The Energy and Resources Institute

Synthesis Report

2012 CLIMATE AND DEVELOPMENT RESEARCH REVIEW

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Acronyms

CBA	Community-Based Adaptation
CDKN	Climate and Development Knowledge Network
CDM	Clean Development Mechanism
CDRR	Climate and Development Research Review
COP	Conference of the Parties (to the UNFCCC)
CRED	Climate and Regional Economics of Development
ESCOs	Energy Service Companies
GDR	Greenhouse Development Rights
GHG	Greenhouse gas
ICTs	Information and Communication Technologies
MRV	Measuring, Reporting and Verifying
NAMA	Nationally Appropriate Mitigation Action
NAPA	National Adaptation Plan of Action
ODA	Official Development Assistance
RCI	Responsibility Capacity Index
REDD	Reducing Emissions from Deforestation and Forest Degradation
REDD+	comprises REDD's deforestation and forest degradation and also conservation, sustainable management of forests and enhancement of forest carbon stocks.
REEEP	Renewable Energy and Energy Efficiency Partnership
R&D	Research and development
SBI	Subsidiary Body for Implementation (of the UNFCCC)
SDRs	Special Drawing Rights
TERI	The Energy and Resources Institute
UNFCCC	United Nations Framework Convention on Climate Change

INTRODUCTION

The climate-development nexus: Renewed efforts

In the 20 years since world leaders gathered at the first Earth Summit in Rio de Janeiro with a pledge to embrace sustainable development, climate change has emerged as a major challenge to both the environment and to development. Scientific understanding of climate change and its potential impacts on Earth's natural systems and people has advanced rapidly. Indeed, scientific understanding has advanced faster than the ability of most institutions to absorb it and act upon it. At the same time, the physical science of climate change holds many uncertainties. Leaders now face tough, and ever more urgent, policy decisions.

The research community has responded by producing a wealth of studies on the links between climate change and development, which span the global, regional, national, and local levels. As a result, a major body of climate and development literature has emerged in the past decade, authored by a wide range of stakeholders. The purpose of the *Climate and Development Research Review* is to draw the main findings from this body of research to inform policy-makers and practitioners who are working towards climate compatible development.

The links between climate change and sustainable development cannot be overstated. While the impact of climate change can hamper developmental efforts in key sectors, such as poverty reduction, agriculture, and health, developmental choices themselves can, to some extent, influence the ability of societies to mitigate and adapt to climate change (Yohe et al., 2007, see Figure i.1). Sustainable development in a changing climate demands action that

- keeps pace with the rate of change
- is delivered at appropriate scales
- focusses on the most vulnerable people and systems
- is integrated in a way which addresses issues at the climate-development nexus (Commission on Climate Change and Development, 2009).

In this context, *climate compatible development* is defined as 'development that minimizes the harm caused by climate impacts, while maximizing the

many human development opportunities presented by a low-emissions, more resilient, future' (Mitchell and Maxwell, 2010).

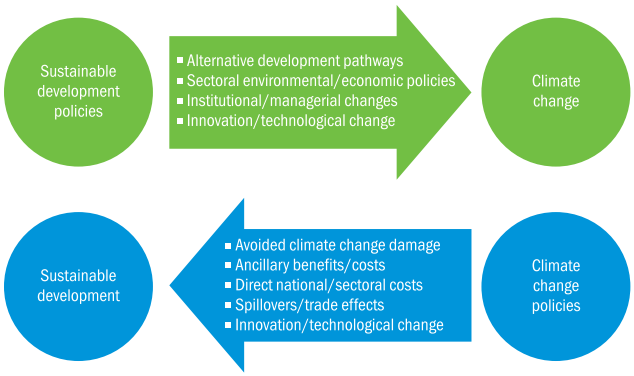

Figure i.1: Linkages between climate change and sustainable development (Yohe et al., 2007)

Why a climate and development research review?

The past decade has seen the emergence of a sizeable body of literature on climate and development that spans global, regional, and national to the local levels. Studies have been carried out by different stakeholders, including international and national governments, the private sector, research institutes, non-governmental organisations (NGOs), community-based organisations, and development agencies. New and innovative approaches are emerging, which integrate methods, sectoral approaches, top-down and bottom-up techniques, and research disciplines. Given the rapid evolution of research on climate and development, the *Climate and Development Research Review* aims to highlight both where climate and development researchers are currently focussing their enquiry, and the big *debates and issues* emerging from the literature for the use of policy makers and practitioners. The Review also pinpoints some of the innovations in climate compatible development captured in the recent literature, in order to demonstrate the frontiers of policy and practice. The Review also aims to be a useful reference for policy researchers and technical advisors to policy-makers, as well as non-specialist policy advisors, civil servants and other decision, makers working in the climate and development arena, particularly in developing countries.

Approach

The Review is based on a meta-synthesis of 572 papers published between January 2010 and August 2011 that provide insights into two key questions:

- How does climate change affect development?
- How can development contribute to climate change adaptation and mitigation?

The selection of the literature for review was refined on the basis of its relevance to ongoing debates on climate and development and its value—current or potential—for policy making. Of the longer list of papers identified, the heart of the Review is based on 93 studies selected for in-depth review (see Box 1: Methodology).

Box 1: Methodology

The team used the following methodology to identify the main themes and most innovative and policy-relevant findings from the climate and development literature.

1. **Identify the key words to be used in the analysis, and the sources of literature to be covered.** Beyond the simple search terms 'climate' and 'development', key words for the most current themes in climate compatible development were identified from three main sources: the topics of United Nations Framework Convention for Climate Change (UNFCCC) side events from late 2009 to mid-2011 (these are indicative of the subjects that country delegates, researchers, and civil society that are currently debating); the results of an online survey conducted via the climate-l mailing list for climate-change professionals (http://climate-l.iisd.org); and consultation with known experts in the field.
2. **Use the selected key words to conduct a Google Scholar search.** From entering these key words in a Google Scholar search, a database of scholarly papers released between January 2010 and August 2011 was created. From a combination of Google Scholar results and recommendations from the survey and experts, a total of 572 papers were selected.
3. **Shortlist the papers deemed to be of greatest relevance to climate and development.**

Based on the team's reading of the abstracts and conclusion/recommendations sections. This assessment led to a shortlist of 225 papers.

4. **Assess each shortlisted paper for its relevance to policy making**. The papers were assessed for their connection to stages in the policy cycle: agenda setting, policy formulation, decision making, policy implementation or policy evaluation (from Howlett and Ramesh, 2003). This filtering process also referenced CDKN's dimensions of change , which define the following policy-related activities necessary to improving the quality of life of the most climate-vulnerable people: changes in the evidence base; changes in understanding and political commitment; changes in institutions and institutional capacity; changes stakeholder coordination, collaboration, and mobilisation; changes in the ability of decision-makers to leverage and channel resources, and changes in the design and delivery of appropriate policies and practices. After this study, the team applied these criteria, the shortlist was refined to 125 papers.
5. **Assess each shortlisted paper for its likelihood of policy influence**. Finally, each paper on the shortlist was further reviewed by an expert team at TERI, based on the following criteria:
   a. Is the paper relevant to the ongoing debates on climate and development?
   b. Is the content new, ground-breaking and likely to be picked up by policy makers?
   c. Is the paper influential and important, or should the findings of this paper be considered for policy application?

The expert review led to a final shortlist of 93 papers.

As with any methodology, the choice of selection criteria may have introduced certain biases in the final shortlist. For instance, starting with key words from the climate change negotiations and seeking expert opinion through a climate professionals mailing list probably generated more climate-focussed papers compared with development-focussed papers. Book chapters were not included to avoid the hazard of misinterpreting the ideas from specific chapters in isolation from the rest of the book. Despite these biases, we are confident that the global survey, expert opinion, and internal assessment have together produced a robust selection of high-quality and innovative research papers.

Navigating the report

The Review draws out key messages from the 93 selected papers, which are presented in four thematic chapters in this report, as follows:

- **Decision making in the face of uncertainty** – How should decision-makers operate in a context of uncertainty around climate impacts, including uncertainty around extreme weather events? How do issues of poverty and power affect decision making?
- **Natural resource management in a changing climate** – How can natural resources be managed most effectively across scales in a changing climate, and how can lessons be best captured and shared?
- **Financial mechanisms for climate action** – Are current climate finance mechanisms fit for purpose? What relative contributions could public and private sources make? How can climate finance be generated, managed and spent effectively?
- **Technological innovation and effort-sharing** – How can the integrated use of market instruments and government regulation transform energy systems? How should climate mitigation efforts be distributed among groups and countries as part of the transition to a low carbon economy?

Each theme places recent research in the context of issues and debates centred on the climate-development nexus. Emerging issues and frameworks for response are highlighted, supported by specific examples from the developing countries of Asia, Africa and Latin America and the Caribbean.

1

DECISION MAKING IN THE FACE OF UNCERTAINTY

The uncertainties of climate change present a major challenge for policy-makers. Physical science remains uncertain at many levels needed, in spite of continued, significant improvements. Beyond the physical science, many wider factors influence human vulnerability to climate change. How do we deal with these very large uncertainties, and multiple, pre-existing factors that may magnify the impact of climatic events?

Some researchers find that only a paradigm shift and transformation of governance will allow us respond to these unprecedented challenges; incremental steps will be insufficient. Some of the most ground-breaking recent research in this area has focused on how to mainstream and build adaptive capacity at different levels of society in order to respond to climate change. Investigations into 'sustainable adaptation' in concept and practice have furthered understanding. However, we still do not know how to prevent negative feedback, maladaptation, and 'policy misfits' (Eriksen et al., 2011).

Decision making in an era of climate uncertainty can be assisted by new approaches focussing on grounded participation in change, the role of institutions and the use of appropriate visualization tools to help change awareness and assist decision makers, as discussed in detailed research in this section.

Conceptual advances in adaptation for decision makers

A number of technical and conceptual advances can help decision-makers plan and execute better management of climate change.

First, new research shows that adaptation actions undertaken today may have a dynamic, fluid, and incremental effect over time. While the potential for accumulating greater positive effects over time from early actions today has been noted for mitigation actions, the application of this concept to adaptation actions, so-called 'adaptation wedges', is new (Diffenbaugh et al., 2011). This shift viewpoints from more linear views of cause-effect or intervention-direct result assumed in many development initiatives, and could provide policy-makers with greater incentives for early adaptation action.

Second, top-down models which integrate approximations of dynamic variables in Integrated Assessment Models are becoming refined. These models include climate scenarios, socio-economic scenarios and vulnerability storylines overlaid on basic climate science data to provide new, better calibrated scenarios. Models are being developed that include dynamics of potential adaptation actions, but require further ground truthing (Patt et al., 2010).

A third area of interest in recent research is that of human responses to climate change, and the potential for errors which cause unintended impacts: maladaptation. Two examples demonstrate maladaptation at the government level. Bunce et al., (2010), found a policy misfit in river basin systems and marine protected areas in Tanzania and Mozambique, contrary to intentions, because the policy developed had not adequately considered multiple stressors, impacts, and responses leading to weakening of community level resilience. Barnett and O'Neill, (2010) found that some actions that are intended to build climate resilience may lock in a future that retains less adaptive capacity (e.g., building water pipelines or desalination schemes) or may inadvertently increase vulnerabilities in one group whilst decreasing others' vulnerabilities.

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Advances in local research into climate impacts

At the local level, recent research makes incremental steps in conceptual development in three areas.

First, using evidence from adaptation initiatives in Lesotho, (Bisaro et al., 2010), classify project approaches as either 'decision-centric' or 'institutional-centric'. Decision-centric approaches use impacts of climate change as a starting point to devise adaptation strategies, while institutional-centric approaches begin with a situation analysis, using stakeholder consultations and measurement of indicators to develop governance recommendations. In the Lesotho case, a lack of awareness on climate change issues among decision makers resulted in a largely expert-driven approach for adaptation planning, which can be less effective in implementation. Bisaro et al., (2010), recommend that methods of assessments are matched to context, rather than beginning with one overarching and rigid framework.

