Economic instruments for biodiversity conservation

par

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Summary

Biodiversity loss has become a global concern. We now realise that biodiversity directly affects our well-being, providing various services (esthetical values, goods, fibres, spiritual, regulation of climate, of illnesses, of air and water quality, protection against erosion, etc.). However, biodiversity is now eroding at an alarming rate and habitat loss/conversion, climate change, nutrient loading, surexploitation, and invasive species have been identified as the main causes of this increasingly rapid biodiversity loss.

One reason why biodiversity loss is still widespread is that markets generally fail to incorporate the total value associated to biodiversity (especially non-market values), which generates externalities and lead to what is known as market distortions. This will often lead to unsustainable practices and discourage long term investments favouring natural resources conservation. With the internalisation of all externalities, the market can achieve its role and allocate resources efficiently. This can be done using economic instruments.

Among the economic tools that can be used in biodiversity-related issues there is establishing property rights, market creation and enhancement, charges, fiscal instruments, financial assistance, liability systems and environmental funds. Economic instruments have the potential to induce changes in behaviour in a cost-effective manner, they are also flexible tools that are recognized to increase the efficiency of environmental management, they generate financial resources, create incentives for investments, and stimulate private agents to engage in environmental protection.

Although economic instruments can be effective and flexible mechanisms, strong limitations have been identified for their application in developing countries. Among these constraints there are problems linked to the difficulty of valuing biodiversity,

institutional constraints, lack of inclusion of local communities, ideological resistance, administrative complexity and limited application in the context of threatened species. Although transfer of technological and financial support could help to resolve some institutional problems, other problems such as corruption can be much more difficult to address. The challenge is thus to develop an integrated strategy that includes short-term direct conservation actions with longer term strategies oriented toward sustainable development.

If one takes a look at the specific case of the north-eastern Brazilian Atlantic forest, biodiversity conservation represents a major challenge. Effectively, the original cover has been reduced to 2% due to forest conversion for sugarcane production and forest lies on the private lands of sugarcane companies. Protection of biodiversity and associated ecosystem services thus require commitment of commodity producers, as well as direct investments in conservation. Economical instruments can be used to incite private companies to engage in conservation activities. Examples of how economic instruments could be used include environmental certification and eco-labelling of companies engaging in conservation projects, charge schemes such as pesticide and fertilizer charges, tax deductions offered to companies that engage into reforestation or conservation activities, etc.

Although application of economic tools can be strongly limited by institutional factors, they have a strong potential to stimulate conservation actions. Perhaps, economic instruments must thus be implemented as part of a global strategy that will include both short-term direct actions and longer term initiatives. This would include educational programs, economic instruments, and direct payments into a comprehensive strategy we would also work at reinforcing institutional frameworks.

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Glossary

Sustainable development:	development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
Biodiversity:	the variability among living organisms from all sources and the ecological complexes of which they are part.
Conservation easements:	voluntary agreements that allow landowners to permanently protect a piece of their land.
Carrying capacity:	the maximum number of individuals of any species that can be supported by a particular ecosystem on a long-term basis.
Bioprospection:	identify genetic resources that may be used to develop products of commercial value.
Bounties:	A reward, inducement, or payment, especially one given by a government for acts deemed beneficial to the state, such as killing predatory animals, growing certain crops, starting certain industries, or enlisting for military service.

Signs, abbreviations and acronyms list

ARPA : *Programa Áreas Protegidas e Apoio ao Arpa* (Amazônia) (Amazon Protected Areas)

BPE : Best Practices in Ecotourism Program. Also known as MPE (*Programa Melhores Práticas para o Ecoturismo*)

CABI : *Capitania del Alto e Bajo Izozag* (indigenous organisation representing the Guaranì-Izoceños)

CBD : Convention on Biological Diversity

CBO : Community-based Organisation

CDM : Clean Development Mechanism

CER : Certified Emission Reductions

CI : Conservation International

CRMB : Coastal Resource Management Board (Philippines)

CTA-ZM : Centro de tecnologias alternativas da zona de Mata de Minais Gerais

FUNBIO : Brazilian Biodiversity Fund – *Fundo brasileiro para a biodiversidade*

GEF : Global Environment Facility

GMO : Genetically-modified organisms

ICMS : *Imposto sobre circulação de mercadorias e prestação de serviços* (tax on the circulation of goods and services)

IFC : International Finance Corporation

ITQ : Individual Transferable Quotas

ITR : *Imposto territorial rural* (Rural Land tax)

IUCN : World Conservation Union
MEA: Millenium Ecosystem Assessment

NGO : Non-governmental Organisation

OECD: Organisation for Economic Co-operation and Development

PACT: Protected Areas Conservation Trust (Belize)

PAPS : Programa de Apoio à Produção Sustentável (Sustainable Production Support Program)

PEFC : Programme for the Endorsement of Forest Certification

PICUS : *Programa Integrado de Conservação e uso sustentável da Biodiversidade* (Integrated Program of Conservation & Sustainable Use of Biodiversity)

RPPN : Reservas particulares do patrimonio natural

SCBD: Secretariat of the Convention on Biological Diversity

SGP : Small Grants Program

SNUC : *Sistema Nacional de Unidades de Conservação*

TDR : Tradable Development Rights

TEV : Total Economic Value

UNDP : United Nations Development Programme

UNEP : United Nations Environment Programme

UNFCCC: United Nations Framework Convention on Climate Change

WWF: World Wildlife Fund

Introduction

Nowadays, we are assisting to an evolution in the environmental awareness of governments and companies. From a reactive strategy in response to environmental crisis, we are moving toward a sustainable development vision[1]. However, biodiversity still continues to be depleted at an alarming rate. This illustrates problems in development strategies at the world level. Effectively, world population is growing at an exponential rate (Anton, 1995). To sustain the needs of this growing population, development strategies often lead to environmental degradation at the local and global levels, which in turn results in a continued rapid biodiversity loss. Not only are we eroding our natural capital, but these strategies are not even socially beneficial, and we are assisting to an increase in disparities between rich and poor social classes (Balmford *et al*., 2002). Awareness is increasing, but development strategies still largely fail to protect biodiversity and are not on tract to meet the United Nations' goals for human development and poverty eradication by 2015 (Balmford *et al*., 2002).

More precisely, biodiversity conservation has become a global preoccupation. Biodiversity can be defined as "the variability among living organisms from all sources… and the ecological complexes of which they are part" (CBD, 1992). It concerns not only the diversity of species but also diversity at the genomic and ecosystemic levels (CBD, 1992). Preserving biodiversity is thus a multidimensional issue and no level of diversity can be neglected. The loss of any one component of biodiversity thus implies much more than a loss of a direct function because of the interconnectedness of all levels. The loss of a single species may thus impact the whole ecosystem. If in 1992 the United Nations decided to create a Convention on Biological Diversity, it was because they were starting to realize that biodiversity loss has the potential to directly affect our well-being and that of future generations (SCBD, 2005). This Convention was thus created to achieve three specific

[1] Sustainable development is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations, 1987).

objectives: conserve biological diversity, promote a sustainable use of its constituents and allow fair and equitable sharing of the benefits related to the utilization of genetic resources (SCBD, 2005). Since then, the awareness has well evolved. In 2001, the secretary general of the United Nations, Kofi Annan, inaugurated a vast initiative, the « Millenium Ecosystem Assessment » (MEA, 2005). This program had the objective to update our knowledge concerning ecosystem changes and their impacts on our well-being and to determine action options in response to these changes. Completed in March 2005, this study involved more than 1300 scientists from more than 95 countries and provides detailed information on the actual state of knowledge, which can serve to both decision-makers and the public (MEA, 2005). Preoccupations are real; from local issues of local pollution events, we now realize that the scope of our actions far exceeds the local level and that it can affects the whole planet. Biodiversity loss is thus a global issue on which the whole international community must work.

