Conservation of Biodiversity and Economic Development: The Concept of Transferable Development Rights

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Abstract. For ecological and economic reasons it is more cost effective to conserve habitats rather than species, and hence biodiversity conservation becomes a land use issue. Since in developing countries, land is the most important productive asset, the opportunity costs of conservation are forgone development, while the benefits from conservation are distant and largely external to the host country. The concept of transferable development rights (TDRs), which has been extensively applied to conservation of historical buildings in urban areas, is extended and adapted here to the conservation of biodiversity, both within a country and globally. Creation of a market for TDRs makes effective the latent demand for and supply of biodiversity conservation and generates benefits for both the supplier (developing countries) and the demander (developed countries). The paper explores the conditions and public interventions necessary for the creation of an active market for TDRs. It also proposes a number of mechanisms such as credits and offsets for purchase of TDRs against domestic regulations and conservation taxes in the developed countries.

Key words. Biodiversity, habitats, land use, economic development, conservation, supply, demand, use value, non-use values, transferable development rights, conservation tax, credits and offsets, capital gains.

1. Introduction

There is a tendency in the developed countries to view tropical biodiversity as a global resource, and the host country as both a beneficiary and a custodian of this resource on behalf of humanity. The implication of this view is that the host country has a responsibility (as well as self-interest) to conserve the biodiversity within its borders regardless of opportunity costs. This misconception derives in part from exaggeration of the biodiversity conservation benefits to the host country, and in part from insufficient appreciation of the opportunity costs in terms of forgone development benefits in the complex ecology of the tropics and the resource-based developing economy of the host country. The exaggeration of the conservation benefits to the host country arise from failure to recognize differences in technology, preferences, and discount rates at different levels of development.

The present paper argues that biodiversity conservation in the tropics is a land use issue, and since land is by far the most important capital asset in developing countries, biodiversity conservation is ultimately a development rather than a conservation issue. Therefore, for biodiversity conservation in

the tropics to be desirable and sustainable, the forgone development opportunities must be fully compensated. The world lacks a mechanism through which biological diversity and its opportunity costs can be valued and exchanged. The paper explores the concept of transferable development rights as a possible mechanism for reconciling biodiversity conservation and economic development in the tropics.

The paper is organized into twelve sections. The first three sections following the introduction make a case for conserving habitats rather than species and for addressing biodiversity conservation as a development policy issue. The following three sections introduce the concept of transferable development rights (TDRs) and its potential applicability to conserving biodiversity at both the local and global levels. Sections 8 and 9 explore how credits and offsets against domestic regulations and conservation taxes can pump-prime the market for TDRs. Sections 10 and 11 discuss the appreciation of the value of TDRs over time and the conditions for and limitations of using a market approach to conserve biodiversity. The paper ends with concluding remarks.

2. Conserving Habitats Rather Than Species

Biodiversity refers to the variety and variability among living organisms and the ecological complexes in which they occur. Thus the term encompasses: species diversity, or diversity *among* species; genetic diversity, or diversity *within* species — the variety of genes; and ecosystem diversity, diversity among ecological systems within a given area, i.e., functional systems that include the organisms of a natural community together with their physical environment (National Research Council, 1992). The argument below is cast in terms of protection of habitats versus protection of species, but it does apply *a fortiori* to gene level as well. Just as genes can only be conserved in practice within the diversity of living species, so species depend on each other for survival and can only be conserved in a comprehensive network of representative living ecosystems, which inhabit the various physical habitats in land and in water (P. Ashton, personal communication).

The conservation of biological diversity in the tropics is largely a matter of conserving entire habitats rather than individual species of flora and fauna (Terborgh, 1992; Whitmore, 1990). First, given the multiplicity and diversity of species in habitats such as tropical forests and coral reefs, there are economies of scale in protecting several species concurrently: the opportunity cost of protecting additional species once one is protected is very low or zero if their habitat is coterminous. While some species may be more vulnerable than others and require extra protection, by and large the (marginal) costs of protecting additional species fall precipitously once a habitat is protected for the preservation of one species. Conservation of biological diversity is a public good not only from the standpoint of the beneficiaries, but also from

the standpoint of the species themselves! (You cannot protect one species without protecting others which share the same habitat.) The importance of recognizing this fact is that the additional benefits from conservation of all or most species in a habitat may justify the conservation of larger areas, which increases the probability of survival under unfavorable natural conditions such as changes in temperature, rainfall, and anthropogenic impacts such as air pollution, acid rain, and encroachment.

A second reason conserving habitats is preferable to conserving species is that we are not certain which species are likely to turn out to be the most valuable or, for that matter, valuable at all. Habitat conservation has quasi-option value in that it keeps our options open until more information becomes available.

A third reason is the complexity of interactions and mutual interdependence among species in tropical habitats, and our limited understanding of these interactions, which together make it necessary to protect many species to ensure the protection of one. Thus, even if we are not interested in certain species directly as an end in themselves, we may still have to protect them as a means to protecting the species we are interested in. Since these other species are themselves dependent on yet other species for survival, soon the need for the protection of the entire habitat becomes inevitable. The conservation of biological diversity is a joint production function with many protected species as its joint inputs and outputs. The larger the number of species protected, the higher the probability of survival of the particular species we want to protect. At the limit, full protection of the entire habitat maximizes the probability of survival, assuming that we know enough to delineate the habitat area, and that no shifts in habitat take place due to climate changes such as global warming. The interaction of ecological and economic factors would determine the cut-off point between critical and "non-critical"[1] habitats.

