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SECOND AD HOC TECHNICAL EXPERT GROUP ON
BIODIVERSITY AND CLIMATE CHANGE
Second meeting
Helsinki, 18–22 April 2009

REPORT OF THE SECOND MEETING OF THE SECOND AD HOC TECHNICAL EXPERT GROUP ON BIODIVERSITY AND CLIMATE CHANGE

INTRODUCTION

1. The Second Ad Hoc Technical Expert Group (AHTEG) on Biodiversity and Climate Change was established in response to decision IX/16 of the Conference of the Parties to the Convention on Biological Diversity. The purpose of the AHTEG is to provide biodiversity-relevant information to the United Nations Framework Convention on Climate Change (UNFCCC) through the provision of scientific and technical advice on the integration of the conservation and sustainable use of biodiversity into climate change mitigation and adaptation activities.

2. In order to fully and effectively complete the terms of reference as outlined in annex III to decision IX/16, it was planned that the AHTEG would convene at least two meetings. The first meeting was held in London from 17 to 21 November 2008. It addressed two main issues: (i) identification of risks and vulnerabilities; and (ii) the enhancement of scientific and technical links between biodiversity and climate change mitigation.

3. The second meeting of the AHTEG was held in Helsinki from 18 to 22 April, 2009 in order to address the links between biodiversity conservation and sustainable use and climate-change adaptation, risks and vulnerabilities. In particular, the second meeting addressed the following elements of the terms of reference:

(a) Identifying case-studies and general principles to guide local and regional activities aimed at reducing risks to biodiversity values associated with climate change (decision IX/16, annex III, paragraph (c));

(b) Identifying ways that components of biodiversity can reduce risk and damage associated with climate change impacts (decision IX/16, annex III, paragraph (l));

(c) Identifying potential biodiversity-related impacts and benefits of adaptation activities, especially in the regions identified as being particularly vulnerable under the Nairobi work programme on impacts, vulnerability and adaptation to climate change (developing countries, especially least developed countries and small island developing States) as adopted by the Conference of the Parties to the United Nations Framework Convention on Climate Change at its eleventh meeting (decision IX/16, annex III, paragraph (d)); [1]

[1] See decision 2/CP.11 of the Conference of the Parties to the United Nations Framework Convention on Climate Change.

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(d) Proposing ways and means to improve the integration of biodiversity considerations and traditional and local knowledge related to biodiversity within climate change adaptation, with particular reference to communities and sectors vulnerable to climate change (decision IX/16, annex III, paragraph (h));

(e) Identifying ways and means for the integration of the ecosystem approach in impact and vulnerability assessment and climate-change adaptation strategies (decision IX/16, annex III, paragraph (e));

(f) Identifying measures that enable ecosystem restoration from the adverse impacts of climate change which can be effectively considered in impact, vulnerability and climate change adaptation strategies (decision IX/16, annex III, paragraph (f));

(g) Highlighting case-studies and identifying methodologies for analysing the value of biodiversity in supporting adaptation in communities and sectors vulnerable to climate change (decision IX/16, annex III, paragraph (b));

(h) Analysing the social, cultural and economic benefits of using ecosystem services for climate change adaptation and of maintaining ecosystem services by minimizing adverse impacts of climate change on biodiversity (decision IX/16, annex III, paragraph (g));

(i) Identifying means to incentivize the implementation of adaptation actions that promote the conservation and sustainable use of biodiversity (decision IX/16, annex III, paragraph (m)).

4. Sources of information for this meeting include background documents prepared by the Secretariat of the Convention on Biological Diversity and the World Conservation Monitoring Centre of the United Nations Environment Programme (UNEP-WCMC). The Group also considered the findings of the first AHTEG on Biodiversity and Climate Change as contained in Technical Series Nos. 10 and 25 and the findings of the first meeting of the second AHTEG (UNEP/CBD/AHTEG/BD-CC-2/2/5). Additional documents include recommendation 135 (2008) of the Standing Committee of the Bern Convention, adopted on 27 November 2008, on addressing the impacts of climate change on biodiversity. Further, an overview of relevant decisions, conclusions, meetings and documents from the United Nations Framework Convention on Climate Change (UNFCCC) was provided by its secretariat.

5. Finally, the Group benefited from input from relevant organizations and individuals as submitted to the online dialogue on climate change and biodiversity convened by the Secretariat of the Convention on Biological Diversity, from 9 to 20 March, 2009.

ITEM 1. OPENING OF THE MEETING

6. Mr. Jo Mulongoy of the Secretariat of the Convention on Biological Diversity (SCBD) welcomed participants on behalf of the Executive Secretary and opened the meeting at 9 a.m. on Saturday, 18 April, 2009. Mr. Mulongoy also expressed his thanks to the Government of Finland for hosting and funding the second meeting and for making participants feel so welcome. Mr. Mulongoy reminded participants of the importance of the meeting to the processes of the Convention, especially given the length and breadth of decision IX/16 adopted by the Conference of the Parties on biodiversity and climate change. Mr. Mulongoy emphasized the fact that the Conference of the Parties placed emphasis on implementation, especially with regards to mutually supportive activities among the three Rio Conventions. Mr. Mulongoy reminded participants that the AHTEG is being convened with an extensive terms of reference leading to the convening of the two meetings with this second meeting focusing on risk and adaptation.

7. Mr. Mulongoy informed participants that the findings of this meeting will be conveyed to the thirtieth meeting of the Subsidiary Bodies of the UNFCCC in preparation for the Copenhagen meeting in December. Finally Mr. Mulongoy thanked all of the organizations who nominated and funded participants from their organization.

8. Mr. Jussi Soramäki of the Government of Finland welcomed participants on behalf of the Ministry of Environment and the Ministry of Foreign Affairs. Mr. Soramäki emphasized their commitment to linking climate change and biodiversity within the frameworks of the Convention on Biological Diversity and the UNFCCC. Mr. Soramäki thanked the Department for Environment, Food and Rural Affairs (Defra) for hosting the first meeting of the second AHTEG and further thanked UNEP-WCMC for the preparation of their background document.

9. Mr. Soramäki explained that while a good deal of expertise on biodiversity and climate change exists, the challenge lies in bringing this expertise into negotiations. As a party to both Conventions, Mr. Soramäki explained that Finland is ready to also take responsibility in improving this link.

10. Finally Mr. Soramäki provided participants with information on the logistics of the meeting and the venue, and invited participants to an informal reception. Mr. Soramäki concluded by stating that climate change challenges cannot be addressed without linking to biodiversity in considering both mitigation and adaptation responses.

ITEM 2. ORGANIZATIONAL MATTERS

2.1. Election of officers

11. After a self-introduction of participants (see full list of participants in annex I), Mr. Mulongoy informed participants that the AHTEG will be receiving input from the Indigenous peoples and local communities from the International Symposium to be held in Anchorage Alaska, from 20 to 24 April, 2009.

12. Based on the suggestion of the Secretariat, the Group elected Mr. Heikki Toivonen, Research Director from the Finnish Environment Institute and Mr. Guy Midgley, Chief Director of the Climate Change and Bio-adaptation Division of the South African National Biodiversity Institute as its co-chairs.

2.2. Adoption of the agenda

13. The provisional agenda prepared by the Executive Secretary (UNEP/CBD/AHTEG/BD-CC-2/2/1) was adopted by the Group.

2.3. Organization of work

14. Following a presentation by Mr. Jo Mulongoy (SCBD) concerning the terms of reference before the AHTEG, the Group adopted the proposed organization of work for the meeting as contained in UNEP/CBD/AHTEG/BD-CC-2/2/1/Add.1 as a flexible framework for the work of the Group.

15. To accomplish this work the Group decided to break into two working groups, one to address agenda item 3 and the second to address agenda items 4 and 5.1. A small drafting committee was also established to address agenda item 5.2.

16. Before breaking into working groups, Mr. Barney Dickson of UNEP-WCMC presented the literature review on biodiversity and climate change adaptation prepared by UNEP-WCMC with funding from the Government of the United Kingdom of Great Britain and Northern Ireland and the Government of Finland.

17. In his presentation Mr. Dickson identified three categories that were addressed in the literature review: the contribution of biodiversity to adaptation, the possible negative impacts of adaptation on biodiversity and the role of adaptation in the conservation sector. Mr. Dickson highlighted that biodiversity-based adaptation is particularly important for the poor because of the contribution of ecosystem services to biodiversity-based livelihoods. Sectors highlighted in the background document include coastal ecosystems, the water sector, agriculture and forests.

18. Mr. Dickson reminded participants that ecosystem-based adaptation should be integrated with other adaptation approaches in order to address the full range of impacts that climate change will have.

19. Some of the possible negative impacts of adaptation activities that the background document highlighted include hard coastal defences causing the degradation of coastal wetlands and increased irrigation use in agriculture, which can decrease water availability for ecosystems.

20. Mr. Dickson further discussed adaptation for the conservation sector within the framework of both natural adaptation and planned adaptation. With regards to planned adaptation the document addresses protected area systems, protected area management and functional connectivity between ecosystems.

21. Finally Mr. Dickson reminded participants that natural resource management may be one of the areas where there is the greatest opportunity for synergies between climate change mitigation and adaptation; nevertheless, some trade-offs may be required.

22. Furthermore, in order to facilitate consideration of the agenda items, Ms. Hanna Hoffmann (UNFCCC) provided participants with an overview of adaptation-related issues under UNFCCC including information on relevant bodies, processes, decisions, conclusions and documents. Ms. Hoffmann also provided participants with information relating to the Nairobi work programme and options for providing input related to the Convention on Biological Diversity to UNFCCC.