Second, concepts of environmentally induced migration have been furthered in recent research, with Renaud et al., (2011), conceptualizing a way to categorize environmental migrants. This tackles the issue of attribution of migration decisions to environmental triggers, though there remain challenges in isolating the degree of climate change

causality in migration caused by rapid onset hazards and ecosystem degradation.

Third, Williams et al., (2010), highlight that suburbs or peri-urban areas may be significantly affected by climate change – focus to date has been on urban and rural areas. Suburban settlements, which are often less densely settled areas, need to be retrofitted with adaptation resources (e.g., rainwater systems or passive ventilation in houses, improved urban drainage systems, and greening of public spaces)., butland management and house ownership can cause problems in long-term decision making and effecting change.

These three advancements demonstrate that various areas of local level research on adaptation still remain to be explored.

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Enabling inclusive planning and collective action

First, one recent case study in Bangladesh has highlighted the challenge of making adaptation planning an inclusive process in practice through a critical analysis of the participatory principle inherent in the planning for the National Adaptation Plan of Action (NAPA) (Ayers, 2011). Mismatches exist between the risks and strategies identified in the NAPA coastal afforestation project document and the perceptions of risk and of adaptation priorities on the ground. According to Ayers (2011), the NAPA process did not reflect well the issues of vulnerability and development among diverse local groups at the community level. The participatory process was executed poorly due to a number of reasons: ignoring issues of power (not including local elected leaders in the consultations); poorly designed stakeholder workshops (presenting pre-defined climate-change risks along with adaptation options); and the expert-driven nature of the process (leading to scientific institutions being far more represented than local institutions). Existing local institutions need to be integrated from the outset to make the process truly deliberative and adaptation planning more inclusive. This is a major challenge for adaptation planners.

Second, in a participatory process, researchers recognize that some factors may coalesce to create barriers to stakeholder cooperation. A study of water management in the City of Cape Town found that decision-makers lacked access to scientific information in a useable format. This, coupled with weak leadership and legislation, resulted in lack of cooperation between stakeholders and impeded adaptation action (Zervogel et al., 2010).

Third, shared learning is critical for the sustainability of change. Cases of city-level resilience planning in India, Indonesia, Thailand, and Vietnam illustrate the importance of shared learning in resilience planning. Leadership at the city, level, while important, can often be transient. In these cases, key stakeholders and decision-makers beyond the leadership can mobilize and sustain planning initiatives (Tyler et al., 2010).

Finally, the notion of collective action is increasingly proposed in relation to adaptation actions. The Community Based Adaptation (CBA) initiative has provided an interesting positive experience. A pilot CBA project in Druadrua Island, Fiji, highlights that developing partnerships and networks with local experts in technology, information, and engineering and their home institutions is effective and recommends CBA projects to focus on this. CBA prioritizes the participation of local institutions and

communities in assessing climate risk, as well as in planning, implementing, and monitoring adaptation strategies, and provides promising early evidence of partnership and cooperation (Dumaru, 2010).

However, cultural backgrounds also influence the effectiveness of, and willingness to engage in, collective action. Individual responses to the understanding of environmental change are shaped by culture, dominant social discourses and institutions. Heyd (2010) argues that individual action can be powerful, even if limited by inadequate institutional support at national and international governance levels. This can create a type of 'second order' solution by introducing changes, such as behavioural changes, that could address climate change. Good quality environmental education can play a vital role in creating a generation of sensitized individuals who will embrace environmentally 'appropriate or correct behaviours' and prepare them to deal with uncertainty and potentially 'radical futures' (Bangay and Blum, 2010).

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Emerging approaches for decision making under uncertainty

A number of new approaches to decision making under uncertainty have emerged, with focus on three areas:
1. Better mainstreaming approaches;
2. New, adaptive policies and policy-making; and
3. Adaptation tipping points and scenarios for the future.

Mainstreaming approaches

The mainstreaming of responses to climate change in policy making is well understood in theory by both national governments and donors. It provides a framework to safeguard development activities that are vulnerable to climate impacts. However, while climate change is addressed directly (with varying levels of success) in NAPAs and National Communications, little is written about how climate adaptation can be best mainstreamed into wider development sectors.

Sietza et al.'s (2011), study of Mozambique—a country with a development process that relies heavily on official development assistance (ODA)—provides important insights into mainstreaming climate change into wider development. Effective mainstreaming is achieved by good information management and access, continuity and networking across national

and international institutions alongside a favourable legislative environment. Specific institutional barriers that impede effective mainstreaming include the lack of skilled human resources and relevant information, the erosion of institutional memory, and lack of institutional coordination and participation, together with scarcity of funds and a focus on short-term developmental priorities.

Mainstreaming approaches in a transboundary context provide further challenges. A comparative analysis of adaptation policies in the Orange-Senqu river basin in Africa and Mekong basin in Southeast Asia demonstrates how effective river basin commissions and other elements of transboundary regimes have interacted effectively to create climate adaptation policies. The analysis shows that the factors that contribute to effective governance regimes in transboundary river basins are also likely to foster the development of effective climate change adaptation strategies. These factors include: respected rules and procedures, organisational structures, the approach of the countries involved, and the wider international context (Kranz et al., 2010).

Adaptive policies

A key conceptual development in adaptation policy making is the notion of dynamic or adaptive policies. Adaptive policies are 'policies that can adapt to a range of anticipated and unanticipated conditions that can affect policy performance in the future'. Policies that are rigid may not perform effectively under uncertainty, and may not achieve their optimal performance and objective. Swanson et al. (2010), claim that policy-making in the uncertainties of the 21st century resembles gardening as it is 'muddy, attentive, and experiential, because we really do not know what growing conditions will prevail'(p. 927).

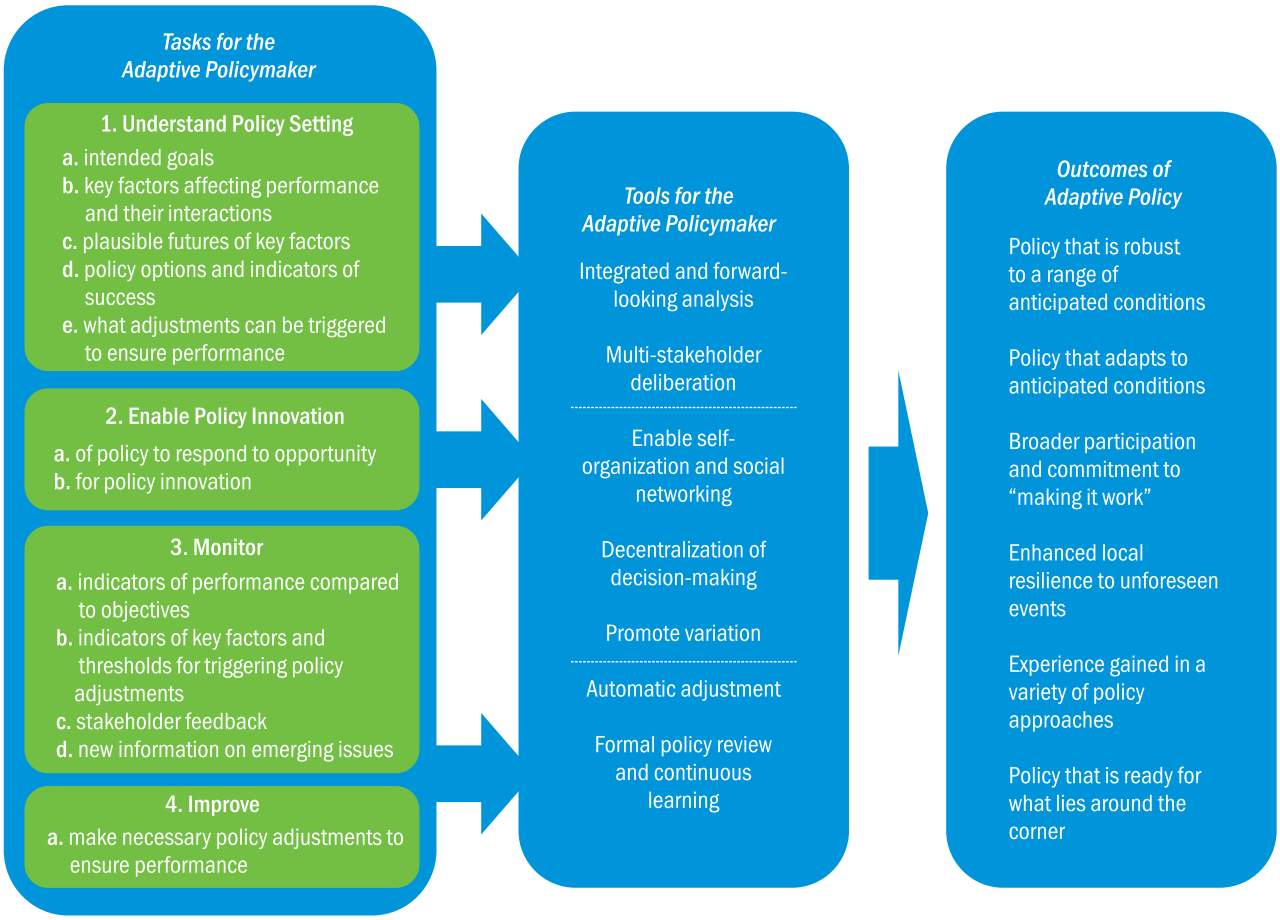

Figure 1.1: Tasks and tools for adaptive policy-making *Source: Swanson et al. (2010)*

Swanson et al. (2010) reviewed policies in Canada and India, and have identified seven tools that assist decision-making under uncertainty by increasing the adaptive nature of this process (see Figure 1.1). These include: integrated and forward-looking analysis using scenario planning, multi-stakeholder deliberation, and the monitoring of key performance indicators to trigger automatic policy adjustments to ensure that the policy to function effectively in the face of expected or unexpected conditions. Adaptive policies can be prepared to deal with unexpected conditions through regular formal review and learning (even when the policy is working well), enabling self-organisation and social networking in communities, and decentralising decision making. Promoting variation or encouraging diversity in policy responses helps to handle the unexpected.

Uncertainty: Adaptation tipping points, future scenarios and speed of action

Three areas of new research inform how we deal with uncertainty – one, around contextual adaptation tipping points; second, how we deal with unexpected events and lastly, a deeper understanding about implementation of decisions and how this affects choices the policy, makers will make.

First, a conceptual challenge for top-down planning approaches to climate change is based on the concept of *'adaptation tipping points'*. Existing policies may fail to meet objectives beyond certain thresholds due to impacts of climate change. In the Netherlands, Kwadijk et al. (2010), find that an approach identifying tipping points is less dependent on scientific climate projections and can help identify 'the most urgent effects of climate change and when these will occur' through a process of examining political, physical, technical, ecological, and economic contexts in the light of uncertainties (p. 737).

Second, future scenario creation is one approach that has been used to deal with uncertainty in climate change during the last 10 years. Surprises, frequently, exist beyond the scope of plausible future scenarios presented, and policy makers can be better prepared for these unexpected events or 'wild cards' by looking at previous unexpected events and responses and developing sets of scenarios (Lindenmayer et al., 2010; Wardekker et al., 2010; Walker et al., 2010).

Smith et al. (2010), argue that current decision-making on adaptation focuses almost exclusively on the gradual adjustment of business-as-usual activities to reach a set of objectives, such as the introduction of climate-hardy crops to maintain food production under climate change. This is wrong, they argue. Under a scenario of rapid and extreme climate change (for example a 4 °C rise in global average temperature) and associated uncertainties, adaptation may have to become truly transformational, altering key objectives, such as changing land-use patterns from farming under transformative adaptation (see Figure 1.2).

