Chapter 15. Adaptation Planning and Implementation

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Executive Summary

Adaptation to climate change is transitioning from a phase of awareness to the construction of actual strategies and plans in societies (high agreement, robust evidence). [15.2.1, 15.2.2] The combined efforts of a broad range of international organizations, scientific reports, and media coverage have raised awareness of the importance of adaptation to climate change, fostering a growing number of adaptation responses in developed and developing countries. This represents major progress since the IPCC Fourth Assessment Report (AR4). The literature illustrates heterogeneity in adaptation planning related to the context specific nature of adaptation, but also to the differences in resources, values, needs, and perceptions among and within societies. However, it is not yet clear how effective these responses currently are and will be in the future. Few adaptation plans have been monitored and evaluated. There is a tendency in the literature to consider adaptation planning a problem-free process capable of delivering positive outcomes, underestimating the complexity of adaptation as a social process, creating unrealistic expectations in societies, and perhaps overestimating the capacity of planning to deliver the intended outcome of adaptation..

The national level plays a key role in adaptation planning and implementation, while adaptation responses have diverse processes and outcomes at the subnational and local levels (high agreement, robust evidence). [15.2.1, 15.5.1] National governments assume a coordinating role of adaptation actions in subnational and local levels of government, including the provision of information and policy frameworks, creating legal frameworks, actions to protect vulnerable groups, and in some cases, providing financial support to other levels of government. In the increasing number of adaptation responses at the local level in developed and developing countries, there is a common trend that local governments are hindered by the absence of applicable guides to adaptation decision-making. Local agencies and planners are often confronted by the complexity of adaptation, and even when information is available, they are left with a portfolio of options to prepare for future climatic changes and the potential unanticipated consequences of their decisions. Therefore, linkages with national and subnational levels of government, as well as the collaboration and participation of a broad range of stakeholders are important. Steps for mainstreaming adaptation have been identified but challenges remain in their operationalization within the current structures or operational cultures of national, subnational and local agencies.

Institutional dimensions in adaptation governance play a key role in promoting the transition from planning to implementation of adaptation. (high agreement, robust evidence). [15.2.2, 15.5.1] While institutional dimensions may both enable and limit adaptation planning and implementation, the literature have so far mostly reported on how current institutional arrangements restrict the mainstreaming of climate adaptation. The most commonly emphasized barriers or enablers of institutional change in planning and implementation identified for both developing and developed countries are: 1) multilevel institutional co-ordination between different political and administrative levels in society; 2) key actors, advocates and champions initiating, mainstreaming and sustaining momentum for climate adaptation; 3) horizontal interplay between sectors, actors and policies operating at similar administrative levels; 4) political dimensions in planning and implementation; and 5) coordination between formal governmental, administrative agencies and private sectors and stakeholders to increase efficiency, representation and support for climate adaptation measures.

Adaptation planning and implementation are dynamic iterative learning processes recognizing the complementary role of adaptation strategies, plans and actions at different levels (national, subnational and local) (high agreement, robust evidence). [15.2.1, 15.3.2, 15.3.3, 15.5.1] Climate change adaptation (CCA) takes place as a response to multiple stresses, which highlights the need of connecting CCA with development strategies and plans, and disaster risk management (DRM). The importance of CCA is influenced by how the issue is framed in particular contexts, and the extent that it is viewed as a public safety issue or a development issue, it has greater resonance within national and local policies. In many cases, the most attractive adaptation actions are those that offer development benefits in the relatively near term, as well as reductions of vulnerabilities in the longer term. There is a growing recognition in the literature that, the linkages between adaptation, development and DRM need to be more explicit targeting co-benefits among the societal goals. Considering adaptation planning and implementation learning processes can help carrying out periodic adjustments to accommodate changes in climate and socioeconomic conditions that can strengthen the role of planning as a societal tool for CCA and DRM.

There is no single approach to adaptation planning because of the complex, diverse and context dependent nature of adaptation to climate change. Although top-down and bottom-up approaches are widely recognized, the actions in practice are combinations of these approaches. (high agreement, medium evidence). [15.2.1, 15.3.1, 15.3.3, 15.5.1.2, Box 15-1] The literature illustrates that the debate of climate change is dominated at present by impacts-led approaches that focus on climate risks through the construction of defensive infrastructure rather than on human vulnerability. It is unclear at this point if these adaptation plans consider impact-led approaches just the start of an adaptation process rather than its culmination. Knowledge of impacts and vulnerabilities does not necessarily lead to the most cost-effective and efficient adaptation policy decisions. This is partly due to the uncertainty associated with future climate and socioeconomic conditions but also to the context specificity of adaptation. The literature suggests that coupling adaptive improvements in infrastructure with efforts to improve ecosystem resilience, governance, community welfare, and development improve community resilience. It also suggests combining top-down and bottom-up approaches strengthens adaptation planning and implementation.

A variety of tools are being employed in adaptation planning and implementation depending on social and management context (high agreement, robust evidence). [15.4] Uncertainties in climate change coupled with the complexities of social-ecological systems emphasize the need for a variety of tools in adaptation planning and implementation. Information and knowledge on climate change risks from various stakeholders and organizations are essential resources for making adaptation planning. Multidisciplinary efforts have been engaged to develop, assess and communicate climate information and risk assessments across timescales. These efforts employ a mixed portfolio of measures from simple agroclimate calendars to computerized decision-support tools. Although a wide range of adaptations are possible with current technologies and management practices, development and diffusion of technologies can expand the range of adaptation possibilities by expanding opportunities or reducing costs. Monitoring and early warning systems play an important role in helping to adjust and revise adaptation implementation, especially on the local scale. Inovative tools have also been developed such as ecosytem-based adaptation and a range of insurance tools.

15.1. Introduction

As impacts of climate change have become apparent around the world, adaptation has attracted increasing attention. The impacts are expected to be particularly severe in the developing world and among marginalized communities because of limited adaptive capacity. Adaptation is an important pillar for the response to climate change, and the IPCC Assessment reports highlight the complimentary roles of mitigation and adaptation in climate policy. Particularly, IPCC Fourth Assessment Report (AR4) (IPCC, 2007) provided an evaluation of adaptation that is the departure point for the present report. The AR4 emphasized that adaptation will be necessary to address impacts resulting from climate change that is already unavoidable due to past emissions. A wide array of adaptation options were noted, but also that the level of adaptation was inadequate for a reduction in vulnerability to future climate change. Moreover, the report showed there are barriers, limits and costs which are not fully understood.

Since the publication of IPCC AR4, significant progress has been made on the adaptation activities both quantitatively and qualitatively. In particular, there is substantial progress in development of national adaptation

strategies and plans. These include climate change adaptation (CCA) legislation and formal national strategies. As of 2012, 26 of the OECD countries have developed or are currently developing strategic frameworks for national adaptation (Mullan *et al*., 2013). Forty-nine least developed countries produced and submitted National Adaptation Programmes of Action (NAPAs) to the United Nations Framework Convention on Climate Change (UNFCCC) as of 2013. At the same time, the academic literature and reports from multilateral development agencies, international organizations and NGOs document numerous cases of community-based activities for CCA in developing countries. Through these activities, a range of lessons are being learnt, while barriers and limits are also emerging. The wider social dimensions of adaptation have also attracted more attention since AR4. As the diverse, complex and context specific nature of adaptation becomes apparent (differences in resources, values, needs, and perceptions among and within societies), the related areas expand in the wider social-ecological system, and the number of the stakeholders increases. Based on this recognition, the importance of mainstreaming adaptation and the integration of adaptation policies within those of development increase.

Current research has expanded its focus to reflect these advances (Biesbroek *et al*., 2010). Until the mid-1990s, research on climate change focused almost exclusively on understanding of climate system dynamics and modeling of future climate. Several programs developed recently give prominence to studies of vulnerability and adaptive capacity, and associated adaptation options, measures and strategies, including local, regional, and sectoral studies. As adaptation activities progress, many challenges have emerged, such as how to manage the decision-making process, how to develop strategies and plans, and how to implement them. In this regard, the roles within multi-level governance become an issue, such as horizontal coordination among different agencies and departments, and vertical coordination of various stakeholders from regional, national, to local actors. Furthermore, many countries face challenges in moving from the development of adaptation strategies and plans to implementation. These provide challenges for the research community as well.

There are many definitions and characteristics of adaptation strategies (Carter *et al*., 1994; Burton *et al*., 2005). For the purpose of this chapter, adaptation strategies are defined as a general plan of action for addressing the impacts of climate change, including climate variability and extremes. Such strategies include a mix of policies and measures that have the overarching objective of reducing vulnerability to climate change impacts. This chapter examines and evaluates the literature on CCA, in order to assess the progress made toward CCA and explore difficulties encountered in the implementation of adaptation plans. The IPCC Working Group II (WGII) Fifth Assessment Report (AR5) has four inter-related chapters about adaptation that discuss complementary aspects of the process (see Figure 14-1). This chapter focuses on the actions taken from international to local levels, in various sectors in order to assess; 1) the recent status of climate change adaptation planning and implementation across the globe; 2) the characteristics of adaptation in different settings; 3) the strategies, approaches and tools used in the adaptation practices; and 4) the governance of adaptation including building adaptive capacities. This chapter also draws attention to factors that motivate and facilitate the development of adaptation strategies, as well as how scientific and technical information, support and collaborative mechanisms are utilized in the process.

15.2. Status of Adaptation Planning and Implementation

15.2.1. Adaptation Planning at Different Levels

15.2.1.1. Common Recognition and International Mechanisms

The combined efforts of a broad range of international organizations, scientific reports, and media coverage have raised the importance of adaptation to climate change since the publication of AR4. Adaptation is transitioning from a phase of awareness and promotion to the construction and implementation of plans, strategies, legislation and projects at national, subnational, and local levels (Biesbroek *et al*., 2009; Preston *et al*., 2009; Tompkins *et al*., 2010; Berrang-Ford *et al*., 2011; Romero-Lankao and Dodman, 2011; Dodman, 2012). The review of the literature identifies a high heterogeneity of adaptation planning. There is significant heterogeneity in adaptation planning that is related to the context specific nature of adaptation (differences in resources, values, needs, and perceptions among and within societies). This heterogeneity also results from different approaches among countries, multilateral

development agencies and international organizations that promote and fund adaptation, and from differences in knowledge, information and awareness on adaptation alternatives across societies.

Although attention to climate change impacts and disaster risk management are key elements of adaptation, they appear to have a more prominent role in the early stages of planning and implementation (Few *et al*., 2007; Hofstede, 2008; Mitchell *et al*., 2010; Garrelts and Lange, 2011; Harries and Penning-Rowsell, 2011; Rosenzweig *et al*., 2011; Rumbach and Kudva, 2011; Etkin *et al*., 2012; IPCC, 2012). Several authors express concern that a strong focus on impacts can overshadow the analysis of the underlying stressors of hazards, neglecting the drivers of vulnerability, and thus, limiting the effectiveness for interventions (Sabates-Wheeler *et al*., 2008; Boyd and Juhola, 2009; Orlove, 2009; Ribot, 2010; Rumbach and Kudva, 2011). This approach could obscure opportunities for connecting development pressures, poverty, social inequality and climate change, particularly for the reduction of social vulnerability (Lemos *et al*., 2007; Hardee and Mutunga, 2010; Sietz *et al*., 2011). Furthermore, other scholars suggest that knowledge of impacts and vulnerabilities does not necessarily lead to the most cost-effective and efficient adaptation policy decisions (Hulme *et al*., 2009; Barnett and Campbell, 2010).

The importance of climate adaptation is also influenced by how the issue is framed. For example, to the extent that adaptation is viewed as a development issue (current development stressors and challenges, existing policy and existing agendas, knowledge, risks, and issues communities already face), it may have greater resonance within local government (Ewing *et al*., 2008; Moser and Satterthwaite, 2008; Dovers, 2009; Hodson and Marvin, 2009; Stringer *et al*., 2009; Measham *et al*., 2010; Sanchez-Rodriguez, 2012). Multilateral development agencies encourage efforts in this direction through a number of guidelines, publication and development assistance (UNDP, 2005; USAID, 2007; OECD, 2009; UNEP, 2010; World Bank, 2010a; UN-HABITAT, 2011a). Central to these efforts is the role of planning that connects adaptation to development needs and challenges (Blanco and Alberti, 2009; Dovers, 2009; Juhola and Westerhoff, 2011; Sanchez-Rodriguez, 2012). A critical issue commonly emphasized in the literature is the consideration of adaptation planning as a problem-free process capable of delivering positive outcomes. There is the risk of underestimating the complexity of adaptation planning as a social process, and it can lead to creating unrealistic expectations in societies, and overestimating the capacity of planning to deliver the intended outcome of preparing societies to adapt to the negative impacts of climate change. This highlights the importance of monitoring, evaluating and reviewing adaptation planning and implementation (Adger *et al*., 2009b; Preston *et al*., 2009; Tompkins *et al*., 2010; Wolf *et al*., 2010).

