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GUIDANCE FOR PROMOTING SYNERGY AMONG ACTIVITIES ADDRESSING BIOLOGICAL DIVERSITY, DESERTIFICATION, LAND DEGRADATION AND CLIMATE CHANGE

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Ad hoc Technical Expert Group on Biodiversity and Adaptation to Climate Change

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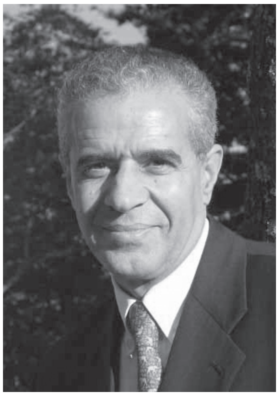
FOREWORD

Major scientific findings during the last few years have confirmed that the biophysical consequences of climate change are no longer theoretical; they are real and they are occurring at this very moment. Atmospheric and ocean temperatures keep increasing, and associated natural disturbances such as hurricanes are becoming more intense due in part to these changes. Hydrological cycles are also being altered: droughts and floods are becoming more frequent, while mountain snowmelt is occurring earlier every year, limiting water supply during periods of peak demand later in the season. Humans have already evacuated low-lying oceanic islands due to unprecedented sea-level rise. Climate change is also expected to significantly alter global food supply. There is also enough evidence to support the fact that the Earth's biodiversity is being directly and indirectly affected, from the ecosystem to the species level. For example, the permafrost is melting in the boreal zone; plant and animal species in many regions across the globe are either moving to cooler environments or are in the process of disappearing; and global warming has been identified in driving disease outbreaks that are causing widespread amphibian extinctions.



The available evidence also clearly indicates that even if we were to stop greenhouse emissions today, climate change impacts would still be felt for decades to come. Hence it is imperative that society adapt to climate change. It is particularly urgent to identify and apply tools and approaches that incorporate biodiversity considerations into the design and implementation of activities aimed at adapting to climate change. The information contained in the present report, prepared by the Ad Hoc Technical Expert Group on Biodiversity and Adaptation to Climate Change, aims to provide preliminary guidance on the issue. The Group, composed of 15 experts nominated by Governments, eight experts from indigenous and local communities, international organizations, United Nations bodies and other biodiversity conventions, and two resource persons, met in Helsinki in September 2005. The report was posted for wider review between February and April 2006 before its final publication.

The report highlights the major biological factors that contribute to ecosystem resilience under the projected impacts of global climate change, assesses the potential consequences for biodiversity of particular adaptation activities under the thematic areas of the Convention, provides methodological considerations when implementing these activities, and highlights research and knowledge gaps. The report both recognizes the potential of, and stresses the need for, synergy in the implementation of activities that interlink biodiversity conservation, mitigation of and adaptation to climate change, and land degradation and desertification in the context of the objectives of the three Rio Conventions and other relevant multilateral environmental agreements.

I wish to thank the Government of Finland for its continued support to the Secretariat in its work on climate change and biodiversity. In particular, for hosting the expert meeting, and for providing funds for the participation of country experts and the publication of this report.

Dr. Ahmed Djoghlaf
Executive Secretary

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The Secretariat of the Convention on Biological Diversity wishes to acknowledge with appreciation the Government of Finland for their financial and organizational support for this work. The Secretariat would also like to thank the members of the Ad Hoc Technical Expert Group on Biodiversity and Adaptation to Climate Change for their contributions during all stages of this work, the resource persons, and the support staff at the Ministry of the Environment in Helsinki. Finally, the Secretariat would like to acknowledge those Parties who provided comments to the draft report.

CONTENTS

I. INTRODUCTION

1. As noted in the Millennium Ecosystem Assessment, climate change is one of the most important drivers of biodiversity loss[1/] and is projected to further adversely affect the role of biodiversity as a source of goods and services. The impacts of climate change on biodiversity have been of major concern to the Convention on Biological Diversity since 2002 when, following a request from the Conference of the Parties and the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA), an Ad Hoc Technical Expert Group was established to carry out an assessment of the interlinkages between biodiversity and climate change. The report[2/] was completed in 2003 and focused primarily on the impacts of climate change mitigation options on biodiversity, and the links between them, in the context of the Kyoto Protocol.

2. At its seventh meeting in 2004, the Conference of the Parties to the Convention on Biological Diversity welcomed the report and requested its wider dissemination. At the same meeting, in decision VII/15, the Conference of the Parties further requested SBSTTA, as the next stage of its work on the interlinkages between biodiversity and climate change, to develop advice or guidance for promoting synergy among activities to address climate change at the national, regional and international level, where appropriate, including activities to combat desertification and land degradation, and activities for the conservation and sustainable use of biodiversity.

3. To this end, SBSTTA established an Ad Hoc Technical Expert Group on Biodiversity and Adaptation to Climate Change in recommendation X/13 in order to:

(i) undertake a supplementary assessment on the integration of biodiversity considerations in the implementation of adaptation activities to climate change at the local, subnational, national, subregional, regional, and international level, drawing on case studies and seeking also to identify and avoid duplication in activities between the Rio conventions; in particular, to identify the major biological factors that contribute to ecosystem resilience under the current and projected impacts of climate change, to assess the potential consequences for biodiversity of those particular adaptation activities, taking into account technical and technological interventions, highlighting gaps in current scientific knowledge and identifying research needs;

(ii) prepare advice or guidance under the thematic areas of the Convention for use at the local, national, regional and international level, as appropriate, for planning and/or implementing activities to address adaptation to climate change and that interlink climate change, biodiversity conservation and sustainable use and land degradation and desertification, including relevant tools and technologies, and taking into account traditional knowledge, innovations, and practices of indigenous and local communities.

4. The need to focus on adaptation to climate change has been also emphasized by the Joint Liaison Group (JLG) of the three Rio conventions (UNFCCC, UNCCD and CBD) at its fifth meeting,[3/] held in January 2004. The JLG recognized that adaptation to climate change is an important area for the three conventions and that activities that promote adaptation to climate

1/ Millennium Ecosystem Assessment (2005). *Ecosystems and Human Well-being: Synthesis*. Island Press, Washington, D.C.

2/ Secretariat of the Convention on Biological Diversity (2003). *Interlinkages between biological diversity and climate change. Advice on the integration of biodiversity considerations into the implementation of the United Nations Framework Convention on Climate Change and its Kyoto Protocol.* CBD Technical Series No. 10.

3/ UNEP/CBD/SBSTTA/10/INF/9

change also contribute to the conservation and sustainable use of biodiversity and sustainable land management. The JLG further noted the potential for creating synergy among the objectives of the three conventions through activities geared at adapting to climate change.

5. The Ad Hoc Technical Expert Group (AHTEG) on Biodiversity and Adaptation to Climate Change met in Helsinki from 13 to 16 September 2005 with financial support from the Government of Finland (the full report of the AHTEG meeting is contained in document UNEP/CBD/SBSTTA/10/INF/5). In November 2005, at its 11th meeting, SBSTTA welcomed the AHTEG report (recommendation XI/14) and at the same time requested its further development, drawing on more case studies relevant to the thematic areas of the Convention and additional information derived from the work of the United Nations Convention to Combat Desertification and the United Nations Framework Convention on Climate Change. Between February and April 2006, the draft report was posted for peer review by national focal points and SBSTTA focal points to the CBD. The draft report was also simultaneously posted for comments on the web sites of the UNFCCC and UNCCD.

6. The present paper contains the final report of the AHTEG. Section II contains an assessment of the integration of biodiversity considerations in the design and implementation of adaptation activities. Section III describes some approaches, methods and tools for planning, designing and implementing adaptation activities that also include biodiversity considerations. Drawing upon the contents of the previous two sections, section IV includes key points for advice.

II. INTEGRATION OF BIODIVERSITY CONSIDERATIONS IN THE IMPLEMENTATION OF ADAPTATION ACTIVITIES

7. **Adaptation to climate change refers to any adjustment that occurs naturally within ecosystems in response to climatic change or any human intervention that either moderates harm or exploits beneficial opportunities in response to actual or expected climate-related environmental changes[4/]. In terms of biodiversity, successful adaptation is an adjustment by an ecosystem or community to a new or changing environment without simplification or the loss of structure, functions and components**. Adaptation activities addressed in this document fall into two categories: biodiversity-specific adaptation activities that primarily aim to minimize loss of biodiversity and ecosystem characteristics, or sectoral adaptation activities that primarily seek to reduce the negative impacts on the relevant sector. Sectoral adaptation activities are important because of their potentially significant negative impacts on biodiversity if they are considered in isolation and also the opportunities for biodiversity to contribute to adaptation in many other sectors. Adaptation activities may include scientific, technological, institutional, behavioural, political, financial, regulatory and/or individual adjustments. Examples of adaptation types and activities associated with thematic areas under the CBD are detailed in Table 1.

8. **Even if all anthropogenic greenhouse gas emissions to the atmosphere were to be stopped immediately, global warming and its consequent impacts such as sea level rise would be expected to continue as projected for at least the next 50 years, owing to the decadal residence time of carbon dioxide in the atmosphere (inertia). Hence, the immediate need for adaptation in response to climate change is clear.** Under a business-as-usual scenario, the atmospheric concentration of carbon dioxide (the main greenhouse gas) is projected to increase during the 21st century to between 540 and 970 parts per million by 2100.[5/] The resultant projected global average temperature increases are very likely to be without precedent during at least the last 10,000 years[6/].

9. **Inertia in the climatic, ecological, and socio-economic systems makes adaptation both inevitable and necessary.** Within both natural and socio-economic systems different components will have either fast or slow responses to climate change so that there will be winners and losers whether in terms of habitats and species[7/] or land uses[8/].

10. **Climate change is already affecting many ecosystems.** There are well documented changes in the phenology and distribution of species along with the composition and structure of habitats[9/,10/]. In addition, progressive reductions in arctic ice extent[11/] and episodes of coral bleaching exemplify the major effects on both terrestrial and marine ecosystems[12/,13/]. Most critically, there is evidence that a number of species extirpa-

4/ Adapted from the IPCC Third Assessment Report.

5/ IPCC (2000). *Special Report on Emissions Scenarios*. Cambridge University Press, New York.

6/ IPCC (2001). *Climate Change 2001: The Scientific Basis.* Cambridge University Press, New York.

7/ Harrison, P. A., Berry, P. M., and Dawson, T. P. (eds.) (2001). *Climate Change and Nature Conservation in Britain and Ireland: Modelling Natural Resource Responses to Climate Change (the MONARCH project)*. UKCIP, Oxford

8/ Accelerates project – http://www.geo.ucl.ac.be/accelerates/

9/ Root, T.L., Price, J.T., Hall, K.R., Schneider, S.H., Rosenzweig, C., and Pounds, J.A. (2003). Fingerprints of global warming on wild animals and plants. Nature 421: 57-60.

10/ Walther, G.R., Post, E., Convey, P., Menzel, A., Parmesan, C., Beebee, T.J.C., Fromentin, J.R., Hoegh-Guldberg, O., and Bairlein, O. (2002). Ecological responses to recent climate change. *Nature* 416: 389-395.

11/ Arctic Climate Impact Assessment (2004). *Scientific Report of the Arctic Climate Impact Assessment*. Cambridge University Press.

12/ Hoegh-Guldberg, O. 1999. Climate change, coral bleaching and the future of the world's coral reefs. *Marine and Freshwater Research*, 50: 839-866.

13/ Donner, S.D., S K I Rving, W.J., Little, C.M., Oppenheimer, M., Hoegh-Guldberg, O. 2005. Global assessment of coral bleaching and required rates of adaptation under climate change. Global Change Biology (2005) 11, 2251–2265.

tions and extinctions can be directly attributed to climatic change, e.g., amphibians in Central America[14/].

11. **Biodiversity's natural responses to changing environmental conditions are called autonomous adaptations.** A number of properties determine the autonomous adaptation capacity of an ecosystem. These include resistance, resilience, inertia, vulnerability and sensitivity. Although each of these properties merits consideration, this paper focuses on the maintenance of ecosystem resilience as an essential component for successful adaptation.

12. **Resilient ecosystems maintain biodiversity and continue to deliver ecosystem goods and services under climate change.** In the geological past, biodiversity at ecosystem, species and genetic levels has adjusted to changes in climate, e.g. through changes in growth, population size, and migration patterns[15/,16/]. However, these occurred within largely unfragmented and undegraded ecosystems (and through longer time periods), which is not the case today.

13. **The autonomous adaptations of natural and managed ecosystems are expected to be insufficient to arrest the rate of loss of biodiversity**. This is almost inevitable in light of the projected magnitude and rate of climate change and greater frequency and magnitude of climatic extremes, alongside the levels of habitat conversion, fragmentation, and degradation already present within most ecosystems.