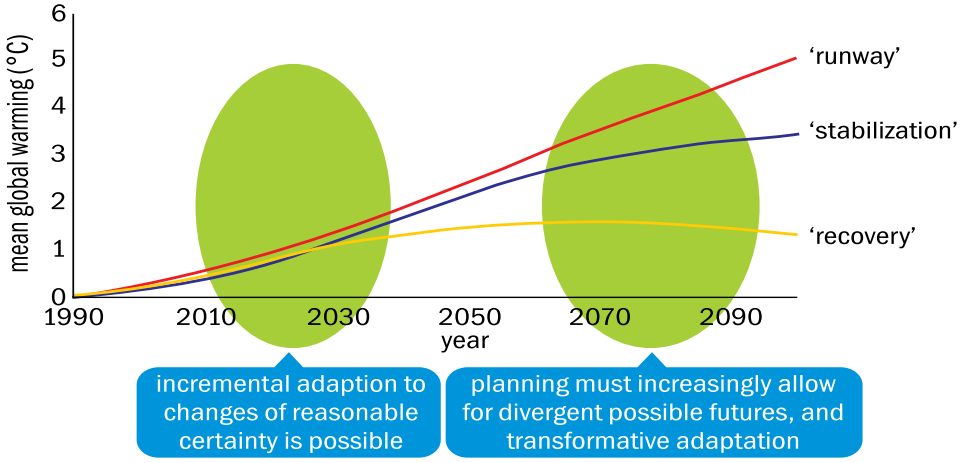

Figure 1.2: Changes in scientific uncertainty (reasonable certainty to divergent possible futures) and changing implications for adaptation. Solid lines illustrate societal response to temperature change: 'recovery', 'stabilisation', or an extreme scenario, 'runaway' Source: Smith et al. (2010)

Finally, a further area of investigation has been looking at behaviour changes and implementation of adaptation decisions. Smith et al. (2010), examine the possibility of a 4 °C world, and show how short-term decisions about adaptation can be nested within a larger longer-term transformative framework of change, with an example of the Thames barrier in the UK. If it takes a long time for adaptation actions to bring about changes (slow response) this is said to be a 'long adaptation decision lifetime'. Shorter adaptation decision lifetimes are easier to enact as benefits are seen more quickly. There may be psychological, perception-based, and institutional barriers in the process of adaptation formulation and implementation in long decision lifetimes. Smith et al. (2010), argue that these barriers can be overcome by breaking the complexity of the adaptation decision-making into actionable steps, and can assist with dealing with longer-term uncertainties by providing short-term positive impacts. This longer-term framework can help to avoid issues of maladaptation mentioned earlier.

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Building long-term adaptive capacities

Effective institutions, good use of new technology, and enabling governance are keys for long-term adaptive capacity.

The final area that has received significant attention from researchers in the last two years in terms of decision making under uncertainty is how to build individuals' and institutions' capacities for long term adaptation to change. Effective institutions, good use of new resources such as information technology, and enabling effective governance, and institutional structures are essential to build long-term capacity (cf. Adaptive Management in Section 3.2).

Firstly, some institutions are very effective in promoting adaptive capacity amongst stakeholder groups. Gupta et al. (2010), analyzed the aspects that are common to these effective institutions (see

Figure 1.3). These institutions encourage varied perspectives, stakeholders and solutions; they enable stakeholders to learn and improve; they encourage stakeholders to modify and alter their behaviour; they help support leadership and have resources for implementation of adaptation; and they support fair governance. These six dimensions and component criteria of the adaptive capacity wheel are a useful tool for policy makers and researchers to help them work out on how to make institutions better equipped to improve people's capacity to adapt to climate change.

Corbera and Schroeder (2010), explore similar aspects in the context of the approaches to climate mitigation in Reduced Emissions from Deforestation and Degradation (REDD+). Institutional architecture and governance structures are still being defined in this sector. The authors apply an Earth System Governance Framework to REDD+, comprising five elements: architecture, agency, adaptiveness, accountability, and allocation and access. These elements, taken individually or collectively, can direct current and future research efforts in the governance and implementation of REDD+.

Second, the critical role of information and communication technology in tracking progress, sharing experiences and spreading information is becoming increasingly apparent in the bid to respond to climate change fast and effectively.

In sectors such as health, understanding and responding to impacts of climate change can benefit from a robust monitoring and tracking system enabled by developments in ICT to identify vulnerable groups (for example, tailor-made visualisation techniques) (Houghtonet al., 2011). Elements of ICTs' own resilience must be strengthened if these technologies are to be effective in meeting the changing needs of the climate change community; these include robustness, scale, redundancy, speed of change, flexibility, self-organisation, and learning (Ospina and Heeks, 2010).

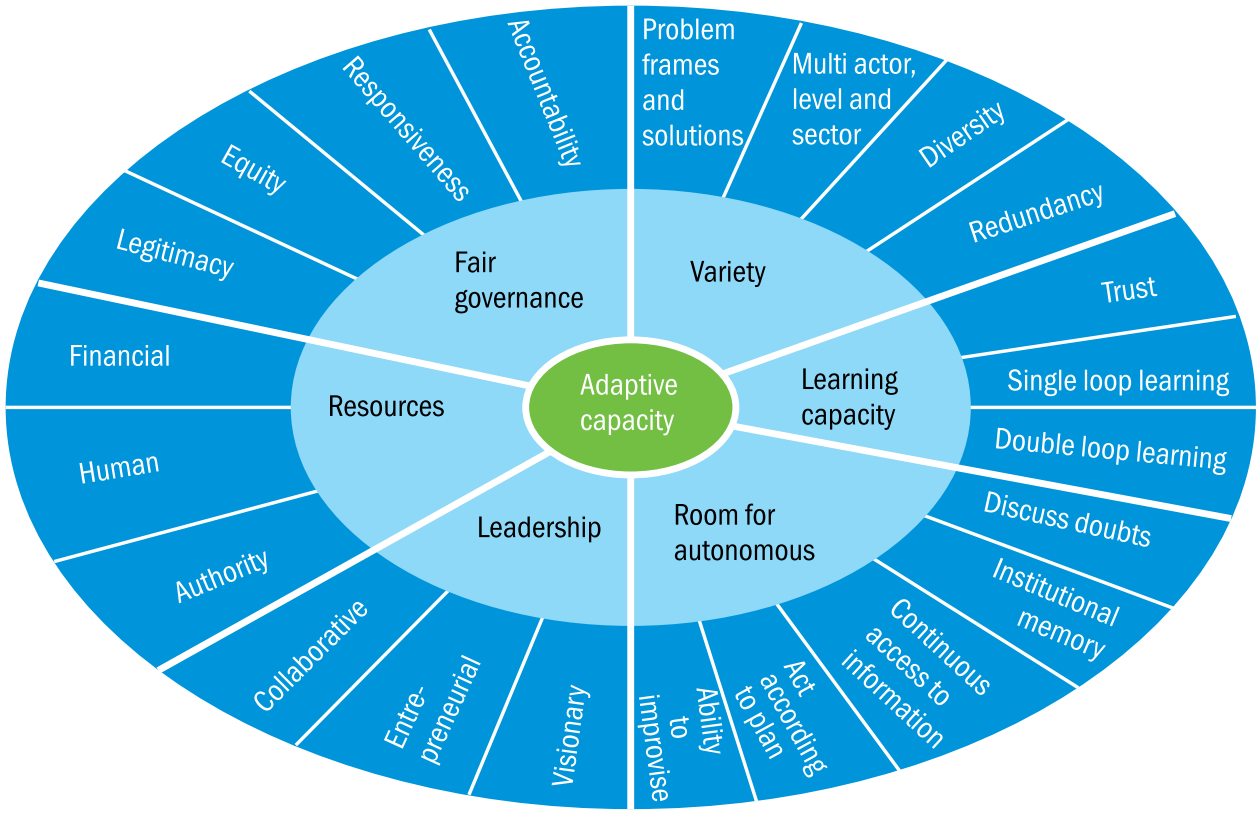

Figure 1.3: The Adaptive capacity wheel *Source: Gupta et al. (2010)*

In terms of information sharing, examples from Asia reveal limitations in the current modes of how climate information is shared. These include mismatches between spatial and temporal scales of forecasts and decision-makers' requirements, end users not being involved in defining information needs, and lack of training in interpreting complex climate data such as probability information. Sometimes communication channels between forecasters and end users are weak, and sometimes equipment to process climate data is unavailable. One way to overcome this is the creation of platforms that bring together all stakeholders in 'climate fora'. This provides an interface between the producers and users of climate information, including forecasters, disaster management and other extension agencies of government, authorities, with communities to prompt timely responses during extreme climate events (Srinivasan et al., 2011).

Finally, building adaptive capacities requires clear governance and legitimized institutional structures. One outcome of COP16 in Cancun, Mexico[1] was to develop a work programme to address loss and damage associated with climate-change impacts in vulnerable countries. This was to be operationalized by the Subsidiary Body for Implementation (SBI) of the UN Framework Convention on Climate Change (UNFCCC). Research efforts so far have focussed on understanding the nature of the risks faced from climate change and the potential damages.

Concepts for disaster risk reduction and insurance instruments suggest ways to enhance the international funding available to vulnerable developing countries for adaptation[2]. But there are few viable plans to operationalize these proposals. Ranger et al. (2011) suggest three options in this respect:

I) developing national climate insurance facilities covering the impact of severe weather events on vulnerable countries;

II) implementing a range of risk management options, including risk transfer and risk reduction, focussing on the frequent and medium-scale risks of loss and damage at the country or regional level;

III) using approaches that address longer-term foreseeable loss and damage. These include rehabilitation associated with slow onset events (such as sea level rise, biodiversity loss, glacial retreat and desertification).

Developments in adaptive capacity over the last two years have focussed on the creation of institutions to support the growth of adaptive capacity among stakeholder communities, as well as being effectively structured and governed, in their own right, to address the challenges ahead.

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[1] 16th Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change

[2] Financial mechanisms related to adaptation and risk reduction are further discussed in Chapter 3

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In summary, Decision-making in the face of uncertainty is of critical importance to those working on climate change and sustainable development. Climate change adds an extra element of uncertainty for decision-makers due to the current limitations of climate science, and the additional challenges of requiring effective interactions with a wider number of institutions and individuals than before. New research increasingly shows, the importance of decision making being context-specific and grounded in local realities, without which, investments may be made that are poor, inefficient, or create maladaptations that bring further future damages.

Two new areas of research are of note among the abstracts highlighted in this report. First, advances in the study of environmental migration led to new understandings of how climate change can be a causal factor in migration decisions. Second, the issue of the impact of climate change on peri-urban areas has been raised, and requires further research to understand adaptation and mitigation prospects and opportunities for these areas.

Planners face challenges of integrating climate change into existing processes, and research highlighted in this section shows case studies of how this might work better through improved cooperation, shared learning and collective action. These processes are lengthy and require political buy-in and ongoing support.

Finally, in the challenge to mainstream climate change, both policy-makers and policies themselves can improve their adaptive capacity, increasing their flexibility and ability to respond to new issues. Even with significant uncertainty, step-based changes can make a large long-term target more manageable, such as a 4 °C global average temperature rise by 2100. Success in these areas with the very significant environmental changes that may occur requires a deep understanding of local context, and conscious adoption and development of new sets of skills at many levels to embrace a transformative approach. Information sharing is a critical element described in the case studies with the use of ICTs.