The fast growth of international mechanisms for supporting adaptation planning has assisted in the creation of adaptation strategies, plans, and actions at the national, subnational and local level. The directives and initiatives of the European Commission (EC) have fostered the creation of a large number of national adaptation strategies and plans in EU member countries since the last IPCC report (Biesbroek *et al*., 2009, 2010; Ford *et al*., 2011). Other relevant regional initiatives are the South Pacific Regional Environmental Programme (SPREP) supported by a number of international agencies, and in the Caribbean through the Caribbean Catastrophic Risk Insurance Facility (Pulwarty *et al*., 2010). The literature reports a growing number of mechanisms developed by multilateral development organizations, development cooperation agencies from developed countries, United Nations programs (UNDP, 2005, 2010a; UNEP, 2010; UN-HABITAT, 2010, 2011a), multilateral development agencies (USAID, 2007; OECD, 2009; World Bank, 2010a, 2011, 2012), and non-governmental organizations (ICLEI, 2008; IFRC *et al*., 2009; Pew Centre on Global Climate Change, 2009; Braman *et al*., 2010; ActionAid *et al*., 2012; Crane, 2013). These organizations focus on their particular geographic and thematic areas of interest in their support for adaptation planning. Particularly relevant are the activities of UNFCCC for least developing countries through the National Adaptation Programmes of Action (NAPAs) and for less developed countries through the National Adaptation Plans (NAPs).

Keyt funding mechanisms are associated with the Global Environmental Facility (GEF) adaptation funds (Least Developed Countries Climate Adaptation Fund and Special Climate Change Fund), support for the Pilot Program for Climate Resilience (PPCR), and special purpose adaptation funds for UN agencies. The Adaptation Fund (AF) set up under the Kyoto Protocol has pioneered direct access mechanisms to developing countries, allowing countries to access essential funds without having to work through a multilateral development agency.

15.2.1.2. National Initiatives

The movement to introduce adaptation into national policies has accelerated in both developed and developing countries. These diverse national adaptation initiatives reflect the characteristics of the domestic political structures, socio-economic conditions, values and perceptions, as well as development stresses and opportunities. National governments are assuming a coordinating role in adaptation actions in subnational and local levels of government. National level coordination includes the provision of information about potential risks, in order to strengthen actions of state and local governments. These activites provide policy frameworks that guide decisions at subnational levels, to spur and coordinate the creation of legal frameworks, to direct action in sectors and resources for national development (agriculture, fisheries, health, ecosystem protection, among others), to protect vulnerable groups, and to provide financial support to other levels of government (Hulme *et al*., 2009; Biesbrock *et al*., 2010; Birkmann and Teichman, 2010; Berrag-Ford *et al*., 2011; Westerhoff *et al*., 2011). National governments also facilitate the coordination of budgets and financing mechanisms (Alam *et al*. 2011; Kalame *et al*. 2011).

In recent years, Europe's creation of national adaptation strategies and plans has been particularly dynamic. Twelve European countries have created National Adaptation Strategies-Austria, Belgium, Denmark, Finland, France, Germany, Hungary, the Netherlands, Norway, Portugal, Spain, and United Kingdom (only two of them were created before the AR4, Finland and Spain) (Biesbroek *et al*., 2010). Moreover, some countries have programmed the evaluation of their national adaptation strategies because they recognize the need to learn from the adaptation process (UK, Germany, Australia, the U.S, Mexico among others) (Bierbaum *et al*. 2013). Most strategies are regarded as the start of a policy process rather than its culmination, providing the important perspective of considering iterative evaluation as part of planning and implementation (Hulme *et al*.,2009, Biesbroek *et al*. 2011, Pulwarty *et al*. 2012).

The Least Developed Countries national adaptation responses, implemented through UNFCCC's NAPAs, provide data on efforts to link local level adaptation and development (Agrawal, 2008; Agrawal and Perrin, 2008; Stringer *et al*., 2009; Ciplet *et al*., *in press*). More than 50% of the projects under this program are concentrated in three key sectors for development and livelihoods: food security, terrestrial ecosystems and water resources. They attract the support of a greater range of actors, but some suggest that linkages between development and adaptation need to be made more explicit (Stringer *et al*., 2009). Sustained monitoring, evaluation and feedback that is needed to learn from the NAPAs process would help these countries transcend from a project by project effort, to a more complete union of adaptation and domestic and local development.

15.2.1.3. Sub-National and Local Activities

Adaptation planning and implementation initiatives illustrate differences on the role of subnational governments in the governance structure of countries, from those with strong concentration of political and economic power to a very minor role in governance and decision-making. Subnational governments often have a complementary role to national governments in adaptation planning that is reflective of the governance structure (Moser, 2005; West and Gawith, 2005; Lemmen *et al*., 2008; Pew Centre on Global Climate Change, 2009; USGCRP, 2009). Although guiding frameworks have not created for subnational governments in many countries, the states and provinces in some countries have an active role in climate change adaptation (CCA) (Brekke *et al*., 2009; Dinse *et al*., 2009; Staples, 2011; Barsugli *et al*., 2012; Bierbaum *et al*., 2013; Mukheibir *et al*., 2013).

There is a significant increase in the number of planned adaptation responses at the local level in rural and urban communities of developed and developing countries since AR4. Climate adaptation is context dependent and it is uniquely linked to location, making it predominantly a local government and community level of action (Corfee-Morlot *et al*., 2009; Glaas *et al*., 2010; Mukheibir *et al*., 2013). Among these efforts are adaptation plans that utilize local knowledge. Local knowledge based adaptation is primarily focused on the use of traditional knowledge to increase adaptive capacity at the community level as examples are shown in Table 15.1. In addition to raising adaptive capacity, local knowledge often highlights vulnerabilities and impacts that may not be well known, especially when the areas where local knowledge is still held are remote and poorly monitored (e.g., Majule *et al*., 2013).

Local councils and planners are often confronted by the complexity of adaptation without adequate access to guiding information or data on local vulnerabilities and potential impacts. Even when information is available, they are left with a portfolio of options to prepare for future climatic changes but without effective guidance on decision-making and the potential for unanticipated consequences arising from those decisions (Wilson, 2006; Storbjörk, 2007; Patt and Schröter, 2008; Urwin and Jordan, 2008; Gupta *et al.*, 2010; Mathew *et al.*, 2012; Rodima-Taylor *et al.*, 2012; Mukheibir *et al.*, 2013).

Local governments play a central role addressing the challenges of adaptation planning and implementation (Blanco and Alberti, 2009; Sanchez-Rodriguez, 2009; Rosenzweig and Solecki, 2010; Simon, 2010; Matthews, 2012). However, scholars stress the important role of partnerships among public, civic, and private sectors in CCA (Berkhout *et al.*, 2006; Agrawal, 2010; Tompkins *et al.*, 2010; Howe, 2011; Tompkins and Eakin, 2012). Inclusive and participatory approaches in adaptation planning at the local level are encouraged by international organizations (UNDP, 2005, 2010a; Moser, 2008; Moser and Satterthwaite, 2008; Ensor and Berger, 2009; Geiser and Rist, 2009; World Bank, 2010a; Ford *et al.*, 2011; UN-HABITAT, 2011a).

Urban areas are also the locus of a growing number of planning initiatives (Revi, 2008; Roberts, 2008; Stren, 2008; Blanco and Alberti, 2009; Hamin and Gurran, 2009; Hardoy and Pandiella, 2009; Lowe *et al.*, 2009; O'Demsey, 2009; Parzen, 2009; Sanchez-Rodriguez, 2009; Tanner *et al.*, 2009; Corfee *et al.*, 2010; Rosenzweig and Solecki, 2010; Simon, 2010; New York, 2011; Romero-Lankao and Dodman, 2011; Rosenzweig *et al.*, 2011; Carmin *et al.*, 2012; Matthews, 2012; Rotterdam, 2012). The primary determinants in creating adaptation plans has been a response to current climate extremes as well as potential future impacts (Rosenzweig and Solecki, 2010; Rosenzweig *et al.*, 2011; Carmin *et al.*, 2012). The difference in approaches has implications for adaptation governance, institutional arrangements, resources, and stakeholders involvement in the planning and implementation processes. Understanding how these approaches work merits further analysis. Enforcing parallel agendas for DRM and CCA runs the risk of duplicating efforts and resources, creating competing actions and potential conflicts with unintended negative consequences, including maladaptation. Institutional arrangements would need to bridge the divide between CCA and DRM, particularly in terms of legislation, operational and management structures, working agendas, and time horizons (Schipper and Pelling, 2006; Birkmann and Teichman, 2010; Falaleeva *et al.*, 2011).

[INSERT TABLE 15-1 HERE
Table 15-1: Application of local knowledge in climate change adaptation.]

15.2.2. Adaptation Implementation

There is a minority of academic literature that provides information on the implementation of adaptation plans in contrast with the large accumulation of literature that discusses concepts, strategies, and plans of adaptation. Projects and cases of adaptation, including those implemented, are mainly presented in reports from international organizations, multi-lateral development organizations, national and sub-national governments and NGOs (e.g., UNFCCC, 2011; Mullan, 2013). In addition, the sectoral and regional chapters in the IPCC WGII AR5 have segments that discuss adaptation planning and implementation, that provide an additional database of sectors and practices. Therefore, this section will assess the status of adaptation implementation based on these chapters in addition to other literature.

Adaptation practices reflected in the WGII AR5 include agriculture, public health for heat-related risks, disaster risk reduction, water resources, coasts, and urban areas among others. Options and approaches used in implementation vary widely ranging from traditional and exiting to new and innovative measures. For example, farmers have been adapting to climate change worldwide, and current common practices include altering sowing times, crop cultivars and species, or irrigation and fertilizer control (Fujisawa and Koyabashi, 2010; Lasco *et al.*, 2011; Olesen *et al.*, 2011), reduced tillage practices and technical measures to more effectively capture rainwater and reduce soil erosion (Thomas *et al.*, 2007; Marongwe, 2011) (see 7.5.1; 22.4.5.7; 23.4.1; 24.4.4.5; 27.3.4.2). These have proven to be effective in many cases, while some measures faced other problems; for example, earlier sowing is often prevented by lack of soil workability and frost-induced soil crumbling (Oort, 2012). Furthermore, simple options such as

changes in sowing and harvesting dates may become less successful in a more variable climate (Morindo et al., 2010; see 23.4.1). Adaptation in agriculture is also linked with water management. Adaptation to water scarcity can be improved by taking into account a set of agronomic practices and irrigation such as deficit irrigation (Geerts and Raes, 2009; see 27.3.4.2). For public health for heat-related risks, major approaches are developing early warning systems and air pollution control. According to the Chapter 11 on Human Health, some studies report that heat wave early warning systems is effective to reduce heat-related mortality, and makes fewer deaths during heat waves after implementation of the system (e.g., Ebi, et al., 2004; Tan *et al*., 2007; Fouillet *et al*., 2008). A national assessment attributed the lower death toll to greater public awareness of the health risks of heat, improved health care facilities, and the introduction in 2004 of a heat wave early warning system (Fouillet *et al*., 2008; see 11.7.3).

Mullan (2013) indicated that implementation of adaptation plans are still at an early stage despite the rapid development of strategies and plans that have occurred in OECD countries. In many sectors, adaptation to both environmental conditions and climate change includes accumulating traditional experience and knowledge for adaptation. Furthermore, each country has also developed its own policies and options to prevent, cope with, mitigate and utilize various environmental changes. As the occurring adaptive actions are usually based on such existing knowledge and options, they are incremental. Research has shown that local governments that have started implementing adaptation plans mostly tend to adopt a reactive or event-driven approach to adaptation relying upon technical measures. Often the focus is on climate variability and current weather extremes rather than long-term climate change (Næss *et al*., 2005; Wall and Marzall, 2006; Tompkins, 2005; Crabbé and Robin, 2006; Storbjörk, 2007; Blanco and Alberti, 2009; Amundsen *et al*., 2010; Glaas *et al*., 2010; Anguelovsky and Carmin, 2011; Measham *et al*., 2011; Preston *et al*., 2011; Dannevig *et al*., 2012; Romero-Lankao *et al*., 2012; Runhaar *et al*., 2012). Climate adaptation efforts reported on at present are often piecemeal and fragmented approaches, dealing with partial solutions and approaches to climate adaptation, rather than more full scale implementation (Granberg and Elander, 2007; Blanco and Alberti, 2009; Bulkeley *et al*., 2009; Amundsen *et al*., 2010; Burch, 2010; Tompkins *et al*., 2010; Preston *et al*., 2011; Dannevig *et al*., 2012; Mees *et al*., 2012; Romero-Lankao *et al*., 2012; Runhaar *et al*., 2012). In many cases, these practices have been embedded in existing policies, and thus not necessarily framed or made visible as climate adaptation actions (Tompkins *et al*., 2010; Berrang-Ford *et al*., 2011; Kenny, 2011; see Box 25-5). It should be noted that several of these reports on local climate adaptation actions have been taking place without explicit regulative demands for climate adaptation.

A particular challenge is implementation of local and short-term decisions in the context of long-term climate information. Improving the use of climate risk information across timescales, especially in the context of early warning systems, has helped bridge these gaps (van Aalst, 2009; IPCC, 2012; Pulwarty and Verdin, 2013). Independent from the growing attention for extremes in climate change adaptation, there has also been a shift in disaster risk management policy and practice, aiming to shift the balance of attention and expenditure from disaster response and reconstruction to disaster risk reduction and building resilience (not limited to climate-related extreme events).

