Forests and Biodiversity in Latin America

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Introduction

The Inter-American Development Bank has reported that the environment is one of the challenges facing Latin America, with deforestation and loss of biodiversity the two areas of greatest concern. However, there are difficulties associated with assigning a value to either, not least because many of the benefits are regarded as global public goods and thus hard to value. For this reason, most decisions which affect them are taken on a political basis. Nevertheless, we attempt here to do as robust a benefit-cost analysis as possible of a number of potential solutions to the challenge.

Forests and Biodiversity

29% of the global land area – virtually 4 billion hectares – was estimated to be forested in 2000, with tropical forests making up nearly half the total. Latin America is rich in forests: they cover about 1064 million hectares, with a large percentage being tropical. Tropical forests are particularly high levels of biodiversity.

There are various ways of defining and analyzing biodiversity, but typically it is considered at three levels: species, genetic and ecosystem. Species form the central unit in studies, but usually encompass a number of sub-species and populations. Because practical conservation aims to maintain the evolutionary potential of unique lines of descent, the main target is often evolutionary significant units (ESUs), which are reproductively isolated from other populations, rather than simply total numbers of species.

Genetic diversity within species is important to the maintenance of healthy populations with good potential to adapt. Ecosystem diversity refers to the mix of species in a particular area, some performing interchangeable roles, others a unique or keystone role.

Various studies have shown that greater diversity tends to increase the productive stability of an ecosystem as a whole. More diverse ecosystems also generally produce more biomass; however, this productivity plateaus at relatively low levels of species richness. More diverse systems also show greater resilience to disturbance and are more robust in their ability to recover.

Biodiversity may be measured in more than one way. Economists have focused on joint dissimilarities between sets of species, but this does not necessarily indicate the value as well as does an ecologically-based approach, based on the relative abundance of species. Since most conservation efforts deal with habitat rather than species, in practice it is sensible to work with habitat-based biodiversity indicators.

Alpha diversity is the number or species in a particular community, while gamma diversity is a measure of the species richness over a wider geographical area. Beta diversity, sometimes calculated as a ratio of the gamma and alpha indices, measures the variability of species over an environmental or geographical gradient. There are a number of other more specialized indices, and a range of different indicators is used to characterize the unique properties of individual ecosystems.

The total number of species in the world is unknown, with a current consensus of around 14 million; only 1.9 million have been described so far. Every year, more than

10,000 completely new species are identified, and there are believed to be vast numbers of undescribed micro-organisms. In general, however, we know that the number of species tends to increase as we move from north to south.

At the same time as new species are being discovered, others are becoming extinct, either on a regional or global basis. The World Conservation Union lists 784 species which have become extinct in the wild since 1500. These extinctions can, of course, occur naturally, and a key question is therefore how current rates compare to the background rate. Fossil records indicate a natural extinction rate of 0.1 to 1 species per million per year. The current average is much higher – between 50 and 1,000 fold – and this high rate must be due at least in part to human activities. Although a serious concern, the number of extinctions has not reached the apocalyptic levels forecast by some commentators about 20 years ago.

Almost certainly the primary cause of species endangerment currently is habitat loss or degradation because of human activity. As well as overall loss of habitat area, creation of smaller "islands" and reductions in their connectivity has an additional negative impact. Non-native species represent a second important threat to biodiversity. Other causes include pollution, over-exploitation of particular species and disease. In addition, some researchers believe that climate change could be a major contributor to biodiversity loss in the long run.

Costs and benefits of Biodiversity: some estimates

Although extinctions are irreversible, much of the evolutionary information lost is shared with other species. Conservation strategies might thus best be focused on the effective preservation of evolutionary history rather than simply the number of species protected, although this is fraught with practical difficulties.

Biodiversity can provide value in three ways: as a global public good, providing regional or national benefits with some externalities, and providing private goods, with different policy approaches being appropriate at each level. Forest ecosystems themselves provide a range of environmental services, largely of a non-market nature such as protecting water resources and neutralizing the effects of pollution. Carbon sequestration is a particularly important ecological service.

Much of the value of biodiversity is related primarily to the intrinsic worth of species' existence, and such non-market values are difficult to estimate. The most commonly applied approach is the contingent value (CV) method, which surveys people to find their approval ratings for specific policy programs, with costs varying across the range of respondents. However, not all economists agree that this is a useful method of valuation.

