

# **CLIMATE CHANGE AND ADAPTATION**

**K.S. KAVI KUMAR**

**DISSEMINATION PAPER - 10**

**Centre of Excellence in Environmental Economics**

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**K.S. KAVI KUMAR**

Professor

Madras School of Economics

Chennai – 600 025

kavi@mse.ac.in

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# Climate Change and Adaptation

## Introduction

The Intergovernmental Panel on Climate Change (IPCC) in its fourth assessment report observed that, ‘warming of climate system is now unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global sea level’ (Solomon *et al.*, 2007, p. 5). Policy responses to climate change include mitigation of greenhouse gases (GHG) that contribute to the expected changes in the Earth’s climate, and adaptation to potential impacts caused by the changing climate. Climate change policy has so far been exclusively focused on GHG mitigation. Despite wide-spread and long-standing demand from developing countries for greater emphasis on adaptation, the climate change negotiations have only recently started paying serious attention to adaptation aspect of climate change policy.

The United Nations Framework Convention on Climate Change (UNFCCC) refers to adaptation only in the context of climate change. In other words without greenhouse gas emissions there is no climate change and hence no need for adaptation. Going by this widely accepted interpretation, adaptation is necessary only because mitigation of greenhouse gases may not completely halt climate change. Stern Review summarizes this view: ‘adaptation is crucial to deal with the *unavoidable* impacts of climate change to which the world is already committed’ (Stern, 2006, p. 457, emphasis added). However the reality is that several millions of people world-over are currently at the risk of climate-related impacts. To say that their sufferings are not the concern of climate change policy could make such policies irrelevant from the point of view of developing countries where most victims of climate-related impacts reside. At the same time, it may not be meaningful to attribute every climate related issue to the climate change policy because it would make an already complex policy issue further complicated. Adaptation in the context of climate change should be discussed taking into account these conflicting perspectives.

Underlying the notion of adaptation is the broader notion of ‘vulnerability’. Two distinct interpretations of vulnerability notion have emerged in the

literature – starting-point and end-point interpretations. Climate change literature has viewed vulnerability as ‘end-point’ of the impact analysis – i.e., the remaining impacts of climate change on say, agriculture, after all adaptations are accounted for. However vulnerability can also be conceptualized as the starting point of analysis as it is the case with several other disciplines (e.g., food security and disaster management) that focus on vulnerability. The key difference between these two interpretations is in terms of assessing the adaptive capacity. In the end-point interpretation, adaptive capacity is used as a measure of whether technological adaptations can be successfully implemented. On the other hand, in the starting-point interpretation, adaptive capacity refers to the present day ability to cope with and respond to stressors, and secure livelihoods. The research and policy community is showing increasing interest in ‘starting-point’ characterization of vulnerability as the associated interpretation of adaptive capacity has significant policy relevance in the ongoing discussion on ‘mainstreaming’ the climate policies. For vast majority of developing countries (including India) climate change is a distant and invisible threat whereas they are presently exposed to a range of stresses (including climate related shocks such as cyclones, droughts and floods). If climate change response strategies were to be embraced by these countries it is imperative that such response strategies are aligned with policies that deal with climate related shocks.

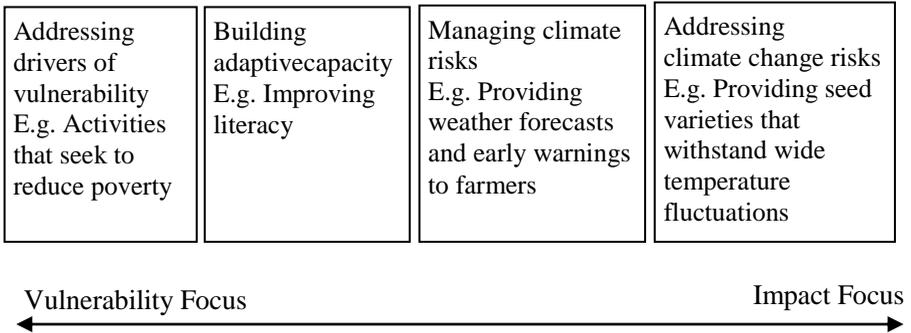
Also, more and more researchers recognize that for adaptation to be employed and to be effective it should be seen as relevant by the local people. It is unrealistic to expect special adaptations policy initiatives to deal with climate change, especially when so many of the suggested adaptation measures (such as drought planning, coastal zone management, early warning etc.) are currently being addressed in other policies and programs. Thus as argued by Smit and Benhin (2004), in order to mainstream, it is essential that the analyst pay serious attention to: (a) the climate related issues that matter now to the community; (b) the management or coping strategies presently employed by the local community to deal with those conditions; and (c) the policy structure that exist now to deal with such conditions.

