“FOREST ECOSYSTEM SERVICES: CAN THEY PAY OUR WAY OUT OF DEFORESTATION?”

EXECUTIVE VERSION

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EXECUTIVE SUMMARY

1. Forests (natural but also human-made or modified) are among the most important providers of ecosystem services for the whole world.

2. Based on scientific evidence, it is certain that:

   (a) Ecosystem services are essential to the survival of human beings.

   (b) Forest ecosystems operate and provide services on such a grand scale and in such intricate and little-explored ways that most cannot effectively could not be replaced by technology.

   (c) Human activities are already impairing the flow of ecosystem services from the forests on a large scale.

   (d) If current trends continue, humanity will dramatically alter a large share of the Earth's remaining natural forest ecosystems within a few decades, especially in the tropics.

One can also be fairly confident that:

   (a) Many of the human activities that modify or destroy natural forest ecosystems may cause deterioration of ecological services. The impact on production systems and human welfare may potentially be very high, but will probably only be fully recognised when these losses have already occurred.

   (b) The functioning of many forest ecosystems could be restored if appropriate actions were taken in time.

3. Regarding economic valuation, we state that it can be a useful instrument but not a solution *per se*:

   (a) We should not expect that the fact that something is vitally important automatically will ensure that its price is high - as shown by the classical example of drinking water provided by conserving forests (cheap, essential for life) versus diamonds (expensive, but we can very well live without them).

   (b) Economics can only value the services of the earth's life-support systems (such as water, food, etc. provided by forests) by evaluating the value of a small ("marginal") change in their availability. Marginal approaches may be inappropriate when services are linked to thresholds of forests quantity and quality, the exact size and nature of which are not fully known. Economic valuation of forests can thus be a useful tool for illuminating the net benefits and incentives for different levels of stakeholders, but it can seldom genuinely determine whether forest conservation is "optimal" or not. We conserve much that we do not value, and do not conserve much that we value.

(c) To conserve systems we must give their owners incentives to do so. We must make conservation more attractive than any other uses. In particular, conserving forests must be more attractive than the agricultural alternatives, i.e. than clearing to plant coffee, bananas or pasture. Incentives are critical for conservation: valuation is not sufficient for establishing the correct incentives, although it may be a prominent tool to reveal the relevant incentive structures.

4. Recommended points of action:

(a) Strengthen biophysical research on forest services the loss of which would seem to have the highest economic value potential (.e.g. climatic/ hydrological changes)

(b) Encourage the use of valuation studies as a tool for revealing current incentives, i.e. the existing distribution of net forest benefits/ opportunity costs across stakeholders - rather than claiming valuation to be an instrument to determine "optimal" land use.

(c) In spatial terms, try to identify those critical forest areas where, on the one hand, forest ecosystem services are substantial and, on the other, changed financial incentives could "tip the balance", i.e. where degradation and deforestation currently are *marginally* more profitable options than conserving forests.

(d) Based on improved knowledge about biophysical links and pre-existing incentive structures, experiment more with those kind of compensation schemes that seek to directly influence forest resource managers on the ground, compared to those that work more indirectly through national stakeholders (forest agencies, timber firms, national governments, etc.).

Forest ecosystem services to pay the way out of forest loss and degradation, myth or reality?

1. Forests, particularly tropical, contribute more than other terrestrial biomes to climate relevant cycles and processes and also to biodiversity related processes. Forest ecosystem services, as other nature's services, have been claimed to be of great economic value and in valuation studies, ecosystem services like carbon storage or hydrological protection frequently fetch higher values than forest products or alternative land uses.

2. Why is it that we continue unabashedly to destroy tropical forests and reduce the supply of these services? Does their importance translate into high economic and financial values? Are these values distributed adequately, providing the right incentives? A lot of hopes have been raised that forest services could provide the compelling argument for the conservation and sustainable use of tropical forests. But perhaps we are simply looking at another shaky argument for forest conservation?

3. Following a brief overview of what are forest ecosystem services, we will consider the reasons of their overall degradation and will show that the main issues are more "underlying ones" that direct ones and that deforestation happens because it pays for local people - not so much because the world is perverse. We conclude that it might be possible to "pay our way out" of the actual vicious circle and that there is scope for services and optimism for forests throughout the world.

