Denmark, the European Union, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, The Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom of Great Britain and Northern Ireland and the United States of America.

in Berlin in 1995 (Decision 11/CP.1). The decision identifies three stages in the adaptation process:

- *Stage I*—Planning, which includes studies of possible impacts of climate change, to identify particularly vulnerable countries or regions and policy options for adaptation and appropriate capacity building;
- *Stage II*—Measures, including further capacity building, which may be taken to prepare for adaptation, as envisaged by Article 4.1(e);
- *Stage III*—Measures to facilitate adequate adaptation, including insurance and other adaptation measures as envisaged by Articles 4.1(b) and 4.4.

According to the GEF Operational Strategy (GEF, 1996), Stage I activities could encompass the following:

- Assessment of national, regional and/or subregional vulnerability to climate change; where appropriate rely on related data-gathering systems to measure climate change effects in particularly vulnerable countries or regions and strengthen such systems as necessary; and identify a near-term research and development agenda to understand sensitivity to climate change;
- Evaluation of policy options for adequate monitoring systems and response strategies for climate change impacts on terrestrial and marine ecosystems;
- Assessment of policy frameworks for implementing adaptation measures and response strategies in the context of coastal zone management, disaster preparedness, agriculture, fisheries and forestry, with a view of integrating climate change impact information, as appropriate, into national strategic planning processes;
- In the context of undertaking national communication, building of national, regional and/or subregional capacity, as appropriate, to integrate climate change concerns into medium and long-term planning.

With respect to financing, Decision 11/CP.1 states the following:

“For Stage I, the Conference of the Parties (...) shall entrust to the Global Environment Facility (GEF) (...) the task of meeting the agreed full costs of the activities required by Article 12.1 of the Convention. This would include meeting the agreed full costs of relevant adaptation activities undertaken in the context of the formulation of national communications; such activities may include studies of the possible impacts of climate change, identification of options for implementing the adaptation provisions (...) and relevant capacity building.”

With respect to Stages II and III, Decision 11/CP.1 states that:

“Based on the outputs of the Stage I studies, as well as other relevant scientific and technical studies (...), the Conference of the Parties may decide that it has become necessary to implement the measures and activities envisaged in Stages II and III. (...).”

In line with this, Decision 11/CP.1 includes the provision that:

“If it is decided (...) that it has become necessary to implement the measures envisaged in Stages II and III, the Parties included in Annex II to the Convention will provide funding to implement the adaptation measures envisaged in these stages in accordance with their commitments contained in Articles 4.3 and 4.4 of the Convention.”

At COP-4 in Buenos Aires (1998) governments adopted Decision 2/CP.4, which states that:

“(...) the GEF should provide funding to developing country Parties to implement adaptation response measures under Article 4.1 of the Convention for adaptation activities envisaged in decision 11/CP.1, paragraph 1(d)(ii) (Stage II activities) in particularly vulnerable countries and regions identified in Stage I activities, and especially in countries vulnerable to climate-related natural disasters (...)”

In spite of this decision no additional funds were made available to the GEF to fund Stage II projects. In addition, no clear guidance exists as to which type of activities are eligible under Stage II, which constrains the development of proposals. As it became clear that such guidance would not be provided in the foreseeable future, countries and organisations have begun to give their own interpretations to the text of Decision 11/CP.1. A number of regional project proposals have been submitted to the GEF, aimed mainly at further adaptation assessment and the identification of adaptation needs. One such project that has received GEF funding under Stage II is “Assessments of Impacts of and Adaptation to Climate Change in Multiple Regions and Sectors” (AIACC), proposed jointly by the United Nations Environment Programme (UNEP) and the IPCC.

With the completion of the negotiations on the Kyoto Protocol to the UNFCCC at COP-7 in Marrakech (2001) agreement has been reached on the establishment of three funds that are relevant to adaptation in developing countries:

- A Special Climate Change Fund;
- A Least Developed Countries Fund;
- An Adaptation Fund.