Whilst the general principles of good decision-making reflected in this section will be familiar, evidence shows that climate-change issues bring specific elements of uncertainty into this equation. These require a new approach that is more reflective and interaction-based, more engaged over the long-term, and more flexible in order to make positive changes towards both mitigation and adaptation.

2

NATURAL RESOURCE MANAGEMENT IN A CHANGING CLIMATE

Managing natural resources across scales

Human activities are already consuming natural resources at unsustainable rates. Climate change poses an additional threat to natural resources under pressure. The different pressures on natural resources cannot be solved in isolation. Stakeholders must understand and address the complex dynamics that connect resources, and the trade-offs that might be required in managing them.

Land is a resource that is under multiple pressures from the local to global level. Harvey and Pilgrim (2011), highlight the pressures on land to deliver food security, energy security, and greenhouse gas mitigation benefits, worldwide. Climate change adds further stresses; for example, by changing growing conditions and leading to shifts in farming patterns. None of society's broad development needs can be addressed without understanding and addressing the complex natural resource dynamics that underpin them. How can society negotiate the difficult trade-offs required?

A 'whole landscape' approach

Managing ecosystem services at a landscape scale is an emerging theme in the research literature and reflects policy makers need to understand and manage for complex interactions among natural resources.

Instead of studying food, fuel, and climate objectives in isolation, De Fries and Rosenzweig (2010), take a 'whole landscape' perspective. They suggest that competing objectives for use of land resources can be addressed by creating: and

- incentives to locate new cultivation on degraded land or land that had already been cleared;
- local strategies that account for site-specific conditions;
- policies that explicitly include multiple objectives (for example, REDD may be an example of a greenhouse gas mitigation policy that does not address food security concerns);
- mechanisms for trading soil-based carbon credits.

Agricultural intensification has received much attention in the recent literature as a possible means of deriving multiple benefits from scarce land resources. Harvey and Pilgrim describe how European agricultural policy has supported research and innovation into sustainable methods for agricultural intensification, so that a combination of food, energy and climate objectives can be met.

DeFries and Rosenzweig (2010), argue that carefully targeted policy measures are needed to deliver multiple benefits—and avoid unintended consequences. Take the dual goals of climate mitigation and improved food production. If agricultural productivity improves, then agriculture becomes more profitable. This is not necessarily good for the climate. When agriculture becomes more profitable, it may fuel demand for land and forest clearance for agriculture. DeFries and Rosenzweig suggest that where forest and agriculture compete for land use, forest protection measures are needed to safeguard forests' climate and broader ecosystem benefits. To illustrate their case, they show how deforestation in Latin America, Africa and Asia increased agricultural land by only 2.9% from 2000-2005, but increased greenhouse gas emissions by 39%.

Another contribution to the 'whole landscape' approach looks at the importance of managing protected areas in the context of the broader ecosystems in which they are situated, and recognizing the flows of ecosystem goods and services that they can generate. Historically, protected areas have been viewed as exclusively being for biodiversity conservation. Ervin (2011), argues that protected areas provide considerable social, economic, and ecological benefits that also make them a cost-effective investment for strengthening climate resilience, adaptation, and mitigation. However, to maximise the benefits of protected areas for climate planning, their location and wise management is crucial.

Ervin suggests that a good first step is for planners to mainstream protected areas planning into sectors such as transportation and energy. Decision-makers should review the economic importance of protected areas in addressing climate-related concerns, and may find opportunities to leverage climate funding to enhance protected area management, including the restoration of ecologically vulnerable areas.

Policies across scales

Many recent studies examine policies that work across scales—national, regional and local—to address the natural resource dynamics at each level. Effective policy making and delivery across scales can help to secure the joint adaptation and mitigation and human development benefits of numerous sectoral policies, particularly in the forestry and land use sectors, and to manage the trade-offs.

A study by Stern (2011), takes the governance of global common property resources as its starting point, and finds that, in order to be effective, global policies must factor in local realities and expectations. Stern (2011), suggests that a governance regime for global commons should be based on the following design principles:

- investing in science to understand the resource and its interactions with users;
- establishing independent monitoring of the resource and its use;
- ensuring stakeholder deliberation and defining the import of scientific results;
- integrating scientific analysis with stakeholder deliberation; and
- facilitating participation of lower-level actors and engaging a variety of institutional forms in decision-making and planning for institutional adaptation and change.

Recent studies on forest management look at issues of cross-scale governance from 'the ground up', particularly in light of new financial opportunities in global carbon markets. Nkem et al. (2010), focussing on two provinces in the Democratic Republic of Congo, find that the role of forests as 'safety nets' for forest-dependent peoples has diminished. Forest communities' tradition of reaping the direct benefits of forest products is fading with the emergence of new regional and global markets not only for forest products, but also for services such as carbon storage and sequestration.

Nkem et al. (2010), discover that much of the monetary gain from sale of non-timber forest products benefits wholesalers and retailers rather than local people. They conclude that REDD+ readiness projects, which

aim for climate mitigation and do not address food security concerns explicitly, have failed to address the different motivations for and dynamics of natural resource use, across scales.

New research also highlights forests as a sector where climate change impacts are acutely felt, and climate change adaptation and mitigation policies must be developed together, in a synergistic way. For instance, where climate change has a negative impact on ecosystems and forest-dependent communities, this can endanger investments and the successful implementation of REDD+ or Clean Development Mechanism (CDM) projects. Again, cross-scale dynamics are a part of this complex picture.

Locatelli et al. (2011), argue that integrating adaptation efforts into mitigation activities is effective at the local level and can foster the greater engagement and buy-in of local stakeholders. Agro-forestry projects under CDM, for example, as well as yielding mitigation benefits, can integrate valuable adaptation options for vulnerable communities: with the right design, they can provide livelihood support, reduce soil erosion, and enhance the recharge of groundwater supplies. Similarly, community-based efforts to monitor natural resources can prove more cost-effective than externally-conducted, technical and expensive Monitoring, Reporting, and Verification (MRV) systems and provides an example of how competencies should be recognised at appropriate scales (Fry, 2011).

Case Study

Ecohealth - a new integrated policy perspective

A new framework to address the complex relationships among ecosystems, society and human health is presented by Bunch et al. (2011), who have developed the concept of 'eco-health'. This approach recognises that 'human health and well-being are both dependent on ecosystems and are important outcomes of ecosystem management' and highlights the potential of social processes to fulfil both ecosystem management and public health promotion objectives.

For example, watershed management has the potential to provide a double dividend: by promoting human health (through clean drinking water and sanitation) and sustainability (by focussing on livelihoods, land use, food and service provision and governance). Some challenges remain in the application of the eco-health approach: jurisdiction (decision-making in biophysical versus administrative boundaries); integration across disciplines; spatial-temporal scales (changes at the watershed level that are considered to represent larger ecosystem processes); and effective stakeholder participation.

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Practicing adaptive management

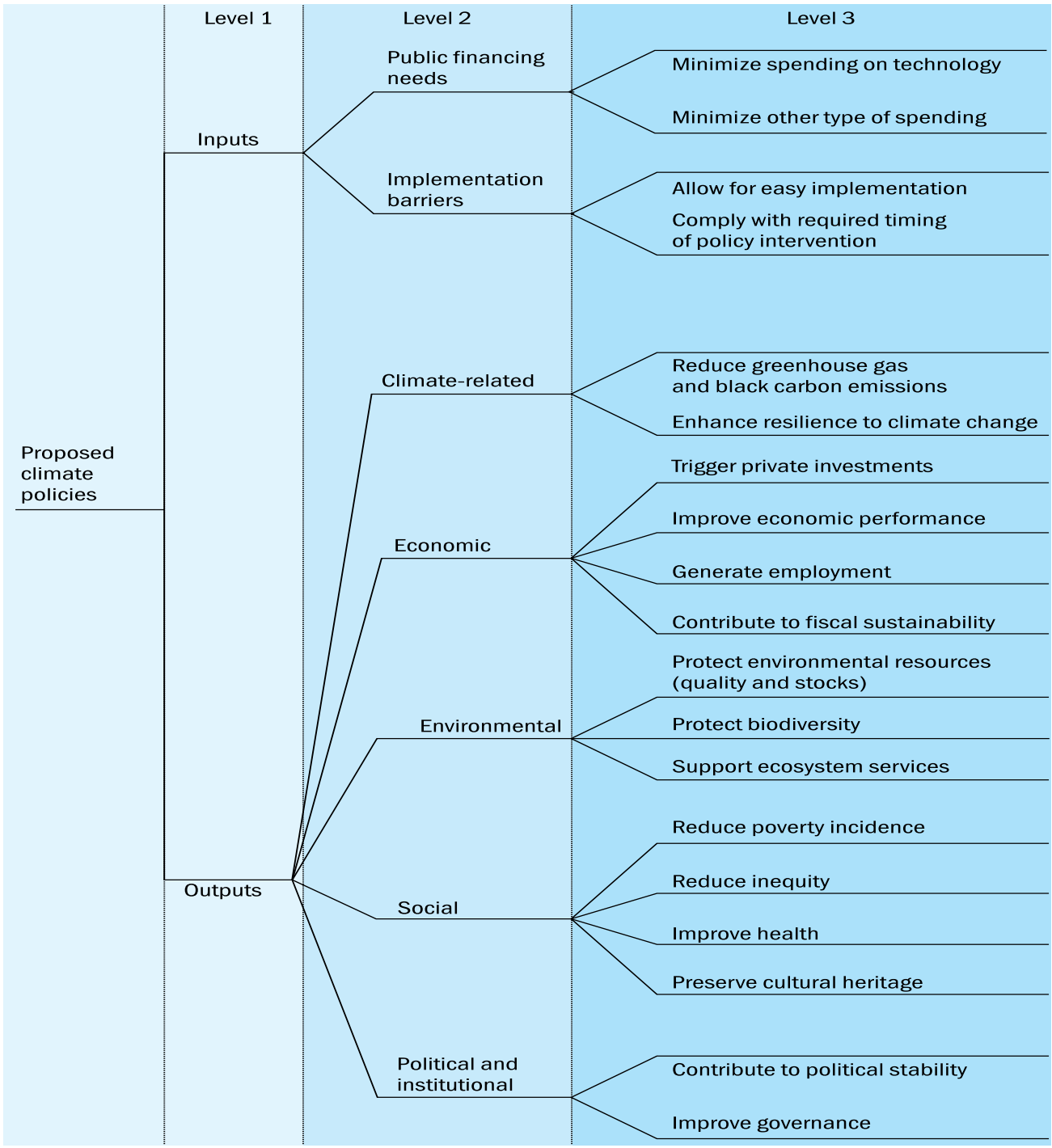
Adaptive management—the refinement of objectives and measures based on real-life learning—is a well-established approach to natural resource management. Two 2011 studies look at the effectiveness of adaptive management systems and warn of pitfalls to avoid in such approaches.

Doremus et al. (2011), find the possibility that adaptive management in the natural resources context can be misused by providing a pretext to delay decisions that are politically uncomfortable and inhibiting public oversight of natural resource management issues. According to the authors, an effective adaptive management programme should: fit the strategy to specific resource problems; ensure accountability and enforceability of rules; promote targeted learning; and ensure regular funding.

Cheung and Sumaila (2011), find that systematic monitoring and evaluation is critical to adaptive management, if impacts are to be properly evaluated and policy objectives updated accordingly. The authors present a framework for evaluating climate change adaptation in marine ecosystems that considers four 'input' criteria which they consider important for policy success, and 15 'output' criteria to evaluate success. These success criteria cut across physical climate, economic, environmental, social and, institutional factors (see Figure 2.1).