23. A further presentation was delivered by Ms. Carolina Lasen Diaz of the Bern Convention with regard to ongoing processes under the Bern Convention. Ms. Lasen provided an overview of the background, membership and objectives of the Bern Convention. Ms Lasen further introduced both climate change mitigation and adaptation related Recommendations adopted by Bern Convention Parties, including on minimizing the adverse impacts of wind power generation and the establishment of a Group of Experts on Biodiversity and Climate Change.

24. Ms. Lasen informed participants of a number of relevant documents and reports and Recommendation 135 on addressing the impacts of climate change on biodiversity including the appendix containing proposed actions for governments relating to vulnerability, invasive alien species, protected areas and principles for adaptation strategies.

25. Finally Ms. Lasen described upcoming activities in 2009 including the fourth meeting of the Group of Experts on Biodiversity and Climate Change.

26. Mr. Jonathan Hoekstra from the Nature Conservancy provided participants with additional details on case-studies concerning implementation of climate-change adaptation activities that integrate biodiversity conservation and sustainable use. In particular Mr. Hoekstra presented a case-study from Papua New Guinea regarding the design of a marine protected areas network, which incorporates reef resilience principles, including representation and replication, critical areas, connectivity and effective management.

27. Mr. Hoekstra also presented a case-study from North Carolina in the United States of America in which sea level rise (7.5 cm) is threatening low-lying areas. In this case, ecosystem-based adaptation involved pre-storing oyster reefs, restoring hydrology through tidal gate management and introducing native salt-tolerant species.

ITEM 3. RISKS TO BIODIVERSITY FROM CLIMATE CHANGE AND RELATED ADAPTATION RESPONSES

28. This agenda item is intended to address items ‘c’ and ‘l’ of the terms of reference presented in annex III to decision IX/16. To introduce this agenda item, before the working groups broke out, Ms. Jaime Webbe of the Secretariat of the Convention on Biological Diversity presented an overview of the background document on approaches to linking biodiversity and climate change related risk and vulnerabilities (UNEP/CBD/AHTEG/BD-CC-2/2/2). In her presentation Ms. Webbe introduced participants to the concepts and definitions of risk and vulnerability. Ms. Webbe also presented some of the activities that are being implemented already in order to reduce risks to biodiversity as a result of

climate change including expanding networks of protected areas, *ex situ* conservation and reducing other threats to biodiversity.

29. The co-chairs reminded participants that additional relevant information can be found in the report of the first meeting of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change (UNEP/CBD/AHTEG/BD-CC-2/1/5) and the background document prepared by UNEP/WCMC.

30. Participants then began discussions on how the agenda item should be addressed emphasizing the challenge of providing key messages to two different audiences (CBD and UNFCCC) and the need to link climate-change risk with climate-change adaptation. Participants also emphasized the importance of linking risks to biodiversity to climate change related risks to other sectors and thematic areas, including livelihoods. Finally participants suggested that it would be useful to identify gaps in information or knowledge.

31. The working group addressing this agenda item convened under the chairmanship of Mr. Guy Midgley (South Africa). In order to complete its work, the working group decided to break into two smaller groups, one to address agenda item 3.1 and another to address 3.2.

3.1. General principles to guide local and regional activities aimed at reducing risks to biodiversity as a result of climate change

32. The chair invited the working group to consider the impacts of climate change on biodiversity identified by the first meeting of the AHTEG and also in the UNEP-WCMC document within the framework of risk and vulnerability and to identify case-studies and general principles that can be applied at various scales in order to reduce the risks to biodiversity as a result of climate change. The proposed principles are contained in annex II to this report.

3.2. Potential benefits and risks to biodiversity as a result of adaptation activities

33. The working group chair invited the working group to review and revise table 1 in CBD Technical Series 25, which presents an indicative list of adaptation activities relevant to the thematic areas considered under the Convention on Biological Diversity and identify potential biodiversity-related impacts of adaptation activities, especially in the regions identified as being particularly vulnerable under the Nairobi work programme. The results of the work are available in the table in annex II to this report.

ITEM 4. BENEFITS OF BIODIVERSITY FOR ENHANCING ADAPTATION OPTIONS UNDER CLIMATE CHANGE

34. The working group addressing this agenda item convened under the chairmanship of Mr. Ian Noble (World Bank) and Mr. Neville Ash (IUCN). In initial discussions, the working group discussed the challenge of producing a report that would be relevant for both the Convention on Biological diversity and UNFCCC.

35. The working group decided to separate its work into two time phases: first addressing the terms of reference items calling for the identification and second the terms of reference items concerning the development of proposals.

36. Accordingly the working group broke into three sub-groups in order to identify the scope of the issue, assess how much can be synthesized from existing literature and suggest main messages with regards to (1) restoration and resilience within climate change adaptation; (2) evidence based justification for the value of ecosystem services in adaptation; and (3) identifying incentives for the inclusion of biodiversity within adaptation.

4.1. Proposals on ways through which components of biodiversity can reduce risk and damage associated with climate-change impacts

37. Under this agenda item, the working group considered the different elements of risk (vulnerability, exposure to hazards and adaptive capacity) within the framework of ecosystem services

provided by biodiversity to identify ways that components of biodiversity can reduce risk and damage associated with climate-change impacts.

4.2. Proposals on improving the integration of biodiversity considerations and traditional and local knowledge related to biodiversity within climate-change adaptation

38. The working group developed proposals on ecosystem-based adaptation. The group also benefited from the work of the sub-group on agenda item 3.2 who contributed information on minimizing negative impacts of adaptation on biodiversity while also maximizing positive impacts from such activities.

39. The working group co-chairs also informed participants that Johnson Cerda, a participant in the first meeting of the AHTEG, will be providing a written report of the relevant findings of the Indigenous Peoples' Global Summit on Climate Change which will be held the 20 to 24 April, 2009 in order to ensure that guidance on traditional and local knowledge related to biodiversity is included.

4.3. Proposals on ways and means to incentivize the implementation of adaptation actions that promote the conservation and sustainable use of biodiversity

40. Based on the decisions adopted under the Convention on Biological Diversity on economics and incentive measures and on a review of other relevant literature, the working group considered both financial and non-financial incentive measures.

ITEM 5. ANALYSIS OF THE VALUE OF INTEGRATING BIODIVERSITY WITHIN CLIMATE-CHANGE ADAPTATION

5.1. The role of biodiversity and ecosystem-based adaptation in supporting adaptation in communities and sectors vulnerable to climate change

41. The working group co-chairs invited the AHTEG to identify the role of biodiversity and ecosystem-based adaptation in climate change adaptation beyond the conservation sector and focusing on those areas which have been identified as being particularly vulnerable to the impacts of climate change by the UNFCCC Nairobi work programme on impacts, vulnerability and adaptation to climate change, namely: developing countries, especially least developed countries and small island developing States.

42. Accordingly the working group sought to define ecosystem-based adaptation and assess the multiple benefits. The working group also considered ways and means to implement ecosystem based adaptation in order to maximize benefits. These ways and means are presented in annex 2.

5.2. Methodologies for analysing the social, cultural and economic value of biodiversity and ecosystem-based adaptation in supporting adaptation in communities and sectors vulnerable to climate change

43. A small drafting committee developed proposals on methodologies as contained in annex II.

ITEM 6. PEER REVIEW OF THE REPORT

44. The Group had before it a draft report highlighting the main findings from the second meeting of the AHTEG as prepared by the co-chairs.

45. The Group also considered key messages to be conveyed by the Executive Secretary to the Secretariat of the United Nations Framework Convention on Climate Change.

ITEM 7. OTHER MATTERS

46. Under this item, participants raised the issue of how to report to the UNFCCC SBSTA. The Group agreed to create three reports:

- The current report to be published on the website of the Convention on Biological Diversity as the report of the meeting;
- A compilation report to be sent for peer-review containing the findings of the first and second meetings for submission to the thirty-first session of the SBSTA in Copenhagen in December;
- A summary of main messages from this meeting with a brief explanatory note for submission to the thirtieth session of the UNFCCC SBSTA in June.

47. With regards to next steps, the Group agreed to review the revised main messages prepared by the co-chairs and Secretariat. The Group also agreed that the compilation report should be revised by the co-chairs and Secretariat and shared with the Group before being sent for peer-review, preferably before the end of May. The Group agreed that the three UNEP-WCMC literature reviews prepared by UNEP-WCMC should be included in the peer-review process. The Group agreed that the comments and submissions of additional text received would be integrated into the compilation document by a drafting committee consisting of a small numbers of participants from the first and second meetings. The proposed dates for the drafting committee meeting are 20 – 24 July, 2009.

48. Finally the Group expressed its appreciation to the Government of Finland for hosting the meeting and to the support staff who allowed the meeting to run smoothly.

ITEM 8. ADOPTION OF THE REPORT AND CLOSURE OF THE MEETING

49. The Group considered and adopted its report on the basis of the draft report of the meeting prepared and presented by the co-chairs.

