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OVERVIEW OF THE ECONOMIC VALUATION OF THE LINKS BETWEEN BIODIVERSITY AND MITIGATION

Note by the Executive Secretary

INTRODUCTION

1. In order to consider all aspects of the terms of reference for the first meeting of the Second Ad Hoc Technical Expert Group (AHTEG) on Biodiversity and Climate Change, as outlined in annex III of decision IX/16 B of the Conference of the Parties to the Convention on Biological Diversity, the following background document has been prepared on the economics of climate change mitigation as it relates to biodiversity and the cross-cutting issue under the Convention of economics and incentive measures.

2. In considering this document, the AHTEG is also contributing to earlier mandates adopted by Parties under the cross-cutting issue of economics and incentive measures. In particular, as early as its sixth meeting, in April 2002, the Conference of the Parties recognized the interlinkages between incentives under different multilateral environmental agreements in its endorsement of recommendations for future cooperation on incentive measures:

> "There is a need to examine the policies and programmes under different multilateral environmental agreements to ensure that they provide mutually reinforcing incentives. In this respect, the Conference of the Parties…suggested attention to incentives with regard to other linkages, such as the United Nations Framework Convention on Climate Change with respect to land-use change and forest biodiversity. In addition, the United Nations Framework Convention on Climate Change is encouraged to give priority to incentives to avoid deforestation, as a substantial amount of greenhouse gas emissions is due to the destruction of forests, the greatest repository of biodiversity." 1/

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

1/ Decision VI/15, annex II, paragraph 14.

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3. The consideration of the economic drivers and incentives influencing the links between biodiversity and climate change mitigation is, therefore, an important component of the work of the AHTEG, especially with regard to: (i) identifying the extent to which biodiversity conservation and sustainable use could and should be considered an externality; and (ii) maximizing synergy between different payment schemes; while (iii) avoiding adverse impacts on biodiversity that may occur through perverse incentives in the carbon market.

4. The purpose of this document is to provide background information on the economic valuation of the links between biodiversity and mitigation. It provides an overview of the concepts of externalities and introduces some of the established policy frameworks and methodologies for the internalization of carbon and biodiversity benefits. The document further identifies perverse incentives for biodiversity created by the carbon market. Finally, the document presents the rationale for internalizing biodiversity in carbon markets demonstrating that such internalization can maximize benefits, lower costs and reduce risks

I OVERVIEW OF EXTERNALITIES AND INTERNALIZATION

Externalities

5. The Intergovernmental Panel on Climate Change (IPCC) defines externalities as:

> "By-products of activities that affect the well-being of people or damage the environment, where those impacts are not reflected in market prices. The costs (or benefits) associated with externalities do not enter standard cost accounting schemes." 2/

6. Externalities can be internalized through a number of instruments including: subsidies and subsidy elimination, domestic or international taxes, tradable permits or quotas, revenue recycling and tax substitution. As the cost or benefits of externalities are not reflected in market prices, eliciting their 'hidden' values, by means of valuation tools, is frequently an important precondition to their internalization.

7. Ignoring externalities, on the other hand, is one contributing factor to the creation of inefficient markets in which goods or commodities are either over- or under-priced. The market failures resulting from ignoring externalities can result in the miscalculation of costs or the inability to realize all benefits leading to the adoption of sub-optimal policies.

Methods to internalize carbon

8. In response to the need to capture benefits from carbon sequestration and storage, international mandates to internalize carbon have been put in place by the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol.

9. Article 4, paragraph 1(d), of the UNFCCC, commits Parties to:

> "Promote sustainable management, and promote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs of all greenhouse gasses (GHGs) not controlled by the Montreal Protocol, including biomass, forests and oceans as well as other terrestrial, coastal and marine ecosystems."