The first two of these funds would require additional funding from Annex II Parties via the GEF, whilst in accordance with Article 12.8 of the Kyoto Protocol the Adaptation Fund would be financed from the share of proceeds on the CDM³.

The text of the relevant COP-7 decisions seems to suggest that the three-stage approach of Decision 11/CP.1 is no longer the only guidance for adaptation funding. Decisions 5/CP.7 and 6/CP.7 list a number of adaptation activities that appear to go even beyond Stage III activities. For example, Decision 5/CP.7 states that the following activities shall be supported through the Special Climate Change Fund and/or the Adaptation Fund and other bilateral and multilateral sources:

- Starting to implement adaptation activities promptly where sufficient information is available to warrant such activities, *inter alia*, in the areas of water resources management, land management, agriculture, health, infrastructure development, fragile ecosystems, including mountainous ecosystems, and integrated coastal zone management;
- Improving the monitoring of diseases and vectors affected by climate change, and related forecasting and early-warning systems, and in this context improving disease control and prevention;
- Supporting capacity-building, including institutional capacity, for preventive measures, planning, preparedness and management of disasters relating to climate change,

³ The purpose of the CDM is to assist developing countries in achieving sustainable development and in contributing to the ultimate objective of the UNFCCC and to assist Annex I Parties (*i.e.*, Annex II Parties, fourteen countries that are undergoing the process of transition to a market economy, Croatia, Liechtenstein, Monaco and Turkey) in limiting greenhouse-gas emissions (Article 12.2 of the Kyoto Protocol).

including contingency planning, in particular for droughts and floods in areas prone to extreme weather events;

- Strengthening existing and, where needed, establishing national and regional centres and information networks for rapid response to extreme weather events, utilising information technology as much as possible.

The Least Developed Countries Fund is to be used in part for the development of National Adaptation Programmes of Action (NAPAs), in which least-developed countries (LDCs) can communicate priority activities addressing their urgent and immediate needs and concerns relating to adaptation to the adverse effects of climate change. As stated in Decision 28/CP.7:

“The rationale for developing NAPAs rests on the low adaptive capacity of LDCs, which renders them in need of immediate and urgent support to start adapting to current and projected adverse effects of climate change. Activities proposed through NAPAs would be those whose further delay could increase vulnerability or lead to increased costs at a later stage.”

It thus appears that COP-7 has removed a number of major barriers to international adaptation funding. Nonetheless, the activities listed in Decision 5/CP.7, as well as those to be identified in the NAPAs, can only be implemented if sufficient additional funding is made available. At COP-7 the Government of Canada expressed its intention to contribute CAD 10 million to the Least Developed Countries fund but this has not yet been followed up by other Annex II Parties.

Even if more money became available for the implementation of adaptation activities, two major barriers to the international funding of such activities remain. First, in line with Article 3.3 of the UNFCCC the GEF Operational Strategy prescribes that activities need to have global benefits in order to be eligible for funding. Mitigation activities, aimed at reducing atmospheric greenhouse-gas concentrations, clearly have global benefits. For adaptation activities on the other hand, it is difficult to imagine how global benefits can be produced. Adaptation takes place at the scale of an impacted system, which is regional at best, but mostly local.

Second, the GEF would not cover the full costs of adaptation (however defined). The GEF assumes that some development and upgrading of systems will take place irrespective of climate change. It would fund only the incremental costs of adaptation, which are the additional costs required to maintain a system climate-safe (*i.e.*, prepared for and able to cope with prevailing weather extremes). In theory, these costs can be estimated by comparing two impact scenarios: one with and one without climate change⁴. By then comparing the costs of alternative adaptation options with their respective

⁴ The protection of a coastal area against storm surges by means of a seawall provides a simple case to illustrate what are the incremental costs of adaptation to climate change. The level at which the seawall should offer protection is essentially a policy decision and reflects the population density and the value of the land and assets in the area at risk of flooding. This protection level determines the design height of the seawall, which for today's storm-surge regime can be calculated using meteorological, morphological and hydraulic data and information. If one were to protect not only against today's storm-surge regime but also to prepare for a climate change induced sea-level rise, the design height of the seawall would have to be increased. The cost difference between a seawall that only offers protection against today's variability and a higher one that also prepares for sea-level rise reflects the incremental costs of adaptation to climate change.

benefits one can determine the (economically) optimal option, which is the one with the highest benefit-cost ratio. In practice, however, estimates of the costs and especially benefits of adaptation to climate change are difficult to make.