There is growing awareness of the need for ecosystem-based, institutional, and social measures, although engineered and technological adaptation options are the most common adaptive responses (see Box CC-EA). A feature captured in the WGII AR5 is that integrated approaches have been pursued in many areas such as integrated water resource management and integrated coastal management (see Table 3.3, Table 8.3.3.4, Table 23.7.2 for water; Tables 5.5 and 5.4 for coasts). These integrated policies aim at addressing multiple objectives including climate change adaptation, development and disaster risk reduction. For example, the US Water Utilities Climate Alliance (WUCA, 2010) provides a comprehensive overview of ways of delivering water management which incorporates climate change and its uncertainty. Climate change has been incorporated into water resources planning in England and Wales (Arnell, 2011; Wade *et al*., 2013) and in the Netherlands (de Graaff *et al*., 2009). Guidance has been also developed on the inclusion of adaptation in water management (UNECE, 2009) and river basin management plans (EC, 2009b; see 23.7.2). Many sectors promote adaptive management in climate change adaptation to improve flexibility in its implementation.

Targets of early adaptation are focused on capacity building within governments and communities. These important first steps include increasing awareness of the risk of climate change, access to the scientific information, development of common goals and creation of operational institutions, which are important premises for adaptation.

Capacity building itself is often a target of adaptation implementation particularly in developing countries (e.g., van Aalst *et al*., 2008; Simões *et al*., 2010; UNFCCC, 2013; see Table 15.1 for capacity building cases). There are many factors to promote or hinder the implementation of adaptation, as Table 15.2 shows examples where the drivers and motivations for transition to implementation are highlighted. The role of institutional dimensions is analyzed in Section 15.5 for both planning and implementation of adaptation.

[INSERT TABLE 15-2 HERE
Table 15-2: Transition from planning to implementation.]

15.2.3. Financing for Adaptation

Adapting to the impacts of climate change requires the mobilization of a significant amount of funding for adaptation measures in a wide range of sectors. A number of studies suggest that the annual amount of adaptation funding needed by developing countries by 2030 is on the order of several tens of billions of dollars (e.g., UNFCCC, 2007; World Bank, 2010a; Smith *et al*., 2013). However, the annual costs could potentially range into the hundreds of billions of dollars (Parry *et al*., 2009). The differences between these estimates highlight the high degree of uncertainty in how they are derived. Key factors that contribute to this uncertainty include differences in the sets of sectors that are included in the analyses and the analytical methodologies used; uncertainties related to future climate changes and how best to adapt to them; and the lack of an agreed operational definition of adaptation (e.g., Christiansen *et al*., 2012; Naidoo *et al*., 2012; Fankhauser and Burton, 2011; Smith *et al*., 2013).

Adaptation financing broadly refers to resources that are deployed to support climate-resilient development (World Bank Group, 2011). Funding for adaptation can be mobilized through a range of international and domestic, public and private financing mechanisms, and can take various forms (e.g., loans and grants). Public financing sources are typically used to support projects in the infrastructure sectors, where returns on investments (ROIs) are usually less attractive to private investors. Sources of public financing for adaptation include contributions from national budgets, multilateral and bilateral development funds, and UNFCCC operational funds – the Adaptation Fund, the Least Developed Countries Fund, and the Special Climate Change Fund (Christiansen *et al*., 2012; Haites and Mwape, 2013; Romani and Stern, 2013). A potentially key source of future public financing for adaptation is the Green Climate Fund that was officially designated at the 17th Conference of the Parties to the UNFCCC in Durban, but is not yet operational.

Example of ongoing work targeting challenges in priority adaptation themes in several countries are provided by the Climate Change and Water Resources program at the Inter-American Development Bank. The lessons from emerging adaptation experiences are, first, that infrastructure investments (e.g., dams, levees, canals) remain critical for climate adaptation and reducing vulnerability to climate and weather related events; and, second, that infrastructure investments need to be complemented by previously neglected investments in soft infrastructure (e.g., watershed management, land use planning and information, and stakeholder engagement) (Miralles-Wilhelm, 2012). Efforts are also being supported by other regional development banks; for example, the Climate Adaptation for Rural Livelihoods and Agriculture (CARLA) project is supported by the African Development Bank Group).

Adaptation measures that offer reasonably predictable ROIs that are comparable to the returns on investments for non-adaptation measures with similar risk profiles have more opportunities to receive private financing (Christiansen *et al*., 2012). The fisheries and agriculture sectors, where operations are often locally owned, are examples of sectors that typically draw relatively high proportions of private financing in developing countries (often from domestic sources). Sources of private financing for adaptation traditionally include a range of financial institutions, such as international banks, multinational corporations, private equity and pension funds, insurance companies, and sovereign wealth funds. Charitable foundations and social investors are also sources of private financing for adaptation; compared to the financial institutions, these sources are often more motivated to provide financing for measures that generate lower ROIs (Christiansen *et al*., 2012)

Private financing for adaptation is primarily of two types: debt and equity. Debt-based financing typically consists of loans (e.g., bank loans) or bonds that must be paid back over time with interest. Equity-based financing generally

involves a transfer of ownership rights through stocks or other assets. Export credits and foreign direct investment are two additional potential forms of private financing for adaptation. Export credits include guarantees, insurance, and other support that can help make developing country exports more competitive on the global market. Foreign direct investment is seen as having only limited potential for adaptation financing because it is highly concentrated in a few sectors and in a limited number of countries (Christiansen *et al*., 2012).

In both the public and private arenas, financing for adaptation is currently substantially less than financing for mitigation. According to an assessment of the total amount of climate finance available in 2009/2010 by Buchner *et al*. (2011), financing for mitigation outnumbered financing for adaptation by a ratio of more than 20:1; whereas $93 billion was provided for mitigation measures, only $4.4 billion was directed to adaptation measures. Buchner *et al*. (2011) also noted that the vast majority (approximately 90%) of adaptation financing during that period came from public sources, primarily bilateral institutions. Private adaptation financing remains limited due to market, institutional, and policy barriers that depress ROIs on these activities (World Bank Group, 2011). However, public-private partnerships that use public financing to leverage private investment are currently used to fund projects in several climate-sensitive sectors, such as infrastructure projects in the energy, transport, and water and sewage sectors (World Bank, 2011; World Bank Group, 2011). These partnerships are not necessarily focused on climate adaptation, but can serve as models for future adaptation projects.

15.3. Strategies and Approaches

15.3.1. Diverse Strategies and Mixed Portfolio Approaches

Strategies and approaches in adaptation planning and implementation vary according to context and level of government. National plans assume a coordinating role in adaptation actions for subnational and local levels of government providing policy frameworks that guide decisions at subnational level, spurring and coordinating the creation of legal frameworks, and directing action in key sectors for national development (Biesbroek *et al*., 2010; Bierbaum *et al*., 2013; ; see 15.2.1). Sub-national governments often have a complementary role to national governments by reflecting of the governance structure in each country (West and Gawith, 2005; Lemmen *et al*., 2008; Pew Centre on Global Climate Change, 2009; USGCRP, 2009). States and provinces in a number of countries have begun to have an active role in CCA (Dinse *et al*., 2009; Staples, 2011; Barsugli *et al*., 2012; Bierbaum *et al*., 2013; Mukheibir *et al*., 2013).

In contrast, local level strategies are more diverse because climate change impacts occur locally and adaptation is context dependent. The scale of community engagement and the approaches used may provide key elements for the success of adaptation programs (Patt and Schröter, 2008; Ensor and Berger, 2009; Ford *et al*., 2011; Pelling, 2011; Picketts *et al*., 2012). Methodological guidelines for community adaptations plans and actions fostered by international organizations emphasize strategies focused on the use of local and traditional knowledge to increase adaptive capacity at the community level (CARE, 2009; IFRC *et al*., 2009; IISD, 2012; Crane, 2013). Moreover, community adaptation planning has been strengthened through the use of geographic information systems (GIS), modeling, climate change scenarios, ecosystem services, and other scientific research methods applied to foster the ability of the community to design adaptation (Shaw *et al*., 2009; Bardsley and Sweeney, 2010; IAPAD, 2010). Multilateral development agencies recognize the importance of inclusive approaches for adaptation planning and implementation, but they tend to focus on strengthening the role of local governments (USAID, 2007; OECD, 2009; UNDP, 2010; World Bank, 2010b; International Bank for Reconstruction and Development and World Bank, 2011; UN-HABITAT, 2011; World Bank, 2012).

The diversity of approaches for local adaptation fosters opportunities for creating and strengthening adaptation planning and its implementation. But local governments and actors can face difficulties to make sense of such diversity of approaches and identify the most suitable and efficient approaches to follow as mentioned in 15.2.1. Lessons learned from the DRM experiences illustrate that a lack of coordination occurs among the strategies taken to reduce the risk of disaster at the local level (ISDR *et al*., 2010; ISDR, 2011). Local CCA strategies can face similar problems. To be effective, local governments and actors critically identify, select, and combine the strengths of diverse approaches. The coordinating role of national and subnational governments can provide support in this

direction. However, multilevel institutional coordination between different political and administrative levels in society can be an institutional barrier to planning and implementation in developed and developing countries (Few *et al*., 2007b; Urwin and Jordan, 2008; Corfee-Morlot *et al*., 2009; Keskitalo, 2009; Pahl-Wostl, 2009; Measham *et al*., 2011; Robinson and Berkes, 2011; Sietz *et al*., 2011; Rodima-Taylor *et al*., 2012; Nilsson *et al*., 2012; Glaas and Juhola, 2013). There appear to be few national guidelines to assist local governments in selecting relevant approaches (Storbjörk, 2007; Glaas *et al*., 2010; Mozumder *et al*., 2011; Carmin *et al*., 2012; Hedensted Lund *et al*., 2012; Adhikari and Taylor, 2012; Peach Brown *et al*., 2013). Similar barriers have been reported in DRM (ISDR *et al*., 2010; ISDR, 2011). A combination of top-down and bottom-up activities may strengthen local adaptation planning and implementation (Urwin and Jordan, 2008; Bulkeley *et al*., 2009; Preston *et al*., 2013). Connecting adaptation planning strategies and local development needs and plans (USAID, 2007; OECD, 2009; UNDP, 2010a; World Bank, 2010b; International Bank for Reconstruction and Development and World Bank, 2011; UN-HABITAT, 2011; World Bank, 2012) and the use of low-regret strategies can also support local adaptation strategies and their implementation (Hallegatte, 2009; UNDP, 2010a).

15.3.2. Adaptation and Disaster Risk Management

The UN Hyogo Convention (2005-2015) has fostered the creation of a significant number of disaster risk management (DRM) plans and actions at the national and local level in developed and developing countries (UN, 2005; UNISDR, 2011). The IPCC SREX Report (IPCC, 2012) highlighted the complementary aspects and differences between DRM and climate change adaptation. Measures that provide benefits under current climate and a range of future climate change scenarios, called low-regrets measures, have been identified as starting points for addressing projected trends in exposure, vulnerability, and climate extremes in national and regional adaptation plans (see 8.3.2.2). These measures have the potential to offer benefits now and lay the foundation for addressing projected changes. Furthermore, the evaluation of DRM implementation helps to strengthen climate change adaptation (CCA) because climate change impacts and DRM are key elements of adaptation and have a prominent role in these early stages of CCA (Few *et al*., 2007b; Hofstede, 2008; Mitchell *et al*., 2010; Garrelts and Lange, 2011; Harries and Penning-Rowsell, 2011; Rosenzweig *et al*., 2011; Rumbach and Kudva, 2011; Etkin *et al*., 2012; IPCC, 2012).

DRM includes managing hazards from extreme weather events and helps communities to deal with the uncertainty of climate change (Mitchell *et al*., 2010). On the other hand, disaster risk management strategies often fail to account for the differing spectrum of threats, and time and spatial scales needed to address the root causes of climate change vulnerability and open opportunities for CCA (Etkin *et al*., 2012). Proponents of merging DRM with CCA stress the mutual benefits of this approach. They also note that currently, CCA and disaster risk reduction are within separate agencies, although they share similar objectives and challenges that can duplicate efforts if there is not an effort towards better coordination and integration (USAID, 2007; IFRC *et al*., 2009; UNDP, 2010b; World Bank, 2010b; UN-HABITAT, 2011b; EIRD, 2012; Turnbull and Turvill, 2012; World Bank, 2012).

Current institutional structure and operation cultures are not congruent with the need for multidimensional approaches for DRM at the national and local level in a number of countries (ISDR, ITC, UNDP, 2010; ISDR, 2011). This chapter identified similar institutional barriers in adaptation planning and implementation discussed in Section 15.5.1.2 (Few *et al*., 2007b; Urwin and Jordan, 2008; Corfee-Morlot *et al*., 2009; Keskitalo, 2009; Pahl-Wostl, 2009; Measham *et al*., 2011; Robinson and Berkes, 2011; Sietz *et al*., 2011; Nilsson *et al*., 2012; Rodima-Taylor *et al*., 2012; Glaas and Juhola, 2013). Addressing these institutional barriers in DRM and CCA jointly can help create more efficient and effective strategies and actions to adapt to short, middle, and long-term climate impacts. Planning has been highlighted as key tool for DRM and adaptation but it requires also transformations in its operational structure and practices to fulfill this role (Wilson, 2006; Blanco and Alberti, 2009; Roberts, 2010; Preston *et al*., 2011; Carmin *et al*., 2012; Mathew *et al*., 2012; Rodima-Taylor *et al*., 2012; Sanchez-Rodriguez, 2012).