10. Furthermore, paragraphs 1 (a) (ii) and (iii) of Article 2 of the Kyoto Protocol state that Annex I Parties in meeting their emission reduction commitments under Article 3, shall implement and/or further

2/ Watson, Robert T., Marufu C. Zinyowera and Richard H. Moss. Technologies, Policies and Measures for Mitigating Climate Change. Intergovernmental Panel on Climate Change Technical Report 1, 1996.

elaborate policies and measures to protect and enhance sinks and reservoirs of GHGs not controlled by the Montreal Protocol, promote sustainable forest management, afforestation and reforestation and sustainable forms of agriculture.

11. Finally, Article 3, subparagraph 3, of the Kyoto Protocol states that carbon sequestered as a result of afforestation, reforestation and deforestation should be included in the inventories of Annex I Parties. Land use, land use change and forestry activities (LULUCF) can also be created through the Clean Development Mechanism (CDM).

12. In response to the above provisions, a number of additional mechanisms have been put in place to value and trade carbon including: the European Union Emission Trading System, Clean Development Mechanism Executive Board-accredited Certified Emission Reductions (CER), the World Bank Prototype Carbon Fund, etc.

13. It should be noted, however, that the Intergovernmental Panel on Climate Change (IPCC) recognizes that carbon sequestration is only one of many ecosystem services which, if not accounted, are distorting markets. Other such services, include for example, nutrient and water cycling, flood regulation, recreational services, etc. Hence, internalizing carbon alone will not lead to efficient markets if important other externalities—such as biodiversity-related externalities remain non-internalized.

Methods to internalize biodiversity

14. In fact, the economic valuation, and subsequent internalization, of all ecosystem services that are relevant under a given decision-making problem, at all relevant scales (local, regional and/or global, on-site and/or off-site) would contribute to efficient decision-making.

15. There are many methodologies available for the economic valuation of biodiversity benefits. 3/ The appropriateness of various methodologies is determined by the biodiversity beneficiary (local versus global, private sector versus non-profit, etc) and the types of biodiversity benefits realized (direct versus indirect use values; use versus non-use values). 4/

16. Some techniques are based on actual observed behaviour data, including methods that deduce values indirectly from behaviour in surrogate markets, which are hypothesized to have a direct relationship with the ecosystem service of interest (so-called "revealed preference techniques"). Other techniques are based on hypothetical rather than actual behaviour data, where people's responses to questions describing hypothetical markets or situations are used to infer value (so-called "stated preference techniques"). Some techniques are broadly applicable, some are applicable to specific issues, and some are tailored to particular data sources.

17. As in the case of private-market goods, a common feature of all methods of economic valuation of ecosystem services is that they are founded in the theoretical axioms and principles of welfare economics. These measures of change in well-being are reflected in people's willingness to pay 5/ for changes in their level of use of a particular service or bundle of services. These approaches have been used extensively in recent years, in a wide range of policy-relevant contexts. However it is suggested that some biodiversity functions are key to the survival of global ecosystems including humans (the so-called life support function) and should, therefore, be treated as a fundamental constraint and not an element of the set of possible economic choices. 6/

3/ For an overview, see *An Exploration of Tools and Methodologies for Valuation of Biodiversity and Biodiversity Resources and Functions* (CBD Technical Series No. 28, Montreal).

4/ Ibid, p. 14.

5/ Dependent on the question that is to be investigated, focus is sometimes also given to the so-called 'willingness to accept' compensation. See Ibid, footnote 10, for a brief discussion

6/ Ibid, pages 10, 13-14.

18. In reality, valuation typically focuses on the economic values of ecosystem goods and services generated by biodiversity resources rather than biodiversity as such. 7/ A comprehensive assessment of the values of ecosystem services was undertaken by the Millennium Ecosystem Assessment (MA). T he Assessment examined all use and non-use values of a variety of ecosystems revealing the importance of full accounting. For example, it revealed that as much as 96 per cent of the economic value of forests can be attributed to non-wood forest products, recreation, hunting, watershed protection, carbon sequestration, and passive use.