Adaptive management has not only been re-examined in the natural resource management arena more broadly; it is also being linked to risk management. According to May and Plummer (2011), climate change adaptation policies raise three important areas for risk management: the need for greater stakeholder engagement and participation, co-creation of knowledge and shared learning; and the promotion of networks of adaptive governance. They argue that adaptive management from a risk perspective can provide a higher degree of participation and learning as well as leading towards governance solutions for climate risk management (rather than technical solutions that arise only from conventional risk management approaches). Their Adaptive Collaborative Risk Management framework provides an entry point for this more participatory approach.

The nexus of natural resource management and climate-related risk is well demonstrated by a recent paper on dam operation in a changing climate (Watts et al., 2010). The authors argue that structural interventions alone, such as increasing storage capacity through dam construction, may not be



Source: Cheung and Sumaila (2011)

Figure 2.1: A sample set of criteria for evaluation of adaptation policy for marine ecosystems

best suited to deal with future scenarios of water stress. A comparison of dam operations reveals the importance of a range of management options to reduce the risk of catastrophic weather-related impacts on society. These include soft engineering measures and land use planning (such as careful floodplain management), coordination of multiple dam operations, and intra-basin legislation to maintain water flow.

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In summary, the Climate and Development Research Review concludes that the different pressures on natural resources cannot be solved in isolation. Stakeholders must understand and address the complex dynamics that connect resources, and the trade-offs that might be required in managing them. Recent research on managing natural resources in a changing climate highlights a range of complex, flexible, and adaptive approaches to resource governance. The complexity and multiple layers of these governance systems reflect the complexity of ecosystems themselves, and of society's use of natural resources.

Many recent studies examine policies that work across scales – national, regional, and local—to address the natural resource dynamics at each level. Effective policy making and delivery across scales can help to secure the joint adaptation and mitigation benefits of many forestry and land use activities and manage the trade-offs. For instance, the costs and benefits of using land for food or biofuel production versus for forest conservation (and hence) carbon storage are more easily assessed at scale.

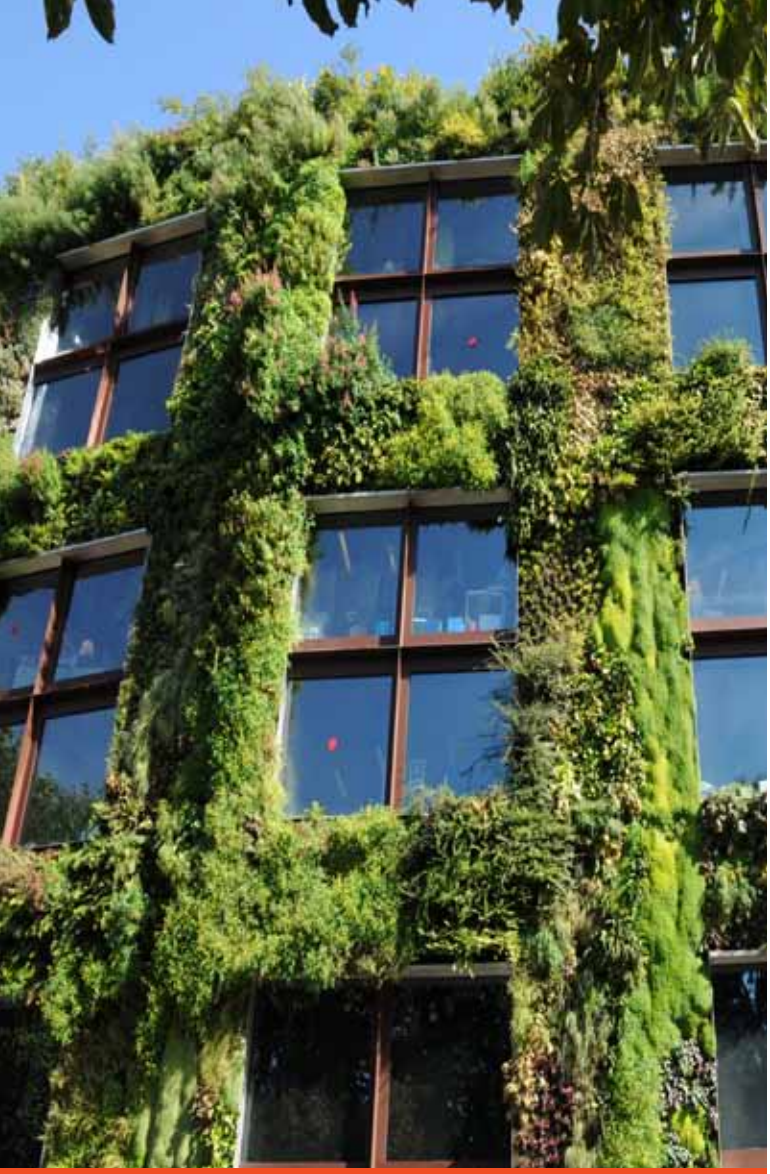
The tensions and complexity among different actors benefitting from natural resources at local, subnational and national scales is especially pronounced for tropical forests, as forest nations prepare for a new international REDD+ regime (a scheme to pay forest managers for reduced emissions from deforestation and degradation). Researchers are increasingly mapping such benefit-sharing issues, and the monitoring, verification, and reporting challenges associated with forest carbon stores.

The possibility of managing ecosystem services at a landscape scale is an emerging theme in the research literature. This includes the importance of managing protected areas in the context of the broader ecosystems in which they are situated. Although, protected areas were traditionally established for biodiversity conservation, scientists increasingly recognise the value of the flows of ecosystem goods and services that they can generate in the broader landscape.

Policy experiments will be needed to learn the most effective natural resource management techniques in a rapidly changing climate. There is a growing recognition that knowledge-sharing through participatory approaches is vital for capturing policy successes and failures.

How to transfer lessons from policy experiments in one location to another, however, is a different matter.

With its emphasis on community-based efforts to monitor natural resources, the Review indicates that global agreements governing global public goods—such as forests—must factor in local realities and expectations. Non-governmental organisations have an important role to play in designing institutions for managing the risks: not just the risks of climate change itself, but the risks involved in designing and delivering climate change policies.



3

FINANCIAL MECHANISMS FOR CLIMATE ACTION

Finance is needed to fund both mitigation and adaptation activities, and through the Copenhagen Accord (2009), high-level commitments have been made to mobilize $100 billion per year by 2020 to support climate action in developing countries. The costs of mitigation have been widely discussed and reported (Barker et al.,2007; Stern, 2007), but recent estimates of annual adaptation costs in developing countries range from about $25 billion to more than $100 billion (see Table 3.1). Adaptation currently receives a small share of total climate finance (Buchner et al., 2011a) and defining climate finance, particularly for adaptation activities, is often difficult.

Table 3.1: Recent estimates of adaptation costs

Source: Fankhauser (2010); World Bank (2010)

Assessment	Estimated adaptation costs in developing countries (billion $ per year, by 2030)
UNFCCC (2007)	27-66
Parry et al. (2009)	(more than) 54-140
Project Catalyst (2009)	25-76
World Bank (2010)	75-100

Key areas covered by recent research include the generation of finance for climate change mitigation and adaptation, particularly from private sources, and the management of climate funds.

Generating climate finance

Official Development Assistance (ODA) is unlikely to reach the scale necessary to meet high-level international climate finance commitments. A range of proposals have been suggested to generate high volumes of finance, most relying on international taxation or international carbon markets.

The focus of climate finance in the UNFCCC negotiations has been on the transfer of public funds from developed countries to developing countries. Developing countries have demanded 'new and additional' resources, over and above existing levels of development aid. In 2008, public funding flows to developing countries, specifically to address climate change, amounted to only $9-12 billion (Buchner et al., 2011b). Given that total Official Development

Assistance (ODA) amounted to $128.5 billion in 2010 (OECD, 2011), the $100 billion annual target for climate finance will be exceptionally difficult to meet from ODA given fiscal constraints in developed countries.

Consequently, recent research has proposed and examined various ideas to generate climate finance from new and innovative sources. In many of these proposals, the potential revenue depends heavily on the ambition of mitigation commitments adopted by countries and on the market price of carbon (see Table 3.2). One exception is the Swiss proposal for a global carbon tax, which is expected to generate high revenues, even with less ambitious mitigation pledges. However, this approach does not directly incorporate the core UNFCCC principles of common but differentiated responsibilities and respective capabilities, and therefore would require higher relative contributions from East Asian countries than other proposals which incorporate these principles (Hof et al., 2010).

Table 3.2: Comparison of selected proposals to generate climate finance

Source: Grubb (2011); Hof et al., (2010), and Silverstein (2010)

Proposal	Description	Expected revenue (billion $ per year)	Predictability of revenue
Swiss proposal (Hof et al., 2010)	Global carbon tax of $2 per tonne of CO2 (with an exemption of 1.5 tonnes of CO2 per capita for all countries)	41-52	High
Bunker fuel emissions tax (Hof et al., 2010)	Tax on international aviation and shipping emissions (equal to the global carbon price)	17-111	Low – depends on market price of carbon
Norwegian proposal (Hof et al., 2010)	Auctioning 2% of Annex I countries' emission allocations	3-26	Low – depends on political pledges and market price of carbon
International emissions trading levy (Hof et al., 2010)	2% levy on share of proceeds from emissions trading, JI, and CDM projects	1-2	Low – depends on political pledges and market price of carbon
Rising carbon tax			
(Silverstein, 2010)	Global carbon tax calculated as a fraction of actual cost to remove carbon from the atmosphere, combined with global climate fund	110	High
Border cost levelling (Grubb, 2011)	Charge for carbon embodied in internationally-traded carbon-intensive commodities	4.5 – 6.5	High

Silverstein (2010), also proposed a global carbon tax as an alternative to the unpredictable revenues raised by carbon market-based approaches. This proposal differs from the Swiss proposal in terms of the calculation of the tax rate and the disbursement of the collected revenues. In this proposal, the tax rate is calculated as a fraction of the actual cost to remove carbon from the atmosphere, and the rate would increase every year during the period 2011-2050. This common tax rate is to be applied to all countries and part of the resulting revenue is to be invested by each country in domestic climate change mitigation and adaptation, while some, proportional to historical responsibilities and capabilities, is to be transferred to a global climate fund. It is proposed that the global climate fund disburse money based on a set of national climate need factors for each country.

[3] At 2010 current prices and exchange rates

Another small but new source of revenue proposed is border cost levelling: a charge for the carbon embodied in carbon-intensive commodities that are traded internationally, mainly steel and cement (Grubb, 2011). It has been proposed that this measure would raise climate finance as well as 'levelling the playing field' between domestic and foreign producers in countries who are taking ambitious mitigation targets. A criticism of this approach is that developing countries may be impacted disproportionately by this approach as many products that they export are highly price sensitive.

As these papers indicate, innovative thinking is still needed on how best to generate the scale of climate finance needed, particularly in light of low levels of mitigation ambition by developed countries and weak demand in international carbon markets.

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Tapping private sources

Potential sources of climate finance from the private sector are large, however innovative mechanisms to reduce risk and build investor confidence are required to tap into these.

The potential of private sources

Given the challenges of scaling up public climate finance, much of the research published in 2010-11 has highlighted innovative approaches to tap private sources for climate finance. Private flows of development aid amounted to $330 billion in 2010 (OECD, 2011), more than double the public flows over the same period, indicating the latent potential of private finance to contribute to climate related activities.

Private climate finance already far exceeds public climate finance (Buchner et al., 2011b), and it has been estimated that of the $100 billion already committed for 'low-carbon, climate-resilient activities' in developing countries, more than half is from private sources (Buchner et al., 2011a), (see Figure 3.1).

