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**Nairobi work programme on impacts, vulnerability and adaptation
to climate change**

Ecosystem-based approaches to adaptation: compilation of information

Note by the secretariat

Summary

This report contains a compilation of information on ecosystem-based approaches to adaptation. With a synthesis of the state of knowledge on ecosystem-based approaches to adaptation, this report provides an overview of how ecosystems can play a role in helping people adapt to climate change, through the compilation of examples and relevant knowledge products, and a discussion of issues related to the understanding and implementation of such approaches.

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I. Executive summary

A. Introduction

1. The Subsidiary Body for Scientific and Technological Advice (SBSTA), at its thirty-fourth session, requested the secretariat, in the context of the Nairobi work programme on impacts, vulnerability and adaptation to climate change, to compile information on ecosystem-based approaches to adaptation.¹ The Nairobi work programme aims to assist all countries, in particular developing countries, including least developed countries (LDCs) and small island developing States (SIDS), to improve their understanding and assessment of the impacts of climate change and to make informed decisions on practical adaptation actions and measures.

2. This report presents an overview of the role ecosystems can play in adaptation to climate change, through the compilation of examples and relevant knowledge products and a discussion of issues related to the understanding and implementation of such approaches.

B. Role of ecosystems in adaptation

3. Ecosystems affect the climate and play an important role in adaptation to climate change. However, climate change affects ecosystems, their functions and the many benefits and services they provide to people along with the ability of ecosystems to regulate water flows and cycle nutrients. As these services are eroded, the implications of the impacts will be felt by people, communities and economies throughout the world. Climate change adds a further pressure on many ecosystems and people already negatively impacted by pollution, deforestation and land degradation. Loss of the services that ecosystems provide is also a significant barrier to the achievement of the Millennium Development Goals.

4. Adaptation strategies involve a range of actions, including behavioural change, technical or hard engineered solutions such as the construction of sea defences or risk management, and reduction strategies such as the establishment of early warning systems. There is also a growing recognition of the role that healthy ecosystems can play in increasing resilience and helping people to adapt to climate change through the delivery of the range of services that play a significant role in maintaining human well-being.

5. Approaches that involve the services that biodiversity and ecosystems provide as part of an overall adaptation strategy to help people adapt to the adverse effects of climate change are known as ecosystem-based approaches to adaptation. The underlying principle is that healthy ecosystems can play a vital role in maintaining and increasing resilience to climate change and in reducing climate-related risk and vulnerability. Examples of such approaches include flood defence through the maintenance and/or restoration of wetlands and the conservation of agricultural biodiversity in order to support crop and livestock adaptation to climate change.

C. Implementation and benefits of ecosystem-based approaches to adaptation

6. Studies and reviews of ecosystem-based approaches to adaptation indicate that although the theoretical concept of ecosystem-based approaches to adaptation is fairly

¹ FCCC/SBSTA/2011/2, paragraph 23(b).

recent, practical approaches to adaptation that utilize the services of healthy ecosystems have been implemented in various guises by different communities for some time. These include approaches to deal with climatic variability developed by pastoralists and measures to reduce the effects of natural disasters.

7. The role of ecosystems in adaptation is relevant to, and can be applied at, many levels, such as the regional, national, subnational and local levels, and in all regions. Ecosystem-based approaches to adaptation are found to be most appropriately integrated into broader adaptation and development strategies, complementing, rather than being an alternative to, other approaches.

8. Ensuring healthy ecosystems is already an integral part of many adaptation strategies. Examples include integrating ecosystem-based approaches to adaptation into relevant strategies, including national adaptation programmes of action (NAPAs), flood control, disaster risk reduction planning and biodiversity strategies. Ecosystem-based approaches to adaptation also seem to be receiving increased attention in a policy context. Despite the fact that some initiatives did not start out as adaptation projects, there is evidence of the application of such approaches as a part of national and local adaptation portfolios.

9. Organizations, including many of the Nairobi work programme partner organizations from both the environment and development sectors, are engaged in research and implementation of ecosystem-based approaches to adaptation. Many Nairobi work programme partner organizations have made action pledges, outlining activities such as promoting the development of tools and methods for ecosystem-based adaptation, disseminating information and implementing pilot or demonstration projects.² A number of collaborative initiatives are being taken forward to enhance knowledge and provide guidance to support the implementation of ecosystem-based approaches.

10. As part of an adaptation strategy, approaches that integrate healthy and intact ecosystems can deliver a number of benefits, including the following:

(a) Ecosystem-based approaches to adaptation are widely applicable at different spatial and temporal scales. This means that there is potential for considering ecosystem-based approaches in many circumstances;

(b) Ecosystem-based approaches to adaptation have the potential to reduce vulnerability to a broad range of climate and non-climate stresses. Such approaches have been shown to be effective for adaptation across sectors, contributing to livelihood sustenance and food security, sustainable water management, disaster risk reduction and biodiversity conservation;

(c) Ecosystem-based approaches to adaptation may be more cost-effective and accessible by rural or poor communities than measures based on hard infrastructure and engineering. Ecosystem-based approaches to adaptation can be particularly important to poor people, who are often the most directly dependent on the services that ecosystems provide;

(d) In addition to providing support for societal adaptation to climate change, ecosystem-based approaches to adaptation also provide for the possibility of multiple economic, social, environmental and cultural co-benefits. Approaches such as forest conservation or restoration of degraded wetlands can also contribute to climate change mitigation measures. Such win-win outcomes could also help to avoid maladaptation.

² More information on action pledges is available at <<http://unfccc.int/5005>>.

D. Lessons learned

11. The information reviewed for this compilation demonstrates that ecosystem-based adaptation is still a relatively new scientific field of endeavour, but that it is rooted in long-standing approaches applied by communities locally in response to episodic and/or long-term climate change. The science and knowledge base is emerging and demonstrates the benefits of such approaches, with case studies from both completed and ongoing projects providing useful evidence for the further evaluation and assessment of effective implementation.³ A wide range of organizations in multiple areas (conservation, development, disaster management) are engaged in implementation, including developing tools to aid the implementation of ecosystem-based approaches to adaptation.

12. As demonstrated by the range of case studies and knowledge products, projects on ecosystem-based approaches and/or with relevance to ecosystems address a broad range of climate change impacts, including drought, floods, storms, and ecosystem productivity and resilience.

13. Lessons learned from the case studies illustrate the advantages of integrating ecosystem-based approaches within adaptation and development strategies in order to deliver a range of co-benefits that provide cost-effective opportunities to achieve multiple objectives relating to climate change, development and biodiversity. The case studies also demonstrate that ecosystem-based approaches are widely applicable to and particularly accessible by the most vulnerable communities. Other findings point to the importance of ensuring broad participation and learning from lessons learned from past interventions.

14. The case studies also identify a number of challenges to the implementation of ecosystem-based approaches to adaptation. These include circumstances that require a more engineered or technical response. Other challenges include ecosystem services being overlooked, misunderstood or ignored in adaptation planning.

15. While there is experience in the use of ecosystem-based approaches in the context of adaptation activities, improved and additional information about ecosystem interactions and practical guidance could help to enhance implementation.

16. Further developing the evidence base for ecosystem-based approaches to adaptation would help to enhance understanding of ecosystem interactions and the economics of ecosystem-based adaptation. Outcomes would need to be monitored and evaluated. The further development of networks to build capacity and share information and experience would also be helpful.

17. The following might be considered to enhance ecosystem-based approaches to adaptation at all levels:

- (a) Targeted awareness-raising, both within the adaptation community (regarding the value of ecosystem-based approaches to adaptation) and within the areas responsible for ecosystem management (regarding the importance of adaptation);
- (b) Capacity-building;
- (c) Further research;
- (d) Development of guidelines, tools, principles, etc.;
- (e) Activities to enhance collaboration and coordination between relevant organizations, including among the Nairobi work programme partner organizations, for example:

³ For a complete description of the case studies see <<http://unfccc.int/6227>>.

- (i) Identifying the pool of expertise and organizations that are best suited to support ongoing activities related to ecosystem-based adaptation in the fields of science, policy and implementation;
- (ii) Identifying Parties' needs and ways in which countries can be supported when implementing activities;
- (f) Increasing collaboration on activities related to ecosystems and adaptation between the three Rio Conventions, especially at the national level.