19. One option to put a monetary value on biodiversity benefits is through replacement costs or lost income. While not a valuation method in the strict sense, cost-based approaches can provide useful guidance under certain conditions. 8/ The Millennium Ecosystem Assessment highlighted a number of examples in this regard including:

- The collapse of the Newfoundland cod fishery in the early 1990s cost at least US$ 2 billion in income support and retraining;
- The damage costs of freshwater eutrophication in England and Wales was estimated to be US$ 105–160 million a year in the 1990s; and
- An algal bloom in Italy in 1989 cost the coastal aquaculture industry $10 million and the Italian tourism industry $11.4 million.

20. Recognizing the need for more comprehensive assessments to facilitate the internalization of biodiversity costs and benefits, efforts are presently underway to provide global estimates of the values of ecosystems and biodiversity to societies. Preliminary results indicate that the loss of tropical forests due to biodiversity benefits alone can be expressed as an annual cost of US$ 2-5 trillion. 9/

II. PERVERSE INCENTIVES GENERATED BY CARBON MECHANISMS

21. Existing carbon markets maintain some market distortions in so far as they rarely internalize externalities such as biodiversity benefits through the provision of ecosystem services. This is creating market distortions in some ecosystems in which internalizing such factors have been demonstrated to reduce risks of carbon loss (permanence) or increase the total amount of carbon stored over the long term. Certain elements of the international carbon markets have already or are modelled to, in the future, create perverse incentives for biodiversity conservation and sustainable use which are resulting in actions in direct conflict with the objectives of the Convention on Biological Diversity. The conditions under which such perverse incentives are or could be created are discussed below.

High opportunity costs

22. Some climate-change-mitigation policies present a perverse incentive for biodiversity conservation and sustainable use by creating new or expanded markets which increase the opportunity cost of biodiversity conservation based on forgone income generation from mitigation options.

23. In Indonesia, for example, the returns per hectare from large-scale oil palm plantations can reach US$ 1,670 compared to US$ 36 and US$ 26 per hectare for rubber and crop production, respectively. 10/ When considering that it is estimated that almost one third of recent deforestation can be attributed to oil-palm production, most of which is being used for biofuel, a link can be drawn between the development of an international market for oil palm as biofuels (which has driven up the opportunity cost associated with non-conversion) and the loss of forest biodiversity in the area.

7/ Ibid, page 7-8

8/ Ibid, page 16-17.

9/ The Economics of Ecosystems and Biodiversity (TEEB), http://ec.europa.eu/environment/nature/biodiversity/economics/index_en.htm

10/ Vermeulen, S. and N. Goad. Towards Better Practice in Smallholder Palm Oil Production. International Institute for Environment and Development, 2006.

24. Economic analysis that fails to internalize other ecosystem services may create inefficiencies even with regard to carbon sequestration. In particular, since the draining of wetlands and the associated degradation of carbon-rich soils were oftentimes not internalized in initial economic analyses of the feasibility of oil-palm plantations, the carbon release associated with the loss of these ecosystem services was also not considered. When such an analysis was undertaken it was revealed that, in many cases, oil palm production was resulting in a net increase in carbon emissions. In fact, the conversion of peat swamp forests to oil palm causes a net release of approximately 650 Mg carbon-dioxide equivalents per hectare. 11/

Differing time horizons

25. Economic analyses use discount rates to reflect the inter-temporal nature of costs and benefits that accrue over time. The way in which discount rates are reflected in climate-change mitigation may result in decisions that are not ideal for biodiversity conservation and sustainable use since the benefits from such actions are accrued over a long time horizon.