4. Benefits of Adaptation

Determining the benefits of adaptation is not a straightforward exercise. First of all, one needs to have a clear understanding of what adaptation benefits exactly are. As shown in Figure 1, one can distinguish between five types of adaptation, each yielding its own benefits. Figure 2 shows how these five types of adaptation relate to three types of impacts: (i) potential impacts, (ii) initial impacts and (iii) residual impacts.

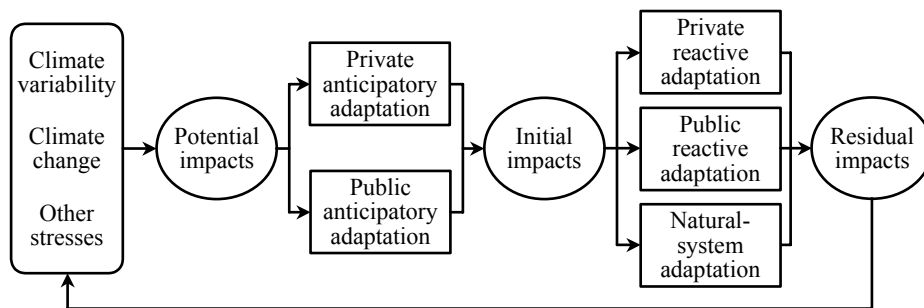


Figure 2. The role of adaptation in determining residual impacts of climate change. Types of adaptation correspond with those defined in Figure 1 (modified from Klein, 1998).

Fankhauser (1997) and Callaway *et al.* (1998) show that, in principle, the benefits of adaptation (all five types taken together) would be the climate-related damage costs one avoids by taking adaptive measures (assuming that climate change would have adverse consequences). Thus, if one quantifies the *potential* impacts of climate change on a system (assuming no adaptation) as well as its *residual* impacts (assuming all five types of adaptation; see Figure 2), the benefits of adaptation are given by the difference between the two. From the value thus obtained one can subtract the costs of implementing the adaptation options (including transition costs) to arrive at the net benefits of adaptation. A mathematical representation and deduction can be found in Callaway *et al.* (1998).

However, there are a number of caveats involved in such analysis aimed at identifying the “optimal” adaptation option, as prescribed by the GEF. Two types of caveats are distinguished here: caveats related to the uncertainty of future scenarios and methodological caveats. Both are discussed below.

4.1. CAVEATS RELATED TO UNCERTAINTY

To date, very few studies have succeeded in incorporating all types of adaptation (anticipatory, reactive, natural system, human system, planned, autonomous) in their impact analyses. Many of the early studies used a so-called “dumb farmer”⁵ scenario: they assumed present-day behaviour and activities would continue unchanged in the future, irrespective of how they may be affected by climate change. By ignoring any adaptation these studies, which are not unique for agriculture, did not distinguish between potential and residual impacts and thus their damage-cost values represent serious overestimates. On the other hand, they served to generate awareness of the potential magnitude of impacts and of the need for anticipatory adaptation.

Most studies do now consider adaptation to varying degrees. However, in doing so they invariably encounter the problem of how to deal with uncertainty: not only are impacts of climate change themselves uncertain but they will occur in a future world that is complex and uncertain as well. Some studies accommodate this problem by using a “clairvoyant farmer” scenario, which assumes that adaptation will be perfect. The results of these studies represent serious underestimates.

