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IDENTIFYING AND ENHANCING THE LINKAGES BETWEEN BIODIVERSITY AND CLIMATE-CHANGE ADAPTATION

I. INTRODUCTION

1. The following document was developed by the Executive Secretary of the Convention on Biological Diversity and The Nature Conservancy (TNC) to facilitate consideration of two items in the terms of reference of the second meeting of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change (AHTEG): (i) potential biodiversity-related impacts and benefits of adaptation activities, especially in the regions identified under the Nairobi work programme 1/ as being particularly vulnerable; and (ii) ways and means to improve the integration of biodiversity considerations and traditional and local knowledge related to biodiversity within climate change adaptation, with particular reference to communities and sectors vulnerable to climate change.

2. This document is supported by the literature review on climate change and adaptation prepared by UNEP-WCMC thanks to the kind financial support of the Government of the United Kingdom of Great Britain and Northern Ireland and the Government of Finland.

II. LINKS BETWEEN BIODIVERSITY AND CLIMATE CHANGE ADAPTATION

3. Climate change adaptation is defined by the UNFCCC as:

> "Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities."

4. For the purpose of consideration by the AHTEG, the links between biodiversity and climate change adaptation can be divided into two main issues: (i) adapting biodiversity to climate change; and (ii) mobilizing biodiversity as a resource for broader climate change adaptation.

* UNEP/CBD/AHTEG/BD-CC-2/2/1/.

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

Adapting biodiversity to climate change

5. Some species and ecosystems will naturally adapt to climate change. For example, some corals are more resilient to bleaching than others and, as such, will be less impacted by changes in sea temperature and chemistry. Likewise, in the face of sea-level rise, mangroves can move inland while maintaining a functioning coastal ecosystem so long as the inland route is not blocked by development.

6. There are a number of species and ecosystems whose natural adaptive capacity has, however, already been exceeded or is expected to be exceeded in the future. The southern African succulent fauna, which has one of the highest rates of endemism, is unable to shift further south beyond the tip of Africa while species restricted to lakes or high mountains have no migration avenues to follow. Such species may require more active interventions in the face of climate change including, for example, *ex situ* conservation.

7. Examples of approaches the countries are taking to assist biodiversity in adapting to climate change includes, the Integrated National Adaptation Project in Colombia which will implement adaptation measures including through ecosystem planning and management with the objective of maintaining biodiversity assets for the benefit of biodiversity and biodiversity-based livelihoods. 2/

Mobilizing biodiversity for climate change adaptation

8. Because of the variety of ecosystem services provided by biodiversity such as the provision of food and fodder and protection from flooding and drought, biodiversity is an important resource for climate change adaptation.

9. In fact, some projects that seek to maximize the contribution of biodiversity to climate-change adaptation have already been adopted. The conservation or restoration of river floodplains in Europe, for example, has been employed as an important response to increasing flooding events or droughts. 3/ Not only can it be more cost-effective than traditional engineering responses but also provides substantial benefits in terms of fisheries, increased resilience and an improved aesthetic and cultural environment.

10. In Samoa, the replanting of mangroves is an integral part of a large restoration project to enhance food security and protect local communities from storm surges which are expected to increase as a result of climate change. 4/ In Uruguay, the development and climate change strategy recognizes that natural resource management is a critical link in efforts to both adapt to and mitigate climate change. 5/

III. ENHANCING THE LINKS BETWEEN BIODIVERSITY AND CLIMATE CHANGE

Integration of the ecosystem approach within climate-change adaptation strategies

11. The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes the conservation and sustainable use of biodiversity in a fair and equitable manner. Since the ecosystem approach takes a broad perspective to management, it is an ideal methodology through which the multiple impacts from climate change, including on biodiversity, can be reflected in comprehensive and responsive adaptation planning. These

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2/ Colombia: Integrated National Adaptation Program. The World Bank Group, 2006

3/ European Water Directive. European Commission, 2000. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2000:327:0001:0072:EN:PDF

4/ Community Based Adaptation: Samoa. UNDP, 2008. http://sdnhq.undp.org/gef-adaptation/projects/websites/index.php?option=com_content&task=view&id=252&sub=1

5/ *Development and Climate Change in Uruguay: Focus on Coastal Zones, Agriculture and Forestry*. OECD, 2004 advantages and guiding principles are reflected in the ecosystem-based adaptation approach which applies the ecosystem approach to climate change adaptation.