Underlying this is the implicit assumption that adaptation strategies geared to cope with climate anomalies that society faces currently embrace a large proportion of the envelope of adjustments expected under long-term climate change. In other words the climate policies (at least in the local context) need not be something different from the current climate management practices.

From the vulnerability assessment literature it is also becoming clear that climate change induced threat operates *along-side* other threats that societies (especially in developing countries) face through other factors such as globalization, land-use changes etc. For instance, quoting other studies Pielke *et al.* (2007) argue that global population at risk from malaria would increase by 100% by 2080 without taking climate change into account, whereas accounting for climate change would further increase this risk by at most 7%. Thus, from developing country perspective, climate change and climate variability are one among several risks that could have significantly adverse effects on well-being. Thus, if adaptation is limited to climate change alone, it neglects the fact that vulnerability to climate change does not emerge in isolation. For instance, when a poor, subsistence farmer is viewed from climate change perspective alone, providing her with say, drought-resistant seed varieties may appear like an appropriate adaptation strategy. However, such strategy can be seen as a completely insensitive one as it ignores the current status of the farmer and the strategies that could potentially improve her food security. Thus, a more comprehensive adaptation strategy that seeks to improve food security of the farmer may include a set of coordinated measures such as agricultural extension, crop diversification, integrated water and pest management, and agricultural information services. Further, as the farmer's ability to benefit from these would improve if she or members of her family are literate, adaptation strategies could also target improving literacy levels. Similarly, strengthening the social networks and improving access to alternative employment opportunities could also be seen as part of adaptation. In other words, building adaptive capacity is much more than developing climate-related strategies.

However, all this need not be interpreted as nullification of need for research on climate change specific adaptation options. On the contrary adaptation

should be seen as a continuum, ranging from narrowly defined activities aimed specifically at addressing impacts of climate change, to building adaptive capacity and addressing the drivers of vulnerability in general. The following flow diagram captures this conceptualization of adaptation advocated by McGray *et al* (2007).