Effectively, in its report, the MEA estimated that the species extinction rate is now 100 to 1000 times higher than the rate observed from fossil records. If the actual tendency is maintained, this could well increase by an order of magnitude, which would correspond to an extinction rate varying between 1000 and 10 000 the fossil records rate (MEA, 2005). In light of these results, it is appropriate to ask ourselves about the importance of biodiversity for our well-being. In fact, benefits from biodiversity far exceed simple material goods. Effectively, in addition to provide food, fibers and drinkable water, biodiversity provides regulation services (regulation of climate, of illnesses, of air and water quality, protection against erosion etc.), cultural services (religious and spiritual values, educational values, inspiration, recreation, esthetical values, etc.) and support services (soil creation, photosynthesis, primary production, nutrient and water cycling, etc.) (MEA, 2005). In order to incorporate the total value of biodiversity, we must considerate both use and non-use values. Extraction of primary resources or recreative activities can be considered as direct use values, while ecosystem services represent indirect use values. Still concerning use values, we also find the category of option value, which represent the preservation of a

resource for a future personal use. If these values are easier to be determined, and thus to be reflected in the market prices, non-use values represent a more ethical category of values, which are often more difficult to be seized or translated in economic terms. It includes certain components of biodiversity that we wish to preserve for future generations (bequest values) or others such as the Panda bear, the Blue Whale or the Dugong, that we may never have the chance to see, but for which we feel satisfaction to know that they exist (existence value) (MEA, 2005). Existence values often refer to cultural, religious or spiritual perceptions of nature (OECD, 1999).

At the global level, five main direct causes to biodiversity loss have been identified (MEA, 2005). Actually, habitat loss and degradation is considered to be the greatest threat to biodiversity. Effectively, world population is constantly growing which consequently exert strong pressures on ecosystems. Forest conversion for agricultural purposes, deforestation, urban expansion and landscape fragmentation are all examples of these pressures. Moreover, surexploitation is another vector directly affecting biodiversity. More specifically, overfishing is the most important surexploitation form, with an estimation of about one-fourth of world's fisheries being overexploited and half being exploited at their maximal capacity. In addition, as a result of the expansion of world trade and transportation systems, exotic species are causing more and more damages to the ecosystems. Effectively, in the absence of natural predators, and with their aggressiveness and rapid dissemination abilities, exotic invasive species are able to quickly colonize ecosystems displacing native species and eventually causing biodiversity declines (MEA, 2005). In Canada, it is estimated that the costs associated with exotic invasive species reach billions of dollars per year (Maxwell *et al*., 2002). Moreover, anthropogenic nutrient loading (nitrogen, phosphorus, sulfur and other nutrient-associated pollutants) is another direct vector of ecosystem change in terrestrial, freshwater and costal ecosystems (MEA, 2005). Aerial deposition of reactive (biologically available) nitrogen and phosphorous accumulation directly lead to diminutions in plant diversity and can cause algal blooms and lead to eutrophisation. Finally, climate change could well become the most important driver for biodiversity loss in the future. Effectively,

the exact impacts of climate changes are still difficult to predict, but they will certainly be major, mostly on species with limited distribution area, endangered species, species requiring large territories for their survival, and alpine species. Moreover, coastal ecosystems could be strongly affected by the elevation of water levels (expected to reach 10 to 88 cm) and by the temperature elevation. For example, corals are very sensitive to temperature variation. A temperature increase of one degree Celcius or more would be sufficient to cause massive coral bleaching (MEA, 2005).

Biodiversity thus represents goods and services that contribute to our well-being, some that can be privately owned some others that remain as public goods. This intrinsic complexity of biological diversity and the variety of pressures to which it is exposed often makes it hard to find one unique solution for its conservation. There is actually a growing understanding that economic instruments can be used as a way to increase the efficiency and cost-effectiveness of environmental management and biodiversity conservation projects (UNEP, 2004). The objective of this essay is to describe economic instruments and to explain why they offer a good potential in biodiversity-related issues. Examples of their application in Brazil will be given throughout their description, with a special emphasis on the Atlantic forest, where possible. This will be followed by a critical analysis on their role and potential application in the context of global biodiversity conservation.

1. The economical science in biodiversity issues – a concept review

It is generally widely recognised that one reason why biodiversity loss is still widespread, is that its adequate valuation is difficult (Ferraro & Kiss, 2003; OECD, 2005). Effectively, markets generally fail to incorporate the total value associated to biodiversity (especially non-market values), which lead to what is known as market distortions (OECD, 2005). This will often lead to unsustainable practices and discourage long term investments favouring natural resources conservation. In fact, non-sustainable activities that lead to ecosystem destruction or degradation are often more profitable at the short term than more sustainable practices (OECD, 2005). However, at the long term, economic benefits of protecting biodiversity may far exceed short term benefits (Balmford *et al*., 2002). In a study of Balmford and his colleagues (2002) on the total economic value (TEV) of biodiversity, the authors estimated that the overall benefit to cost ratio of an effective global program for the conservation of remaining wild nature would be at least 100:1. Without proper valuation of biodiversity, when comparing two alternatives land use, non-sustainable or less sustainable land uses may be favoured over conservation (OECD, 2003). For example, forest conversion to agriculture purposes will be estimated to have a greater economic value than forest preservation, which may not necessarily be the case. The more the economic values of biodiversity remain unseized by markets, the more land use changes prejudicial to biological diversity have chances to be justified (OECD, 2003). This implies that non-market values of biodiversity will not only need to be measured but they will need to be seized through a mechanism that will allow their conversion in financial fluxes or fluxes of resources (OECD, 2003). Market creation and economic incentives thus constitute interesting options for efficient monetary comparisons between sustainable use of an ecosystem and its destruction for an intensive exploitation activity.

The objective of the economical science is to manage scarcity; individuals' desires and needs are infinite but production factors/resources are limited (OECD, 2004). Another problem associated with biodiversity conservation is that economic policies are based on the notion that it is scarcity that gives economic value (OECD, 2004). The complexity and interconnectedness of the components of biodiversity makes it harder to perceive scarcity. For example, the loss of one species may not seem to be very problematic but as species are interacting within ecosystems, the loss of one species can induce modifications that will ultimately affect the whole ecosystem functioning. This difficulty in identifying scarcity related to biodiversity complexity can also explain why markets for biodiversity goods and services generally do not appear by themselves and will need to be implemented by government policies (OECD, 2004). In fact, this represents a market failure (Lescuyer, 2005). The impacts of biodiversity loss are not properly represented in the markets; externalities are not taken into account, i.e. are not internalised. Negative externalities represent negative impacts resulting from market transactions that affect economic agents (i.e. consumers or producers) that did not necessarily take part of the market transaction and that do not receive any compensation from this loss of well-being (Lescuyer, 2005). For example, species losses will degrade certain ecological functions, i.e. generate a negative external effect for certain human populations which will not receive any monetary compensation for this degradation of their land (Lescuyer, 2005). Often, environmental damages related to consumption and/or production of certain goods or services are not represented in the market prices (Tacheix, 2005). Economic agents always seek to maximise their benefits. If the environmental costs are not reflected in the market prices, an industry will have no incentive to invest in a more efficient technology or to adopt more environmentally-friendly strategy. This gratuity of environmental goods and services thus contribute to distort choices of production factors toward technologies that will use more environmental capital. Internalisation of externalities consists in finding ways for the decision-makers to take into account the external costs associated with their activities. With the internalisation of all externalities, the market can achieve its role and allocate resources efficiently. This can be done using economic instruments (OECD, 2004).

2. Economic instruments

Economic instruments are defined by the UNEP (2004) as tools that affect estimates of costs and benefits of alternative actions open to economic agents. The advantages of using economic instruments in biodiversity-related issues is that they have the potential to induce changes in behaviour in a cost-effective manner, they are also flexible tools that are recognized to increase the efficiency of environmental management, they also generate financial ressources, create incentives for investments, and stimulate private agents to engage in environmental protection (UNEP, 2004). In addition to their economical efficiency and flexibility, economic instruments allow internalisation of external effects (i.e. externalities) and represent incentives for technological changes (Klarer *et al*., 1999).