12. Ecosystem-based adaptation encompasses a range of strategies whereby ecosystem management, restoration and uses are modified or diversified to confer greater resilience of natural ecosystems, production landscapes, human settlements and livelihoods in the face of accelerated climate change. These strategies can be broadly described in six categories:

(a) Identifying and protecting climate refugia;

(b) Increasing connectivity of habitats;

(c) Protecting environmental gradients;

(d) Reducing other threats that may be exacerbated by climate change;

(e) Designing resilient networks of conservation areas; and

(f) Habitat restoration.

13. This list is not intended to be exhaustive, other strategies could include ex situ conservation and adjusting use and extraction habits. It represents some of the principal types of strategies that can be employed. Furthermore, these strategies should not be viewed as mutually exclusive. Nor is it necessary to apply all strategies in every instance of adaptation.

14. Ecosystem-based adaptation complements other climate change responses in two ways. First, it helps to make ecosystems more resistant and resilient in the face of climate change so that they can continue to provide the full suite of services that nature provides. Such strategies are especially important for sustaining natural resources like water, timber and fisheries that people, especially the poor, depend on for their well-being and livelihoods. Second, ecosystem-based adaptation protects and restores ecosystems that can provide cost-effective protection against some of the threats that result from climate change. For example, wetlands, mangroves, coral reefs, oyster reefs, and barrier beaches all provide shoreline protection from storms and flooding that can reinforce and enhance engineered solutions while sustaining biodiversity at the same time. 6/ These interventions are not without costs – all will demand adaptation of management, governance and institutional settings – but they are necessary to safeguard ecosystems and the essential services that biodiversity provides to people.

15. Examples of some of the elements of ecosystem-based adaptation include:

(a) Ensuring that ecosystems remain intact and interconnected to allow for biodiversity and people to adjust to changing environmental conditions;

(b) Restoration of fragmented or degraded ecosystems, or simulation of missing ecosystem processes such as migration or pollination;

(c) The use of natural infrastructure such as wetlands or fringing mangrove communities to buffer human settlements from floodwaters or storms; and

(d) Changing the way in which resource managers adjust management practices or human use of ecosystems

The establishment and good management of protected areas

16. The establishment of national protected area systems that ensure both the representation and persistence of biodiversity in protected areas is also a means to ensure adaptation through increasing resilience to climate change, and the continued delivery of ecosystem services in the production landscape/seascape. Specific measures to ensure the resilience of protected area systems include:

6/ B. P. Piazza, P. D. Banks, M. K. La Peyre, *Restoration Ecology* 13, 499-506 (2005).

(a) The incorporation of climate modelling into systematic conservation planning, to ensure that major ecological gradients, corridors and refuges are incorporated in these systems;

(b) The adjustment of management plans and programmes to addresses changes in such factors as fire incidence and the impact of plant and animal invasions;

(c) Capacity-building and awareness-raising among protected-area managers concerning management under conditions of increased risk and uncertainty; and

(d) The recognition and involvement of all forms of governance including the role of indigenous peoples' territories, local communities and the private sector in completing and managing protected-area systems.

17. Protected area systems involving the full range of governance types provides a unique opportunity for communities that are directly involved in the stewardship of natural resources to play a direct role not only in the management of these areas in the face of climate change, but also directly in community-based adaptation to secure the ecosystem services on which their own livelihoods depend. Under these circumstances, community-based and livelihood-focused ecosystem-based adaptation offers a unique opportunity at local levels for the incorporation of local and indigenous knowledge into adaptation processes.

18. Key principles for designing a resilient network are to build in replication and representation of all ecosystem types, include protection of critical sites, maintenance of ecological connectivity, and ensuring effective ongoing management. These principles have been well-developed for coral reef systems which are susceptible to climate-induced bleaching which can kill reefs and collapse local fisheries. Detailed guidance and tools for designing resilient networks is documented at www.reefresilience.org.

Ecosystem restoration

19. When climate change impacts damage or degrade natural habitats, restoration may be necessary to help species and ecosystems recover. Ecosystem restoration involves activities that transform a degraded ecosystem into an ecosystem that is less disturbed and better able to provide ecosystem services. Restoration should be guided by the ideal of returning the ecosystem to its historical state; however this is an ideal that is seldom fully realized. Restoration is considered to be successful once ecosystem resilience has been re-achieved. 7/

20. Restoration can involve reducing pressure and allowing ecosystems to naturally recover or undertaking movement related activities such as replacing lost ecosystem services with temporary artificial alternatives or the re-introduction of lost species. Typically restoration includes both physical restoration (restoration of the basic physical structure of the ecosystem) and biological restoration (restoration of the species assemblages and functional roles).

