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BIODIVERSITY, GLOBAL CHANGE AND DEVELOPMENT - A DIALOGUE?

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ABSTRACT: Biodiversity is threatened by expanding human activities and development. For development decisions to take into account tradeoffs between development and biodiversity, a more quantitative understanding of biodiversity and its effects needs to be developed. In particular, expressing the benefits of greater biodiversity indiscriminately in terms of ecosystem services is fraught with problems because the relationships between diversity and services are not linear and do not only depend on diversity as such but also on the kinds of organisms present. In order to permit a more rational dialogue on biodiversity conservation and development, gaps in scientific knowledge need to be filled and results communicated in terms that permit the valuation of biodiversity relative to possibly forgone development benefits.

Keywords: climate change, biodiversity

The populations of a large number of organisms are threatened by human activities, and many ecosystems are degrading under human use. As societies grow and their impacts on natural environments expand, cumulative environmental effects result in global changes that raise concern about the sustainability of human activities. At the same time as sustainability is being questioned there is still a need for further development to reduce poverty and hunger in many countries. Human impacts on earth systems including biodiversity are therefore being discussed in both contexts of development and of conservation, two contexts that often are very far apart.

Biodiversity loss is a concern, but why and to whom? at what level of diversity does it become a concern? is it species diversity that counts, or assemblages of species in ecosystems? is it the diversity itself or a function of diversity that is valued? Answers to these questions are needed in order to address the balance between development and conservation. Both additional knowledge and a dialogue are needed on the value and valuation of biodiversity. The meaning of biodiversity and the relevance of different levels of biodiversity to the discourse on global change must become clearer. Too often, arguments in favour of biodiversity conservation are repeats of decades-old statements: bioprospecting (a new word for an old activity) is important for the development of medicines; human nutrition relies on a very narrow slice of biodiversity and additional genetic diversity is needed to safeguard this against future pest,

diseases and environmental change; and most importantly - ecosystem services that are vital to humanity are supported by biodiversity. All of these arguments are valid but their repeated use does not shift the decision-making process towards greater consideration of biodiversity in the face of much more calculable economic interests in development.

A better quantification and presentation of the ecosystem services argument is particularly important in the context of development since it could show that reductions in biodiversity caused by development processes may directly undermine the development in question - a classic case of unsustainability. As a consequence, policies aiming at development must achieve a balance between impacts on biodiversity and ecosystem services on one hand and development outputs on the other. Achieving that balance requires understanding and knowledge. Some of the following examples indicate that gaps in scientific knowledge and in the communication of such knowledge are still significant impediments to rational decision making between development and biodiversity conservation.

Holling (1998) identified an "analytic approach" in ecology that expands existing knowledge by experimentation, and an "integrative approach" that brings together existing knowledge from different disciplines. Biodiversity research has probably done too little of the latter and communicated too little of an integrated knowledge base to allow differentiated judgments on the appropriate balance between conservation and development. In particular, the "value" of biodiversity needs to be assessed in order to advise policy. Increasingly "value" is associated with more or less quantifiable economic indicators.

In economic terms, the 'right' amount of conservation effort is one where the marginal economic benefits from conservation just equal the marginal costs of conservation. In applying this to biodiversity, it is difficult to put a value on the economic benefits, and even more so to quantify marginal benefits. In order to overcome this difficulty there is a common trend to evaluate ecosystem services instead and somehow attribute them to biodiversity. The G8, 2007 Potsdam initiative, rather than quantifying the benefits of biodiversity has asked to estimate the economic costs of global biodiversity loss. (Cor)relating visible and measurable loss to economic damage represents a "removal experiment" and may be easier than evaluating functional systems in which the relationships are unclear. The initiative shows, though, that we don't (yet) know the cost of degradation or the benefit of conservation.

The United Nations Development Program in its brief to the financial sector (UNEP, 2007) goes as far as coining the acronym BES for biodiversity-ecosystem-services, in order "to provide a simple and clear association between these two inter-related aspects of the natural world". But, even though biodiversity underpins many ecosystem services, the relationships are not linear. There are mutual non-linearities, not identities. As biodiversity increases, the marginal return in ecosystem services diminishes. In addition biodiversity cannot really be defined in incremental levels of diversity. There is no single measure (or even two or three measures taken together) that provides a comprehensive, systematic sense of biodiversity across scales. The ways in which biodiversity matters to ecosystem services depends on what organisms there are. (Diaz *et al.,* 2006).

This complexity adds up to confusion about what biodiversity is. The public perception is one of selected taxonomic diversity, or species richness often reduced to "charismatic mega fauna". Functional diversity is ill understood and often conflicts directly with the species perspective of threatened biodiversity since rare species are likely to have small effects.

The Convention on Biodiversity (CBD) defines biodiversity as the variability among organisms and the ecological complexes of which they are part. UNEP links this to ecosystem services which "are the goods and services that biodiversity provides" introducing the short-circuit between diversity and services that needs closer scrutiny.