14. **Planned adaptation activities are urgently needed to slow the rate of biodiversity loss.** The roles of autonomous and planned adaptation in slowing the rate of biodiversity loss are depicted in Figure 1. Planned adaptation actions are necessary across all sectors, including water management, forestry, agriculture, and infrastructure development. They can attenuate loss at local, sub-national, national, sub-regional, regional, and international levels. Planned adaptation will benefit from a better understanding of the sensitivity of biodiversity to the potential impacts of climate change, of measures and means to assess adaptive capacity, of the ability to reduce vulnerabilities, and enhancing resilience.

15. **Planned adaptation for biodiversity aims for resilience to be maintained and restored.** Activities to maintain and restore resilience can be thought of in terms of three components. The first component is to maintain adequate and appropriate space, structure and environmental conditions for ecosystems, species and individuals to respond over temporal and spatial scales. This includes enhancing the capacity for species movement and replacement due to climate change by, for example, preventing habitat fragmentation and loss. The second component is to limit stresses that amplify the impacts of climate change. This includes addressing stresses such as over-harvesting, invasive species, and pollution (contaminants and nutrients). These are generally approachable on more local scales. The final component is to employ adaptive management, including monitoring to allow the testing of different approaches while implementation is underway. This is important due to significant knowledge gaps, which are coupled with the need to begin taking action now due to increasing costs and option limitations as climate change progresses. Additionally, adaptive management can provide lessons learned to be shared beyond the locations with the capacity to undertake such projects[17/].

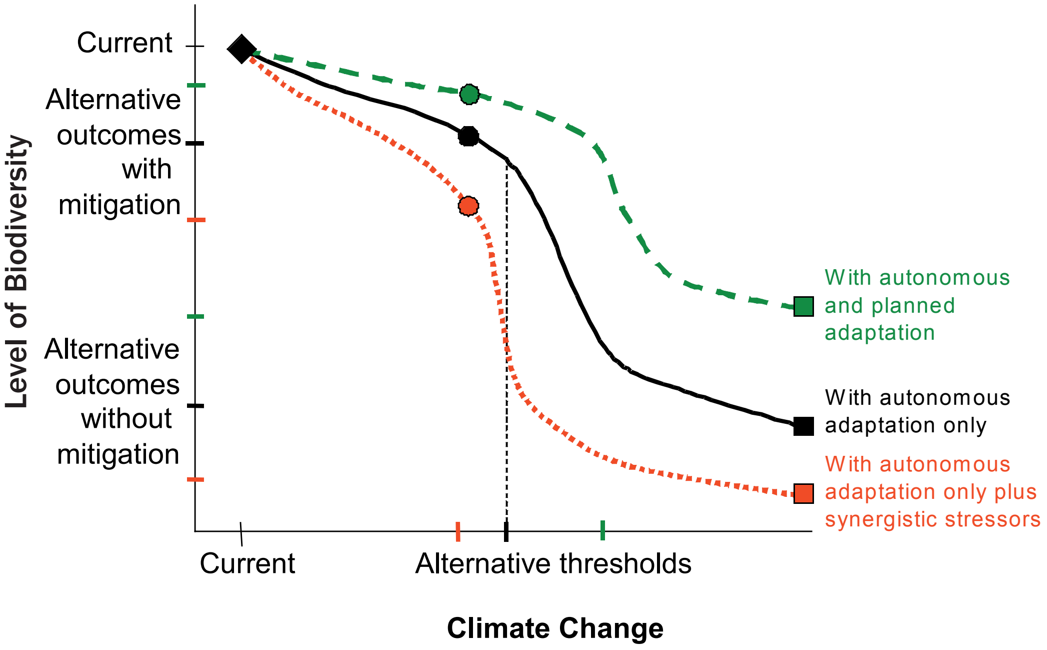
14/ Pounds, J. A., Bustamante, M. R., Coloma, L. A., Consuegra, J. A.,. Fogden, M. P. L., Foster P. N., La Marca, E., Masters, K. L., Merino-Viteri, A. Puschendorf, R., Sanchez-Azofeifa, G. A., Still, C. J., and. Young, B.E. (2006). Widespread amphibian extinctions from epidemic disease driven by global warming. Nature 439: 161-167.

15/ IPCC (2002). *Climate Change and Biodiversity*. Technical Paper V.

16/ Foster, D.R., Schoomaker, P.K., and Pickett, S.T.A. (1990). Insights from paleoecology to community ecology. *Trends in Ecology and Evolution* 5:119-122.

17/ Hansen, L.J., J.L. Biringer, and J.R. Hoffman (2003). *Buying Time: A User's Manual for Building Resistance and Resilience to Climate Change in Natural Systems.* World Wildlife Fund.

Figure 1. **A schematic diagram of biodiversity responses to climate change applicable to a given thematic area under the CBD**



Biodiversity responses to climate change are non-linear, with critical inflection points (solid line). Stressors that operate synergistically with climate change increase the rate of biodiversity loss (dotted line). Planned adaptation reduces the rate of biodiversity loss (dashed line) as compared to autonomous adaptation alone (solid line). Both mitigation and adaptation influence biodiversity outcomes for a given CBD thematic area. If carbon mitigation activities constrains climate change below the critical threshold, outcomes (●) will be significantly less severe than unmitigated outcomes (■).

16. **Many factors influence ecosystem resilience.** These include population size, habitat area and shape, presence of environmental gradients, existence of habitat refugia, degree of habitat connectivity, presence of ecotones and seres, degree of genetic heterogeneity, species richness, regenerative capacity, intermediate disturbance regimes, behavioural plasticity, multiple stable states, and stable hydrological cycles. Key biological factors for successful planned adaptation are:

(i) Maintaining **genetic heterogeneity**, which is both a goal of and a tool for planned adaptation. Replicate, viable and heterogeneous populations minimize their shared risk and maximize their opportunities for successful autonomous adaptation;

(ii) **Regenerative populations** are essential for the sustainability of species populations and community structure. The maintenance of climatic conditions necessary for all life cycle phases is crucial for the long-term viability of populations. The management of habitats to ensure suitable micro-climates for key phases is an essential adaptation activity;

(iii) Maintaining habitat heterogeneity, for example, by providing **multiple suc-**

cessional states that confer contrasting resource and habitat types under which selected species are able to persist and reproduce;

(iv) Climate change will cause species with limited tolerance to relocate to more suitable locales requiring a combination of **habitat connectivity and landscape permeability across environmental gradients**. Planned adaptation needs to enable access to these new locations often across fragmented or disturbed landscapes or seascapes. These new habitat needs cannot necessarily be predicted. As a result it may be prudent to ensure a range of habitat options along environmental gradients.

17. **Adaptation strategies have limits, requiring that mitigation action also be taken to limit the rate and extent of climate change**.

(a) Cost increases and options decrease with delay in action as climate change proceeds. Biodiversity responses to climate change are non-linear, with thresholds that research indicates occur 1–3°C above current levels[18/,19/]. These thresholds vary between ecosystems and species[20/]. For example, a 1°C increase above the historic mean annual maxima is likely to lead to extensive coral bleaching and similar dramatic effects relating to loss of ice habitat in the Arctic. Modelling suggests that under linear conditions, an increase in temperature of this magnitude could occur as early as 2015[21/]. After a threshold is passed, most adaptation strategies are unlikely to be successful and remaining ones prohibitively costly. Avoidance of this threshold requires action on mitigation concurrent with adaptation efforts;

(b) Under current constraints prioritization may be necessary in selecting adaptation projects as the need for adaptation is great but capacity (including cost) limited;

(c) Our ability to design and implement adaptation activities is limited by knowledge gaps and lack of synthesis of existing knowledge and experience, technology, awareness and political will to act. Overcoming these hurdles requires addressing the gaps and challenges relating to tools, research, synthesis and communications (section III);

(d) Given the current concerns with the growing incidence of natural disasters and their impact on biodiversity, national biodiversity strategies and action plans could benefit from the integration of knowledge on prevention, preparedness, and response strategies developed by the natural disaster management community.

18. **Planned adaptation activities are already being implemented to reduce many of the adverse impacts of climate change and produce economic and social benefits in the future. These adaptation activities can have positive, neutral or negative effects on biodiversity, and ecosystem goods and services**. Planned or directed adaptation activities carry implications for all ecosystems covered by the work programmes under the CBD. Table 1 illustrates how

18/ Tirpak, D., Ashton, J., Dadi Z.,. Filho, L.G.M., Metz, B., Parry, M., Schellnhuber, J., Yap, K.S., Watson, R., and Wigley, T. (2005). *Avoiding Dangerous Climate Change: International Symposium on the Stabilisation of Greenhouse Gas Concentrations.* Report of the International Steering Committee. Hadley Centre, Met Office, Exeter, UK 1-3 February 2005.

19/ IPCC (2001). *Third Assessment Report: The Scientific Basis.*

20/ Burkett, V.R., Wilcox, D.A., Stottlemeyer, R., Barrow, W., Fagre, D., Baron, J., Price, J., Neilsen, J.L., Allen, C.D., Peterson, D.L., Ruggerone, G., and Doyle, T. (2005). Nonlinear dynamics in ecosystem response to climatic change: case studies and policy implications. *Ecological Complexity* 2: 357-394.

21/ IPCC (2001). *Third Assessment Report: The Scientific Basis.*

different ecosystems can be affected by planned adaptation activities. The impacts on biodiversity contained in the table have been evaluated as positive, adverse, or neutral. The construction of seawalls, for example, poses a serious risk to island and coastal biodiversity, as they prevent the movement of coastal, estuarine, and marine species. Common adaptation measures, such as soil and water conservation, are applicable across many ecosystem types and/or CBD work programmes. Yet it is advisable to further explore commonalities among these work programmes, drawing on other assessments, such as the Arctic Climate Impact Assessment, and their implications for certain programmes of work, such as that on mountain biodiversity. It is important to note that the applicability of the different instruments/actions identified in column 5 of Table 1 may vary between countries due to different regulatory frameworks, availability of incentive schemes, and capacity to carry out assessment and monitoring.

19. **Understanding changes in biological diversity due to climate change may include the active participation of local and indigenous communities**. Sustainable development in light of adaptation to climate change needs to document, analyse and apply traditional knowledge in ways that complement science-based knowledge and vice versa. Enhanced competency and capacity are needed in indigenous organizations, their institutions, and their universities to contribute to the understanding of climate change impacts on biodiversity, and local and indigenous communities, as exemplified by the work on the Arctic Climate Impact Assessment project. New information technology will facilitate communication between local and indigenous communities, such as web-based multilingual tools.

Table 1. **Indicative list of adaptation activities[22/] relevant to the thematic areas considered under the Convention on Biological Diversity, their potential impacts on and risks to biodiversity, and possible adaptive management actions**

Adaptation activity	*Type of adaptation* [23/]	*Likely impact on biodiversity*	*Potential risk to biodiversity*[24/]	*Possible action for adaptive management*
Marine and coastal biodiversity				
Seawalls, dykes and tidal barriers	Technological and economic	Adverse	High–very high if concrete/rock structures are used Low–medium if mud walls and vegetation are used	Include biodiversity (terrestrial and coastal/marine) considerations in Environmental Impact Assessment (EIA)
Bridges to cross potentially inundated areas	Technological and economic	Adverse	Medium–high depending on the location	Include terrestrial and aquatic biodiversity considerations in EIA
Construction of buildings on stilts	Technological and economic	Adverse to neutral	Low if already in urban areas	Monitor for likely effects on biodiversity and include adaptive management
Re-zoning in coastal areas	Institutional and regulatory	Adverse or positive	High–very high if high- biodiversity areas are urbanized; low otherwise	Strategic environmental assessment should consider the impact on biodiversity and zone accordingly; allow for appropriate conservation areas for biodiversity
Migration of people from coastal areas and/or marginal lands (e.g., in semi-arid areas)	Behavioural and individual	Adverse or positive	Low if moving to urban areas, although could place additional pressure on water and energy resources; high if moving to slightly less marginal areas	Educate urban planners to minimize the exploitation of natural resources; effect of other migration may be hard to manage
Introduction of salt-tolerant varieties of native plants and animals for coastal protection/revegetation	Scientific and economic	Positive to neutral	Low	Monitor for likely effects on biodiversity and include adaptive management

22/ The adaptation activities may be anticipatory or reactive. Usually they refer to human systems. Many of these activities are described in some detail in the CBD Technical Series no. 10, section 4.11.

23/ Human systems may require adjustments to the changing climate, e.g., in the scientific, technological, institutional, behavioural, political, financial, regulatory and/or individual area. Classification of adaptation activities may vary between countries, and other categories could be appropriate in some cases.

24/ The effects of an activity on biodiversity may vary according to specific circumstances; the information in this column is for indicative purposes only.