A fourth reason is the relatively narrow range of habitats of several tropical species and the irreversibility of destruction of tropical habitats. Severe modification of a limited number of fragile habitats is likely to result in massive extinction of species since both the capacities of the species to adapt to a new environment and of habitats to recover their original ecosystem are severely limited (Terborgh, 1992; Whitmore, 1990). This contrasts with many temperate species which tend to have wide ranges of latitude, temperature and moisture regimes, and to exist in habitats that tend to be less fragile and easier to rehabilitate or "recreate" than tropical habitats. The implication is that for tropical biodiversity conservation, a quasi-option value should be imputed to the avoidance of irreversible destruction or severe modification of "critical" habitats rather than to the (temporary) protection of individual species from extinction. If we knew which species would become valuable and we could protect them *ex situ*, the opportunity costs would be substantially lower, but we do not have that "luxury".

A final reason for adopting a "habitat" rather than a "species" approach to the conservation of tropical biodiversity is the associated non-biodiversity benefits from habitat preservation such as watershed protection, harvesting of non-timber forest products, and attraction of recreational and scientific tourism (Panayotou and Ashton, 1992). These are joint products of habitat conservation but not of species conservation *per se* except for the scientific tourism to some degree. These joint products are of particular importance as a source of livelihood and foreign exchange to developing countries, and hence a more compelling reason for conserving biodiversity rather than the protection of individual species. While the latter is a primary object of biodiversity conservation from the standpoint of developed countries, it is only a by-product from the standpoint of developing countries; it is an added benefit to the host country only to the extent that the ensuing global benefits can be captured through tourism, royalties, or international transfers (Panayotou, 1992). Carbon sequestration is an additional global byproduct of habitat preservation for the purpose of protecting biodiversity that may or may not be internalized to the developing country that hosts tropical forests. However, the adoption of a habitat approach to species conservation does *internalize* a significant portion of the benefits to the host country through watershed protection, sustainable production of non-timber forest products, and enhanced opportunities for local and international tourism. Consideration of these additional benefits has three implications: (a) the conservation of a larger area maybe justified; (b) a somewhat different mix of conservation areas may be chosen to include critical watersheds, tourist attractions, etc., thereby reducing the opportunity costs of conservation; and (c) the motivation of the host country to set aside and protect habitats is thereby enhanced.

3. Biodiversity Conservation as a Form of Land Use

If it is accepted that for a combination of ecological and economic reasons, biodiversity conservation in the tropics is a matter of identifying and protecting critical habitats, the issue collapses into one of land use. Setting aside land as protected habitat for the conservation of biodiversity and other associated benefits has an opportunity cost in terms of forgone benefits from alternative land uses. Assuming profit (or rather rent) maximization on the part of land owners, privately held land would be set aside as biodiversity habitat only if this is the best possible land use in the sense that it maximizes the net present value of land rents (given the landowners discount rate). This is an unlikely possibility since most of the benefits from biodiversity conservation and habitat protection are public rather than private. Therefore, without government intervention through regulations, economic incentives, or outright purchase of private land, and without sufficiently funded NGOs, very little private land is actually set aside as conservation land. Furthermore, because of wrong government intervention (e.g., distortionary agricultural

and resource policies), the conversion of natural habitats to other uses is often greater and faster than it would be under a free market. This raises the question as to the type and level of intervention that can "best" internalize to the private land owner the public benefits of biodiversity conservation to induce the socially desired land use allocation.

Public land, on the other hand, is state property precisely for the purpose of the production of public goods, such as conservation of biodiversity and watershed protection. Given limited (land and non-land) resources and alternative public (and private) uses, however, there are substantial social opportunity costs to setting aside public lands as habitats for biodiversity and other environmental benefits. For example, forest land can be developed into logging or mining concessions earning foreign exchange resources for industrialization, or used as a site for an irrigation reservoir or other public project such as a road or airport. Assuming public policy that aims to maximize net social benefits, land will be set aside as protected habitat or conservation area only if this is the use that will maximize the net present value of social benefits accruing to the citizens of the country. Since the benefits from biodiversity conservation are largely global (and hence external to the host country), while the opportunity costs in terms of forgone development benefits are national and hence internal to the country, a considerably smaller area would be set aside for conservation than is required for maximization of global welfare. This raises the question as to the level and type of economic incentives that can most cost-effectively internalize to the host country the global benefits from biodiversity conservation to bring about the globally optimum land use allocation.