Other studies take a normative—prescriptive—approach to adaptation. These studies evaluate what would be the *optimal* adaptation strategy given certain climate and, possibly, non-climate scenarios. Such evaluation yields quantitative results that quickly find their way to the desks of decision-makers and the computers running integrated assessment models. However, the strength of these results is also its weakness: when reduced to numbers, the results present only part of the picture. Typically, the studies assess a limited set of—often arbitrary—adaptation options, which are assessed for their optimality without giving thought to their appropriateness in a broader societal context, nor to their performance in a world in which not only climate changes but most other relevant factors as well. Moreover, one tends to lose sight of the fact that the results obtained are only valid for the presupposed scenarios, which are surrounded by uncertainty.

An important uncertainty of all climate scenarios relates to the effect of a changing climate on the frequency, magnitude and spatial occurrence of extreme weather events such as floods, cyclones and droughts. To date, climate models have been unable to present unambiguous results for extreme events. Consequently most impact and adaptation studies assume only gradual changes in climate. However, as shown by West and Dowlatabadi (1999), considering extremes can lead to estimates of damage costs and hence to conclusions on optimal adaptation that differ significantly from those based only on gradual changes (*cf.* Yohe *et al.*, 1996; Yohe and Neumann, 1997). The reason for this is intuitive: most damage will not be caused by gradual changes in climate but by occa-

⁵ The dumb farmer is a metaphor for any impacted economic agent that does not anticipate climate change or acts upon its manifestation. Instead, it continues to act as if nothing has changed. By not responding to changing circumstances, the agent reduces its profitability or fails to take advantage of emerging opportunities. It thus incurs larger damages than would have been the case had some adaptation taken place. The clairvoyant farmer, on the other hand, has perfect knowledge and foresight and is able to minimise damages or maximise benefits. As always, reality will be somewhere in between.

sional extreme events. Reactive adaptation will therefore be triggered mainly by the impacts of extremes, whilst appropriate anticipatory adaptation will need to be designed to cope with these extremes.

Given the current impossibility to construct plausible scenarios that consider all aspects that determine the costs and benefits of an adaptation option, the normative assessment of “optimal” adaptation strategies may well be a step too far. Instead, a positive analysis of the full range of possible and appropriate adaptation options—with their costs, benefits and other implementation considerations—could be at least as informative to decision-makers.

4.2. METHODOLOGICAL CAVEATS

In addition to the above caveats associated with uncertainty there are methodological issues that constrain the assessment of adaptation benefits. These methodological issues may relate to the economics of assessing future costs and benefits or to an incomplete consideration of the full process of adaptation.

To start with the latter, when calculating the costs of adaptation most studies consider only the costs of implementing adaptation options. Furthermore, they consider only those options that are well-defined and (infra)structural or technological by nature (as opposed to legal, institutional, financial or behavioural options). Klein *et al.* (1999) suggested that the process of adaptation represents a continuous and iterative cycle involving four main steps: (i) information development and awareness raising, (ii) planning and design, (iii) implementation and (iv) monitoring and evaluation (Figure 3). A single focus on implementation and its costs is too limited. Such a focus ignores that successful implementation depends on the availability of various types of resources to assist the other three steps (*i.e.*, the capacity to adapt). There is a cost to raising adaptive capacity and creating an enabling environment but this is what is required for adaptation to have any benefits at all. To assume that the full benefits of an option can be reaped only at its implementation cost is therefore misleading.

A large literature exists on the economics of calculating future uncertain costs and benefits. This literature discusses issues such as the use of discount rates, intergenerational equity, risk assessment, opportunity costs, the precautionary principle, weighting uncertainty in cost-benefit analysis and so on. Each of these issues is a source of intense academic debate and there appears to be no consensus as to what would be the appropriate way of assessing the benefits of adaptation. Multiple “optimal” adaptation strategies can therefore be recommended for the same expected climate impacts, depending on the methods and assumptions used. This scientific discord blurs the analytical picture and hampers the straightforward interpretation of results, both by fellow scientists and by policymakers.

