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

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for the Forestry Roundtable to be held in conjunction with the UNFF II,
Costa Rica on March 11, 2002.

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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 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, human activities 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 will automatically ensure 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. more attractive 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 kinds 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.).

INTRODUCTION

1. Services provided by natural ecosystems are crucial to our survival and humans probably could not live without them (for a comprehensive review on all ecosystem services, see Daily 1997). Forests, particularly tropical forests, contribute more than other terrestrial biomes to climate relevant cycles and processes and also to biodiversity related processes. Forest ecosystem services, as with other nature's services, have also been claimed to be of great economic value (Costanza *et al.* 1997, Pearce & Pearce 2001, Pearce & Moran 2001). In forest valuation studies, service components like carbon storage or hydrological protection frequently fetch higher values than forest products.

2. An influential paper by Costanza *et al.* (1997) estimated the combined value of all the world's ecosystem services at US$33 trillion a year. However, this paper caused considerable controversy, and its assumptions were described as both "heroic" and "foolhardy". The journal Ecological Economics (25, 1-72; 1998) devoted a special issue to the paper, and an economist of Resources for the Future characterised the $33 trillion figure as "*a serious underestimate of infinity*". Others wrote that the calculations "*risk ridicule from both scientists and economists"*. Yet, the article brought much society-wide attention to the issue of ecosystem services.

3. 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?

4. In this paper we will first give a brief overview of what are and what represent forest ecosystem services. Then we will consider the issues of price and valuation, and show that valuation itself is not a solution but merely a tool. Considering then the reasons of the overall degradation of forest ecosystem services we will show that the main reasons tend to be fundamental: **deforestation most often happens because it pays for local people - not so much because the institutionally created arrangements are perverse. We conclude that if we (national, regional and global "off-site" beneficiaries) can increasingly "pay our way out" of the actual vicious circle, there will be more scope for optimism regarding the conservation of forests and their services to mankind throughout the world.**

FOREST ECOSYSTEM SERVICES, WHAT IS AT STAKE?

What are we talking about?

Facts and definitions

5. For the purpose of this paper we will use what we could call “user-friendly” definitions of ecosystem functions and services taking an anthropogenic approach. While recognising that some ecologists might have some difficulties with these definitions we consider that they are more appropriate given the scope of this document.

6. Ecosystem functions are the biophysical processes that take place within an ecosystem. They can be characterised apart from any human context (e.g., fish and waterfowl habitat, cycling carbon or trapping nutrients), though they are generally affected by human activities. The level – local, regional, global - of functions depends on the ecosystem (e.g. terrestrial or marine, tropical, temperate or boreal, covering small or large areas, simple or complex, biodiversity-rich or not, damaged or intact, etc.) and on certain aspects of the landscape context (e.g., connectedness to other natural/human features, accessibility, etc.).

7. Ecosystem services are the outcomes from ecosystem functions that benefit 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 acknowledge 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**. Before discussing these services in detail, it is useful to keep the following general dimensions in mind.

8. Different level of benefits: Corresponding to the layer distinction for ecosystem functions, benefits also accrue at different spatial levels. Notably, it is vital to distinguish between services *internalised* at the local level by forest owners and managers (e.g. local pest control functions), versus *external* benefits. The latter can include both regional benefits (e.g. a downstream farmer using water for irrigation), national (e.g. a downstream hydroelectric dam) and global ones (e.g. carbon storage mitigating climate change). Many valuation studies have shown that the external (off-site) service values tend to be higher than the internal (local) ones - sometimes by orders of magnitude.

9. Net benefits: It is often conveniently forgotten by conservationists that the presence of a **forest does not only imply benefits, but can also incur costs** to humans. For the local forest or forest-margin dweller, this can for instance include forest predators attacking domestic livestock, forest birds damaging crops, or forest elephants devastating human infrastructure or the opportunity cost of using that land for more profitable uses, such as agriculture. What is decisive for local actors are the net benefits - i.e. the sum of all forest benefits and costs. When deciding on local land-use changes, an individual landowner or forest manager has to make his or her own individual valuation exercise, to determine whether these net local benefits are superior to the best possible land-use alternative. As we will discuss below, in many cases they are not. **Local people tend to convert tropical forests because it pays for them to do so**. This is the principal reason for advancing deforestation.

10. Variability and uncertainty: **Many forest ecosystem services are complex in nature and highly site-specific**. For instance, while **in some places *deforestation*** (e.g. for annual crops) **can reduce the amount, quality and stability of water flows, in other locations, or compared to other alternatives** (e.g. perennial crops), **that does not hold; *reforestation* with fast-growing species can often consume water and reduce run-off. That makes it difficult to generalise across sites. It also often means that the ecosystem service is only really "valued" when it has been lost already, and the consequences of this loss become fully apparent. Yet, for some ecosystem services, it can even be hard to scientifically prove their validity at all. Obviously, that makes them difficult to "sell" to policy makers. Yet, the debate about global warming is an example where many would question whether the link to greenhouse gas emissions is fully scientifically proven, but where a majority of global stakeholders seems determined to act upon the *probability* of such a link, given the high risks involved for humanity.**

11. Precautionary principle: In prolongation of this, consider that ten years from now, rapid Amazon deforestation provides us incrementally with the empirical foundation to establish a clear causal link to (or an overwhelming likelihood of), say, an increased frequency of cyclones in the Americas. Given the high costs caused by the latter, we would need to reconsider *a posteriori* the social costs of Amazon deforestation and the economic value of the natural forest that was lost. **Yet, valuations here and now are limited by our present stage of knowledge; we cannot even assign a credible probability to that option. The example shows that it makes sense to apply a *precautionary principle* to decisions regarding the conservation of natural forest cover, even where a fully complete social cost-benefit analysis shows that the economic benefit from forest conversion are marginally higher than the net benefits: forest conservation makes sense from the viewpoint of minimising high environmental risk under considerable uncertainty. Rather than aiming to stretch valuation studies to ridiculous extremes, we should acknowledge that valuation is only one, though important tool for socially rational decision-making.**

Biodiversity and forest ecosystem services

12. Contrary to most previous studies, we will not consider forest biodiversity as an ecosystem service. For the Convention on Biological Diversity (1992) the term "*means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems*." From this it should be clear that biodiversity is integral to sustainable ecosystem functions and, therefore, vital for the availability of ecosystem services, from tourism to timber or non-timber products, and including the information flows. Though most economists would probably still try to isolate the "diversity" value elements - for local "risk spreading" and plant enrichment, for pharmaceutical prospecting, for existence values and for "option values". It is important to consider carefully this dichotomy between biodiversity and diversity.