The United Nations Environmental Program (UNEP, 2004), has identified seven economic tools that can be used in biodiversity-related issues: property rights, market creation and enhancement, charges, fiscal instruments, financial assistance, liabilty systems and environmental funds. Each of them will now be described in details.

2.1 Property rights

Property rights can be established on land (e.g. a forest) or specific elements of biodiversity (e.g. a breeding couple of endangered birds). It is well established that complete, exclusive, enforced and transferable property rights is an essential prerequisite for the efficient management of natural resources (SCBD, 2001). In fact, it is estimated to be one of the first steps in improving patterns of ressources use (UNEP, 2004). Incomplete or absent property rights result in a lack of private incentives to invest in conservation and sustainable use as these practices constitute initial investments that cannot be secured in the long term in the

absence of ownership (SCBD, 2001). This is for example the case when biodiversity values take the form of public goods. Under this scenario an industry has little incentive to limit the quantity of effluents it rejects for the benefits it would produce to the residents downstream, as it would not receive any monetary compensation (Tacheix, 2005). On the other hand, privately owned forests may be highly dependent upon the attitude and values of its owner and changes in ownership may affect drastically the fate of the remnants (SCBD, 2001). This can be solved through mechanisms of payments for ecosystem services. For example, the Costa Rican government recognizes the value of forests as carbon sinks, as providing hydrological services, as protecting biodiversity and as having a scenic value. It has also established a financing mechanism and a regulation system to compensate forest owners for the ecosystem services they contribute to maintain (SCBD, 2001). However, while it is necessary to establish property rights for an efficient management, it may not always guarantee an adequate level of habitat protection. In 1959, Ronald Coase stated that well-defined property rights allow optimal allocation of resources (Raharinirina, 2005). This theorem, known as the Coase Theorem, is now an important basis for most modern economic analyses (Raharinirina, 2005). However, one of the conditions to this theorem is that transaction costs (ex: to evaluate the value of benefits or the value of compensations) must be limited, which is rarely the case when dealing with global issues such as biodiversity conservation (Harou & Stenger, 2005). In addition, one problem when dealing with biodiversity issues is that the number of involved agents is often too important to ensure optimal resource allocation; that is, it may be difficult to identify owners or to distribute property rights in an equitable manner. As a result, establishing well-defined property rights is a critical basic step for biodiversity conservation (SCBD, 2001), perhaps it must be followed by other strategies to develop economic alternatives (SCBD, 2001). Property rights can also come from environmental measures such as conservation easements or communal property rights (UNEP, 2004).

2.1.1 Conservation easements

Conservation easements are voluntary agreements that allow landowners to permanently protect a piece of their land (Nature Conservancy, 2006). The easement represents a legally binding agreement that will permanently restrict the type and amount of development for the current and subsequent owners (Nature Conservancy, 2006). In addition, it can also include obligations to carry out certain specific management practices (UNEP, 2004). Conservation easements are enforced by land trusts that are responsible of monitoring and applying restrictions (UNEP, 2004). Conservation easements are generally promoted through fiscal instruments such as tax deductions or exemptions (UNEP, 2004).

In Brazil, voluntary conservation easements are multiplying in the private sector, generally in the form of private natural heritage reserves (RPPNs) that apply for Rural Land tax exemption (see section 3.4 on fiscal instruments) (Young, 2005). Although RRPNs can play an important role in conserving biodiversity, they still represent a very small proportion of protected areas as a whole. Moreover, as they are voluntary actions, they depend on the good will of landowners and may fail to address particular regional conservation priorities (Young, 2005).

2.1.2 Communal property rights

Communal property rights operate as common property inside and as private property outside the social group (UNEP, 2004). It is a form of land right that limits access to public land and establish a management system for a given natural resource or area to be respected by all community users (UNEP, 2004). Not only does it promote community involvement in biodiversity conservation, but it can also contribute to safeguard traditional livelihoods & culture, improve food availability & nutrition, etc. (The World Ressources, 2005). This form of land rights can be particularly interesting to secure rights of indigenous communities. For example, in the 1990s, negociations between Bolivia's government and an indigenous

organization representing the Guaranì-Izoceños (the Capitania del Alto y Bajo Izozog (CABI)) resulted in the creation of national park with 1.5 million hectares of adjacent land designed as a communally-owned indigenous territory for the Guaranì-Izoceño (The World Resources, 2005). In addition to gain the exclusive rights to exploit their territory, this was a major step in preserving livelihoods and food security (The World Resources, 2005).

Indigenous territories occupy more than one million acres in the Brazilian Amazon, which represents about 21% of the Amazonian forest (Schwartzman & Zimmerman, 2005). These territories are distributed in 400 legally recognized reserves which encompass a wider range of ecosystems than all other types of protected areas combined. The future of Amazonian reserves is thus of a major importance since indigenous lands and protected areas act as one of the most important barrier against forest fires and forest logging expansion along the deforestation arc. If establishing property rights is an essential element to sustainable management of natural resources, it does not necessarily prevent resource overexploitation. This implies that indigenous peoples will necessitate new institutions to properly manage their natural resources (Schwartzman & Zimmerman, 2005). Effectively, political and sociological changes within indigenous communities can lead to increased pressures on natural resources and to a gradual loss of traditional knowledge. Perhaps, with adequate support they can control access to their territories and negotiate with the other social and economical actors at the local scale. The challenge is thus to develop long term investment strategies and economic alternatives allowing to remunerate indigenous people for the ecosystem services they contribute to maintain. Alliances with conservationists must also be stimulated to help to develop territorial control strategies and economic alternatives (Schwartzman & Zimmerman, 2005).

2.2 Market creation and market enhancement

Market creation, even if not necessarily the least costly method, offers more flexibility than the other economic instruments (OECD, 2004). In fact, the general objective is to create the institutional framework for a better coordination of the transactions between those who supply and those who demand biodiversity-related products or services (OECD, 2004). Moreover, according to the OECD, market creation is an effective strategy because it is often the most direct way to address the problem of biodiversity loss (OECD, 2004). Biological agriculture, sustainable forestry, non-timber forest products and genetic resources markets have been identified as particularly promising (OECD, 2003).

Markets can be created or enhanced in order for the value of products and services of biodiversity to be better captured (UNEP, 2004). Market enhancement can be done by increasing incentives offered to producers whose activities promote biodiversity conservation. Examples of new markets or market enhancement include carbon sequestration offsets, tradable development rights, tradable quota system, eco-labelling and certification, and bioprospection (UNEP).

2.2.1 Tradable quotas

Tradable quotas can be used to directly target the protection of one species or one natural resource (e.g. fisheries) or can be used to regulate something that will indirectly affect biodiversity (e.g. tradable quota system for greenhouse gases).

It has been established that climate changes will have an impact on ecosystems as well as on species (especially alpine species and those requiring large territories for their survival) (MEA, 2005). A system of emissions trading (or carbon sequestration offsets) has been proposed by the Kyoto protocol as a mechanism to reduce greenhouse gases emissions

(UNFCCC, 1998). This system of tradable quotas targets climate changes but will indirectly impact biodiversity. For example, this mechanism could encourage landholders to maintain forest cover or to reforest land by providing a market that allows them to be compensated for the opportunity cost of conservation (UNEP, 2004). Forests are considered as carbon sinks and can plan an important role in mitigating CO_2 emissions (Backéus *et al*., 2005). As a result, landholders, by providing a guarantee to maintain natural vegetation or to reforest land, can guarantee to maintain a certain level of carbon sequestration and this can be sold to investors interested in offsetting their emissions (UNEP, 2004). In addition to the emissions trading system, the Kyoto Protocol proposes another mechanism for countries to fulfill their reduction commitments which is the Clean Development Mechanism (CDM) (UNFCCC, 1998). Under the CDM, industrialized countries (known as Annex-I parties) have the opportunity to implement projects that will reduce emissions of greenhouse gases in developing countries (Non-Annex I Parties), in return for Certified Emission Reductions (CERs) (UNFCCC, 1998). Annex-I countries can thus participate in afforestation and reforestation projects in non-Annex I countries (e.g. Brazil); activities that can contribute to biodiversity conservation (Olschewski *et al*., 2005). Under the CDM, land use, land-use change and forestry activities subjected to earn CERs are limited to afforestation and reforestation activities (Jung, 2005). This represents a major limitation to its application in Brazil where the most important source of greenhouse gas emissions comes from forest conversion to agriculture (mainly in the Amazonian region) (Young, 2005). The Brazilian government agreed on the rule limiting eligibility for CERs to afforestation and reforestation activities, rendering ineligible projects that avoid deforestation. Carbon markets were expected to represent a major potential source of funding for conservation projects, but under this rule, resources that can be obtained under the Kyoto Protocol are limited (Young, 2005).