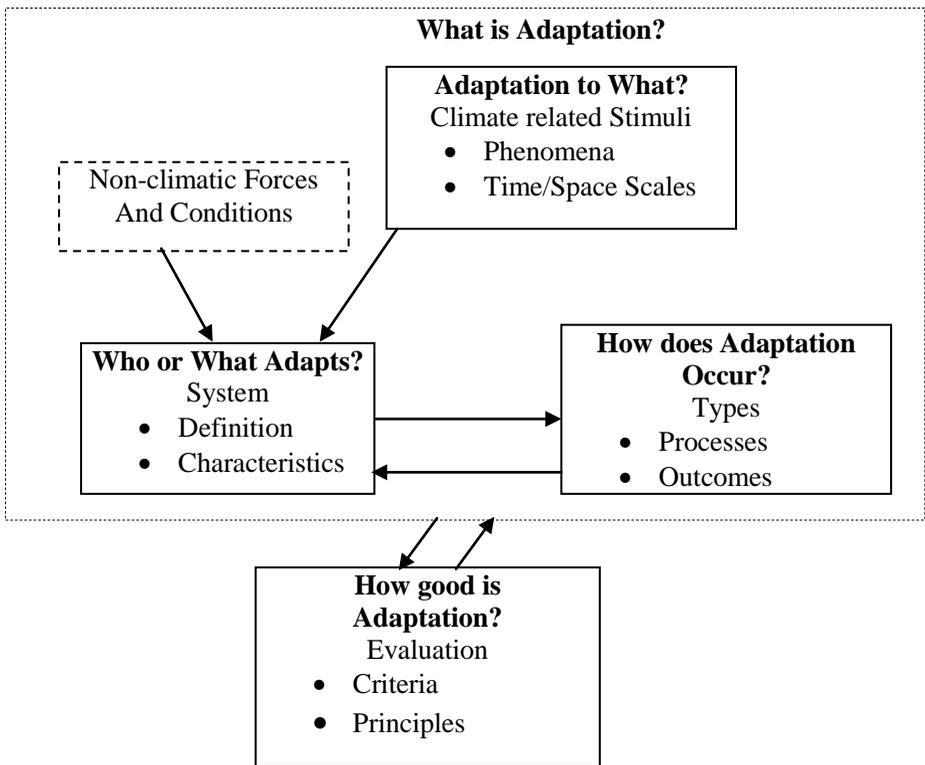


**Figure 1. Adaptation as a Continuum**

(Adopted from McGray *et al.*, 2007)

**ADAPTATION - TYPOLOGY**

In climate change context, adaptation is seen as the adjustment in human and natural systems to actual or expected climatic stimuli, which can reduce negative impacts and take advantage of the positive (Agrawala and Fankhauser, 2008). In general, adaptation involves both building adaptive capacity thereby increasing the ability of individuals, groups or organizations to adapt to changes, and implementing adaptation decisions, i.e. transforming that capacity into action (Adger *et al.*, 2005). In an effort to derive a framework systematically, the literature has raised a few key questions: adaptation to what, who or what adapts, how does adaptation occur, what and how resources are used, how good is the adaptation (see figure 2) (Smit *et al.*, 1999). In the following broad adaptation typologies that emerged from these questions are discussed.



**Figure 2: Adaptation to Climate Change and Variability**  
(Adopted from Smit *et al.*, 1999; McCarthy *et al.*, 2001)

### **Adaptation – Based on Nature of Activity**

Are there stand-alone climate change specific adaptation strategies, or improving the adaptive capacity to deal with present day climate risks would enable regions/people to better handle the climate change threat as well, or strategies that help regions/people to achieve broad development goals are more effective adaptation options?

As argued above in the first section, increasingly the research and policy community is showing interest in ‘starting-point’ characterization of vulnerability. Hence, adaptation is being seen in a broader context than narrow perspective of taking actions that are explicitly aimed at ameliorating the

climate change induced impacts. For instance in the context of sea level rise, this distinction implies that adaptation need not be restricted to building a sea wall of specific height that protects a region from a predicted rise in sea level, but could include several activities that could broadly correspond to integrated coastal zone management. Based on the way adaptation is understood, the cost-benefit calculations also differ. Typically, the stand-alone adaptations could cost less than the activities aimed at building adaptive capacity. However, increasing adaptive capacity would generally have co-benefits – that is, benefits that need not be seen as avoided climate change damages. Consideration of co-benefits could translate the overall adaptation costs to appear lower.

### **Adaptation – Based on Type of Activity**

On the basis of how it occurs adaptation can be categorized as either autonomous (e.g. reducing physical activity during a heat wave) or purposefully planned (e.g. adopting new building codes). The planned adaptation has different interpretations based on timing, i.e. reactive (e.g. after some impacts have been experienced) or proactive/ anticipatory (e.g. before major damage has occurred); on time-horizon of planning, i.e. short-term or long-term (see Table 1); on form, i.e. technological, institutional, legal, educational, and behavioural; on actors, i.e. public and private.

In general, autonomous adaptation refers to the changes that natural and human systems undergo in response to changing conditions in their immediate environment. Changes in farming practices, the purchase of air conditioning devices, insurance policies taken out by individuals and private firms, and change in recreational and tourist behaviour are all examples of autonomous adaptation. Planned adaptation, in contrast, describes the result of decisions that are based on an awareness that conditions have changed – or are about to change – and that some type of action is required to achieve, maintain, or return to a desired state. Building of sea walls in anticipation of a sea level rise is a classic example of planned adaptation. Planned adaptation uses the information about present and future climate change to review the suitability of current and planned practices, policies, and infrastructure (Fussler, 2007), which generally addresses the questions as how will future climatic and non-climatic

conditions differ from those of the past, do the expected changes matter to current decisions, what is a suitable balance between the risk of acting now or latter.