13. Biodiversity provides a vast array of forest products, tourism and recreation opportunities, a storehouse for genetic resources, an insurance against extreme events, etc. Conservation of forest biodiversity appears therefore as a pre-requisite for the conservation of the complete array of forest ecosystem functions. Yet, **conserving this complete array may be neither, necessary, desirable nor realistic**. Forests are diverse and made of diverse interacting species that provide a wide range of goods and services, but:

14. From a human viewpoint, a **very high diversity is not necessarily linked to more useful or valuable forest goods and services**. The existing 'Vavilov' centres of annual crop genetic diversity, for example, are mainly in areas with low forest diversity. **Less species doesn't mean less important.** Monodominant *Gilbertiodendron* forests in Central Africa are not less valuable than the incredibly diverse lowland rainforests of Papua New Guinea. On the contrary, the "oligarchic" forests dominated by few species of abundant fruit bearing trees (e.g. *Myricaria dubia*) or palms (e.g. *Euterpe oleracea*) have often a higher economic value than more diverse forests (Peters 1992); the same is true for timber (e.g. tropical *vs*. boreal forests)

15. **Some ecosystem services do not require high diversity forest values or even forests per se to be provided**. For instance, scientific studies show that well-managed crop fields can provide the same clean water and have a higher dry season runoff than a natural forest. However, in most cases the variety of ecosystem services would be higher in natural or near natural ecosystems.

AN OVERVIEW OF THE DIFFERENT FOREST GOODS AND SERVICES

Goods

Timber

16. Although the focus of this paper is on forest *services*, it may be helpful to briefly keep in mind the (commercial and subsistence) *goods* that forest also provide. First, forests produce timber for both commercial and non-commercial uses. 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). In spite of the growing recognition of other forest products, timber still constitutes the commercially most important economic product for most forests.

Fuelwood

17. 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 was 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 2000). All sources agree that fuelwood is of major importance for poorer countries, and for the poor within those countries. Extraction rates may or may not be sustainable, depending on vegetation types (dry forests are often more vulnerable than rainforests) and population density (large urban centres and high densities are always correlated with unsustainable harvests). Fuelwood or charcoal seldom enters international markets and a great part of the former is for direct consumption or local sale.

Non-wood forest products (NWFPs)

18. While wood usually is the commercially most important product from forests, non-wood forest products - a highly heterogeneous category *per se* - occupy in many cases a prime place in rural people's livelihoods, both for products sold and for auto-consumption. Harvesting of various wild resources constitutes only in a few cases the primary source of cash or staples. But it has a vital gap-filling or "safety-net" function. Non-wood forest products help people survive in the case of famines, emergencies, in periods between crop harvests, and in some cases they constitute the main source of income for landless or unemployed people. Forests provide low cost building materials, income, fuel, food supplements and traditional medicines. Cash income from the sale of NWFPs can be highly variable, however, even for the same resource category. Earnings vary from a few dollars for *ad hoc* sales to several thousand US$ per year. In rural Madhya Pradesh, India, for example, NWFPs provide 40-63% of total annual income (Tewari & Campbell 1996). Across seven study areas in southern African, wild plant resources contributed US$194-$1114 per household per year (Shackleton *et al.* 2000). Subsistence values can also be high, particularly for poorer rural households. In Zimbabwe, for example, Cavendish (1997) found that extraction from wildlands for domestic uses made up about one third of average household incomes. In West Bengal, NWFPs account for 20-35% of household income (Kant *et al.* 1996). In the Maya Biosphere Reserve in Guatemala they accounted for 50% of the economic benefits from a community forest concession (Mollinedo *et al*. 2001)

19. **In 1996 the estimated value of the global markets for all herbal medicines was approximately US$14 billion** (Yuan & Grunwald 1997). Europe was the largest market representing one-half of the global trade. Asia commanded approximately 36 percent of the

global market. The estimated size of the North American market for herbal medicines in that year was approximately US$4 billion. 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, Yuan & Grunwald 1997).

ECOLOGICAL SERVICES

Water quantity and quality

20. About 119,000 cubic kilometres of water rains annually onto the Earth's land surface (Shiklomanov 1993). Much of this water is soaked up by soils and gradually meted out to plant roots or into aquifers and surface streams. 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. Is there rain in a rainforest because of forest cover or, conversely, is the humidity an exogenous precondition that allows forests to thrive? Wiersum (1984), Calder (1998), Bruijnzeel (1990) and Chomitz & Kumari (1996) all review parts of the literature on forest-water links. They highlight a number of myths where the hydrological benefits of forests have in some cases been exaggerated.

21. 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 rates are low in natural forests (0.3 t/ha/year) and in the fallow phase of swidden cultivation (0.2 t/ha/year) and in plantations where weeds and leaf litter are retained (0.6 t/ha/year). Erosion rates in swidden crop fields are ten times as high as in natural forest (2.8 t/ha/year) and in plantations where weeds and litter have been removed, erosion is more than a hundred times as great as in natural forests (53 t/ha/year). Erosion may also result from road construction associated with conventional logging rather than from a change in land use proper. Hodgson & Dixon (1988) find that the rate of erosion in Palawan, the Philippines, increased four times as a result of conventional logging, but the conversion of uncut forest to road surface increased erosion by a factor of 260. In Northern California, Hagans *et al.* (1986) found that roads can contribute 50 to 80% of the sediment that enters streams. Thus, although roads account generally for a very small percentage of the logged area, they are accounting for more than 80 percent of the surface erosion.

22. **Popular belief and casual empiricism link deforestation with decrease of runoff. However, scientific results do not confirm these beliefs for the great majority of cases.** Reviewing the results of several recent studies, Calder (op. cit.) 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. Forest types also matter and Bruijnzeel (1990) shows that "cloud forests" are capable of capturing atmospheric moisture because of their specific structures.