Wild species are no longer essential for human survival, but can have a direct value for hunting, fishing or gathering. Hunting, for example, can be worth between $30 and $45 per day per hunter. However, willingness to pay (WTP) to protect individual species varies greatly, with charismatic megafauna such as the bald eagle attracting the highest scores. It should be borne in mind that most of the data refers to the United States, and is not likely to be representative of Latin America.

Other survey work – again in the USA – has tried to estimate the value of natural habitats. A range of WTP figures are available for individual habitats, and taking a

broader view a figure of $242 emerged for preservation of water quality for all lakes and rivers.

Valuing ecosystem services such as water purification and maintenance of soil productivity also presents challenges, even though the benefits are undeniable. For example, wetlands can act as flood defenses as well as providing fish spawning grounds and hunting and recreation opportunities. A range of figures have been published, using additional methods such as averting expenditures as well as contingent valuation. A practical example of ecosystem service valuation relates to the Catskill Mountains, where New York city water supplies come from. Originally, no filtration was necessary to provide potable water, but by the 1980s the quality had been degraded. Rather than invest $8-10 billion in a filtration plant, the city spent $1.5 billion on preserving the rural environment in the Catskills and restored the quality of its water supply.

Forests and Biodiversity in Latin America

Latin America itself has vast areas of relatively undisturbed forest, with accompanying high levels of biodiversity, but some of these forests are also gravely threatened. For the period 2000-2005, it is estimated that the global annual loss of forest was 13 million hectares. Brazil, with the world's largest area of tropical forest, contributed over 3.1 million ha to this, and Venezuela comes in at number ten globally, losing over a quarter of a million hectares each year.

Although the region represents only 16% of the Earth's land area, it is home to 27% of the world's mammal species, 42% of known reptile species, 43% of bird species and 34% of known flowering plants. It also has a range of conservation "hot spots" along the Pacific coast from northern Mexico southwards, parts of the Atlantic coast of Brazil and a number of inland areas. The extent of the problem is illustrated by the 2004 IUCN (World Conservation Union) Red List of 15,589 species threatened with extinction. 10,823 are found in South America, and about 60% are forest dwellers.

Valuation of benefits and costs of protection of global ecosystems and biodiversity

As we have seen, benefits from protecting ecosystems can be very difficult to value. However, costs are generally easier to quantify. In practice this means that, rather than do a full benefit-cost analysis, attention is normally focused on how to achieve a given environmental goal at the lowest cost.

Global ecosystem value has been put in the range of $16 to $54 trillion annually by Robert Constanza (who is known for his research on ecological economics) et al in 1996, although the study is considered by most economists as fundamentally flawed and an overestimate. For those who see the global ecosystem as essential for life on the other hand, it has been argued that the figure is a serious underestimate of infinity.

Conservation of biodiversity has often been justified on the basis of its value as a source of pharmaceutical compounds, with a consequent large economic return from bio-prospecting. However, since one compound is often present in a number of species, the incremental value of a single species is not very high. In the 1990s, Merck Pharmaceutical provided $1 million to Costa Rica for 1,000 plant collected from its forests. However, the return to the company was apparently poor and this model seems not to have become popular. It seems that the benefits of bio-prospecting rarely exceed the opportunity costs of the land for other uses.

Increasing concerns about climate change have led to concentration on the role of forests in sequestering carbon. Old, primary tropical forests may contain 300 tons of carbon per hectare, and even young forests may have 100 tons. Taking the lower figure and assuming a carbon cost of $20 per ton, it has been estimated that the total value of the Earth's forests and other systems is $12 trillion. Although the market price of carbon is rather volatile at present, the fact that a market exists makes ecosystem service valuation a realistic option.

Latin America benefit and cost estimates

Looking now specifically at the region, carbon sequestered by Latin American forests (including dead wood, litter and soils as well as trees) is estimated by Pearce to have a value of $3.4 trillion, consistent on a pro rata basis with the lower range of the (much criticized) Constanza study. Valuation on the basis of bio-prospecting for pharmaceutical compounds is far lower.

Costs of protecting the forest can be pro rated from global studies, assuming that Latin America has 20% of the world's total forest area. The cost of preserving the 670 million hectares of closed canopy forest in the region can be estimated as equivalent to the opportunity cost of using the forest for other economic purposes such as clear-fell logging and farming. At a calculated $183 per hectare, the cost of maintaining the entire forest area is $12.3 billion annually.