While it is relatively easy to assess the costs associated with the planned adaptation, the autonomous adaptation poses significant challenges for costing as it is difficult to characterize the scope and extent of autonomous adaptation. One of the typical ways to assess the costs associated with the autonomous adaptation is to make an estimate of the avoided impacts due to the adaptation. Reactive adaptation could typically cost more than proactive or planned adaptation, since planned adaptation would enable efficient resource utilization. Due to scale advantages public adaptation could be less costly than private adaptations.

**Table 1: Examples of Autonomous and Planned Adaptation**

<b>Types of response to climate change</b>	<b>Autonomous</b>	<b>Planned</b>
<b>Short-run</b>	<ul style="list-style-type: none"> <li>• Making short-run adjustments, e.g. changing crop planting dates</li> <li>• Spreading the loss, e.g. Pooling risk through insurance</li> </ul>	<ul style="list-style-type: none"> <li>• Developing greater understanding of climate risks, e.g. researching risks and carrying out a vulnerability assessment</li> <li>• Improving emergency response, e.g. early-warning systems</li> </ul>
<b>Long-run</b>	<ul style="list-style-type: none"> <li>• Investing in climate resilience if future effects relatively well understood and benefits easy to capture fully, e.g. localized irrigation on farms</li> </ul>	<ul style="list-style-type: none"> <li>• Investing to create or modify major infrastructure, e.g. larger reservoir storage, increased drainage capacity, higher sea walls</li> <li>• Avoiding the impacts, e.g. land use planning to restrict development in floodplains or in areas of increasing aridity</li> </ul>

*(Source: Stern, 2006)*

## **Adaptation – Based on Likely Threat**

Most of the adaptation in climate change literature is discussed in the context of gradual change in climate. However, climate change could include abrupt changes also. In fact there is growing literature on ‘tipping points’ of the climate system and if the Earth’s climate system crosses such tipping points there are likely to be widespread and significant impacts. Adapting to such sudden and catastrophic impacts could in principle be similar in nature to the adaptation to the climate extremes, but may require new adaptation strategies also. The infrastructural losses associated with extreme events are relatively easy to identify and hence estimation of associated adaptation costs are feasible. However, estimating the costs associated with human sufferings – either in the form of loss of life or injury, and broader effects of migration (for instance, inland migration caused due to significant rise in sea levels) – is difficult, to say the least. The statistical value of life and related measures for assessing loss to human sufferings may provide only partial assessment of the damages and hence adaptation costs.

## **COSTS AND BENEFITS OF ADAPTATION – ILLUSTRATIVE EXAMPLE**

Fankhauser (1998) provided one of the earliest conceptual frameworks for assessing the adaptation costs and benefits. The framework is best illustrated through an example shown in table 2. There are two states of climate – current and future, and two adaptation strategies – current and extended. Current adaptation is assumed to provide ‘optimal’ coverage for current climate, but could be insufficient in the face of future climate. On the other hand, extended adaptation – with understandably higher cost than the current adaptation – may be cost ineffective under current climate, but could turn out desirable under changed climatic conditions.

**Table 2 : Illustrative Example of Adaptation Cost and Benefits**

	<b>Current Climate</b>	<b>Future Climate</b>
<b>Current Adaptation</b>	Cost of adaptation = 90 Ordinary climate damages = 50 Climate change damages = 0	Cost of adaptation = 90 Ordinary climate damages = 50 Climate change damages = 200
<b>Extended Adaptation</b>	Cost of adaptation = 150 Ordinary climate damages = 20 Climate change damages = 0	Cost of adaptation = 150 Ordinary climate damages = 20 Climate change damages = 120
<b>Net Benefit of Extended Adaptation</b>	Incremental costs of adaptation = 60 Incremental benefit = 30 + 0 Net benefits = -30	Incremental cost of adaptation = 60 Incremental benefit = 30+80 = 110 Net benefits = 50

Assume that ordinary climate damages in the absence of current adaptation are equal to 150. From above table it is clear that current adaptation costs 90 and reduces the climate damages from 150 to 50, and hence cost effective for the current climate. That is why these adaptation measures are undertaken in the first place. Extended adaptation has an incremental cost of 60, but lower incremental benefit (= 30). Thus, extended adaptation is not cost effective under current climate.