23. The same counter-intuitive conclusions arise from the study of the links between flooding and deforestation. 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.**

24. Another popular belief is that forests improve the quality of the water. In this case, scientific evidence agrees with popular wisdom. 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 forests themselves.

Climate regulation

25. There is a long-standing belief that deforestation reduces rainfall or that forests increase rainfall. 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. In fact, the situation is much more complicated. 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 it is **no longer 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**, and are likely to be numerically small.

26. 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 Storages

27. Trees and forests store carbon. A number of studies suggest potentially a very large size for these carbon storage functions. Brown and Pearce (1994), Dixon *et al*. (1994) and IPCC (2000) suggest benchmark figures for carbon content and loss rates for tropical forests. A closed primary forest stocks in vegetation and soils around 250 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.

28. To the extent that this carbon stored in forests is at risk of being released into the atmosphere, it has a high economic value. 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. In practical terms a better guide to the value of carbon is what it is likely to be traded at in a "**carbon market**". Markets for carbon dioxide (CO2) and carbon monoxide (CO) are however not that well established, although there has been some experimental trading of CO2 recently, usually in the $1 to $20 per ton range (see examples in Egenhofer and Mullins 2000, Williams *et al.* 2000). Costa Rica developed its system of Certified Tradeable Offsets (CTO). These CTO's are credits of carbon fixation based on the amount of carbon dioxide fixed in forests. The first batch were sold of 200,000 tons of carbon for US$10 per ton of C for US$2,000,000 to Norway (Suback 1999)

Pollination

29. Pollination is an essential part of a healthy forest ecosystem. While some plants are self-pollinated or wind-pollinated, **most trees require help from pollinators to produce fruit and seed**. Over 100,000 invertebrate species - bees, moths, butterflies, beetles, flies, etc. - serve as pollinators worldwide. At least 1,035 species of vertebrates, including birds, mammals, and reptiles, also pollinate many plant species. In turn, **the continued availability of these pollinators depends on the existence of a wide variety of habitat types needed for their feeding, successful breeding, and completion of their life cycles** (Nabhan & Buchmann 1997). The importance of pollination processes in agriculture is well documented. 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.**

30. **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

31. **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. For instance, the white-bark pine (*Pinus albicaulis*), a tree found in the Rockies and Sierra Nevada - Cascade Mountains, cannot reproduce successfully without a bird called Clark's Nutcracker (*Nucifraga columbiana*), which chisels pine seeds out of the tightly closed cones and disperses and buries them; without this service, the cones do not open far enough to let the seeds fall out on their own. 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

32. 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, recreational and amenity services

33. Many people have a deep appreciation of natural forests. That is apparent in the art, religions and traditions of diverse cultures, as well as in activities such as gardening and pet-keeping, nature photography and film-making, bird feeding and watching, hiking and camping, eco-touring and mountaineering, river-rafting and boating, fishing and hunting, and in a wide range of other activities.

Tourism

34. Forests hold a wide range of recreational opportunities. They constitute crucial habitat for game animals and fish sought by hunters and anglers. A major part of non-consumptive recreational activities such as hiking, bird watching, wildlife viewing and other such pursuits occur within forest stands. Ecotourism is a booming business and constitutes a potentially valuable non-extractive use of tropical forests. Some sites attract large numbers of visitors. In 1996, recreational activities accounted for a value of $1 billion in five national forests in the southern Rocky Mountains (Krieger 2001) and Barnhill (1999) estimated the total economic impact of hunting activities and wildlife viewing in the Southern Appalachians region at $594 million and $407 million, respectively. 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 them 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 values

35. There is some evidence that living near to forests secures some benefit in terms of amenity. From the few available studies (Anderson & 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

36. 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 women 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.

37. The belief that forest and trees are homes of the gods can be found in nearly every culture. It has led to both respect and reverence for sacred forests or trees, which were often protected from cutting or dismemberment. Whenever it is necessary to fell trees for a worthwhile purpose, special prayers are made to the tree's indwelling god or angelic being. The trees are respected for their practical material value and also for their importance in the community's spiritual life.

OF PRICES, VALUES AND VALUATION

Forest services - important but inexpensive?

38. **Economists are generally more concerned with *prices*, as observable and quantifiable indicators, than with broader value concepts**. First, prices do not reflect importance in a philosophical sense and seemingly unimportant goods are valued more highly by the market than very important goods. The classic illustration is the diamonds and water paradox, which perplexed economists through the eighteenth and nineteenth centuries until its resolution by A. Marshall. Water is clearly more important to people's livelihoods than diamonds, but it is cheap while diamonds are expensive. This is because prices are controlled by supply and demand, and the supply of water (at least in Marshall’s time and place) was so large that it exceeded the quantity that could be demanded at any price. Nowadays, increasing demand for and scarcity of water increases water prices, though not at the same scarcity level as for diamonds.

39. One might expect that the market would automatically take care of determining an optimal balance between the supply and demand of forest goods and services, and secure a socially desirable outcome. Certainly, markets can, and eventually will have to do part of the trick. The price of important forest services like watershed protection or pollination might only rise as soon as scarcity begins to prevail, creating a willingness to pay for these services on behalf of economic agents. Yet, several obstacles may prevail. First, as mentioned above, **scientific uncertainties may imply that we do not fully appreciate these services before they actually are gone**. Second, **state policies may provide “perverse incentives”, for examples by subsidising agricultural expansion over the preservation of forests and its**

services, or by denying people land tenure rights unless they occupy it “actively”. Third, **prices also reflect the distribution of income**. Poor people's demand for water, for example, thus has a lower weight in market prices than rich people's demand for diamonds. Finally, markets for forest services are somewhat more complicated than the market for diamonds, to the extent that external beneficiaries may “free ride” on natural services - they may receive them without paying for them to the supplier. The issue of service compensation shall be dealt with in greater detail in the last section of this paper.

Forest values and valuation

Values

40. The Webster Dictionary defines a value to be “the quality of a thing according to which it is thought of as being more or less desirable, useful, estimable or important”. Brown (1984) considers that value is “the worth of a product or service to an individual or a like-minded group in a given context”. Using these definitions, the value of any ecosystem might be defined in terms of its beauty, uniqueness, contribution to life support functions, livelihoods, commercial or recreational opportunities. Economic values of ecosystems are simply measures of how important ecosystem services are to people – what they are worth.