II. Introduction

A. Mandate

18. The SBSTA, at its thirty-fourth session, requested the secretariat, in the context of the Nairobi work programme, to compile information on ecosystem-based approaches to adaptation.⁴ The Nairobi work programme aims to assist all countries, in particular developing countries, including LDCs and SIDS, to improve their understanding and assessment of the impacts of climate change and to make informed decisions on practical adaptation actions and measures.

B. Scope

19. The aim of this report is to provide an overview of how ecosystems can play a role in helping people to adapt to climate change, through the compilation of examples and relevant knowledge products and a discussion of issues related to the understanding and implementation of such approaches. This review covers all types of ecosystems and geographic regions.

C. Approach

20. The information contained in this report has been compiled and synthesized from the following:

- (a) A review of the existing literature on ecosystem-based approaches to adaptation;
- (b) A review of available projects and approaches contained within reports, databases, websites and other knowledge products produced by organizations engaged in the research and implementation of ecosystem-based approaches to adaptation;
- (c) A limited number of discussions with relevant experts.

21. Chapter III provides the state of knowledge on ecosystem-based approaches to adaptation. This is followed by a compilation of examples of ecosystem-based approaches to adaptation (chapter IV). The last chapter describes the key lessons learned relating to ecosystem-based approaches to adaptation (chapter V).

⁴ FCCC/SBSTA/2011/2, paragraph 23(b).

III. Synthesis of knowledge on ecosystem-based approaches to adaptation

A. Ecosystems and climate change interactions

22. The impacts of climate change, such as changing precipitation patterns, increased instances of severe weather events, including flooding and droughts, sea level rise and ocean acidification, are being felt by vulnerable ecosystems and people. There is a growing body of evidence on the links between biodiversity – at the level of ecosystems, species, genetic diversity within species and ecological interactions – and climate change. The interactions are expanded upon in several reports, including the report of the Convention on Biological Diversity (CBD) Ad Hoc Technical Expert Group (AHTEG) on Biodiversity and Climate Change,⁵ other detailed literature reviews by the CBD,⁶ various Intergovernmental Panel on Climate Change (IPCC) outputs and other reports, for example by the World Bank,^{7, 8} Dudley et al.⁹ and the United Nations Environment Programme (UNEP).¹⁰

23. Climate change will affect ecosystems, their functions and the many benefits and services they provide to society (see the figure). These include services, such as the provision of food, fuel and fibre; regulating services, such as the regulation of floods, climate and drought; supporting services, such as soil formation and nutrient cycling; and cultural services, including recreation and non-material benefits.¹¹ Climate change adds further pressure on many ecosystems and people already negatively impacted by unsustainable practices such as deforestation and land degradation. Loss of ecosystem services is also a significant barrier to the achievement of the Millennium Development Goals.

24. There is a growing recognition of the role that healthy ecosystems can play in increasing resilience and helping people adapt to climate change through the ongoing delivery of the range of services that help to maintain human well-being.

25. The IPCC's *Climate Change and Biodiversity: IPCC Technical Paper V*¹² recognized that land management activities that are designed to take into account projected

⁵ Convention on Biological Diversity. *Connecting Biodiversity and Climate Change Mitigation and Adaptation: Report of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change*. Technical Series No. 41. Montreal: Convention on Biological Diversity.

⁶ Convention on Biological Diversity. *Review of the Literature on the Links between Biodiversity and Climate Change: Impacts, Adaptation and Mitigation*. Technical Series No. 42. Montreal: Convention on Biological Diversity.

⁷ World Bank. 2008. *Biodiversity, Climate Change and Adaptation: Nature-based Solutions from the World Bank Portfolio*. Washington, D.C.: World Bank.

⁸ World Bank. 2010. *Convenient Solutions to an Inconvenient Truth: Ecosystem-based Approaches to Climate Change*. Washington, D.C.: World Bank.

⁹ Dudley N, Stolton S, Belokurov A, Krueger L, Lopoukhine N, MacKinnon K, Sandwith T and Sekhran N. (eds.). 2010. *Natural Solutions: Protected Areas Helping People Cope with Climate Change*. Gland, Switzerland, Washington, D.C., and New York: International Union for Conservation of Nature, World Commission on Protected Areas, Nature Conservancy, United Nations Development Programme, Wildlife Conservation Society, World Bank and World Wide Fund for Nature.

¹⁰ United Nations Environment Programme. 2010. *Integrated Solutions for Biodiversity, Climate Change and Poverty*: UNEP Policy Series Brief. Nairobi: United Nations Environment Programme.

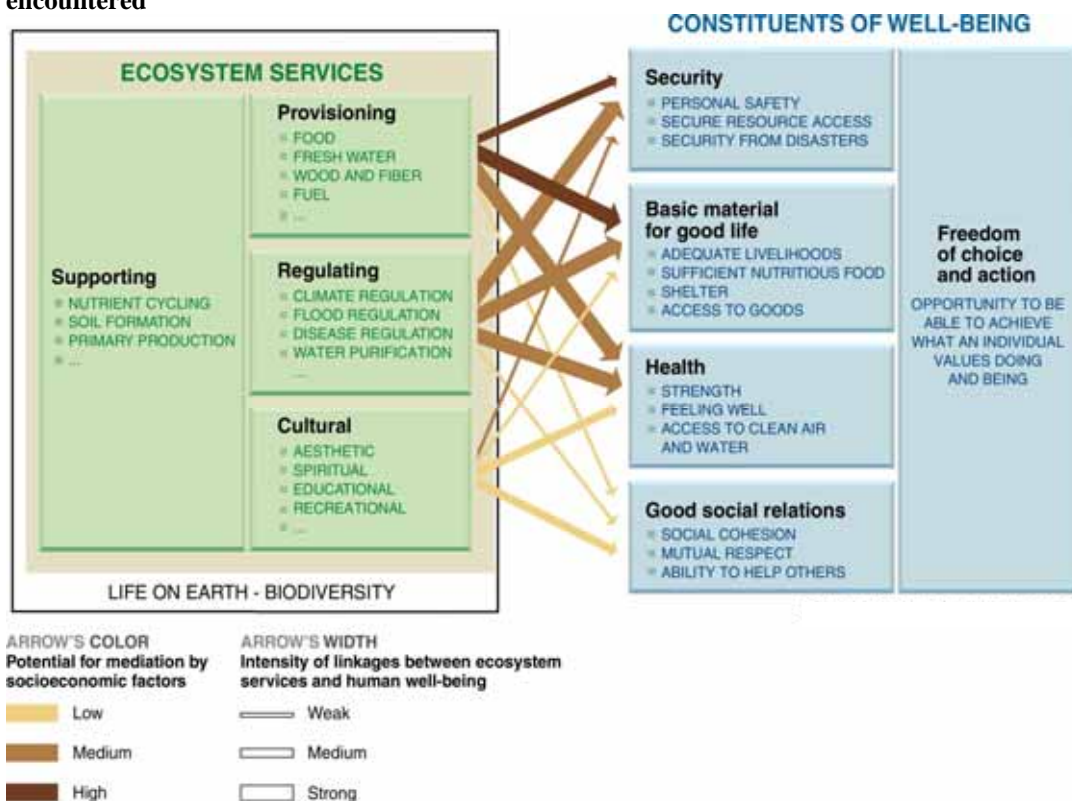
¹¹ Millennium Ecosystem Assessment. 2005. *Ecosystems and Human Well-being: Synthesis*. Washington, D.C.: World Resources Institute.

¹² Intergovernmental Panel on Climate Change. 2002. *Climate Change and Biodiversity: IPCC Technical Paper V*. Geneva: Intergovernmental Panel on Climate Change.

changes in climate, along with those that reduce non-climatic pressures on biodiversity in order to reduce vulnerability to changes in climate, can sometimes also make people less vulnerable to climatic extremes.

26. The second CBD AHTEG on Biodiversity and Climate Change, convened in 2008–2009 to provide scientific and technical advice and assessment on the integration of the conservation and sustainable use of biodiversity into climate change mitigation and adaptation activities, described ecosystem-based adaptation as “the use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people adapt to the adverse effects of climate change.” Such approaches to adaptation “use the range of opportunities for the sustainable management, conservation, and restoration of ecosystems to provide services that enable people to adapt to the impacts of climate change”.¹³ The principle is that such approaches aim to maintain and increase the resilience and reduce the vulnerability of ecosystems and people in the face of the adverse effects of climate change.