Forest ecosystem services

4. From an anthropogenic point of view, ecosystem services can be defined as the outcomes from ecosystem functions that benefit to human beings (e.g., better fishing and hunting, cleaner water, better views, 'free' wild pollinators, safer or less vulnerable areas to natural disasters, lower global warming, new discoveries for pharmaceutical uses or more productive soils). In principle, these could include both forest products (timber and non-timber) and services. While we briefly mention the main products serving people, our focus here will be on services in the strict sense - i.e. the less tangible benefits derived from forests. Ecosystem services cannot be characterised apart from any human context and require some interaction with humans. Functions only become services to the extent that humans value them within their social systems of value generation. However, unlike forest products, most forest service values are not paid for. This means that the economic value of services more often than not remains without a financial counterpart, in other words those who own or control forests where those services are produced, do not capture the economic benefits that result from those services. The ecological services of forests are many. Forests provide consumption goods, regulate local and global climate, buffer weather events, regulate the hydrological cycle, protect watersheds and their vegetation, water flows and soils, and provide a vast store of genetic information. The various forest ecosystem services and some estimates of their economic value are summarized in table 1.

Causes of forest loss and degradation

5. Forest decline results from many direct causes, some of which are natural but are aggravated by humans, such as climate change. Important factors are the permanent conversion to cropland and pasture, overgrazing, unmitigated shifting cultivation, unsustainable forest management including poor logging practices, over-extraction of fuelwood and charcoal, or over-exploitation of non-timber forest resources - including bush meat and other living organisms. Other sources are the introduction of alien and/or invasive plant and animal species, infrastructure development (road building, hydro-electrical development, improperly planned recreational activities, urban sprawl), mining and oil exploitation, forest fires caused by humans, and pollution (SCBD 2001). Statements about these direct causes may provide little insight unless we know why each of the proximate factors comes about - e.g. why do loggers log unsustainably, why do agricultural pioneers penetrate the forest, why do forest people hunt unsustainably, and so on. There can be strong economic incentives or disincentives to engage in deforestation or forest degrading activities. Recent research on deforestation causes emphasises that these "underlying causes" may be powerful (see Kaimowitz & Angelsen 1998 for an overview). In general, economic policies that favour agricultural land extensification (e.g. subsidies for colonisation, lower agricultural export taxes, better crop and livestock prices) will all cause higher forest loss. Similarly, measures that induce a higher profitability of logging and other forest-based extraction (exchange rate depreciation, road building into forested areas or national booms in urban construction) will all induce higher forest degradation.

6. It is good to be aware that pressures on forests often originate from the larger "underlying" development trends in society. However, all too often underlying causes are mechanically being blamed for forest loss, without having established the specific link to the proximate causes. For instance, a standard "vicious circle" explanation is that people clear their forests because they are poor, which will make them even worse off. However, the evidence shows that "wealth" is at least as important a deforestation explanation as "poverty", and that even poor people predominantly clear forest to actively improve their situation, i.e. to become better off. A general lesson is also that the driving forces behind biodiversity losses are numerous and interdependent (WRI et al. 1992; McNeely et al. 1995). Beyond of the policy factors just sketched, some general yet interrelated development trends are important to keep in mind such as high population growth, high and rising consumption levels, trade and globalisation (including specialization and homogenisation), deficiencies in knowledge and in its application, etc.

7. Can we pay our way out?

8. We can divide ongoing deforestation or degradation into four basic situations of stakeholder interests and their relative weight in decision-making:

(a) Deforestation is *not* profitable for the local land owner/manager, but it still occurs because of perverse policy and institutional incentives (credits, subsidies, land tenure rules, etc.).

(b) Deforestation is profitable for the local land owner/manager, but not when other national stakeholders (downstream users, hydroelectric companies, tourism companies, national government, etc) are aggregated and taken into account.

(c) Deforestation is profitable *both* for the local land owner/manager and for national interests, but not when global environmental interests (in conservation, carbon storage, etc) are considered.