41. Forest ecosystem services can be grouped under use and non-use, direct and indirect values. Examples of direct use values in forests include timber, non-timber products and non-commodity benefits such as forest recreation. Indirect use values include the services of forests in protecting watersheds, fisheries and carbon storage. Non-use (option, existence and bequest) values include values attached to forests merely because they exist, or values attached to maintaining them for future options to use them or as bequests to coming generations.

42. As briefly noted above, there is a distinction between local, regional, national, and global values associated with forests:

(a) Local values generally refer to goods and services where the actual forest user derives the benefits (e.g. forest products collected by a community for sale or own consumption; timber harvested and sold by a logger; the recreation experience of a family).

(b) Regional values can be defined (e.g. at the state or provincial level) or by the nature of a forest-service link (e.g. downstream users of a watershed).

(c) National values refer to values that are captured beyond the local forest user (e.g. wildlife habitat protection for national tourism or hydroelectric generation).

(d) Global values refer to those received by individuals living outside the sovereign nation producing them (e.g. carbon sequestration).

(e) The distinction between local, national, regional and global values depends on who captures the benefits. In an operational sense, they are not necessarily mutually exclusive. The distinction is important to understand the incentives for conserving these values.

Do we need the valuation of forest services?

43. **It is generally assumed that the incomplete valuation of the forest goods and services is one of the main reasons contributing to deforestation and forest degradation** (Gregersen *et al.* 1995). If the total economic value of forests was really taken into account then people would recognise their importance and better protect and manage forest ecosystems. Valuation results can also be used in determining or influencing pricing, land use and incentive policies (Munasinghe 1993) or to influence or justify land-use and natural resource management decisions, including in terms of fiscal accountability and public support and internalisation of costs. Forest valuation is therefore a tool that can provide society and decision-makers with information for deciding among alternatives or upon preferred combinations of possible interventions (Kengen 1997).

44. Valuation of forests is nevertheless fraught with complexity and ambiguity. Most forest ecosystem services accrue to the recipients as public goods. They may be enjoyed by any number of people without affecting other people's enjoyment. For instance, an aesthetic forest view is a pure public good - no matter how many people enjoy the view, others can also enjoy it. Other services may be quasi-public goods, where at a certain level of use, other people's enjoyment may be diminished. For example, a public recreation area may be open to everyone. However, crowding can decrease people's enjoyment of the area. The problem with public goods is that, although people value them, no one person has an incentive to pay to maintain the good.

45. Even for public and non-market types of forest services, a variety of economic valuation techniques exist to express the benefit of the natural ecosystem service to society. We refer to Appendix A for a list of some of the main tools used in environmental economics. Nevertheless, alternative methods often give variable results that are highly sensitive to changed basic assumptions. **This is especially the case when valuation becomes "science fiction**", in the sense that it is extended into areas of biophysically complex ecosystem services where the scientific insecurities are high and the counterfactual baseline scenarios are ill-defined. We should hence regard economic valuation of forest services as often crude estimations of their true social value.

WHY ARE WE STILL LOSING FORESTS AND THEIR SERVICES?

Direct and underlying causes

46. Forests provide basic life support services, globally important products and are a source of cultural or aesthetic pride. Why is it then that we are still destroying or degrading forests at an unsurpassed rate?

47. Forest decline results from many direct causes, some of which are natural but are aggravated by humans, such as climate change. The most important factors are human-induced causes, including both factors of deforestation: a) the complete or near-complete removal of tree cover, and b) forest degradation resulting from significant changes in forest structure that diminish or destroy its ability to deliver certain services. 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).

48. Statements about these direct causes may provide little insight unless we answer why each of the proximate factors comes about: 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 the causes of deforestation 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.

Development and forest loss

49. It is good to be aware that pressures on forests often originate from "underlying" development trends in society. Yet, 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 because people are poor, they are inevitably forced to clear their forests to survive, which will make them even worse off. However, the evidence shows that "wealth" is at least as important a deforestation explanation as "poverty" by increasing the ability and incentives to clear forests. Even poor people predominantly choose among several livelihood options to 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 the policy factors just sketched, some general development trends are important to keep in mind:

(a) *High population growth*: Another billion people are likely to be added to world population for each of the next three decades. This population increase will occur mainly in developing countries, creating a strong demand for agricultural lands and forest products. To meet the associated food demand, crop production will need to increase, consistently, by over 2% every year through this period (Walker & Steffen 1997). One response to the food supply issue is new land-saving technology, another one is more efficient production and distribution. In the tropics, one major solution is the likely conversion of forests to agricultural land.

(b) *High and rising consumption levels*: Concurrent with the expanding population, economic advances will lead to an increase in per capita consumption of natural resources. Humans are already diverting nearly 40% of the total primary production (Vitousek *et al.* 1986). The trend is that humanity will appropriate an ever-increasing share of the earth's resources. Consumerism is intimately related to industrialisation, both driving industry and in turn being driven by advertising and by a shift to disposable and short-life products. Today, a fifth of the world's population, mainly from industrialised countries, uses 85% of the resources.

(c) *Trade*: It has been hypothesised that ancient cultures like the Mayas, the Aztecs (Central America and Mexico) Mesopotamia (Near East) or Carthage (North Africa) gradually expanded their consumption levels, expanded cropping into more and more marginal lands and ultimately over-exploited their natural resource base - which allegedly was one reason for their decline (Ponting 1991; McNeely 1993). Nowadays, the globalisation of trade and investment flows enables consumers in the developed world to expand the use of paper, timber, minerals, energy etc., without suffering - or often even without noticing - the environmental consequences of their expanding consumption levels. Trade provides the means and incentives to spatially divorce consumption from the natural resource base. The financial and political power of the large companies adds dramatically to pressures in forest ecosystems that had previously been too remote to attract attention, such as some Central African's rainforests or the far-eastern Russia's Taiga.