21. Restoration may also be a tool for helping address other adaptation problems such as more frequent and intense flood events. Rather than constructing more dams or trading off reservoir capacity for flood control instead of irrigation and hydropower production, floodplain restoration could serve to provide the extra flood water storage that is needed, while also improving riparian habitat that is critically important for fish and wildlife. For example, in certain cases, foreseeable unavoidable impacts of climate change such as inundation by sea-level rise could be addressed by "pre-storing" habitats. Along the Albemarle Peninsula in North Carolina, United States of America, The Nature Conservancy is seeding oyster reefs along the shore in anticipation of increased salinity and coastal erosion. It is hoped that the oyster reefs will help an already degraded coastal ecosystem to recover and also provide a living sea wall to protect the low-lying coast from wave and storm damage.

7/ *Foundations of Restoration Ecology*. Society for Ecological Restoration International. Edited by Falk, D., M. Palmer and J. Zedler. 2006.

22. It should be noted, however, that restoration often has high cost implications when compared to conservation. For example, the cost of physical restoration in coral reefs has been estimated at between US$ 100,000 and US$ 1 million per hectare. 8/ There is a need to undertake careful cost-effectiveness analyses to ensure that the most appropriate approach is adopted and to compare with other infrastructure-based alternatives.

23. An analysis of guidelines adopted for restoration as an adaptation process highlights the need to:

(a) Consider economic, legal, social, political and ecological constraints;

(b) Establish clear targets and indicators;

(c) Involve all relevant stakeholders, including restoration experts;

(d) Integrate adaptive management into restoration projects;

(e) Set a dynamic target considering present and future conditions.

24. In the context of climate change, restoration ecology takes on a more complex set of guidelines. Fore example, while under stable climatic conditions, native species tend to be the best adapted to conditions and, therefore, the best candidates for restoration – as climatic conditions change, in some ecosystems rapidly, native species or varieties of species may no longer be the appropriate choice for restoration. 9/ Furthermore, when establishing the target for restoration, climate change may require an adjustment towards broader concepts of sustainability and ecosystem services rather than a recreation of historic assemblages which may no longer be appropriate. 10/

Identifying and protecting climate refugia

25. With climate change leading to unpredictable and often negative ecological changes, a relatively straight forward and intuitive approach to adaptation is to focus on identifying and protecting biodiversity in those areas least likely to be impacted by climate change.

26. Some areas in a land or seascape may be buffered from short to medium term climate impacts because of their local topography, oceanography and microclimate. Protecting such refugia can be a good adaptation strategy because the biodiversity found there would be likely to persist, and could serve as a source for later recovery of other places that might be marginalized or degraded by climate change.

Increasing connectivity of habitats

27. Another intuitive adaptation strategy is to increase the connectivity of habitats so that species are better able to migrate and shift their distributions in response to climate change. By protecting linked areas across a land or seascape, species and communities have a better opportunity to adapt naturally to changes in their environment.

Protecting environmental gradients

28. Climate change will inevitably alter the distribution of biodiversity across an ecoregion. Expansions, contractions and shifts of species' ranges, along with all the novel interactions that arise from these, mean that conservation areas designed to be representative of today's biodiversity, will, at best, unpredictably represent biodiversity into the future.

8/ *Reef Restoration – Concepts and Guidelines*. Edwards, A. and E. Gomez. 2007

9 / Climate Change and Paleoecology: New Contexts for Restoration Ecology. Millar, C. and L. Brubaker. In *Foundations of Restoration Ecology*. Society for Ecological Restoration International. 2006

10/ Ecological Restoration and Global Climate Change. Harris, J., R. Hobbs, E. Higgs and J. Aronson. *Restoration Ecology* 14, 170-176 (2006)

29. Although climatic environmental conditions (e.g. precipitation, temperature, etc.) will almost certainly be subject to change over coming decades, many edaphic and topographic environmental conditions will remain stable or at least change far more slowly.