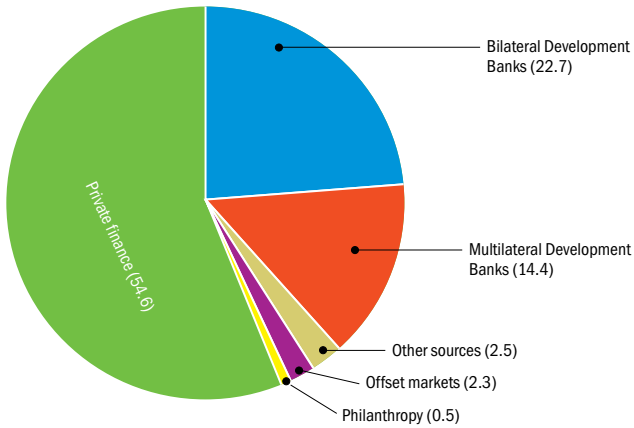

Figure 3.1: Climate finance flows to developing countries in 2009-10 (in $ billion)

Source: The Economist (2011), with data from Buchner et al. (2011a)

However, this estimate of private climate finance raises issues of definition as it uses a very wide definition of relevant projects that meet many objectives, of which the climate component may be small. The majority of finance included in this estimate ($74-87 billion of $97 billion) takes the form of equity or loans and not grants which are more likely to be provided by the public sector or philanthropists. However, this

estimate does highlight the need to look beyond carbon offset markets for private sector climate finance as carbon markets contributed only $3 billion in 2009/10. It also demonstrates that private capital can be attracted to invest in clean technology and infrastructure if the associated risks are managed appropriately (Buchner et al., 2011a).

The role of risk in private sector investments

Long-term institutional investors in particular (such as pension funds, insurance funds, and sovereign wealth funds) are looking for new investment avenues that can offer stable returns (Holm, 2010). These investors can be encouraged to invest in clean technologies and infrastructure and several papers have emphasized the central role of risk in such investment decisions (Holm, 2010; Ward, 2010; Nassiry and Wheeler, 2011). According to Fuss et al. (2010), this risk stems from five types of uncertainty:

1. Scientific uncertainty (e.g., about climate sensitivity and feedback effects)
2. Market uncertainty(e.g., as a result of fuel price volatility)
3. Technological uncertainty (e.g., about the availability of renewable energy technology)
4. Socio-economic uncertainty (e.g., related to different macroeconomic factors)
5. Policy uncertainty (e.g., about commitment to specific targets and the stability of CO2 prices).

As a result of these uncertainties, investments in clean technologies may be perceived as risky. Additionally, any investment in developing countries can be affected by exchange risks, geopolitical risks, and credit (payment default) risks. And, private investors demand correspondingly high returns, raising the cost of capital for climate related projects.

Proposals to tap private sector finance

Guarantees, funds of funds, project aggregation mechanisms, climate bonds, public private funds

New ideas have emerged on managing the risks and reducing the cost of capital for mitigation and clean technology projects. Credit guarantees by public sector bodies in developing countries are one way of reducing risks for private sector investors (Ward, 2010; Holm, 2010).

A 'fund of funds' approach is proposed by Nassiry and Wheeler (2011), as a public private partnership designed to increase investments in clean technology innovation and deployment. The approach involves public and private investors making equity investments into two clean technology funds (innovation and deployment), which would then make further investments into a number of appropriately focussed venture capital (innovation) and infrastructure (deployment) investment funds. This would allow the public sector to be 'cornerstone' investors, leveraging private sector capital for clean energy innovation and deployment in developing countries. This type of approach has been adopted by the UK Innovation Investment Fund, California Green Wave Initiative, and California Clean Energy Fund (Nassiry and Wheeler, 2011).

Generally, investors prefer to invest in larger projects that are easier to monitor and have more favourable returns. This means that smaller projects which may have greater climate and development benefits find it difficult to attract private sector funding. According to Holm (2010), 'mechanisms offering incentives and guarantees for financing smaller projects, such as project aggregation mechanisms, could help change this situation' (p.29).

Climate bonds

Climate bonds are another financial instrument being proposed to channel private sector finance to climate related activities. Mathews et al. (2010), suggests that climate bonds are an effective way to mobilise private sector finance which is integral in driving the energy revolution that is needed for climate mitigation to be successful. The paper draws on historical examples demonstrating the effectiveness of financial bonds at financing large projects with long gestation periods.

Bonds have also been suggested as a way to leverage resources for the Green Climate Fund from private and official investors (Brendenkamp and Patillo, 2010). They suggest that to achieve the scale required, the Green Climate Fund could use an initial capital injection by developed countries to provide an equity base for the fund, which could then issue 'green bonds' that could be sold to private investors.

Contributor countries may find it easier to participate in this scheme if their equity in the Green Climate Fund could be structured as reserve assets, so the transaction is purely an exchange of reserve assets, and therefore would not typically have an upfront budgetary cost for contributors. Brendenkamp and Patillo (2010), suggest that Special Drawing Rights (SDRs), recently issued in proportion to countries IMF quota shares, are one type of reserve assets that might be appropriate. An initial equity endowment of around $100 billion could be sufficient to generate the scale of financing envisaged in the Copenhagen Accord.

In addition to highlighting the potential for climate bonds to provide debt finance, Ward (2010), proposes that public-private funds should be further explored to lower the cost of equity finance for green investments in developing countries. The public-private fund structure would be complemented by a range of instruments to reduce the risks for projects that the fund invests in. To illustrate the impact of this model, the paper suggests that $0.5 billion public sector investment could attract an additional $9.5 billion in private sector investment. This $10 billion invested in equity could then help to raise $15 billion in debt finance providing an overall total of $25billion for investment in green projects.

Table 3.3, highlights potential revenue that could be generated from the proposals to tap potential private sector sources of climate finance. The role of the public sector is highlighted as key in all of these proposals either through reducing investment risks, building investor confidence, or providing the equity base for raising debt finance.

Table 3.3: Proposed new private sources of climate finance

Reference	Source of funds	Potential revenue
Brendenkamp and Patillo (2010)	Initial capital through SDRs (special drawing rights), issue green bonds to leverage private finance	$100 billion per year by 2020
Ward (2010)	Two-tier model with public-private top fund to seed debt funds, with 'de-risking' commitments by public sector bodies	$25 billion, from an initial public investment of $0.5 billion

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Scaling up – NAMAs

NAMAs provide a framework for attracting financing for policy or programmatic mitigation activities

Developing Nationally Appropriate Mitigation Actions (NAMAs), is one method that developing countries can use to fund policy or programmatic measures, scaling up finance for these types of activities. NAMAs have been discussed, but Cheng (2010), visualises a new approach, whereby public policies and public sector investments are used to boost private sector investment in energy efficiency in dispersed energy end-use sectors (e.g., building and industrial sectors). This new NAMA framework would be designed in a flexible way to meet the needs of each developing country.

NAMAs have also been explored as a mechanism to direct public and private financial resources to low-carbon transport (Millard-Ball, 2010). Different types of NAMAs are discussed including unilateral, supported and credit-generating NAMAs, with supported NAMAs being most appropriate for the transport sector.

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Managing the funds

Governance of climate funds and the eligibility of different types of projects for climate finance is the subject of intense discussion and research. There is still much work to be done in developing a standard definition of climate finance, including what is additional, and on how to most effectively use climate finance to meet climate and development objectives.

The management of climate finance that has already been committed to international climate funds is of high interest to developed and developing countries. Issues such as access to finance, defining climate finance, additionality of resources and the effectiveness of funded activities have been the focus of recent research.

The intense focus in the climate negotiations on the process of administering climate finance can be seen as symptomatic of the lack of trust between donor countries and recipient countries (Fankhauser and Burton, 2011). Both have their concerns about climate finance. On one hand, donor countries are concerned about their own competitiveness in the world economy, and about the effective utilization of the funds donated. On the other hand, recipient countries are concerned about the additionality of resources, the predictability of funds, and the associated conditionalities.

Governance structure of international climate finance

The governance structure of international climate funds has received attention, particularly as the institutional architecture and governance structure of the Green Climate Fund is being developed. A review of 33 climate funds revealed that few gave

voting rights to beneficiary countries, most lacked clear compliance mechanisms, and all depended on voluntary contributions or market prices (Ghosh, 2010). Other recent papers have reviewed experience with climate and non-climate funds, to understand how these concerns can be addressed without making the system unnecessarily complex. Current sources of public climate finance have highly interlinked governance structures, making it difficult to trace and monitor fund flows.

Definition of climate finance

Defining what climate finance is, and measuring and tracking flows of climate finance has been a challenge that a number of papers have tried to address. Some papers take a bottom up approach by defining whether a project is climate related, and therefore whether the finance provided to that project is climate finance.

In the case of adaptation, the question 'what are eligible projects?', invites the larger question of 'what is adaptation?'. Is it the same as development, or 'development under an adverse climate'? (Stern, 2009; cited in Fankhauser and Burton, 2011). Other criteria used to define adaptation related activities (such as efficiency, effectiveness, equity, transparency, national appropriateness) are not unique to climate or adaptation projects. Buchner et al. (2011b), distinguish between 'climate finance' and 'climate-relevant finance' and acknowledge that tracking financial flows for climate action becomes difficult without a universally accepted definition of climate finance (Buchner et al., 2011b).

Additionality of financial commitments

Stadelmann et al. (2010), argue that the lack of clearly defined baselines for 'new and additional' climate finance is a chief source of distrust among countries, and is impeding financial flows for climate action. Drawing on a review of the political acceptability of eight options for finance baselines (over and above aid flows), they maintain that pre-defined projection of business-as-usual development assistance as a baseline will create trust and predictability between developed and developing countries. In the longer term, the benchmark could be funds from new sources only.

Effective use of climate finance

Some arguments have been made that to maximize efficiency, climate finance should only be used to cover the incremental cost of projects i.e., the additional cost of projects to meet climate change objectives or respond to the impacts of anthropogenic climate change (Przyluski and Hallegatte, 2010).

Particularly for adaptation, this is notoriously difficult to calculate and spending decisions would be unlikely to assist the most vulnerable populations and countries. Based on experience of European Union-financed projects, Przyluski and Hallegatte (2010), outline some lessons for adaptation funds including the need for climate finance to fund more than the incremental cost to trigger co-financing and enable projects to happen.

Another risk of using the incremental cost approach to allocate climate finance, is that 'softer' adaptation measures such as mainstreaming, planning, and preparedness may be neglected because the incremental costs may be hard to measure, very low or even negative (Fankhauser and Burton, 2011).

Similarly, other authors have warned against strict application of the incremental cost approach to climate finance. Huizenga and Bakker (2010) argue that taking this approach may discourage policy-type NAMAs, which have strong potential to reduce GHGs and high co-benefits (but low or negative incremental costs) in favour of technology-type NAMAs that have high incremental costs. It would also limit the flow of funds to the transport sector, as has been the case with transport projects under the CDM. In fact, Huizenga and Bakker (2010), argue in favour of rewarding projects with high co-benefits by linking financial support to the resulting co-benefits, 'whereby realized co-benefits would result in a premium on top of the support received for reducing GHG emissions.'

Lack of institutional capacity has been highlighted as a key factor in unsuccessful projects in climate related and other sectors. A number of papers suggest that because of the impact of capacity on the ability of developing countries to mainstream policy, climate finance would be better spent on projects (Ghosh, 2010; Przyluski and Hallegatte, 2010) or capacity building initiatives (Fankhauser and Burton, 2011; Przyluski and Hallegatte, 2010).

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Case studies

The implementation of climate related programmes is in its early stages, but lessons should be drawn to ensure that climate finance mechanisms are designed to respond to on-ground challenges.

The preceeding sections outline the relevant research and highlight the challenges of generating, measuring, and spending climate finance effectively. It is also useful to highlight two practical examples of how climate finance has delivered climate and development outcomes, demonstrating the link between theory and practice.

The distribution of improved cookstoves in Peru, Uganda, and Cambodia (Simon et al., 2011), demonstrates how climate finance can fund projects effectively, with mutually supporting climate and development benefits.