4. Biodiversity Conservation as a Development Policy Issue

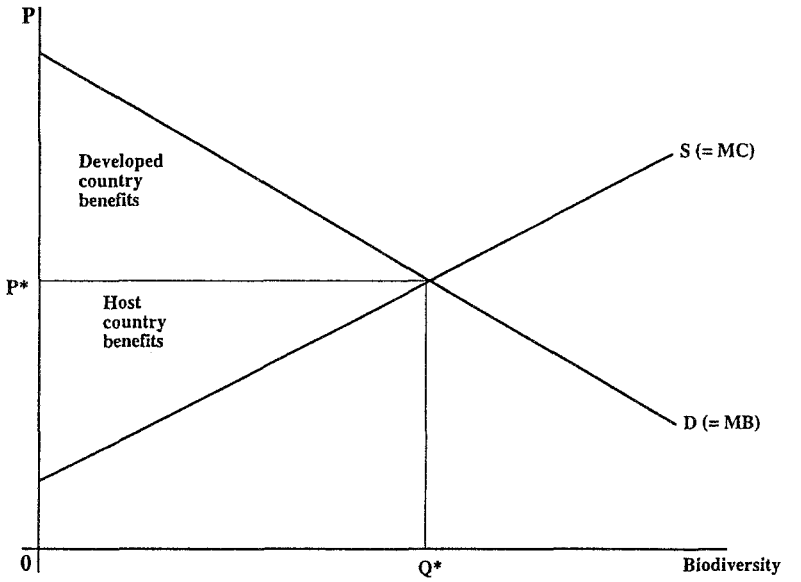
In developing tropical countries with limited accumulations of physical and human capital, land is the single most valuable economic asset. Land use issues are development issues *par excellence*. Land and its associate resources of soil, water, forests, and minerals are not only the sources of employment and income for the great majority of the population, but they are also the main sources of investible surplus for industrialization. A decision to set aside land as habitat for biodiversity conservation has high opportunity costs both in terms of current income and forgone development opportunities. In private terms, alternative employment opportunities are scarce due to low levels of education and limited industrialization. If land is privately owned, compensation of land owners by the state is not a realistic option because of (a) the large land area involved in protecting habitats, and (b) the limited budgets and large deficits facing many developing country governments. If land is state property, and the state is in complete control of its use and disposal, it might be easier to set it aside for biodiversity conservation. However, the opportunity costs are equally real and must be compensated

for if the society is not to be made worse off, unless conservation generates sufficient benefits internal to the country to offset such costs. The greatest difficulty arises when the status of the reserve is one of open and free access. In such a case, either secure property rights must first be established, or other institutions such as public trust funds must be created to compensate those who collectively depend on the "common" property resource for their livelihood.

In social terms, agriculture and other resource-based sectors are often the only sources of savings for investment and foreign exchange earnings for the import of producer durables. External borrowing and foreign development assistance cannot compensate for the loss of export earnings from resource-based sectors because loans must be repaid and development assistance in many countries does not even offset the outflow of foreign exchange for the service of existing foreign debt.

Thus, biodiversity conservation is perceived by both land owners and the host country government as a forgone development opportunity, one of few such opportunities available, and should be treated as such by its advocates and beneficiaries rather than as a global resource that the host country has an obligation to protect. To a tropical developing country facing limited options, a development opportunity may be as scarce and its loss as irreversible as endangered species and habitats are to the developed world. Once biodiversity conservation is viewed as a forgone development opportunity by both sides, the critical question is what would it take to compensate the host country for the lost opportunity. Theoretically, there is a demand and a supply of biodiversity conservation and an "equilibrium" price that clears the market. The demand reflects the developed world's full valuation of biological diversity (inclusive of use, option, bequest, and existence value) as reflected in their willingness to pay, which is itself a function of income level, education, environmental awareness, and other socioeconomic characteristics. The demand curve for habitats (in terms of area) is downward-sloping because of the diminishing marginal utility of saving additional species, as well as the fact that conservation of additional areas yields diminishing marginal benefits in terms of increased probability of survival and protection of additional species (Figure 1).

The supply function reflects the forgone marginal benefits of the development opportunity sacrificed in order to supply (protect) an additional unit of biological diversity by expanding the country's conservation area. The supply curve of biological diversity is upward-sloping, reflecting the rising supply price of increasingly less remote, more productive lands with higher opportunity costs (Figure 1). These opportunity costs are in turn a function of the country's level of development and the availability of alternative development opportunities. They are likely to be low at very low and very high levels of development and high at intermediate levels. Thus, while we expect the demand price of biodiversity conservation to rise over time (the demand



* Market-clearing price and quantity

Fig. 1. Demand and supply of biodiversity (protection).

curve shifts to the right due to rising incomes and changing tastes), the supply price of a particular host country might rise or fall depending on the country's level of development. On balance, we expect the "price" of biodiversity to rise over time due to increasing demand and shrinking supply, even as more land is freed from other uses for habitat conservation because of the irreversibility of earlier land allocation decisions.

For any market-clearing level of biodiversity, the division of the benefits from biodiversity conservation between the host country (supplier) and the developed country (demander) depends on the slopes of the demand and supply curves. The steeper the supply curve and flatter the demand curve, the larger the share of the host country. We expect the supply curve to become fairly steep as biodiversity protection moves from species-rich, low-opportunity cost habitats to species-poor, high opportunity cost habitats. The demand curve is likely to be steeper for those who "demand" biodiversity for its intrinsic or existence value and flatter for those who demand it for its use value, including its "offset" value following the introduction of transferable development rights, as discussed below.