(d) Deforestation is profitable both for the local land owner/manager and for national interests, and even the negative impact on global environmental interests cannot change the calculus.

9. The traditional conservationist argument has been that situation 1 prevails - deforestation (and many forest degradation processes) is predominantly the result of perverse incentives, inequities, and other shortcomings in the way the world has been arranged. It is becoming increasingly clear that this worldview does not hold true. Situation 1, characterised by perverse incentives, is the exception rather than the rule. With the existing markets, institutions and mega-trends of development, it is in many cases economically rational for the forest owner/manager to reduce the area under forest cover. What impedes him or her from accelerating the process is often the presence of high risks, the lack of capital, transport infrastructure, etc. In some cases, national interests in the conservation and sustainable forest use are strong enough to potentially reverse that picture (situation 2). But situation 3 and 4 are probably more common than both 1 and 2: Deforestation, local income generation and national economic development tend to go hand in hand, just as they have done historically in developed countries - though not necessary linked in a linear manner over time and space. In the case of situation 3, the global economic interest in conserving forests would potentially be strong enough to stop forest loss. But we should not forget that in many places types of situation 4 exist, where forest conversion is simply so profitable (good agricultural soils, market-near areas) and/or global forest values (including from ecosystem services) are likely to be so low that forest loss will occur sooner or later.

10. Situation 1 is where the emphasis of policy leverage and conservation action has traditionally has been put. On the other hand, situation 4 represents a scenario that is basically hopeless for forests. But, in between the two extremes, there is a lot of current deforestation that could potentially be avoided, if effective tools existed to economically and financially "represent" external off-site interest in local land users decision making: the external beneficiaries have to pay if they want to keep the forest. If forest owners have no incentive to take eco-services into account in their land-use decisions, it means that these will eventually be lost. By paying those local people who would otherwise cease to provide these services, i.e. those that have high opportunity costs of not "developing" their forestlands, both service providers and off-site beneficiaries can potentially gain.

11. Compensations are relevant to at least four areas: (1) carbon storage and sequestration (reduced forest conversion and tree planting); (2) biodiversity conservation; (3) hydrological services (water and erosion protection) and (4) forest-based tourism.

12. The following example serves to illustrate opportunities and challenges for service compensations. A downstream water user may consider paying an upstream forest owner for not deforesting an erosion-prone plot, if that is decisive for securing downstream water quality for, say,

drinking water and irrigation. There are at least four and a half prerequisites for such a payment to take place:

(a) The service user must first be aware about and convinced of the existence of an externality, i.e. he must believe that the upstream forest owner's action truly affects his or her water quality, i.e. that the forest owner is a critical service supplier.

(b) The service user only wants to implement a payment if it is likely to be effective in achieving protection of the water quality, so that he gets something for his money. This puts demands on the careful design of their agreement and the monitoring of compliance. It probably entails also that the upstream forest owner actually controls the forest plot, by property or exclusive user rights.

(c) The service user would obviously not want to pay the upstream forest owner for a plot that was so remote, unfertile or otherwise unattractive that the upstream forest owner would never dream of clearing it anyhow. In other words, nobody wants to pay in situations when the opportunity cost of conserving the service is actually perceived to be zero.

(d) The service provider is satisfied with the payment arrangement in such a way that it motivates him or her to avoid converting the forest to a more profitable land use option.

(e) The incentive structure under point 3 may induce the forest owner to adopt strategic behaviour, i.e. to (threaten to) deliberately clear forest which he or she otherwise would not have touched, if this move makes the service user regard him or her a critical service supplier, instead of a passive, indifferent one (e.g. Mohr 1990). In other words, the introduction of payments may promote speculative conduct among suppliers. The "half prerequisite" is thus that means and ways can be found to limit strategic behaviour, in order to avoid excessive cost of the payment scheme.

13. The design of compensation schemes has to bridge the interests of service providers and service recipients - to the benefit of both parties: the greater the willingness to pay on behalf of the recipients, the more likely the chance that these transfers can eventually make the forest-service providers better off (matching “willingness to pay” with “willingness to accept”). The development of international markets for ecological services may provide a mechanism for long-term investment flows from the North to the South, which may eventually also provide macroeconomic benefits to the national economies of the South.