Summary of ecosystem services, depicting the strength of linkages between categories of ecosystem services and components of human well-being that are commonly encountered^a



^a Source: Millennium Ecosystem Assessment. 2005. *Ecosystems and Human Well-being: Synthesis*. Washington, D.C.: World Resources Institute.”

27. Examples of ecosystem-based approaches to adaptation include the following:

(a) Coastal defence through the maintenance and/or restoration of mangroves and other coastal wetlands to reduce coastal flooding and coastal erosion;

¹³ Convention on Biological Diversity. *Connecting Biodiversity and Climate Change Mitigation and Adaptation: Report of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change*. Technical Series No. 41. Montreal: Convention on Biological Diversity.

- (b) Sustainable management of upland wetlands, forests and floodplains for the maintenance of water flow and water quality;
- (c) Conservation and restoration of forests to stabilize land slopes and regulate water flows;
- (d) Establishment of diverse agroforestry systems to cope with increased risk from changes in climatic conditions;
- (e) Managing the spread of invasive alien species that are linked to land degradation and that threaten food security and water supplies;
- (f) Managing ecosystems to complement, protect and extend the longevity of investments in hard infrastructure;
- (g) Conservation of agrobiodiversity to provide specific gene pools for crop and livestock adaptation to climate change;
- (h) Establishing and effectively managing systems to ensure the continued delivery of the services ecosystems provide that increase resilience to climate change, for example through protected areas.

B. Ongoing work on ecosystem-based approaches to adaptation

28. There is some scientific literature available on ecosystem-based approaches to adaptation, including the AHTEG report and a review of literature prepared under the auspices of the CBD, reflecting the recent emergence of the theory and practice of adaptation to climate change from a biodiversity view point. The scientific contribution is supported by increasing amounts of evidence in the grey literature, including technical reports of field activities from organizations engaged in research and implementation.

29. United Nations agencies are also developing programmes on ecosystem-based adaptation. For example, UNEP has teamed up with the United Nations Development Programme (UNDP) and the International Union for Conservation of Nature (IUCN) to establish the Ecosystem-based Adaptation Flagship Programme, which includes, among its activities, piloting of ecosystem-based adaptation approaches and comparing the costs and cost-effectiveness of ecosystem-based adaptation approaches with other adaptation strategies.

30. The World Bank is among the organizations that have seen the number of projects and programmes that emphasize the linkages between ecosystems and climate change increase – “Over the last decade, more and more Bank projects have been making explicit linkages between conservation and sustainable use of natural ecosystems, carbon sequestration, and watershed values associated with erosion control, clean water supplies, and flood control.”¹⁴

31. Practical approaches to adaptation that utilize the services of healthy ecosystems have been implemented in various forms by different communities for some time. For example, pastoralists have developed traditional strategies to deal with climate variability, including mixed species grazing.¹⁵ There are also links to community-based adaptation¹⁶ approaches, which often involve the management of natural resources.

¹⁴ World Bank. 2010. *Convenient Solutions to an Inconvenient Truth: Ecosystem-based Approaches to Climate Change*. Washington, D.C.: World Bank.

¹⁵ Convention on Biological Diversity. *Connecting Biodiversity and Climate Change Mitigation and Adaptation: Report of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change*. Technical Series No. 41. Montreal: Convention on Biological Diversity.

32. A number of examples of ecosystem-based approaches to adaptation are referenced in this report and described in more detail in the UNFCCC online database on ecosystem-based approaches to adaptation, which can be found on the UNFCCC website.¹⁷ It should be noted that these examples provide an indication of the types of initiatives addressing these approaches.

1. Nature of approaches

33. A range of strategies to address vulnerabilities due to climate change are employed, spanning from the initial steps assessing and evaluating vulnerability through to improving capacity or involving design or policy measures and involving the implementation of ecosystem-based measures in response to the particular impact. The natures of the approaches included in the case examples are based on these different types of strategies.

34. One case study describes a project to assess the vulnerability of Madagascar's marine and terrestrial environments to climate change, which in a second phase will inform the design of a comprehensive adaptation programme for building community and ecosystem resilience and will promote policy change. Other case studies focus on the implementation of measures on the ground, for example restoration activities such as planting trees to enhance the flooded forests of Tonlé Sap in Cambodia, increasing the resilience of the ecosystem to altered precipitation patterns in the face of climate change and other non-climatic pressures and at the same time contributing to increased food security for local communities.

2. Integration of ecosystem-based approaches to adaptation into relevant strategies, policies and programmes

35. Ecosystem-based approaches to adaptation are found to be most appropriately integrated into broader adaptation and development strategies,¹⁸ complementing rather than substituting other approaches. Ensuring healthy ecosystems is already an integral part of many adaptation strategies. For example, of 485 NAPA priority projects submitted to the secretariat as of September 2011, 15.5 per cent focus on terrestrial ecosystems.¹⁹ At least 13 of the 46 countries that had submitted their NAPAs identified three or more priority projects on terrestrial ecosystems. For example, Bhutan has four out of nine; Burundi four out of 12; Ethiopia four out of 11; Madagascar three out of 15 and Haiti eight out of 14. Similarly, as of September 2011, eight per cent of total NAPA priority projects focus on coastal zones and marine ecosystem. At least five of the 46 countries that had submitted their NAPAs identified three or more priority projects on coastal zones and marine ecosystems: Guinea-Bissau has three out of 14; Guinea four out of 18; Haiti three out of 14; Kiribati three out of 10; and Tuvalu three out of seven.

36. Several case studies describe the implementation of projects identified within NAPAs and/or national adaptation plans. For example, Colombia is implementing an integrated national adaptation plan of pilot activities, which includes the maintenance of ecosystem services in the high mountain ecosystems in the Andes, including the provision of freshwater. A recently approved initiative in Samoa – the Integration of Climate Change Risk and Resilience into Forestry Management – which is part of a programme of sectoral

¹⁶ Definition of community based adaptation available at <<http://www.iied.org/climate-change/key-issues/community-based-adaptation/community-based-adaptation-exchange-cba-x>>.

¹⁷ <<http://unfccc.int/6227>>.

¹⁸ Convention on Biological Diversity. *Connecting Biodiversity and Climate Change Mitigation and Adaptation: Report of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change*. Technical Series No. 41. Montreal: Convention on Biological Diversity.

¹⁹ Terrestrial ecosystems include land management, forest ecosystems, wetlands/lakes and natural sites.

NAPA implementation projects funded by the Least Developed Countries Fund,²⁰ will also seek to enhance the resilience of forest ecosystems in order to enhance the adaptive capacity of people dependent on forest resources.

37. The Cancun Agreements²¹ also recognize the need to consider ecosystems for enhanced action on adaptation. In this context, the Cancun Adaptation Framework affirms that enhanced action on adaptation should take into consideration vulnerable groups, communities and ecosystems, and should be based on and guided by the best available science and, as appropriate, traditional and indigenous knowledge, with a view to integrating adaptation into relevant social, economic and environmental policies and actions, where appropriate.

38. There is also evidence of integration of ecosystem-based approaches to adaptation into other relevant strategies. For example, projects in Argentina and Ecuador are integrating protection of natural forests as cost-effective contributions to flood control strategies that complement early warning systems and investments in hard infrastructure.²² In other cases, ecosystems have been integrated into disaster risk reduction planning (e.g. afforestation measures to reduce landslides on hillsides in Rio de Janeiro, Brazil), as well as into biodiversity strategies (e.g. measures to re-establish the natural water cycle to manage water run-off and drainage issues to reduce vulnerability to climate change related flooding in Nagoya, Japan).

39. Ecosystem-based approaches to adaptation seem to be receiving increased attention in a policy context. For example, a recent UNDP and Global Environment Facility (GEF) report on adaptation²³ states that ecosystem-based solutions will play an increasingly important role as part of UNDP's integrated adaptation investment strategy. The World Bank²⁴ argued for including ecosystem-based approaches to mitigation and adaptation as an essential pillar in national strategies to address climate change. World leaders at the Group of Eight summit in 2011 also recognized the role of ecosystems in adaptation to climate change.²⁵

3. Initiatives related to ecosystem-based approaches to adaptation

40. The role of ecosystems in adaptation is relevant to, and can be applied at, many levels and in all regions. Adaptation initiatives with a focus on ecosystems available in the UNFCCC online database include regional examples such as the West Africa shorelines of Cape Verde, Gambia, Guinea-Bissau, Mauritania and Senegal, which involved measures to reduce the impact of climate change induced coastal erosion through coastal restoration activities, helping to protect the fisheries that support local communities. Similarly, the green coast project, operating in India, Indonesia, Malaysia, Sri Lanka and Thailand, involved the restoration of mangrove forests to reduce vulnerability to extreme weather events such as storms.