It has been suggested that most biodiversity could be preserved in a protected area comprising just 10% of the total ecosystem (which is also consistent with the area of South America's biodiversity hot spots). If so, this reduces the annual cost to $1.23 billion. Another study has suggested that 10 to 15 percent of global biodiversity could be protected for $18-27.5 billion each year. This translates to $3.5-5.5 billion for the Latin American situation.

Of course, although this protects biodiversity, most of the carbon sequestration capacity would be lost if the bulk of the forest were to be cleared. An alternative looked at by Pearce is to pay up-front for the land not to be converted to other uses. Assuming cleared land to be worth $300 per hectare, a payment of $500 should secure its future as forest, a cost o $500 billion for the entire one billion hectares.

Another study looked at the costs of compensating owners for keeping their land forested. This covered eight countries with annual forest losses of 6.2 million ha – 46% of the global total – and included Brazil and Bolivia. This was estimated to cost $5 billion, plus an additional $23-93 million in administrative and monitoring costs. In principle, the same compensation costs would be incurred each year, and administrative costs would escalate to between $250 million and $1 billion annually after ten years.

Proposed solutions: benefits and costs

Not surprisingly, given the difficulties associated with valuing the benefits, a wide range of benefit-cost ratios can be derived, depending on the assumptions used. At one end of the spectrum, taking the benefit figures from Constanza's study with a range of cost estimates from the literature, we arrive at extremely high CBRs, between 572 and more than 9,000. At the other extreme, the benefit-cost ratio of bio-prospecting is only 0.13, which may explain the lack of current enthusiasm for this approach.

Nevertheless, between these two extremes, we find benefit-cost ratios of 2.4 and 4.0 using Pearce's more realistic benefit calculations and his own and other cost estimates from the literature.

The four solutions proposed and examined are:

1. **Protecting Biodiversity for its value in drugs.** As we have seen, the benefits ($20.63 per ha) are heavily outweighed by the costs ($150 per ha), so the conclusion must be that conserving biodiversity purely for its potential healthcare benefits cannot be justified economically.
2. **Protecting Forests to prevent carbon emissions.** In this case, there is a truly market-based valuation of benefits ($12.4bn), given the developing market in carbon emissions trading. The costs are based on compensating land owners in areas likely to suffer deforestation, together with ongoing (and significant) administration and monitoring expenses. The overall cost is estimated as $5.2bn, giving a benefit-cost ratio of 2.4.
3. **Protecting Ecosystems for ecosystem services.** Constanza's work provides a figure of $11 trillion for the value of ecosystem services in Latin America. While open to the criticism of over-estimation (but also accused by others as being too low!) the value of carbon sequestration alone is $3.4 trillion, so this apparently high figure seems to be in the right order of magnitude. Taking either the least cost option of protecting 10% of the forests (at an annual cost of $1.2bn) or the alternative of a yearly cost of $5.8bn to protect 70% of the region's biodiversity, benefit-cost ratios are extremely high.
4. **Protecting Forests for carbon values.** It is also possible to value Latin American forests for their carbon sequestration capacity, which is relatively straightforward as carbon now has a market price (albeit somewhat volatile at present). Using a low-end estimate of 100 tons of carbon per hectare and a $20 per ton price for carbon, the region's one billion hectares of forest have an ecosystem service value of $2 trillion for carbon sequestration alone. This rises to $3.4 trillion if the capacity of the dead wood, litter and forest soils is included. Using a figure of $500bn as a one-time payment to protect the entire forest, the benefit cost ratio is 4.0, for the value of the growing trees alone (6.8 if the value of dead wood, litter and soil is included).

We favor solutions two and four as being cost effective and realistic. However, solution four takes a very broad view of the entire forested area of Latin America, much of which is not under immediate threat. For this reason, we recommend solution two, the targeted protection of areas of forest under threat, as being the most practical and effective approach.

Conclusion

Studies of the value of protecting biodiversity and forests are limited and often very narrow in scope. Nevertheless, based on the available data and the development of a market for carbon emissions, we are able to show that targeted protection of forests at risk has an attractive benefit-cost ratio for carbon sequestration alone. Preventing deforestation will, of course, also provide other benefits – particularly to biodiversity – which are more difficult to value in a market-based way.