Adaptation activity	*Type of adaptation* [23/]	*Likely impact on biodiversity*	*Potential risk to biodiversity* [24/]	*Possible action for adaptive management*
Establishment of aquaculture, including mariculture, to compensate for climate-induced losses in food production	Technological and economic	Neutral to adverse	High if alien or GMOs fish or carnivorous fish (due to harvest of wild fish for food) are used; high if harmful chemicals are released	Monitor for likely effects on biodiversity and include adaptive management
Rehabilitation of damaged ecosystems	Scientific, regulatory and institutional	Positive	Generally low unless invasive exotic species are used or neighbouring areas are damaged	Monitor for likely effects on biodiversity and include adaptive management
Establishment of protected areas or management for sustainable use	Regulatory and institutional	Positive or neutral	Low	Monitor for likely effects on biodiversity and include adaptive management
Inland water biodiversity				
Construction of buildings on stilts	Technological and economic	Neutral	Low if already in urban areas	Monitor for likely effects on biodiversity and include adaptive management
Diversion of fresh water to areas suffering water shortage (dams, water transfers, or irrigation channels) or increased extraction of groundwater supply	Technological, regulatory and economic	Adverse or neutral	Medium–high depending on environmental flow, the rate of withdrawal, etc.	Include terrestrial and aquatic biodiversity considerations in EIA
Introduction of cultivated plant varieties tolerant to higher temperatures	Scientific and economic	Neutral to adverse	High if using more water for growth; potential increased impacts of invasive alien species	Monitor for likely effects on biodiversity and include adaptive management
Introduction of pest-resistant varieties	Scientific, technological and economic	Neutral to positive if pesticide use is reduced	Low if limited impact directly on biodiversity; high if invasive alien species are introduced.	Monitor for likely effects on biodiversity and include adaptive management

Adaptation activity	*Type of adaptation* [23/]	*Likely impact on biodiversity*	*Potential risk to biodiversity*[24/]	*Possible action for adaptive management*
Landscape-scale management of water resources	Scientific, regulatory and institutional	Positive	Low–very low if aimed to benefit biodiversity; potentially high if not planned properly	Monitoring would still be necessary to ensure that the goals are being met; need to consider and, if necessary, enact policies to deal with land tenure issues and compensation for reduction in farming and logging intensity
Establishment of aquaculture, including mariculture to compensate for climate-induced losses in food production	Technological and economic	Neutral to adverse. Positive if pressure on wild resources is reduced	Potentially high if alien or GMO fish or other aquatic, including marine, organisms escape, if eutrophication occurs, or if harmful chemicals are released	Monitor for likely effects on biodiversity and include adaptive management
Rehabilitation of damaged ecosystems	Scientific, regulatory and institutional	Very positive, particularly where natural ecosystem functions are restored to mitigate against impacts of climate change (e.g., flood mitigation).	None if the objective is rehabilitation towards a more natural state.	Monitor for likely effects on biodiversity and include adaptive management
Island biodiversity				
Islands, particularly small islands, are socially and ecologically vulnerable to climate change. All adaptation activities identified for the thematic areas marine and coastal biodiversity, inland waters, agricultural biodiversity, dry and subhumid land biodiversity, forest biodiversity and mountain biodiversity might also be relevant for island biodiversity but their implementation may need special considerations.[25/]				
Agricultural biodiversity				
Diversion of fresh water to areas suffering water shortage (dams or irrigation channels) or increased extraction of groundwater supply	Technological, regulatory and economic	Adverse or neutral	Medium–high depending on environmental flow, the rate of withdrawal, etc.	Include terrestrial and aquatic biodiversity considerations in EIA

25/ See e.g., Tompkins et al. (2005). *Surviving Climate Change in Small Islands: A Guidebook*. Tyndall Centre for Climate Change Research, U.K.

Adaptation activity	*Type of adaptation* [23/]	*Likely impact on biodiversity*	*Potential risk to biodiversity*[24/]	*Possible action for adaptive management*
Introduction of drought-tolerant varieties	Scientific and economic	Neutral or adverse if extending into marginal lands not previously cultivated	Low if the growing season is not extended; potentially high if they become invasive	Monitor for likely effects on biodiversity and include adaptive management
Introduction of salt-tolerant varieties of agricultural plants	Scientific and economic	Positive to adverse	Low unless salt-tolerant varieties reduce endemic biodiversity by becoming invasive or extending agriculture into marginal areas	Monitor for likely effects on biodiversity and include adaptive management
Introduction of plant varieties tolerant to higher temperatures	Scientific and economic	Neutral to adverse	High if using more water for growth or becoming invasive	Monitor for likely effects on biodiversity and include adaptive management
Introduction of pest-resistant varieties	Scientific, technological and economic	Neutral to positive	Low if neutral impact on biodiversity, high if they become invasive	Monitor for likely effects on biodiversity and include adaptive management
Introduction or extension of multi-cropping or mixed farming systems (e.g., agroforestry systems) to enhance ecosystem resilience; introduction of new crop/animal species and varieties	Scientific and economic	Positive if there is reduction in chemical use for pest and disease control and/or decrease in erosion due to year-round crop cover, or reduction in land used for agriculture	Low – medium if replacing an existing crop without extending the cropland; possibly high–very high if the crop/animal becomes an invasive species or if multicropping leads to higher use of irrigation water	Assess the potential invasiveness risk of the introduced species; minimize the land under intensive agriculture
Low-tillage cropping, maintaining cropping residues and reducing fallow periods[26/]	Scientific, technological and economic	Positive due to possible decreased soil erosion and decreased loss of soil biodiversity	Low but high if low tillage leads to increased herbicide application	Monitor for gains in biodiversity or reduction in erosion and potential water use

26/ Can be a Land Use, Land Use Change and Forestry (LULUCF)-based mitigation option under the Kyoto Protocol.

Adaptation activity	*Type of adaptation* [23]	*Likely impact on biodiversity*	*Potential risk to biodiversity* [24]	*Possible action for adaptive management*
Changes in timing and type of irrigation and fertilizer use	Technological, institutional and economic	Positive if introducing water saving (e.g. drip irrigation) in areas that were already irrigated, negative if introducing irrigation into new areas	Low–medium	Monitor for changes and/or examine the possibility of introducing the most appropriate irrigation for the crop and for the fertilizer; timing of fertilizer application can be important in minimizing the risk to biodiversity
Changes in grazing management[3]	Economic	Positive if reducing the intensity of grazing in areas under high pressure, negative if extending additional pressure on the areas grazed	Low–medium	Monitor the effects on biodiversity
Abandonment of agriculture	Economic and regulatory	Positive if native/endemic species colonize old fields; negative if old fields colonized by non-native and/or invasive species or if moderate disturbance (low intensity grazing) is suppressed.	Low to moderate	Management of the abandoned land may be necessary to provide maximum benefits to biodiversity
Establishment of corridors	Scientific, regulatory and institutional	Positive	Low–medium if allowing migration of invasive species	Monitor the migration of plant and animal species in the corridors and the connected cells of the landscapes, and manage invasive species when detected

Adaptation activity	*Type of adaptation* [23/]	*Likely impact on biodiversity*	*Potential risk to biodiversity*[24/]	*Possible action for adaptive management*
Landscape-scale management	Scientific, regulatory and institutional	Positive	Low–very low if aimed to benefit biodiversity	Monitoring would still be necessary to ensure that the goals are being met; need to consider and, if necessary, enact policies to deal with land tenure issues and compensation for reduction in intensity of farming practices
Rehabilitation of damaged ecosystems	Scientific, regulatory and institutional	Positive by increasing agricultural output whilst improving sustainability.	Neutral–low unless invasive species are used or neighbouring areas are damaged	Monitor for likely effects on biodiversity and include adaptive management
Establishment of protected areas or management for sustainable use	Regulatory and institutional	Positive or neutral	Low	Monitor for likely effects on biodiversity and include adaptive management
Reduction of other pressures on biodiversity arising from habitat conversion, over-harvesting, pollution, and alien species invasions	Scientific, technological and regulatory	Positive	Low, but methods may have secondary effects on biodiversity	Monitor for likely effects on biodiversity and include adaptive management EIA and Strategic Environmental Assessment (SEA) on the activities causing the pressures
Dry and sub-humid lands biodiversity				
Diversion of fresh water to areas suffering water shortage (dams or irrigation channels) or increased extraction of groundwater supply	Technological, regulatory and economic	Adverse or neutral	Medium–high depending on environmental flow, the rate of withdrawal, etc.	Include terrestrial and aquatic biodiversity considerations in EIA
Introduction of drought-tolerant varieties	Scientific and economic	Neutral or adverse if extending into marginal lands not cultivated before	Low if the growing period is not extended	Monitor for likely effects on biodiversity and include adaptive management

Adaptation activity	*Type of adaptation* [23/]	*Likely impact on biodiversity*	*Potential risk to biodiversity*[24/]	*Possible action for adaptive management*
Introduction of salt-tolerant varieties of native biota	Scientific and economic	Neutral to adverse	Low	Monitor for likely effects on biodiversity and include adaptive management
Introduction of plant varieties tolerant to higher temperatures	Scientific and economic	Neutral to adverse	High if using more water for growth	Monitor for likely effects on biodiversity and include adaptive management
Introduction of pest-resistant varieties	Scientific, technological and economic	Neutral to positive	Low if pests do not affect other biodiversity, high if they do	Monitor for likely effects on biodiversity and include adaptive management
Introduction or extension of multi-cropping or mixed farming systems to enhance ecosystem resilience; introduction of new crop/animal species and varieties	Scientific and economic	Positive if there is reduction in chemical use for pest and disease control and/or decrease in erosion due to year-round crop cover	Low – medium if replacing an existing crop without extending the cropland; high–very high if the crop/animal becomes an invasive species	Assess the potential invasiveness risk of the introduced species; minimize the land under intensive agriculture
Low-tillage cropping, maintaining cropping residues and reducing fallow periods[27/]	Scientific, technological and economic	Positive due to possible decreased soil erosion and decreased loss of soil biodiversity	Low; high if low tillage leads to increased herbicide application	Monitor for gains in biodiversity or reduction in erosion and potential water use
Changes in timing and type of irrigation and fertilizer use	Technological, institutional and economic	Positive if introducing water saving (e.g., drip irrigation) in areas that were already irrigated, negative if introducing irrigation	Low–medium	Monitor for changes and/or examine the possibility of introducing the most appropriate irrigation for the crop; for fertiliser; timing of fertilizer application can be important in minimizing the risk to biodiversity
Changes in grazing management	Economic	Positive if reducing the intensity of grazing in areas under high pressure, negative if extending additional pressure on the areas grazed	Low–medium	Monitor the effects on biodiversity

27/ Can be a Land Use, Land Use Change and Forestry (LULUCF) -based mitigation option under the Kyoto Protocol.

Adaptation activity	*Type of adaptation* [23/]	*Likely impact on biodiversity*	*Potential risk to biodiversity*[24/]	*Possible action for adaptive management*
Abandonment of agriculture	Economic and regulatory	Positive if native/endemic species colonize old fields; negative if old fields colonized by non-native and/or invasive species, or if moderate disturbance (low-intensity grazing) is suppressed	Low–medium	Management of the abandoned land is necessary to provide maximum benefits to biodiversity
Natural forest regeneration, sustainable forest management[28/] and avoided deforestation	Regulatory, institutional and economic	Positive if natural forest regeneration occurs and sustainable forest management harvesting practices are applied	Low	Monitoring to assess the gains for biodiversity
Establishment of corridors	Scientific, regulatory and institutional	Positive	Low–medium if allowing migration of invasive species	Monitor the migration of plant and animal species in the corridors and the connected cells of the landscapes and manage invasive species when detected
Landscape-scale management	Scientific, regulatory and institutional	Positive	Low–very low if aimed at benefiting biodiversity	Monitoring would still be necessary to ensure that the goals are being met; need to consider and, if necessary, enact policies to deal with land tenure issues and compensation for reduction in intensity of farming practices
Rehabilitation of damaged ecosystems	Scientific, regulatory and institutional	Positive	Low–neutral unless potentially invasive exotic species are used or neighbouring areas are damaged	Monitor for likely effects on biodiversity and include adaptive management

28/ Some Annex B Parties to the UNFCCC can declare this as an activity under the Kyoto Protocol