Moreover, tradable quotas can be applied to a number of areas directly related to biodiversity. One well-known example concerns fisheries (UNEP, 2004). Traditionally, input controls (net mesh size, vessel size restrictions, fishing day restrictions, etc.) were used to manage fisheries (Gibbs, in-press). Although relatively cheap and easy to implement,

input control has not succeed in properly managing world fisheries (MEA, 2005). As mentioned earlier actually one-fourth of fisheries are being overexploited (Gibbs, in-press). In order to address the issue of overexploitation, individual transferable quotas (ITQs) have been distributed as a way to create clear property rights that would limit the open access regime (OECD, 2003). Fisheries managers have determined the carrying capacity[2] of the fishery and have distributed individual quotas to fishers accordingly (the sum of the ITQs does not exceed the carrying capacity of the ecosystem) (UNEP, 2004). Quotas are tradable so that individuals who wish to diminish their fishing effort can sell their quotas to individuals who wish to increase their production rate or to enter the market. Prices of the quota are determined by the market (UNEP, 2004). In certain ecosystems such as marine ecosystems, carrying capacity may be difficult to determine as it requires detailed information on energy transfers between trophic levels, on primary and secondary production, etc. (Schwartz., 2005). However, tradable quotas is a flexible and efficient mechanism that allows to determine directly the total catch (excluding illegal fishing). Management strategies focussing on input controls have the potential to influence the fishing effort by imposing regulations on the vessel size or on net mesh size, but have no direct control on the total harvest output (Gibbs, in-press). Tradable quotas are also more flexible because managers can decide to increase or decrease the number of available quotas, which is much easier than to change regulations (Webster, 2005).

2.2.2 Tradable development rights (TDRs)

Similarly, tradable development rights can be established. The tradable development right system differs from strict zonation in that it offers the possibility for people living in conservation areas to be compensated for the fact that they cannot develop their land (Chomitz, 1999). In fact, development rights or credits can be attributed to people living in conservation areas (where development is prohibited) equivalent to the number of hectares

[2] Carrying capacity is defined as the maximum number of individuals of any species that can be supported by a particular ecosystem on a long-term basis (Cunningham *et al*., 2003).

they own that are under protection (UNEP, 2004). On the other hand, these development credits can be purchased by landowners willing to develop but that need to comply with regulations on legal reserve requirements (UNEP, 2004). This offers a monetary compensation to landowners of areas reserved for conservation, while allowing landowners to comply with protected areas requirements legislations (Chomitz, 1999).

Tradable development rights have not been widely used in Brazil (Young, 2005). However, recently, local legislations in the states of Mato Grosso and Paraná have been modified to allow trading in forest set asides. The Brazilian Forest Code of 1965 indicates a minimum percentage of private properties (larger than 50 hectares) that must be maintained under natural forest cover. Percentages vary in function of the biomes. In the Atlantic forest biome, 20% must be set aside as forest reserves. It is now possible for landowners with inadequate forest coverage to acquire protected forest elsewhere to comply with legislation requirements (Young, 2005). Legal reserve property owners given development rights can thus sell their rights to developers, as long as they are located in the same ecosystem and that they preserve forest of equal or greater ecological value (Chomitz, 1999). In addition to its flexibility, the TDRs system has several advantages over the old legislation. First of all, reserve creation can be concentrated in regions of higher biological diversity and endemism. In addition, one of the greatest ecological advantages of allowing this increased flexibility is that the old legislation tended to lead to fragmentation. By acquiring development rights from reserve landowners, the size of the reserves can be increased. Moreover, reserve management is effectuated by the reserve owner which offers a considerable advantage for the buyer willing to earn development credits over buying forested land elsewhere for which it will be responsible for its conservation (Chomitz, 1999).

2.2.3 Eco-labelling and environmental certification

One of the reasons why markets generally fail to incorporate the values of biodiversity is the lack of information. Ways to remediate to this situation include eco-labelling and

environmental certification. These strategies are based on the principle that if information on environmental consequences linked to the inputs, to the products or to the production factors are available, behaviours (i.e. the consumer's choice) can be modified. These strategies have gained considerable attention from the private sector and are now often voluntary processes (UNEP, 2004). They enable consumers to differentiate between production techniques, product qualities or producing organization (UNEP, 2004). Because determining the environmental impacts of good production may be a difficult task, eco-labelling and environmental certification can help making trade and environmental protection being mutually supportive (Engel, 2004). Effectively, unlike appearance, flavour or durability, that are generally revealed, environmental attributes may never be perceived (Hamilton & Zilberman, in-press). Examples of environmental certification include timber certification systems such as those used by Canada, Indonesia, Brazil, Costa Rica, and groups of Nordic and African countries. The European Union has also introduced a labelling system to identify GMOs. These systems allow the consumer to be better informed and thus to better express its preferences for product attributes such as recycled, biodegradable, sustainable, or non-toxic (Hamilton & Zilberman, in-press). In addition, it allows internalisation of the environmental costs related to unsound production (Engel, 2004). Consumers are more and more aware of the importance of preserving the environment, and consequently biodiversity. In United States, green products represent 9% of new products. This apparent willingness to pay for environmentally-friendly products has been traduced, for example, by the development of markets for products such as dolphin-safe tuna and organic food (O'Brien & Teisl, 2004). Eco-labelling and environmental certification are strategies designed to reward producers that integrate environmental considerations into production and this is possible because consumers may be willing to pay important price premiums for environmentally certified products or products with environmental attributes (UNEP, 2004 ; Hamilton & Zilberman, in-press).

In 2005, Brazil's national certification system for sustainable forest management was endorsed through the Programme for the Endorsement of Forest Certification (PEFC)

Council (PEFC, 2006). They thus have their own national certification system proving that timber comes from sustainable forest management practices that respect social, ecological and economical functions of forests (PEFC, 2006). Certification of forest products is an incentive that has a great potential for forest conservation (Young, 2005).

2.2.4 Bioprospection

Bioprospection is another economical instrument that has been identified as having the potential to contribute to biodiversity conservation (UNEP, 2004). Bioprospection's goal is to "identify genetic resources that may be used to develop products of commercial value » (UNEP, 2004). The Convention on Biological Diversity recognizes countries sovereignty over their biological resources (thus including genetic resources), giving the responsibility of regulating access to genetic resources and legislation implementation to the countries' governments (Raharinirina, 2005). Bioprospectors conduct scientific research to find genetic resources that will have an application in the pharmaceutical industry, horticulture, cosmetics industry, botany, or agriculture (UNEP, 2004). In addition, bioprospection include collecting indigenous knowledge that can help to identify new genetic or biochemical resources (Dutfield, 2002). Prior to the CBD, genetic resources were considered as a common heritage of humankind and industrialized countries could benefit from this free access to effectuate bioprospecting activities without any restrictions (Raharinirina, 2005). Giving property rights to countries over their genetic resources is seen as an opportunity for developing countries to exploit their genetic resources, to receive adequate economic returns that will benefit to local communities and to maintain the objective of conservation and sustainable use (Raharinirina, 2005). Following the Coase's Theorem on property rights, establishing clear property rights is supposed to lead to an optimal allocation of resources and to equitable benefit-sharing. In fact, bioprospection agreements unfortunately do not necessarily lead to the economic and environmental sustainability promoted by the CBD (Raharinirina, 2005). A few factors can explain why bioprospection often fails to meet goals of biodiversity conservation and equitable sharing of benefits. First of all, the principle of equitable sharing

of benefits is rarely respected by bioprospectors because no strict scheme of application of bioprospecting agreements is imposed by the CBD. Moreover, pharmaceutical industries are in low numbers and can choose from a variety of potential developing countries to provide inputs. Developing countries are thus competing with each other because they do not succeed to cooperate to improve the genetic resources market (Raharinirina, 2005). In addition, bioprospecting companies deny the fact that important economical benefits are generated from this activity. Effectively, as they have to evaluate various potential species to find a single active principle, economical repercussions are not stable and secured. In addition, short term local development preoccupations will often compete with environmental preoccupations. Benefits from genetic resources exploitation may thus often be directed to meet short term needs rather than being directed to conservation (Raharinirina, 2005).