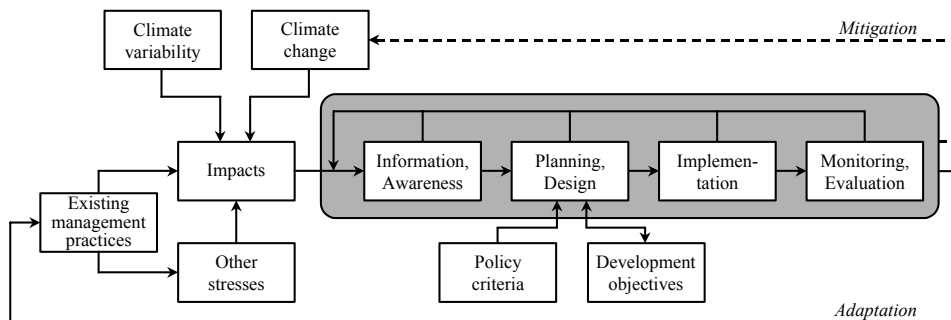


Figure 3. Conceptual framework showing in the shaded area the iterative steps involved in adaptation to climate variability and change (generalised from Klein *et al.*, 1999).

An additional and recurring methodological issue is the use of what are often considered western decision tools for situations in non-western societies. The prevalent decision framework in western countries is based on maximising economic efficiency and effectiveness, with the optimal—or “rational”—decision being the one where marginal costs equal marginal benefits. This framework presupposes that all relevant values can be expressed and compared in monetary terms. However, many non-western societies rely greatly on socio-cultural and subsistence values, which are generally considered to be inappropriate or impossible to express in monetary terms. Therefore, western decision tools cannot be universally applied to assess adaptation benefits and determine the optimality—in terms of its societal desirability—of adaptation options.

5. Discussion and Conclusions

This paper has shown that the international funding of adaptation to climate change faces a number of political, as well as scientific, challenges. These challenges are not limited to the GEF: very few projects have been initiated, funded and implemented with a specific focus on climate change as part of bilateral or multilateral programmes as well. However, bilateral and multilateral development assistance has the advantage of being potentially more flexible and thus more effective than the GEF in making funding decisions. The need for such flexibility pertains in particular to the distinction between climate change and climate variability and the related issue of incremental costs.

Its mandate requires the GEF to make a distinction between adaptation to a future, scenario-based climate change and adaptation to today’s climate variability. Adaptation to climate change would be eligible for funding, whereas adaptation to climate variability is not. Both types of adaptation, however, are very similar by nature and they can mutually reinforce each other. For example, both types of adaptation would include protection against weather extremes and related hazards. Weather extremes occur independently of climate change but their magnitude and frequency of occurrence is likely to be affected as a result of climate change. Adapting to extremes that result from today’s

variability would be a good start to prepare for the extremes associated with a future climate.

Particularly if one accepts that human-induced climate change is already taking place, the distinction between the two types of adaptation becomes highly theoretical. It assumes that one is able to identify the relative contributions to weather extremes of human-induced climate change and natural climate variability. This is not only impossible but also immoral. The attribution question and related issues of funding eligibility are highly irrelevant to people who lose their lives or livelihoods as a result of weather extremes.

As far as the calculation of incremental costs of adaptation is concerned, this too requires information of a type that is not always possible to obtain. As explained in Section 3, incremental costs are the additional costs required to keep a system climate-safe. This definition assumes that systems that are subject to adaptation to climate change are already climate-safe. Alternatively, it assumes that it is the responsibility of the individual countries to make these systems climate-safe, using alternative—possibly their own—funds.

In the example of Footnote 3 it is immediately clear what the incremental costs of adaptation to climate change are. However, reality is often not as straightforward. As explained in Section 4, adaptation is a process that can comprise a range of different legal, institutional, economic and structural measures. It involves information development and awareness building regarding the needs and opportunities to adapt, the planning and design of adaptation measures, their implementation in line with existing policy criteria and development objectives and the monitoring and evaluation of the adaptation performance (Figure 3). In addition, it requires the development of an enabling environment for implementing adaptation measures.