5. The Concept of Transferable Development Rights

Much of the conflict between developed and developing countries concerning the conservation of biodiversity arises from a failure to distinguish between

ownership and spatial exercise of development rights. The treatment of biodiversity as a global rather than national resource and the pressures to conserve it are perceived by developing countries as a challenge to their ownership and sovereignty over these resources. If, however, the prime purpose of efforts to protect biodiversity is conservation, not redistribution of resources, the first step is to recognize the ownership of developing countries over these resources and their right to develop them as to maximize their own benefits. The only negotiable issue is then the terms at which the development rights over critical habitats would voluntarily be transferred elsewhere in the country or abroad. Ownership of land conveys certain rights of development attenuated in some respects. Such rights can be further attenuated through sale or transfer not of the land itself, but of the right to use the land in some ways and not in others. The designation of land as conservation area is a "radical" attenuation of development rights which results in a substantial reduction of the net present value of the stream of benefits expected from the land, and hence a reduction in the market value of the land which is to a large extent the embodiment of the capitalized (net) income stream from the land. This gives rise to claims for compensation which, however, is impractical and prohibitively costly when large areas are involved, as in the case of biodiversity conservation.

The concept of transferable development rights (TDRs) makes possible the creation of conservation areas without the need for assessment of land values and compensation: it simply creates a market with demand and supply of development rights that result in an equilibrium price at which exchange or transfer takes place. The concept is being used extensively in the preservation of buildings of historical or archaeological value or areas of unique natural beauty in urban centers. For example, TDRs have been used in Chicago (Costonis, 1974) and New York City (Schnidman, 1978) for building conservation, and in Puerto Rico for coastal conservation (Costonis, 1975).

The concept of transferable development rights works as follows: the owner of a preserved building does not lose his rights to develop his property; he simply can not exercise them *in situ*; he can exercise them elsewhere where he can increase his building density and/or building coefficient by a given percentage beyond what is allowed by law in that zone; the allowable excess is specified by law (say 10% beyond what is normally allowed). Alternatively, he may sell his development rights to the highest offer. In this manner, the society benefits by preserving important cultural sites without depriving their owners of their legitimate rights and without paying astronomical sums in compensation.

The introduction of transferable development rights involves several steps toward market creation:

1) Declaration of certain areas as conservation areas and prohibition of some or all types of development in these areas.

2) Legislation permitting the transfer of development rights of land owners from the conservation area to other areas where development is permitted; this creates the supply of development rights.
3) Legislation permitting developers to exceed the area plot ratios and building coefficients by a certain pre-specified percentage through the use of owned or purchased development rights[2]; since land in development areas is usually more costly than in conservation areas, developers would prefer to purchase development rights from conservation areas rather than additional land;[3] this creates the demand for development rights.
4) Since there is both demand and supply, a market for development rights would come into existence reducing transaction costs and setting a price for TDRs; the bulk of TDRs, like land, are being sold and purchased through the intermediation of real estate agencies. The equilibrium price of TDRs depends on the ratio of conservation areas to the permitted "excess" development area. TDRs have been used extensively in American and European cities for the conservation of historic buildings and other cultural heritage.

Similarly, sites of natural beauty or those rich in ecological and biological resources, both within a country and internationally, could be preserved in their natural state without depriving their owners of their development rights and without paying compensation, through the concept of transferable development rights. In principle, the total land area of a country can be divided into development areas and conservation areas. Land owners in conservation areas would retain their rights, but they would not be allowed to exercise them on the site. They would instead be allowed to sell or transfer these rights to property in the development area. Since the development area is likely to be several times the conservation area, there would be a strong demand for development rights from land owners in the development area as long as these rights can be used in lieu of land in the development area (e.g., to sidestep zoning or building regulations). Thus an active market in development rights will be created through which the land owners in the conservation areas will be fully compensated for their "frozen" development rights and they will thus share in the benefits of economic development. Here it is not assumed that buyers and sellers share similar access to information but it is precisely one of the objectives of the TDRs to make information about the value, cost, and level of protection of biodiversity more transparent and to facilitate the free flow of information between the buyers and the sellers. The price that TDRs would fetch in the market would convey information about the value (marginal benefit), the supply cost (marginal cost), and the level and value of protection of habitats from which TDRs originate, thereby internalizing the costs of mismanagement to their issuers.

Thus, the TDR is a land-management device which severs the development

potential from the land and treats it as a separately marketable commodity. It is a means of providing an equitable return to property owners whose return may otherwise be lessened by regulations or restrictions of use aimed at enhancing social welfare. The transference of the development rights form the sending (conservation) area to the receiving (development) area enables the marketplace to compensate the owner of land where development is restricted in order to supply a public good (biodiversity). The buyer and holder of a TDR from a conservation area acquires the right to additional development (in the development area) beyond what non-holders are permitted. Alternatively the holder of a TDR may use it to offset other conservation obligations or environmental regulations he/she is otherwise obliged to meet.

The benefits from introducing the concept of transferable development rights are varied and substantial:

a) the critical natural habitats of a country are preserved and their species of fauna and flora protected;
b) the land owners in these areas are fully compensated; they might even become better off as a result of competition for transferable development rights, as the price of these rights would approximate the value of the land in the most developed and prosperous areas; at the same time, they would maintain some rights to the land as rural land or park land;
c) the Government would have solved the problem of conservation vs. development without the need to pay compensation and without the opposition of local land owners or environmental groups;
d) the costs of conservation and environmental improvement are widely, efficiently, and equitably distributed among the beneficiaries.

We are not aware of any tropical country applications of TDRs as a biodiversity conservation mechanism. The quotation describes a proposed application of the concept to the conservation of one of the last remaining virgin areas in the East Mediterranean. The proposal is currently under consideration and debate.