DRM experiences reveal the importance of linking development and disaster risk prevention and reduction. Strengthening the integration of CCA with development has been also suggested (Lemos *et al*., 2007; Ewing *et al*., 2008; Hodson and Marvin, 2009; Hardee and Mutunga, 2010; Sietz *et al*., 2011). Connecting DRM and CCA to

existing development pressures, agendas, policies, governance structures, and community welfare can help reduce the risk of unintended consequences of adaptation. DRM would also facilitate the support and acceptance of adaptation by decision-makers and stakeholders at the subnational and national level (Dovers, 2009; Sovacool *et al*., 2012). Integrating DRM and CCA with development strategies, policies, plans, actions, and pressures can help address social vulnerability to climate change while providing opportunities for adaptation.

National and local efforts in disaster risk reduction recognize the importance of considering DRM a continuous learning process. Adaptation to climate change can also be viewed as a continuous learning process (not a single outcome), requiring regular monitoring and evaluation, as climatic and socioeconomic conditions change, and knowledge of the impacts increases (Adger and Barnett, 2009; Hinkel *et al*., 2009; Hulme *et al*., 2009; Preston *et al*., 2009; Arnell, 2010; Hofmann *et al*., 2011). Considering DRM and CCA learning processes assists in creating integrated approaches for national and local development strategies and plans. The process can also attend to intersecting social processes and help aleviate differing vulnerabilities that result from inequalities in socioeconomic status, income, and exposure to climate risks.

Lessons from DRM highlight the importance of participatory approaches and the use of local knowledge in the design and implementation of disaster risk prevention and reduction and CCA(Few *et al*., 2007b; van Aalst *et al*., 2008; ISDR *et al*., 2010; UNDP, 2010b; EIRD, 2012). By the same token, local knowledge based adaptation is primarily focused on the use of traditional knowledge to increase adaptive capacity at the community level (see Table 15.1 for examples). Local knowledge often highlights vulnerabilities and impacts that may not be well known due to the close interactions between climatic and non-climatic stressors associated with structural inequalities to vulnerability in societies (exposure, sensitivity, and adaptive capacity) (Majule *et al*., 2013). Combining top-down and bottom-up approaches and using low-regret strategies and actions in DRM and in adaptation planning and implementation increase climate resilience, improve livelihoods, reduce development pressures, and strengthen economic and social well-being (Moser and Satterthwaite, 2008; Hallegatte, 2009; UNDP, 2010b; World Bank, 2010b). It can also help alleviate the concerns of limiting the effectiveness of policy interventions, as mentioned in 15.2.1.

15.3.3. Adaptation and Development

Discussions of the relationships between sustainable development and climate change have increased over the past decades (Cohen *et al*., 1998; Yohe *et al*., 2007; Bizikova *et al*., 2010). As impacts of climate change hinder the achievement of development goals at all scales, O'Brien *et al*. (2012) emphasizes that disaster risk management is increasingly considered as one of the frontlines of adaptation, and a promising arena for mainstreaming or integrating climate change adaptation into sustainable development planning. In many cases, the most attractive adaptation actions are also those that offer development benefits in the near term, as well as reductions of vulnerabilities in the longer term (Agrawala, 2005; Klein *et al*., 2007; McGray *et al*., 2007; Hallegatte, 2008; NRC, 2010). In developing countries, adaptation has been embedded in the development context in NAPAs and national adaptation strategies.

Attention to the social dimensions of adaptation, including rates of change in social conditions, in part of the literature coincides with the interest of international organization and scholars in the relationship between adaptation planning and implementation and development (UNDP, 2005; Lemos *et al*., 2007; Dovers, 2009; OECD, 2009; Stringer *et al*., 2009; UNEP, 2010; World Bank, 2010b; UN-HABITAT, 2011b). The literature supports the standing contention that adaptation takes place as a response not just to climate change but to multiple stresses (Adger *et al*., 2005; Thomas and Twyman 2005). Linking existing policy, agendas, knowledge, risks, and issues communities already face with adaptation planning can help reduce the unintended consequences of adaptation (Dovers, 2009). The importance of climate change adaptation is also influenced by how the issue is framed. For example, to the extent that it is viewed as a public safety issue or a development issue, it may have greater resonance within local government (Measham *et al*., 2010). Other authors consider integrating local knowledge and experience, including households, into multidimensional and multi-scale approaches to guide the construction of adaptation responses to climate change, and integrate them with development strategies (Ewing *et al*., 2008; Moser and Satterthwaite, 2008; Blanco and Alberti, 2009; Hodson and Marvin, 2009).

Other literatures emphasize the role of planning as a switchboard for adaptation and development (Füssel, 2007; Hallegatte, 2009; Preston *et al*., 2011). This might require systemic changes to enable planning approaches capable of managing complexity, uncertainty, multidimensional, and multi-level coordination (Pahl-Wostl, 2009; Tompkins *et al*., 2010; Huntjens *et al*., 2011; Huntjens *et al*., 2012).

15.4. Tools Used for Decision-Making, Planning, and Implementation

15.4.1. Decision Support Tools

Adaptation decision making is informed by various tools present in both top-down and bottom-up forms. Top-down tools often include downscaled simulated climate scenarios for regional level projections, accompanied by expert opinions. These are applied using multi-criteria optimization methods, evaluation of feasibility that may include cost-effectiveness such as cost-benefit analyses, and assessment of potential impact severity (Carter *et al*., 1994; IPCC-TGICA, 2007; Adger *et al*., 2009a, b; see 5.5.3, 9.4.2).

In the bottom-up approach, those affected or at risk examine their own impacts and vulnerabilities and incorporate adaptive options for the appropriate sector or community. Stakeholders may organize social and institutional activities in the light of actions and interactions among those engaged in the process. Advances in stakeholder participatory methods have significantly enhanced the development of this type of decision making tool in recent years (Epstein and Axtell, 1996; Wolfram, 2002; Kaner *et al*., 2007; see 2.4.4).

No single tool suits all circumstances of adaptation decision making, although information development tools such as Community-based Risk Screening Tool-Adaptation and Livelihoods (CRiSTAL) can manage diverse vulnerabilities and risks (IISD, 2012). By outlining the problems and the available inputs to the adaptation decision process, this tool may provide a suitable option (Gimblett, 2002). IPCC (2012) notes there are distinct differences in problem orientation and solution space depending on whether an adaptation plan commences with climate modeling outputs, versus that of a risk and vulnerability-based framework.

15.4.2. Tools for Planning

Uncertainties in climate change coupled with the complexities of social-ecological systems require a dynamic approach to adaptation planning and implementation. Knowledge about climate change risks from various stakeholders and organizations are essential resources for adaptation planning. Multidisciplinary efforts, some of which are discussed below, have engaged in development, assessment and communication of climate information and risks across different timescales.

15.4.2.1. Monitoring, Modeling, and Spatially Integrated Tools

The integration of monitoring and/or modeling systems with the techniques of geographical information systems (GIS) can strengthen adaptation planning and implementation. The complex, multi-scale, interdisciplinary nature of climate change impact on socio-ecological systems has made the computer-based modeling approach a tool for understanding the evolving processes and future conditions (Alter, 2004; Pyke *et al*., 2007). These include remote sensing and global positioning systems and discussion support or a dynamic dialogue between researchers and practitioners. As a result, much more powerful, process-visual and spatially implicit decision support systems have been developed. One example is the development of the Invasive Species Forecasting System (ISFS) (Stohlgren *et al*., 2005) that combines USGS science and NASA Earth observations with software engineering to provide regional-scale patterns of invasive species and vulnerable habitats. Similarly, in the Yellow River, the second largest drainage basin of China, low-flow seasons caused the lower channel to dry up and forced governments to develop a basin-scale decision support system (Li and Li, 2009). The European Spatial Planning Adapting to Climate Events

Project (ESPACE) asserts that that urban planning contributes to adaptive efforts by uutilizing tools for adaptation through both conventional and green infrastructure and design (porous surfacing, green roofs, etc.) (ESPACE, 2008).

15.4.2.2. Communication Tools

There are a wide range of communication tools that can play an important role in adaptation implementation. These tools include brochures, bulletins, posters, magazines, policy briefs, videos, TV and radio broadcasts, internet, and many more that are being employed to carry out multi-way participatory dialogues. These provide avenues for communication among information developers (e.g. scientists, trainers, project implementers, government agencies, etc.) and community members, groups at risk, etc., who also influence the nature of information disseminated. At the local level, interactive strategies include theater, role-playing, music, learning-by-doing, hands-on exercises. There are also group discussions of community members to debate climate risks and possible solutions to cope with impacts that positively affect behavior and practices. Reports, concept notes, brochures, magazines, presentations and workshops provide a more effective tool to communicate with policy makers at local and national levels. At country/regional level, broad dissemination channels such as TV, radio and internet broadcast, and high-level summits, have been effective in creating widespread awareness as demonstrated in Advancing Capacity for Climate Change Adaptation (ACCCA) project (http://www.acccaproject.org/accca/), UK Climate Impacts Program (UKCIP) (Pringle, 2011) and the SREX report (IPCC, 2012).

To assist the syntheses, a variety of rule- or matrix-based methods has been applied for screening adaptation options such as relative cost-effectiveness of alternative adaptation measures (Benioff and Warren, 1996), and for adaptive opportunities for coastal zone management (Uljee *et al.* 1999). Greater emphasis on user interaction, sensitivity analysis and capabilities currently provides more effective visualization and customized reports (Sarewitz *et al.*, 2000; Sarewitz, 2004). Multi-criterion and multi-actor participatory approaches allow users to consider alternative adaptation strategies and evaluate tradeoffs, typically in the development of tools for environmental assessment and management (Julius and Scheraga, 2000).

15.4.2.3. Early Warning and Information Systems

Monitoring and early warning systems (EWS) have long-played important roles in helping in adjustment, and adaptation especially on the local scale. The disaster research community has shown that successful warnings of impending events are those that are complemented by information on the risks actually posed by the hazards, but also the potential strategies and pathways to mitigate damage within a particular context (Drabek, 1999; UNISDR, 2006). The use of climate data analyses and projections in early warning and information systems is an important and established mechanism to inform disaster risk mitigation (Pulwarty and Verdin, 2013) or climate-related health risks (see 11.7.3). It helps to ensure the link between generation and application of climate knowledge for management of climate-related risks and CCA. In this regard, interest in climate services in growing in many countries (see 2.4.1).

EWS include a diversity of approaches. These range from technological advances systems satellite information and climate modeling (UNISDR, 2006; Smith *et al.*, 2009; Bierbaum *et al.*, 2013), to local level early warning based on traditional knowledge needed to develop and inform strategic responses options in adaptation planning and implementation. The value of local knowledge can be complemented with scientific climatic data, research and planning tools (GIS, modeling, etc.) to strengthen community-based monitoring and vulnerability assessment in disaster risk management and adaptation to climate change (Green and Raygorodetsky, 2010; Kalanda-Joshua *et al.*, 2011; Newsham and Thomas, 2011; Nakashima *et al.* 2012).

Current science and technology do not resolve the uncertainties in modeling, and in the response of ecosystems to climate change and management interventions at levels needed for probabilistic early warning, the need for precise climate information is often overstated (Smith *et al.*, 2009). The long-standing experience with climate extremes and variability offers many usable lessons in spite of these uncertainties. The impacts of climate change will be most strongly felt by resource insecure populations, who are more vulnerable to changes in the distribution and magnitude

of extreme weather and climate events, as these affect crops, disease outbreaks and soil and water quality. The diverse type of EWS in developed and developing countries are valuable tools that could help societies develop strategies to cope and adapt to climate-related risks.

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Box 15-1. Examples of Tools and Measures

Conventional and Green Infrastructure

- Large investment has been made on engineered structure to protect coastal areas against climate-related events. In New York City, infrastructure adaptation strategies to climate change include both hard and soft measures. Hard structures in the New York City region include seawalls, groins, jetties, breakwaters, bulkheads, and piers, but these have not yet been strengthened and elevated over time in response to projected rates of sea-level rise (Gornitz, 2001). Storm-surge barriers have been recommended to protect against high water (Aerts *et al*., 2009; Zimmerman and Faris, 2010). Such barriers are also used in the Thames in London (UK Environment Agency, 2010; see Box 5-1) and Rotterdam (Aerts *et al*., 2009). Soft measures involve wetland and dune restoration, beach nourishment, enhancement and expanding the Staten Island Bluebelt - a stormwater management system to other areas (NYCDEP, 2008).
- In the Netherlands, during the second half of the twentieth century, large structures had been built to protect the coastal area (Kabat *et al*., 2009). To keep the country flood-proof over the 21st century, an estimated total cost of implementing of a new ambitious plan is €2.5-3.1 billion a year to 2050, representing a 0.5% of the current Dutch annual GDP (Stive *et al*., 2011). The new plan is a paradigm shift which addresses coastal protection "working with nature" and providing "room for river" instead of only "fighting" the forces of nature with engineered structures.
- Development of engineered structures can lead to more GHG emission and potential negative impacts on ecosystems (see 5.5.6). On the contrary, green infrastructure (porous surfacing, green roofs, etc.) have been used in parts of Europe (ESPACE, 2008), Portland, Philadelphia, New York (Foster *et al*., 2011), London (GLA, 2011), Quy Nhon in Vietnam (Brown *et al*., 2012) (see 8.3.3.7).