Solar parks in India, funded by the Clinton Climate Initiative, show how climate finance can be disbursed in a way that manages risks for investors and helps scale up 'hard' mitigation projects (Ward, 2011). Regional governments lease out the land and supporting infrastructure for clusters of solar power plants to individual developers. These developers are free to finance the project according to their own preferences. But being part of such a solar park reduces the risks and, therefore, the cost of accessing debt.

These examples demonstrate the challenges, but also the successes of early climate finance. Further, evaluation of early climate change projects and programmes and the financing behind them will be essential to draw the lessons from early implementation to feed into the design of future climate finance structure and mechanisms.

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In summary, there is a clear need for large volumes of finance and innovative financial mechanisms to support mitigation and adaptation activities in developing countries. Most climate finance is currently provided towards mitigation activities, while the finance need for adaptation is extensive.

There is high level global commitment to generate significant volumes of climate finance. The limited volume of public sector funding available has led to many papers focussing on how best to tap private sector flows of finance for climate related activities; in order to do so, the role of risk in investment decisions must be understood. A range of fund structures and risk reduction mechanisms have been proposed to unlock private sector finance for climate change. Recent research also highlights the complementary role of the public sector to enhance investor confidence, by reducing risk or providing co-finance.

In parallel to the generation of climate finance, there has also been a focus on the management and effective spending of climate finance. Key issues in this area include the definition of climate finance and how to spend climate finance most effectively. For developing countries in particular, the additionality of climate finance flows and ensuring that emerging governance structures for climate are finance built on lessons from existing climate funds and development finance is important.

4

TECHNOLOGICAL INNOVATION AND EFFORT-SHARING

Moving towards low carbon, high, efficiency energy systems, mitigating emissions, securing energy supplies, and resolving the imbalance of payments caused by energy imports are all looming problems that challenge nations worldwide. With case studies ranging from the global to local scale, research published in 2010-11 has emphasized the integrated use of markets and regulatory policy to achieve an energy systems transformation. In addition, recent research also warns us that this transition to a low carbon pathway should start as soon as possible, and examines the distribution of mitigation efforts.

In this chapter, we will examine six key success factors highlighted in recent research as necessary for significant technological innovation: systems transformation; integration of climate change into sectoral regulation; enabling environment; tailoring solutions to the developing country context; equity and effort sharing; and monitoring, reporting and verification issues.

Systems transformation

Incremental efficiency improvements or one-off technological breakthroughs are unlikely to be enough to shift to a low-carbon trajectory.

Incremental efficiency improvements or one-off technological breakthroughs are unlikely to be enough to shift to a low-carbon trajectory. Zysman and Huberty (2010), call for a complete systems transformation. Clean energy technologies will not succeed without complementary infrastructure, and will not lead to economic growth if 'brown jobs' are simply replaced by a similar number of 'green jobs'. Conventional policy instruments, such as carbon pricing, technology policy, regulatory policy, and public investment in infrastructure, are not enough to induce a genuine system's transformation.

Penuelas and Carciner (2010), emphasize the urgent need to shift to affordable and low-carbon energy sources. They argue that such a shift requires multilateral and bilateral cooperation on technologies and regulatory policies (such as harmonized carbon taxes). It also requires national and local interventions in all energy production and consumption sectors.
While regulation such as carbon pricing can encourage adoption of existing technologies, it

cannot effectively spur innovation. Technology policy works better for capital-intensive Research and Development (R&D) projects than for diffuse innovations and influence over market choices. Furthermore, regulatory policy cannot provide incentives for private investment in the long term. Overall, there are still a number of unresolved issues with public investment in infrastructure, such as how best to organize public-private partnerships (Zysman and Huberty, 2010).

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Integration of climate change into sectoral regulation

Climate change should be fully integrated into sectoral policies, rather than be treated as a separate environmental or development issue.

Bazilian et al. (2010), argue that climate change mitigation objectives should be fully integrated into sectoral policies so that the relevant government ministries can plan and implement appropriate actions. The traditional positioning of climate change as an environment or development issue, rather than as an integrated energy, transport, or land use issue, impedes the prospects of incentivizing and delivering appropriate sector-specific policies that are essential to address the problem.

Not surprisingly, the research on low, carbon transition has focussed on sector specific options, issues, and challenges. Understandably, the power sector has received significant attention. For instance, analyzing a case study in the US, Duane (2010), evaluates various policy options for `greening the grid'. This paper argues that successful renewable technology deployment policy must focus on much more than price alone; contract structure, interconnection issues, and a variety of other considerations are equally important. In addition, if emission caps are applied separately (rather than in an integrated manner) to the transport and electricity sectors, then technological advances in transport (e.g., hybrid vehicles) may lead to increased emissions from the electricity sector (Duane, 2010).

Furthermore, a long-running, controversial discussion in most countries' power sector concerns scenarios for future electricity generation, particularly in terms of the share of renewable energy, the role to be played by carbon capture and storage, and investment priorities for the sector. Ludig et al. (2011), provide evidence to support the view that natural gas powered turbines may emerge in the long term as the best option to balance fluctuations in electricity demand and in renewable energy production. Coal-fired power stations with post-combustion capture also score well in their analysis. While capturing carbon dioxide emissions from natural gas-based electricity generating units seems to be cost effective (WorleyParsons Schlumberger and the GCSSI, 2011), more research is needed on storage aspects. However, if storage is addressed, or capture and utilization methods are proven, then natural gas-powered turbines would certainly emerge as the best option to meet fluctuating electricity demands and curb emissions simultaneously.

Similarly, the nuclear debate has been in the spotlight of controversies in the power sector. In terms of alternative choices for the low-carbon transition, it is argued that countries with mature nuclear technology might be wise to deploy fast reactor systems. In the time before renewable energy becomes a meaningful and efficient energy source, making nuclear energy safer may be one stop-gap option for the transition from fossil fuels to renewable energy (Jeong et al., 2010).

In addition, sectors like urban transport and buildings have also attracted significant attention in recent years. Salon et al. (2010), for example, discuss the implications of city carbon budgets as a new climate

policy instrument to reduce urban greenhouse gas emissions. Such an instrument would be one step beyond the voluntary climate change action plans that are being adopted by cities around the world at present.

Kwok and Rajkovich (2010), call for a paradigm shift. They show that quick wins can be achieved by changing building codes to prioritize the 'adaptive comfort' thermal comfort model instead of the conventional 'static' one. Changing building standards to allow behavioural adaptation and giving occupants greater control over energy flows in their buildings (by having windows or skylights that open, or using fans) would bring considerable energy savings and carbon emissions reductions.

As these examples indicate, regardless of the sector, climate change and development considerations should be embedded in broader regulatory frameworks, rather than being addressed only in stand-alone regulations.

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Enabling environment

The enabling environment required to encourage low being carbon technology innovations include not only better patents processes, but also significant investment in Research and Development (R&D), as well as exchange of different types of data sets.

Technology is the key to increased mitigation action – whether it is the development of new technology or effective dissemination of existing low carbon and energy saving technologies. However, given that the development and spread of technologies will vary from country to country, having a standard mechanism to link Intellectual Property Rights (IPRs) with the spread of green technologies seems difficult. Hall and Helmers (2010) Argue that while IPRs can help bridge the gap between private and social returns to innovation, they might not adequately capture environmental externalities and IPRs may not be the ideal and only policy instrument to foster effective transfer of clean technology.

A sharp rise in patent activity related to wind and waste-to-energy since the mid-1990s, is identified in an analysis for the role of public policy in fostering innovation in renewable energy technologies within the Organization for Economic Cooperation and Development (OECD), (Johnstone et al., 2010). The study highlights the key role of public policy in prompting an increase in patent activity in renewable energy technologies. While taxes, obligations,

and tradable certificates are found to be the most significant policy instruments, their efficacy differs depending on the particular renewable energy technology in hand. A 'one-size-fits–all' situation is not suitable, given the differences in the type of technology and the contexts of specific countries. More effort is needed to unleash the potential of patents to influence technological innovation for low -carbon transition.

Likewise, more effort is needed to build capacity for research and development (R&D). One approach is to establish an interlinked set of global, regional, and national R&D networks of technology institutes, private industry, funding agencies and international organisations. These networks could develop technology roadmaps, plan coordinated R&D programmes and initiate technology demonstration partnerships (Benioff et al., 2010).

In addition, if the future climate regime calls for higher conformity in relation to technology standards or efficiency standards, then the new reporting systems would need totally different types of data sets—beyond emission data, such as data on investment flows and technology market shares, which currently are fragmented and rarely available. Access to this information is essential in order to complement the existing quantitative information on greenhouse gas emissions from countries, sectors, products and companies. The availability of such data will help decision makers anticipate emission trends, manage technological changes, prioritise funding needs and design sound policies, particularly to ensure compliance with efficiency-based targets in the future (Harnisch, 2011).

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Tailoring solutions to the developing country context

One size does not fit all when it comes to technology innovation: solutions should be tailored according to different developing countries contexts

A number of studies highlight that considering a country's economic situation, access to finance, and incentives to entrepreneurship are essential in understanding how to promote technology innovation (Palit and Chaurey, 2011; Parthan et al., 2010).

Parthan et al. (2010), for example, emphasize that the lack of finance for renewable energy and energy efficiency technology, risk reduction instruments and retail level institutions are common in several developing countries. Providing clean energy solutions to the poor can sustain as a profitable business, if supported by the right policies and practices. Experiences from REEEP (Renewable Energy and Energy Efficiency Partnership) projects suggest the following three lessons for business modelst:.

- the need for supply chains and marketing networks for renewable energy devices;
- the need for incubating energy enterprises that are often run by inexperienced first generation entrepreneurs;

- the need for funding Energy Service Companies (ESCO) businesses that tend to be under-capitalized.

Putting the poverty context on the table, Palit and Chaurey (2011), point out that the South Asia region accounts for the greatest proportion of the global population without access to electricity. They examine the role of off-grid technologies and find that successful outcomes depend on economic linkages, access to credit and institutional arrangements in place, especially for off-grid renewable energy.

Likewise, Silveira and Khatiwada (2010), make an assessment of the potential of ethanol production and fuel substitution in Nepal and find positive economic benefits, including: gasoline import reduction, an incentive for improved sugar cane yields, and higher income and job creation in rural areas.

Government policy can play an important role in achieving the dual objective of mitigating climate change and advancing development. For instance, policy support to wind energy in China has boosted the local manufacture of wind turbines, which has grown to cater both the domestic and international markets (Benioff et al., 2010). In India, Das and Balakrishnan (2010), explore how innovative institutional arrangements can be critical for low carbon transition. They analyse the optimisation of the national power shortages during periods of peak demand with ESCOs in the smart-grid network. They draw our attention to the importance of such arrangements being embedded in the Energy Conservation Act 2001 under the Bureau of Energy Efficiency (BEE) for sustainable development of the rural and urban sector. Das and Balakrishnan propose that the next generation of innovation will include mobile smart-grid city for efficient real-time collaborative use of renewable and non-renewable energy sources.

These case studies provide details on how governments have tailored climate-change solutions to fit their developing country contexts, and tackle economic growth and development alongside climate-change goals in new policies. Wolsink (2010), however, reminds us that social acceptance for new policies (especially those related to infrastructure) is critical in the process of leapfrogging to a low-carbon development path.

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Equity and effort sharing

The ethical issue of sharing the global effort to mitigate and adapt for climate change should not get in the way of individual country actions.

For a long time, the ethical issue of sharing the global effort - i.e., who should do, how much, and when–has been a critical stumbling block to a global agreement and has hindered mitigation actions. Putting into practice the Kyoto Protocol's principle of "common but differentiated responsibilities", and evolving a present-day understanding of this principle, is not easy.