²⁰ More information on status of NAPA implementation under the Least Developed Countries Fund is available at <<http://unfccc.int/5632>>.

²¹ FCCC/CP/2010/7/Add.1.

²² World Bank. 2010. *Convenient Solutions to an Inconvenient Truth: Ecosystem-based Approaches to Climate Change*. Washington, D.C.: World Bank.

²³ United Nations Development Programme. 2011. *Adapting to Climate Change: UNDP-GEF Initiatives Financed by LDCF, SCCF and SPA*. New York: United Nations Development Programme.

²⁴ World Bank. 2008. *Biodiversity, Climate Change and Adaptation: Nature-based solutions from the World Bank Portfolio*. Washington, D.C.: World Bank.

²⁵ Group of Eight. 2011. G8 Declaration: Renewed commitment for freedom and democracy. Available at <<http://www.g20-g8.com/g8-g20/g8/english/the-2011-summit/declarations-and-reports/declarations/renewed-commitment-for-freedom-and-democracy.1314.html>>.

41. National-level initiatives include a project to incorporate biodiversity information into land-use planning and decision-making in South Africa, with the purpose of building resilience within ecosystems in order to reduce the vulnerability of people to climate change impacts such as reduced provision of vital ecosystem services and protection against extreme weather events, including fires.

42. At the subnational level, initiatives in the high-altitude peatlands of the Ruogai marshes project in China involve management of wetlands by reducing other pressures on the ecosystem in order to ensure the continued provision of the services that ecosystems provide, including freshwater, that can help people adapt to climate change. Edmonton's urban forest management plan (Canada) is an example of a project implemented at the local level to support people to adapt to the adverse effects of climate change through regulating temperature, air quality and storm water run-off. Another project in the Kikuyu escarpment forest of Kenya involved management of the forest to maintain water flows and establish diverse agroforestry ecosystems.

43. Organizations from both the environment and development sectors, including Nairobi work programme partner organizations, are engaged in research and implementation of ecosystem-based approaches to adaptation. These include, among others, the World Wide Fund for Nature, the IUCN, Nature Conservancy, Birdlife International, World Resources Institute, CARE, the World Bank, the GEF, UNEP, UNDP and the CBD. Many Nairobi work programme partner organizations have made action pledges outlining activities such as promoting the development of tools and methods for ecosystem-based adaptation, disseminating information and implementing pilot or demonstration projects.²⁶

44. Many of these organizations are contributing to the knowledge base through the publication of compilations reviewing good practice of ecosystem-based adaptation and lessons learned,^{27, 28, 29, 30, 31, 32} in a European context,^{33, 34} and relating to disaster risk reduction.³⁵ A number of databases also provide further examples of ecosystem-based

²⁶ More information on action pledges made by Nairobi work programme partner organizations is available at <<http://unfccc.int/5005>>.

²⁷ Birdlife International. 2009. *Partners with Nature: How Healthy Ecosystems are Helping the World's Most Vulnerable Adapt to Climate Change*. Cambridge: Birdlife International.

²⁸ Convention on Biological Diversity. *Connecting Biodiversity and Climate Change Mitigation and Adaptation: Report of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change*. Technical Series No. 41. Montreal: Convention on Biological Diversity.

²⁹ Convention on Biological Diversity. *Review of the Literature on the Links between Biodiversity and Climate Change: Impacts, Adaptation and Mitigation*. Technical Series No. 42. Montreal: Convention on Biological Diversity.

³⁰ Colls A, Ash N and Ikkala N. 2009. *Ecosystem-based Adaptation: A Natural Response to Climate Change*. Gland, Switzerland: International Union for Conservation of Nature.

³¹ Ecosystems and Livelihoods Adaptation Networks. 2011. ELAN case studies: good practices. Available at <<http://www.elanadapt.net/good-practices>>.

³² Andrade PA, Herrera Fernandez B and Cazzolla Gatti R. (eds.). 2010. *Building Resilience to Climate Change: Ecosystem-based Adaptation and Lessons from the Field*. Gland, Switzerland: International Union for Conservation of Nature.

³³ Doswald N and Osti M. 2011. *Ecosystem-based Adaptation and Mitigation: Good Practice Examples and Lessons Learnt in Europe*. Skripten, Germany: German Federal Agency for Nature Conservation.

³⁴ Cowan C, Eppe C, Korn H, Schliep R and Stadler J. (eds.) 2009. *Working with Nature to Tackle Climate Change: Report of the ENCA/BfN Workshop on "Developing Ecosystem-based Approaches to Climate Change – Why, What and How"*. Skripten, Germany: German Federal Agency for Nature Conservation.

³⁵ ProAct Network. 2008. *The Role of Environmental Management and Eco-engineering in Disaster Risk Reduction and Climate Change Adaptation: Report's Case Studies*. Available at <<http://www.proactnetwork.org/proactwebsite/en/component/content/article/47-policytoolsguidance/98-the-role-of-environmental-management-in-disaster-risk-reduction-and-climate-change-adaptation-case->

approaches to adaptation.^{36, 37} The annex provides an overview of some relevant knowledge products developed under a range of initiatives.

45. Ongoing work includes a review of the evidence for the effectiveness of ecosystem-based approaches to adaptation by the Cambridge Conservation Initiative, a partnership of the University of Cambridge and a number of leading conservation organizations. The German Federal Agency for Nature Conservation is also undertaking a study on ecosystem-based adaptation and mitigation, with a focus on good practice examples and lessons learned in Europe.

46. A number of collaborative initiatives are being undertaken to increase knowledge and provide guidance to support increased implementation of ecosystem-based approaches. For example, a partnership involving the IUCN, the Tropical Agriculture Research and Higher Education Center, Conservation International, CARE, Birdlife International, the World Wildlife Fund (United States of America) and the Center for International Forestry Research is currently developing principles and guidelines for integrating ecosystem-based approaches to adaptation in project and policy design.

C. Benefits of ecosystem-based approaches to adaptation

47. Analysis of case studies reveals that the benefits of ecosystem-based approaches to adaptation can be realized over both short and long timescales. These approaches are relevant at both the project and the programmatic scales, building resilience at all levels. This means that there is potential for considering ecosystem-based approaches in many circumstances.

48. Ecosystem-based measures can contribute to, inter alia, the following:

(a) **Livelihood sustenance and food security.** Initiatives such as the Maya nut agroforestry project operating in El Salvador, Mexico and Nicaragua, the Kikuyu escarpment forest project in Kenya and the Jordan Valley permaculture project demonstrate the benefits of adaptation measures that contribute to diverse, resilient ecosystems, providing access to essential natural resources. Healthy ecosystems, including protected areas, can contribute to food security by protecting essential water supplies for downstream farming. In Madagascar, an economic study of these benefits led to a substantial expansion of the protected area network,³⁸ which led to the country coping better with climate variability;

(b) **Sustainable water management.** Climate change and rising temperatures will lead to an increase in water shortages, both for agricultural and domestic purposes. Resilient ecosystems, including forests, protect water supplies and water quality. A third of 105 of the world's largest cities (including Jakarta, Indonesia, New York, United States, Mumbai, India, Quito, Ecuador, and Melbourne, Australia) derive their water from forest protected areas.³⁹ Implementation of the Pangani River Basin management project in the United Republic of Tanzania and restoration of wetlands in New Zealand demonstrate the

studies>.

³⁶ <<http://www.grabs-eu.org/casestudies.php>>.

³⁷ <<http://adaptation.cbd.int/activities.shtml>>.

³⁸ World Bank. 2010. *Convenient Solutions to an Inconvenient Truth: Ecosystem-based Approaches to Climate Change*. Washington, D.C.: World Bank.