26. In many ecosystems, the rationale behind management decisions taken to maximize carbon sequestration is directly in conflict with management decisions which would otherwise be taken to maximize biodiversity levels. In moist tropical forests, for example, ecosystems tend to sequester four times as much carbon during the first ten years of growth when compared to the second ten years. As such, when seeking maximum carbon payments, investments will favour the protection or proliferation of young forests. Biodiversity, however is maximized when there is a variety of different aged forests. In fact, in temperate forests, if biodiversity values are given the top priority for management decision making, only 13 per cent of forests are maintained under 20 years of age. 12/

27. With regards to land-use change, the nature of the perverse incentive associated with afforestation and reforestation can be demonstrated by examining a case in which biodiversity valuation methods are included in decision making. When evaluating two options in southern Spain, cork-oak (native, slow-growing) and eucalyptus (non-native, fast-growing), it was revealed that a much larger area of cork-oak would be planted if biodiversity values are considered along with carbon values when compared to carbon values alone. The exception to this result is under conditions of very high-valued carbon, at which point eucalyptus are preferred. 13/

28. In reality, however, because of the tendency towards the internalization of carbon alone, markets for carbon generated by afforestation and reforestation may have negative impacts on biodiversity under certain conditions. 14/ For example, based on an economic analysis of carbon only, many decisions are taken for the conversion of land to large-scale, single-species plantations consisting of fast-growing species. 15/

Limited pricing and payment options

29. Depending on the circumstances, the price of carbon can serve as either an incentive for biodiversity conservation and sustainable use or for land conversion. One model predicted that farmers in the United States would adopt conservation tillage and other practices benefiting biodiversity at a carbon

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11/ Germer, J. and J. Sauerborn, Estimation of the impact of oil palm plantation establishment on greenhouse gas balance. Environment, Development and Sustainability, Volume 10, Number 6 / December, 2008.

12/ The Biodiversity Guidebook, Forest Practices Code of British Columbia, Province of British Columbia, September 1995

13/ Caparrós, A., E. Cerdá, P. Ovando and P.Campos Carbon Sequestration with Reforestations and Biodiversity-Scenic Values. Nota Di Lavor, March, 2007. http://www.feem.it/Feem/Pub/Publications/WPapers/default.htm

14/ Caparros, Alejandro and Frederic Jacquemont. Conflicts between Biodiversity and Carbon Sequestration Programs: economic and legal implications. Ecological Economics 46 143-157, 2003.

15/ Van Kooten, Cornelius and Erwin H. Bulte. The Economics of Nature: Managing Biological Assets. Environmental and Resource Economics, Volume 23, Number 4, 472-474(3), 2002.

price of US$ 10 per tonne; however, the same model predicted that at a price of US$ 25 and up, farmers would convert agricultural land to forest. 16/ In areas where deforestation has occurred to support farming, this could benefit biodiversity by restoring natural habitat (depending on the species used for replanting). However, in a previously non-forested areas, such as grasslands, this may place increasing pressure on native grassland and agricultural biodiversity and, therefore, yield a net negative impact.

30. This was demonstrated through an econometric evaluation of the conversion of agricultural land to forests and its impact on 615 bird species. The model predicted losses of farmland birds in the United States of between 10.8–12.2% under afforestation. While there was some increase in forest-bird populations (varying from 0.3% to 21.8%), a net loss in total bird populations was predicted in all study areas.

31. A number of other policy decisions that are expected over the next few years will impact the economics of biodiversity conservation and sustainable use. On such example is the emerging mechanisms for reducing emissions from deforestation and forest degradation (REDD) which is being negotiated under the UNFCCC process in recognition of the fact that an estimated 20% of anthropogenic greenhouse gas emissions can be attributed to deforestation and forest degradation. The incentive framework that will be set up under REDD, and its impact on biodiversity, will be influenced by decisions concerning the eligibility of countries and areas. For example, if the baseline is discussed against a background of historic deforestation rates, and present and future levels of threat then countries with a positive track record of implementing the programmes of work on forest biodiversity and protected areas under the Convention on Biological Diversity (i.e. with a low rate of deforestation) might be perceived to be ‘penalized’ compared to countries with high deforestation rates, and a high level of threat to their forest biodiversity, thus creating a disincentive for implementation of the Convention.

