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Biodiversity and climate change: framing an economic approach

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BACKGROUND AND MOTIVATION

Biodiversity, a term that encompasses the diversity of genes, populations, species, communities and ecosystems, underlies all ecosystem processes. Over the past few hundred years there have been significant losses of biodiversity, largely driven by human-induced changes in land use, habitat loss and degradation, and overexploitation of particular species (Millennium Ecosystem Assessment, 2005). Loss of biodiversity is associated with negative impacts on ecosystem function and human well being, although it is not always easy to identify the direct links. Some instances of serious negative impact clearly linked to loss of biodiversity include the costs incurred by the impacts of invasive species, or the loss of pollinators.

Although most biodiversity loss is the result of anthropogenic causes, climate change exacerbates the problem considerably. In certain ecosystems, such as coral reefs and montane habitats, climate change is becoming the dominant force driving biodiversity loss. In other areas, climate change may increase biodiversity through the introduction of new species, but with unknown consequences. But while climate change both increases the threat to biodiversity, it also provides new opportunities for addressing the problem.

Global concern about climate change provides a unique opportunity to leverage a much broader constituency for biodiversity than biodiversity alone has attracted in the past. Under the climate change agenda, large amounts of money have already been committed, and more will be committed in the future, for implementing a wide range of mitigation measures that can affect biodiversity, such as REDD, which could benefit biodiversity. Additional funding is likely to be available for adaptation to climate change; 'hard' adaptation measures such as sea walls for coastal defense and dams to control flooding may exacerbate threats to biodiversity while ecosystem-based adaptation measures may enhance biodiversity (World Bank, 2009a). There is an opportunity to mobilize these funds to jointly achieve mitigation/adaptation objectives and biodiversity objectives, if an economically sound case for biodiversity can be made in this context.

All the major studies of climate change caution that we can expect large losses of biodiversity in the coming decades with serious negative impacts on ecosystem function and human well being, but none has come up with a credible economic value for it. The treatment of biodiversity in climate change studies has ranged between two extremes:

- Biodiversity loss is not given an economic value in the Stern Report, the UNFCCC Report (2007) or the recent report by the World Bank (2009b), which note the importance of biodiversity but admit that we don't have a sound basis for valuing the loss or determining appropriate adaptation measures and their cost;

- At the other extreme, the recent critique of UNFCCC by IEED by Parry et al (2009) proposes a value for adaptation measures for biodiversity—$355-$370 billion annually—that dwarfs all other adaptation costs but is not based on sound economic principles, straining credibility. (See annex.)

Not identifying a value for biodiversity may be theoretically defensible but of little use for guiding policy, while providing a value that cannot be justified economically is not useful in the tradeoff analyses that countries must make, and may provide misleading signals for policy makers.

Given the large amounts of money committed for implementing a wide range of mitigation measures that can affect biodiversity and the likelihood that much more will be committed for adapting to climate change, it is critical to provide policy makers with a sound economic perspective on the value of biodiversity loss and potential adaptation measures. However, there is an information gap that has limited valuation of biodiversity: understanding and quantifying the links between biodiversity and the provision of ecosystem services. This ESW will develop a framework for filling that knowledge gap.

OBJECTIVE

Our objective is to provide a framework for a sound economic approach to biodiversity loss and its economic consequences in the context of climate change and deforestation. Forests are particularly important because they contain roughly 80% of terrestrial biodiversity and are also a major focus of actions related to mitigating climate change. The framing paper will not provide all the answers that will define a practical way forward for policy makers and scientists. The framing paper will identify a policy-driven research agenda and set priorities for further work as well as providing some guidelines for policy.

AUDIENCE

This report targets mainly an external audience of professionals in the climate change community and biodiversity community-- policy makers, economists and environmental specialists in government agencies as well as international organizations, NGOs and academia. The framework paper will contribute improving the dialogue on climate change and biodiversity, and the design of appropriate actions for both mitigation and adaptation by showing how to overcome the two extremes to the economics of biodiversity currently seen in the climate change literature —either no economic assessment, or an assessment that is not credible.

APPROACH

Biodiversity derives value in two quite different ways

1. Value arises when biodiversity provides services directly to an end user (an 'ecological end-point' (Wainger and Boyd, 2009)) such as the value of charismatic species (tourism, option or intrinsic value) or the value of biodiversity for bioprospecting.

2. Biodiversity also derives value indirectly, as a critical characteristic of an ecosystem that supports ecosystem functioning that generates ecosystem services. This indirect relationship between biodiversity and the generation of ecosystem services which are of

economic value, the 'ecological production function,' (See Box) is not well understood conceptually.

The valuation of the first category of values is relatively well understood conceptually, although measurement problems abound, so the framing paper will not focus on this aspect of biodiversity. The paper will primarily address the second source of value, to understand the relationship between biodiversity and the production of ecosystem services, because this is where the critical knowledge gap lies.

Ecological production functions

The ecological production function is similar to the production functions used in economics to define the relationship between inputs (e.g., labor, capital equipment, raw materials) and outputs of goods and services. In economic production functions, inputs derive value from their marginal impact on the output of goods and services.

Ecological production functions describe the relationships between the structure and function of ecosystems, and the provision of various ecosystems' services. Biodiversity is an 'input' to the ecological production function and derives value from the value of ecosystem services produced. The economic value of biodiversity is defined at the margin as the change in value of ecosystem services that results from a change in biodiversity.