50. The meeting closed at 7.15 pm on Wednesday, 22 April 2009.

Annex I

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Annex II

TERMS OF REFERENCE AS ADDRESSED BY THE AHTEG[3]

I. IDENTIFYING CASE-STUDIES AND GENERAL PRINCIPLES TO GUIDE LOCAL AND REGIONAL ACTIVITIES AIMED AT REDUCING RISKS TO BIODIVERSITY VALUES ASSOCIATED WITH CLIMATE CHANGE

1. Principles for adaptation activity planning and implementation

a. Establish objectives and define expected outcomes for adaptation activities. Objectives should describe how adaptation activities are intended to address the climate-change impacts on the priority species and ecosystems. Outcomes should be defined in measurable, time-bound terms so that the efficacy of adaptation activities can be evaluated.

b. Monitor, measure and evaluate the effectiveness of adaptation activities. Monitoring practices should be designed to: verify that the intended objectives of adaptation activities are achieved; address uncertainty regarding the timing and magnitude of climate-change impacts; and avoid maladaptation. Indicators should be matched to the intended objectives and outcomes of adaptation activities. Indicators should be well-defined, practical and measurable so that they provide timely and relevant information. The specific choice of indicators is flexible and should be tailored to the situation being evaluated.

c. Inform decision making by integrating traditional knowledge, scientific information and evidence about climate-change impacts and the effectiveness of adaptation activities. A research agenda should be elaborated to address questions about the ecological, social and economic impacts of climate change. Climate change and impact models are needed to improve the predictive capacity at spatial and temporal scales that are relevant to decision-makers and designers of adaptation activities. Mechanisms for bringing together lessons learned and for facilitating knowledge transfer (e.g., the Ecosystems and Livelihood Adaptation Network; Nairobi Work Programme databases and Focal Point forum) should be encouraged.

d. Build and strengthen management and technical capacity for biodiversity protection and sustainable use of natural resource by involving local and indigenous communities. All relevant stakeholders, especially local and indigenous communities who may be most dependent on adaptation activities, should be involved in management decisions. This requires robust management institutions that facilitate knowledge transfer (e.g., lessons learned, best practices) among communities, economic sectors, and the general public to ensure informed decision-making. Appropriate training and capacity-development needs to be ensured.

2. Principles regarding adaptation activity objectives and outcomes

a. Maintain intact and interconnected ecosystems to allow for biodiversity and people to adjust to changing environmental conditions. This can be accomplished by: (i) representing in protected areas and other conservation strategies genetic, species, community and ecosystem diversity, and ecological redundancy of occurrences; (ii) identifying and protecting refugia[4] where climate change impacts are expected to be less; (iii) maintaining connectivity; and (iv) maintaining key ecological attributes within natural ranges of variation. Ecosystem integrity can also be enhanced by abating other threats (e.g., habitat loss, invasive species). A comprehensive and adequate protected area system should be the backbone of land- and sea-scape wide approach to conservation management.

[3] It should be noted that the following text represents the draft text as agreed by participants at the time of the closing of the meeting. The final text will be presented in a peer-reviewed compilation document to be prepared by the drafting committee of the AHTEG.

[4] Climatic refugia are locations where species can persist when the environmental conditions in the broader landscape change and no longer provide suitable habitat (Mackey et al. 2002).

b. Fragmented or degraded ecosystems should be restored or rehabilitated, and critical processes should be reestablished, to maintain ecosystem services [note: harmonize with restoration section]. Key ecological processes such as habitat connectivity, hydrological flows, fire regimes, and pollination dynamics should be restored or rehabilitated in line with altered conditions.

c. Preserve and enhance protective ecosystem service values that help buffer human communities from floods, storms, erosion and other climate change hazards. The potential for natural ecosystems to provide physical protection from climate change hazards should be assessed and considered. The social, environmental and economic costs and benefits of maintaining these ecosystem services should be compared to those of other kinds of adaptation activities.

d. Ensure that any use of renewable natural resources is sustainable given climate change impacts. The sustainable use of ecosystems may be effected by climate change if, among other things, the biological productivity declines. Management plans should be updated and harvest or use rates modified on the basis of such assessments to ensure sustainability.

3. Principles regarding adaptation strategies

a. Strengthen and enhance protected area networks. Gaps in the representativeness, ecological integrity & viability of species, communities, and ecosystems should be filled; taking into account future climatic conditions. The effectiveness of management should be monitoring and results incorporated into management cycle planning. Long-term financial mechanisms for PA design, management and expansion are needed.

b. Recognize, maintain and restore biodiversity values across land uses and tenures. New approaches to conservation are needed for biodiversity and associated ecosystem assets outside protected areas. Examples include biological corridors that span continental scales and involve local communities and traditional owners, and integrated watershed management.

A. Case-studies for best practices on addressing climate change related risk to biodiversity

1. Gondwana Link, Australia

Principle: 2b

Objectives: The aim of the project is achieve "Reconnected country across south-western Australia…in which ecosystem function and biodiversity are restored and maintained". This region is a recognized global biodiversity hotspot, having been to broadscale clearing for intensive agriculture. The region is experiencing ongoing ecological degradation and threats from fragmentation, salinity and climate change.

Activities: Protecting and re-planting bushland over more than 1,000 km; purchasing bushland to protect and manage it; re-vegetating large areas of cleared land advocacy for stronger protection of public land; providing incentives for better land management; developing ecologically supportive industries such as commercial plantings of local species.

Participants: A consortium of local and national non-government organizations, universities, local councils, university research centres, government mediated networks and agencies, and business enterprises; including Bush Heritage Australia, Fitzgerald Biosphere Group, Friends of Fitzgerald River National Park, Greening Australia, Green Skills Ink, The Nature Conservancy, and The Wilderness Society Inc.

Adaptation outcomes: Gondwana Link will provide some protection against the worst ecological impacts of climate change by enabling gradual genetic and species interchange on a broad front. In previous (slower) periods of climate change, species and systems have predominantly "moved" along a south-west/north-east pathway; the direction Gondwana Link is spanning. The project is also consolidating north-south linkages, which may also be critical pathways for species impacted by climate

change. The re-vegetation activities will also assist in stabilizing landscapes where clearing has led to large scale salinity, wind erosion and other degradation.

Reference: www.gondwanalink.org

2. Costa Rica Biological Corridor Programme (part of the Mesoamerican Conservation Corridor)

Principle 2b

Objectives: Update a proposal for improving structural connectivity for the National System of Protected Areas.

Activities: (a) Designed an ecological conservation network in order to improve the connectivity between protected areas and key habitat remnants; (b) Designed latitudinal and altitudinal connectivity networks; (c) The National Biological Corridors Programme, which aim is to provide technical and multi-sector coordination support to local management committees, and a national technical committee for advising biological corridor design and management were established.

Participants: National System of Conservation Areas (SINAC), The Nature Conservancy (TNC), Tropical Agronomic Research and Higher Education Center (CATIE), Conservation International, National Institute of Biodiversity (INBio).

Outcomes: (a) An ecological network that enhance ecosystem resilience to CC has been established; (b) local community committees for management the main biological corridors have been established; (c) Monitoring and systematic planning tools that include adaptation issues has been developed and implemented in order to provide input and feedback on their management.

Source: Arias, E; Chacón, O; Herrera, B; Induni, G; Acevedo, H; Coto, M; Barborak; JR. 2008. Las redes de conectividad como base para la planificación de la conservación de la biodiversidad: propuesta para Costa Rica. Recursos Naturales y Ambiente no. 54:37-43.

3. Nariva Wetland Restoration Project-Trinidad and Tobago; World Bank Project

Principle 2b

Objectives: The Nariva wetland (7,000 ha) is a biodiversity-rich environment with a mosaic of vegetation communities (tropical rain forest, palm forests, mangroves, and grass savannah/marshes). However, it was subject to hydrologic changes and land clearing by illegal rice farmers.

The objective of the project is the reforestation and restoration of the Nariva wetlands ecosystem.

Activities: (a) Restoration of hydrology - Water management plan to: (i) review the water budget of Nariva; (ii) identify land form composition of wetland area; (iii) develop criteria to select high priority restoration areas; and (iv) design and implement natural and engineered drainage options; (b) Reforestation programme. 1,000 - 1,500 hectares being reforested; only native species used; (c) Fire Management Programme - training for fire responders, fire response planning, and community environmental education; (d) Monitoring - Response of reforestation activities and biodiversity through key species.

Participants: Government, World Bank, NGOs, communities

Outcomes: Strengthening of buffer service for inland areas against anticipated changes climate and climate variability. The carbon sequestered and emission reductions effected will be sold and the proceeds from the sale will support community development and further adaptation actions as required.

Reference: www.worldbank.org

4. Conservation Measures Partnership (CMP)

Principles 1a, 1b

Objectives: Establish standards, best practices and tools to support the design, management and monitoring of conservation projects at multiple scales.

Activities: The Conservation Measures Partnership compiled consistent, open standard guidelines for designing, managing, and measuring impacts of their conservation actions. They also developed a software tool based on these standards that helps users to prioritize threats, develop objectives and actions and select monitoring indicators to assess the effectiveness of strategies. This software is available at https://miradi.org. The software also supports development of work-plans, budgets and other project management tools.

Participants: Members of the Conservation Measures Partnership include: African Wildlife Foundation, The Nature Conservancy, Wildlife Conservation Society and World Wide Fund for Nature/World Wildlife Fund. Collaborator include: The Cambridge Conservation Forum, Conservation International, Enterprise Works Worldwide, Foundations of Success, The National Fish and Wildlife Foundation, Rare and the World Commission on Protected Areas/IUCN.

Outcomes: Consistent open standards have been established, and continue to be improved on the basis of experience by users.

Reference: www.conservationmeasures.org

5. Marine Protected Areas in Kimbe Bay, PNG

Principle 2a

Objectives: Establish a network of marine protected areas that will conserve globally significant coral reefs and associated biodiversity, and sustain fisheries that local communities depend on for food and income.

Activities: Warming seas threaten to increase the frequency and extent of coral bleaching events in Kimbe Bay. When corals bleach, fish habitat and fisheries productivity are diminished. Systematic conservation planning methods were used to design a network of marine protected areas that (i) includes replicated examples of all coral and other coastal ecosystem types found in the bay; (ii) protects critical areas for fish spawning and reef sections that are more resistant to bleaching; and (iii) ensures connectivity across MPAs so that areas that might become depleted or degraded by coral bleaching can be repopulated. Local communities manage their own protected areas in the network so that they can best protect their fisheries and benefit from additional livelihood opportunities such as eco-tourism and sport fishing.

Participants: The Kimbe Bay MPA network was designed and implemented through a partnership between local communities and The Nature Conservancy.

Outcomes: The Kimbe Bay MPA network is expected to maintain the ecological integrity of the coral reefs and make them more resilient to bleaching.