The Akamas Peninsula:
A Proposed Application of TDRs in Biodiversity Conservation

The Akamas Peninsula is 250 square kilometers and is situated in the northwest of Cyprus; it is considered to be the last virgin territory in the eastern Mediterranean. This unique area has remained almost untouched by development despite the quadrupling of the number of tourists who have visited the island in the last ten years alone.

Due to the variety of its geomorphological features and the microclimate of its individual localities, Akamas displays a large concentration of biotopes, making up a unique ecosystem. The area supports an indivisible natural resource base comprising a rich flora and fauna, beautiful beaches and landscape, and interesting historical, archeological, and cultural heritage.

The flora of Akamas includes at least twenty endemic and other rare species. About fourteen different kinds of orchids and Tulipa Cypria (a rare endemic species) are also found

in the area. Akamas also hosts the Loggerhead-Turtle (Caretta Caretta) and the Green Turtle (Chelonia Mydias), both under threat of disappearing from the Mediterranean, as well as a rare species of vulture (Griffon Vulture), a fresh water crab (Potamion Potamios), and endemic species of birds and butterflies. In addition, the area is used as a temporary stop-over by a multitude of birds when migrating from one continent to another.

The remarkably rich natural resources of Akamas are undergoing severe pressures and are threatened with degradation from a variety of sources including:

- Day visitors in the area destroying flowering plants, forests, and animal species.
- Property owners putting pressures on the government to open up the area for tourist development.
- Inhabitants in nearby villages demanding some kind of development.

The Government has responded by zoning part of the Akamas area as a non-development area, stopping short of declaring it a national park. This response has intensified the conflict. On one side, local and international environmental groups such as the Friends of Akamas and Greenpeace find this response inadequate protection for the last unspoiled part of the island and demand stricter policies and the declaration of the area as a National Park.

In the opposite camp are the inhabitants of villages surrounding Akamas, who own land in the area. They are demanding that the government provide them with roads and other infrastructure for tourist development as it has in the rest of the island. Being among the poorest people on the island, they see tourist development as their only chance for a better life; they have allied themselves with developers in lobbying the government to open the area to tourist development, and they are especially distressed because the prices of their land have dropped significantly following the government restrictions on development. Appropriation of the land by the government and compensation of land owners is out of the question because of the large amounts involved were this land to be compensated at its market value (as coastal property suitable for tourist development).

The result of these unresolved conflicts is a stalemate that neither protects biodiversity nor allows development to proceed. Akamas is neither a protected national park nor a managed tourist development zone. This uncertain situation is open to pressures for readjustments, exemptions, and relaxations that prey on nature in a silent but equally destructive way.

To resolve these development versus conservation conflicts, which are not unique to Akamas but arise throughout the island, the concept of transferable development rights has been proposed by the Enalion Environmental Management Centre (Panayotou *et al.*, 1991). The concept of transferal of development rights would ensure that areas of natural beauty be preserved in their natural state. It has been introduced in Cyprus for the first time in recent legislation for the preservation of buildings of unique cultural and historical value. It is now proposed that sites of natural beauty or those that are rich in ecological and biological resources could also be preserved through the use of this mechanism, without depriving their owners of their development rights and without paying compensation. The coastal area and, in fact, all of Cyprus could be divided into development areas and conservation areas. Land owners in conservation areas would retain their rights but they would not be allowed to exercise them on the site. They would instead be allowed to sell or transfer these rights to property in development areas, thus sharing in the benefits of development without actually developing their own land, which would remain in their hands in a natural state. It is estimated that the NPV of preservation benefits in terms of improved quality of tourism in the development areas combined with ecotourism on the conservation area would exceed the NPV forgone earnings from not developing Akamas into a mass tourism area like other parts of the island.

6. International Application of TDRs

In principle, there is no reason why TDRs cannot be used internationally to transfer development rights between countries. In one sense, the debt-for-nature swaps are a form of transfer of development rights over conservation land from developing countries to international environmental NGO's in exchange for payment of a part of the national debt (e.g., Bolivia, Costa Rica, Equator, Philippines, Poland). However, these have been *ad hoc* deals with arbitrary determinations of the value of the exchange and no sustainable long-term financing sources. To the extent that a market for debt-for-nature swaps has been created, it is a very thin one in terms of the volume traded and a costly one in terms of transaction costs. Moreover, since the rate of conversion of debt into conservation is not the result of the "free" interplay of market forces of demand and supply, there have been complaints about unfairness and ambiguity about what rights have been actually transferred and what obligations have been created. Leaving aside criticism concerning their inflationary effects and implications for the country's credit-worthiness, debt-for-nature swaps have been constrained by weak demand and reluctant supply and a general lack of financial resources to effect such conversions on a large scale. Repayment of debt that is heavily discounted in secondary markets is not generally regarded by developing countries as adequate compensation for transference of development rights over large areas of tropical forest.

Another existing TDR-type of mechanism is, in some sense, the Global Environmental Facility (GEF), which is in part a collective arrangement for the "transfer" of development rights out of critical environments in developing countries with "compensation" for the foregone development opportunities provided largely by the developed countries. However, GEF is severely constrained by its limited funding and its project-by-project approach which does not benefit from the interplay of market forces.