To conclude this section on market for biodiversity, while some products or services can be marketed such as genetic resources, marketing biodiversity generally remains a complex task, primarily because products and services resulting from biodiversity generally exhibit characteristics of public goods (OECD, 2003). For example, someone's use (direct or indirect) of a biodiversity-related good or service will often not limit its use by others. Public characteristics of biodiversity goods and services create a market failure which limits their easy transaction in markets. As a result, prices generally do not reflect the totality of the value society attributes to biodiversity (OECD, 2003). In the case of a pure public good or service (e.g. existence of a species, aesthetic value of nature, etc.), for which developing or enhancing markets may be difficult, the solution could be to couple this non-marketable good or service with another biodiversity-related product that is more easily marketable. In doing so, pure public goods conservation can be achieved without needing to rely on direct governmental or private financing (OECD, 2003).

2.3 Charges

In areas capable of supporting a certain level of exploitation and frequentation, users can be charged for ecosystem services and/or products (UNEP, 2004). Charge systems are interesting ways to promote natural resources conservation and market creation while providing financial revenues for resources management and protection. Various charge schemes can be used depending on the nature of the area where conservation can be achieved. Perhaps, as they imply a certain level of utilisation, their applicability is quite limited in areas requiring strict conservation. Charges are widely applied in protected areas such as national parks. They include entrance fees, concession payments for tourism, and hunting and fishing fees (UNEP, 2004). Concessions generally work on the basis that a private operator will be allowed to conduct and operate tourism facilities within a national park in return for concession payments (Fearnhead, 2003). Concession agreements will generally be associated with a series of financial, environmental, social, etc., obligations. As the other type of charges, concession payments for tourism generate revenues that can be reinvested to finance the park conservation and management activities (Fearnhead, 2003). When charges are used in the context of agricultural biodiversity conservation, charges per unit of pesticide or fertilizer can be used (UNEP, 2004).

2.4 Fiscal instruments

Fiscal instruments such as taxes and tax exemptions may be applied to discourage unsustainable production and consumption practices or to encourage environmentally-sound projects (UNEP, 2004). As for charges, fiscal instruments also raise funds that can be reinvested in biodiversity protection or conservation initiatives. Taxes schemes include differential land use taxation (e.g. higher taxes for land used for development), deforestation taxes (e.g. based on the amount of extracted wood) and tax exemptions or deductions (e.g. for activities that support conservation and sustainable use) (UNEP, 2004). Different

approaches can be used in tax implementation (OECD Observer, 2001). It can be based on declared intention of governments which will include the inscription of the fiscal instrument (e.g. taxes) and its motive to the text of law. For example, it could be stated that to reduce pollutant emissions in watercourses, a tax will be imposed on industrial emissions. A second approach concerns taxes that seek to incite consumers to adopt behaviours that lead to environment improvement. For example, a tax on gasoline has the effect of increasing prices which reduces consumption and thus decreases emissions of pollutants (OECD Observer, 2001). Removal or mitigation of perverse fiscal policies may also sometimes be necessary to promote biodiversity protection (UNEP, 2004). This includes subsidies in the agricultural, fisheries and other natural resources sectors. Effectively, if subsidies to agriculture lead to forest conversion into agricultural fields, it may be necessary to remove these perverse incentives before trying to apply taxes. Moreover, some countries apply high import taxes on technologies. These should be reviewed to facilitate transfer of technologies related to biodiversity protection (UNEP, 2004).

In Brazil, a tax on the circulation of goods and services (ICMS) is collected by state governments (Young, 2005). A portion of the revenues form the ICMS must be redistributed among municipalities. Some states have created environmental criteria for tax redistribution among municipalities e.g. to reward for protected areas of watershed reserves. Under this scheme, tax revenues redistribution is made as a proportion of the municipality designated as a reserve, acting as a strong incentive to develop new protected reserves (Young, 2005). Such a scheme has been implemented in the Brazilian state of Paraná where the number of protected areas has increased of 165% (Tabarelli *et al*., 2005).

Another fiscal instrument that has had significant impact is the "environmental compensation" scheme introduced as part of the law on National Protected Areas System (Sistema Nacional de Unidades de Conservação (SNUC)) (Young, 2005). This legislation obliges any private or public entity to engage in a project that will have a significant environmental impact to pay a certain percentage of the total value of the project as a

compensation for environmental damages. The minimum value was fixed to 0.5% of the project value and so far ranged between around 2 to 3.5%. The percentage varies according to the degree of impact and will be used to create and manage strictly protected areas. Limitations associated with the environmental compensation scheme include problems in defining "significant environmental impact" and a lack in adequate institutional structure to manage the funds (Young, 2005).

Moreover, the Brazilian land use taxation scheme was revised in the 1990s to create a better incentive for forest protection (Young, 2005). Prior to this revision, forests were subject to higher taxes than agriculture and ranching which were considered as more productive activities. This distortion was corrected and private protected reserves (RPPNs) registered by the Brazilian Institute for the Environment (IBAMA) are now exempted from the Rural Land tax (ITR). Although this was done as to create an incentive for forest conservation, the impacts were not significant due to tax evasion (Young, 2005).

2.5 Financial assistance

Financial assistance for biodiversity conservation and sustainable use can be achieved through various other financial mechanisms beyond fiscal instruments and charges (UNEP, 2004). These include small targeted grants, bounties and other cash rewards, conservation leasing, and soft credits.

2.5.1 Small targeted grants

Small targeted grants channel financial and technical support to non-governmental organisations (NGOs) and community-based organisations (CBOs) that are involved in biodiversity conservation or promotion of sustainable use and management of biodiversity. Small targeted grants can be implemented within an integrated conservation and

development project to support community participation and to offset costs associated with conservation, or to directly finance biodiversity conservation projects (UNEP, 2004). The small grants programme (SGP) is a corporate program funded by the Global Environment Facility (GEF) of the United Nations Development Program (UNDP) (SGP, 2004). The SGP supports activities of NGOs and CBOs in developing countries in five focal areas: biodiversity, climate change, international waters, land degradation and persistent organic pollutants. The proportion of small grants invested in biodiversity projects is approximatively 60% (SGP, 2004). Small targeted grants are transfer payments of a limited duration of one to two years (UNEP, 2004).

2.5.2 Bounties[3] or other cash rewards

Bounties[4] or other cash rewards can also be used to encourage conservation of endangered species on private lands (UNEP, 2004). This can be made on the basis of individuals or breeding pairs of endangered species found on their land. The monetary reward thus gives an incentive to protect the species (UNEP, 2004).

2.5.3 Conservation leasings

Similarly, conservation leasings involve government agencies or private organisation that will offer payments to landowners that accept to protect an endangered species for a given period of time (UNEP, 2004).

[3] "A reward, inducement, or payment, especially one given by a government for acts deemed beneficial to the state, such as killing predatory animals, growing certain crops, starting certain industries, or enlisting for military service." (The American Heritage Dictionary of the English Language, 2000)

2.5.4 Soft credits

Finally, soft credits are loans with flexible forms of payment or lower interest rates used to finance projects that combine conservation and economic returns for the landowner (e.g. ecotourism, organic agriculture, and sustainable extraction of forest products) (UNEP, 2004).