Trying to address the equity question, Kartha et al. (2010), propose, a 'Greenhouse Development Rights (GDR) framework' and suggested measures of responsibility and capacity that can be combined into a single indicator of obligation–the Responsibility Capacity Index (RCI), which could be applied in the global climate talks. Meanwhile, Fei et al. (2011), use quantitative methods, such as a Carbon Gini Index, to measure inequality in climate change discussions. An analysis by Ackerman et al. (2011), goes further and compares the scenarios from Climate and Regional Economics of Development (CRED) integrated assessment model with those of the Greenhouse Development Rights (GDRs). They argue that either way the results are ultimately quite consistent, largely, because both approaches imply large transfers from the developed countries to developing countries.

Despite not reaching an agreement on precisely how to reflect effort sharing and take into account "common but differentiated responsibilities" in a global deal, developing countries have made voluntary pledges to reduce emissions. A study from Kartha and Erickson (2011), reviews four studies of country pledges under the Cancun Agreement and concludes that developing countries' mitigation pledges exceed those from developed countries.

While equity is central to the UNFCCC negotiations, the issue of fairness has been discussed outside the negotiations as mistrust in multilateral processes prevails. Winkler and Beaumont (2010), suggest that fair and equitable multilateral negotiations can progress via two scenarios: the 'big bang' scenario (a comprehensive package that defines the overall solution upfront); and the 'fragmentation' scenario (all efforts to reach a global agreement are abandoned, and issues are dealt in a fragmented manner). While the first scenario would achieve what science demands, the second scenario is more realistic in political terms.

Another approach that tries to address the effort-sharing question is the adoption of carbon budgets, combining climate science and economics. Messner et al. (2010), argue that such budgets create incentives for countries to make the transition to a low-carbon economy, and particularly provide regulatory certainty for private sector investment in green technology (Messner et al., 2010). They highlight that the carbon budget approach can lead to a change in the traditional roles of countries as 'donors' or 'recipients' to 'partners with mutual common interests'.

With or without a global deal, countries should consider unilateral action such as the 'Green New Deals' proposed by the United Nations Environment Programme and President Obama of the United States. 'Green New Deals' could help start a transition to a low-carbon global economy. But sustaining such a transition would require fundamental change in investment patterns (to promote both GHG mitigation and create economic opportunities) and integrating equity and sustainability concerns into coherent transition strategies (Opschoor, 2010).

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Measuring, reporting, and verification (MRV)

There are a number of outstanding questions surrounding MRVs in relation to NAMAs, REDD+ and on carbon emission reductions as a whole, which need to be worked out as part of a global commitment to mitigate climate change.

Monitoring, Reporting, and Verification (MRV) of greenhouse gas emissions reductions are part of the effort-sharing equation. While the UNFCCC already has in-built MRV systems through national inventories and national communications, MRV is now being further discussed for mitigation actions, particularly for Nationally Appropriate Mitigation Actions (NAMAs). It is, however, rather difficult to quantify and attribute emission reductions as a result of a specific policy: this requires a credible database; a high level of sectoral organisation; and some way to discern the impact of specific policies. Okubo et al. (2011), argue that where it is difficult to quantify the emissions reductions generated by a particular policy, that policy should be credited by using discount factors or conservative default values.

Although, the term MRV was coined in Bali (2008), its interpretation and operationalization has been a point of contention ever since. Van Asselt et al. (2010), conducted an analysis of the NAMAs submitted by the BASIC countries – Brazil, South Africa, India, and China to the UNFCCC (following the requirement to do so by the Copenhagen Accord that emerged from COP15 in 2009). They highlight that there are a number of outstanding questions regarding MRV. For instance, does MRV apply to all NAMAs, to only those that have international support, or both? How should MRV take place (e.g., which are the relevant metrics)? Should the MRV method be different for different types of actions? Who should carry out MRV, and when?

Despite the uncertainties surrounding the MRV debate, some proposals of how to tackle it are emerging. Niederberger and Kimble (2011), for example, suggest adoption of a proposal for a certification scheme for National Climate Management Systems (NCMS). The NCMS would

require countries to establish a climate policy, set national goals and timetables, secure resources to implement related national actions, and track their progress over time.

In addition to the issues surrounding MRV in the NAMAs context, there are also a number of issues in relation to MRV in the REDD+ context. Usually, highly uncertain forest carbon data and poor quality land cover maps prevent the accuracy of MRV on REDD+ projects. Asner (2011), presents three ideas to overcome these scientific barriers:

- training of practitioners by scientists in the use of measurement and monitoring methods;
- replacement of traditional forest inventory techniques with innovative methods, such as the use of satellite and aircraft technology, and sharing of the higher resolution and data generated;
- using the experience with forest monitoring programmes at sub-national scales (e.g., the inclusion of REDD+ credits from Brazil's Acre State and Mexico's Chiapas State in California's carbon market).

In addition, Phelps et al. (2012), point out that concerns about the accuracy and credibility of MRV also threaten to centralize the control of REDD+ projects with governments, reversing the trend of the past two or three decades towards community-based forest management. In an interesting new insight about REDD+, they argue for greater community control over project design, implementation, and monitoring. Further, research to assess how community participation affects carbon sequestration will help to identify the optimal combination of government and community roles in REDD+ projects.

Overall, at the moment, there are more questions than answers surrounding MRVs, be it on NAMAs, REDD+ or on carbon emissions reductions as a whole. Nevertheless, addressing the details of how MRV systems would work in practice is part of a bigger picture around global commitment to mitigate climate change.

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In summary, this chapter has drawn on recent research to emphasize the integrated use of markets and regulatory policy to transform technology, and scale up current mitigation efforts.

Nations are striving to move towards low-carbon development pathways, but research warns that this transition must accelerate. Such a shift requires cooperation on technology and regulation, as well as national and local interventions in every sector. The research finds that one-off technological breakthroughs and conventional policy instruments will not be enough to create a genuine systems transformation. Climate change should not be positioned solely as an environment or development issue. Climate change objectives should be embedded in all sectors, including energy, transport, and land use.

This chapter has also reviewed the elements of an environment that encourages low-carbon technology innovations, including the role of public policy in fostering such innovation. Besides better patent processes, significant investment is also necessary on Research and Development (R&D), and the exchange of diverse, supporting data sets. Economic linkages, finance, and incentives for entrepreneurs are also seen as critical in leapfrogging to a low-carbon pathway, as is the social acceptance of new policies.

The issue of global effort-sharing on mitigation has been a stumbling block to progress on a global deal. Notwithstanding the contention in this debate, developing countries have made voluntary pledges to reduce emissions which are, in some cases, more ambitious than the commitments by developed countries. Unilateral action, such as 'Green New Deals', could become a first phase of a fundamental transition towards a decarbonized global economy.

Last, addressing the outstanding issues on MRV (monitoring, reporting and verification) and working out the details of how MRV systems would work in practice is part of a bigger picture around global commitment to mitigate climate change.

5 CONCLUSION

This review has shown that the current literature reflects a growing understanding of the current impacts of climate change, however their future impacts are still uncertain. This highlights the need for policies to deal with climate-related disasters as well as slow-onset and long-term climate-change impacts.

There is value in top-down policy making that considers 'best estimates' of climate change impacts, including the potential for extreme events, and allows the possibility of transformational, rather than incremental, approaches to climate adaptation. However, it is vital that top-down approaches are grounded in local realities. Otherwise, maladaptation (efforts to adapt to climate change which end up undermining the original intent), 'policy misfits' and negative feedback can occur. It vital to build capacities for individual, as well as collective, responses to climate change.

Institutions play a vital role in determining human stresses on natural resources because they govern access to, and allocation of, natural resources across society. Much climate and development research to date has focussed on community level climate adaptation but an emerging area of research is on the broader role of institutions, including across geographical scales and mapping to the range of ecological scales on which biophysical change can occur.

Innovation and long-term commitment are needed to overcome the continued challenges to the mobilization of climate finance: lack of an agreed definition, lack of clarity on sources, and issues on where and how to channel and manage climate finance. In many cases, this is a question of framing support as a crucial investment opportunity, rather than a case of simple resource allocation.

One-off technological breakthroughs and conventional policy instruments will not be enough to transform energy production and consumption patterns. Far more fundamental public policy change will be required, globally. In developing countries, external investments and technology transfers are needed to support the transition to a low-carbon economy.

Finally, adaptation has its limits. In the absence of an inclusive international agreement for ambitious climate mitigation, human society will be tested beyond these limits. There is a danger that the conversation becomes increasingly about how global society copes with the loss and damage inflicted by climate change: what happens when mitigation efforts are insufficient and adaptation fails.

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Annexes

Questionnaire for expert opinion and global survey

Climate Development Research Review

TERI [The Energy and Resources Institute] is working with the Climate and Development Knowledge Network (CDKN) on an annual publication Climate and Development Research Review (CDRR) that aims to provide an expert summary of recent research on key aspects of climate and development. We will appreciate if you could take a few minutes of your time to complete this brief questionnaire for the publication. Your inputs will be duly acknowledged.

1. Name:

2. Institutional affiliation:

3. Which of the following categories cover your current area of policy/ research focus?

☐	Mitigation	☐	Impacts and vulnerability assessments. Please tick specific sector (s) of focus ☐ Agriculture ☐ Water resources ☐ Forestry and biodiversity ☐ Coastal issues ☐ Human health ☐ Others, please specify
☐	Adaptation	☐	Human security
☐	Finance	☐	Urban impacts and resilience
☐	Technology	☐	Poverty and livelihoods
☐	International policy	☐	Climate science
☐	Renewable energy	☐	Energy issues
☐	Equity	☐	Disaster risk reduction
☐	Public awareness	☐	Other, please indicate
☐	Market mechanisms		

4. In your view, post COP15 at Copenhagen, which are the emerging global and regional issues with respect to 'climate and development' that require international policy action?

4a. Global:

4b. Regional: Please identify for one of more of the following regions

☐	Africa:
☐	Asia:
☐	Latin America and the Caribbean:

5. In reference to the issues identified in Q. 4, which recent piece (s) of literature in your view has (/ have) been instrumental in shaping international/ regional policy opinion or has (/have) the potential to do so? Please cite this literature (you can also refer to your own recent work).

Please provide the following information for the supporting literature.

Author(s). Year. Title of the paper. Title of the publication (journal/newsletters/ book). Volume no. (issue no.): page nos.

We are interested specifically (and ONLY) in documents which are:

- Peer-reviewed journal articles and non-academic literature (policy briefs and technical reports)
- Published/ uploaded during **January 2010 to May 2011**
- Focussing on one or more of the following regions- Asia, Africa, Latin America, and the Caribbean

List of keywords/acronyms

Accounting
Adaptation
Africa
Asia
Aviation
Bio-energy
Bunker fuel
Carbon budgeting
Carbon capture and storage
Carbon market
Caribbean
Climate change
Climate finance
Climate justice
Community engagement
Construction
Crediting
Disaster reduction
Energy
Energy efficiency
Equity
Ethics
Fast start finance
Fast track finance
FDI
Feed in tariff
Food security
Forest carbon tracking
Forest management
Gender
Geo-engineering
Green
Green jobs
Health
Human rights
ICTs
Indigenous, women LULUCF
Insurance
International investment agreements
International policy
IPR
Land rights
Landscape accounting
Latin America
Legal frameworks
Levy
Low-carbon
Maritime transport shipping
Market mechanisms
MEAs
Migration
Mitigation
Mountain development
Marine ecosystem
MRV
Multi-stakeholder
NAMA
NAPA
Negotiations
NGOs
Participation
Post 2012
Poverty alleviation
Private sector investment
Renewable energy
Resilient cities
Rural
Sustainable building
Sustainable development
Sustainable transport
Tax
Technology
Traditional rights
Transport

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