III. BENEFITS OF ADDRESSING MARKET DISTORTIONS IN EXISTING AND EMERGING CARBON MARKETS

Maximizing carbon storage

32. IPCC has recognized that including carbon as the only externality when designing policies can actually maintain or expand many of the existing market distortions. In fact, creating multiple ecosystem-service markets may result in the maximization of the amount of carbon being sequestered and stored over the long term.

33. This is due, in part, to the fact that internalizing other ecosystem services may allow for the capture of, and payment for, additional benefits, thereby reducing the carbon-price option at which sequestration or the sustainable management of sinks is selected as the preferred option over low-carbon options, such as intensive agriculture or deforestation.

34. This link between alleviating market distortions and maximizing long term benefits is captured in the Fourth Assessment Report of the IPCC, 17/ which elaborates on the difference between market potential and economic potential when considering mitigation potential, where:

(a) *Mitigation potential* means an assessment of the total greenhouse gas emission reduction that could be achieved at a given market price for carbon;

16/ Lewandrowski, Jan, Carol Jones, Robert House, Mark Peters, Mark Sperow, Marlen Eve and Keith Paustian. Economics of Sequestering Carbon in the U.S. Agricultural Sector. U.S. Department of Agriculture Technical Bulletin No. 1909, 2004

17/ Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change: Summary for Policy Makers. Approved at the 9th Session of Working Group III of the IPCC, Bangkok, Thailand. 30 April - 4 May 2007

(b) *Market potential* means mitigation potential considering costs and discount rates from the point of view of the private consumer or company.

(c) *Economic potential* means mitigation potential considering the removal of existing market barriers and including social costs and benefits (i.e. the creation of more efficient markets).

35. Based on the above definitions, IPCC concludes that improving the efficiency of markets, through the inclusion of externalities, can in fact, result in the achievement of a higher mitigation potential.

36. Furthermore, internalizing biodiversity considerations will reduce the risk of any given project operating in an inefficient manner and will, therefore, lead to higher quality decision-making in which production, carbon sequestration and other ecosystem services can be maximized on a global scale.

37. For example, over long time-scales, internalizing biodiversity benefits would, in some cases, yield a landscape with increased stands of older forests. In fact, such a landscape would increase overall carbon sequestration potential since the total potential carbon sequestration in mature primary tropical forests may be as much as 50 per cent higher than secondary forests and plantations. 18/

38. The current situation in which biodiversity is seldom internalized is, however, limiting the realization of maximum carbon benefits. Mature tropical forests, which are among the largest sinks of carbon per acre, are among the most threatened forest types in part because the other services they provide (such as non-timber forest products, nutrient and water cycling, etc) are not usually included in economic analysis of land-use practices. 19/

39. Such an internalization would, however, enable the capture (and possibly compensation) of biodiversity benefits within projects in those areas with positive co-benefits for biodiversity while reducing the likelihood of conversion in some areas where conversion would have a negative impact on biodiversity. The internalization of biodiversity benefits would also likely result in the conversion of some areas which would have negative impacts on biodiversity but such activities would be based on a sound analysis.

Minimizing costs

40. The cost of maintaining sinks has been estimated for a number of ecosystems and mechanisms. A report prepared for the Stern Review on the Economics of Climate Change evaluated the cost of avoiding deforestation in Bolivia, Brazil, Cameroon, Congo, Ghana, Indonesia, Malaysia and Papua New Guinea to be between US$ 3 billion and US$ 11 billion a year (with the most realistic estimate being US$ 5 billion a year). T his study was conducted assuming that the alternative to deforestation would be forest conservation. 20/ The Eliasch Review, on the other hand, estimates that the costs of halving emissions from the forest sector by 2030 could be around $17-33 billion per year. However the Review clarifies that the net benefits of halving deforestation could amount to $3.7 trillion over the long term. 21/

41. In fact, forest conservation has been estimated to be one of the most cost-effective ways of capturing carbon benefits in forests. A baseline for the price of creating one tonne of carbon offsets in

18/ Ramirez, Octavio A., Carlos E. Carpio, Rosalba Ortiz and Brian Finnegan. Economic Value of the Carbon Sink Services of Tropical Secondary Forests and its Management Implications. Environmental and Resource Economics 21, 1, January, 2002.