2.6 Liability systems

The objective of liability mechanisms is to ensure that polluters or individuals that engage in environmentally risky behaviours will pay for the environmental damages that they are causing (UNEP, 2004). Environmental fines can be applied to companies that do not respect environmental regulations as a disincentive to engage in practices that are armful for the environment. To be efficient, managers must determine fines that represent an important opportunity cost for non-compliance and a monitoring system needs to be implemented to identify adequately contraveners. Environmental fines can also be used to yield revenues that can finance environmental cleanup, site restoration or other environmental projects. Another liability system that can be used in the case of biodiversity conservation is environmental performance bonds. Under this scenario, polluters or users may be required to pay a deposit that will only be refunded if compliance with environmental or natural resources requirements is achieved (UNEP, 2004).

2.7 Environmental Funds

While not *per se* economic instruments, environmental funds are appropriate for long-term issues and can be used as complements to economic instruments (UNEP, 2004). The objective of these funds is generally to complement other economic tools. A combination of

more than one environmental fund can also be used. They include endowment, sinking, revolving, biodiversity venture capital and ethical investment funds (UNEP, 2004).

2.7.1 Endowment funds

Endowment funds consist in funds for which only the incomes realized from the capital are spent, while the capital remain untouched (UNEP, 2004). The capital can provide from international donors and be combined with host country governmental contribution, or can be established using the mechanism of debt-for-nature swaps (Resor, 1997). Debt-for-nature swaps were initiated in 1984 by the World Wildlife Fund (WWF) as a mechanism to multiply conservation efforts in developing countries. It generally involves a conservation organisation that will purchase foreign debt of a developing country which will engage in conservation activities in return. For example, following a debt-for-nature swap in 1988, the Philippinian environmental foundation Haribon Foundation used the funds from the debt swap to engage in a series of conservation actions such as enhancement management support for national parks and local training. Debt-for-nature swaps rely on willingness of financial institution to sell foreign debt at a cost lower than the actual loan. They would accept to do so because many indebted countries have been unable to fully repay their loans and may well never be able to do so. The country who wishes to benefit from the debt-for-nature swap needs to establish general guidelines of the conservation actions to be implemented and call for conservation organization participation (Resor, 1997). Debt can be converted in local currencies to invest in conservation activities and can also constitute an endowment fund that can provide a long term source of revenues to engage conservation actions with long term horizons (Resor, 1997). For example, two swaps were carried out in Ecuador in 1987 and 1989 and funded a $10 million conservation program. The Central Bank of Ecuador paid out swap proceeds over a period of nine years to an Ecuadorian conservation NGO, Fundación Natura, with a percentage invested in an endowment fund annually. This $10 million swap program generated more than an additional $10 million in local currency for conservation in Ecuador and will continue to yield revenues. In Brazil, there is no record of debt-for-nature

swaps since 1992. In fact, the success of debt-for-nature swaps relies on both the viability of the proposed program and on the capacity of implementing and managing it. In the conservation history of Brazil, lack of human, financial and institutional resources often constituted strong limitations to properly implement conservation actions. Moreover, while debt-for-nature swaps were very popular in the early 90s, they have considerably reduced in numbers since then. Effectively, in addition to organizational and institutional limitations, many countries have undergone structural adjustment programs (SAPs) in the mid- to late-90s, which have reduced considerably the premium associated with debt conversion (Resor, 1997). Reductions in debt swaps were thus in part the result of the relative improvement of their debt situation. Actually, debt-for-nature swaps still represent a good opportunity on a case-by-case basis, but have reached a point of limited potential because a major portion of the debt of highly indebted countries are in the form of multilateral development bank (MDB) debt, for which conversion through the debt swap proceed is actually not possible (Resor, 1997). As a result, other initiatives for sustained funds will need to be developed.

2.7.2 Sinking funds

Sinking funds differ from endowment funds in that the initial capital investment, in addition to yield income that will be directed to conservation, the capital is gradually used over a fixed period (Resor, 1997). The Brazilian Biodiversity Fund (FUNBIO) is an example of this kind of fund (FUNBIO, 2003). Created in 1995 from a $20 million donation of the Global Environmental Facility (GEF) through a contract with the World Bank, FUNBIO's mission is to catalyze resources to support strategic actions of conservation and sustainable use of biodiversity in Brazil. In order to achieve these objectives, the investment of the GEF is completed by private investments and donations from companies or organizations interested to participate in the efforts for biological diversity conservation. Created as an innovative fund, FUNBIO seeks diversification of its activities by financing both public and private agents and projects with different modalities, biomes and regions. Facing the necessity of developing new sources of financing, FUNBIO developed partnerships for the creation of

other funds with specific approaches in sectors lacking stimulation and support. From these new "partnerships funds" (*Fundos de parceiras*), seven projects have been supported. Currently four modalities of support have been identified: biodiversity conservation, sustainable use associated to conservation of biodiversity, development of applied research whose result may provide input to conservation and sustainable use of biological diversity, and analyses and studies of policies and measures for conserving biological resources and stimulating their sustainable use. Other programs implemented include the Sustainable Production Support Program (PAPS), Ford Foundation/FUNBIO Program, the Best Practices in Ecotourism Program (BPE), Amazon Protected Areas (ARPA), and more recently the Integrated Program of Conservation and Sustainable Use of Biodiversity (PICUS). Example of projects financed through the FUNBIO programs include the Strategic plan for conservation and sustainable use of the Atlantic forest's biodiversity (Association for the protection of the North-eastern Atlantic forest - PICUS), the Project of education and environmental recuperation of the Atlantic forest in the Rio Doce Valley (Instituto Terra – Partnership fund), and the Project of economical sustainable based on the valorization of biodiversity in familiar agricultural systems (Centro de Tecnologias Alternativas da Zona da Mata de Minais Gerais (CTA-ZM) – Ford Foundation/FUNBIO) (FUNBIO, 2003).

2.7.3 Revolving funds

Another type of fund that has been proposed as a complement to economic instruments by the UNEP (2004) is revolving funds. Revolving funds consist in finding a source of revenues that will perpetuate over time such as earmarked taxes or fees, and continually spends these revenues (WWFa, 2006). New sources of revenues also include charges for specific environmental services, membership fees and individual donations, or conservation fees paid for example by all foreign tourists (Resor, 1997). The objective is to be able to develop conservation financing in-country rather than to rely on external sources (WWFb, 2006). Examples of successful projects of revolving funds include the Protected Areas Conservation Trust (PACT) of Belize and scuba diving user fees in Mabini, Philippines. In Belize, an

entrance fee of 3.75$ was implemented for all foreign tourists and a 20 percent commission on recreation-related license fees and concession fees in public protected areas was also developed (WWFb, 2006). Since its creation in 1996, over 30 protected area management and conservation programs were financed by the revenues generated by the PACT. Only in 2001, the PACT yielded over $700 000 which not only contributed to support biodiversity protection, but also the economic development of the country (WWFb, 2006). Similarly, in Mabini, Philippines, a dive fee system was created to generate fund to deal with the issue of pollution and exploitation from unregulated human activities that was threatening the municipal waters in the absence of an adequate system of resources use and protection (WWFb, 2006). A Coastal Resource Management Board (CRMB) was also created to ensure that funds would be directed to conservation, protection and management. The CRMB also implemented marine sanctuary policies, waste management programs, and an enforcement patrol (WWFb, 2006). The PACT of Belize could serve as an example of revolving fund that could also be used in public nature reserves of the Brazilian Atlantic Forest to generate sustainable financing. However, as most of the remaining Atlantic forests of north-eastern Brazil are located on private lands (Tabarelli *et al*., 2005), the potential of this type of fund is unfortunately limited in the perspective of new reserve creation. Revolving funds could be implemented in already existing public protected areas. While revolving funds are not economic instruments on their own, conservation fees and charges are economic instruments that were discussed earlier (see section 3).