Coupled with information about how the ecological input (biodiversity) will be affected by climate change, ecological production functions can be used to predict the effects of climate change on ecosystem services. While there are limits to the analogy between ecological and economic production functions, it is a useful analogy for developing the kinds of models needed to guide policy action. (Barbier, 2007; EPA, 2009)

The framing approach will be developed by a panel of experts during a 2-day workshop in February, co-chaired by Geoffrey Heal (Columbia University) and Glenn-Marie Lange (The World Bank). A paper will be drafted and circulated to the group for further work after the meeting. A final draft will be widely circulated to experts and policymakers outside the group for discussion and comments before finalization.

The meeting participants consist of a small interdisciplinary group of academic experts from economic and natural sciences who have been leading the work on biodiversity both in scientific and policy settings. Most of the participants are US-based, mainly due to funding constraints, but four participants are from outside North America. The participants have played leading roles in public policy forums such as the Millennium Ecosystem Assessment, Diversitas and the Coalition for Rainforest Nations that has so actively promoted REDD.

The work of the experts group is to define the role of biodiversity in the delivery of ecosystem services, i.e., as an input to an ecological production function. Biodiversity can be viewed as a characteristic of an ecosystem which affects ecosystem functioning and the provision of economic services. The point where natural scientists and economists meet is the provision of ecosystem services and valuation of those ecosystem services. Eventually, these links would be quantified to

derive a marginal value of biodiversity as part of an ecological production function, although the group will only be able to develop a framework for doing so.

The meeting will focus on biodiversity change as driven by changes in land use, loss of habitat and the resulting impact on the mix of species in human-dominated ecosystems, rather than the traditional conservation agenda that starts from species loss, refugia and pristine areas. The group will consider what the mix of species means for human health, the health of other species and ecosystem services, for example,

- Reduction in ecosystem services due to invasive species, pathogens
- What is happening to the natural ranges of, eg, pollinators or pathogens
- Externalities to biodiversity loss, e.g., open oceans

The group will begin with a few presentations and discussions as background, and then employ an approach often used by ecological groups--developing a simple working model with simulated data as an example in order to work through the framework for valuation. Several alternative frameworks may emerge, and it may not be necessary to fully understand the science of biodiversity in order to formulate useful guidelines for policy.

The framing paper will report on the model and what would be needed to develop the working model into an operational model. A draft paper will be prepared immediately after the meeting and will circulated for further work by the group.

Meeting Agenda

Chair: Geoffrey Heal

Day 1 Morning

1. G-M Lange: Introduction: background and objective of the meeting
2. C Perrings: What have we learned about the economics of biodiversity?
3. E Barbier: Valuing ecosystem services as productive inputs
4. S Polasky: The Natural Capital Project and valuation of biodiversity
5. S Naeem: Clarifying the role of biodiversity
6. S. Naeem: Presentation on a modeling approach

Day 1 Afternoon - Day 2 Morning: Develop model

Day 2 Afternoon: First draft of framework paper

List of experts participating in the meeting, February 4-5, 2010

Geoffrey Heal, Columbia University
Charles Perrings, Arizona State University
Steven Polasky, University of Minnesota
Edward Barbier, University of Wyoming
Jeffrey Vincent, Duke University
Thomas Sterner, University of Gothenburg
Gretchen Daily, Stanford University
Simon Levin, Princeton University
Shahid Naeem, Columbia University

Don Melnick, Columbia University
Ruth DeFries, Columbia University
Peter Mumby, University of Exeter
Thomas Elmqvist, Stockholm University
James Boyd, Resource for the Future
Andrew Dobson, Princeton University
Margaret Palmer, University of Maryland
Richard Ostfeld, Cary Institute of Ecosystem Studies
Anantha Duraiappah, UNEP
Glenn-Marie Lange, World Bank
Kirk Hamilton, World Bank
Geoffrey McCarney, Columbia University, rapporteur

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_____ 2009b. *Economics of Adaptation to Climate Change.* Washington, DC: World Bank.

ANNEX: UNFCCC 2007 AND ITS CRITICS: COSTS OF ADAPTATION TO CLIMATE CHANGE FOR ECOSYSTEMS

The UNFCCC originally commissioned a case study of the costs of adaptation for ecosystems, which was defined as maintaining biodiversity, but omitted the figure from its final report on global costs of adaptation for two reasons:

- the study failed to distinguish costs associated with the 'adaptation deficit' from those for the existing 'development deficit,' and
- the study could not show that the measures proposed would in fact maintain biodiversity (or how to measure what it was that would be preserved)

In light of the recent IIED critique of the UNFCCC report by Parry et al. (2009), which called for reinstating the biodiversity costs—by far the largest single component of global adaptation costs—the omission of biodiversity costs has become a contentious issue and warrants some review.

The case study for the UNFCCC report estimated the cost of adaptation defined as measures needed to conserve biodiversity 1) within protected areas, and 2) outside protected areas.

1. For biodiversity within PAs, the case study proposed expanding the percent of territory under protected status to meet the IUCN 1993 target for PAs, upgrade the level of protection status and extend PAs to the oceans. The estimated cost is $65-$80 billion annually.
2. For biodiversity outside protected areas, the case study drew on a notional figure developed by (James et al., 2001). At the end of an article presenting a careful assessment of the funding of protected areas, James et al. noted that maintenance of some ecological processes requires a much broader landscape than protected areas afford, with connections among different blocks of habitat. Drawing on two earlier studies by (Jenkins, 1990 and Pretty, 1998) about the cost of protecting biodiversity on the agricultural lands of UK ($29 billion annually), they reasoned that since UK contributes 1% of global cereal production, global costs were 100 times the UK costs, or $290 billion.