Use of Information and Communication Technologies

- Information and communication technologies (ICTs) can help strengthen the physical preparedness of livelihood systems for climate change-related events. These can contribute to design of defences and determination of their optimal location, and make the livelihood system more robust. GIS technology was applied to foster the ability of the community to deal with climate change hazards and trends in the Philippines (IAPAD, 2010) and form modelling processes of climate change adaptation which supported regional stakeholders to develop better protection of key spaces in the landscape (Bardsley and Sweeney, 2010). Visualization of sea level rise and climate change damage in Delta in British Columbia, Canada, increased awareness of long-term risks and response challenges to local community, government and the public (Shaw *et al*., 2009).
- By sharing observations and reflections through ICT tools, users foster new ways of assimilating or translating information, which can be shared through wider networks, and then influence action, enabling new experiments/practices to take place. This generation of new and broader learning cycles will in turn strengthen systematic resilience (Ospina and Heeks, 2010). Karanasios (2011) outlines the range of new and emergent ICTs (e.g., wireless broadband, sensor networks, GIS and Web-based tools) being applied to climate change issues, and investigates their use in developing countries.

Other Tools

- Other tools are being used such as insurance (see also 8.4.2, Table 10.8), linking CCA to ICZM (see 5.5.3.) or DRR (see 8.3.2.2), reduction of emissions from deforestation and forest degradation (see 13.3.1.2), using CC scenarios (see Box 14-1), ecosystem-based adaptation (see Box CC-EA, Box 8-2, 22.4.5.6, Figure 22-6), and land-use (see Box 25-10).

_____ END BOX 15-1 HERE _____

15.4.3. Technology Development, Transfer, and Diffusion

Development and diffusion of technologies and management practices will continue to be critical to many adaptation efforts. While a wide range of adaptations are possible with current technologies and management practices, technologies expand the range of adaptation possibilities by expanding opportunities or reducing costs (Smith *et al*., 2009). Technologies related to information collection and diffusion are particularly important for adaptation planning, including technologies for data collection and information dissemination during extreme events and emergencies. Despite remaining uncertainties, technologies to project climate changes, and identify potential impacts and vulnerabilities are frequently seen as precursors to successful adaptation planning. Developing countries require enhanced access to improved climate models, but also adaptation planning tools that focus on robustness in the face of uncertainty (Dessai *et al*., 2009).

Technology choices can both reduce and exacerbate risk, and their use in adaptation planning and implementation requires considering their potential effects (Jonkman *et al*., 2010). For example, technologies can strengthen physical infrastructure, such as bridges and buildings, so that they can withstand more extreme hazards. However, relatively centralized high-technology systems increase efficiency under normal conditions but risk cascading malfunctions in the event of emergencies. In some circumstances, technologies to reduce short-term risk and vulnerability contribute to increased future vulnerability to larger extreme events (Etkin, 1999; Moser, 2010). This was seen in the impacts of Hurricane Katrina on New Orleans, where a flood defense system enabling construction in a floodplain was subject to catastrophic failure in the face of a particularly large extreme event (Freudenburg *et al*., 2008; Link, 2010).

International efforts for technology transfer have been concentrated in the UNFCCC framework's five themes: technology needs and needs assessments, technology information, enabling environments, capacity building, and mechanisms for technology transfer. A key project is developing a technology transfer clearinghouse called TT:CLEAR, and establishing a Technology Centre and Network (UNFCCC, 2012). However, successful technology transfer requires not only exchange of technological solutions, but also strengthening policy and regulatory environments, and capacities to absorb, employ and improve appropriate technologies. In both developed and developing countries, multilateral institutions can support collaboration which engages private interests in regulatory planning and possibly activities, particularly if ongoing funding is expected (Tessa and Kurukulasuriya, 2010).

15.4.4. Insurance and Social Protection

Insurance is widely seen as a cost-effective tool for adaptation planning and implementation for increasing financial resilience, especially when compared to ex-post disaster aid (Warner *et al*., 2009; Linnerooth-Bayer *et al*., 2011). It is in this context that insurance has received the attention of those planning and managing climate adaptation: The IPCC's SREX report (IPCC, 2012) recognizes that risk sharing and transfer mechanisms at local, national, regional and global scales can increase resilience to climate extremes, while for slow-onset impacts it is usually considered unsuitable (Collier *et al*., 2009). The main question is if and how insurance products, particularly natural disaster and agricultural cover, can be designed so that they trigger adaptive behaviour. The insurance price signal is widely considered as the first step in taking risk reduction measures (Fankhauser *et al*., 1999), but it does not imply that action will be taken. In fact those at risk, such as local farmers, may not have the capacity to act because they lack tools, methods or financial means. The role of insurance is also discussed in 10.7 of Chapter 10 in this report.

Many scholars agree on the theoretical potential for insurance to facilitate climate risk reduction through a wide scale of activities, these include awareness raising, sharing of modelling and risk mapping data and tools, to providing economic incentives for risk reduction and by mandating adaptation as a condition for granting insurance (Crichton, 2008; Suarez and Linnerooth-Bayer, 2011; Surminski and Oramas-Dorta, 2011; Paudel, 2012). Evidence of how this is successfully achieved is limited to private insurance and reinsurance companies, scientists and governments aiming at adaptation – most notably through sector initiatives such as ClimateWise and UNEPFI's Insurance Working Group (Mills, 2004).Existing insurance schemes for flooding in the US (Michel-Kerjan and Kunreuther, 2011) and the UK (Ball *et al*., 2013) show the challenges of fostering risk reduction through insurance.

Those two schemes are on opposite ends of a broad scale – the US National Flood Insurance Program being a public sector scheme, while the UK's flood insurance is provided by a private insurance market. Both systems struggle with the implementation of risk based pricing as the guiding principle of insurance. Picard (2008) highlights the trade-off between the effectiveness of risk based pricing and equity – as those most vulnerable struggle to pay for risk-based premiums. Public-private partnerships may be able to assist through premium subsidies, or broader collaboration on risk management, as seen in the case of the UK's flood insurance.

The use of insurance to manage extreme weather events varies across the world, with penetration of insurance cover mainly determined by income levels (Ranger and Surminski, 2012) with insurance in most low- and middle-income countries still in its infancy (Churchill, 2007; Warner *et al*., 2009). Demand-side limitations include access to and affordability of cover, desirability of products and financial literacy (Linnerooth-Bayer *et al*., 2011).

Over the last decade, risk transfer schemes have been developed in low-income countries, often run as pilot-projects between the private sector and public authorities. Analysis of the existing disaster risk transfer activities in low- and middle-income countries indicates that the potential for utilizing risk transfer for risk reduction is far from exhausted, with only very few schemes showing an operational link between risk transfer and risk reduction (Surminski and Orama-Dorta, 2011; IPCC, 2012, p.355;). Some innovative efforts are currently being tested to address these challenges, such the ENSO insurance scheme in Peru, an index-based forecast insurance that pays out on the basis of a seasonal forecast, giving policyholder the opportunity to use the pay-out for preventive measures, such as the purchase of drainage cleaning machinery or to improve transport infrastructure or adjust cash flows in anticipation of possible income reduction (GIZ, 2012). A regional insurance system is also an innovative tool for sharing disaster risks among participating countries. For example, the Caribbean Catastrophic Risk Insurance Facility (CCRIF) was established as a risk pooling facility, attended by sixteen countries, to limit the financial impact of catastrophic hurricanes and earthquakes to Caribbean governments by quickly providing short term liquidity. Another approach is the agricultural insurance scheme in Sudan, where farmers are required to adopt more resilient farming practices to gain access to the risk transfer scheme and the Horn of Africa Risk Transfer for Adaptation (HARITA) scheme in Ethiopia (Oxfam, 2009).

15.5. Governance for Adaptation Planning and Implementation

15.5.1. Institutional Dimensions for Planning and Implementing Adaptation

15.5.1.1. Importance of Institutional Dimensions

Since the AR4 findings on substantial barriers to mainstreaming adaptation and suggested research challenges in further understanding adaptation processes of mainstreaming adaptation (Adger *et al*., 2007), academic literature identifying drivers and barriers to climate adaptation planning and implementation has increased. A recent review has shown that more than 200 context dependent barriers have been identified in 81 peer-review papers, mostly but not exclusively based on small-n inductive case studies (Biesbroek *et al*., 2013). The message from the literature is clear; adaptive capacity signals potential but does not guarantee adaptive action (O'Brien *et al*., 2006; Adger and Barnett, 2009; Burch, 2010; Tompkins *et al*., 2010). While there is growing recognition that adaptation planning is essential (Ayers and Huq, 2009; Wilbanks and Kates, 2010; Ford *et al*., 2011), research reporting on planning and implementation have increased appreciation of the magnitude of the institutional dimension for limiting or enabling the mainstreaming of climate adaptation (Moser and Ekstrom, 2010; Berkhout, 2012; Biesbroek *et al*., 2013). Several studies, in different settings e.g. river basin management in Brazil (Engle and Lemos, 2010), municipalities in Canada (Burch, 2010) and Australia (Measham *et al*., 2011), villages in Western Nepal (Jones and Boyd, 2011), and pastoralist groups in Kenya (Eriksen and Lind, 2009; Robinson and Berkes, 2011; Adhikari and Taylor, 2012) illustrate such difficulties. Adaptation studies, targeting specifically how institutional dimensions limit or enable the mainstreaming of climate change considerations in policy-making, planning and decision-making at different levels and in different sectors, has grown in number (Crabbé and Robin, 2006; Koch *et al*., 2007; Roberts, 2008; Bulkeley *et al*., 2009; Engle and Lemos, 2010; Glaas *et al*., 2010; van den Brink *et al*., 2011; Storbjörk and Hedrén, 2011; Huntjens *et al*., 2012; Termeer *et al*., 2012; Glaas and Juhola, 2013).

Institutions are comprised of tangible formal procedures, laws and regulations and tacit informal values, norms, traditions, codes and conducts that shape expectations and guide actions among actors and organizations, serving as manifestations of institutions (Ostrom, 1990; Dovers and Hezri, 2012). Adaptation planning and implementation follows formal institutions associated with regulations, policies, and standards created and enforced by government actors but also requires the participation of informal institutions through interactions among stakeholders according to cultural, social, and political conditions in societies (Moser and Satterthwaite, 2008; Carmin *et al*., 2012). Chapter 14 describes the importance of these institutional frameworks for adaptive capacity. Chapter 16 presents a framework for adaptation, opportunities and limits, where governance and institutional arrangements are included. This section assesses the literature on how institutional dimensions limit or enable adaptation planning and implementation and what lessons can be learned from these experiences.

15.5.1.2. Institutional Barriers

While the literature clearly states that institutional dimensions may both enable and limit adaptation planning and implementation, the literature referred to in Section 15.5.1.1 have so far mostly reported on how current institutional arrangements restrict the mainstreaming of climate adaptation. Biesbroek *et al*. (2013) have stated that although studies in developed countries are more common and comparative approaches of institutional dimensions, exploring differences and similarities in different countries, are rare, institutional dimensions are highlighted for both developing and developed countries. Low-income developing countries report on weak institutional environments and middle and high income countries emphasize institutional barriers that prevent the mobilization of adaptive capacity. Barriers in general are seen as dynamic and context dependent across sectoral, spatial and temporal scales, meaning that how a particular institutional barrier operates to either strengthen or limit adaptation planning and implementation can vary both between and within countries, depending on case study locations. Also, the importance and severity of each barrier to the proposed change supposedly changes over time and interacts with other constraints (Burch, 2010; Moser and Ekstrom, 2010; Biesbroek *et al*., 2013). Barriers are also shown to differ in different stages of planning and implementation, e.g. initial problem framing and agenda setting, planning and strategy-making, implementation, monitoring and evaluating, which studies have increasingly made clear (Moser and Ekstrom, 2010; Mees *et al*., 2012; Dannevig *et al*., 2012). The following sections illustrate five of the most commonly emphasized barriers or enablers of institutional change.

First, the importance of multilevel institutional coordination between different political and administrative levels in society is increasingly cited in both developing and developed countries as challenging (Few *et al*., 2007; Urwin and Jordan, 2008; Corfee-Morlot *et al*., 2009; Keskitalo, 2009; Pahl-Wostl, 2009; Measham *et al*., 2011; Robinson and Berkes, 2011; Sietz *et al*., 2011; Nilsson *et al*., 2012; Rodima-Taylor *et al*., 2012; Glaas and Juhola, 2013). Several studies report on unclear roles and responsibilities between levels and actors inhibiting climate adaptation. They show that there are few national requirements or guidelines to help local governments approach climate adaptation, stressing the importance of developing regulations, policies, and codes to support the institutionalization of local climate actions (Næss *et al*., 2005; Crabbé and Robin, 2006; Storbjörk, 2007; Glaas *et al*., 2010; Mozumder *et al*., 2011; Adhikari and Taylor, 2012; Carmin *et al*., 2012; Hedensted Lund *et al*., 2012; Peach Brown *et al*., 2013). Vammen Larsen *et al*. (2012) stress that climate change does not possess clear institutional characteristics as a municipal professional area. Rather, it is viewed as a void with no clear rules and norms according to which politics is to be conducted and policy measures agreed upon. This has meant that climate adaptation remains ad hoc and based on processes of "muddling through" in a sense that increases risks of failure (Preston *et al*., 2011).