On the other hand, current adaptation is inadequate for future climate as the future climate imposes additional damages (200 in the above example). The incremental benefits of extended adaptation are hence higher than the incremental costs of undertaking the extended adaptation under future climate.

This framework is applicable for dealing with adaptation activities that have exclusive climate change focus and are implemented in project mode. While the overall price tag on the adaptation is critically important from the negotiation perspective, decision making at local level (where adaptation

actually takes place) needs a comparative assessment of various adaptation options to prioritize the efficient options. The tools needed are not exactly same for these two end points. Further, given the diverse perspectives on adaptation discussed above, the assessment of adaptation costs and benefits has no universally applicable framework.

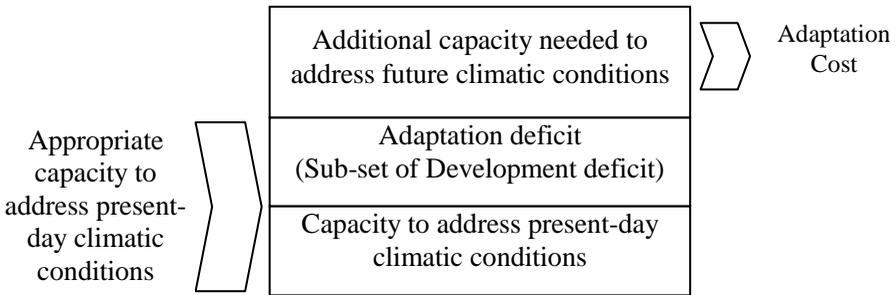
## **COSTS OF ADAPTATION – MACRO ESTIMATES**

Adaptation cost estimates are of crucial importance in the present climate regime as they could provide useful inputs for the climate negotiations. Before looking at the cost estimates it is important to take note of two concepts that have crucial bearing on the monetary estimates.

### **Adaptation Deficit**

As discussed in the previous sections, often development may serve as effective adaptation strategy for climate as well as other risks. It is in this context the notion of adaptation deficit emerges. Adaptation deficit at a narrow level implies inadequate adaptation to the present day climatic conditions, where as it implies at a broad level inadequate adaptation to the present day risks – climate as well as other risks. The following schematic (figure 3) explains the concept.

In most studies, cost of adaptation to climate change is assessed under the assumption that societies have undertaken optimal adaptation to the current climatic conditions – that is, there is no adaptation deficit. But in reality, there is significant adaptation deficit in many developing countries. If cost of adaptation to climate change includes the adaptation deficit as well, then the cost estimates increase significantly. However, it is extremely difficult to operationalize the adaptation deficit and estimate it quantitatively.



**Figure 3. Link between Adaptation Deficit and Adaptation Cost**

### **Hard vs Soft Adaptation Options**

As discussed in the previous sections the adaptation could be based on both ‘hard’ and ‘soft’ adaptations. Here, hard adaptations would include structural changes and explicit policy shifts. The soft adaptations on the other hand relate to the behavioral changes of economic agents. Such adaptations are not only innumerable, but also difficult to evaluate in economic terms. Most studies assessing adaptation costs have typically focused on hard adaptation options and have ignored the soft options. However, even the soft adaptation options would have considerable cost implications, and hence the available estimates in general provide an under-estimate of the total adaptation costs. At the same time, since the soft adaptation options could often be cheaper than the hard adaptation options, non-consideration of the soft options may exaggerate the current cost estimates.

Given these caveats the available adaptation cost estimates are discussed below under three board heads: (a) adaptation cost estimates based on broad assumptions; (b) adaptation cost estimates based on detailed sectoral analyses; and (c) adaptation cost estimates based on single sector analysis.