19/ Millennium Ecosystem Assessment, Ecosystems and Human Well-being: Biodiversity Synthesis. World Resources Institute, 2005.

20/ Grieg-Gran, Maryanne. The Cost of Avoiding Deforestation. International Institute for Environment and Development, 2006.

21/ Eliasch, Johan The Eliasch Review: Climate Change: Financing Global Forests, Office of Climate Change of the United Kingdom, 2008.

tropical forests has been estimated at $11.06 while corresponding price for sequestering a tonne of carbon through planting and agroforestry are $17.98 and $25.39, respectively. 22/

42. In agricultural ecosystems, conservation tillage has been identified as a low-cost option for the enhancement and maintenance of soil carbon sinks. 23/ However, the potential for carbon sequestration in an active conservation-tillage agricultural system is, in many areas, lower than the total carbon that could be sequestered if the land was retired from production. 24/ In this case, what may be best for biodiversity at a local level (retirement of land) would also yield the greatest benefits for carbon sequestration; however, this option is not currently economically viable.

43. Finally, a 2007 study by the secretariats of the Convention on Biological Diversity and the Ramsar Convention suggests that the conservation and restoration of wetlands can be up to 100 times more cost-effective than other mitigation measures. 25/

Reducing long-term risks

44. When biodiversity externalities are not included, long term risks associated with climate-change-mitigation projects are also often ignored. In particular, when policies are decided upon under existing ecosystem parameters without considering the potential negative impacts of the climate-change-mitigation activity on ecosystem services in the future, the long-term sustainability of the project can often not be fully demonstrated.

45. One example of this is oil-palm production in Indonesia, as discussed above. As another example, a study of plantation forests in the United States revealed that plantations established for the purpose of carbon sequestration were acidifying the soil and reducing water runoff. In fact, the afforestation of grasslands, shrublands, and croplands decreased stream flow by an average of 38% per year with 13 per cent of streams in the study area drying up completely for at least one year. 26/ Since water scarcity can have a drastic impact on carbon sequestration rates, 27/ failing to internalize other ecosystem services can increase the risk of the long-term failure of carbon sequestration projects.

22/ Van Kooten, Cornelis G. and Alison J. Eagle. Climate Change and Forest Ecosystem Sinks: Economic Analysis. Resource Economics and Polity Analysis Research Group, University of Victoria, 2003.

23/ Antle, John M., Susan M. Capalbo, Keith Paustian and Md Kamar Ali. Estimating the Economic Potential for Agricultural Soil Carbon Sequestration in the Central United States using an Aggregate Econometric-process Simulation Model. Climate Change 80: 145-171, 2007.

24/ Feng, Hongli, Lyubov A. Kurkalova, Catherine L. Kling, and Philip W. Gassman. Environmental Conservation in Agriculture:
Land Retirement versus Changing Practices on Working Land. Working Paper 04-WP 365, June 2004

25/ Convention on Biological Diversity and Ramsar Convention on Wetlands. Wetlands, biodiversity and climate change – workshop report. 2007.

26/ Jackson, Robert B., Esteban G. Jobbágy, Roni Avissar, Somnath Baidya Roy, Damian J. Barrett, Charles W. Cook, Kathleen A. Farley, David C. le Maitre, Bruce A. McCarl, and Brian C. Murray. Trading Water for Carbon with Biological Carbon Sequestration. Science, Vol. 310. no. 5756, pp. 1944 – 1947, 2005.

27/ Stape, Jose Luiz, Dan Binkley and Michael G. Ryan Production and carbon allocation in a clonal *Eucalyptus* plantation with water and nutrient manipulations Forest Ecology and Management. 255: 920-930, 2008