Further, the literature shows that the lack of clear national agendas and incentives may burden local governments differently, based on their different capacities (Juhola and Westerhoff, 2011; Anguelovski and Carmin, 2011; Dannevig *et al*., 2012). Authors have also cautioned against a too heavy emphasis on national guidance, suggesting that centralized approaches may in some cases constrain local initiatives and create unfortunate dependencies. Instead a combination of top-down and bottom-up activities is proposed where national actors sets a proactive agenda for climate adaptation and supports implementation that occurs at sub-national levels (Urwin and Jordan, 2008; Bulkeley *et al*., 2009; Preston *et al*., 2013). Connected to this question of guidance and support is also a large strand of research showing that simply producing more and better knowledge is not sufficient. This illustrates the role of knowledge-brokers, policy entrepreneurs, and bridging organizations to communicate and mediate the co-

production of knowledge between science and practice and make climate knowledge consistent and credible at appropriate decision-making scale (Tribbia and Moser, 2008; Tompkins *et al*., 2010; Mozumder *et al*., 2011; Amundsen *et al*., 2010).

Second, the literature show that key actors, advocates and champions are decisive for initiating, mainstreaming and sustaining momentum for climate adaptation planning and implementation in different national settings (Bulkeley *et al*., 2009; Burch, 2010; Moser and Ekstrom, 2010; Tompkins *et al*., 2010; Garrelts and Lange, 2011; Runhaar *et al*., 2012; Romero-Lankao, 2012). Key actors can be particularly important in the absence of strong national level (Anguelovski and Carmin, 2011; Dannevig *et al*., 2012). Champions further involve actors in different roles, from junior staff to senior executives and elected representatives (Measham *et al*., 2011). The literature on leadership have distinguished between different types of leadership, where visionary leadership means showing direction and motivating others, entrepreneurial leadership means ability to get things done and, finally, collaborative leadership means bridging gaps, spanning boundaries and building coalitions (Gupta *et al*., 2010; van den Brink *et al*., 2011). Although there is wide agreement that leaders are key for driving change, a dependency on personal commitments and dedication of key individuals may render adaptation planning and implementation fragile if it takes place at the prize of organizational learning (Næss *et al*., 2005; Crabbé and Robin, 2006; Storbjörk, 2010).

Third, the horizontal interplay between actors and policies operating at similar administrative levels is seen as key in institutionalizing climate adaptation. Several international studies have shown that local governments and administrations consists of different professional silos with their own internal norms, values and priorities and that the institutional rigidity of existing administrative and political sectors creates unfortunate compartmentalization where climate adaptation is seen as the isolated task of a singular sector which may hinder the mainstreaming and horizontal coordination across sectors and departments (Mickwitz *et al*., 2009; Burch, 2010; Roberts, 2010; Storbjörk, 2010; Runhaar *et al*., 2012; Vammen Larsen *et al*., 2012; van den Berg and Coenen, 2012; Wilby and Keenan, 2012;). Preston *et al*. (2011) have determined that adaptation plans from Australia, the UK and the US, largely frame adaptation in a narrow sense overlooking the capacity and institutional challenges involved in the process of mainstreaming in other sectors. Institutional rigidity also takes the form of path dependency where past policies, decisions, habits and traditions, constrain the extent to which systems can learn or adapt to climate change (Garrelts and Lange, 2011; Berkhout, 2012; Preston *et al*., 2013; Runhaar *et al*., 2012). Some authors have identified such cultures of reactive management or structural engineered approaches to climate adaptation negatively influencing institutional change (Næss *et al*., 2005; Measham *et al*., 2011; Harries and Penning-Rowsell, 2011). Several writers have emphasised the need to facilitate improved cross-sectoral interaction, exchange and organizational learning to drive institutional change (Berkhout *et al*., 2006; Crabbé and Robin, 2006; Pelling *et al*., 2008; Hinkel *et al*., 2009; Burch, 2010). How cross-sectoral coordination is achieved in practice, remains one of the major challenges in transitioning for planning to implementation.

Fourth, the need to acknowledge political dimensions in planning and implementation are highlighted in several studies, both in developing and developed countries. Studies indicate that politicians have not recognized climate adaptation as being politically urgent enough to elevate on the policy agenda. Subsequently they identify a tendency to prioritize other political concerns, often more short-term tangible issues (O'Brien *et al*., 2006; Storbjörk, 2007; Glaas *et al*., 2010; Corfee-Morlot *et al*., 2011; Measham *et al*., 2011; Runhaar *et al*., 2012; Preston *et al*., 2013). This has implications for the availability of resources and financial means in the form of staff and time (Tribbia and Moser, 2008). Other studies document competing values, conflicting objectives, tensions and trade-offs between different policy agendas and priorities in planning and implementing climate adaptation (Næss *et al*., 2005; Berkhout *et al*., 2006; Adger *et al*., 2009a; O'Brien and Wolf, 2010; Measham *et al*., 2011; Storbjörk and Hedrén, 2011). In a developing country context, a study in the drylands of Kenya call for increased consideration of political dimensions of local adaptation by showing how power relations at multiple geographic scales and interaction of informal institutions e.g. clans and spiritual leaders and government institutions shape the local negotiation of conflicting interests (Eriksen and Lind, 2009).

Fifth, improved coordination between formal governmental and administrative agencies and private stakeholders is highlighted in the literature. Private sector involvement is often seen as a way to increase the efficiency of climate adaptation (Engle and Lemos, 2010; Mees *et al*., 2012; Tompkins and Eakin, 2012). As part of highlighting private sector involvement, studies from developing and developed countries emphasize the need for stakeholder

participation, representation, accountability, and equality to influence the sharing and shaping of knowledge in adaptation decision-making and achieve change on the ground (Gupta *et al*., 2010; Harries and Penning-Rowsell, 2011; Robinson and Berkes, 2011; Adhikari and Taylor, 2012; Huntjens *et al*., 2012; McNeeley, 2012; Tompkins and Eakin, 2012;). Participatory approaches potentially allow maintaining regard for the highly localized and contextual nature of climate adaptation, balance standardization and context in adaptation planning and implementation and bolster support for and facilitate implementation (Preston *et al*., 2011; Mees *et al*., 2012). Elaborate forms of participatory designs for facilitating a co-production of knowledge, interactive learning and stakeholder exchange, mediated by boundary organizations and knowledge brokers, is being undertaken but more are needed (Pahl-Wostl, 2009; Pulwarty *et al,* 2009; Tompkins *et al*., 2010; Jonsson *et al*., 2012). At the same time authors clarify that stakeholders can hold private, sectarian interest and represent local elites, meaning that which voices actually get represented is an important issue (Romero-Lankao, 2012). Studies in Western Nepal have documented obstacles to political inclusion due to social status and caste-based political discrimination where societal elites suppress marginal voices (Jones and Boyd, 2011). Other studies have documented how existing centralized top-down institutions have been complemented and sometimes challenged by public-private partnerships at critical stages in implementation (Juhola and Westerhoff, 2011; Rodima-Taylor *et al*., 2012).

15.5.1.3. Facilitating More Effective Climate Adaptation Planning and Implementation

Although Section15.2 shows that international studies clearly report a large number of ongoing responses to support climate adaptation, which are most commonly incremental responses within existing institutional arrangements (with some rare examples of institutional transformations), there is a large body of evidence of the mainstreaming of climate adaptation resulting in limited implementation. Subsequently most studies on climate adaptation planning and implementation have focused on identifying barriers and challenges. Biesbroek *et al.* (2013) have suggested to move forward in our current context specific and fragmented understanding of barriers, including institutional dimensions, and embrace comparative approaches, synthesizing knowledge and analyzing barriers more systematically. Recent discussions suggest focusing more attention on how to transform barriers to enablers of action and institutional change (Burch *et al*., 2010; Moser and Ekstrom, 2010; Park *et al*., 2012; Biesbroek *et al*., 2013). Dovers and Hezri (2010) have claimed that there is a predominant focus in adaptation research on what should happen rather than how that might be achieved, the latter targeting strengths and weaknesses with different forms of institutional structures, procedures and ways of organizing climate adaptation that supports change. Others have suggested that monitoring and evaluating the effectiveness of strategies adopted and interventions undertaken needs further attention (Mullan *et al*., 2013). Further, it is suggested that propositions for change tend to be driven by theory rather than empirically substantiated and tested and that the adaptation literature would benefit by embracing lessons and experiences of mechanisms for enabling institutional change gained in other policy sectors and past policy interventions (Dovers and Hezri, 2010; Biesbroek *et al*., 2013).

15.5.2. Increasing Capabilities

Governance of adaptation creates the space and conditions for achieving specific goals or collective outputs by aligning principles and norms for regulations, decision making procedures and organizations in providing an overarching system to comprehensively address a challenge (Biermann *et al*., 2009; Young, 2010; DeWulf *et al*., 2011). However, the embryonic stage of adaptation planning and implementation faces challenges to develop governance approaches (Glaas *et al*., 2010; Gupta *et al*., 2010; Tompkins *et al*., 2010; Carmin *et al*., 2012; Huntjens *et al*., 2012; Rodima-Taylor *et al*., 2012; Mukheibir *et al*., 2013). The previous section on the institutional dimensions of adaptation in this chapter stressed the obstacles in current structures of national, subnational, and local governments to address complex and multidimensional problems (Wilson, 2006; Koch *et al*., 2007; Roberts, 2008; Bulkeley *et al*., 2009; Inderberg and Eikeland, 2009; Engle and Lemos, 2010; Glaas *et al*., 2010; Sietz *et al*., 2011; Storbjörk and Hedrén, 2011; van den Brink *et al*., 2011; Huntjens *et al*., 2012; Rodima-Taylor *et al*., 2012; Termeer *et al*., 2012; Vammen Larsen *et al*., 2012; Glaas and Juhola, 2013). Similar fragmented approaches for adaptation planning and implementation also hinder a dynamic and diverse participation of other stakeholders in these processes (Folke *et al*., 2005; Raschky, 2008; Urwin and Jordan, 2008; Coles and Scott, 2009; Dessai *et al*., 2009; Handmer, 2009; Scheffer, 2009; Nath and Behera, 2010; Reid *et al*., 2010; Sissoko *et al*., 2011). Additionally,

there have been very few documented changes in forecasts, plans, design criteria, investment decisions, budgets or staffing patterns in response to climate risks (Repetto, 2008; Tompkins *et al*., 2010; Berrang-Ford *et al*., 2011).

Expanding and improving capabilities of stakeholders strengthen operational approaches for adaptation to climate change at different levels. The literature recognizes four areas where improved capabilities can facilitate this creation of governance approaches for adaptation planning and implementation: creating learning processes incorporating various knowledge systems and experiences to facilitate developing a common understanding and policies critical for cross-institutional coordination and multi-stakeholders actions (Engle and Lemos, 2010; Huntjens *et al*., 2012); enhancing monitoring and evaluation of adaptation planning and implementation currently limiting opportunities for learning and improvement of current and future adaptation initiatives (Manuel-Navarrete *et al*., 2009; Preston *et al*., 2011; Nilsson *et al*., 2012); improving cross level coordination within government structures at the national, subnational, and local level (Urwin and Jordan, 2008; Bulkeley *et al*., 2009; Amundsen *et al*., 2010; Robinson and Berkes, 2011; Preston *et al*., 2013); enhancing the participation of stakeholders from the assessment of vulnerability to the design and implementation of operational approaches of adaptation (Moser and Satterthwaite, 2008; Anguelovski and Carmin, 2011; Carmin *et al*., 2012; Dannevig *et al*., 2012).

These interacting aspects strengthen incorporating climate change risks to systems and sectors, and the corresponding response planning and implementation actions occurring at different spatial and temporal scales. The help improving mechanisms to foster and strengthen coordination in the scale of governance together with a clear division of tasks and responsibilities of actors, especially under conflicting timescales of interventions (Koch *et al*., 2007; Amundsen *et al*., 2010; Biesbroek *et al*., 2010; Biesbroek *et al*., 2011). They can also support addressing jurisdictional scales and mandates across sectors, and local, national and sub-national policies, constricting the potential benefits of close dependencies between institutions, institutional systems and organizational units in planning and implementation of adaptation (Dovers and Hezri, 2010).

Creating capabilities to through coordination is reported to expand the adaptive capacity of local actors and enhancing opportunities for policy formulations of larger governance networks and learning opportunities for policy formulations (Keskitalo and Kulyasova, 2009; Owen, 2010). Capturing various perspectives of multiple stakeholders and actors holding different views, power and influence, is pivotal in mutually achieving short-term and long-term adaptation needs to climate change (O'Brien *et al*., 2008; Shaw *et al*., 2009; Bardsley and Sweeney, 2010; IAPAD, 2010; Corfee-Morlot *et al*., 2011). Capabilities to enhance and complement the value of local knowledge through scientific knowledge can become a useful source of community-based adaptation planning and implementation (McLeman *et al*., 2008; Green and Raygorodetsky, 2010; Berrang-Ford *et al*., 2011; Birkmann, 2011; Ford *et al*., 2011; Newsham and Thomas, 2011; Nakashima *et al*., 2012).

Increasing capabilities for adaptation planning and implementation can also benefit from approaches with greater emphasis on nature-based protection strategies or buffers. Related climate change adaptation efforts also improve ecosystem resilience by implementing sustainable forestry management, expanding floodplain setbacks, implementing coastal aforestation, coral reef propagation, restoring degraded lands, maintaining healthy vegetation on slopes, incentivizing development away from coastal areas and bluffs, and removing barriers to the migration of plants and animals, all of which are necessary for the resilience of communities facing climate change impacts (Tobey *et al*., 2010; Sovacool *et al*., 2012).