Thus, the range of measures countries may wish to take to adapt to climate change is much broader than only structural measures such as building a seawall. An adaptation strategy may include actions such as:

- Setting up a monitoring network to enable the early warning of weather-related hazards;
- Changing institutional arrangements to enhance the effectiveness of political decisions;
- Strengthening a country's legal system to improve compliance with existing regulations;
- Changing fiscal arrangements to provide adaptation incentives to the private sector;
- Supporting the role of non-governmental organisations to ensure public involvement in decision-making.

It is clear that measures like these would have benefits that go beyond those of adaptation to climate change. However, it is also clear that it will be impossible to determine the relative contributions of these measures to the various types of benefits. As a result, the incremental costs of adaptation measures that are less straightforward than building a seawall are difficult or even impossible to determine.

It goes without saying that the two issues sketched above will be a major constraint when it comes to providing funds for actual adaptation to climate change by the GEF

(*i.e.*, beyond Stage III). The effectiveness of adaptation to human-induced climate change depends on a country's own initiative and ability to adapt to today's climate variability. If no funds are available for the latter type of adaptation, adaptation to climate change is unlikely to be successful.

In view of the caveats described in Section 4 and the consequent barriers to adaptation funding, it is concluded that the quantitative assessment of future adaptation costs and benefits should play a less significant part in determining the optimality and appropriateness of adaptation options and hence in the allocation of adaptation funds. This does not suggest that adaptation projects should not make efficient or effective use of resources. However, a project's benefit-cost ratio alone is not a good indicator for the appropriateness of the adaptation. After all, given the uncertainties surrounding future climatic and non-climatic conditions, as well as the methodological discord on the use of decision tools, any quantitative estimate of adaptation costs and benefits can and will be questioned.

Instead of concentrating on its longer-term economic aspects, one could assess the economic value of an adaptation project to today's society. Assessment of today's costs and benefits is more straightforward and not fraught with so many difficulties as the assessment of those occurring in an uncertain future. In addition, a focus on today's climate variability can be critical in terms of saving lives and livelihoods. The recent series of natural disasters in the developing world has shown that many current systems cannot be assumed to be climate-safe. Hundreds of thousands of people died in weather-related disasters in Honduras, Venezuela, India and Mozambique, illustrating the urgent need to adapt to today's climate variability.

Measures to reduce the vulnerability of these countries to climate variability will be a good starting point to reduce vulnerability to climate change. But even if climate change were not to take place such measures would still be important and beneficial and would therefore be justifiable in their own right. Analogous to "no-regret" mitigation measures (which help to reduce greenhouse-gas emissions but also have immediate benefits to society that make them worthwhile to implement irrespective of climate change) adaptation measures that have both immediate and long-term benefits can be termed "no-regret" adaptation measures.

In addition, non-economic aspects determine the appropriateness of adaptation. Adaptation activities need to be designed keeping site-specific natural and socio-cultural circumstances in mind. No adaptation option will be successful when implemented in an environment that is not ready, willing or able to receive the option. Strengthening technological, institutional, legal and economic capacities as well as raising awareness are prerequisites for effective adaptation.

It thus appears that there are numerous cost-effective opportunities to invest in adaptation already today (which corresponds with the findings of Fankhauser *et al.*, 1999). However, investment decisions should not be dictated by questionable normative numbers but informed by sound and positive assessments of how vulnerability to climate can already be reduced now. Such adaptation could have any of the five generic objectives of anticipatory adaptation listed in Section 2, with an emphasis on the latter three. These three types tend to refer to no-regret options that serve to increase adaptive

capacity to climate change whilst also reducing vulnerability to current climate conditions. Thus, their benefits are greater than the difference between residual and potential impacts shown in Figure 2.

It is clear that the current funding mechanisms for adaptation have not been designed for an investment strategy as suggested above. Finding the institutional means to accommodate the adaptation needs for both today and the future is therefore an important challenge to the international climate community. It appears that important steps have been taken at COP-7 in Marrakech.

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