2.7.4 Biodiversity venture capital funds

Biodiversity venture capital funds are another type of funding opportunity that is designed to address the special needs of inherently high-risk biodiversity-related business activities (UNEP, 2004). Often, traditional financial institutions will not or will be hesitant to invest in biodiversity-related initiatives that represent higher risk (Moles, 2003). This risk aversion explains why the inherent high risks of biodiversity-related projects (subject to natural disasters, volatile markets, etc.) can act as a barrier to entry to most traditional financial

institution (UNEP, 2004). Effectively, wild populations exhibit a great degree of variability (seasonal, annual, between forest types, etc.) and unpredictability in resource productivity (Neumann & Hirsch, 2000). Venture capitalists often work in a high-risk/high-return scenario and will accept to finance activities, trusting the market and the entrepreneurial potential of managers, but will also often expects larger returns than traditional equity investors (Moles, 2003). The first biodiversity venture capital fund to be created was effectuated by the Terra Capital Fund. Terra Capital was created in 1998 by the Environmental Assistance Fund and A2R, a socially responsible fund management company based in São Paulo, Brazil. Also funded by the International Finance Corporation (IFC), Terra Capital has made the first investment in a certified non-timber product from the Brazilian Atlantic forest. Other sectors of investment opportunities for biodiversity venture capital fund include organic agriculture, sustainable tourism, timber and non-timber forest product extraction, and sustainable fisheries (Moles, 2003). Other examples of biodiversity venture capital funds include the Kijani facility which combines the expertise of the World Conservation Union (IUCN) and of the IFC (Vorhies, 2002). Kijani is looking for potential investments in areas such as ecotourism and organic agriculture throughout Africa. There is also Conservation International (CI) that has created the Conservation Entreprise Fund. One of the fund's investments helped to develop a project of organic coffee in Chiapas, Mexico. Moreover, The Nature Conservancy developed the EcoEntreprises Fund and one of its projects is a Bolivian joint venture for the production of biodiversity-friendly pharmaceutical products to be exported to the United States (Vorhies, 2002). Biodiversity venture capital funds represent only a small portion of venture capital funds. They are currently widely used in the technology development sector, but some characteristics of biodiversity-related projects create limitations to their application in this sector (Moles, 2003). Effectively, venture funds rely on the entrepreneurial capacities of managers. As most biodiversity linked businesses are often located in remote locations, entrepreneurs are often rare and managers often are not properly trained to develop and implement management plans. Capacity building will be an important element to be developed in order to venture funds to work in the biodiversity sector. Moreover, other limitations include problems associated with

enforcement of contracts and regulations in developing countries, and limited liquidity of biodiversity-related businesses in comparison with other sectors where venture funds are applied (Moles, 2003).

2.7.5 Ethical investment funds

The last category of environmental funds consists in ethical investment funds that are broad-based instruments that will look for projects that would fulfill certain ethical, social or environmental criteria (UNEP, 2004).

Throughout the description of the different categories of environmental funds, we have tried to demonstrate how they can be applied in the context of the Atlantic forest conservation. Although it was possible to enumerate a few examples where these funds have been applied in the past, it is impossible to indicate which fund could be used in the specific case of the north-eastern Brazilian Atlantic forest or even for Serra Grande. However, it is important to understand the general objectives of each type of fund and to get familiarized with each one of them. Knowing and understanding funds that exist allow managers or conservation organization, when facing a precise need for conservation, reforestation, reserve creation, capacity building, etc., to focus their researches for the appropriate fund. For example, we know that FUNBIO's funds work on a basis of call for projects. The specific objectives of each project call differ in order to diversify activities and to represent all Brazilian regions. FUNBIO has already financed projects in the Atlantic forest, and it thus represents a potential source of financing.

3. The role and application of economic instruments for biodiversity conservation

Given the forecast increase in the human population of approximatively 3 billion by 2050 and the fact that some 1.2 billion people still live on less than 1 US$ per day, development is clearly essential (Balmford *et al*., 2002). It would not be realistic to engage in strategies that would only focus on biodiversity conservation as economic and social pressures would sooner or later compromise its long term efficacity. The idea is, rather than focussing solely on environmental protection, to develop integrated strategies that will combine social, economical and environmental goals as to be sustainable in the long term. The concept of sustainable development lies in the inclusion of the three sphere of development mentionned above (sociological, economical and environmental), at the short and long terms in the optic of preserving the choice capacity of future generation (NRC, 2002). The objective of policies is generally not to completely stop biodiversity loss, it is rather to reach a more sustainable use of ressources and a level of conservation that will benefit a maximum of people (OECD, 2003). At the present, the problem is that we are converting and degrading habitats for short-term private gains without realizing that we are affecting and eroding the overall human welfare (Balmford *et al*., 2002). As mentioned earlier, this is recognised by economists to be the result of market distortions preventing economic agent from taking sound decisions (Lescuyer, 2005). Economic instruments are designed to address market failures by internalising external effects related to biodiversity use (Harou & Stenger, 2005).

In the prior section, we have described the categories of economic instruments that can be used in the context of biodiversity conservation and provided examples of situations where it has been applied. Throughout this description, we have seen various examples of situations where it has been applied and a few limitations have been identified. For example,

differential land use taxation system to favour forest conservation over land conversion for agriculture or ranching failed to provide significant impacts due to tax evasion. In fact, while it is true that economic instruments can support biodiversity conservation, they also have significant limitations (UNEP, 2004). These include problems linked to the difficulty of valuing biodiversity, institutional constraints, lack of inclusion of local communities, ideological resistance, administrative complexity and limited application in the context of threatened species (UNEP, 2004). While some constraints are related to the intrinsic nature of biodiversity, other are related to the context in which the projects are implemented.

As introduced in the section 2, the intrinsic nature of biodiversity makes it difficult to properly measure and value biodiversity, because it has ethical, cultural and spiritual values which are difficult to valuate in monetary terms. Moreover, monetarisation must incorporate all spatial levels (from the household to the global level) which require ecologists to determine the biophysical flows of goods and services which is a complex and time-consuming task (Du Toit *et al*., 2004). Economic instruments work on the basis of market principles. As a result, they work best in situations where accurate pricing and valuation is possible (UNEP, 2004). In addition, when the situation requires immediate action such as in the case of species threatened of extinction, economic instruments may not be appropriate (UNEP, 2004).

One of the strongest limitations to the application of economic instruments is related to the institutional context of developing countries. Economic instruments are said to rely on market principles, but this does not imply that the government does not have an important role to play in their implementation (UNEP, 2004). Effectively, one of the major limitations is the lack of an adequate institutional structure for the implementation and management of these instruments (UNEP, 2004). This is necessary to ensure that legislations are respected, to collect funds, to coordinate project activities, to monitor protected areas, to ensure that revenues will be properly reinvested in biodiversity conservation programs, etc. In the absence of a strong institutional framework, the application of economic tools is limited. In

Brazil, despite increases in staff and financial resources, illegal deforestation persists, and the IBAMA is still largely unable to penalize offenders and to collect fines (Tabarelli *et al*., 2005). In addition, there is a permanent lobby to expand agricultural lands, residential areas, and land settlements (Tabarelli *et al*., 2005). We believe that there is a strong necessity to reinforce the institutional framework of developing countries if we want any economical tool to have significant positive impacts on biodiversity conservation. This will be achieved through transfers of financial and technical resources and through capacitation as have been called by the Convention on Biological Diversity (CBD, 2005). Ideological resistance, lack of inclusion of communities, and undefined property rights are also limitations associated with the context (UNEP, 2004).