### **Estimates based on Broad Assumptions**

Starting with a study done by the World Bank in 2006, several subsequent studies including Stern (2006), Oxfam (2007), and UNDP (2007) have followed some simplifying assumptions to estimate adaptation costs. For developing countries, World Bank (2006) study estimated the annual Overseas

Development Assistance (ODA) at \$100 billion, annual Foreign Direct Investment (FDI) at \$ 160 billion, and annual Gross Domestic Investment (GDI) at \$ 1500 billion. Thus, the total annual financial outlay to developing countries is estimated as \$ 1760 billion. About 40 percent of the ODA, 10 percent of FDI and 2 to 10 percent of GDI are assumed to be climate sensitive. Hence, the climate sensitive financial flows are estimated to range between \$86 to \$206 billion. Further assuming that the climate proofing costs range between 10 to 20 percent of the financial exposure, the annual adaptation costs in developing countries are estimated to range from \$8.6 to \$ 41 billion. Other studies mentioned above followed more or less similar procedure with minor variations as shown in table 3.

**Table 3 : Adaptation Costs – Estimates for Developing Countries**

<b>Assessment</b>	<b>Cost of Adaptation (USD billion per year)</b>	<b>Time Frame</b>	<b>Comments on Methods/Sources</b>
World Bank (2006)	9-41	Present	Estimate based on OECD and World Bank analyses of official flows exposed to climate risk. Costs of ‘climate proofing’ are assumed in the analysis.
Stern (2006)	4-37	Present	Update, with slight modification, of world Bank study
Oxfam (2007)	At least 50	Present	World Bank study plus extrapolation of cost estimates from NAPAs and NGO projects.
UNDP (2007)	86-109	2015	World Bank study plus costing of targets for adapting poverty reduction programmes and strengthening disaster response system

## **Estimates based on Sectoral Analysis**

UNFCCC has commissioned a study in 2007 in an effort to arrive at a more 'accurate' estimate of adaptation cost. Based on detailed bottom-up analysis of agriculture, forestry, fisheries, water supply, human health, coastal zones and infrastructure, UNFCCC (2007) estimated adaptation costs both at developing country level and at global level. This study remained as a benchmark study for the subsequent studies.

Parry et al. (2009) reviewed the UNFCCC (2007) study and provided an alternative cost estimate by relaxing some of the assumption. The World Bank under the Economics of Adaptation to Climate Change (EACC, 2009) has also brought a new estimate of adaptation costs in developing countries based on a comprehensive study covering eight sectors (infrastructure, coastal zones, water supply, agriculture, fisheries, human health, forestry and ecosystem services, and extreme weather events) and using a uniform and consistent methodology applied to seven developing countries (Bangladesh, Bolivia, Ethiopia, Ghana, Mozambique, Samoa, and Vietnam). Table 4 provides an overview of the adaptation cost estimates based on these studies. The adaptation cost estimates provided by the UNFCCC study are criticized as under-estimates by Parry et al. (2009). EACC (2009) on the other hand concludes that adaptation costs per year in developing countries are roughly same order of magnitude as the foreign aid that developed countries now give to the developing countries every year.

**Table 4 : Adaptation Costs based on Detailed Sectoral Analyses**

<b>Assessment</b>	<b>Cost of Adaptation (USD billion per year)</b>	<b>Time Frame</b>	<b>Countries Included</b>	<b>Sectors</b>	<b>Comments on Methods /Sources</b>
UNFCCC (2007)	28 – 69	2030	Developing countries	Agriculture, forestry, fisheries, water supply, human health, coastal zones, infrastructure	In depth costing of specific adaptation in water, health and coastal zones. Less detailed costing for agriculture, infrastructure, and ecosystem. Infrastructure more abstract.
UNFCCC (2007)	22 – 105	2030	Developed countries	- do -	- do -
Parry et al. (2009)	2- 3 times higher than UNFCCC estimates	2030	Developing countries	- do -	Overcomes several stringent assumptions of UNFCCC study
EACC (2009)	75 – 100	2010-2050	Developing countries	UNFCCC sectors, plus extreme weather events	Based on consistent methodology applied in seven developing countries