Adaptation activity	*Type of adaptation* [23/]	*Likely impact on biodiversity*	*Potential risk to biodiversity* [24/]	*Possible action for adaptive management*
Establishment of protected areas or management for sustainable use	Regulatory and institutional	Positive or neutral	Medium–high	Monitor for likely effects on biodiversity and include adaptive management
Reduction of other pressures on biodiversity arising from habitat conversion, over-harvesting, pollution, and alien species invasions	Scientific, technological and regulatory	Positive	Methods can have low to high secondary effects on biodiversity	Monitor for likely effects on biodiversity and include adaptive management, EIA and SEA
Use of prescribed grazing management regimes	Scientific and regulatory	Positive or negative	Potentially high if overgrazing occurs	Monitor for likely effects on biodiversity and include adaptive management
Efficient management of rain water	Technological, behavioral and individual	Positive	Low	Monitor for likely effects on biodiversity and include adaptive management
Forest biodiversity				
Introduction of pest-resistant varieties	Scientific, technological and economic	Neutral to positive	Low if pests do not affect other biodiversity, high if they do	Monitor for likely effects on biodiversity and include adaptive management
Abandonment of agriculture	Economic and regulatory	Positive if native/endemic species colonize old fields; negative if old fields colonized by non-native and/or invasive species or if moderate disturbance (low-intensity grazing) is suppressed	Low–medium	Management of the abandoned land is necessary to provide maximum benefits to biodiversity
Natural forest regeneration, sustainable forest management[29/] and avoided deforestation	Regulatory, institutional and economic	Positive if natural forest regeneration occurs and sustainable forest management harvesting practices are applied	Low	Monitoring to assess the gains for biodiversity

29/ Some Annex B Parties to the UNFCCC can declare this as an activity under the Kyoto Protocol

Adaptation activity	*Type of adaptation* [23]	*Likely impact on biodiversity*	*Potential risk to biodiversity*[24]	*Possible action for adaptive management*
Establishment of corridors	Scientific, regulatory and institutional	Positive	Low–medium if allowing migration of invasive species	Monitor the migration of plant and animal species in the corridors and the connected cells of the landscapes and manage invasive species when detected
Landscape-scale management	Scientific, regulatory and institutional	Positive	Low–very low if aimed at benefiting biodiversity	Monitoring would still be necessary to ensure that the goals are being met; need to consider and, if necessary, enact policies to deal with land tenure issues and compensation for reduction in intensity of farming practices
Rehabilitation of damaged ecosystems	Scientific, regulatory and institutional	Positive	Low unless potentially invasive exotic species are used.	Monitor for likely effects on biodiversity and include adaptive management
Establishment of protected areas or management for sustainable use	Regulatory and institutional	Positive or neutral	Low	Monitor for likely effects on biodiversity and include adaptive management
Reduction of other pressures on biodiversity arising from habitat conversion, over-harvesting, pollution, and alien species invasions	Scientific, technological and regulatory	Positive	Medium–high. Methods can have secondary effects on biodiversity	Monitor for likely effects on biodiversity and include adaptive management, EIA and SEA
Practice of low-intensity forestry	Scientific and regulatory	Positive	Low–medium–	Monitor for likely effects on biodiversity and include adaptive management
Mountain Biodiversity				
Introduction of cultivated plant varieties tolerant to higher temperatures	Scientific and economic	Neutral to adverse	High if using more water for growth	Monitor for likely effects on biodiversity and include adaptive management

Adaptation activity	*Type of adaptation* [23/]	*Likely impact on biodiversity*	*Potential risk to biodiversity*[24/]	*Possible action for adaptive management*
Introduction of pest-resistant varieties	Scientific, technological and economic	Neutral to positive	Low if pests do not affect other biodiversity, high if they do	Monitor for likely effects on biodiversity and include adaptive management
Natural forest regeneration, sustainable forest management[30/] and avoided deforestation	Regulatory, institutional and economic	Positive if natural forest regeneration occurs and sustainable forest management harvesting practices are applied	Low	Monitoring to assess the gains for biodiversity
Establishment of both horizontal and vertical corridors	Scientific, regulatory and institutional	Positive	Low–medium if allowing migration of invasive species	Monitor the migration of plant and animal species in the corridors and the connected cells of the landscapes and manage invasive species when detected
Landscape-scale management	Scientific, regulatory and institutional	Positive	Low if aimed at benefiting biodiversity	Monitoring would still be necessary to ensure that the goals are being met; need to consider and, if necessary, enact policies to deal with land tenure issues and compensation for reduction in intensity of farming practices
Rehabilitation of damaged ecosystems	Scientific, regulatory and institutional	Positive	High if potentially invasive exotic species are used	Monitor for likely effects on biodiversity and include adaptive management
Establishment of protected areas or management for sustainable use	Regulatory and institutional	Positive or neutral	Low	Monitor for likely effects on biodiversity and include adaptive management
Reduction of other pressures on biodiversity arising from habitat conversion, over-harvesting, pollution, and alien species invasions	Scientific, technological and regulatory	Positive	Methods can have secondary effects on biodiversity	Monitor for likely effects on biodiversity and include adaptive management, EIA and SEA

30/ Some Annex B Parties to the UNFCCC can declare this as an activity under the Kyoto Protocol

20. **Adverse consequences to biodiversity can be minimized, and positive benefits enhanced if biodiversity considerations are incorporated formally and routinely into adaptation planning.** Planned adaptation actions should proactively take into account biodiversity considerations that are mainstreamed into development policies, plans and projects at national, sub-national and local scales. For example, adaptation to climate change in different ecosystems, e.g., actions already planned under the implementation of UNFCCC and UNCCD commitments for drylands, should take into account relevant biodiversity considerations in the CBD programme of work on dry and sub-humid land biodiversity.

21. **As an adaptation strategy, maintaining biodiversity allows ecosystems to provide goods and services while societies cope with climate change. This is essential if UNFCCC objectives and Millennium Development Goals for poverty alleviation, food production and sustainable development are to be met**. The categorization of ecosystem services (provisioning, supporting, regulating and cultural), as presented in the Millennium Ecosystem Assessment[31/] is useful in determining their importance for the subsistence of human beings. Many ecosystem services are largely unrecognized in their global importance or in the role they play in meeting societal needs. Ecosystem services play a vital role in both mitigation and adaptation to climate change. Nearly 60 per cent of the carbon that is now emitted to the atmosphere from human activities is absorbed and stored by terrestrial and ocean ecosystems, thereby slowing the rate of global climate change. An estimated 40 per cent of the global economy is directly based on biological products and processes, and the goods provided by biodiversity represent an important part of many national economies. Ecosystems also provide essential services for many local and indigenous communities such as non-timber forest products and other needs for subsistence and traditional medicines. Successful adaptation to climate change thus includes enabling the sustainable use of ecosystem services.

22. **Greater synergy in implementing the commitments adopted under different multilateral environmental agreements (MEAs) is needed for improving the delivery of the three objectives of the Convention on Biological Diversity.** The rationale for collaboration among the multilateral environmental agreements stems from the interlinkages between the issues that they address[32/]. Climate change can be an important driver of biodiversity loss and desertification. Ecosystem dynamics and patterns of land use can impact the earth's carbon, energy and water cycles and therefore affect local and regional climate. Furthermore, measures undertaken to implement commitments under one convention may have consequences for the implementation of other commitments in different conventions.

(a) While recognising the distinct mandates of relevant multilateral environmental agreements and conventions, the importance of enhanced cooperation has been repeatedly emphasized;

(b) Enhanced cooperation between international conventions, organizations and bodies aims to ensure the environmental integrity of the conventions, promote synergies under the common objective of sustainable development, avoid duplication of efforts, strengthen joint efforts and enable more efficient use of available resources;

(c) The Joint Liaison Group (JLG) between the secretariats of the Convention on Biological Diversity, the United Nations Framework Convention on Climate

31/ Millennium Ecosystem Assessment 2003 Report "People and Ecosystems: A Framework for Assessment"

32/ Described in detail in CBD Technical Series no. 10.

Change and the United Nations Convention to Combat Desertification has assessed past and current forms of collaboration and identified options for enhanced cooperation among the three Rio conventions (UNEP/CBD/SBSTTA/10/INF/9 and FCCC/SBSTA/2004/INF.19). Options for further enhancing cooperation include:

(i) at the national and international levels: encouraging collaboration among national focal points and collaboration at the level of the convention bodies and secretariats;
(ii) issues addressing climate change impacts, adaptation, mitigation, land degradation and the conservation and sustainable use of biodiversity;
(iii) specific areas such as capacity-building; technology transfer; research, monitoring and systematic observation; information exchange and outreach; reporting, and financial resources.

23. **Provisions, decisions and resolutions from the governing bodies of the UNFCCC, UNCCD, CBD, the Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention), and the Convention on the Conservation of Migratory Species of Wild Animals (CMS) have identified already many concrete activities related to adaptation, as illustrated in Table 2.** These can be grouped under the following headings:

(a) Development of options for adaptation activities;
(b) Assessment of options for adaptation activities ;
(c) Effective management of particular ecosystems;
(d) Promotion of societal actions;
(e) Restoration of degraded ecosystems; and
(f) Integration of adaptation activities into other policies and strategies.

24. The list above demonstrates the variety of options for complementary work across multilateral environmental agreements to fulfil their objectives whilst contributing to adaptation. At the same time, the list is useful for identifying possible areas where more complementary work could be undertaken in the future, such as in recognizing the role of ecosystems in adaptation, promoting biological diversity in climate change adaptation activities, and minimizing the adverse effects of adaptation actions on the environment.

25. **An integrated adaptation framework to climate change would benefit from a proactive attempt at developing a comprehensive complementary strategy that engages the various multilateral environmental agreements, for instance, through the Joint Liaison Group**. The concept of adaptation to the adverse effects of climate change originated in the context of the climate change negotiations. The UNFCCC refers to adaptation as its ultimate objective[33/], and a number of its articles and decisions of the Conference of Parties to the UNFCCC include the preparation of national adaptation programmes of action in least-developing countries. The recent adoption in 2005 of the UNFCCC SBSTA 5 year programme of work on impacts, vulnerability and adaptation to climate change aims to assist UNFCCC Parties to make informed decisions on practical adaptation actions and measures to respond to climate change.[34/] Synergy

33/ The ultimate objective of the UNFCCC is to achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

34/ Annex to UNFCCC COP decision 2/CP.11

between biodiversity, climate change, desertification, sectoral policies and programmes (e.g. land management, wetlands, agriculture, forests) is essential especially at the national and local levels when designing and implementing an adaptation activity. It is considered that adaptation activities may be best carried out as part of an overall approach to sustainable development, integrated, for example, with national biodiversity strategies and action plans, and related projects.

Table 2. Examples of complementarity and/or overlap in provisions, decisions, and resolutions on adaptation options/activities/objectives between selected multilateral environmental agreements (MEAs)[35/]

ACTIVITIES	SOURCE
Element 1. Develop options for adaptation activities	
UNFCCC	
Identify key climate change adaptation measures in the process of preparing national adaptation programmes of action (NAPAs)	**UNFCCC Decision 28/CP.7**, Guidelines for the preparation of national adaptation programmes of action. NAPAs are prepared by least developed countries. **UNFCCC** article 4.1 (b).
Ramsar Convention	
Encourage the development of appropriate methods of integration of flood and natural hazard management and water quality control through maintaining natural coastal wetland processes in all phases of integrated costal zone management (ICZM)	**Ramsar Resolution VIII.4**, Wetland issues in Integrated Coastal Zone Management (ICZM), Annex (Principles and guidelines for incorporating wetland issues into Integrated Coastal Zone Management (ICZM): Action 5.5, Guideline No. 5 – Ensuring the recognition by Contracting Parties of the role of coastal wetlands in regulating water flows and water quality
CBD	
Develop methods for adapting marine and coastal protected areas management in response to possible changing species and habitat distribution patterns, which may result from climate change	**CBD Decision VII/5**, Marine and coastal biological diversity, Annex I (Elaborated programme of work on marine and costal biological diversity): Paragraph (c), Priority 2.3: Identifying the best indicators for assessing management effectiveness at various scales within an overall system, Appendix 4, research priorities, including research and monitoring projects associated with programme element 3: marine and coastal protected areas
Element 2: Assess options for adaptation activities	
Component 1: general	
UNFCCC	
Select and identify priority adaptation activities based on agreed criteria	**UNFCCC Decision 28/CP.7**, Guidelines for the preparation of national adaptation programmes of action), paragraph 8(c)(iii), Annex (Guidelines for the preparation of national adaptation programmes of action). **UNFCCC** Article 4.1(f).