The recent purchase of prospecting rights in a Costa Rican tropical forest by an American pharmaceutical company and the purchases of land for conservation by Nature Conservancy approximate more closely a market-based system of internationally tradable TDRs. However such transfers, like the debt for nature swaps, have been limited by a thin demand and a thin supply. The demand has been confined to a few highly publicized cases where most of the benefits accrue in the form of publicity rather than biodiversity. The supply has been similarly constrained to a few special sites of low opportunity cost or high political benefits. When markets are thin, transactions costs are high. Markets are thin partly because of the indivisibility of the good (habitat conservation) and its public good aspects. The concept of TDRs introduces divisibility and "privatization" of the good, thereby "thickening" the market and lowering transactions cost.

7. Implementing International Tradable Development Rights (TDRs)

Tropical countries could set aside habitats for biodiversity conservation and divide each habitat into a number of TDRs, corresponding to an area unit, say, a hectare.[4] Each TDR states the location, condition, diversity, and degree of protection of the habitat and any special rights that it conveys to the buyer/holder. TDRs could then be offered for sale both locally and internationally at an initial offer price that covers fully the opportunity cost of the corresponding land unit (i.e., the net present value of the income stream of the foregone development opportunity). It is preferable to start at a relatively high price to test the market, since undervaluation is irreversible (following sale), while overvaluation is reversible (following non-sale). If the price turns out to be too high to clear the market, i.e., to exhaust the supplied TDRs for a particular habitat, the price could be lowered to attract additional demand. Alternatively, the quality of the TDR can be enhanced by enlarging the area to include additional biodiversity values or by improving its protection and management. We do not assume here that there exists in the host country an entity that can automatically ensure the protection of biodiversity. We assume, instead, that the government of the host country is prepared to transfer sufficient revenues, obtained form the sale of TDRs, to individuals and communities that own, occupy, or simply encroach on forest land to make it in their best interest to protect rather than destroy the habitat. Another part of the revenues could be used to employ management services (including those of international management firms and/or environmental organizations) to ensure and certify the effective protection of the conserved habitats as to maintain a high and rising price for TDRs. Only when the potential revenues from the sale of TDRs under efficient management exceed the "compensation" and "management" costs will there be an economic justification for the country to forego development and issue TDRs.

The free and open access status of tropical forests, even when they are legally a state property, poses certain difficulties concerning: (a) who is entitled to compensation and for how much, and (b) how is further encroachment to be prevented after TDRs have been issued. Far from being an intractable problem, open access can be "closed" using precisely the mechanism of TDRs: the current encroachers or common users can be "grandfathered" and turned into protectors of the conserved area, paid in exchange from TDR revenues deposited into trust funds in the name of the community concerned. Payments could be linked to both individual and collective performance to induce self- and peer-group enforcement.

The potential buyers of TDRs include local and international environmental organizations, local and international foundations and corporations, developed country governments, chemical and pharmaceutical companies,[5] scientific societies, universities and research institutions, even individuals in

the developed countries who are environmentally minded. The motivation for purchasing TDRs would naturally vary among prospective buyers. Some may have direct use values such as prospecting for new chemicals or pharmaceuticals. Others may be expressing their non-use values through the purchase of TDRs. Yet others might buy and hold TDRs if they expect them to rise in value as a result of decreasing supply and increasing demand due to population and income growth or change in tastes and increase in environmental awareness. Certainly every new discovery of a valuable new species, or even a new use of existing species found in a particular habitat would increase the value of the TDRs of that site.

It may be countered that if an area is already designated as a conservation area and protected against loss of biodiversity, a nature conservation organization would have no motivation to buy TDRs from land owners. The response is that designation of an area as a conservation area is provisional and contingent upon adequate demand for TDRs to compensate for the opportunity costs (potential benefits of forgone development). If demand, expressed by advanced subscription (intent of purchase), is weak, the host country has the option to cancel the issuance of TDRs and return the land to development. This would put immense pressure on nature conservation organizations and conservation-minded governments, corporations, communities, and individuals to subscribe to purchase TDRs if the habitat concerned has a significant biodiversity value. Developers, who seek low-cost offset of their environmental and conservation obligations, may also find it advantageous to buy TDRs from the tropics rather than meet stricter and more costly regulations at home. Both conservationists and developers would thus compete in the market for TDRs. The difference is that the former would buy TDRs and neutralize them, while developers would buy them and exercise them at home where their environmental impact is presumably less than at the country of origin, from a developed country or the global community perspective.

Despite the variety of increasing benefits that TDRs may confer on perspective buyers and holders, it is unlikely that there will be sufficient demand to preserve all the habitats that ecologists, or even economists, might judge worth conserving (e.g., based on contingent valuation of willingness to pay), for reasons that range from myopia to free-riding. Like charity, voluntary conservation is necessary but never sufficient. Given the public-good nature of biodiversity conservation, the government of developed countries (the main beneficiaries) could take action to stimulate the demand for TDRs (pump-priming).

There are at least two methods to enhance the demand for TDRs. One method is by providing credits or offsets against domestic regulations in exchange for purchase of TDRs from conservation areas in the tropics. The other is by introducing a conservation tax and then allowing people the option to pay this annual tax or purchase and hold TDRs from conservation areas in lieu of the tax.