30. An alternative strategy to selecting conservation areas that represent the distribution of current biodiversity is to target representation of the underlying environmental variables that drive this distribution. The rationale for this is two-fold:

(a) These same locations will stand a good chance of representing the spectrum of biodiversity and ecological communities in the future, even if they are different from present;

(b) The spectrum of present-day environmental conditions will still be largely protected, even if they are in different locations to present. This provides the potential for both natural and assisted adaptation/migration of species and communities in response to changing climatic conditions.

31. This strategy also has the pragmatic benefit that data on the distribution of biotic variables are often more easily mapped than the distribution of biodiversity, or even biological surrogates for it. The environmental gradients strategy is predicated on the assumption that the diversity of ecological communities is to a large extent driven by diversity in the underlying environmental variables, e.g. rainfall, temperature, geology, altitude, slope, etc.

Reducing other threats that may be exacerbated by climate change

32. Climate change is only one of many risks facing biodiversity. Since many of these risks act cumulatively, in most cases an already degraded or denuded ecosystem will be more susceptible to the additional negative impacts of climate change. In particular, threats like invasive species, habitat fragmentation, overfishing and altered fire regimes can degrade ecosystems or put species at risk of extinction, and increase their susceptibility to climate change impacts. By minimizing those stresses, ecosystems and species can be made more healthy and more naturally resistant to climate-change impacts.

IV. DRAFT GUIDING PRINCIPLES FOR THE ENHANCED INTEGRATION OF BIODIVERSITY WITHIN CLIMATE-CHANGE ADAPTATION

33. Adaptation strategies that integrate biodiversity considerations should be designed and chosen to address a specific climate impact or vulnerability. Some elements which could be considered when developing and advancing appropriate ecosystem-based adaptation to climate change include:

(a) Establishing a baseline of knowledge and information;

(b) Impact assessment;

(c) Assessing natural adaptive capacity;

(d) Future-looking strategy development; and

(e) Monitoring and adaptive management.

34. This framework has been developed in the context of biodiversity conservation, but could be mainstreamed for wider integration into land-use planning and other sectoral plans (e.g., agriculture, water management, fisheries management).

35. Approaches can be top-to-bottom or bottom-up. For example, you can start the process with a broad impacts assessment or you can start with a very specific place, system, process, or species in mind and then work your way up for broader context.

36. It is also essential to consider the social adaptive capacity for implementation of an adaptation strategy (McClanahan et al. 2008). Some communities may require capacity-building before they are able to successfully implement certain adaptation strategies.

Establishing a baseline of knowledge and information

37. The first meeting of the second AHTEG identified a number of sources of information and knowledge including modelling, observational data and traditional knowledge. Before implementing adaptation activities it is important to take stock of all sources of available information including on:

(a) The nature and severity of predicted impacts;

(b) The stakeholders likely to be affected;

(c) Relevant management plans already in place (including existing risk management plans and adaptation measures already put in place within sectors and by local communities);

(d) Linkages and possible synergies between different sectors facing impacts; and

(e) Resources (human, financial and cultural) available.

38. In defining and cataloging available information, including traditional knowledge, it is important that the principles of prior and informed consent are respected.

Impact assessment

39. Understanding the extent and severity of physical changes in climate is a necessary prerequisite to understanding how biodiversity and people may be impacted. Physical impacts may be chronic – resulting from continuous gradual changes in climate – or acute – resulting from changes in the occurrence of extreme events like hurricanes, fires and droughts.

40. Brooks (2003) identifies three categories of hazardous climate impacts:

(a) *Category 1*: Discrete recurrent hazards, as in the case of transient phenomena such as storms, droughts and extreme rainfall events.

(b) *Category 2*: Continuous hazards, for example increases in mean temperatures or decreases in mean rainfall occurring over many years or decades (such as anthropogenic greenhouse warming or desiccation such as that experienced in the Sahel over the final decades of the twentieth century (Hulme, 1996; Adger and Brooks, 2003).

(c) *Category 3*: Discrete singular hazards, for example shifts in climatic regimes associated with changes in ocean circulation; the palaeoclimatic record provides many examples of abrupt climate change events associated with the onset of new climatic conditions that prevailed for centuries or millennia (Roberts, 1998; Cullen et al., 2000; Adger and Brooks, 2003)."(Brooks 2003)

41. These categories define climate impacts in purely physical terms related to how changes in climate are manifested. Exposure to these physical impacts of climate change is a key component in determining ecological vulnerability and the need for adaptation measures.