Some authors argue that direct payments are the unique solution (or in the absence of better alternatives, the best solution) to preserve biodiversity, while others deny their usefulness in protecting biodiversity in the long term (Swart, 2003). We believe that biodiversity conservation must be achieved by both investments in short term actions (for example, direct payments), but for these actions to be successful in the long term, they will have to be coupled with more indirect incentives that will focus on changing consumers' behaviours, debate and education, as well as on sustainable development. As for any conservation effort, direct payments must be part of an integrated strategy where they would constitute a start-up method for a more sustainable conservation project (Swart, 2003). Unfortunately, such self-financing projects which require direct payments only for a short period and then succeed to be sustainable economically indefinitely seem to be rare (Ferraro & Kiss, 2003). In fact, they often fail to reach the expected development goals or if they do so, demand may become so high that producers will be tempted to engage in non-sustainable activities or competitors will enter the market without keeping the conservation objective (Ferraro & Kiss, 2003). Direct payments have been demonstrated to be very cost-efficient for short-term interventions (Swart, 2003). They are thus very useful when a threatening catastrophe requires rapid action. As people often work reactively in biodiversity conservation, direct payments may be of critical importance (Swart, 2003). Low-income countries may be

reluctant to engage sustainable practices because of the substantial efforts that they need to realize in the short term for an uncertain future gain (Ferraro & Kiss, 2003). Moreover, the global community benefits from biodiversity conservation and it makes economic and social sense that it should participate to its conservation through direct transfers to developing countries. Although no perfect solution exists, direct payments have been demonstrated to be a cost-effective and flexible strategy for conservation (Ferraro & Kiss, 2003).

Economic instruments can be effective and flexible mechanisms that act as strong incentives for investments in environmental protection, and expansion of markets for products and services resulting from sustainable management techniques (UNEP, 2004). However, strong limitations have been identified for their application in developing countries. Although transfer of technological and financial support could help to resolve some institutional problems, other problems such as corruption can be much more difficult to address. As it has been mentioned earlier, the challenge is thus to develop an integrated strategy that includes short-term direct conservation actions with longer term strategies oriented toward sustainable development. Moreover, some economic instruments may be easier to apply than others. For example, markets for organic agriculture, non-timber forest products and sustainable forestry have already been developed and are recognised as promising (OECD, 2003). Focussing on economic instruments that have already been implemented under similar contexts may help to overcome more easily barriers associated with institutional framework.

4. The North-eastern Brazilian Atlantic forest

The Brazilian Atlantic forest is considered as one of the 25 world's biodiversity hotspots. These represent areas that collectively house the majority of the species of the planet, but are under eminent threat (Niesten *et al*., 2004). With over 20,000 species of plants, 620 sp. of birds, 280 sp. of amphibians, 261 sp. of mammals, 200 sp. of reptiles, of which about 40% are endemic, its unique biota has been confined to archipelagos of mostly small to tiny islands embedded in an agricultural matrix (Tabarelli & Filho, 2004). The Northeastern Brazilian Atlantic forest is probably the most threatened sector of the Atlantic forest, with only 2 % of its original cover remaining. This is particularly important given that this sector has a very distinctive biota that was influenced by the Amazonian forest. Most of the natural habitats have been converted for agricultural purposes and of what is left only a small portion is protected in nature reserves, mostly small, isolated and badly managed, that fail to represent the totality of the biodiversity of this biome. This might be particularly critical for endangered species that are not protected in existing reserves. To illustrate this, Tabarelli and his colleagues (2005) estimated that among the 104 threatened vertebrate species of the Brazilian Atlantic forest, 57 have not been recorded in any protected areas. As a result, ecological processes, such as pollination and dispersion, are highly affected and many species could not be able to maintain viable populations in the long-term. If the actual trend continues, the north-eastern Brazilian Atlantic forest could experience a severe impoverishment in shade-tolerant and large-seeded tree species. In the future, it will probably be dominated by tree species abiotically dispersed and tree species bearing small fruits, as large fruit-eating birds and large frugivorous vertebrates will be locally extirpated or will be restricted to large forest fragments as they will be unable to cross large tracts of inhospitable matrix. In fact, some scientists believe that large frugivorous birds and mammals should be considered as "umbrella species", that is, as species that require special attention as they are necessary to maintain key ecological processes for forest maintenance

and regeneration. Conservation actions in the Atlantic forest now focus on transforming medium-to-large fragments into protected areas. However, as most priority areas in north-eastern Brazil are too small to maintain viable populations of large fruit-eating birds and mammals, conservation actions should be reviewed and should rather seek to increase connectivity and find conservation strategies at the bioregional level. It is important to emphasize that despite inadequate budgets, human resources and constant land use pressures, protected areas are necessary as they constitute the most direct way to protect areas of special concern for biodiversity conservation against the expanding agricultural frontiers (Niesten *et al*., 2004). However, as most of the remaining Atlantic forests of north-eastern Brazil is located on private lands, and, as mentioned previously, as most fragments are too small to maintain ecological processes, creation of new nature reserves will not be sufficient and one will need to develop innovative strategies to develop networks of sustainable landscapes at the regional level (Tabarelli *et al*., 2005). Over the last decades, biodiversity conservation efforts have been multiplied in the north-eastern Brazilian Atlantic forest (Tabarelli et al., 2005). Effectively, numerous environmental funds, non-governmental organisations (NGOs), protected areas, and incentive mechanisms have been created to contribute to biodiversity protection. However, their impacts have been limited and they are still insufficient to adequately preserve biological diversity (Tabarelli *et al*., 2005). Managers are thus facing a great challenge which is to develop innovative strategies which will represent incentives for conservation in the long-term. This will be achieved by integrating actual regulations, public policies, new opportunities, incentive mechanisms for forest protection and resoration, and governmental and non-governmental projects and programs in a single comprehensive strategy.

Particularly in the case of the north-eastern Brazilian Atlantic forest, where the original cover as been reduced to 2% due to forest conversion for sugarcane production, and where forest lies on the private lands of sugarcane companies, protection of biodiversity and associated ecosystem services require commitment of commodity producers, as well as direct investments in conservation (Tabarelli & Roda, 2005). Economical instruments can be used

to incite private companies to engage in conservation activities (UNEP, 2004). For example, charge schemes could be implemented to sugarcane companies, such as pesticide and fertilizer charges. Tax deductions could also be offered to companies that engage into reforestation or conservation activities. In addition, through reforestation activities, they could become eligible to earn carbon emissions credits (CERs) under the Clean Development Mechanism (CDM) of the Kyoto Protocol (Jung, 2005). However, actual regulations have been identified has being still largely inadequate and poorly enforced (Tabarelli & Roda, 2005), which may indicate that the potential for economic instruments is limited due to institutional limitations. Conservationists and landscape managers are expected to develop partnerships with the sugar sector in order to develop better management practices which will include habitat protection, control of fire and pesticides, creation and financing of protected areas, reforestation of riverbanks and implementation of forest corridors (Tabarelli & Roda, 2005). In addition, sugar companies are starting to understand the potential benefits of using better management practices for public image, market and water supply. Environmental certification and eco-labelling thus represent a great potential to further stimulate companies to engage in conservation projects. By using these economic instruments, conservationists can achieve increased benefits in biodiversity protection and private company managers can gain monetary benefits. Sugar companies are thus key partners in developing a single comprehensive strategy that will result in greater connectivity at the regional landscape level and that represents the only way for remaining biodiversity of the region to be able to persist in the long term (Tabarelli *et al*., 2005). Governments will also need to find market mechanisms for forest restoration, ecotourism and ecosystem services (Tabarelli & Filho, 2004). Local populations must also be involved (Tabarelli & Filho, 2004). We have observed that in Serra Grande, local populations seem to neglect local environment protection. For example, watercourses are being polluted by wastes that are left behind by residents of the local communities; no care is given to waste disposal, etc. Although this observation is very subjective, it could be interesting to determine if the absence of property rights can explain a lack of incentives to protect their environment.

Conclusion

Various economic instruments can be used as a flexible and efficient way to increase biodiversity protection. These include defining property rights, market creation and enhancement, charges, fiscal instruments, financial assistance, liability systems and environmental funds. Although their application can be strongly limited by institutional factors, economic instruments must be implemented as part of a global strategy that will include both short-term direct actions and longer term initiatives. Prior to the implementation of new economic instruments, we also suggest verifying if the actual economical practices are adequate. For example, it would be important to suppress agricultural subventions that favours land conversion over forest protection, rather than trying to implement other economic incentives to stimulate forest conservation. The idea is to ensure that strategies are not contradictory and that our efforts are efficient.

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