(d) *Specialisation and homogenisation*: The global economic exchange, based on principles of comparative advantage and specialisation, has increased both uniformity and interdependence. In forest areas, the rapid and total conversion of forests into cash crops is an advancing phenomenon, fuelled by better transport access and expanding markets. The introduction of specialised commercial production systems implies a loss of biodiversity, and frequently a reduction of other forest services. Simultaneous to the productive specialisation processes, a cultural homogenisation sweeps across the world, eroding the vast range of human knowledge, skills, beliefs, and responses about biodiversity. This leads to a great cultural impoverishment in the pool of human intellectual resources. Loss of cultural diversity leads to loss of biological diversity by diminishing the variety of approaches to human, plant and animal coexistence that have been successful in the past, and by reducing the possibility of imaginative new approaches being potentially developed in the future.

(e) *Deficiencies in knowledge and in its application*: While traditional knowledge about biodiversity is continuously being lost, scientific knowledge about forest services lags behind the increasing capacity of humankind to change and convert forests. Human gaps in knowledge are the result of a lack of understanding of how various components fit together and interact and about changes in ecosystem use. Even where scientific or traditional knowledge exists, it does not flow efficiently to decision-makers, who often fail to develop policies that reflect the scientific, economic, social and ethical values of biodiversity.

Can forest loss be stopped?

50. We can divide ongoing deforestation 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.

51. The traditional conservationist argument has been that situation (a) 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 (a) 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 (b)]. But situation (c) and (d) are probably more common than both (a) and (b): 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 (c), 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 (d) 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.

52. Situation (a) is where the emphasis of policy leverage and conservation action has traditionally has been put. On the other hand, situation (d) 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. This means that transfers from the external beneficiaries to the local land users are necessary in order to give the latter an incentive to conserve the forest services they provide; external users 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, such as those that incur a high opportunity costs for not “developing” their forestlands, both service providers and off-site beneficiaries can potentially gain. The following section thus looks briefly at the most promising initiatives in the field of the conservation of forest services: the introduction and design of compensation schemes.

CAN WE PAY OUR WAY OUT?

Basic principles of payment schemes

53. 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.

54. 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*. He must believe the forest owner is a critical service supplier whose actions affect his or her water quality.

(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 (c) may induce the forest owner to adopt *strategic behaviour* for example, to threaten to deliberately clear forest which he or she otherwise would not have touched, in order to make 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 ways can be found to limit strategic behaviour, in order to avoid excessive cost of the payment scheme.

(f) As a general observation, 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 provides 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.

Carbon storage and sequestration

55. Forestry projects that store or sequester carbon can under the Clean Development Mechanism (CDM) of the Kyoto Protocol receive technological and financial transfers. At the 6th session of the UNFCCC in Bonn in July 2001, forestry activities under CDM were limited to afforestation and reforestation, for example, activities to reduce deforestation were *not* included for the first commitment period (2008-2012). Still, there are a number of uncertainties as to the terms of the future implementation. The political doubts relate to the ratification of the Kyoto protocol and to the implementation guidelines for land use, land-use change and forestry (LULUCF) activities. Furthermore, a number of methodological problems still constrain progress - including additionality, duration, project boundaries and leakage (see IPCC 2000 for a comprehensive overview). Over 30 carbon-offset projects have been developed to date (IPCC 2000), and most of them are in the incipient stages and it is still unclear whether these projects will be eligible for CDM-based credits.

56. What type of forest owners and managers are likely to benefit first from compensation schemes? Many smallholders and communities do not have formal property rights to the land they use. This makes it difficult to make agreements with them, as they frequently do not have effective and exclusive control over land use (prerequisite 2). Transaction and

monitoring costs of working with smallholders may be large, including the administrative costs of implementing the payments to them. Large-scale plantation schemes under simple management and clear tenure might be preferred by investors, compared to small-scale forestry involving poor rural households. On the other hand, smallholders and forest communities control an increasing share of tropical forestland (though it might be argued that 100 years ago small holders and communities controlled most tropical forest land, so over that time period there has been a decreasing share of control), so bringing them on board is critical for achieving climate mitigation goals. There are examples of high involvement of local communities in carbon forestry, such as the PROFAFOR project in Ecuador (CIFOR 2001) and Uganda (FACE Foundation see http://www.facefoundation.nl/Eng/projectAfrica.html). An inherent bias towards large schemes might also be counteracted if development agencies decide to subsidise these schemes towards a more pro-poor profile.

Biodiversity conservation

57. Numerous protected areas were already in existence in tropical countries before World War Two. Since the 1970s, many protected areas have been added. While this process may still not be entirely concluded, it seems clear political resistance is mounting against land purely being set aside for conservation, restricting previous uses and/or relocating people. This pressure comes not only from local residents affected by use restrictions, but also by national governments that experience limitations on the spatial expansion of agricultural and other land uses and their limited capacity to manage protected areas properly. Local people want alternative income sources in return, and politicians want 'expansion zones' where they can channel the increasing population. One response has been the widespread attempt to establish Integrated Conservation and Development Projects (ICDPs). Unfortunately, most of them have achieved little success, especially in terms of the forest-conservation objectives that had originally justified their funding (Wells & Brandon 1992; Wunder 2001).

58. As a basic problem, the core underlying assumption of the ICDPs has proved questionable. Providing alternative employment does not necessarily reduce the incentives or the means of forest encroachment, in fact the opposite might well be the case. They have also proved to be highly complex and demanding in administrative terms. An alternative would be to compensate people directly for the conservation of biologically diverse forests on their land, and to make these payments directly contingent on a monitored quality of the forest resource. This can either take the form of investments or, often preferably, of annual payments that can be halted in the case of non-compliance. The incentives would be much more direct and focused than development interventions. A scheme of this sort was implemented in 1992 by the BOSCOSA Project in the biodiversity rich forests of the Osa Peninsula in Costa Rica. This scheme was developed with the participation of the forests owners and provided them with a payment of US$24^{-1} ha year^{-1}, which was based on the opportunity cost of their land. A trust fund called FIPROSA was created and managed with the participation of different stakeholders. The five-year agreements resulted in an effective way to conserve forests while at the same time helping poor people living near the Corcovado National Park. The demand from other communities, that otherwise would convert their forests into agricultural land, grew rapidly but unfortunately not enough funds were available for the scheme to expand.

