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ANALYSIS

Ecotourism: a means to safeguard biodiversity and ecosystem functions?

Stefan Gössling *

Human Ecology Division, Lund University, Finngatan 16, 223 62 Lund, Sweden

Abstract

This paper argues that, at present, ecotourism can contribute to safeguard biodiversity and ecosystem functions in developing countries, even though meeting the requirements for ecotourism is extremely difficult. A cost-benefit analysis of those ecosystems richest in species diversity, i.e. tropical rainforests, leads to the conclusion that non-use values often outweigh the values of conventional uses (clear-cutting, pasture, etc.), but are hardly considered in development decisions. Therefore, tourism and its high direct use value can play an important role as an incentive for protection. As tourism causes significant emissions, e.g. by flying, the concept of Environmental Damage Costs is introduced and integrated into the calculations. Further, international tourism development is analyzed and related to protection goals. Visitation rates of sensitive areas need to be limited; education, management, and control measures have to be integrated; and the proportion of money captured from tourists has to be increased. In the long run, tourism needs to undergo substantial changes.

Keywords: Biodiversity; Cost-benefit analysis; Ecosystem functions; Ecotourism; Rainforests

1. Introduction

Ecosystems provide services essential to humanity, which in short can be described as supporting life, supplying materials and energy, and absorbing waste products (Daily, 1997). As these services are encoded in biodiversity, the importance of maintaining nature's variety in general is clearly rendered prominent (Chapin et al., 1997; Tilman, 1997; Vitousek et al., 1997). Nevertheless, human activities have contributed to an increase in species extinction, which has made the implementation of safeguarding strategies an imperative issue (Ehrlich and Ehrlich, 1981; Wilson, 1985; Lawton and May, 1995). In the following,

* Tel.: +46-46-2223696/142493; fax: +46-46-2223695.
E-mail address: stefan.gossling@humecol.lu.se (S. Gössling)

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the role of present and future tourism in the conservation process is discussed.

2. Biodiversity and tourism

Species richness generally increases with decreasing latitude. Due to this biogeographical phenomenon, the overwhelming majority of species are located in developing countries (DCs) (WCMC, 1992). DCs often face problems like rapid population growth, workforce-pressure, lack of capital and foreign debts, which lead to over-exploitation of wild living resources, expansion of agriculture, forestry and aquaculture, and—with mounting pressure on the remaining habitats—to loss of biodiversity (Burgess, 1993; Vorlaufer, 1996) (Fig. 1).

Industrialized countries (ICs), in contrast, are characterized by high and increasing demand for nature-based vacations, with protected areas representing first-rate attractions. Tourism could therefore be a means of redistributing economic resources, mitigating the socio-economic situation both at local and national scale and contributing to biodiversity conservation (Budowski, 1976; Western and Henry, 1979; Boo, 1990; WWF, 1995). There is a broad consensus that such tourism should be fully compatible with conservation goals, while at the same time posing the minimum threat to the continuation of local culture and society. Moreover, it should contribute by means of income and education to the conservation of ecosystems. Meeting these requirements would qualify the process as ecotourism (Goodwin, 1996; Brown et al., 1997).

Present definitions of ecotourism have excluded travel-related resource consumption. Major preconditions for strong sustainability are the conservation of non-renewable resources and waste emission within the assimilation capacity of ecosystems (Turner, 1993; Rennings and Wiggering, 1997). Air travel consumes both fossil fuels and leads to significant emissions—it is therefore a weak sustainability activity.

Ecotourism represents a small segment of nature-tourism. Nature-tourism is understood as travel to relatively undisturbed or uncontaminated natural areas and constitutes about 15% of all tourism (WWF, 1995).