14. Economic valuation studies can be useful tools in pointing out the structure of costs and benefits, and have frequently illustrated the dominance of forest-service elements in the total economic value of forests. However, valuation studies should generally pay greater attention to per household (rather than exclusively per-hectare) values, to the real possibility to capture this value and to the distribution of costs and benefits among different stakeholders. It is insufficient to say that the conservation of forest plot X is

the socially preferable to deforestation and one should also not shy away from publishing the opposite finding, whenever that is the case! It is also necessary to state "who has to pay how much to whom" and also in which way to convert these values into efficient economic incentives. We also need more experiments with compensation payments, to see which ones are likely to be effective, and at the same time acceptable in term of their equity outcomes. Strategically selected valuation studies can provide useful inputs for that purpose but valuation is neither necessary nor sufficient for conservation. The economic prerequisite for conservation lies in incentives: To conserve forests we must give their owners or users incentives to conserve them. We must make conservation more attractive than any other uses. Conserving healthy forests (not necessarily "untouched" forests) must be more attractive than clearing them to plant coffee, bananas or cocoa or raise cattle.

15. Compensation schemes are currently being tried out for carbon sequestration/ storage projects, conservation concessions, and hydrological services. Tourism is another forest service with a high economic potential, where the extent of local benefits has often been underestimated.

16. To do this we have to translate some of the social importance of ecosystem services into income and ensure that this income accrues to the owners of the ecosystems as a reward for their conservation. Providing the right incentives (or removing perverse ones) is not the same as valuing the services. Too often, we value the services without providing incentives for conserving them (cf. the thousands of valuation studies in the literature). Ecosystem services from tropical forests over the next decade will increase in importance and value, relative to "classical" forest products. As tropical forests recede, areas to be harvested will also become scarcer. But timber supply is more flexible than often believed. New technologies, improved processing efficiency and adapting preferences will allow for harvesting more secondary species and an increased timber output value per hectare of primary forest or timber from plantations or trees outside forests, as is the case in Costa Rica. At the same time, forest plantations, trees on farms, secondary forests and non-tropical forests will provide an increasing share of supplies. For several forest goods, domestication or substitutes will play a greater role. Notably, the same substitutability does not exist for (all) forest services; they are a more unique contribution from natural forests. That is in particular true for biodiversity related services. Forest ecotourism is also unique, though the same service can be provided from many similar, competing sites. Carbon mitigation and hydrological services may be delivered by other sources, too, but we would still consider that forests are service supply sources that will increase their participation in the future. As scientists get a clearer picture of ecosystem functions, new services from forests may unfold. This is in itself an argument for providing incentives to slow down forest loss, even where there are marginal economic returns to be made at the private and/or national levels.