59. These 'set-asides' with so-called 'conservation performance payments' or 'conservation concessions' are still in a pioneer phase of application, but donor funding seems to be available on the demand side (Ferraro 2000; CIC 2000). Incipient implementation by large conservation organisations, such as Conservation International (CI), has been concentrated on conservation concessions as an alternative to timber concessions - i.e. paying an annuity, typically to the country's forest service, for area *not* to be logged. These experiments have mostly been focussed on avoiding forest degradation, rather than deforestation. Payments are generally made to state institutions rather than to local landholders.

60. It will be interesting to see this type of scheme applied more to deforestation proper, such as to potential agricultural conversion zones, with payments made directly to landholders. As indicated in the carbon section above, the latter may be more complicated to implement. First, the per-hectare opportunity costs of conservation in agricultural expansion zones may often be higher than in forests that are exclusively logged. Second, in many situations one would need to compensate and monitor a myriad of smallholders with weak property rights over their land.

61. One successful experience is being implemented nationwide in Costa Rica, where in 1996 the Forest Law incorporated an innovation that consists of the decision to compensate forest owners for the ecosystem services their forest provide to society. This program is known as the Payment for Environmental Services (PES) and has been financially supported by a tax on fossil fuels that internalises, at least partially, the cost of environmental degradation. New proposals have also been developed involving the private sector, such as, including the cost of protecting watersheds for hydroelectricity generation and drinking water production (Table 2).

62. These types of efforts reinforce the multifunctional value of forests, where tropical biodiversity plays a very important role. The underlying hypothesis is that forests would be better conserved if forest owners were compensated for the services provided by their forests to society. One of the problems in implementing sustainable management practices is that, although society benefits from it, forest owners usually do not capture these benefits. In this respect, the payment of environmental services may be an effective way for internalising benefits to those people responsible for implementing in the field sustainable practices that contribute to conserving tropical forests.

The four environmental services recognized by the Costa Rican Forest Law No. 7575

- Mitigation of greenhouse gases
- Protection of water sources for urban, rural and hydroelectric uses
- Protection of biodiversity for its conservation and sustainable uses, including scientific, pharmaceutical and genetic improvement
- Protection of ecosystems, forms of life and natural scenic beauty for tourist and scientific uses

63. Different forestry land use types are entitled to receive payment for environmental services in the Costa Rican PES Program, however, the payment and the commitment period varies according to the land use type as is shown in Table 1.

64. Since 1996 Costa Rica has been working to establish an institutional structure with credibility and operational capacity to manage this Program. It includes the National Fund for Forestry Finance (FONAFIFO), responsible for managing and financing projects, the Costa Rican Office for Joint Implementation (OCIC), responsible for marketing the environmental services in the international market, and the state agency the National System of Conservation Areas (SINAC), which manages all protected areas and facilitates the development of the private sector.

65. An important debate has taken place around the payment and how it should vary according to the forest type. In this respect, the Tropical Science Centre, in a study commissioned by SINAC, estimated an average payment of US$50 ha^{-1} yr^{-1} as a starting point (Watson *et al*. 1998).

Table 1. Amount paid for environmental services and commitment period for each forestry land use type in the Payment of Environmental Services in Costa Rica (October 2001. 1US$=329 colones).

Land use type	**Total amount paid[4] over a five year period (US$ ha^{-1})**	**Annual payments as percentage of total for years 1-5**					**Commitment period[5] (years)**
		1	2	3	4	5	
Reforestation	565	50	20	15	10	5	15
Natural Forest Management	344	50	20	10	10	10	10
Natural Forest Preservation or Regeneration	221	20	20	20	20	20	5

66. In 1997 US$14 million was invested in the payment for environmental services in Costa Rica, which resulted in the reforestation of 6,500 ha, the sustainable management of 10,000 ha of natural forests and the preservation of 79,000 ha of private natural forests. Eighty percent of this funding originated nationally from the tax on fossil fuels; the other 20% came from the international sale of carbon from public protected areas and contributed with US$2 million dollars. More recently, several organisations from the public and private sector have signed agreements with FONAFIFO for the protection of natural forests in critical watersheds or lands of value for its role as biological corridors. Table 2 shows the different sources of funding to the PES in Costa Rica. Two private and one public hydroelectric power plants are by this means internalising the costs of forest conservation. A brewery which depends on a high quality supply of water is doing the same. It should be mentioned that most

[4] The payment is modified every year according to inflation (approx. 10%) but affect only new contracts.

[5] Period when the forest owner transfers to the Costa Rican Government the rights to market the environmental services from the forest or tree plantation receiving the PES.

of this funding is directed to natural forest protection and regeneration. Future agreements need to be developed in order to promote sustainable forest management practices that also have the potential to provide these environmental services.

67. Recently, the World Bank provided a US$32.6 million loan to Costa Rica to fund the PES trough a Project called "Ecomarkets". It came along with a grant from the Global Environment Facility (GEF) of approximately US$8 million. US$5.6 million will be invested in PES for private lands critical for their role as biological corridors previously identified by SINAC and the Mesoamerican Biological Corridor, an international conservation initiative supported by all Central American countries. The target with this project is to protect 100,000 ha of natural forests (Table 2). This was the first time the PES received an international compensation for biodiversity conservation.

Table 2. Sources of funding to the Payment of forest Environmental Services in Costa Rica.

Enterprise or Organisation	**Watershed or region target**	**Total area funded (ha)**	**Amount contributed (US$ $ha^{-1}yr^{-1}$)**
Energía Global	Volcán River	2,493	10
	San Fernando River	1,818	10
Hidroeléctrica Platanar	Platanar River	1,400	15 for lands with title 30 for lands with no title plus regent costs and 5% for FONAFIFO
Compañía Nac. Fuerza y Luz	Aranjuez River Balsa River Cote Lake	11,900	53 (40 for forest owner rest to cover costs of regent and FONAFIFO)
GEF	Biological corridors identified	100,000	10
Brewery "Costa Rica"	Rio Segundo	1,000	45 plus regent costs and 5% for FONAFIFO

Source: FONAFIFO. October, 2001

68. The demand for PES is much higher than the funding available. It is estimated the funding available could only cover between 15-30% of the demand. For example, in 2000 the demand was approximately 175,000 ha, but the PES could only fund 21,000 ha, while in 2001 the demand was 97,000 ha but only 28,000 ha is expected to be funded. This may somehow indicate that forest owners might be in agreement with the amount paid for the environmental services provided by their forests.