35/ This is a sample of the activities listed under the adaptation section of the biodiversity and climate change module of UNEP's Issue-Based Modules for Coherent Implementation of Biodiversity Conventions (http://svs-unepibmdb.net/)

ACTIVITIES	SOURCE
Component 2: protected areas	
UNFCCC	
Provide opportunity for research, including for adaptive measures for protected areas to cope with climate change	**UNFCCC Article 4.1(e)**, and **Kyoto Protocol Article 11.2**
Component 3: coastal wetlands	
Ramsar Convention	
Assess the feasibility of adaptation options for coastal wetlands in relation to climate change and sea-level rise scenarios	**Ramsar Resolution VIII.4**, Wetland issues in Integrated Coastal Zone Management (ICZM), Annex (Principles and guidelines for incorporating wetland issues into Integrated Coastal Zone Management (ICZM)): Action 6.3, Guideline No. 6 – Ensuring recognition by Contracting Parties of the role of coastal wetlands in mitigating impacts of climate change and sea level rise
Review opportunities for the rehabilitation or restoration of degraded coastal wetlands	**Ramsar Resolution VIII.4**, Wetland issues in Integrated Coastal Zone Management (ICZM), Annex (Principles and guidelines for incorporating wetland issues into Integrated Coastal Zone Management (ICZM)): Action 5.2, Guideline No. 5 – Ensuring the recognition by Contracting Parties of the role of coastal wetlands in regulating water flows and water quality
Consider the creation of additional constructed wetlands within coastal areas	**Ramsar Resolution VIII.4**, Wetland issues in Integrated Coastal Zone Management (ICZM), Annex (Principles and guidelines for incorporating wetland issues into Integrated Coastal Zone Management (ICZM)): Action 5.2, Guideline No. 5 – Ensuring the recognition by Contracting Parties of the role of coastal wetlands in regulating water flows and water quality
Assess options for maximizing benefits of coastal wetlands in mitigating climate change and sea-level rise impacts	**Ramsar Resolution VIII.4**, Wetland issues in Integrated Coastal Zone Management (ICZM), Annex (Principles and guidelines for incorporating wetland issues into Integrated Coastal Zone Management (ICZM)): Action 6.2, Guideline No. 6 – Ensuring the recognition by Contracting Parties of the role of coastal wetlands in mitigating impacts of climate change and sea-level rise
Component 4: coral reefs	
CBD	
Support further target research programmes that investigate management options to building resilience to mass coral bleaching on both short- and long-time frames	**CBD Decision VII/5**, Marine and coastal biological diversity, Annex I (Elaborated programme of work on marine and costal biological diversity): Subparagraph 2(a)(v)(c) of Appendix 1, specific work plan on coral bleaching
Estimate the cost to implement the necessary activities to meet the targets of the programme of work on protected areas	**CBD Decision VII/28**; Protected areas (Articles 8 (a) to (e)), paragraph 10
Element 3: Effectively manage natural systems	
Component 1: general	
CBD	
Take measures to manage ecosystems to maintain their resilience to extreme climatic events and to help mitigate and adapt to climate change	**CBD Decision VII/15**, Biodiversity and Climate Change, paragraph 12

ACTIVITIES	SOURCE
Component 2. marine and coastal zones	
UNFCCC	
Develop and elaborate appropriate and integrated plans for coastal zone management	**UNFCCC Article 4.1(e)** and **KP Article 11.2**
CBD	
Take measures to manage coastal and marine ecosystems, including mangroves, seagrass beds and coral reefs	**CBD Decision VII/5**, Marine and coastal biological diversity, paragraph 8. The objective is to maintain their resilience to extreme climatic events.
Maximize the effectiveness of marine and coastal protected areas and networks	**CBD Decision VII/5**, Marine and coastal biological diversity, paragraph 8. The objective is to enhance biodiversity by addressing threats.
Identify, test and refine management regimes	**CBD Decision VII/5**, Marine and coastal biological diversity, Annex I (Elaborated programme of work on marine and costal biological diversity): Subparagraph 1(a)(ii), Management actions and strategies to support reef resilience, rehabilitation and recovery, an action identified as being of highest priority for implementation. Specific examples given of means to implement these actions are the application of appropriate protective status, reduction of reef stressors, and management of reef communities. The objective is to enhance reef resilience to and recover from higher sea temperatures and/or coral bleaching.
Component 3: water resources and agriculture	
UNFCCC	
Develop and elaborate appropriate and integrated plans for water resources and agriculture	**UNFCCC Article 4.1(e)** and **Kyoto Protocol Article 11.2**
CBD	
Carry out a series of case studies to identify key goods and services provided by agricultural biodiversity	**CBD Decision V/5**, Agricultural biodiversity: review of phase I of the programme of work and adoption of a multi-year work programme, Annex 5 (Programme of work on agricultural biodiversity): Activity no. 2.1, Programme element 2. Adaptive management. One of the specific issues that the case studies are required to deal with is the role of genetic diversity in providing resilience, reducing vulnerability, and enhancing adaptability of production systems to changing environments and needs. According to the Appendix to CBD Decision V/5 agricultural biodiversity provides the following climate-related ecological services: erosion control and climate regulations and sequestration.
Component 4: drought, desertification and floods	
UNFCCC	
Develop and elaborate appropriate and integrated plans for protection and rehabilitation of areas, particularly in Africa, affected by drought and desertification, as well as floods	**UNFCCC Article 4.1(e)** and **Kyoto Protocol Article 11.2**

ACTIVITIES	SOURCE
UNCCD	
Integrate sustainable land management issues within the UNFCCC national adaptation programmes of action	**UNCCD Decision 12/COP.7**, Activities for the promotion and strengthening of relationships with other relevant conventions and relevant international organizations, institutions and agencies, paragraph 7
Component 5: wetlands	
Ramsar Convention	
Integrate policies on the conservation and wise use of wetlands in the planning and decision/making processes at national, regional provincial and local levels, particularly concerning responses to climate change	**Ramsar Resolution IX.8**, Streamlining the implementation of the Strategic Plan of the Convention 2003-2008, Annex (A Framework for the implementation of the Convention's Strategic Plan 2003-2008 in the 2006-2008 period), Strategy 1.4
Plan the management of mangrove ecosystems, including required adaptation measures	**Ramsar Resolution VIII.32**, Conservation, integrated management, and sustainable use of mangrove ecosystems and their resources, paragraph 20. The objective is to ensure that they may respond to impacts caused by climate change and sea-level rise.
Manage wetlands through effective strategies, among others, through promoting wetland and watershed protection and restoration.	**Ramsar Resolution IX.9**, The role of the Ramsar Convention in the prevention and mitigation of impacts associated with natural phenomena, including those induced or exacerbated by human activity, paragraphs 12 and 14 and **Ramsar Resolution VIII.3**, Climate change and wetlands: impacts, adaptation and mitigation, paragraph 14. The objective is to increase wetland resilience to climate change and extreme climatic events and to reduce the risk of flooding and drought in vulnerable countries.
Integrate fully the "Principles and guidelines for wetland restoration" into National Wetland Policies and Plans	**Ramsar Resolution VIII.16**, Principles and guidelines for wetland restoration, paragraphs 11 and 12
Put priority on wetlands which are of special significance for coastal protection	**Ramsar Resolution VIII.25**, The Ramsar Strategic Plan 2003-2008, Annex (The Ramsar Strategic Plan 2003-2008): Action 3.3.1, Operational Objective 3.3: Increase recognition of significance of wetlands for reasons of water supply, coastal protection, flood defense, food security, poverty alleviation, cultural heritage, and scientific research, Operational Objective 3. Integration of wetland wise use into sustainable development.
Component 6: migratory species	
CMS	
Maintain a network of suitable habitats in relation to the migration routes of migratory species in CMS agreements	**CMS Article 5(f)**
Produce guidance to help CMS Parties introduce adaptation measures to help counteract the effects of climate change on migratory species	**CMS Resolution 8.13**, Climate change and migratory species, paragraph 2
Implement adaptation measures that would help reduce the foreseeable adverse effects of climate change on Appendix 1 species	**CMS Resolution 8.13**, Climate change and migratory species, paragraph 3

ACTIVITIES	SOURCE
Component 7: Effectively manage forest ecosystems	
CBD	
Promote the maintenance and restoration of forest biodiversity in forests	**CBD Decision VI/22**, Forest biological diversity, paragraph 10 and CBD Decision VI/22, Annex (Expanded programme of work on forest biological diversity): Programme element 1: conservation, sustainable use and benefit-sharing, goal 1: to apply the ecosystem approach to the management of all types of forests, objective 3: mitigate the negative impacts of climate change on forest biodiversity, activity (c). The objective is to enhance the capacity of forests to adapt to climate change.
Develop coordinated response strategies and action plans on forest biological diversity at global, regional and national levels	**CBD Decision VI/22**, Forest biological diversity, paragraph 10 and CBD Decision VI/22, Annex (Expanded programme of work on forest biological diversity): 10: Programme element 1: conservation, sustainable use and benefit-sharing, goal 1: to apply the ecosystem approach to the management of all types of forests, Objective 3: mitigate the negative impacts of climate change on forest biodiversity, Activity (b)
Element 4: Promote societal actions	
Ramsar Convention	
Take measures to protect against impacts such as cyclones, storm surges, droughts and floods through the sustainable use and restoration of wetlands	**Ramsar Resolution IX.14**, Wetlands and poverty reduction, paragraph 7. The activity falls under the heading "human life and safety."
Increase the adaptive capacity of society to respond to the changes in wetland ecosystems due to climate change	**Ramsar Resolution VIII.3**, Climate change and wetlands: impacts, adaptation and mitigation, paragraph 15
CBD	
Consider and promote the mainstreaming of agricultural biodiversity into national plans, programmes and strategies	**CBD Decision VII/3**, Agricultural biological diversity, paragraph 10
Element 5: Restore degraded ecosystems	
CBD	
Develop and implement programmes to restore degraded mountain ecosystems.	**CBD Decision VII/27**, Mountain biological diversity, Annex (Programme of work on mountain biological diversity). The objective is to enhance the capacity of mountain ecosystems to restore and adapt to climate change.
Ramsar Convention	
Restore Ramsar sites, other wetlands and associated ecosystems in accordance with natural hydrological regimes	**Ramsar Resolution IX.9**, The role of the Ramsar Convention in the prevention and mitigation of impacts associated with natural phenomena, including those induced or exacerbated by human activities, paragraphs 12 and 14. The objective is to reduce the vulnerability of wetlands to natural disasters and to mitigate the impacts of natural phenomena such as floods, provide resilience against drought in arid and semi-arid areas, and contribute to wider strategies aimed at mitigating climate change and desertification and thus reduce the incidence or magnitude of natural phenomena induced or enhanced by such change.

ACTIVITIES	SOURCE
Review opportunities for the rehabilitation and restoration of degraded coastal wetlands	**Ramsar Resolution VIII.4**, Wetland issues in Integrated Coastal Zone Management (ICZM), Annex (Principles and guidelines for incorporating wetland issues into Integrated Coastal Zone Management (ICZM)): Action 1.2.1 of Goal 1.2: To protect, recover and restore mountain biological diversity, Programme element 1: direct actions for conservation, sustainable use and benefit-sharing
Element 6. Integrate adaptation activities into other policies and strategies	
CBD	
Integrate climate change adaptation measures in protected area planning, management, and design	**CBD Decision VII/28**, Protected areas (Articles 8 (a) to (e)), Annex (Programme of work on protected areas): Suggested activity no. 1.4.5, Goal 1.4 – To substantially improve site-based protected area planning and management, Programme of Work on Protected Areas
Ramsar Convention	
Apply the principles and guidelines for incorporating wetland issues into Integrated Coastal Zone Management (ICZM)	**Ramsar Resolution VIII.4**, Wetland issues in Integrated Coastal Zone Management (ICZM), Annex (Principles and guidelines for incorporating wetland issues into Integrated Coastal Zone Management (ICZM)): Action 6.2, Guideline No. 6 – Ensuring the recognition by Contracting Parties of the role of coastal wetlands in mitigating impacts of climate change and sea-level rise of Principle 3. Coastal wetlands have important values and functions and provide multiple goods and services of high economic value: Ensure that information on the implications and vulnerability of coastal wetlands in relation to climate change and sea-level rise, and the options for maximizing their benefits in mitigating climate change and sea-level rise impacts are made available to the integrated coastal zone management (ICZM) processes
World Heritage Convention	
Consider the potential impacts of climate change on world heritage properties within their management planning and take early action in response to these potential impacts	**WHC Decision 29 COM 7B.a**, paragraph 6

III. APPROACHES, METHODS AND TOOLS FOR PLANNING, DESIGNING AND IMPLEMENTING PLANNED ADAPTATION ACTIVITIES

26. **Various approaches, methods, and tools can be used for planning, designing, and implementing planned adaptation activities**. Some of these are more relevant and applicable at the local to sub-national scale and others at national and fewer at global/international scales (Table 3). Often at the national scale, the amalgamation of various methods and tools provide opportunities for exploiting and addressing the synergies between the objectives of multilateral environmental agreements and sustainable development goals. The approaches fall into two main categories; "top-down" (modelling or scenario-driven) and "bottom-up" (community or vulnerability-driven) and incorporate information and policy links. They are complementary and in some ways form a continuum (for details see chapter 4 of CBD Technical Series No. 10). Annex I contains a series of case studies grouped under the thematic areas of the Convention where both "bottom up" and "top down" approaches are used.