Sources: Green, A., Lokani, P., Sheppard, S., Almany, J., Keu, S., Aitsi, J., Warku Karvon, J., Hamilton, R. and . Lipsett-Moore. 2007. Scientific Design of a Resilient Network of Marine Protected Areas. Kimbe Bay, West New Britain, Papua New Guinea. TNC Pacific Island Countries Report 2/07.

6. Mangrove restoration in Viet Nam

Principle 2c

Objectives: Restore coastal mangrove forests along the coasts of Viet Nam to provide coastal protection.

Activities: Waves and storm surges can erode shorelines, damage dykes, and flood communities, rice

paddies, and aquaculture facilities. Such hazards are expected to increase because of sea level rise and changes in storm frequency and intensity associated with climate change. Mangroves have been replanted along coast of Viet Nam in order to improve protection of communities and coasts. Restored mangroves have been demonstrated to attenuate the height of waves hitting the shore, and to protect homes and people from damaging cyclones.

Participants: Mangrove restoration has been led by Viet Nam national and provincial governments, with support from the World Bank and various humanitarian NGOs such as the Red Cross.

Outcomes: Since 1975, more than 120,000 hectares of mangroves have been restored. They have provided community and levee protection during severe storm events in 2005 and 2006, and ongoing support for livelihoods associated with mangrove habitats such as replanting and tourism.

Source: http://www.expo-cosmos.or.jp/album/2008/2008_slide_e.pdf Mangroves and Coastal Dwellers in Viet Nam – The long and hard journey back to harmony. Commemorative lecture at Kyoto University, November 2nd, 2008

7. Restoring floodplains along the Danube River, in Eastern Europe

Principle 2c

Objective: Restore 2,236 km2 of floodplain to form a 9,000 km2 "Lower Danube Green Corridor".

Activities: More frequent flooding is expected along the Danube River because of climate change. Floods in 2005 killed 34 people, displaced 2,000 people from their homes, and caused $625M in damages. Dykes along the Lower Danube River are being removed to reconnect historic floodplain areas to river channel. These areas are of only marginal value for other industrial activities. However, once restored, they are estimated to provide flood control and other ecosystem services valued at 500 Euros per hectare per year.

Participants: This restoration is being done by the World Wildlife Fund, working in conjunction with the Governments of Bulgaria, Romania, Moldova and Ukraine.

Outcomes: Restored floodplains serve to retain and more slowly release floodwaters that might otherwise threaten to overtop or breach dykes.

Source: Orieta Hulea, S Ebert, D Strobel. 2009. Floodplain restoration along the Lower Danube: a climate-change adaptation case-study. IOP Conf. Series: Earth and Environmental Science 6 (2009) doi:10.1088/1755-1307/6/0/402002[5]

[5] CBD (2009) Ad Hoc Technical Expert Group on biodiversity and climate change. Convention of Biological Secretariat, Paper BD-CC-2/2/2.
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Nairobi Work Programme; <http://unfccc.int/adaptation/nairobi_workprogramme/compendium_on_methods_tools/items/2674.php>

II. IDENTIFYING WAYS THAT COMPONENTS OF BIODIVERSITY CAN REDUCE RISK AND DAMAGE ASSOCIATED WITH CLIMATE CHANGE IMPACTS

Ecosystem-based adaptation may be described as the use of ecosystem management activities to support societal adaptation. Ecosystem-based adaptation identifies and implements a range of strategies for the management, conservation, and restoration of ecosystems to provide services that enable people to adapt to the impacts of climate change. It aims to increase the resilience and reduce the vulnerability of ecosystems and people in the face of climate change. Ecosystem-based adaptation is most appropriately integrated into broader adaptation and development strategies.

Ecosystem-based adaptation can be applied at national regional and local level, at both project and programmatic levels, and over short or long time scales. Means of implementing ecosystem-based adaptation include:

- sustainable water management where river basins, aquifers, coasts and their associated vegetation provide water storage, flood regulation and coastal defences
- disaster risk reduction where restoration of coastal habitats such as mangroves can be a particularly cost-effective measure against storm-surges
- sustainable agriculture where using indigenous knowledge of specific crop and livestock varieties, and conserving mosaic agricultural landscapes secures food provision in changing local climatic conditions
- protected areas example.

Adaptation approaches that include ecosystem-based adaptation may often be cost-effective, and can provide significant social, economic and environmental co-benefits. In addition to the direct benefits for adaptation, ecosystem-based adaptation activities can also have indirect benefits for people, for biodiversity, and for mitigation. For example, the restoration of mangrove systems can provide shoreline protection from storm surges, but also provide increased fishery opportunities, and carbon sequestration.

Ecosystem-based are often more accessible to the rural poor than actions based on infrastructure and engineering. The poor are often the most directly dependent on ES and thus benefit from adaptation strategies that maintain those services. Ecosystem-based adaptation can be consistent with community-based approaches to adaptation; most effectively builds on local knowledge and needs; and can provide particular consideration to the most vulnerable groups of people, including women, and to the most vulnerable ecosystems.

III. IDENTIFYING POTENTIAL BIODIVERSITY-RELATED IMPACTS AND BENEFITS OF ADAPTATION ACTIVITIES, ESPECIALLY IN THE REGIONS IDENTIFIED AS BEING PARTICULARLY VULNERABLE UNDER THE NAIROBI WORK PROGRAMME ON IMPACTS, VULNERABILITY AND ADAPTATION TO CLIMATE CHANGE (DEVELOPING COUNTRIES, ESPECIALLY LEAST DEVELOPED COUNTRIES AND SMALL ISLAND DEVELOPING STATES) AS ADOPTED BY THE CONFERENCE OF THE PARTIES TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE AT ITS ELEVENTH MEETING

Many strategies adopted for societal adaptation may have negative impacts on biodiversity while some strategies may have positive impacts. The impacts of adaptation strategies on biodiversity will vary across sectors and will depend on the way in which such strategies are implemented. In most cases there is the potential to minimize negative impacts and maximize positive effects through, for example, the application of the ecosystem approach and the adoption of strategic environmental assessments. As such, when deciding on measures to address a given climate-change impact, e.g. that of drought on agriculture in a certain area, there is usually a range of available options. The suitability of these options (taking into account environmental, social and economic implications) will depend on the site-specific

environmental and socio-economic setting. Often, a spatially differentiated combination of measures may be appropriate.

Identifying and minimizing potential negative impacts on biodiversity is especially important for small island developing States and Least Developed Countries. Islands tend to be characterized by high endemic biodiversity, while both islands and least developed countries are also socially and ecologically highly vulnerable to climate change. All adaptation activities identified for the other thematic areas might also be relevant for islands and least developed countries but their implementation may need special considerations due to their limited size, which do not permit great retreat and/or high reliance on biodiversity resources for livelihoods. Risks for mal-adaptation may be higher especially on small islands with catastrophic results (extinction).

To guide adaptation decisions which maximize positive impacts and minimize negative impacts on biodiversity, the following principles are recommended:

- **The potential of ecosystem-based adaptation options as contrasted with technical solutions should be fully considered** (reference to sections of the report and case-studies on advantages of ecosystem-based adaptation).
- **Strategic Environmental Assessment and Environmental Impact Assessment should be applied** in order to include a full consideration of all available alternatives, i.e. not be restricted to different variants of the same technical option (as often happens).
- **Monitoring and adaptive management approaches are a prerequisite for adaptation to succeed**, particularly because of the high degree of uncertainty in projections about the future on which adaptation decisions are based. The base of monitoring data with regard to biodiversity especially in developing countries needs to be considerably strengthened.
- Further specific recommendations on how to maximize positive and minimize negative impacts of individual types of adaptation options are given in the table.

IV. PROPOSING WAYS AND MEANS TO IMPROVE THE INTEGRATION OF BIODIVERSITY CONSIDERATIONS AND TRADITIONAL AND LOCAL KNOWLEDGE RELATED TO BIODIVERSITY WITHIN CLIMATE-CHANGE ADAPTATION, WITH PARTICULAR REFERENCE TO COMMUNITIES AND SECTORS VULNERABLE TO CLIMATE CHANGE

A. At the planning stage

(i) Identify stakeholders and ensure their active participation;

(ii) Define the size of the ecosystem area (taking into account the concept of landscape, seascape; eco-region etc., also bearing in mind the definition of ecosystem in article 2 of the Convention on Biological Diversity);

(iii) Characterize the structure, function (ecosystem services) and management of the ecosystem.

- What ecosystems goods and services (and their values)
- Is the ecosystem (and its services) under threat or used beyond its capacity (Principle 5 and Principle 6)

(iv) Define the type of management needed

- What kind of management should be applied? What services are maintained or lost through this management? Any new service acquired?
- Is the management decentralized to the lowest appropriate level so as to ensure active participation/involvement of those communities directly depending on the resources, and at the right level (governance?)
- Is conservation balanced with use (Principle 10)

- Is traditional knowledge, know-how and practices taken into account

(v) Consider economic issues that will affect the ecosystem and its inhabitants (principle 4)

- Are there negative incentives, market distortions etc. leading to unsustainable use of ecosystems goods and services
- Costs and benefits need to be internalized

(vi) Define short and long-term goals (principles 7 to 9)

B. At the management level

(i) Assess/monitor impact of management and their effectiveness in space and time, and adjustment (adaptive management[6])

(ii) Need for monitoring methodologies including indicators

(iii) Address capacity needs at all levels

V. IDENTIFYING WAYS AND MEANS FOR THE INTEGRATION OF THE ECOSYSTEM APPROACH IN VULNERABILITY ASSESSMENT AND CLIMATE CHANGE ADAPTATION STRATEGIES

At its fifth meeting of the Conference of the Parties, in Nairobi in 2000, the Convention on Biological Diversity adopted the ecosystem approach as the primary framework for actions to help reach a balance of the three objectives of the Convention; viz. (i) the conservation of biological diversity; (ii) the sustainable use of its components; and (iii) the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding.