69. A priority has generally been given to fund protection of natural forests against sustainable forest management (SFM) and tree plantations. In this respect, some studies have shown that Costa Rican society is generally willing to internalise the costs to maintain the ecological functions and environmental services from forest ecosystems. A study by CATIE found that most Costa Ricans agreed to pay for the environmental services provided by forests. The same study shows that the services Costa Ricans most value are water protection, followed by biodiversity protection, mitigation of greenhouse gasses and scenic beauty (35%, 25%, 20% and 20% respectively). At the same time they considered water

protection as an environmental service that directly benefits them, while the other services were seen as indirect benefits. In that respect they prefer the conservation of natural forests against tree plantations, because, according to their perceptions, it is directly correlated to biodiversity conservation and the maintenance of other ecological functions.

Hydrological benefits

70. As mentioned above, scientific insecurities, complexities and site-specific features abound in regard to water-related forest benefits. Nevertheless, this has not impeded the implementation of a number of payment schemes to upstream forest owners. Many of them have been in Latin America. In Colombia, Costa Rica and Ecuador, payments have been implemented from beneficiaries such as hydroelectric power plants, drinking water consumers, and users of irrigated water (Pagiola 2001). Most other experiences of this type seem to come from developed countries, such as the USA, France and Australia (Perrot-Maitre & Davis 2001).

71. Payments for water services have often been combined with biodiversity conservation payments (see last section), but as yet there seem to be no specific assessments of the welfare implications of these transfers. Brazil has in several federal states implemented an Ecological VAT, where heavily forested municipalities are tax-rewarded for their water and recreation services (Grieg-Gran 2000). As a result, they have received a more than proportional share of VAT tax revenues, based on regular monitoring of their forest size and quality, so that forest rehabilitation is also being rewarded.

Forest-based tourism

72. Tourism is one of the world's largest and fastest growing industries. As mentioned above, forests offer and support various recreational activities, and eco-tourism and forest-based tourism have made up highly dynamic segments within the sector. Projections were that expenditures on nature-based tourism would double between 1995 and 2000 (Wells 1997). For international high-class ecotourism, open areas with a large frequency and good visibility of charismatic mammal species, such as savannah areas in Southern and Eastern Africa or the Galápagos Islands, have done particularly well. But tropical forests have occupied an important niche. A country like Costa Rica has, in spite of an accelerated historical deforestation process, been able to promote an ecotourism concept based on a well-functioning protected area system, which has made the sector a principal source of foreign exchange. This also shows that tourism may make use of high-quality forests in a fragmented landscape with easy infrastructure access, rather than large and remote frontier forests. While there is a clear upwards trend in global economic revenues from tourism, the flip side of the coin is that international tourism is highly sensitive to security problems and political turmoil, which in politically unstable countries causes large fluctuations in tourism incomes.

73. To what extent does forest-based tourism help to compensate and promote forest dwellers' conservation efforts? Tourism differs from the three above forest-service cases in the sense that it provides not only off-site 'externalities', but it also sets off local cash flows related to tourists' on-site expenditure on tourism goods and services. The latter are usually also intensive in the employment of unskilled labour (services in hotels, restaurant, transport,

etc.), which tends to favour the poor. In other words, the hedonic value of forests and protected areas attracts tourists and triggers other expenses that favour the local economy. In some cases, tour companies may also explicitly pay fees to local communities for the right to continuously access a locally controlled natural site.

74. Unfortunately, many case-study assessments of local impacts have focused one-sidedly either on perceived cultural distortions or on the *relative* distribution of tourism income, stating the somewhat self-evident conclusion that tourism companies tend to reap the bulk of profits from luxury operations. However, even a minor share in that profit going to local people can raise their absolute household income significantly - and provide efficient conservation incentives. Evidence from many parts of the world suggests that it is possible to design nature-based tourism operations in a way that significantly benefits local people. This includes the classical CAMPFIRE project in Southern Africa (The Zimbabwe Trust *et al.* 1994), the Annapurna Conservation Area Project in Nepal (Gurung & Coursey 1994) and community benefits in Belize (Lindberg & Enríquez 1994). But this also holds true for company-run international ecotourism operations in Ecuador (Wunder 1999) or nationally dominated tourism of urban backpackers to forest recreation areas in Brazil (Wunder 2000). Regrettably, the economic potentials for local income generation from this variety of institutional arrangements are still ignored by most forest stakeholders.

CONCLUSION

75. Forests are still disappearing in the tropics at a rapid pace, and natural forests worldwide continue to be under severe degradation and conversion pressures. This endangers forests' biological diversity, and the ecosystem services related to it. In some cases, this process is driven by the continuous use of 'perverse' institutional arrangements and by policy incentives that are heavily biased against forests. But in most cases, agricultural expansion, forest conversion and interventions are land-use responses to development trends related to growing population, higher consumption, expanding trade and specialisation. Predominantly, these responses are economically rational from the local and/or national point of view - people tend to cut down forests because it is profitable. In many cases, they have only failed to accelerate deforestation previously because they lacked sufficient capital and infrastructure. Admitting that this is the predominant situation is an important shift in the diagnosis of deforestation, as reflected in the bulk of the recent literature. The Amazon deforestation debate is a prime example in case for the changing direction of the debate, recognising the legitimate rationality of (some) continued deforestation from the perspective of most national stakeholders (Kaimowitz 2001).

76. This also has important strategic implications for forestry and forest conservation. Notably, in some cases forest services represent high economic values that could "tip the balance" in a social cost-benefit analysis from forest conversion to conservation, were they to be followed up by corresponding financial flows. Forests owners or users must have incentives to conserve forests, which make them a more attractive option than clearing for coffee, bananas, or pastures. 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.

77. 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 socially preferable to deforestation – and one should 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 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. Still, if our concern is to conserve these services, then valuation is insufficient (Heal 1999). 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.