## **Estimates based on Single Sector Analysis**

Nelson *et al.* (2009) estimated the costs of adaptation to ameliorate the adverse effects of climate change (on agriculture) in the form of additional investments in agricultural research, irrigation expansion, irrigation efficiency improvement, and rural infrastructure. The additional annual investment needed to return the child malnutrition numbers to those that would prevail under no-climate change scenario in 2050 are estimated to range from \$7.1 to \$7.3 billion under different climate change scenarios. Adaptation costs are highest in Sub-Saharan Africa, followed by South Asia and Latin America.

## **ADAPTATION POLICY**

Though UNFCCC and Kyoto Protocol have focused more on mitigation policy, both have paid some attention to adaptation issues as well. A brief chronology of adaptation discussion in the evolution climate change policy is given below:

- Article 4.4 of UNFCCC states, ‘the developed country parties shall assist the developing country parties that are particularly vulnerable to adverse effects of climate change in meeting costs of adaptation to those adverse effects’ (UNFCCC, 1992). Articles 4.8 and 4.9 further stress the need for assisting most vulnerable and least developed countries.
- In order to address the concerns of developing countries regarding the adverse impacts of climate change, first conference of parties (COP-1) in Berlin in 1995 set out three distinct stages of activities relating to adaptation process. The global environmental facility (GEF) is to provide funding for these stages. Stage I involves identifying vulnerable regions through impact assessment studies; Stage II involves capacity building measures for adaptation; and Stage III includes measures that facilitate adaptation.
- COP-4 in Buenos Aires in 1998 gave further guidance to GEF for implementation of adaptation measures in the context of vulnerable countries identified in Stage I activities.

- At COP-6 in 2000 the limited capacity of least developed countries is recognized and at the second phase of COP-6 the negotiators agreed that adaptation would be included in the special climate change fund along with technology transfer, capacity building and assistance for economic diversification.
- The decisions at COP-7 in 2001 led to the creation of three adaptation funds – special climate change fund (SCCF), least developed country fund (LDCF), and adaptation fund.
- Intense pressure from developing countries culminated in COP-8 in 2002 at New Delhi adopting Delhi Declaration that called for greater attention to adaptation in international climate change policy negotiations.
- COP-11 in Montreal, a five-year programme of work on impacts, vulnerability and adaptation to climate change was initiated with a view to ‘improve understanding and assessment of impacts, vulnerability and adaptation, and to make informed decisions on practical adaptation actions and measures’.
- COP-13 in Bali provided guidance to operationalize adaptation fund. Bali negotiations in 2007 have culminated in creation of adaptation fund board to operate under the guidance of COP/MOP.

As the above chronology suggests the significant feature of climate change policy with reference to adaptation is creation of several funds such as adaptation funding under GEF, SCCF, LDCF and Adaptation Fund. The GEF funds mainly supported preparatory work, and vulnerability and adaptation assessments in developing countries. The Stage III of GEF is supposed to provide support for actual adaptation activities, but it is burdened by the incremental cost principle and reluctance on the part of GEF donors to permit use of funds for adaptation capacity improvements. For instance the GEF funds are inaccessible for activities that could enhance adaptive capacity of Bangladesh or India through insurance mechanism aimed at climate-related events such as cyclones, droughts and floods. Thus adaptation activities are defined in a narrow sense limiting its practical use from developing country perspective.

The SCCF created through decisions at COP-7 provides funding on sliding scale principle which demands co-financing from the developing country accessing the fund. Further the fund is applicable for many activities with adaptation as one of those activities. The LDCF is targeted towards preparation and implementation of National Adaptation Programmes of Action in least developed countries. The fund availability on additional cost principle makes its use limited. Finally, the adaptation fund potentially has significant amount at its disposal for funding adaptation activities in developing country parties that are particularly vulnerable to the adverse effects of climate change. The fund is not linked to developed country contributions but to a 2% levy on clean development mechanism projects. Several issues regarding the management of this fund are still being negotiated. Table 5 provides an overview of these funds along with earmarked amounts.