The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. It is based on the application of appropriate scientific methodologies focused on levels of biological organization which encompass the essential processes, functions and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of ecosystems.

The ecosystem approach is described by 12 principles:

1. The objectives of management of land, water and living resources are a matter of societal choice.

2. Management should be decentralized to the lowest appropriate level.

3. Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.

4. Recognizing potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context. Any such ecosystem-management programme should:

    a. reduce those market distortions that adversely affect biological diversity;
    b. align incentives to promote biodiversity conservation and sustainable use; and
    c. internalize costs and benefits in the given ecosystem to the extent feasible.

5. Conservation of ecosystem structure and functioning, to maintain ecosystem services, should be a priority target of the ecosystem approach.

[6] TS 10: "Adaptive management", which is an integral part of the ecosystem approach, allows for the reevaluation of results through time and alterations in management strategies and regulations to achieve goals.

6. Ecosystems must be managed within the limits of their functioning.

7. The ecosystem approach should be undertaken at the appropriate spatial and temporal scales.

8. Recognizing the varying temporal scales and lag-effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long term.

9. Management must recognize that change is inevitable.

10. The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity.

11. The ecosystem approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices.

12. The ecosystem approach should involve all relevant sectors of society and scientific disciplines.

The CBD website provides comprehensive guidance and examples of the application of the principles. There are similar sets of guidance such as Ramsar's "wise use" and the principles of Sustainable Forest Management (Wit 2004). At its seventh meeting of the Conference of the Parties, the Convention on Biological Diversity recognized "there is no single correct way to achieve an ecosystem approach to management of land, water, and living resources". The underlying principles can be translated flexibly to address management issues in different social contexts. Already, there are sectors and Governments that have developed sets of guidelines that are partially consistent, complementary or even equivalent to the ecosystem approach (CBD decision VII/11). There has been a vigorous debate in the technical and policy related communities. Many see the ecosystem approach as a "promise unfulfilled" and as providing little pragmatic guidance while others see them as a revolutionary attempt to reassemble the policy formulation process and institutions (Murawski 2007). IUCN (Shepherd 2004) has suggested a practical way to implement the ecosystem approach, using a five-step method:

Step A Determining the main stakeholders, defining the ecosystem area, and developing the relationship between them. (Principles 1, 7, 11, 12)

Step B Characterizing the structure and function of the ecosystem, and setting in place mechanisms to manage and monitor it. (Principles 2, 5, 6, 10)

Step C Identifying the important economic issues that will affect the ecosystem and its inhabitants. (Principles 4)

Step D Determining the likely impact of the ecosystem on adjacent ecosystems. (Principles 3, 7)

Step E Deciding on long-term goals, and flexible ways of reaching them. (Principles 7, 8, 9)

Step F Research, monitoring and adaptive management

VI. IDENTIFYING MEASURES THAT ENABLE ECOSYSTEM RESTORATION FROM THE ADVERSE IMPACTS OF CLIMATE CHANGE WHICH CAN BE EFFECTIVELY CONSIDERED IN VULNERABILITY AND CLIMATE-CHANGE ADAPTATION STRATEGIES

The restoration of ecosystems can decrease their vulnerability to climate change, and provide ecosystem services that support societal adaptation. The restoration of ecosystems can remove or limit stresses on ecosystems that prevent adaptation to climate change. Restoration activities may include limiting human activities such as grazing or logging and allowing ecosystems to recover, or restoring ecological components such as connectivity, hydrological regimes, through activities such as reflooding wetlands.

Restoration of ecosystems can be a cost-effective ecosystem-based adaptation strategy. Restoration of ecosystems can increase their capacity to serve protective functions. Restoration activities include limiting human activities such as grazing or logging to allow ecosystems to recover, or restoring

ecological components such as connectivity, hydrological regimes, through activities such as re-flooding wetlands. For example, an alternative to constructing additional dams or reservoirs for increased flood water storage could be flood-plain restoration, which would also improve riparian habitat. Restoration of ecosystems can be of economic importance where those systems protect property, but also critically important to biodiversity and to those people whose livelihoods are drawn from the ecosystem. However, it is often cheaper to conserve ecosystems rather than restore them, so careful cost-effective analysis are required to ensure the most appropriate approach is adopted.

Just as general strategies of conservation need to adjust to take into account future rapid climate change, so too will restoration efforts need to take place in the context of a changing environment. Ecosystem restoration is aimed at re-establishing functioning ecological communities in locations that have suffered environmental degradation. Strategies in the future will need to consider:

- *Role of extreme events:* Climate change will not only alter mean climate (e.g. mean annual temperature and rainfall) but will also alter the intensity and frequency of extreme events such as droughts, floods, cyclones and fire. Understanding and anticipating the potential changes in disturbance regimes that influence successional processes will be a key to restoration of functioning ecosystems.

- *Restoration of function not species composition:* As the climate changes, many species will become increasingly unsuited to conditions within their present day geographic range. Successful restoration of ecosystems will therefore need to focus on restoring functionality and ecosystem services, rather than re-creating the species composition that previously existed at a location. For example, a given area may continue to be predominated by oaks (*Quercus* spp.) or eucalyptus under a future climate but the particular species may differ.

- *Genetic provenances used in re-establishment:* A long-held paradigm of restoration ecology is the desirability of re-establishing individuals of local provenance i.e. propagation material collected within a narrow radius of the restoration site that is thought to be best-adapted to local conditions. As the climate, and therefore local conditions change in the future, this strategy may reduce the potential for the restored community to be sustainable in the medium- to long-term. The use of a mixture of genetic provenances collected over a broad range of sites and therefore climates, will increase the probability of restoration success and may be an effective form of risk-spreading.

VII. HIGHLIGHTING CASE-STUDIES AND IDENTIFYING METHODOLOGIES FOR ANALYSING THE VALUE OF BIODIVERSITY IN SUPPORTING ADAPTATION IN COMMUNITIES AND SECTORS VULNERABLE TO CLIMATE CHANGE

Valuation techniques are important to ensure that the true value of ecosystems and their services provided are taken into account when estimating the impact of human-induced climate change on ecosystems. Informed decisions should evaluate the implications of any decision on all ecosystem services and estimate the value of changes in the services that result.

Economic techniques for valuing ecosystem services are typically applied a within cost-benefit analysis or a cost-effectiveness analysis, whose results would otherwise be incomplete whenever relevant external costs and/or benefits are present. Cost-benefit analysis estimates the difference between the costs and benefits of a particular decision, e.g., the costs of a particular adaptation action compared to the benefits that would accrue for the action, where-as cost effectiveness analysis assesses the costs of different actions to achieve a particular outcome, e.g., to protect a particular coastal region. These economic analyses should in turn be applied within broader decision-making frameworks which go beyond mere economic logic, such as environmental impact assessments (EIA), strategic environment assessments (SEA), life-cycle analysis (LCA), risk assessment, and multi-criteria analysis.

Cost-benefit analyses that factor in uncertainty, inertia and the importance of biodiversity to future generations support an aggressive approach to conserving biodiversity and ecosystem services. One issue that has engendered endless debate is the choice of discount rate. Different choices of discount rate lead to very different estimates of the damage costs of climate change on biodiversity and ecosystems, and the relative costs and benefits of different strategies. Stern argued on ethical grounds that a low discount rate should be chosen to assess the damage costs of climate change. He considered how the application of appropriate discount rates, assumptions about the equity weighting attached to the valuation of impacts in poor countries, and estimates of the impacts on mortality and the environment (including on biodiversity) would increase the estimated economic costs of climate change. This led Stern to conclude that the costs of inaction significantly exceeded the costs of stabilizing at 450 and 550 ppm CO_2. Other analyses that use social discount rates between 2-4 per cent significantly decrease the estimated damage costs of climate change.

There are many methodologies available for estimating the economic valuation of ecosystem services. The appropriateness of various methodologies is determined by the biodiversity beneficiary (local versus global, private sector versus non-profit, etc) and the types of biodiversity benefits realized (direct versus indirect use values; use versus non-use values). A common feature of all methods of economic valuation of ecosystem services is that they are founded in the theoretical axioms and principles of welfare economics. These measures of change in well-being are reflected in people's willingness to pay for changes in their level of use of a particular service or bundle of services.

Methods for eliciting values should use a combination of economic and non-economic valuation methods as appropriate to the context of the decision.

- *Economic valuation* techniques include: (i) so-called revealed preference techniques, which are based on actual observed behavioural data (conventional and surrogate markets, based on for example market prices, hedonic pricing, travel cost method); and (ii) so-called stated preference techniques, which are based on hypothetical rather than actual behaviour data, where people's responses to questions describing hypothetical markets or situations are used to infer value (hypothetical markets based on for example contingent valuation and choice modeling).

- *Non-economic* valuation can be addressed through deliberative or participatory approaches. These approaches explore how opinions are formed or preferences expressed in units other than money.