GOODS	
Timber	In spite of the growing recognition of other forest products, timber (for both commercial and non-commercial uses) still constitutes the commercially most important economic product for most forests. The World's annual industrial roundwood production is estimated at 1.52 billion m3 (FAO 2001), of which about four fifths come from developed country forests. No accurate estimates of the total financial value of world timber output appear to be available but the annual value of world trade in industrial wood products is around $140 billion, (FAOSTAT Statistical Database 2001).
Fuelwood	FAO (2001) statistics suggest that in 1999 some 1.75 billion m3 of wood was extracted for fuelwood and conversion to charcoal about 90% of which has been produced and consumed in developing countries. The International Energy Agency (1998) estimates that 11% of the world energy consumption comes from biomass, mainly fuelwood. 19% of China's primary energy consumption comes from biomass, the figure for India being 42%, and the figure for developing countries generally being about 35% (IEA 1998; UNDP et al., 2000). All sources agree that fuelwood is of major importance for poorer countries, and for the poor within those countries.
Non-wood forest products	Non-wood forest products help developing world people survive in the case of famines, emergencies, in periods between crop harvests, and in some cases is the only source of income for landless or unemployed people. They provide low cost building materials, income, fuel, food supplements and traditional medicines. Earnings vary from a few dollars for ad hoc sales to several thousand US$ per year. Across seven study areas in southern African, wild plant resources contributed US$194-$1114 per household per year (Shackleton et al. 2000). In Zimbabwe, Cavendish (1997) found that extraction from wildlands for domestic uses made up about one third of average household incomes. In developed world, 1996 the estimated value of the global markets for all herbal medicines was approximately US$14 billion (Genetic Engineering News 1997). In 1998, the total retail market for medicinal herbs in the United States was estimated at $3.97 billion, more than double the estimate for North America in 1996 (Brevoort 1998, Genetic Engineering News 1997).
ECOLOGICAL SERVICES	
Water regimes	When natural forested landscapes are denuded, rain can compact the surface and turn soil to mud; mud clogs surface cavities in the soil, reduces infiltration of water, increases runoff, and further enhances clogging (Hillel 1991) and reduces water quality. However, there is an enormous variability of situations. Reviewing eighty studies of the impact of land use change on erosion, Wiersum (1984) concludes that ground cover, rather than canopy, is the chief determinant of erosion. Erosion may also result from road construction associated with conventional logging rather than from a change in land use proper. Reviewing the results of several recent studies, Calder (1998) concludes: "The new understanding indicates that in both very wet and very dry climates, evapotranspiration from

	forests is likely to be higher than that from shorter crops and consequently runoff will be decreased from forested areas, contrary to the folklore." So in extreme events forests could play an important role by reducing runoff (more evapotranspiration and infiltration). This is consistent with Chomitz & Kumari (op. cit.) analysis though these authors reckon that under certain circumstances, deforestation may indeed reduce water tables and increase runoff. The hydrological studies reviewed by Calder (op. cit.) also show little linkage between land use and storm flow. Chomitz & Kumari (op. cit.) describe that deforestation increases flooding in small watersheds, but seldom in larger basins, indicating that the scale of assessment matters. Except for highly polluted climates, water purity, e.g. for drinking water, hydroelectric power plants or fishing (e.g. trout), is likely to be better from forested catchments. Adverse effects of forests on water quality are more likely to be related to bad management practices rather than to the presence of the forests themselves.
Climate regulation	Deforestation breaks the local water recycling process by removing evapotranspiration from the forests. Knowing that in some cases this evapotranspiration represents 80% of incident rainfall (Wilkie & Trexler 1993), one could expect a dryer climate. The situation is much more complicated in fact. Deforestation also changes the surface albedo and aerodynamic drags, affects temperatures, cloudiness, air circulation, etc. The result is a highly, scale-dependent and non-linear system (Chomitz & Kumari op. cit.). Comprehensive reviews of results obtained at different scales using micro-scale empirical studies, meso-scale climate models and general circulation models (Chomitz & Kumari op. cit., Calder op. cit.) show that no longer is it clear a priori that deforestation reduces rainfall. These reviews conclude that the assumption that deforestation affects local climate is plausible and cannot be totally dismissed from a water resources perspective but also that the magnitude and sign of the effect remain to be clearly demonstrated but are likely to be relatively small. The effect of forest cover on local temperature extremes is somewhat clearer. Forests moderate local temperature extremes under cover providing shade and surface cooling. They act as insulators, blocking searing winds and trapping warmth by acting as a local greenhouse agent. (Chen 1991, Ledwith 1996)
Carbon storage	Trees and forests store carbon. A number of studies suggest potentially very large values for these carbon storage functions. Brown and Pearce (1994) suggest benchmark figures for carbon content and loss rates for tropical forests [Use the IPCC special report as ref here – it is much more up to date [2000]]. A close primary forest has some 280 tons of carbon per ha and if converted to swidden agriculture would release about 200 tons, and a little more if converted to pasture or permanent agriculture. Open forests would begin with around 115 tons of carbon and would lose between a quarter and third of this on conversion. This carbon stored in forests has enormous potential economic value. [Word of caution – the only carbon stored in natural forest that has $ value is that which is at risk of return to the atmosphere] A recent review of the literature by Clarkson (2000) suggests a consensus value of $34 per ton and Tol et al. (2000) suggest that it is difficult to produce estimates of marginal damage above $50 per ton.