³⁹ Dudley N, Stolton S, Belokurov A, Krueger L, Lopoukhine N, MacKinnon K, Sandwith T and Sekhran N. (eds.). 2010. *Natural Solutions: Protected Areas Helping People Cope with Climate Change*. Gland, Switzerland, Washington, D.C., and New York: International Union for Conservation of Nature, World Commission on Protected Areas, Nature Conservancy, United Nations Development Programme, Wildlife Conservation Society, World Bank and World Wide Fund for Nature.

potential for contributing to sustainable water management by restoring and protecting healthy ecosystems to provide water storage and flood regulation functions. Similarly, the Working for Water Programme in South Africa is removing thirsty invasive alien trees to restore native vegetation and increase water supplies for agriculture, industry and domestic use; a cost-effective solution that also provides biodiversity and employment benefits for previously poor and disenfranchised communities;⁴⁰

(c) **Disaster risk reduction.** Projects restoring tsunami-affected coastal areas in India, Indonesia, Malaysia, Sri Lanka and Thailand, or initiatives undertaking management of ecosystems in Armenia and Australia to prevent forest fires, demonstrate the importance of healthy ecosystems for providing natural buffers against impacts associated with many extreme weather events, including storms, flooding, droughts, fires, landslides, hurricanes and cyclones;

(d) **Biodiversity conservation.** Projects such as the implementation of a resilient network of marine protected areas in Kimbe Bay, Papua New Guinea, demonstrate how intact and interconnected ecosystems that can adjust to changing environmental conditions help biodiversity and people to adapt to climate change. Measures can include the restoration of fragmented or degraded ecosystems in order to increase the resilience of the ecosystem to future change, or the re-establishment of critical environmental processes such as water storage regulation.

49. Existing literature shows that ecosystem-based approaches to adaptation may be more cost-effective and accessible by rural or poor communities than measures based on hard infrastructure and engineering, including the studies by World Bank⁴¹ and a global study on the Economics of Ecosystems and Biodiversity (TEEB).⁴² Protecting and restoring 'green infrastructure', for example through mangrove restoration or wetland creation, can be significantly less costly over the long term than building engineered solutions. A global study on the Economics of Ecosystems and Biodiversity (TEEB) found that protecting biodiversity and ecosystems and using them sustainably is the best way to preserve and enhance their resilience and is one of the most cost-effective defences against the adverse impacts of climate change. It also notes that as well as being cost-effective, such approaches enable sometimes a more feasible adaptation solution than can be achieved solely through conventional engineered infrastructure. Protecting natural habitats can also significantly extend the lifetime of investments in costly hard infrastructure, for example the establishment of major protected areas to protect watersheds around hydro-electric power dams such as Nam Theun in the Lao People's Democratic Republic or irrigation schemes in Indonesia.⁴³ The case of the Whangamarino wetlands in New Zealand demonstrates the value of wetland restoration versus the construction of stopbanks along the river to prevent flooding. Cost-benefit analyses of mangrove restoration also testify to this. One example cited by the CBD AHTEG report involved the planting of nearly 12,000 hectares of mangroves in Viet Nam at a cost of USD 1.1 million. This represented savings of an estimated USD 7.3 million per year in dyke maintenance while also providing protection against a typhoon that devastated neighbouring areas. The use of ecosystem-based measures is one of the adaptation options readily accessible to the countries and

⁴⁰ World Bank. 2010. *Convenient Solutions to an Inconvenient Truth: Ecosystem-based Approaches to Climate Change*. Washington, D.C.: World Bank.

⁴¹ Convention on Biological Diversity. *Connecting Biodiversity and Climate Change Mitigation and Adaptation: Report of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change*. Technical Series No. 41. Montreal: Convention on Biological Diversity.

⁴² Economics of Ecosystems and Biodiversity. 2010. *The Economics of Ecosystems and Biodiversity for National and International Policy Makers*. Geneva: Economics of Ecosystems and Biodiversity.

⁴³ World Bank. 2010. *Convenient Solutions to an Inconvenient Truth: Ecosystem-based Approaches to Climate Change*. Washington, D.C.: World Bank.

communities most in need of implementing measures to adapt to the impacts of climate change. Ecosystem-based measures are particularly relevant given that the poor are often the most directly dependent on the services that ecosystems provide, with three quarters of the world's poorest citizens – those living on less than USD 2 per day – dependent on the environment for their livelihoods.⁴⁴ The TEEB study⁴⁵ also analysed case studies on ecosystem restoration and estimated the potential benefits of restoration projects in various biomes. This found that all biomes showed potential for exceptional rates of return and thus a high return for the restoration of ecosystems and their services.

50. Ecosystem-based approaches to adaptation also provide for the possibility of multiple economic, social, environmental and cultural co-benefits if the approach is designed and implemented appropriately. Ecosystem-based approaches to adaptation provide a range of other benefits that need to be taken into account when assessing and evaluating adaptation strategies.⁴⁶ Such win-win outcomes also help to avoid maladaptation.⁴⁷ Table 1 provides a summary of potential co-benefits. Restoring mangroves is a way to protect vulnerable coastal areas from coastal flooding and erosion. In addition to reducing the vulnerability of communities to storms, the mangroves provide a range of other services, such as habitats for fish nurseries, which provide environmental and socio-economic benefits that help to support livelihoods. Additionally, ecosystem-based approaches to adaptation, such as forest conservation or restoration of degraded wetlands, can also contribute to climate change mitigation measures, for example through increased absorption and/or storage of carbon and reducing emissions caused by ecosystem degradation.

⁴⁴ World Resources Institute. 2008. *Roots of Resilience – Growing the Wealth of the Poor*. Washington, D.C.: World Resources Institute.

⁴⁵ Economics of Ecosystems and Biodiversity. 2009. *The Economics of Ecosystems and Biodiversity: Climate Issues Update*. Geneva: Economics of Ecosystems and Biodiversity.

⁴⁶ Economics of Ecosystems and Biodiversity. 2010. *The Economics of Ecosystems and Biodiversity for National and International Policy Makers*. Geneva: Economics of Ecosystems and Biodiversity.

⁴⁷ Paterson JS, Araújo MB, Berry PM, Piper JM and Rounsevell MDAR. 2008. Mitigation, adaptation and the threat to biodiversity. *Conservation Biology*. 22: pp.1352–1355.

Table 1
Examples of ecosystem-based adaptation measures that provide co-benefits^a

<i>Adaptation measure</i>	<i>Adaptive function</i>	<i>Co-benefits</i>			
		<i>Social and cultural</i>	<i>Economic</i>	<i>Biodiversity</i>	<i>Mitigation</i>
Mangrove conservation	Protection against storm surges, sea level rise and coastal inundation	Provision of employment options (fisheries and prawn cultivation) Contribution to food security	Generation of income to local communities through marketing of mangrove products (fish dyes, medicines)	Conservation of species that live or breed in mangroves	Conservation of carbon stocks, both above ground and below ground
Forest conservation and sustainable forest management	Maintenance of nutrient and water flow Prevention of landslides	Opportunities for: Recreation Culture Protection of indigenous peoples and local communities	Potential generation of income through: Ecotourism Recreation Sustainable logging	Conservation of habitat for forest plants and animal species	Conservation of carbon stocks Reduction of emissions from deforestation and degradation
Restoration of degraded wetlands	Maintenance of nutrient and water flow, quality, storage and capacity Protection against floods or storm inundation	Sustained provision of: Livelihoods Recreation Employment opportunities	Increased: Livelihood generation Potential revenue from recreational activities Sustainable use Sustainable logging of planted trees	Conservation of wetland flora and fauna through maintenance of breeding grounds and stopover sites for migratory species	Reduced emissions from soil carbon mineralization
Conservation of agrobiodiversity	Provision of specific gene pools for crop and livestock adaptation to climatic variability	Enhanced food security Diversification of food products Conservation of local and traditional knowledge products	Possibility of agricultural income in difficult environments Environmental services such as bees for pollination of cultivated crops	Conservation of genetic diversity of crop varieties and livestock breeds	

<i>Adaptation measure</i>	<i>Adaptive function</i>	<i>Co-benefits</i>			
		<i>Social and cultural</i>	<i>Economic</i>	<i>Biodiversity</i>	<i>Mitigation</i>
Conservation of medicinal plants used by local and indigenous communities	Local medicines available for health problems resulting from climate change or habitat degradation, for example malaria, diarrhoea, cardiovascular problems	Local communities have an independent and sustainable source of medicines Maintenance of local knowledge and traditions	Potential sources of income for local people	Enhances medicinal plant conservation Local and traditional knowledge recognized and protected	Environmental services such as bees for pollination of cultivated crops
Sustainable management of grassland	Protection against floods Storage of nutrients Maintenance of soil structure	Recreation and tourism	Income generation for local communities through products made from grass	Forage for grazing animals Provide diverse habitats for animals that are predators and prey	Maintenance of carbon storage of soil

^a “Source: Convention on Biological Diversity. *Connecting Biodiversity and Climate Change Mitigation and Adaptation: Report of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change*. Technical Series No. 41. Montreal: Convention on Biological Diversity.”