However, exploitation of natural resources, consumerism, and extremely high per capita de-

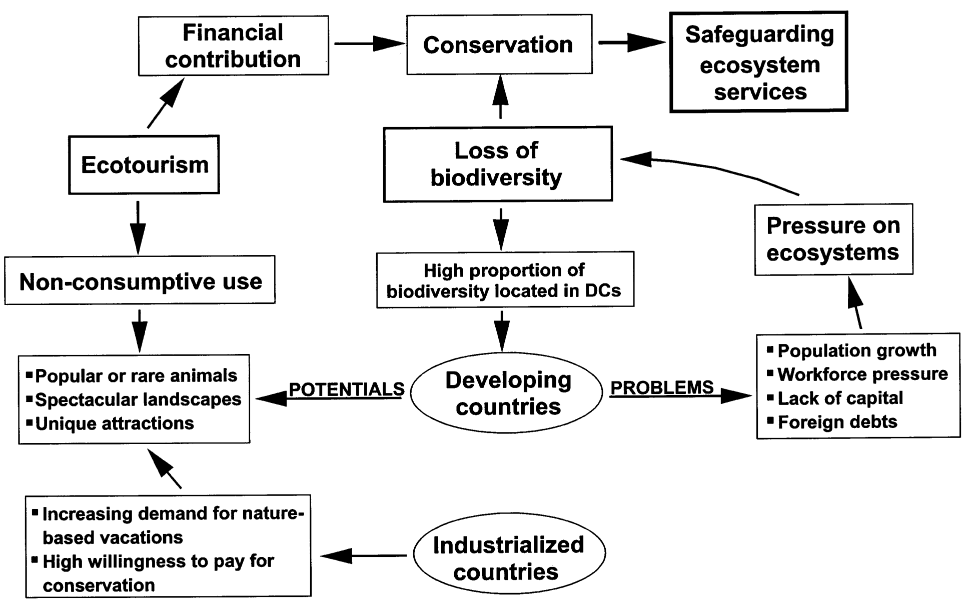

Fig. 1. Biodiversity loss and ecotourism.

mand of resources also contribute to loss of biodiversity. The root causes are in fact embedded in the way societies use resources, the failure of economic systems, and present policies to value environment and its benefits (Costanza and Folke, 1997).

3. Conservation: how and where?

The maintenance of a significant proportion of the world's biodiversity at present only appears feasible by maintaining organisms in their wild state and within their existing range (McNeely et al., 1990; WCMC, 1992). With protected areas being at the forefront of efforts to conserve biodiversity (Wells and Brandon, 1992), the World Commission on Environment and Development (1987) proposed to preserve 12% of the terrestrial surface, representing all kinds of biomes. This figure possibly represents a minimum (for more detailed discussion see Myers, 1983; Noss and Cooperrider, 1994), because most protected areas today face moderate to high human use (IUCN, 1992; WCMC, 1992) and are exposed to the influences of, for example, transborder acid rain, tropospheric nitrogen deposition, or changes in atmospheric composition and climate (Ehrlich, 1988; Chapin et al., 1997). Moreover, some protected areas are only small remnants of habitats, not big enough to sustain all occurring species, while others are not sufficiently well managed to achieve the conservation objectives (Noss and Cooperrider, 1994; Ceballos-Lascuráin, 1996). Nevertheless, conserving more extensive tracts of habitats seems to be politically difficult at the moment in the absence of practicable and sustainable income generation opportunities for DCs.

Overall, the concept of protected areas may be a necessary response in times of rampant habitat loss, but it does not address the fundamental economic and social causes of the threats to biodiversity. Boundaries that go with protection may even suggest that surrounding areas are free for exploitation (McNeely et al., 1990). Protection of biodiversity 'hot spots' is therefore a necessary but not sufficient condition for biodiversity conservation under a strong sustainability policy objective.

The IUCN (1990) has set up different categories of protected areas (Table 1).