27. **In certain circumstances, one approach may have more strengths than the other**. For example, models are useful in depicting general trends and dynamic interactions between the atmosphere, biosphere, oceans, land and ice, but have low resolution and limited ability to project the impacts of climate change and are unable to provide the information needed to support planning and prioritization of adaptation activities at the local level. However, as models are refined they can gain credibility and robustness. The vulnerability-driven approach to adaptation usually involves assessing past and current climate vulnerability, existing coping strategies, and how these might be modified with climate change. They have the potential to address immediate needs to respond to extreme climatic events and adding to the coping capacity for future changes.

28. **The various approaches and methods can be combined into a framework for adap-**

Table 3. Some approaches and tools that are used for designing and implementing adaptation activities.

In many cases, participatory/multi-stakeholder approaches and cooperation between stakeholders are an essential component. Other tools such as cost-benefit analysis, and multi-criteria analysis, are also relevant at a wide range of scales. A more comprehensive list of tools and approaches to design and implement adaptation activities has been prepared under the UNFCCC.[36/]

Approach/methods tools	**Scale (local, sub-national, national, regional and international/ global) at which it is most appropriate**
Strategies and action plans	International, national
Legislation	National, regional (e.g. EU)
Environmental Impact Assessments	Local (as project based)
Strategic Environmental Assessments	National, regional
Modelling (quantitative and qualitative)	Global, regional, limited at national –local
Sustainable livelihood approach	National-local
CBD Ecosystem Approach	Local, sub-national and regional

36/ http://unfccc.int/adaptation/methodologies_for/vulnerability_and_adaptation/items/2674.php

tation that integrates biodiversity concerns, and specific tools can be used in different stages of the framework. Adaptation should be an iterative process. This framework for biodiversity is designed to assist countries in the integration of biodiversity in adaptation to climate-change-related risks (Figure 2). The suggested framework incorporates both the scenario driven and vulnerability driven approaches. It is also consistent with the framework for assessment of impacts, vulnerability and adaptation suggested by the IPCC,[37/] adaptation policy framework,[38/] risk management approaches, Ramsar risk assessment framework, and national adaptation programmes of action (NAPAs).

29. **The framework (Fig. 2) follows a risk management approach and includes iterative steps including the identification of the problem, ensuring and seeking participation from multiple partners, assessing the knowledge base, preparing and implementing adaptation action plans**. These stages are followed by monitoring the outcomes of the plan and when needed supplementing and strengthening the information/knowledge base and research activities. Communication and transparency are important throughout the process.

30. **A wide range of adaptation activities have been designed or planned, but few have been implemented to date**. These activities have used different approaches and combinations of methods and tools (see examples in Box 1) as either "stand alone" projects (e.g. Sudan, Kiribati, Mexico) or embedded within national development plans (e.g. South Africa, Finland, Canada). Yet there is an urgent need to implement more adaptation activities, document best practices, and modify methods and tools if appropriate. In the case of both Kiribati and Sudan, the aim is to move from the "stand alone" project to being part of a national development planning. Local knowledge is being incorporated into the design of the Arctic Vulnerability Study. Overall, there is a need for detailed information for the application of the different approaches and methods particularly at scales suitable for informing adaptation planning and implementation (Table 3). Diverse stakeholder involvement is an important element of many of the projects mentioned in Box 1, including developing partnerships with a range of agencies/organisations and in some cases with the local community. An inclusive approach to adaptation activities is more likely to result in their implementation across sectors and their widespread acceptance within communities.

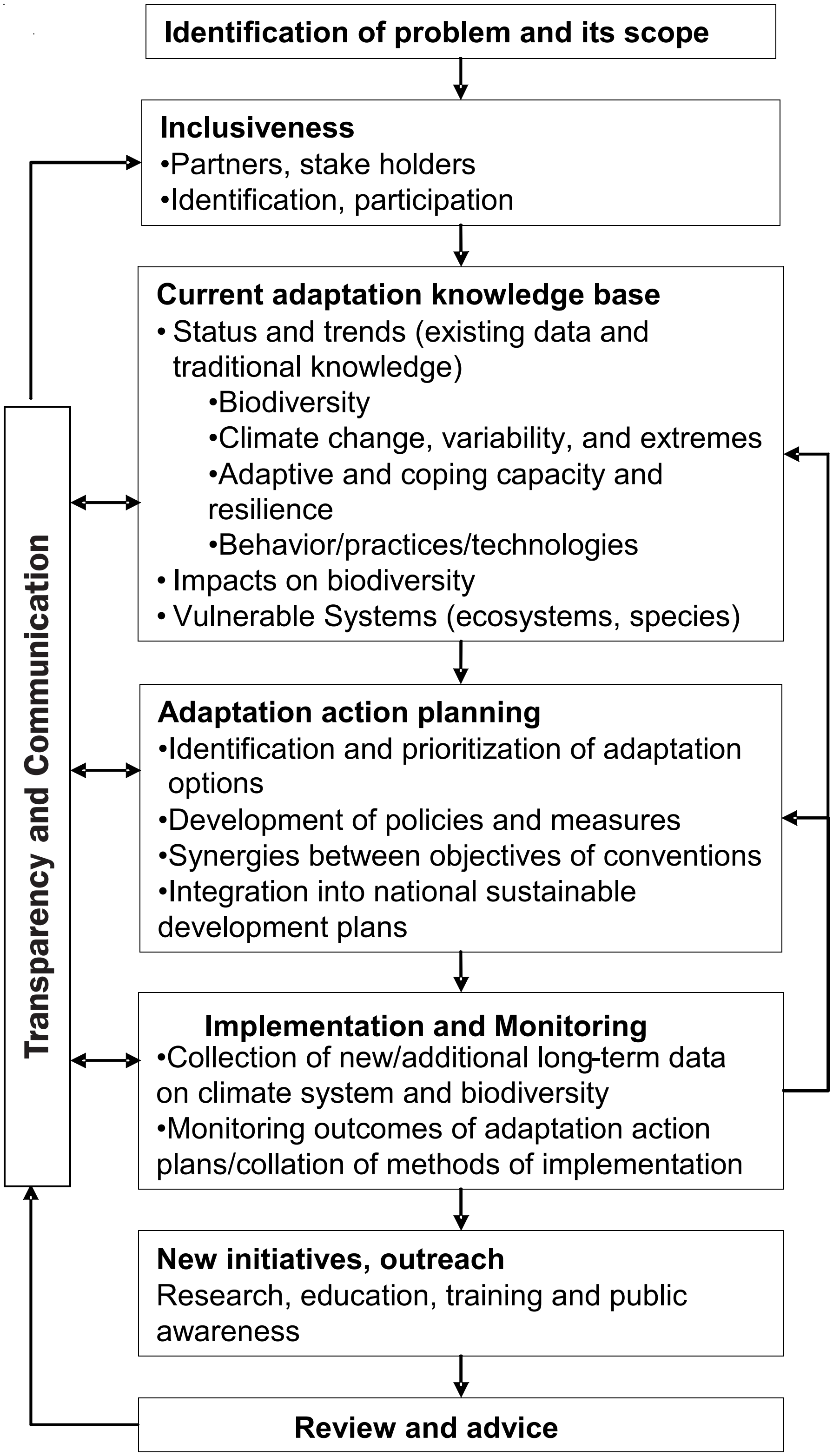
31. The need to both collate and expand the knowledge base before planning adaptation action is repeatedly addressed by the case studies contained in Box 1. Indeed, many of them largely or exclusively focus on building capacity for adaptation; this is a common aspect because they are often at an early phase of development and/or are ongoing. One of the main achievements of many projects has been awareness-raising among stakeholders and communities. Many of the case studies are also focused on the reduction of other causes that harm biodiversity in order to alleviate the impacts of climate change. The expansion of protected areas, restoration of damaged and/or degraded ecosystems, the reduction of pollution, and the implementation of sustainable resource management practices, appear as common themes.

32. **The knowledge base and participatory processes needed to support adaptation planning and its implementation for biodiversity should be strengthened. Major gaps and challenges fall into four major categories: tools/data needs, research, synthesis/participation and communication.**

37/ IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptations with a Summary for Policy Makers and a Technical Summary

38/ UNDP-GEF. (2005). Adaptation policy frameworks for climate change. Cambridge University Press.

Figure 2. A framework for adaptation integrating biodiversity concerns



Box 1. Selected case studies illustrating the diverse ways in which different approaches and tools can be integrated for development and implementation of adaptation activities. The list is not exhaustive and reported information is of ongoing nature.

1. South Africa. Cape Floral Kingdom and Succulent Karoo.

South Africa has implemented measures to protect the biodiversity of The Succulent Karoo, the world's richest arid hotspot and home of the diverse Fynbos Biome. This very sensitive region is strongly influenced by climate fluctuations. Without mitigation, climate change is projected to lead to extensive loss in biodiversity and changes in species composition and distribution. Adaptation strategies include: (i) modeling vulnerable areas by assessing the impacts of climate change; (ii) developing policy frameworks and legal instruments; (iii) conserving vulnerable areas by regional planning, expansion of protected areas and conservation farming; (iv) developing seed banks and DNA banks; (v) monitoring activities and expected outcomes; (vi) researching impacts of elevated CO_2 atmospheric concentrations and changes in precipitation patterns; (vii) engaging in information exchange and capacity building.

2. Sudan. Sustainable Livelihood Framework.

Sudan has developed strategies to mitigate the impacts of drought and land degradation that is severely disrupting the region because of climate change. Losses in biodiversity, displacement of people and curtailment of human livelihood is considerable. Studies are underway to examine the coping capacity of communities in the face of current climate variability and also to better understand their potential resilience and adaptive capacity in the face of future climate change. The concept of the five capitals (natural, physical, financial, human and social) is included to address the complexity of the impacts. Adaptation measures include a) documenting examples of sustainable livelihood measures that had been successfully used to reduce a communities' vulnerability to drought and b) identifying adaptation activities - win-win actions – that reduce poverty, increase human security, improve natural resource stocks and ecosystem integrity.

3. Kiribati. Local Consultation.

Kiribati has implemented a national framework and strategy to reduce the risk of rising sea levels due to changes in climate. Kiribati is one of the most isolated Least Developed Countries in the world, consisting of 33 low-lying islands highly susceptible to sea-level rise and prone to other environmental pressures. Using established risk management tools the Kiribati Adaptation Project held two major national consultations which built awareness of climate change and commitment to adaptation. The consultation brought together Chief Councilors, government staff, clerks, *unimanwe* representatives (traditional elders), women and youth from each of the islands. Key results included: (i) awareness that the changes faced were spread across all islands; (ii) a catalogue of kinds of changes experienced over the last 20-40 years, and traditional coping mechanisms used to deal with those changes; (iii) a preliminary assessment of areas where people felt they needed additional assistance in coping with their vulnerabilities; (iv) a strategy to take results back to their islands for further local level consultations; (v) a shared and distinctively Kiribati definition of what is *vulnerability* and *adaptation*.

4. Finland. National Strategy for Adaptation to Climate Change.

Finland has prepared a study investigating the impacts of climate change in the sectors of food production, forestry, fisheries, reindeer husbandry, game management, water resources, biodiversity, industry, energy, traffic, land use and communities, building, health, tourism and recreation, and insurance. By request from the Finnish Parliament, the Government completed the preparation of the National Strategy for Adaptation to Climate Change in 2005, based on available information and expert assessments and judgements. The main content of the Adaptation Strategy and priorities for implementation are to be included in the National Climate and Energy Strategy. Priorities for increasing adaptation capacities in Finland include: (i) mainstreaming climate change impacts and adaptation into sectoral policies; (ii) addressing long-term investments; (iii) coping with extreme weather events; (iv) improving observation systems; (v) strengthening research and development base; (vi) international co-operation http://www.mmm.fi/sopeutumisstrategia/.

5. ***Canada. Agri-Environmental Standards for Biodiversity, Air and Water.***
Canada has initiated projects to improve the economic competitiveness of Canadian farmers by developing agri-environmental standards for biodiversity, air and water. The impact of agriculture on biodiversity will be evaluated and new agri-environmental standards developed to reduce the impacts of climate related and other stresses. Thematic work programmes of the CBD and national biodiversity strategies have been used to guide the development of these standards. The implementation of these standards will be applied at the farm level scale for the conservation of water and biodiversity. A number of studies have addressed the valuation of water, incentives/disincentives, water quality and hazards. Additional implementation examples for biometeorology and adaptation under the International Society of Biometeorology are available on-line (http://www.arborvitae.org/c4i.htm).

6. Mexico. Resilience of Coastal Wetlands.
Mexico has developed a project to address the impacts of projected rises in sea level as a result of climate change with subsequent changes in hydrology, salinity and loss of wetland habitat. The coastal region along the Gulf of Mexico is one of the most vulnerable areas in the country and has been identified as susceptible to rises in sea level. This project serves as a basis for developing specific adaptation measures for reducing the impacts of climate change on biodiversity and local communities. The project has two main phases: (i) an assessment of the vulnerability of the flora, fauna, and economic assets of the region; (ii) design and implementation of restoration measures that will conserve coastal wetlands and their ecosystem services as the climate changes.