8. Enhancing the Demand for TDRs through Credits or Offsets

One way by which developed countries can stimulate the demand for TDRs is by providing credits to domestic firms and property owners for the acquisition of TDRs from developing countries against domestic environmental regulations such as building codes, forest harvesting and replanting regulations, environmental emission standards, CO_2 emissions, etc. In an analogous case recently a Connecticut utility planted trees in Guatemala as a partial offset of its CO_2 emissions. To the extent that the value of these credits exceeds the cost of TDRs, there will be an active demand for TDRs that will bid up their price to the value of the credit. The level of the credit per TDR would then determine the position of the demand curve for TDRs. The criticism of this method might be that the conservation of biodiversity in the tropics has been acquired at the expense of the domestic environment. One way around this problem is to tighten the environmental regulations from current levels and then provide offset credits for holding TDRs. In such a case, the demand for TDRs originating from the south would depend on how strict development regulations are in the north. To support this demand without deterioration of environmental conditions at home, the north must introduce development regulations deliberately stricter than otherwise intended. But even without such compensatory tightening of regulations in the north, the global environment and welfare would benefit more with TDRs than without them because the trade in TDRs will bring about a better match between "endowments" and "preferences". The transaction costs may be substantial, but they are offset by the absence of transport costs which "constrain" the trade in commodities.

9. Stimulating Demand for TDRs through a Conservation Tax

A more direct method for stimulating the demand for TDRs is the introduction of a conservation tax based on income, property, or a combination of the two for the explicit purpose of financing biodiversity in the tropics. The annual revenues from the tax (T) equals the country's total willingness to pay for habitat conservation which, given the price of TDRs (P_{TDR}), indicates the desired quantity of TDRs (Q_{TDR}). Therefore:

$$T = [(P_{TDR})(Q_{TDR})] \cdot r$$

where r is the rate of interest.

Assuming a property-based conservation tax, the tax rate τ is obtained as:

$$\tau = \frac{(P_{TDR})\,(Q_{TDR})}{V} \cdot r$$

where V is the total valuation of property in the country ($V = \Sigma\, v_i$). Under

this formula the individual property owner would pay a tax $\tau \cdot v_i$ per year. In the first year his tax payment equals:

$$\tau_{V_i} = \frac{(P_{TDR})\,(Q_{TDR})}{V} \cdot r_{v_i}$$

If he chooses to continue paying the conservation tax rather than to purchase and hold a TDR, his tax payment would depend on the changes in the value of his property and/or his income depending on the base of the tax. If, on the other hand, he purchases and holds a TDR, he has no further tax obligation but he incurs an opportunity cost, that is the interest forgone on the funds used to purchase the TDR, minus (or plus) any appreciation (depreciation) of the value of TDR that he holds. Therefore, a land owner will be buying TDRs to defray his conservation tax obligation if he expects the value of his property to appreciate, the real interest rate to fall, the price of the TDR to rise, or some combination of the above. If he expects the reverse movement of these variables he would be better off selling off his TDRs and paying the annual conservation tax instead. With τ and Q_{TDR} fixed and the interest rate independent of the market for TDRs, a rise in the demand for TDRs would raise their price to reestablish equilibrium between their supply and demand.

10. Appreciation of TDRs Over Time

TDRs are nothing else but a vehicle of transformation of development values into conservation values, based on the premise that for certain resources the marginal conservation value (demand price) exceeds the marginal development value (supply price). For reasons that are analyzed in detail by Krutilla and Fisher (1985), the value of preservation benefits is likely to increase over time relative to the value of development benefits. First, the demand for environmental services including biodiversity conservation being income elastic, will increase with income growth as well as a result of population growth and increased environmental awareness. Since the supply of environmental assets is either fixed or declining, their value is likely to increase over time. In contrast, the forgone development benefits would diminish in value due to technological change and expansion of development opportunities with the growth and diversification of the economies of the host developing countries.

However, TDRs do not reflect all the environmental services and preservation values associated with conservation areas; they reflect only the global benefits from biodiversity conservation and from carbon sequestration. The rights to other services such as ecotourism, watershed protection, etc. remain with the host country, because they can be best captured locally and also because they provide a partial motivation for protection of conservation areas. Nevertheless, the growth in the value of biodiversity over time would

result in appreciation of TDRs over time as scientists, biotechnologists, and pharmaceutical companies seek access to conservation areas for research and exploration for new substances and products. The owners of TDRs as shareholders in a particular habitat will be entitled to dividends and/or earn capital gains on their TDRs which will be in great demand should one or more species in the relevant habitat prove to be highly valuable. The carbon sequestration value of biodiversity habitats such as tropical forests is also likely to rise with the predicted growth in CO_2 emissions from fossil fuel consumption.

Thus, through appreciation of the value of TDRs, the taxpayers who, in the first instance underwrite the conservation of biodiversity, would be able to recover part if not all of their conservation tax payments and in some cases enjoy a "profit" (capital gain).

A rise in the price of TDRs would be an indication of rising demand for (and value of) biodiversity conservation and would automatically generate additional revenues for the purchase of additional TDRs from tropical countries at a rising supply price. Whether appropriate sites would be available for conservation would depend on expectations and speculation about the future price of TDRs. We anticipate that the introduction of TDRs would have at least two positive effects on future supply of conservation sites:

a) more careful land management and protection to minimize damage to existing and prospective conservation areas from development activities;
b) some additional lands rich in biodiversity that qualify as "critical" habitats ecologically but not economically as yet would be set aside for speculation purposes in anticipation of higher future conservation values due to rising demand (and falling supply elsewhere). The very existence of a TDR market that assigns a value to biodiversity internalizes future conservation benefits in non-conservation areas to the extent that the rate of expected appreciation exceeds the rate of interest.