15.6. Research Needs for Maximizing Opportunities

The following interrelated research needs extracted from the chapter can create and maximize opportunities for adaptation planning and implementation.

The emphasis on impacts and defensive infrastructure has been documented in a number of early adaptation plans (Few *et al*., 2007; Hofstede, 2008; Mitchell *et al*., 2010; Garrelts and Lange, 2011; Harries and Penning-Rowsell, 2011; Rosenzweig *et al*., 2011; Rumbach and Kudva, 2011; Etkin *et al*., 2012; IPCC, 2012). Research on the design and implementation of these plans and the lessons that can be extracted from them can help address concerns in the literature that an impact approach can overshadow the analysis of underlaying stressors of hazards, the drivers of

vulnerability, and opportunities for connecting development pressures and climate change (Lemos *et al*., 2007; Sabates-Wheeler *et al*., 2008; Orlove, 2009; Boyd and Juhola, 2009; Hulme *et al*., 2009; Hardee and Mutunga, 2010; Ribot, 2010; Rumbach and Kudva, 2011; Sietz *et al*., 2011). These lessons can help balance the design of adaptation planning including projects for defensive infrastructures needed through flexibility and safety margins and at the same time incorporating other actions seeking to reduce social vulnerability and enhancing adaptation. Relevant in these efforts is building a better understanding of how early adaptation plans can transcend from defensive but fragmented approaches, to multidimensional policy process recognizing adaptation planning and its implementation as learning processes (Hulme *et al*., 2009; Biesbroek *et al*., 2011).

Research on operational strategies and approaches for adaptation can help maximizing available resources for adaptation to climate change. Current contributions in the literature help build a better understanding on diverse dimensions of this complex process, but these contributions have provided little attention to the discussion and suggestion of guidelines to build operational approaches. Some authors stress that few studies show hoWadaptation to climate change is actually being delivered (Arnell, 2010; Tompkins *et al*., 2010; National Research Council, 2011). Key elements in these research efforts are: expanding the understanding the knowledge on the connections between adaptation and development in different context and at different governance levels (Boyd and Juhola, 2009; Dovers, 2009; Hulme *et al*., 2009); the role of multiple stresses - not just climate- in adaptation planning and its implementation (IPCC, 2007; Tompkins *et al*., 2010); the role of low-regret strategies strengthening operational approaches for adaptation (Hallegatte, 2009; UNDP, 2010).

Section 15.5.1 highlights how limitations of current institutional arrangements restrict the mainstreaming of climate adaptation (Roberts, 2008; Burch, 2010; Engle and Lemos, 2010; Glaas *et al*., 2010; Moser and Ekstrom, 2010; Jones and Boyd, 2011; Robinson and Berkes, 2011; Storbjörk and Hedrén, 2011; Dannevig *et al*., 2012; Dovers and Hezri, 2012; Huntjens *et al*., 2012; McNeeley, 2012; Vammen Larsen *et al*., 2012; Glaas and Juhola, 2013; Biesbroek *et al*., 2013). Expanding research on institutional arrangements in at least three key areas can help improve the implementation of adaptation plans in both developed and developing countries, 1) on approaches to improve multilevel institutional coordination between different political and administrative levels in society with a particular emphasis balancing a combination of top-down and bottom-up activities (Urwin and Jordan, 2008; Bulkeley *et al*., 2009; Amundsen *et al*., 2010; Robinson and Berkes, 2011; Preston *et al*., 2013); 2) on approaches to overcome the institutional rigidity limiting the horizontal interplay within local governments where climate adaptation is seen as the isolated task of a singular sector which hindering the mainstreaming and horizontal coordination across professional sectors and departments and constraining the extent to which systems can learn or adapt to climate change (Bulkeley *et al*., 2009; Burch, 2010; Dovers and Hezri, 2010; Glaas *et al*., 2010; Storbjörk, 2010; Juhola and Westerhoff, 2011; Hedensted Lund *et al*., 2012; Runhaar *et al*., 2012; Uittenbroek *et al*., 2012; van den Berg and Coenen, 2012; Wilby and Keenan, 2012); and 3) on approaches improving coordination between formal governmental and administrative agencies and social and private stakeholders in order to create participatory approaches maintaining regard for the highly localized and contextual nature of climate adaptation, and facilitating a collaboration for production of knowledge and interactive learning (Pahl-Wostl, 2009; Engle and Lemos, 2010; Tompkins *et al*., 2010; Preston *et al*., 2011; Jonsson *et al*., 2012; Mees *et al*., 2012).

The literature illustrates a trend to consider planning a problem-free process capable of delivering positive outcomes for adaptation to climate change. Expanding research seeking to build a better understanding of the limitations and strengths of planning can help avoid underestimating the complexity of adaptation as a social process, and creating unrealistic expectations in societies about the capacity of planning to deliver the intended outcome of adaptation. (Repetto, 2008; Biesbroek *et al*., 2009; Blanco and Alberti, 2009; Dovers, 2009; Berrang-Ford *et al*., 2011; Juhola and Westerhoff, 2011; Mozumder *et al*., 2011; Preston *et al*., 2011; Sanchez-Rodriguez, 2012). Research efforts considering adaptation planning and implementation as learning processes can help carrying out periodical adjustments to accommodate changes in climate, socioeconomic conditions and emergent risks in order to strengthen the role of planning as a societal tool for adaptation (Holden, 2008; Frommer, 2009; Hinkel *et al*., 2009; Glaas *et al*., 2010; Hofmann *et al*., 2011). The literature recognizes monitoring and evaluation as important learning tools in adaptation planning but it also acknowledges both as under-researched topic (Adger *et al*., 2009b; Preston *et al*., 2009; Tompkins *et al*., 2010; Wolf *et al*., 2010). Expanding the research on the metrics tocharacterize the success of the goals of adaptation, the trade-offs involved, and recognizing the importance of context can help avoid generalized assessments about the contribution of adaptation to managing the risks posed by climate change, and to

identify what builds adaptive capacity and what functions as limits and barriers to adaptation (Barnett and Campbell, 2010; Arnell, 2010; Engle, 2011).

Adaptation planning and implementation can benefit from holistic approaches afforded by linking adaptation to development, by coupling adaptive improvements in infrastructure with ecosystem services, governance and community welfare, improved community resilience by enhancing local ownership, and created organizations able to respond to climate change issues through increased adaptive capacity.

Frequently Asked Questions

FAQ 15.1: What is the present status of climate change adaptation planning and implementation across the globe? *[to remain at the end of the chapter]*

Climate change adaptation has been receiving increasing attention due to recent media coverage and reports. Since the publication of the IPCC Fourth Assessment Report (AR4), a large assortment of adaptive actions has taken place in response to observed climate impacts. These actions mostly address sectoral interests, such as agricultural practices (e.g., altering sowing times, crop cultivars and species, and irrigation and fertilizer control), public health measures for heat-related risks (e.g., early warning systems and air pollution control), disaster risk reduction (e.g., early warning systems), and water resources (e.g., supply and demand management). Some of these are "autonomous" actions in a specific sector.

Another area where progress has been made since AR4 is the development of broad national-level plans and adaptation strategies. These have now been established in developed and developing countries worldwide. Because adaptation policy requires decision-making amid uncertainties about future climate change and its impacts, the major pillars of adaptation plans are iterative assessment, flexible and adaptive planning, and enhancement of adaptive capacity. Adaptation plans are being developed and documented at the national, subnational, and community levels and by the private sector; however, these is still limited evidence of adaptation implementation. Implementation remains challenging because in the transition from planning to implementation the many interested parties must overcome resource, institutional, and capacity barriers. The difference in time scales between medium- and long-term adaptation plans and pressing short-term issues poses a significant problem for prioritizing adaptation.

In parallel with national-level planning, community-based adaptation (CBA) has become an increasingly prevalent practice, particularly in developing counties. It is increasingly apparent that CBA potentially offers ways to address the vulnerability of local communities by connecting climate change adaptation to non-climate local needs. Cities and local governments have also begun active engagement in climate change adaptation. Local governments play an important role in adaptation because they directly communicate with affected communities. For the past several years, leading practices have begun in New York City, Mexico City, Toronto, Albay Province in the Philippines, and elsewhere. These achievements were possible because of elected and local leadership; cooperation among national and local governments, private sectors, and communities; and the participation of boundary organizations, scientists and experts.

FAQ 15.2: What types of approaches are being used in adaptation planning and implementation? *[to remain at the end of the chapter]*

Adaptations employ a diverse portfolio of planning and practices that combine subsets of

- Infrastructure and asset development
- Technological process optimization
- Institutional and behavioral change or reinforcement
- Integrated natural resources management (such as for watersheds and coastal zones)
- Financial services, including risk transfer
- Information systems to support early warning and proactive planning

Although approaches vary according to context and the level of government, there are two general approaches observed in adaptation planning and implementation to date: top-down and bottom-up. Top-down approaches are scenario-driven and consist of localizing climate projections, impact and vulnerability assessments, and formulation of strategies and options. National governments often take this approach. National adaptation strategies are increasingly integrated with other policies, such as disaster risk management. These tendencies lead to adaptation mainstreaming, although there are various institutional barriers to this process. As the consideration of the social

dimensions of climate change adaptation have attracted more attention, there has been an increased emphasis on addressing the needs of the groups most vulnerable to climate change, such as children, the elderly, disabled, and poor. Bottom-up approaches are needs-driven and include approaches such as community-based adaptation (CBA). CBA is often prominent in developing countries, but communities in developed countries also use this approach. Where a combination of top-down and bottom-up activities have been undertaken, the links between adaptation planning and implementation have been strengthened. In either approach, participation by a broad spectrum of stakeholders and close collaboration between research and management have been emphasized as important mechanisms to undertake and inform adaptation planning and implementation.

Local governments and actors may face difficulties in identifying the most suitable and efficient approaches because of the diversity of possible approaches, from infrastructure development to "softer" approaches such as integrated watershed and coastal zone management. National and subnational governments play coordinating roles in providing support and developing standards and implementation guidance. Therefore, multilevel institutional coordination between different political and administrative levels is a crucial mechanism for promoting adaptation planning and implementation.

Cross-Chapter Box

Box CC-EA. Ecosystem Based Approaches to Adaptation - Emerging Opportunities

[Rebecca Shaw (USA), Jonathan Overpeck (USA), Guy Midgley (South Africa)]

Ecosystem-based adaptation (EBA) integrates the use of biodiversity and ecosystem services into climate change adaptation strategies (e.g., CBD, 2009; Munroe et al., 2011; see Chapters 3, 4, 5, 8, 9, 13, 14, 15, 16, 19, 22, 24, 25, and 27). EBA is implemented through the sustainable management of natural resources and conservation and restoration of ecosystems, to provide and sustain services that facilitate adaptation both to climate variability and change (Colls et al., 2009). It also sets out to take into account the multiple social, economic, and cultural co-benefits for local communities (CBD COP 10 Decision X/33).

EBA can be combined with, or even a substitute for, the use of engineered infrastructure or other technological approaches. Engineered defenses such as dams, sea walls and levees adversely affect biodiversity, potentially resulting in maladaptation due to damage to ecosystem regulating services (Campbell et al., 2009; Munroe et al., 2011). There is some evidence that the restoration and use of ecosystem services may reduce or delay the need for these engineering solutions (CBD, 2009). EBA offers lower risk of maladaptation than engineering solutions in that their application is more flexible and responsive to unanticipated environmental changes. Well-integrated EBA can be more cost effective and sustainable than non-integrated physical engineering approaches (Jones et al., 2012), and may contribute to achieving sustainable development goals (e.g., poverty reduction, sustainable environmental management, and even mitigation objectives), especially when they are integrated with sound ecosystem management approaches. In addition, EBA yields economic, social, and environmental co-benefits in the form of ecosystem goods and services (World Bank, 2009).

EBA is applicable in both developed and developing countries. In developing countries where economies depend more directly on the provision of ecosystem services (Vignola et al., 2009), EBA may be a highly useful approach to reduce risks to climate change impacts and ensure that development proceeds on a pathways that are resilient to climate change (Munang et al., 2013). EBA projects may be developed by enhancing existing initiatives, such as community-based adaptation and natural resource management approaches (e.g., Khan et al., 2012; Midgley et al., 2012; Roberts et al., 2012).

Examples of ecosystem based approaches to adaptation include:

- Sustainable water management, where river basins, aquifers, flood plains, and their associated vegetation are managed or restored to provide resilient water storage and enhanced baseflows, flood regulation services, reduction of erosion/siltation rates, and more ecosystem goods (e.g., Day et al., 2007; Midgley et al., 2012; Opperman et al., 2009)
- Disaster risk reduction through the restoration of coastal habitats (e.g., mangroves, wetlands, and deltas) to provide effective measure against storm-surges, saline intrusion, and coastal erosion (Jonkman et al., 2013)

- Sustainable management of grasslands and rangelands to enhance pastoral livelihoods and increase resilience to drought and flooding
- Establishment of diverse and resilient agricultural systems, and adapting crop and livestock variety mixes to secure food provision; traditional knowledge may contribute in this area through, for example, identifying indigenous crop and livestock genetic diversity, and water conservation techniques
- Management of fire-prone ecosystems to achieve safer fire regimes while ensuring the maintenance of natural processes.