7. Colombia. Adaptation Synergies.
Colombia has implemented measures to protect the vegetation in its high-elevation regions and to conserve its water resources and availability which are being severely impacted by changes in climate. High-elevation páramo vegetation is one of the tropical mountain ecosystems most threatened by climate change. One of the ecosystem services at stake is the capture and regulation of water that is indispensable to upper mountain communities that have no other source of water, and also carbon sequestration and storage in the form of peat. Commitments within the Ramsar Convention are also threatened. Consequently, synergistic implementation of the instruments of relevant conventions is needed. The case of Paramo Las Hermosas brings together resources from the Clean Development Mechanism "Amoya" project to generate hydropower, and resources from the pilot Global Environment Facility-INAP project on adaptation to climate change; addressing both conservation and development of adaptation strategies.

8. United Kingdom. The MONARCH project and UK Biodiversity Action Plan.
The MONARCH project (http://www.ukcip.org.uk) has modelled the impact of climate change upon some 180 species of conservation importance in Britain and Ireland[39/,40/]. Through a stakeholder workshop involving those responsible for the conservation of these species, the implications of the results for policy changes and conservation management is being considered. In parallel guidance on climate change adaptation for those involved in implementing work towards the National Action Plan for biodiversity has been developed, addressing seven principles: i) conserve Protected Areas and other high quality wildlife areas; ii) reduce other sources of ecological harm, such as pollution; iii) protect species and habitat range and ecological variability; iv) protect and enhance variation within the landscape; v) establish ecological networks and facilitate dispersal; vi) respond to decline and extinction by thorough ecological analysis and vii) adapt conservation priorities and targets in response to monitoring and surveillance. MONARCH is a good example of a multi-partner project with a climate envelop-based modelling approach to the systematic assessment of the projected impact of climate change upon species. In conjunction with the guidance for those involved in the National Action Plan an informed choice of adaptation actions necessary for taxa can be made.

39/ Harrison, P.A., Berry, P.M. & Dawson, T.P. (2001). *Climate Change and Nature Conservation in Britain and Ireland: Modelling natural resource responses to climate change (the MONARCH project).* UKCIP Technical Report, Oxford.

40/ Berry, P.M., Harrison, P.A, Dawson, T.P. and Walmsley, C.A. (Eds.) (2005). Modelling Natural Resource Responses to Climate Change (MONARCH): A Local Approach. UKCIP Technical Report, Oxford.

9. Nordic Saami Institute. Arctic Vulnerability Study.
Local knowledge is applied to reindeer herding in a changing climate. Climate variability, climate change and the societal/cultural transformations associated with globalisation have been, and continue to be, responsible for major changes in physical environment, the biota and the cultures of the indigenous communities in the Arctic. Little is known about the vulnerability of such systems to change. An interdisciplinary, intercultural study has been established that will assess the vulnerability of coupled human-ecological systems in the Arctic to variation and change in key aspects of the natural and human environments and biodiversity. The key projects from the Saami University College and Nordic Saami Institute focuses on reindeer herding in Arctic and sub-Arctic Eurasia. Its approach is holistic, integrating social and natural science and users' understanding in the co-production of knowledge. Reindeer herders' experience and understanding will be documented, analysed and, under their guidance, combined with data in social and natural sciences.

10. Atlantic Ocean. The North American Eel Fishery.
North America has experienced unprecedented decline in the American eel due to changes in the Gulf Stream and the North Altantic oceanic currents as a consequent result of global warming. The Atlantic meridional overturning circulation, which carries warm upper waters into far-northern latitudes and returns cold deep waters southward across the equator, has slowed by about 30% between 1957 and 2004 (http://www.nature.com.nature). This slowdown in the overturning circulation, related to increasing levels of C02, has profound implications for climate change and the biodiversity of fish species present in aquatic and marine ecosystems. There has been a notable decline in juvenile eels entering the St. Lawrence River since 1996 and the North American eel fisheries was completely closed between 2004 to 2005.The North American eel, which lives in freshwater but reproduces in salt water in the Caribbean, is directly influenced by the slowing of the Atlantic meridional overturning circulation, exotic species invasions, contaminants, and changes in water temperature. The thermocline near the Bahamas showed substantially warmer waters in 2004 with temperatures 1 to 2°C warmer between 400 and 800 m. This warming extends eastwards from the Bahamas over at least several hundred km. Adaptation measures include (i) reducing and eliminating contaminants entering our waters, (ii) reducing greenhouse gases entering the atmosphere, and (iii) ensuring that eel migration routes are not obstructed by dams or other obstacles.

33. **For tools/data needs, specific gaps and challenges are**:

(a) Lack of baseline data and systematic monitoring to assess biodiversity response to climate change and adaptation activities (e.g. figure 2).
(b) Development of predictive models and decision support tools to guide the design and selection of adaptation strategies at different scales (biome, local, subnational, national, regional; landscape/seascape);
(c) Development of scenarios of likely future changes in drivers, status and condition of ecosystems, and biodiversity outcomes, reflecting both scientific and traditional knowledge;
(d) Strengthening expertise and institutional capacity in developing countries and indigenous communities for all the above.

32. **Regarding research, there is a need for**:

(a) Improved understanding of how biological and physical systems will respond to climate change and how their interactions influence outcomes on ecosystems. Discerning these complexities represents one of the largest uncertainties for projecting future biodiversity;[41/]
(b) An analysis of the impacts on biodiversity of existing and planned adaptation

41/ CBD Technical Series no. 10.

activities in response to climate change and improved understanding of ecosystem/species adaptations to *current* environmental change as it can provide important information for designing future options;
(c) An improved understanding of the biological factors and ecosystem processes that contribute to resilience and natural adaptive capacity;
(d) A critical analysis of the use of key indicators and other methodologies, such as risk assessments, for assessing biodiversity status and trends;
(e) Improved sophistication, robustness, downscaling and coupling of climate and ecosystem models and improved capacity for simulating effects of multiple drivers and pressures (climate and non-climate) on biodiversity, distinguishing anthropogenic and natural climate impacts;
(f) Long-term monitoring of key biophysical parameters so to provide time-series data for developing baselines as climate changes. Monitoring success of adaptation is equally important (see figure 2);
(g) Developing research agendas that reflect priorities for vulnerable communities such as local and indigenous populations and those with limited capacity for adaptation.

33. **With respect to synthesis/participation and collaboration, main issues are**:
(a) Incorporating both scientific and traditional knowledge to facilitate adaptation planning and implementation, and collecting traditional knowledge prior to is disappearance;
(b) Ensuring participatory approaches and partnerships for planning and implementing adaptation strategies;
(c) Documenting case-studies of adaptation in ecosystems and their limits in conjunction of the records of the present climate variability and extremes as a basis for designing adaptation options;
(d) Synthesizing information derived from top-down and bottom-up approaches leading to the development of planned adaptations for biodiversity (e.g. box 1).

34. **With respect to communication, there is a need for**:
(a) Cooperation, networking, and large-scale (biogeographical) approaches for documenting present distribution and future shifts in ecosystems and species ranges across political boundaries;
(b) Collection, systematic analysis, and dissemination of information and lessons learned from adaptation activities through the clearing-house mechanism under the Convention on Biological Diversity and similar approaches at national, subnational and local levels, including dissemination of information describing the effectiveness of impact assessment tools.

IV. SUMMARY OF KEY ISSUES FOR ADVICE AND GUIDANCE

35. Adaptation is an adjustment in natural or human systems to a new or changing environment. Planned adaptation actions need to be incorporated into the thematic work programmes and relevant cross cutting issues of the Convention on Biological Diversity. Yet, adaptation activities alone will not be adequate to reduce the rate of biodiversity loss. Mitigation activities are also essential if the three objectives of the Convention on Biological Diversity are to be met. Adaptation and mitigation activities to climate change are both needed within the context of sustainable development.

36. National policies, programmes and plans for adaptation should take biodiversity considerations into account. For example, planned adaptations are already being implemented to reduce many of the adverse impacts of climate change to produce economic and social benefits in the future. If biodiversity considerations are incorporated formally and routinely into adaptation planning, negative consequences can be minimized and positive benefits enhanced.

37. Adaptation options for biodiversity need to take into account natural disaster preparedness and relevant mitigation actions within the context of sustainable development. However, the emphasis should be on risk-management rather than capacity for disaster response.

38. Maintaining biodiversity should be part of all national policies, programs and plans for adaptation to climate change to allow ecosystems to continue providing goods and services. This is essential if the UNFCCC objective and Millennium Development Goals for poverty alleviation, food production and sustainable development are to be met.

39. In particular, programmes and plans for adaptation to climate change should take into account the maintenance and restoration of resilience, which is an essential element to sustain the delivery of ecosystem goods and services. Biological factors, which confer resilience, include genetic heterogeneity, regenerative populations, multiple successional states, and habitat connectivity across environmental gradients.

40. Various approaches, methods and tools are currently available and can be used for planning; designing and implementing planned adaptation activities following the framework for adaptation that integrate biodiversity concerns.

41. There is an urgent need to implement more adaptation activities, extract lesson learned, improve methods and tools, document best practices and disseminate this information through the clearing-house mechanism under the Convention on Biological Diversity.

42. An enhanced knowledge base, in particular for new adaptation research, data, tools, synthesis and communication, is needed to support adaptation planning for biodiversity. This knowledge base should include both traditional and scientific knowledge.

43. Training, capacity building and strengthening institutions is critical for building the much needed expertise in developing countries to implement different adaptation actions.

44. Effective collaboration and networking between biodiversity and climate change communities at all levels is essential for the successful implementation of adaptation activities for biodiversity and the integration of biodiversity concerns in adaptation activities and other sectors.

45. A number of adaptation related activities have been identified in several multilateral environmental agreements (MEAs). Greater synergy in these adaptation efforts is needed for moving the adaptation agenda forward while contributing to the effective implementation of the objectives of different multilateral environmental agreements.

46. It is recognised that adaptation to the effects of climate change due to both natural and human factors is a high priority for all countries. Moreover, developed countries committed themselves to assist developing countries to improve their resilience and integrate adaptation goals into their sustainable development strategies.

47. It is clear that biodiversity considerations into adaptation activities is a rapidly developing area with many new national adaptation plans in preparation. Many opportunities to further develop synergies between conventions or the sharing of best practice from on-going work warrant further consideration by national Governments and the Convention on Biological Diversity.

GLOSSARY

Adaptive capacity is the ability of an ecosystem to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

Habitat connectivity describes the spatial interlinkages between core areas of suitable habitat. It is often focused on the establishment or maintenance of corridors of similar habitat to link core areas, although consideration may be given to the capacity of other habitats to act as conduits for dispersal.

Landscape permeability is the capacity for dispersal of biodiversity across the entire landscape, including the identification of potential barriers to movement. It is based on the premise that within a heterogeneous landscape species movement between areas of suitable habitat will be constrained by their varying ability to disperse across other habitats via a multitude of routes (cf. habitat connectivity). Improving the capacity for species to disperse across marginal or unsuitable habitats enhances landscape permeability.

Inertia is the delay, slowness, or resistance in the response of the climate, biological, or human systems to factors that alter their rate of change, including continuation of change in the system after the cause of that change has been removed.

Resilience is the ability of an ecosystem to maintain its functions after being perturbed. A measure of resilience is the magnitude of disturbance required to move an ecosystem irreversibly to an alternative state. Resilience decreases an ecosystem's sensitivity.

Resistance describes the capacity of an ecosystem to persist unchanged despite environmental change. Resistance decreases an ecosystem's sensitivity.

Succession is the natural, sequential change (stage) of species composition in an ecosystem in a given area.

Sensitivity measures the magnitude and rate of response in proportion to the magnitude and rate of climate change. Ecosystems will be particularly sensitive to changes in climate variability and the frequency and magnitude of extreme events.

Vulnerability measures an ecosystem's exposure to and sensitivity to climate change. Vulnerability is determined at specific spatial and temporal scales and is a dynamic property dependent on local conditions; for example, a forest during the dry season.

Annex I

SELECTED CASE STUDIES ON ADAPTATION TO CLIMATE CHANGE UNDER THE THEMATIC AREAS OF THE CONVENTION ON BIOLOGICAL DIVERSITY

1. Agricultural biodiversity: floating gardens in Southwestern Bangladesh

The southwest coastal region of Bangladesh is home to about 10 million people whose livelihood depends on agriculture and, to a lesser degree, fisheries. Yet human-induced environmental degradation and frequent natural disasters, such as tropical cyclones, flooding and unusual high tides, render their livelihoods precarious. Due to its low-lying elevation (less than 1 m above sea level) and its location on a flat, deltaic tidal flood plain, rising sea levels associated with climate change and the increasing frequency of extreme weather events increase the vulnerability of this region, subjecting scarce farmland to increasing waterlogging and salinity, and the rivers to siltation and bank erosion. Already, the loss of farmland has led to loss of livelihood and out-migration, frequently to the Sunderbans, a mangrove forest with exceptional biodiversity. Here, migrants extract forest resources, threatening an ecologically important ecosystem.