What if biodiversity cannot simply be equated with ecosystem services and we cannot define a level of biodiversity or its loss that is safe? What then is the right amount of conservation? Agriculture relies on simplified ecosystems with managed landscapes, managed and selected biodiversity, well-defined benefits and largely known costs. This may help to show up some of the relationships between diversity and service. A typical "green" criticism of agriculture is that ecosystem functioning and stability are compromised by low diversity typical of managed ecosystems. But in reality there has always been a substitution of biological function by management inputs when ecosystems are used and goods extracted. In economic terms there is a problem in defining that balance of management input, ecosystem goods and services and the degradation associated with the use of land. To optimize land use change decisions expected benefits should equal or exceed expected costs (Pagiola *et al.,* 1998) based on accountable ecosystem services and accounted agricultural production. Too often the degradation costs are externalities to the accounting because

information is lacking on how to include them. Ecosystem services may increasingly be taken into account, although down-stream services are often excluded. But, again, what if biodiversity can indeed not be equated to ecosystem services? and if we need to account for the value of biodiversity on a separate balance sheet? In many agricultural systems biodiversity *per se* has measurable values and is valued by land users: risk averse farmers use crop diversity to hedge income risk under variable climate and market conditions. In this use biodiversity represents an insurance value (Di Falco and Perrings, 2003). Managed increases in biodiversity by intercropping or agroforestry practices may achieve overyielding by providing extra yield due to low competition between the species chosen for association (such as combinations of deep and shallow rooting crops). Genetic resources from wild species and crop ancestors commonly are needed to manage pest and disease susceptibility. Genetic diversity has declined and still is declining among domesticated species (MEA, 2005) and this may imply quantifiable losses and additional risks.

Most societies have benefited from the conversion to managed ecosystems but losses in biodiversity and ecosystem services have reduced well-being, increased poverty and stifled development of some regions and groups. Does this recognition translate into sensible policy? Not really. Many developing countries discriminate against agriculture through overvalued exchange rates, protection of competing sectors, high direct taxation on production or even on potential production, and price controls that benefit the urban, voting poor. Such policies discourage investments to improve productivity and leave only area expansion to increase agricultural production. Yet the agricultural context offers clear conservation options: improve biodiversity in agricultural landscapes, retain ecological functionality through agroforestry, protect key areas such as corridors between remaining habitats or remnants of natural habitats. Under each case, society, rather than the individual producer must reconcile competition between protection and "forgone development opportunities".

In the absence of a broad-based understanding of biodiversity and its benefits at different levels of diversity, biodiversity conservation is seen as a luxury of rich nations eager to preserve "Nature". Debt for Nature Swaps, although well-meaning reinforce this perception. Rich nations forgive debt for nature in poor nations that are therefore exempt from developing "ownership" and stewardship of that nature. With a payment of at most, US$ 5 per ha for the 'average' swap (Ruitenbeek, 1992) biodiversity is valued quite lowly. Such low pricing is easily confirmed by a survey of logging license fees which can be less than US$ 1/ha even for highly diverse tropical forests. The conclusion that "the

world does not care too much about the biodiversity capital and its bequests to future generations" by Pearce (2007) does therefore not surprise. It is affirmed by the ratio of actual global expenditures on ecosystem conservation which are only some US$10^10 compared to perhaps US$10^14 for economic subsidies (Pearce, 2007; James *et al.*, 2001). The UNEP financial sector briefing on BES shows that even some fundamental values are lacking in the balance between development and conservation: it includes advice to "commit to comply with BES laws" and "avoid protected areas". In other words, UNEP sees a need to admonish the financial sector to avoid aiding law breakers.

What already used to be difficult decisions based on complex relationships between biodiversity and resilience of ecosystems have become even more complicated under climate change and under human responses to climate change. In what ways does global change, and mitigation and adaptation efforts affect biodiversity and vice versa? Mitigation of CO_2 emissions by expansion of palm oil or sugar cane will cause biodiversity loss, yet a doubling in atmospheric carbon dioxide will also threaten the integrity of biodiversity-rich regions. Climate change and habitat loss interact in landscapes, and regional landscapes rather than individual ecosystems may have to be managed in the future. Sanctuaries may no longer work under climate change as climatic boundaries shift species out of protected areas or threaten their survival in protected zones undergoing permanent temperature or precipitation changes. Integrated approaches between climate, biological and human sciences will be needed to find answers to pressing questions of biodiversity use and conservation and, most importantly, science results must be communicated effectively and proposed actions justified to those who will foot the bill. Perhaps here the social sciences might serve as an example. Nobody would offer a single index and be content with a Shannon-Weaver index (a single number which expresses biodiversity of a community taking into account only the number of individuals in a community, the number of species, and the number of individuals in each species) like number to characterize a society under development. We are all used to multi-dimensional measures that consider such things as education, wealth distribution, mortality, demographics, infrastructure, access to water and other resources, energy use etc. to define "development". The complex interactions of the diversity of species, functional groups, water and nutrient cycles, ecosystems and their services, landscapes, and regions call for similarly multi-dimensional analysis communicated in terms that decision makers and voters understand.

To assist policy decisions and negotiation evaluation and accounting of ecosystem services must advance, and crucial knowledge gaps must be filled.

Studies of development and biodiversity must explore potential outcomes of decisions, explore links and tradeoffs between poverty alleviation (development) and biodiversity conservation. Most importantly, scientists must collaborate with policy makers from the beginning to identify questions and interventions of relevance to society (Agrawal and Redford, 2006). In this context, "collaborate" cannot mean a bottom-up approach to science steering since most stakeholders will have little systematic knowledge on the valuation of biodiversity; a dialogue is needed in which science knowledge combines with stakeholder concerns and analysis.

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