D. Other considerations relating to the implementation of ecosystem-based approaches to adaptation

51. The empirical evidence of the case studies implies that ecosystem-based adaptation is not without complexity, uncertainty and risk. In order to ensure that the benefits of ecosystem-based approaches are fully realized, a number of issues would need to be considered. For example, planting mangroves in the wrong places may destroy otherwise important coastal habitats, thereby increasing vulnerability due to climate change impacts. Similarly, many ecosystems are vulnerable to the adverse effects of climate change, so care must be taken to ensure that measures are ‘climate proofed’. Thorough assessment of proposed measures is a necessary part of the evaluation process to ensure that approaches are sound.

52. In addition, ecosystem-based approaches to adaptation rely on a good understanding of ecosystem services and the relative importance of different ecosystem services. Managing ecosystems for adaptation may require the prioritization of certain services that ecosystems provide at the expense of others. For example, managing wetlands to provide coastal protection may require emphasis on silt accumulation and stabilization, possibly at the cost of reduced wildlife and possibilities for recreation.⁴⁸ It is therefore important that

⁴⁸ Convention on Biological Diversity. *Connecting Biodiversity and Climate Change Mitigation and Adaptation: Report of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate*

decisions to implement ecosystem-based adaptation are subject to risk assessment, scenario planning and adaptive management approaches that recognize and incorporate these potential trade-offs. It is also worth noting that broad stakeholder participation can be a measure of successful implementation, since many ecosystems and ecosystem services are managed by local users.

IV. Examples of ecosystem-based approaches to adaptation

53. The following examples of ecosystem-based approaches to adaptation are intended to provide an indication of the range of approaches being undertaken by various governments, intergovernmental organizations, regional organizations and networks across all ecosystems and geographic regions (see table 2 and the full examples in the online database on ecosystem-based approaches to adaptation).⁴⁹ To achieve a good overview, cases were extracted from projects and approaches contained within reports, databases, websites and other knowledge products produced by organizations engaged in the research and implementation of ecosystem-based approaches to adaptation.

54. Projects that had already concluded were emphasized, owing to the potential for learning lessons and best practices. However, many projects are still under development or implementation, almost certainly due to the recent emergence of adaptation as a field of work. It is also for this reason that some examples included in this compilation are unlikely to have been designed as ecosystem-based approaches to adaptation. For example, some adaptation projects incorporate a range of ecosystem-based components without being labelled as ecosystem-based adaptation. Likewise, other initiatives involve sustainable management, conservation or restoration of ecosystems, although they may not have been explicitly designed to promote adaptation or have identified adaptation as a specific objective, including some disaster risk reduction or landscape management initiatives. Nevertheless, these initiatives contribute to increasing resilience and reducing vulnerability to climate change impacts and as such have been included here in the interests of demonstrating the full range of measures that are relevant to ecosystem-based approaches to adaptation.

55. A range of strategies to address vulnerability in the face of climate change is employed. These strategies are not mutually exclusive, and many examples employ a suite of approaches. The range of activities can be clustered within three broad areas, as follows:

- (a) Assessment of vulnerability: assessment and valuation (including accumulating knowledge on bioclimatic modelling, valuing the services of ecosystems and filling information gaps with regard to ecosystem functions);
- (b) Improvements in capacity, design and policy measures, including the following:
 - (i) Capacity-building;
 - (ii) Awareness-raising/education;
 - (iii) Identifying and/or developing adaptation approaches;
 - (iv) Promoting policy change;
 - (v) Incorporating ecosystem-based approaches into relevant strategies (including adaptation strategies and plans, national biodiversity strategies, poverty reduction strategies, disaster risk reduction strategies, sustainable land management strategies

Change. Technical Series No. 41. Montreal: Convention on Biological Diversity.

⁴⁹ <<http://unfccc.int/6227>>.

and plans such as integrated water resource management plans, forest management plans and private-sector plans);

(c) Implementation of ecosystem-based adaptation measures, including the following:

- (i) Pilot and demonstration schemes;
- (ii) Natural resource management (including sustainable management, conservation and restoration of ecosystems);
- (iii) Establishment of protected areas and planning for conservation networks;
- (iv) Diversification of livelihoods;
- (v) Changing management practices, for example alternative agricultural approaches and water conservation practices.

Table 2
Index of examples of ecosystem-based approaches to adaptation^a

<i>Description</i>	<i>Region</i>	<i>Country</i>	<i>Ecosystem</i>	<i>Nature of approach</i>	<i>Type of institution</i>	<i>Name of institution</i>
Responding to shoreline change and its human dimensions through integrated coastal area management	Africa	Cape Verde, Gambia, Guinea-Bissau, Mauritania, Senegal	Marine and coastal	Improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	United Nations agency	United Nations Development Programme; Global Environment Facility; United Nations Educational, Scientific and Cultural Organization
Community-based fire management in Australia	Oceania	Australia	Rangeland and grassland; forest and woodland	Improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	Government	Northern Territory Government
Protective capacity of forests against snow avalanches	Europe	Switzerland	Mountain; forest and woodland	Improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	Government	Government of Switzerland
Enhancing adaptive capacity in semi-arid mountainous regions	Latin America and the Caribbean	Bolivia (Plurinational State of)	Mountain	Assessment of vulnerability; improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	Government	Netherlands Climate Assistance Programme
Carpathian integrated assessment of vulnerability to climate change and ecosystem-based adaptation measures project	Europe	Czech Republic, Hungary, Poland, Romania, Serbia, Slovakia, Ukraine	Mountain; forest and woodland	Assessment of vulnerability; improvement in capacity, design and policy measures	Government	European Commission
CEIBA-PILARES project	Latin America and the Caribbean	Ecuador, Peru	Forest and woodland	Improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	Non-governmental organization	Nature and Culture International

<i>Description</i>	<i>Region</i>	<i>Country</i>	<i>Ecosystem</i>	<i>Nature of approach</i>	<i>Type of institution</i>	<i>Name of institution</i>
Coping with drought and climate change in the Chiredzi district	Africa	Zimbabwe	Agriculture; rangelands and grasslands	Assessment of vulnerability; improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	Government; United Nations agency	Government of Zimbabwe; United Nations Development Programme
Integrated national adaptation plan – Colombia highland ecosystems	Latin America and the Caribbean	Colombia	Mountain; inland water	Assessment of vulnerability; improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	Intergovernmental organization; non-governmental organization; United Nations agency;	Global Environment Facility; World Bank; Conservation International
Edmonton's urban forest management plan	North America	Canada	Urban; forest and woodland	Assessment of vulnerability; improvement in capacity, design and policy measures	Government	City of Edmonton
Drought resistant agriculture in El Salvador	Latin America and the Caribbean	El Salvador	Agriculture	Improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	Non-governmental organization; United Nations agency	Red Cross; World Food Programme
Managed realignment and the re-establishment of salt marsh habitat, Frieston Shore	Europe	United Kingdom	Marine and coastal	Improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	Government; non-governmental organization	Royal Society for the Protection of Birds; Environment Agency of the United Kingdom
Agriculture in the Lower Flint River Basin, Georgia	North America	United States	Agriculture	Improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	Non-governmental organization	Nature Conservancy
Community-based coastal habitat restoration (green coast project)	Asia	Indonesia, India, Sri Lanka, Malaysia, Thailand	Marine and coastal; forest and woodland	Improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	Intergovernmental organization; non-governmental organization;	Wetlands International; Both Ends; World Wildlife Fund; International Union for Conservation of Nature