In order to build the capacity of households to adapt to the adverse effects of climate change, Care Bangladesh, in cooperation with local non-governmental organizations and with funding from the Canadian International Development Agency (CIDA), implemented the Reducing Vulnerability to Climate Change (RVCC) project, which ran from 2002 to early 2006. The project aimed to increase awareness of climate change and build capacity among different levels of society: policy-makers, NGOS and community leaders. Its focus, however, was to introduce a number of alternative agricultural methods and livelihood strategies aimed at increasing food and income security, and to train 4300 households to adopt them.

New agricultural measures include floating gardens (hydroponics), whereby vegetables such as tomatoes, potatoes and okra are cultivated on floating beds of water hyacinth and other aquatic plants, and the introduction of drought-resistant crops and saline-tolerant varieties of chili, mustard, maize and potato. Trials were conducted with saline- and waterlogging-tolerant rice varieties that have been successfully grown in other areas of the country. Cage aquaculture was introduced as a means of adapting to waterlogging conditions by raising fish for sale or consumption. Cultivation of *mele*, a reed that is woven into mats, was introduced, and some households were trained to produce these mats. As a result of these pilot projects, many households have successfully increased their capacity to adapt to climate change.

These practical actions were accompanied by activities that have successfully raised awareness of climate change, its effects on livelihoods and potential coping options. Traditional folk songs and drama performances on the theme of climate change were performed, eco-clubs for youth were formed, and school programs were developed. As a result of such activities, 1 million people in the area have been exposed to awareness-raising activities, and all levels of government have been sensitized to the need for strategic intervention to enhance the adaptive capacity of households.

Sources: http://www.bothends.org/strategic/localcontributions_bangladesh.pdf
http://www.care.ca/work/projects/story_e.asp?storyid=30, accessed on 23 January, 2006.

2. Marine and coastal biodiversity: The Albemarle Peninsula Project

The Nature Conservancy's (TNC) Global Climate Change Initiative has begun working with a number of partners to develop long-term management strategies to maintain the biodiversity of the coastal ecosystems on North Carolina's Albemarle Peninsula, in the United States, to the stresses caused by sea-level rise and other climate-related forces and to give them the time necessary to adapt.

The peninsula is so low and flat—and laced by so many waterways—that water and earth have mingled to form a complex landscape of dark swamp forests, nearly impenetrable peat bogs, and vast expanses of fresh and brackish marshes. More than 400,000 acres of the peninsula are protected in national wildlife refuges and preserves. But sea level is rising about 4 cm every 10 years in the Albemarle Region, threatening its biological diversity. When the sea rises just a few centimeters here, flooding extends far inland. High-resolution models show that up to 469,000 acres of low-lying lands could be flooded by a one-third metre rise in sea level and that nearly 750,000 acres could be flooded by a half-metre rise.

Many of the areas at risk are the peninsula's most important conservation lands. Even without actual inundation, essential ecological processes and ecosystem functions could be altered by increased erosion, saltwater intrusion, a rising water table, shifts in species distribution and vegetation structures, alien species invasions, altered fire regimes, and disintegration of the region's peat soils.

TNC is working to develop a clearer understanding of which hydrologic and forest management strategies are most likely to contribute to the resilience of wetland ecosystems on the peninsula and to the stability of the peninsula's large deposits of peat. They are partnering with the U.S. Fish and Wildlife Service on a pilot project to design and test such strategies at the Alligator River National Wildlife Refuge. TNC and its partners will build on the findings of this initial project by applying successful approaches elsewhere on the peninsula.

Several management actions are being considered. TNC intends to acquire additional conservation areas, especially inland and upland of existing conservation lands, in order to facilitate the movement of species away from rising seas. Existing conservation lands will also be restored. Key drainage ditches and canals, channels for salt-water intrusion into areas with peat soils, will be filled or outfitted with tide gates or other water control structures, in an attempt to reduce the impacts of salt intrusion and peat soil reduction. In addition, water control structures may be installed to manage water levels for wetland restoration. The project will test whether these ecosystems can be manipulated to foster peat growth or reduce peat degradation in ways that have conservation or carbon sequestration potential.

Another tactic being considered is planting flood- and salt-tolerant species in areas that are likely to be submerged in the short term. For instance, the native bald cypress (*Taxodium distichum*) is tolerant of brackish water and once well established is capable of persisting for decades and even centuries after its roots are submerged in estuarine waters. Project managers are also exploring options for restoring native oyster reefs (*Crassostrea virginica*) along the shorelines of the peninsula as a way to reduce wave energy and erosion and create habitat complexes of reefs and semi-sheltered shorelines. These fringing reefs could be built in areas that may be more amenable to oyster survival under future climate conditions.

Sources: http://nature.org/success/art14181.html, accessed on 23 January, 2006.
Jeffrey Smith DeBlieu, Albemarle Project Director, personal communication, January 2006

3. Mountain biodiversity: Glacial Lake Outburst Floods (GLOF)—adapting to climate change in the high mountains of Nepal

When glaciers advance down a valley, they push rocks and soil, known as moraine, along with them, creating a wall at their terminus (the furthest down-valley extent of the glacier). When glaciers retreat, the water left behind is dammed by these moraine walls. These dams are relatively unstable, however, and a disturbance, such as a rapid increase in the rate of accumulation of water, can cause a breach. This triggers a glacial lake outburst flood (GLOF), whereby a huge volume of water and debris is released suddenly, with disastrous consequences hundreds of kilometers downstream. Lives are lost and infrastructure, agricultural land, and forests are destroyed.

The rising temperatures associated with global climate change have been causing glaciers in the Hindu Kush-Himalaya (HKH) region to melt rapidly since the mid-20th century. For example, Nepal's Tradkarding glacier, which feeds the Tsho Rolpa glacial lake, is retreating at a rate of over 20 metres a year. The Tsho Rolpa Glacial Lake Outburst Flood Risk Reduction Project aimed to reduce the risk of a catastrophic flood.

In the Tibetan area of the Himalayas, at least 12 GLOFs have been recorded since 1935; five GLOFs occurred in Nepal from 1977 to 1998 alone. In 1985, the Dig Tsho GLOF killed nine people and destroyed arable land and infrastructure 90 km downstream, causing $1.5 million worth of damage to the nearly completed Namche Small Hydropower Plant. Nor has Bhutan been spared, with four such events since 1957. Thirty five GLOFs have been recorded in the upper Indus River system in Jammu and Kashmir, one of which had a discharge greater than 15,000 cubic metres per second and extended 1300 km downstream.

A study conducted by the International Centre for Integrated Mountain Development (ICIMOD) and the United Nations Environment Programme (UNEP) reported that there are some 50 lakes in Nepal and Bhutan with a potential to generate GLOFs. Studies indicated that the Tsho Rolpa (altitude 4580 m) was one of the most dangerous in Nepal. By 1997, the lake had a surface area of 1.65 km^2—a six-fold increase since 1957-59, when its area was 0.23 km^2—and a volume of 90-100 million cubic metres, held back by a 150 m high moraine dam. Several studies warned of an imminent GLOF with the possibility of releasing 30-35 million m^3 of water and causing serious damage for at least 100 km downstream. Lowering the lake level was the recommended adaptation measure.

The Tsho Rolpa GLOF Risk Reduction Project involved the construction of a gated, open channel through the moraine to divert the lake water to the Rolwaling River. Construction began in 1999, and a three-metre drawdown in water level was achieved in mid-2000. This measure reduced the risk of GLOF by about 20%, at a cost of nearly US$ 3 million. It is not, however, a permanent solution; assessments suggest that a further 17 metre lowering is necessary to permanently prevent a GLOF. The Nepalese Department for Hydrology and Meteorology is preparing plans for a next phase, subject to donor funding. The Tsho Rolpa GLOF Permanent Remediation Project (TRPRP) would permanently eliminate the possibility of a GLOF.

Source: http://www.dhm.gov.np/tsorol/index.htm, accessed on 23 January, 2006.
Pradeep Mool, International Centre for Integrated Mountain Development, personal communication, January 2006.

4. Island biodiversity: "Water every where, nor any drop to drink": climate change on a Pacific island

Small-island developing states are particularly vulnerable to the effects of climate change. For example, the increasing frequency of spring tide events, tidal waves and cyclones, together with sea-level rise, lead to coastal erosion and create permanent flooding conditions or standing pools of water. Such was the case in the village of Lateu, on Tegua, one of the northernmost islands in the Vanuatu chain, where the coastline has eroded 50 metres over the past 20 years.

Lateu, a village of subsistence farmers and fishers, is located less than 5 metres from the high water mark, on low-lying land. Flooding interfered with everyday activities, such as cooking and sleeping, despite the fact that buildings were raised on foundations of limestone rocks. Houses deteriorated rapidly, and the resulting dampness created unhealthy living conditions; standing water was a vector for water-borne diseases such as malaria, diarrhea and skin infections. Pit toilets overflowed, endangering the community's small freshwater storage facility.

The community decided that the best way to adapt to the flooding induced by climate change was to move. With funding from the Canadian International Development Agency (CIDA) and on-site assistance from the South Pacific Regional Environment Programme (SPREP), the community's 16 households, aid post and church were relocated to higher ground, 600 metres from the coast. The relocation of Lateu is one of three pilot projects in Vanuatu conducted under the Capacity Building for the Development of Adaptation in Pacific Island Countries (CBDAMPIC) project. The relocation was completed in August 2005, and the new settlement was named Lirak.

The other important aspect of this project involves ensuring the community had access to adequate supplies of fresh water. Rainwater is the main source of fresh water on the island, supplemented by coastal springs. Average annual rainfall is expected to increase (by 200mm by the 2050s and 280 mm by the 2080s), which would have been good news, had the community had adequate freshwater collection and storage facilities. Both, however, were limited in the original settlement. Without them, increased rainfall would have done nothing more than compound the flooding problem. Furthermore, increased rainfall variability, which is already being experienced, made such facilities imperative.

To this end, the project included the provision of six new rainwater tanks, enabling the new community to store up to 36,000 litres of fresh water. Rainwater catchment facilities, in the form of roofing irons, were installed on several buildings. The project also involved the installation of a communication system to provide the community with timely access to weather-related information.

Using a methodology they call Community Vulnerability and Adaptation Assessment and Action (CV&A), SPREP consulted with the community to increase awareness of climate change, identify and prioritize climate-related problems and effects on livelihood, identify and assess current coping strategies, and develop, prioritize and select adaptation options. The community was involved in the decision-making process throughout the project, resulting in a high level of community ownership.

The CBDAMPIC project improved the adaptive capacity of the community by increasing its resilience to the effects of climate change.

Source: http://www.sprep.org/article/news_detail.asp?id=247, accessed on 23 January, 2006.
Brian Phillips "Community Vulnerability and Adaptation Assessment and Action Report", CBDAMPIC Vanuatu (undated).

5. Forest biodiversity: Tropical Forests and Climate Change Adaptation: Southeast Asia, West Africa and Central America

Tropical forests are extremely vulnerable to changes in temperature and rainfall. Extreme climate events are already affecting these ecosystems and the livelihoods of many who depend on them. Understanding the links between tropical forest ecosystems, development, and climate change is the purpose of the Tropical Forests and Climate Change Adaptation (TroFCCA) project. More specifically, as of 2006, this four-year project aims to identify climate-change adaptation strategies for tropical forest ecosystems and the communities that depend on them, and to have these strategies incorporated into national development policies. Among its goals is to "mainstream" adaptive management in the forestry sector. The project will begin by assessing the vulnerability of tropical forests to climate change, after having developed appropriate methodologies.

The climate-change-related events comprising the focus of the project will be forest fires in Southeast Asia (Indonesia, in particular); drought in West Africa (Burkina Faso, Ghana and Mali); and flooding in Central America (Honduras, Nicaragua and Costa Rica). The Center for International Forestry Research (CIFOR) will carry out the project components in Southeast Asia and West Africa, while the Tropical Agriculture Center for Research and Higher Education (CATIE) will operate in Central America. The project (2005-2008) is being funded by the European Commission.

Although it is too early to describe specific adaptation efforts, TroFCCA does indeed have a very practical focus. The project will emphasize the "development side of adaptation". That is, TroFCCA "will assess how climate change is likely to affect the provision of goods and services that support or contribute to specific development priorities". The project team also intends to keep government representatives involved in the project from the start in order to augment the likelihood that its results will be relevant for national policy-making.

Source: http://www.cifor.cgiar.org/trofcca

Annex II

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