Regardless of the methodology employed, the interim report of TEEB outlined nine key principles of best practices for ecosystem valuation including:

- The focus of valuation should be on marginal changes rather than the "total" value of an ecosystem;

- Valuation of ecosystem services must be context specific, ecosystem-specific and relevant to the initial state of the ecosystem;

- Good practices in "benefit transfers" need to be adapted to biodiversity valuation, while more work is needed on how to aggregate the values of marginal changes;

- Values should be guided by the perception of the beneficiaries;

- Participatory approaches and ways of embedding the preferences of local communities may be used to help make valuation more accepted;

- Issues of irreversibility and resilience must be kept in mind;

- Substantiating bio-physical linkages helps the valuation exercise and contributes to its credibility;

- There are inevitable uncertainties in the valuation of ecosystem services, so a sensitivity analysis should be provided for decision makers; and;

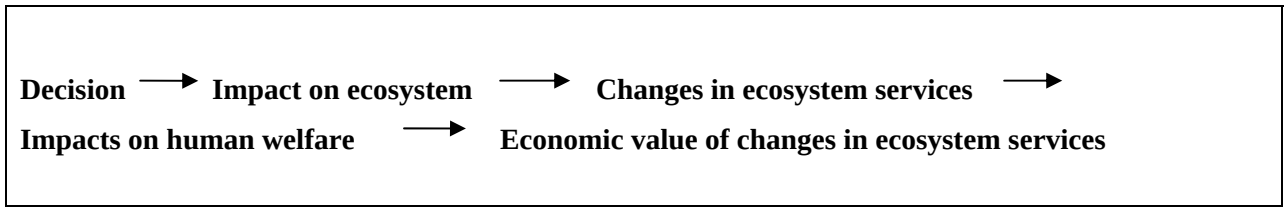
- Valuation has the potential to shed light on conflicting goals and trade-offs but it should be presented in combination with other qualitative and quantitative information and may not be the last word.

Given that the application of many valuation techniques is costly and time-consuming, and require considerable expertise, a cost/benefit criterion should be applied, as appropriate, to the valuation study itself: in principle, they should be applied when the anticipated incremental (including long-term) improvements in the decision are commensurate with the cost of undertaking the valuation study.

Therefore the key steps in estimating the impact of different climate change adaptation or mitigation decisions are:

- Establish the ecosystem baseline;
- Identify and provide qualitative assessment of the impacts of different decisions on ecosystem services;
- Quantify the impacts of different decisions on specific ecosystem services;
- Assess the effects on human welfare; and
- Value the changes in ecosystem services.

Figure: Overview of the impact pathway of a climate-change decision

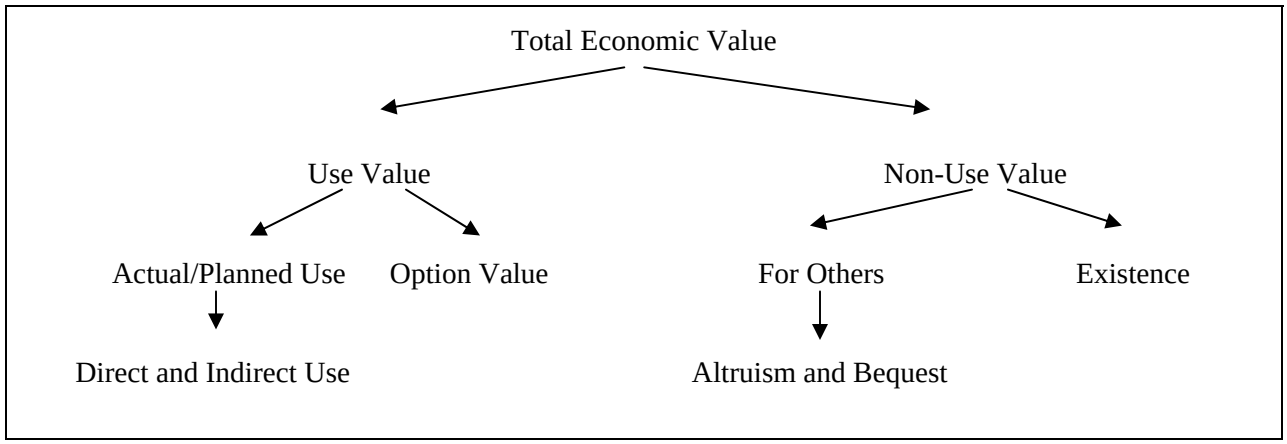


Following these steps can help to ensure a more systematic approach to accounting for the impacts of different decisions on ecosystems. Even an initial screening of what ecosystem services are affected, how potentially significant these impacts could be and developing an understanding of the key uncertainties and gaps in evidence can be useful first steps towards integrating these considerations into decision-making.

There is considerable complexity in understanding and assessing the causal links between a decision, its effects on ecosystems and related services and then valuing the effects in economic terms. Integrated working with the science and economics disciplines will be essential in implementing this approach in practice. The critical importance of the links to scientific analysis, which form the basis for valuing ecosystem services, needs to be recognized.

As noted, **a range of methodologies are available to value changes in ecosystem services.** These values can be considered in a Total Economic Value framework that takes into account both the use and non-use values individuals and society gain or lose from marginal changes in ecosystem services. As many ecosystem services are not traded in markets, it is necessary to assess the relative economic worth of these goods or services using non-market valuation techniques.

Figure: Total Economic Value (TEV)



TEV refers to the total change in well-being from a decision measured by the net sum of the willingness to pay (WTP) or willingness to accept (WTA). The value that we are trying to capture is the total value of a marginal change in the underlying ecosystem services.

***Use values* include direct use, indirect use and option value**. Examples of *direct use* can be in the form of consumptive use, e.g., use of extracted resources such as food and timber (activities that can be traded in the market), or non-consumptive use, e.g., recreation (a non-marketable activity). Examples of *indirect use, which are not normally traded in the market*, are those where society benefits from services such as climate regulation, pollination, and soil maintenance. *Option value* is the value society places on the option to use a resource in the future, e.g., an individual may well be willing to pay for a national park even if they have no intention of using it in the near future, but want to keep the option open to visit in the future.

***Non-use values* include bequest, altruistic and existence values:** *bequest value* where society attaches value to passing on the ecosystem services to future generations; *altruistic value* where individuals attach value to the availability of ecosystem services to others within the current generation; and *existence value* where an individual has no planned or actual use of an ecosystem service but is willing to pay for it to be maintained.

Typically, provisioning services have direct use and option values; regulating services have indirect use and option values; and cultural services have direct use, option and non-use values.

The type of valuation technique chosen will depend on the type of ecosystem service to be valued, as well as the quantity and quality of data available. Some valuation methods may be more suited to capturing the values of particular ecosystem services than others. Benefits transfer, which applies economic values that have been generated in one context to another context for which values are required, is also discussed. The use of such transfers is seen as being essential to the more practical use of environmental values in decision-making.

The valuation methodologies discussed are not new in themselves. The challenge is in their appropriate application to ecosystem services. The ecosystem services framework emphasises the need to consider the ecosystem as a whole and stresses that changes or impacts on one part of an ecosystem have consequences for the whole system. Therefore, considering the scale and scope of the services to be valued is vital if we are to arrive at any meaningful values.

Table: Valuation methods for different ecosystem services[7]

Valuation method	***Element of total economic value (TEV) captured***	***Ecosystem service(s) valued***	***Benefits of approach***	***Limitations of the approach***
Market prices	Direct and indirect use	Those that contribute to marketed products e.g. crops, timber, fish	Market data readily available and robust	Limited to those ecosystem services for which a market exists
Cost-based approaches	Direct and indirect use	Depends on the existence of relevant markets for the ecosystem service in question. Examples include man-made defences being used as proxy for wetlands storm protection; expenditure on water filtration as proxy for value of water pollution damages.	Market data readily available and robust	Can potentially overestimate actual value
Production function approach	Indirect use	Environmental services that serve as input to market products e.g. effects of air or water quality on agricultural production and forestry output	Market data readily available and robust	Data-intensive and data on changes in services and the impact on production often missing
Hedonic pricing	Direct and indirect use	Ecosystem services that contribute to air quality, visual amenity, landscape, quiet, i.e. attributes that can be appreciated by potential buyers	Based on market data, so relatively robust figures	Very data-intensive and limited mainly to services related to property
Travel cost	Direct and indirect use	All ecosystems services that contribute to recreational activities	Based on observed behaviour	Generally limited to recreational benefits. Difficulties arise when trips are made to multiple destinations.

[7] Table adapted from table 4.2 of DEFRA: *An Introductory Guide to Valuing Ecosystem Services*. A similar table is included in the annex to decision VIII/25 of the Conference of the Parties to the Convention on Biological Diversity, on the application of tools for valuation of biodiversity and biodiversity resources and functions.

Valuation method	***Element of total economic value (TEV) captured***	***Ecosystem service(s) valued***	***Benefits of approach***	***Limitations of the approach***
Random utility	Direct and indirect use	All ecosystems services that contribute to recreational activities	Based on observed behaviour	Limited to use values
Contingent valuation	Use and non-use	All ecosystem services	Able to capture use and non-use values	Bias in responses, resource-intensive method, hypothetical nature of the market
Choice modelling	Use and non-use	All ecosystem services	Able to capture use and non-use values	Similar to contingent valuation above

Key challenges in the valuation of ecosystem services relate to how ecosystems provide services and to dealing with issues of irreversibility and high levels of uncertainty in how ecosystems function. Thus, while valuation is an important and valuable tool for good decision-making, it should be seen as only one of the inputs. Methodologies to deal with these challenges that account systematically for all the impacts on ecosystems and their services are very much in development.

A. Case-studies of value derived from linking biodiversity conservation and sustainable use and climate change adaptation

1. Cost effective protection from natural disasters

Protecting and restoring ecosystems can be a cost-effective and affordable long-term strategy to help human communities defend against the effects of climate change induced natural disasters. Protection against storm surges or high winds associated with more intense cyclones can include: (i) hard infrastructures including seawalls and levees, which can be expensive, require ongoing maintenance, and can fail catastrophically under severe storm conditions, e.g., New Orleans, USA; or (ii) the protection and restoration of "green infrastructure" such as healthy coastal wetlands (including mangrove forests) and coral reefs, which can be more cost-effective means for protecting large coastal areas, require less maintenance, and provide additional community benefits in terms of food, raw materials and livelihoods as well as benefiting biodiversity. Examples include:

- Red Cross of Viet Nam began planting mangroves in 1994. By 2002, 12,000 hectares had cost US$ 1.1 million, but saved annual levee maintenance costs of US$ 7.3 million, shielded inland areas from typhoon Wukong in 2000, and restored livelihoods in planting and harvesting shellfish.
- In Malaysia, the value of existing mangroves for coastal protection is estimated at US$ 300,000 per km of coast based on the cost of installing artificial structures that would provide the same coastal protection.
- In the Maldives, the degradation of protective coral reefs around Malé required construction of artificial breakwaters at a cost of US$ 10 million per kilometre.