<i>Description</i>	<i>Region</i>	<i>Country</i>	<i>Ecosystem</i>	<i>Nature of approach</i>	<i>Type of institution</i>	<i>Name of institution</i>
Integrating agro-forestry practices in the farming system	Small island developing States/Latin America and the Caribbean	Grenada	Agriculture; mountain	Implementation of ecosystem-based adaptation measures	Government	Government of Grenada
Integration of climate change risk and resilience into forestry management	Small island developing States/Oceania	Samoa	Forest and woodland	Improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	Government; United Nations agency	United Nations Development Programme; Global Environment Facility; Government of Samoa
Jordan Valley permaculture project	Asia	Jordan	Agriculture	Improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	Research	National Center for Agricultural Research and Transfer of Technology, Jordan; Permaculture Research Institute of Australia
Kikuyu escarpment forest	Africa	Kenya	Forest and woodland	Implementation of ecosystem-based adaptation measures	Non-governmental organization; government	Birdlife International; Kenyan Forestry Service
Kimbe Bay: scientific design of a resilient network of marine protected areas	Small island developing States/Oceania	Papua New Guinea	Marine and coastal	Assessment of vulnerability; improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	Non-governmental organization	Nature Conservancy
Assessing the impacts of climate change on Madagascar's biodiversity and livelihoods	Africa	Madagascar	Forest; marine and coastal	Assessment of vulnerability; improvement in capacity, design and policy measures	Government; non-governmental organization	Government of Madagascar; United States Agency for International Development; Conservation International; World Wildlife Fund for Nature

<i>Description</i>	<i>Region</i>	<i>Country</i>	<i>Ecosystem</i>	<i>Nature of approach</i>	<i>Type of institution</i>	<i>Name of institution</i>
Using the Maya nut tree to increase tropical agroecosystem resilience to climate change in Central America and Mexico	Latin America and the Caribbean	El Salvador, Guatemala, Mexico, Nicaragua	Forest and woodland; agriculture	Improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	Non-governmental organization	Maya Nut Institute
Adapting to climate change in the Mesoamerican reef	Latin America and the Caribbean	Belize	Marine and coastal	Assessment of vulnerability; improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	Non-governmental organization	World Wildlife Fund for Nature
Coping with drought and climate change	Africa	Mozambique	Agriculture; rangeland and grassland	Improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	United Nations agency	United Nations Development Programme
Nagoya water revitalization plan	Asia	Japan	Urban; inland waters	Improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	Government	City of Nagoya
New Orleans: preserving the wetlands to increase climate change resilience	North America	United States	Inland water; marine and coastal	Improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	Government	City of New Orleans
Nomadic herders: enhancing the resilience of pastoral ecosystems and livelihoods	Polar	Mongolia, Russian Federation	Mountain; rangeland and grassland	Assessment of vulnerability; improvement in capacity, design and policy measures	Non-governmental organization; research; United Nations agency	United Nations Environment Programme/GRID-Arendal; Association of World Reindeer Herders; UArctic EALÁT Institute

<i>Description</i>	<i>Region</i>	<i>Country</i>	<i>Ecosystem</i>	<i>Nature of approach</i>	<i>Type of institution</i>	<i>Name of institution</i>
Netherlands Ooijpolder 'climate buffer' project	Europe	Netherlands	Inland water	Improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	Government; non-governmental organizations; private landowner	ARK Nature; Rivierenland (Water Board); Birdlife Netherlands; National Forest Service; and a private landowner
Orito Ingi Ande Medicinal Plants Sanctuary	Latin America and the Caribbean	Colombia	Forest and woodland	Improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	Government; local communities	Government of Colombia; local communities
Pangani River Basin management project	Africa	United Republic of Tanzania	Inland water; agriculture	Improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	Intergovernmental organization; non-governmental organization; United Nations agency	Pangani River Basin management project; International Union for Conservation of Nature; United Nations Development Programme
Rio de Janeiro's community reforestation project	Latin America and the Caribbean	Brazil	Urban; forest and woodland	Improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	Government	City of Rio de Janeiro
Ecosystem-based adaptation by smallholder farmers in Roslagen	Europe	Sweden	Agriculture	Improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	Informal network of smallholder farmers	Not applicable
Conservation and management of high altitude peatlands of Ruoergai marshes for water security and climate change adaptation	Asia	China	Mountain; inland water	Improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	Non-governmental organization	Wetlands International

<i>Description</i>	<i>Region</i>	<i>Country</i>	<i>Ecosystem</i>	<i>Nature of approach</i>	<i>Type of institution</i>	<i>Name of institution</i>
Maintenance of hydropower potential in Rwanda through ecosystem restoration	Africa	Rwanda	Inland water	Improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	Government	Government of Rwanda
South Africa: ecosystem-based planning for climate change	Africa	South Africa	All	Improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	Government	Government of South Africa
Community-based rangeland rehabilitation	Africa	Sudan	Rangeland and grassland; agriculture	Improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	United Nations agency	United Nations Development Programme; Global Environment Facility
Adaptation to climate change impacts in the Syunik mountain forest ecosystems	Asia	Armenia	Forest and woodland; mountain	Improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	Government; United Nations agency	Global Environment Facility; United Nations Development Programme; Government of Armenia
Increasing taro crop diversity	Small island developing States/Oceania	Samoa	Agriculture	Improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	Government; non-governmental organization; research	Secretariat of the Pacific Community; The Australian Agency for International Development; Australian Centre for International Agricultural Research
Tonlé Sap	Asia	Cambodia	Forest and woodland; inland water	Assessment of vulnerability; improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	Government; non-governmental organization	Conservation International; Government of Cambodia
Whangamarino wetlands	Oceania	New Zealand	Inland water	Improvement in capacity, design and policy measures; implementation of ecosystem-based adaptation measures	Government	Government of New Zealand

^a Complete descriptions of these case studies are available at <<http://unfccc.int/6227>>.

V. Lessons learned

56. A number of lessons and good practices emerging from the case studies have been identified. These include the following:

(a) Measures can and should be integrated within the broader adaptation context to avoid maladaptation and can complement other approaches (including engineered or technical solutions) through realizing multiple co-benefits, including mitigation. Integrated examples (e.g. agriculture in the Lower Flint River Basin in Georgia, United States, ecosystem-based planning in South Africa or the integrated national adaptation plan in Colombia) can provide cost-effective opportunities to achieve multiple objectives relating to climate change, development and biodiversity;

(b) Ecosystem-based approaches are widely applicable and can be implemented at the appropriate scale, including the river basin level, as demonstrated through a regional initiative on the West Africa shorelines of Cape Verde, Gambia, Guinea-Bissau, Mauritania and Senegal and a local example of Edmonton's urban forest management plan in Canada;

(c) Ecosystem-based approaches are accessible by vulnerable communities, and because they can be locally managed and provide vital ecosystem resources that support adaptation they are often enduring. This has been demonstrated through approaches such as the Maya nut agroforestry project in El Salvador, Mexico and Nicaragua that serve to provide access to natural resources, or the green coast community-based coastal habitat restoration project in India, Indonesia, Malaysia, Sri Lanka and Thailand that contributes to disaster risk reduction,

(d) Involving broad participation is vital to planning, buy-in and sustainability of these measures (e.g. novel, low-cost and practical agricultural practices have been accepted by the local community through drought-resistant agriculture in El Salvador and the benefits of community involvement have been demonstrated through the scientific design of a resilient network of marine protected areas in Kimbe Bay, Papua New Guinea);

(e) Approaches can benefit from knowledge of past interventions and best practices, as has been demonstrated through Zimbabwe's work on coping with drought and climate change in the Chiredzi district.

57. The case studies also identified a number of challenges, including the following:

(a) There are limits to what is possible when undertaking an ecosystem-based approach (some circumstances may require a more engineered or technical solution);

(b) The role of ecosystems and ecosystem services is sometimes overlooked, misunderstood or ignored, which can lead to maladaptation and reduced resilience;

(c) Possible reticence about, conflict with or opposition to new approaches or concepts (e.g. reducing grazing to restore services that ecosystems could provide);

(d) The length of time for implementation can be long in certain cases (e.g. creating wetlands or salt marshes) and some require continuity to be successful (e.g. lessons learned from community-based fire management in Australia);

(e) A lack of concrete (scientific and technical) information about the effects of different management options relating to the following:

(i) Understanding of ecosystem interactions, including potential trade-offs (e.g. the Whangamarino wetlands in New Zealand, where the current management prioritizes some ecosystem services, such as water regulation, over others);

(ii) Insufficient monitoring and reporting of data (including for those projects that have concluded, for which it is sometimes difficult to find review/evaluation documents);

(f) A lack of practical guidance on how to build resilience/incorporate ecosystem-based approaches to adaptation in strategies.