11. Conditions and Limitations of a Market Approach to Biodiversity Conservation

For TDRs to be effective as a mechanism for conserving biodiversity, the revenues from the sale of TDRs must reach the local people who either own, occupy, or encroach on the land which is to be preserved. The "compensation" of forgone benefits of development (opportunity costs of conservation) must be sufficient to alter the incentive structure decisively in favor of preservation. To avoid perverse incentives and threat-making behavior to gain compensation, the local communities and individuals in and around the preservation area must be entrusted with its protection and their rewards

must be linked to performance. An internationally reputable management firm or environmental organization must be recruited to monitor the protection of the habitat, to avoid adverse selection as a result of asymmetric information between buyers and sellers about the degree of protection afforded to the preserved habitat.

Another condition for the success of the market approach is clarity (if not homogeneity) of what is sold and bought. TDRs must explicitly describe the "property" rights that are being transferred. TDRs separate the right of development from the right of ownership: they freeze the unit of development *in situ* and transfer it to another location or country in exchange for compensation. The seller of TDRs maintains ownership of the physical asset (land), minus the transferred rights to certain types of development specified in the TDR, while the buyer acquires the right of "additional development" *ex situ*, and a specified share of any capital gains due to the discovery of new species or new uses for known species in the habitat from which the TDR originates. To ensure a continued benefit from the protection of biodiversity and hence a sustained interest in its protection, the issuing country should reserve for itself (or for the land owners) a share of the profits from any scientific discoveries associated with the preserved habitat. The respective shares of the seller and buyer should be clearly specified on the TDR certificate.

It should be clear by now that unlike the case of TDRs for the conservation of buildings, which are individually transferred, TDRs for habitat conservation have both private and public components. While they are also individually transferred, their value depends on the management and protection of the entire habitat of which they are a part. Therefore it is only entities with control over the entire habitat that can issue and trade TDRs. Such entities include, but are not limited to, government, communities, tribes, non-governmental organizations, and corporations. However, like other market transactions, TDRs require a basic legal framework and sanctioning by the state.

Inevitably, a market approach in general, and TDRs in particular, have their limitations as mechanisms for conserving biodiversity, as do other approaches and mechanisms. The market approach assumes that the host country governments are interested in maximizing national welfare and see TDRs as a mechanism for trading development for conservation rather than as a surrender of property rights or sovereignty. That sovereignty is not compromised can easily be seen from the fact that even private institutions, analogous to the National Conservancy in the United States, can purchase land for conservation and issue TDRs, tradable internationally, to finance the purchase. Perhaps the greatest limitation of the approach is that only habitats with rich biodiversity, high endemism, and low opportunity cost would be conserved through the market unless the TDRs are valued and demanded not only for biodiversity, but also for carbon sequestration, or governments engaged in pump-priming the market through offsets and credits.

12. Concluding Remarks

The proposed scheme of internationally transferable development rights differs from other related proposals such as the patent system for genetic resources (Sedjo, 1988) and the system of tradable forest protection and management obligations (Sedjo, 1991), in that it explicitly aims to reconcile the conservation of biodiversity and economic development. Another difference is that TDRs could be issued unilaterally and transferred bilaterally without the need for an international convention on biodiversity or on tropical forests. Except for a minimum level of legislation to establish the TDRs and some pump-priming to stimulate their demand, the system relies on the market to determine their value and to achieve the optimal level of biodiversity conservation. Of course, there remain many aspects to be tackled, such as the level of protection of habitats, the content of rights attached to TDRs (e.g., right of access, dividends from discoveries, etc.). Politically it is likely to be more acceptable to developing countries in that it establishes a symmetry between the biodiversity conservation and its development opportunity costs.

Notes

[1] A "non-critical" habitat is here loosely defined as an area which is not critical directly or indirectly to the survival of valuable or potentially valuable species.

[2] This seems to imply that TDRs can work only if there are legally enforced restrictions on land-use in the non-conservation area, a strong assumption for a developing country. However, since here TDRs are proposed for global use, it is the developed countries which have the required enforcement capability.

[3] The reverse is often true in the case of urban development, but since development areas are many times larger than the conservation areas, the ratio of exchange can be set at a level which makes the purchase of TDRs less costly than the purchase of additional land.

[4] TDRs should always be issued by the host country, even if the country is poor and undeveloped. Issuing TDRs is no different than deciding to participate in international trade or to follow export-orientated industrialization. Advice and technical assistance could be sought from developed countries and the global development and environmental institutions, but the ultimate decision should be that of the sovereign state or of the institutions that have secure, exclusive, and transferable prerty rights over the area concerned.

[5] A reviewer has raised the issue of the potential risk that "once a company owns a gene . . . it may be tempted to annihilate the living source of the gene in order to exercise a monopolistic advantage." If there is such risk, it is much lower with TDRs than under the current system of open access and indiscriminate destruction of habitats. Since TDRs aim to protect habitats, they do not surrender the sovereign powers of the host state, and are held by a larger number of people around the world, it is difficult to see how a single company will be able to acquire exclusive control over species or genes and exercise control.

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