2. Sustaining local livelihoods

From farming, ranching, timber and fishing, to water, fuel-wood, and subsistence resources, human welfare is inextricably tied to natural resources and the benefits that ecosystems provide. The World Bank's Strategic Framework for Development and Climate Change warns that the disproportionate impacts of climate change on the poorest and most vulnerable communities could set back much of the development progress of the past decades and plunge communities back into poverty. By protecting and restoring healthy ecosystems that are more resilient to climate change impacts, ecosystem-based adaptation strategies can help to ensure continued availability and access to essential natural resources so that communities can weather the conditions that are projected in a changing climate. Strategies that involve local governance and participation will also benefit from community experience with adapting to changing conditions, and may create greater commitment among communities for implementation. Examples include:

- In Kimbe Bay, Papua New Guinea, coral reef resilience principles were applied to design a network of marine protected areas that can withstand the impacts of a warming ocean and continue to provide food and other marine resources to local communities. This approach is already being implemented at several more sites in Indonesia and for the Meso-American reef.
- In Southern Africa, the tourism industry has been valued at US$ 3.6 billion in 2000, however, the Intergovernmental Panel on Climate Change projects that between 25 and 40 per cent of mammals in national parks will become endangered as a result of climate change. As such, the National Climate Change Response Strategy of the Government of South Africa includes interventions to protect plant, animal and marine biodiversity in order to help alleviate some of this projected lost income.

3. Ecosystem services provided by forestry

Well managed forests and woodlands deliver a range of ecosystem services with social and environmental benefits, including:

- Providing opportunities for open access outdoor recreation.
- Supporting and enhancing biodiversity.
- Contributing to the visual quality of the landscape.
- Carbon sequestration.
- A report by the Forestry Commission in 2003 estimated the total value of annual benefits to people in Britain to be around £1 billion. Annual benefits (£ million) include: (i) recreation £393 m; (ii) biodiversity £386 m; (iii) landscape £150 m; and (iv) carbon sequestration £94 m, for a total benefit of £1023 m. However, this analysis is only partial and did not take into account other social and environmental benefits, such as improving air quality and regulating water supply and water quality. For example, forests and woodlands 'clean' the air as trees trap harmful dust particles and absorb gases such as sulphur dioxide and ozone, thus the improved air quality can be valued through the resulting improvements to human health. In addition, forests and woodlands can reduce soil erosion, stabilize riverbanks and reduce pollution in run-off.

4. The economic value of protected areas can be very high

- **The value of the Okavango Delta in the economy of Botswana – a Ramsar site**
  The Okavango Delta generates an estimated 1.03 billion pula (P) in terms of gross output, P 380 million in terms of direct value added to gross national product (GNP) and P 180 million in resource rent. The direct use values of the Okavango Delta are overwhelmingly dominated by the use of natural wetland assets for tourism activities in the central zone. Households in and around the delta earn a total of P 225 million per year from natural resource use, sales, salaries and wages in the tourism industry, and rents and royalties in community-based natural-resource management (CBNRM) arrangements. The total impact of the direct use of the resources of the Ramsar site is

estimated to be P 1.18 million in terms of contribution to GNP, of which P 0.96 million is derived from use of the wetland itself. Thus the Ramsar site contributes 2.6 per cent of the country's GNP, with the wetland contributing most of this (2.1 per cent). The multiplier effect is greater for the formal sector than for the poorer components in society, because the former activities have greater backward linkages and households are primarily engaged in subsistence activities. The natural capital asset value of the Ramsar site is estimated to be about P3.9 billion, of which the Okavango Delta is worth P3.4 billion.

- **The economic value of the Great Barrier Reef to the Australian Economy**
  This analysis is partial and does not use the TEV but focuses on the value of tourism, commercial fishing and recreational activities, net of tourism. The values are AUS$5107 million, AUS$149 million, and AUS$610 million, respectively, for a total of AUS$5,866 million. Clearly the true economic value, when considering all the other non-use values, is considerably higher.

B. Case-studies of estimates of lost value associated with the impacts of climate change on biodiversity

A number of studies have estimated the costs of climate change under different scenarios. For a 2°C increase in global mean temperatures, for example, annual economic damages could reach US$ 8 trillion by 2100 (expressed in U.S. dollars at 2002 prices).

There are few studies available, however, on the lost value associated with the impacts of climate change specifically on biodiversity in large part because of the difficulty in separating climate change impacts from other drivers of biodiversity loss. Some case-studies include:[8]

- The World Bank estimated that coral reef degradation in Fiji attributable to climate change is expected to cost between US$ 5 million and US$ 14 million a year by 2050 due to the loss of value from fisheries, tourism and habitat.
- The loss in welfare associated with climate change in a mesic-Mediterranean landscape in Israel is estimated at US$ 51.5 million if conditions change to Mediterranean climate, US$ 85.5 million if conditions change to a semi-arid landscape and US$ 107.6 million for conversion to an arid landscape based on loss grazing and willingness to pay.
- The lost value for protected areas associated with the projected impacts of climate change in Africa, based on willingness to pay, is estimated at US$ 74.5 million by 2100.
- The predicted negative impacts of climate change on coral reefs in the Bonaire National Marine Park in the Netherland Antilles, based on willingness to pay estimates by divers was US$ 45 per person per year if coral cover drops by from 35 per cent to 30 per cent and fish diversity drops from 300 species to 225 species and US$ 192 per person if coral cover drops from 35 per cent to 5 per cent and fish diversity drops from 300 species to 50 species.

VIII. ANALYSING THE SOCIAL, CULTURAL AND ECONOMIC BENEFITS OF USING ECOSYSTEM SERVICES FOR CLIMATE CHANGE ADAPTATION AND OF MAINTAINING ECOSYSTEM SERVICES BY MINIMIZING ADVERSE IMPACTS OF CLIMATE CHANGE ON BIODIVERSITY

Ecosystem-based adaptation can generate significant social, cultural and economic co-benefits for local communities. Communities that are managing ecosystems specifically to adapt to climate-change impacts can also benefit from these interventions in other ways, if they are designed and managed appropriately (Table 1). For example, conserving and restoring mangroves not only reduces the vulnerability of coastal communities to flooding, but also helps to maintain fish populations that local communities depend on. Appropriately designed and managed agricultural systems can enhance their

[8] In conducting the studies, a number of assumptions had to be taken and choices made which could affect the outcomes including: (i) the discount rate; (ii) the General Circulation Model that the impacts are based upon; and (iii) future greenhouse gas scenarios.

resilience to climate change, while also continuing to provide a range of other ecosystem services (such as water regulation and pollination) that are important for rural poor communities, that are often directly dependent on ecosystem services. Similarly, *in-situ* conservation of agricultural biodiversity can help address future challenges from climate change and variability by providing the genetic stock needed for crop adaptation, while also maintaining traditional knowledge and cultural practices.

Ecosystem-based adaptation, if designed and implemented appropriately, can also contribute to biodiversity conservation. Conserving, restoring and sustainably managing ecosystems, as part of an adaptation strategy to decrease human vulnerability to climate change, can also help conserve biodiversity by providing important habitats and biological resources, and maintaining landscape connectivity. For example, the conservation or restoration of wetlands to ensure continued water flow in periods of drought also conserves plant and animal species that live or breed in these systems. The establishment of diverse agroforestry systems with native plant species as an adaptation measure can similarly help conserve biodiversity (Schroth et al. 2004). The creation or expansion of community conserved areas in dryland regions can not only provide additional fodder resources for pastoralists, but also conserve dryland biodiversity. Similarly, the establishment or creation of networks of marine protected areas can ensure the continued provision of ecosystem services for adaptation, as well as biodiversity conservation.

Ecosystem-based adaptation can also contribute to climate-change mitigation, by conserving carbon stocks, reducing emissions from ecosystem degradation and loss, and enhancing carbon stocks. The conservation, restoration and sustainable management of terrestrial ecosystems is an integral part of both adaptation and mitigation efforts. Ecosystem-based adaptation measures that conserve natural forest also provide significant climate change mitigation benefits by maintaining existing carbon stocks and sequestration capacity, and preventing future emissions from deforestation and degradation. Adaptation projects that prevent fires or restore wetlands on tropical forest peatlands will be particularly important for mitigation efforts, as these ecosystems have very high carbon stocks and release significant quantities of GHG emissions when degraded. Restoration of degraded forest ecosystems increases sequestration and enhances carbon stocks. Similarly, the conservation and restoration of other natural ecosystems (such as savannahs, grasslands and wetlands) can result in both adaptation and mitigation benefits.

In order to ensure ecosystem-based adaptation measures deliver significant additional social, cultural, economic and biodiversity benefits, it is important that these co-benefits be specifically considered in the planning, design, implementation and monitoring and evaluation of these measures. Adaptation measures are more likely to deliver significant co-benefits if social, economic and cultural aspects are explicitly considered in all phases of project development and implementation, if all tradeoffs and synergies are carefully identified and explored, and if all stakeholders are given a voice in deciding how adaptation measures are implemented. In addition, systems to monitor and evaluate the co-benefits of adaptation measures can be established to ensure the equitable distribution of co-benefits among stakeholders. Guidelines already exist for ensuring the delivery of co-benefits in climate mitigation projects (e.g., Climate, Community and Biodiversity Standards; CCBA) and these could potentially be adapted to guide ecosystem-based adaptation measures.