58. The following might be considered to enhance the implementation of ecosystem-based approaches to adaptation:

(a) Targeted awareness-raising, both within the adaptation community (regarding the value of ecosystem-based approaches to adaptation) and within the sectors responsible for ecosystem management, regarding the importance of adaptation;

(b) Capacity-building measures;

(c) Further research to address gaps;

(d) Development of guidelines, tools, principles, etc.;

(e) Activities to enhance collaboration and coordination between relevant organizations, including the Nairobi work programme partner organizations;

(f) Identifying the existing pool of expertise and organizations that are best suited to support ongoing activities related to ecosystem-based adaptation in the fields of science, policy and implementation;

(g) Identifying Parties' needs and ways in which Parties can be supported when implementing activities;

(h) Increasing collaboration on activities related to ecosystems and adaptation between the three Rio Conventions, especially at the national level.

Annex

Matrix of some knowledge products on ecosystem-based approaches to adaptation

<i>Institution</i>	<i>Report (can include case studies)</i>	<i>Database/case studies</i>	<i>Toolkit</i>	<i>Ecosystem-based approach focused (versus general focus on adaptation to climate change)</i>	<i>Source</i>
Adaptation Learning Mechanism		√			< http://www.adaptationlearning.net >
German Federal Agency for Nature Conservation (BfN)	√			√	<i>Working with Nature to Tackle Climate Change: Report of the ENCA/BfN Workshop on “Developing Ecosystem-based Approaches to Climate Change – Why, What and How”</i> < http://www.bfn.de/fileadmin/MDB/documents/service/Skript264.pdf >
United Nations Environment Programme-World Conservation Monitoring Centre, commissioned by the German Federal Agency for Nature Conservation (in preparation and expected to be available in late 2011)	√	√		√	<i>Ecosystem-based Adaptation and Mitigation – Good Practice Examples and Lessons Learnt in Europe</i> < http://www.bfn.de/0502_skripten.html?&no_cache=1&L=1 >
Birdlife International	√			√	<i>Partners with Nature: How Healthy Ecosystems are Helping the World's Most Vulnerable Adapt to Climate Change</i> < http://www.birdlife.org/climate_change/pdfs/Ecosystemsandadaptation.pdf >
Convention on Biological Diversity		√		√	< http://adaptation.cbd.int/activities.shtml >
Convention on Biological Diversity	√			√	<i>Connecting Biodiversity and Climate Change Mitigation and Adaptation: Report of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change</i> < http://www.cbd.int/doc/publications/cbd-ts-41-en.pdf >
Convention on Biological Diversity	√				<i>Review of the Literature on the Links between Biodiversity and Climate Change: Impacts, Adaptation and Mitigation</i> < http://www.cbd.int/doc/publications/cbd-ts-42-en.pdf >

<i>Institution</i>	<i>Report (can include case studies)</i>	<i>Database/case studies</i>	<i>Toolkit</i>	<i>Ecosystem-based approach focused (versus general focus on adaptation to climate change)</i>	<i>Source</i>
Center for International Forestry Research		√		√	< http://www.cifor.org/forest-research/research-themes/adapting-to-climate-change/adapting-to-climate-change-projects.html >
Conservation International		√			< http://www.conservation.org/learn/climate/strategies/field/pages/projects.aspx >
Ecosystems and Livelihoods Adaptation Network (ELAN)		√		√	ELAN case studies: good practices < http://www.elanadapt.net/good-practices >
Global Water Partnership			√		< http://www.gwptoolbox.org/index.php >
GRaBS project		√			< http://www.grabs-eu.org/casestudies.php >
International Union for Conservation of Nature	√			√	<i>Building Resilience to Climate Change: Ecosystem-based Adaptation and Lessons from the Field</i> < http://data.iucn.org/dbtw-wpd/edocs/2010-050.pdf >
International Union for Conservation of Nature	√			√	<i>Ecosystem-based Adaptation: A Natural Response to Climate Change</i> < http://cmsdata.iucn.org/downloads/iucn_eba_brochure.pdf >
Natureandpoverty.net		√	√	√	< http://www.natureandpoverty.net/eba/ >
Netherlands Climate Assistance Programme		√			< http://www.nlcip.net/ >
ProAct Network		√		√	<i>The Role of Environmental Management and Eco-engineering in Disaster Risk Reduction and Climate Change Adaptation: Report's Case Studies</i> < http://www.proactnetwork.org/proactweb/site/en/component/content/article/47-policytoolsguidance/98-the-role-of-environmental-management-in-disaster-risk-reduction-and-climate-change-adaptation-case-studies >
Economics of Ecosystems and Biodiversity		√			< http://www.teebweb.org/TEEBcases/tabid/29858/Default.aspx >
Economics of Ecosystems and Biodiversity	√				<i>The Economics of Ecosystems and Biodiversity: Climate Issues Update</i> < http://www.teebweb.org/InformationMaterial/TEEBReports/tabid/1278/Default.aspx >
Nature Conservancy			√		< http://www.reefresilience.org/ >

<i>Institution</i>	<i>Report (can include case studies)</i>	<i>Database/case studies</i>	<i>Toolkit</i>	<i>Ecosystem-based approach focused (versus general focus on adaptation to climate change)</i>	<i>Source</i>
Ecologic Institute and Environmental Change Institute, commissioned by the European Commission, Environment Directorate-General (in preparation and expected to be available in late 2011)	√			√	<i>Assessing the Potential on Ecosystem- based Approaches to Adaptation and Mitigation in Europe</i> < http://ec.europa.eu/environment/nature/ climatechange/index_en.htm >
Nature Conservancy		√		√	< http://www.nature.org/ourinitiatives/ur gentissues/climatechange/placesweprote ct/index.htm >
Nature Conservancy	√			√	<i>Adapting to Climate Change: Ecosystem-based Approaches for People and Nature</i> < http://conserveonline.org/workspaces/c limateadaptation/documents/ecosystem- based-approaches-for-people-and- nature >
United Nations Development Programme		√			< http://www.undp- adaptation.org/portfolio/ >
United Nations Environment Programme	√			√	<i>Integrated Solutions for Biodiversity, Climate Change and Poverty</i> < http://www.unep.org/ecosystemmanage ment/ >
UNFCCC		√			< http://maindb.unfccc.int/public/adaptati on/ >
weADAPT		√	√		< http://www.weadapt.org >
Wetlands International		√			< http://www.wetlands.org/Whatwedo/A daptingtoclimatechange/Mapofadaptatio nprojects/tabid/2086/Default.aspx >
Wetlands International	√			√	<i>Making the Invisible Visible: The Role of Impact Assessments in Climate Change Adaptation Measures</i> < http://www.wetlands.org/LinkClick.asp x?fileticket=OWOtWtkP5x8%3d&tabid =56 >
World Bank	√			√	<i>Convenient Solutions to an Inconvenient Truth: Ecosystem-based Approaches to Climate Change</i> < http://climatechange.worldbank.org/cli matechange/content/convenient- solutions-inconvenient-truth >

<i>Institution</i>	<i>Report (can include case studies)</i>	<i>Database/case studies</i>	<i>Toolkit</i>	<i>Ecosystem-based approach focused (versus general focus on adaptation to climate change)</i>	<i>Source</i>
World Bank	√			√	<i>Biodiversity, Climate Change and Adaptation: Nature-based Solutions from the World Bank Portfolio</i> < http://siteresources.worldbank.org/INT/BIODIVERSITY/Resources/Biodiversity_10-1-08_final.pdf >
World Resources Institute		√		√	< http://projects.wri.org/adaptation-database >
World Resources Institute	√	√	√		<i>World Resources Report</i> < http://www.worldresourcesreport.org/ >
World Resources Institute			√		< http://www.wri.org/project/vulnerability-and-adaptation/nac-framework >
World Wildlife Fund for Nature	√				<i>WWF Adaptation Case Studies for Responding to Climate Change Impacts</i> < http://www.worldwildlife.org/what/where/erewework/mesoamericanreef/WWFBinaryitem14669.pdf >
World Wildlife Fund for Nature	√			√	<i>Natural Solutions: Protected Areas Helping People Cope with Climate Change</i> < http://cmsdata.iucn.org/downloads/natural_solutions.pdf >
World Wildlife Fund for Nature		√			< http://test.worldwildlife.org/climate/WWFBinaryitem3831.pdf >