**Table 5: Funding for Adaptation in Climate Change Policy – Overview**

<b>Fund</b>	<b>Created Through Decision At</b>	<b>Objective</b>	<b>Available Amount (in million US\$)</b>	<b>Disbursed Amount (in million US\$)</b>	<b>Basis for Disbursement</b>
GEF – Stage I	COP-1	To provide support for first and second national communications	130	80	Full cost funding
GEF – Stage II	COP-1	To provide support for capacity building for adaptation	60		Full cost funding
GEF – Stage III	COP-1	To support demonstration projects	50	15	Incremental cost
SCCF	COP-7	To support activities, programmes and measures in adaptation, technology	32	32	Sliding scale

		transfer, economic diversification			
LDCF	COP-7	To support urgent adaptation projects in LDCs	41	9.6	Additional costs for adaptation
Adaptation Fund	COP-7	TO support real adaptation projects and programmes in developing countries	2% of CDM revenue: \$270 to 600 M*	102	Not finalized

\* The range is based on low and high estimate of CER price estimate in 2012

*Source: Various UNFCCC documents.*

The entire adaptation related fund committed over last decade is quite small – roughly equal to \$600 to 900 million. In contrast the global overseas development assistance flows amount to \$100 billion per year, whereas the foreign direct investments in developing countries amounts to \$160 billion per year. Obviously the adaptation efforts have a long way to cover if they were to have any perceivable influence on decision making process in developing countries. As discussed above, costs required for “climate-proof” investments (ODA, foreign direct investments, and domestic investment) in developing countries would put adaptation budget in the vicinity of \$10 to 40 billion per year (World Bank, 2006). Other adaptation cost studies discussed above provide even higher estimate of adaptation budget. Thus there is a clear dichotomy between the adaptation as defined in the climate change context and adaptation the way it needs to be defined in order to ‘mainstream’ it.

As could be seen from the discussion in above sections, the notion of adaptation is going through a metamorphosis in climate change literature. This has obvious manifestations the way climate change negotiations are carried out in future. From the vulnerability assessment literature it is becoming clear that climate change induced threat operates at the ‘margin’ of significant threat that societies (especially in developing countries) face through other factors. The

phrase ‘main-streaming’ has emerged as a key notion in the climate change parlance. It describes the integration of policies and measures that address climate change into development planning. While importance of integrating climate change mitigation policies with energy policies is well understood, the link between climate change adaptation policies with development policies has only recently gained wider acceptance. Since development needs are highly location specific, the adaptation policies should also be designed to satisfy local requirements. In other words it may not be appropriate to look for generic strategies (i.e., one size may not fit all). While close association with development policies and adherence to local needs would ensure effectiveness of adaptation policies, clear grounding in commonsense morality (i.e., to ensure the responsibility of nations to provide resources for adaptation and compensate for climate impacts in other nations) would firmly keep climate change connection.

Though it appears simple and straight forward, main-streaming of adaptation policies poses important dilemma for the policy makers. While from developing country perspective a rupee spent on ‘adaptation’ is most effective if it contributes towards increasing adaptive capacity in general, the developed countries would like to see that their contribution to developing countries is going towards new and additional activities geared towards climate change rather than towards ‘business-as-usual’ development.

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The Ministry of Environment and Forests, Government of India has designated Madras School of Economics as a Centre of Excellence in the area of Environmental Economics for a period of ten years from April 1, 2002. The centre carries out research work on: Development of Economic Instruments, Trade and Environment, and Cost-Benefit Analysis. The Centre is primarily engaged in research projects, training programmes, and providing policy assistance to the Ministry on various topics. The Centre is also responsible for the development and maintenance of a website (<http://coe.mse.ac.in>), and for the dissemination of concept papers on Environmental Economics.

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**Centre of Excellence in Environmental Economics**

Madras School of Economics

Gandhi Mandapam Road

Chennai - 600 025

Ph: 2235 2157/2230 0304/2230 0307

Fax: 2235 4847/2235 2155

Email: [coe@mse.ac.in](mailto:coe@mse.ac.in)

Web: <http://coe.mse.ac.in>