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

		Co-benefits			
Adaptation measure	**Adaptive function**	**Social and cultural**	**Economic**	**Biodiversity**	**Mitigation**
Mangrove conservation	Protection against storm surges, sea-level rise and coastal inundation	Provision of employment options (fisheries and prawn cultivation) and 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 and below-ground
Forest	Maintenance of	Recreational and	Potential generation	Conservation of	Conservation of

		Co-benefits			
Adaptation measure	**Adaptive function**	**Social and cultural**	**Economic**	**Biodiversity**	**Mitigation**
conservation	water flow and prevention of land slides	cultural opportunities	of income through ecotourism and recreational activities	habitat for forest plant and animal species	carbon stocks and reduction of emissions from deforestation and degradation
Restoration of degraded wetlands	Maintenance of water flow and quality and protection against storm inundation	Provision of recreational and employment opportunities	Potential revenue from recreational activities	Conservation of wetland flora and fauna and maintenance of breeding grounds for migratory species	Reduced emissions from wetland draining
Establishment of diverse agroforestry systems in agricultural land	Diversification of agricultural production to cope with changed climatic conditions	Contribution to food and fuel wood security.	Generation of income from sale of timber, firewood and other products	Conservation of biodiversity in agricultural landscape	Carbon storage in both above and below-ground biomass and soils
Conservation of agrobiodiversity	Provision of specific gene pools for crop adaptation to climatic variability	Enhanced food security, diversification of food products, and conservation of local and traditional knowledge and practices	Possibility of crops in difficult environments.	Conservation of genetic plant diversity	N/A
Conservation of medicinal plants used by local and indigenous communities	Local medicines available for key diseases such as malaria, dengue resulting from habitat destruction and degradation	Local communities have a better and sustainable source of medicines Maintenance of local knowledge and traditions	Local markets, if assessed and tapped, could be a reasonable source of income for local people	Medicinal plant conservation efforts enhanced; local and traditional knowledge inputs recognized and protected.	N/A

IX. IDENTIFYING MEANS TO INCENTIVIZE THE IMPLEMENTATION OF ADAPTATION ACTIONS THAT PROMOTE THE CONSERVATION AND SUSTAINABLE USE OF BIODIVERSITY

Changes in the economic background to decision-making and non-financial incentives are essential to implement ecosystem-based adaptation activities to climate change that can benefit biodiversity and ecosystem services and human well-being. Incentives for ecosystem-based adaptation should be carefully designed not to negatively affect ecosystem services including the conservation of biological diversity.

- Change the economic basis to decision-making: (i) ensure the value of all ecosystem services, not just those bought and sold in the market, are taken into account when making decisions; (ii) remove subsidies to, for example, agriculture, fisheries, and energy that cause harm to people and the environment; (iii) introduce payments to landowners in return for managing their lands in ways that protect ecosystem services, such as water quality and carbon storage, that are of value to society; (iv) implement appropriate pricing policies for natural resources, e.g., for fresh water; (v) establish market mechanisms to reduce nutrient releases and promote carbon uptake in the most cost-effective way; and (vi) apply fees, taxes, levees, and tariffs to discourage activities that degrade biodiversity and ecosystem services.

- Non-financial incentives and activities include: (i) laws and regulations; (ii) new governance structures nationally and internationally that facilitate the integration of decision-making between different departments and sectors, (iii) promote individual and community property or land rights; (iv) improve access rights and restrictions; (iv) improve access to information and education to raise awareness about ecosystem-based adaptation; (v) improve policy, planning, and management of ecosystems by: including sound management of ecosystem services in all planning decisions; (vi) develop and use environment-friendly technologies; and (vii) influence individual behavior.

Financial incentives, such as the payment for ecosystem services and environmental funds, could provide alternative sources of income/livelihoods for the poor that are heavily dependent on biodiversity and its components. For example, a forest ecosystem provides a range of regulatory services besides their role as mitigation against climate change.[9] It is these services that need to be maintained hence appropriate incentives such as the payment for ecosystem services and the use of environmental funds[10] services will ensure communities are better able to maintain a balance between ecosystem and their use of the resources. The World Bank together with other multilateral financial institutions and conservation NGOs provide a plethora of financial funds.

Internalizing the value of biodiversity and ecosystem services, other than carbon, in climate change-related activities can provide a strong economic incentive for conserving biodiversity. A range of financial instruments are available and can be effective in a specific manner in accordance with ecosystem type, project scale and projected period (see table below).

Proper criteria and indicators need to be developed to assure that the ecosystem services used as the incentives are not degraded over time. For instance, verification systems based on biological/ecosystem criteria and indicators can provide projects/countries with a financial incentive that ensures ecosystem-based adaptation for the long-term benefits of UNFCCC and the Convention on Biological Diversity. Proper criteria and indicators can become a surrogate of the intactness of ecosystems and adaptability, which can help in achieving the objectives of UNFCCC and the Convention on Biological Diversity.

Non-financial mechanisms can become indirect incentives to achieve multiple benefits of adaptations and can help build societal capacity to accept ecosystem based adaptation to climate change. Non-financial mechanisms may be the use of laws and regulations, property or land rights, access rights and restrictions, and valuation and education to raise awareness about ecosystem-based adaptation. Enhancing food security and other ancillary benefits can be incentive to adopt ecosystem-based approach for the people who rely on such benefits for their livelihood. On a local scale, traditional codes have been a societal regulation to avoid the overuse of common ecosystem services. Incentives taking account for such societal codes can ensure the societal adaptability for climate change as well as biological conservation.

While there are a wide range of incentives available, choosing one or combination of those incentive measure one need to consider several factors of conditions and scales. For examples, characteristics (physical, biological, social and economic) of the challenge, current and future financial and institutional arrangements, human resource and institutional capacities, gaps and obstacles, possibility of creating adverse impacts on other systems and sectors, opportunity for long-term sustainability and linkages with other programs. The incentive measures adopted should also address issues on transparency, equity and should be regularly monitored and evaluated. The Convention on Biological Diversity documents such as the Proposals for the Design and Implementation of Incentive Measures (http://www.cbd.int/doc/publications/inc-brochure-01-en.pdf) may be consulted for criteria and approaches for selection of incentives.

[9] Campbell A.,Kapos V., Cheney A., Kahn, S. I., Rashid M.,Scharlemann J.P.W.,Dickson B 2008. The linkage between biodiversity and climate change mitigation, UNEP World Conservation Monitoring Centre.

[10] Environment Funds as stated by the CBD cover a range of possible funding options, see http://www.cbd.int/incentives/case-studies.shtml

Table. Tools and incentives for implementing ecosystem-based adaptation

Tools and incentives	***Application to ecosystem-based adaptation***
Financial	
• Payment for ecosystem services (not tradable)	Payment to reward the ecosystem services to those who maintain the service (e.g., payments for watershed management)
• Carbon finance	Payment for carbon storage (e.g., Clean Development Mechanism, Voluntary carbon market)
• Incentives related to REDD	Positive incentive on issues relating to reducing emissions from deforestation and forest degradation in developing countries.
• Biodiversity based mechanism, such as biodiversity banking, biodiversity offset	Payment based on indicators or surrogate of biodiversity (e.g, area of intact forest)
Debt for Nature Swaps	Cancellation of debt in exchange for the conservation of natural ecosystems (e.g., creation of protected areas in Costa Rica in return for debt relief)
• Conservation Trust Funds	Funds for improving the management of/and ensuring conservation of protected areas (e.g; Conservation Covenant)
• Certification and labeling	Certification of products and services which are produced with minimal impacts on ecosystems, verified using rigorous standards and indicators e.g. eco tourism, forest stewardship council.
• Access/Price Premium to Green Markets	Adding value and increasing market access for sustainable products and services.e.g. niche market for organic products, organic coffee
• Market development[11]	Creation of new markets and expansion of existing markets for products and services that are environmentally friendly.
Agri – Environmental programme	Subsidies to organic farming, preservation of rare breed, eg; land set aside schemes, stewardship payments, rural credit /loans
Environmental Prize/Award[12]	Public recognition for good environmental stewardship.
• Eliminate Perverse Subsidies (eg; Fishing; Agriculture)	Eliminate subsidies that destroy, degrade or lead to the unsustainable use of ecosystems. Ecosystems.
• Taxation	Taxation of activities that destroy, degrade or mismanage natural resources (e.g., taxation of pesticide use, unsustainable timber harvesting…)
• Quotas and Charges	Establishment of quotas for the extraction of goods (such as firewood, timber, fish harvest, harvest of wild species) from natural ecosystems, to ensure their sustainable management
Non-financial	
• Definition of land tenure, and use planning and ownership and land use and management rights[13]	Clarification of land tenure and rights, to enhance conservation, restoration and sustainable management of ecosystems
• Public awareness and capacity-building on ecosystem-based adaptation	Increased recognition of the value of ecosystem-based adaptation and its role in adaptation strategies, leading to increased implementation
• Development, refinement and enforcement of legislation	Legislation that promotes the implementation of ecosystem-based adaptation and tools to ensure compliance; Legislation that promotes sustainable use of ecosystems or discourages mismanagement (e.g., protected area legislation, pesticide use regulations, water pollution laws)

[11]. Market development based on the Joint Forestry Management project in India, COP 9/12/12 Feb 2008.
[12] Example from Oman,ibid.
[13] ,ibid.

Tools and incentives	***Application to ecosystem-based adaptation***
• Institutional strengthening and creation of partnerships	Provision of financial and human resources to relevant institutions and establishment of networks involving diverse stakeholders
• Development, transfer, diffusion and deployment of environmentally sound technology	Develop soft and hard technologies and methodologies that could help in the implementation of ecosystem-based adaptation (e.g., software development, early warning systems, artificial reefs)