Application of EBA, like other approaches, is not without risk, and risk/benefit assessments will allow better assessment of opportunities offered by the approach. The examples of EBA are too few and too recent to assess either the risks or the benefits comprehensively at this stage. EBA is still a developing concept but is should be considered alongside adaptation options based more on engineering works or social change, and existing and new cases used to build understanding of when and where its use is appropriate.

[INSERT FIGURE EA-1 HERE
Figure EA-1: Adapted from Munang et al. (2013). Ecosystem based adaptation (EBA) uses the capacity of nature to buffer human systems from the adverse impacts of climate change. Without EBA, climate change may cause degradation of ecological processes (central white panel) leading to losses in human well-being. Implementing EBA (outer blue panel) may reduce or offset these adverse impacts resulting in a virtuous cycle that reduces climate-related risks to human communities, and may provide mitigation benefits.]

Box CC-EA References

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Table 15-1: Application of local knowledge in climate change adaptation.

Location	Sector	Approach and Strategy	Adaptive action implemented	Institutions	References
Australia, S. Kimberley	Water Supplies	Define Vulnerabilities Increase Adaptive Capacity	Compile observed changes Increase monitoring Water resource management Review TEK	Universities, NGOs United Nations University	Green *et al*., 2010 Prober *et al*., 2011 Leonard *et al*., 2013
Bolivia Trinidad, North central Bolivia	Ecosystems, Agriculture	Reduce Vulnerability	Revive "camellones" TEK[1] (camellones- earthen platforms) Reduce erosion Document local observations	OXFAM International, NGOs Bolivian Government FAO (Food & Agricultural organization)	Oxfam International, 2009
California, United States Pinoleville Pomo Nation	Infrastructure	Mitigation - Solar Power Increase Adaptive Capacity	Co-design infrastructure Address insufficient capital Address water shortages and energy needs	Universities NGOs Housing &Urban Development	Shelby *et al*., 2012 Redsteer *et al*., 2013 Pinoleville Pomo Nation Housing flyer, 2013
Fiji, South Pacific	Ecosystems And Water Supply	Define Vulnerabilities Increase Adaptive Capacity	Recognition of TEK* Enable adaptive decision-making Enhance community awareness Participation in development	AusAID Fiji Dept. of Environment University of the South Pacific	Dumaru, 2010
E. Africa Kenya Tanzania, Malawi Zimbabwe, S. Zambia	Agriculture	Define Vulnerabilities Increase Technical Capacity Increasing Adaptive Capacity	Drought early warning Application of TEK[1] Development of novel reporting Compile observed changes Rainwater harvesting Change tilling practices Use of appropriate crop varieties	University of Capetown University of Nairobi DFID/IRDC (Department for International Development)	Chang'a *et al*., 2010 Mugabe *et al*., 2010 Kalanda-Joshua *et al*., 2011 Majule *et al*., 2013 Masindel *et al*., 2013
Western United States Reservation lands	Health, Water Supplies, Environment	Define Vulnerability & Impacts - Increasing Adaptive Capacity	Compiled observed changes Utilize environmental legislation Review Indigenous knowledge Analyze local meteorological data Analyze historical/legal context Increase monitoring	Universities & affiliated NGOs Tribal offices federal agency research	Redsteer *et al*., 2010 Doyle *et al*., 2013 Gautam *et al*., 2013

* Traditional Ecological Knowledge: Adaptive ecological knowledge developed through an intimate reciprocal relationship between a group of people and a particular place over time

Table 15-2: Transition from planning to implementation.

Scale	What is being implemented and why?	Transition from planning to implementation	Monitoring and Evaluation
Village of Kaslo (British Columbia) and surrounding unincorporated rural areas (Regional District of Central Kootenay-RDCK Electoral Area D). Implemented 2010 – 2012 (Kaslo/Regional District of Central Koote2010)	The Village of Kaslo and RDCK Electoral Area D developed a Climate Adaptation Action Plan identified water supply as a key community vulnerability related to projected climate change. Action plan noted that current demand for water almost equaled supply and observed the very limited data on water supply for creeks that supply water for the community.	The Village of Kaslo and RDCK Electoral Area D brought in experts in fields related to climate change impacts and involved extensive public outreach and engagement. Adaptation planning process identified projected changes in stream freshet and stream flows associated with climate change could result in insufficient water supply. Community leaders working through the Kaslo and District Community Forest Society sought funds to establish stream flow monitoring stations, developed a monitoring framework on key creeks to track changes in flows providing water to communities within Kaslo and RDCK Area. The Columbia Basin Trust contributed funding to this effort as part of follow-up to its support of the initial climate change planning process.	Monitoring and evaluation performed by Columbia Basin Trust's Communities Adapting to Climate Change Initiative. Area D Advisory Planning Commission monitors the implementation of action recommendations
National Framework on Local Adaptation Plans for Action(LAPA)-Nepal. Implementation began in 2011 (Government of Nepal, 2011)	Nepal adopted the LAPA in 2011, becoming the first country to promote a bottom-up approach to adaptation planning and implementation. The NAPA & the National Climate Change Policy states that at least 80 per cent of the available budget will go towards directly implementing adaptation actions at the local level. To date, 70 LAPAs have been prepared (69 at the village administrative scale and 1 within a municipality) and are under implementation by vulnerable communities.	Policy makers recognised the need to integrate local and context specific adaptation plans into local to national adaptation planning as a way to ensure robust climate change adaptation planning and implementation. The Ministry of Science, Technology and Environment (MoSTE) and the Ministry of Federal Affairs and Local Development (MoFALD) played a leadership role at the central level in coordinating the development and implementation of LAPAs.	Monitoring and evaluation play key roles in supporting iterative planning. Financial arrangements play a key role in integrating local adaptation options into development planning processes. Adaptation investments are being costed and integrated into annual and medium-term budget frameworks and resource mobilisation strategies. Nepal's budget for FY 2013/14 has included Climate Change Financing Code and of the total budget 5.36 percent is directly related to the climate change financing

Local Government-the Albay Province (Philippines) Implementation began in 2008. (Lasco et al, 2009)	"Albay Declaration on Climate Change Adaptation" specified mainstreaming climate change into local and national development policies. AIARP (Albay Integrated Agricultural Rehabilitation Program) though establishing farm clusters to assist farmers and fisher folks in their agricultural needs, food assistance, technological needs and training needs.	Program planning began in December 2006 after Typhoon Reming devastation. Plan prevent scarcity of agricultural commodities and accelerate food production; pump-prime the Agricultural Industry in the Province; and speed up rehabilitation of upland agricultural areas in Albay. The provincial government of Albay established the Center for Initiatives and Research on Climate Adaptation (CIRCA) in 2008, a living research and training institution in collaboration with the Environment Management Bureau (EMB), World Agroforestry Centre (ICRAF), Bicol University (BU) and the University of the Philippines Los Banos (UPLB). Local champions such as the Governor of committed time and resources to put climate change on provincial agenda and also in the national development and policy agenda addressing the needs the farmers and fisher folks	Main mechanism for institutional and stakeholder collaboration is through the Inter-Agency Committee on Climate Change (IACCC) Philippine Senate Resolution No 191 passed during 14th Congress 1st regular session Adopting the Albay Declaration on Climate Change Adaptation as a framework. Mainstreaming of global warming concerns gives a voice to the Albay Declaration in Congress and directly encourages policy makers to mainstream climate change in policy-making; and Indicators measure cleaner environment for the community improvement of infrastructure development plans, land development/ conversion activities institutionalization of pre-planning, enhanced implementation and enhanced monitoring and evaluation .
Pilot Program on Climate Resilience, 2009 (CIF, 2012; PPCR, 2013)	The Pilot Program for Climate Resilience (PPCR) through Climate Investment Funds (CIF) Phase I (planning) , supported by multilateral development bank (MDB) partners, in 2 years developed a strategic plan consistent with national development objectives. Phase II (implementation)Countries define "transformational change" in the context of their national circumstances. Scaling-up potential of successful pilots (e.g. use of good practices in Bangladesh) Addressing basic needs (e.g. food security in Niger) Mobilization of large-scale resources for investments (e.g. coastal highways in Samoa). Country leadership capacity dependant on experience with integrating climate change into	The capacity of countries to take on leadership role depended on their prior experience with integrating climate change considerations into planning activities; institutional and human capacities; and demands to respond to other emergencies. The strategic plans drew on NAPAs, national climate change strategies (if they existed), and national development strategies and plans Lead agency roles assigned to planning or finance ministry (e.g., Zambia, Samoa) or their environment-related ministries (e.g., Bangladesh) Disaster risk management units included Coordinate the work of donors and/or leverage non-PPCR resources. For example, Cambodia and Zambia have leveraged co-financing from the International Fund for Agricultural Development and the Nordic Development Fund, respectively.	Framework includes five core indicators designed to measure outcomes at the country level, aggregated from individual PPCR components. These are: (i) Number of people supported by the PPCR to manage the effects of climate change; (ii) b) Degree of integration of climate change in national, including sector planning; (iii) Extent to which vulnerable households, communities businesses and public sector services use improved PPCR supported tools, instruments, strategies, activities to respond to climate vulnerability and climate change; (iv) Evidence of strengthened government capacity and coordination mechanism to mainstream climate resilience; and (v) Quality of and extent to which climate responsive instruments/ investment models are developed and tested. All of the core indicators address gender issues either directly or indirectly

	planning activities, institutional and human capacities; and need to respond to emergencies.Recent climate-extreme related disasters have affected development.		
United Kingdom National Adaptation Programme. Implementation in 2012 (UK HM Government, 2013)	Pursuant to Climate Change Act 2008, the Climate Change Risk Assessment 2012 (CCRA) for the UK brought together the best available evidence, using a consistent framework to identify the risks and opportunities related to climate change. The assessment distilled approximately 700 potential risks down to more than 100 for detailed review. Recent extreme weather in Britain, such as the flooding in the winter of 2012 and the drought of early 2012 brought into sharp relief the importance of anticipating and managing weather extremes. Costs of rebuilding and impacts on essential public services highlighted the need for implementing preparedness and adaptation.	The Climate Ready Support Service provides direct support and online information to help organisations assess their sensitivity to a changing climate and take steps to manage their climate risks. Through the Service the EA is working with partners in priority sectors to provide tailored tools, guidance and training to enable them to understand and respond to the challenges of a changing climate. Established partnerships are with the Met Office, the Local Government Association, Climate UK and the Climate Change Partnerships. The government is also supporting the building of networks of organisations that may share common risks, for example the Infrastructure Operators Adaptation Forum	Progress indicators provide iterative measures of progress and to develop the next CCRA: • Process-based markers, such as whether planned policies have been implemented. • Quantitative data, such as statistics on trends in factors that influence risks from flooding and water scarcity. These provide a strong foundation for assessing overall adaptation in relevant areas. Discussions about the most appropriate framework are continuing. The Adaptation Sub-Committee (ASC) of the Committee on Climate Change under Climate Change Act assesses progress towards implementation of objectives, proposals and policies highlighted in this report and the Register of Actions, with assessments published in 2015 and every two years hence.

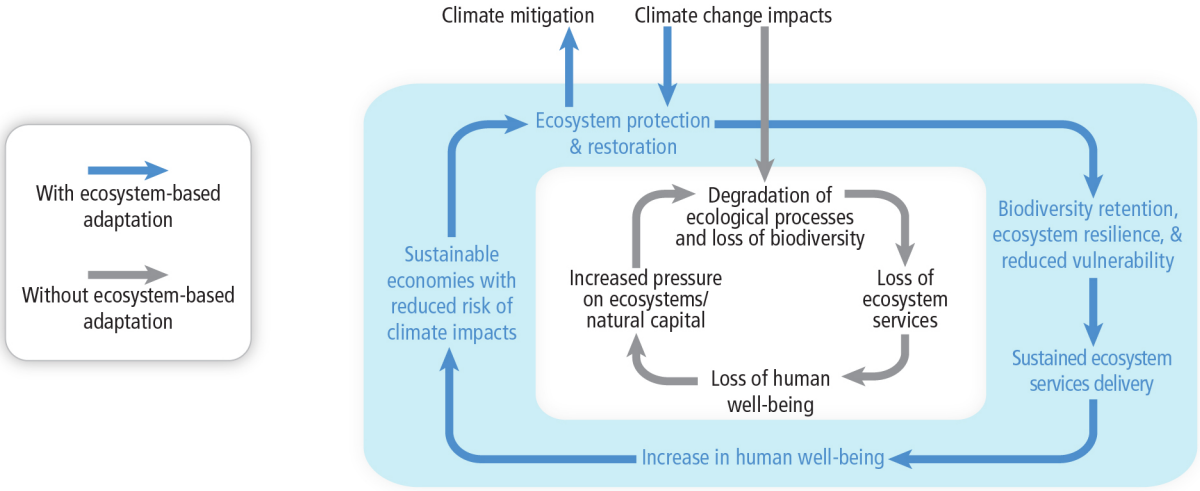

Figure EA-1: Adapted from Munang et al. (2013). Ecosystem based adaptation (EBA) uses the capacity of nature to buffer human systems from the adverse impacts of climate change. Without EBA, climate change may cause degradation of ecological processes (central white panel) leading to losses in human well-being. Implementing EBA (outer blue panel) may reduce or offset these adverse impacts resulting in a virtuous cycle that reduces climate-related risks to human communities, and may provide mitigation benefits.