42. Additional tools for identifying and evaluating climate impacts include:

(a) Climate wizard – http://www.climatewizard.org – an online tool for exploring historic data and future projections of temperature and precipitation;

(b) Dynamic and Interactive Vulnerabilty Assessment (DIVA) – http://www.pik-potsdam.de/diva – a modelling resource for evaluating coastal zone impacts associated with sea-level rise

Assessing natural adaptive capacity

43. Ecological responses to climate change will be highly variable. Some species and communities will be extremely sensitive to even small changes in climate, whereas others will be able to tolerate large changes in climate with little apparent impact. Predicting such responses represents a considerable challenge for adaptation science, but the ecological research community is active and advances are being made swiftly.

44. The ecological sensitivity of species and ecosystems may be assessed by a number of approaches. For example, envelope modeling might be used to quantify the range of environmental conditions under which an organism can survive, and to estimate how much change it can tolerate. Alternatively, a species or ecosystem might be susceptible to prolonged drought or changes in soil-moisture content, the risk of which can be modeled directly from climate impact information.

45. Adaptability depends on the innate ability of a species or community to adapt or respond to changes in climate and also on constraints that may be imposed by geography and topography. Highly mobile species like birds might be able to migrate to new habitats where climate conditions are more favorable, while trees and other sedentary species might be able to change their distribution only slowly over generations. Adaptability may be constrained if there is simply nowhere else to go. Such constraints can be imposed by natural continental or oceanic boundaries, or by altitudinal limits to migration.

46. Adaptability can also be constrained by land-use and other human and sectoral responses to climate change. For example, consider the potential adaptability of species and natural communities that depend on water resources in a drying environment. Options and constraints on adaptability will depend not only on biology, but also on how human communities use and manage water resources. How might those uses impact water flows? Will climate drying induce changes in land-use or food production that could also impact adaptability?

Future-looking strategy development

47. Even with the most thorough scenario and sensitivity analysis, decision-makers will not have perfect vision into the future. Uncertainty is inherent, and with that comes risk. Making smart decisions about adaptation strategies in the face of inherent uncertainties suggests a precautionary approach and for strategies that are both adaptive and preventive. Preventive and precautionary approaches imply anticipatory and proactive risk management instead of reactive crisis management.

48. Climate change increases risks to biodiversity and to people for two reasons. First, it creates some brand new hazards like inundation of land as sea level rises. Sea level is going to rise; it is only a question of when and how high. That uncertainty creates a risk to coastal habitats and to people who live in low-lying areas. Second, climate change may change the frequency, intensity and duration of "regular" hazards like hurricanes and storm surges. These risks have always been there, but our expectations of how likely they are to impact nature or human communities may no longer be valid because of climate change.

49. For these reasons, future-looking adaptation strategies should include risk-management provisions. One element of such risk management should be to continue the advancement of science and other analyses to improve understanding of how climate change will impact biodiversity. Better understanding leads to less uncertainty which in turn can be used to reduce exposure to risks. A second element is development of practical tools for monitoring and re-assessing risks so that adaptation strategies can be adjusted appropriately.

50. Forward-looking, risk-managing adaptation strategies can be developed using scenario and sensitivity analyses. Kareiva et al. (2008) recommend several steps. First is to develop a conceptual model that links physical climate changes, specific impacts and vulnerabilities, and potential interventions. Next is to identify and develop suitable data to parameterize the model.

And then, to choose a set of climate change scenarios that are consistent with associated global-scale scenarios, physically plausible, and sufficiently detailed to support an assessment of how adaptation strategies may perform under different climate scenarios.

51. The range of outcomes generated by such scenario and sensitivity analysis can then be used to select adaptation options that promise to be most effective, but also to inform decisions that account for associated risks and uncertainties.

Monitoring and adaptive management

52. Comprehensive monitoring plans and adaptive management are imperative for ensuring that adaptation actions are working as intended. Uncertain events and changes could necessitate that strategies be adjusted and revised in the future.

53. In designing an appropriate monitoring and adaptive management programme, consider early warning indicators that could alert to critical climate changes or other impacts that might require adaptation actions to be modified. This is especially relevant when adaptation plans are based on different emission or impact scenarios in order to identify triggers which indicate movement from one threat level to the next.

54. It is also important to include monitoring provisions for strategy effectiveness to ensure periodic verification that actions are working as expected or are in need of correction and to design monitoring plans which facilitate the involvement and contributions of all relevant stakeholders.