Pollination	Over 100,000 species (vertebrates and invertebrates) serve as pollinators worldwide. The most important pollinator for agricultural purposes is the honeybee (a European species) but natural 'wild' pollinators services are worth between $4 and $7 billion a year to United States agriculture (Moskowitz & Talberth 1998). These wild pollinators are often forest species and are sustained by natural forest habitats adjacent to farmlands. Most forest plant species, either valuable timber trees (e.g. for Dipterocarps see Ashton 1982, Appanah 1998, Bawa 1998) or other forest products (sago palms, rattans, etc.), depend on animal pollination for reproduction. A major disruption in the pollination processes implies that yields of important crops would decline precipitously and many forest plant species would become extinct.
Seed dispersal	Many plants (especially in tropical forests) require the presence of animals for successful seed dissemination. Without thousands of animal species acting as seed dispersers, many forest plants would fail to reproduce successfully. Animal dispersers play a central role in the structure and regeneration of many forest trees (see Lanner 1996 for pine forests or Howe 1990, Holbrook & Smith 2000 for tropical mixed forests). Disruption of these complex services may leave large areas of forest devoid of seedlings and younger age classes of trees, and thus unable to recover swiftly from human impacts such as land clearing (Gomez-Pompa et al. 1972; Terborgh 1990).
Natural Pest control	An estimated 99 percent of potential crop pests are controlled by natural enemies, including many birds, spiders, parasitic wasps and flies, lady bugs, fungi, bacteria, viral diseases, and numerous other types of organisms (DeBach 1974). These natural biological control agents save farmers billions of dollars annually by protecting crops and reducing the need for chemical control (Naylor & Ehrlich 1997). Moskowitz & Talberth (1998) report that the cost to U.S. agriculture of replacing natural pest control services with chemical pesticides would be about $54 billion annually. In Costa Rica, a citrus plantation pays an adjacent forested conservation area $1 per hectare every year to provide natural pest control services (Reid 1999).
CULTURAL, AESTHETICS, AMENITY SERVICES	
Tourism	Forests hold a wide range of recreational opportunities. Ecotourism is a booming business and constitutes a potentially valuable non-extractive use of tropical forests. The value of ecotourism in the Wolong Panda Reserve lies between $29-42 million per annum (Swanson et al. 2001). In Costa Rica, one million tourists visited the country in 2000 and more than half of the visited the forests in public protected areas or private lands (Campos et al. 2001). However, we should note that the values generated are captured by many different stakeholders, from the tourist's own consumer surplus to travel agents and capital-based operators. Although the percentage of total value that accrues at the local forest level tends to be small or non-existent, even a minor share may constitute an important amount in absolute terms.
Amenity	There is some evidence living near to forests secures some benefit in terms of amenity. From the few available studies (Anderson &

values	Cordell 1988, Powe et al. 1997, Tyrväinen & Miettinen 2000) it seems that the presence of a forest or woodland near housing estates increases house prices though in one case (Garrod & Willis 1992), the tree species had an influence: Sitka Spruce stands would reduce the price whereas broadleaved forest would increase it.
Cultural values	Forests have clear and important cultural values for people both leaving in or near the forests or in towns. Obviously cultural values and symbolism is higher for forest dependent cultures. For early human societies, trees have been viewed as having souls and spirits. Trees have long been believed to possess natural powers, including a wide range of natural forces such as making the rain fall and the sun shine, ensuring abundant harvests, helping flocks and herds to multiply, ensuring the fertility of woman and easing childbirth. Some indigenous people have referred to humans as "walking trees," whose spine is the tree's trunk, whose pelvis enfolds the roots and whose brain is contained in the branches (Altman 1994). Trees provide shelter and serve as a natural cooling system; some, like maples, oaks, and walnuts, provide food for humans and animals. Our early ancestors' conscious dependency on trees, rivers, and animals for food, protection, healing shelter, and other forms of sustenance led our early ancestors to possess a deep awareness of their environment.