78. 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. In some cases, we can provide the incentives without valuing the services, though we need some basis for making the decisions of how much to pay out. Too often, we value the services without providing incentives for conserving them (cf. the many valuation studies and manuals in the literature). Ecosystem services from tropical forests over the next decade will increase in importance and value, relative to "classical" forest products such as tropical hardwoods. As tropical forests recede, areas to be harvested will also become scarcer. But timber supply is more flexible than is 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 some forest products, domestication and synthetic substitutes will play a greater role. Notably, the same substitutability does not exist for all forest services, many of which are unique to natural forests. That is particularly 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 should still remember 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.

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APPENDIX A: VALUATION TECHNIQUES

1. There is a wealth of information on economic valuation techniques for ecosystem services. The interested reader can consult Bann (1998), Godoy & Lubowski (1992), Hanley & Ruffel (1992), Heal (1998), Kengen (op. cit.), Pearce & Moran (1994, 2001), Pearce & Pearce (2001) or http://www.ecosystemvaluation.org/. There are three generally accepted approaches to estimating economic values of ecosystem services, each one including several methods.

Market Prices – Revealed Willingness to Pay

2. The values of ecosystem goods or services traded in markets can be measured using market prices and can be estimated by estimating consumer and producer surplus, as with any other market good. Other ecosystem services, such as clean water, are used as inputs in production, and their value may be measured by their contribution to the profits made from the final good. Some ecosystem or environmental services, like aesthetic views or many recreational experiences, may not be directly bought and sold in markets. However, the prices people are willing to pay in markets for related goods can be used to estimate their values. For example, people often pay a higher price for a home with a view of the forest, or will take the time to travel to a special forest for fishing or bird watching. These kinds of expenditures can be used to place a lower bound on the value of the view or the recreational experience.

Market Price Method

3. The market price method estimates the economic value of ecosystem products or services that are bought and sold in commercial markets. It can be used to value changes in either the quantity or quality of a good or service and uses standard economic techniques for measuring the economic benefits from marketed goods, based on the quantity people purchase at different prices, and the quantity supplied at different prices.

Productivity Method

4. The productivity method (or net factor income or derived value method) is used to estimate the economic value of ecosystem products or services that contribute to the production of commercially marketed goods. It is applied in cases where the products or services of an ecosystem are used, along with other inputs, to produce a marketed good.

Hedonic Pricing Method

5. The hedonic pricing method is used to estimate economic values for ecosystem or environmental services that directly affect market prices. It is most commonly applied to variations in prices that reflect the value of local environmental attributes.

Travel Cost Method

6. The travel cost method is based on the assumption that consumers value the experience of a particular site at no less than the cost of getting there, including all direct transport costs as well as the opportunity cost of time spent travelling to the site (i.e. foregone

earnings). This survey-based method is widely used to estimate the value of forest recreational benefits.

Circumstantial Evidence – Imputed Willingness to Pay

7. The value of some ecosystem services can also be measured by estimating what people are willing to pay, or the cost of actions they are willing to take, to avoid the adverse effects that would occur if these services were lost, or to replace the lost services. Forested water catchments provide clean water. The amount that people pay to set up a water purification plant in areas similar to those protected by the forests can be used to estimate the willingness to pay for the water protection services.

Damage Cost Avoided, Replacement Cost, and Substitute Cost Methods

8. The damage cost avoided, replacement cost, and substitute cost methods are related methods that estimate values of ecosystem services based on either the costs of avoiding damages due to lost services, the cost of replacing ecosystem services, or the cost of providing substitute services. They consider that the costs of avoiding damages or replacing ecosystems or their services provide useful estimates of the value of these ecosystems or services. This is based on the assumption that, if people incur costs to avoid damages caused by lost ecosystem services, or to replace the services of ecosystems, then those services must be worth at least what people paid to replace them. Thus, the methods are most appropriately applied in cases where damage avoidance or replacement expenditures have actually been, or will actually be, made.

Surveys – Expressed Willingness to Pay

9. Many ecosystem services are not traded in markets, and are not closely related to any marketed goods. Thus, people cannot "reveal" what they are willing to pay for them through their market purchases or actions. In these cases, surveys can be used to ask people directly what they are willing to pay based on a hypothetical scenario. Alternatively, people can be asked to choose tradeoffs among different alternatives, from which their willingness to pay can be estimated.

Contingent Valuation Method

10. The contingent valuation method (CVM) is used to estimate economic values for all kinds of ecosystem and environmental services. It can be used to estimate both use and non-use values, and it is the most widely used method for estimating non-use values. It is also one the most controversial of the non-market valuation methods. The contingent valuation method involves directly asking people, in a survey, how much they would be willing to pay for specific environmental services. In some cases, people are asked for the amount of compensation they would be willing to accept to give up specific environmental services. It is called "contingent" valuation, because people are asked to state their willingness to pay, contingent on a specific hypothetical scenario and description of the environmental service.

Contingent Choice (Choice Modelling) Method

11. This method is similar but differs from contingent valuation because it does not directly ask people to state their values in monetary terms. Instead, values are inferred from the hypothetical choices or tradeoffs that people make. The contingent choice method asks the respondent to state a preference between one group of environmental services or characteristics, at a given price or cost to the individual, and another group of environmental characteristics at a different price or cost. Because it focuses on tradeoffs among scenarios with different characteristics, contingent choice is especially suited to policy decisions where a set of possible actions might result in different impacts on natural resources or environmental services. In addition, while contingent choice can be used to estimate dollar values, the results may also be used to simply rank options, without focusing on dollar values.

Appendix B: Terms of Reference (ToR)

1. CIFOR is invited to undertake the preparation of the issues paper on Ecosystem Services. The issues paper will set out clearly and succinctly the main issues of forests in relation to the item concerned (such as scientific and technical, policy and implementation aspects). It should set out the conventional wisdom, contemporary understandings and views, as well as uncertainties that still exist. It should also layout the challenges and conflicts in relation to SFM (including biodiversity conservation). These issues should be explored at various spatial scales (local, national, regional and global). The paper should not be more than 20 pages, and should include an executive summary. A draft paper should be sent to GEF Secretariat by 30th October, and a final paper by 15th November. You are welcome to co-author it with other key institutions, agencies and country counterparts. You will also provide key points for the video, and may be contacted for brief interviews with the team (TVE) producing the forestry video.

2. You will liaise with Ms. Kanta Kumari from the GEF Secretariat