These cover the most common types of reserves, with category I (Scientific Reserve/Strict Nature Reserve) being the only one excluding mainly any use. This category covers 9.3% of the overall protected area. Nature Conservation Reserves/Managed Nature Reserves/Wildlife Sanctuaries (category IV) are the most prevalent type in terms of number of sites, while National Parks (category II) cover more area than any other (40.7%). The majority of the world's protected area is contained in a relatively few large sites, with the Greenland National Park (972 000 km^2) and the Great Barrier Reef Marine Park (340 000 km^2) accounting for almost 17% of the global total (7 734 900 km^2). At present, about 5.2% of the earth's land surface are protected in roughly 8500 sites (WCMC, 1992).

As indicated above, an equal distribution of protected areas over the countries of the world is not efficient nor sufficient for sustainability, as their land surface share is not of equal value for biodiversity conservation. Indeed, a very few countries, lying partly or entirely within the tropics, account for a very high percentage of the world's biodiversity: 60–70% is sheltered by Brazil, Colombia, Ecuador, Peru, Mexico, Congo (formerly Zaire), Madagascar, China, India, Indonesia, Malaysia, and Australia. Therefore, they have been characterized as 'megadiversity countries' (Mittermeier and Werner, 1990). Other biodiversity 'hot spots' have been identified by Mittermeier (1988), Myers (1988a, 1990b), Cowling et al. (1992), and Gentry (1992a).

In Table 2, a general database is provided for 60 of the more important tourist destinations in DCs.

Columns 1–3 list data on the total surface, the remaining proportion of original wildlife habitat, and the area currently protected. Data are also presented for population (4), Gross National Product (GNP) per capita (5), foreign debts per capita (6), tourist arrivals (7) and receipts (8), receipts per tourist (9) and tourism receipts as percentage of exports (10). These allow for conclusions on tourism's structure and importance relative to the socio-economic background of each country.

Table 1
Categories of protected areas[a]

Basic categories		
I	Scientific Reserve/Strict Nature Reserve	Managed mainly for science or wilderness protection Tourism: not permitted (only for scientific purposes)
II	National Park	Managed mainly for ecosystem protection and recreation Tourism: high priority
III	Natural Monument/Natural landmark	Managed mainly for conservation of specific natural features Tourism: high priority
IV	Nature Conservation Reserve/Managed Nature Reserve/Wildlife Sanctuary	Managed mainly for conservation through management intervention Tourism: permitted (basically including hunting tourism)
V	Protected Landscape or Seascape	Managed mainly for landscape/seascape conservation and recreation Tourism: high priority
Additional categories		
VI	Resource Reserve	Tourism: basically permitted
VII	Anthropological Reserve/Natural Biotic Area	Tourism: permitted with reservation
VIII	Multiple Use Management Area/Managed Resource Area	Tourism: high priority (basically including hunting tourism)
IX	Biosphere Reserve	Tourism: permitted
X	World Heritage Site (Natural)	Tourism: high priority

[a] Source: IUCN, 1990; IUCN, 1994; AG Ökotourismus/BMZ, 1995.

4. Costs and benefits of biodiversity protection

The following analysis is based on the assumption that applying economic measures to the evaluation of biodiversity is reasonable and may be unavoidable given present real world contexts (McNeely et al., 1990; for discussion see Goulder and Kennedy, 1997).

Cost benefit analysis (CBA) is the most widely used technique to assess nature conservation economically, even though it does not adequately capture the multiple values of biodiversity (Pearce and Moran, 1994). Clearly, "the economies of the Earth would grind to a halt without the services of ecological life-support systems, so in one sense their total value to the economy is infinite" (Costanza et al., 1997, p. 253). However, ascribing economic value to the individual functions and services provided by biodiversity while incorporating both qualitative and quantitative benefits may make it possible to formulate more powerful arguments for its conservation (McNeely, 1988; Dixon and Sherman, 1990; Pearce and Moran, 1994; Turner et al., 1998).

When an area gets protection status, local residents often have to bear high opportunity costs for foregone development alternatives or traditional activities, which may have been sustainable (McNeely et al., 1990; Gadgil et al., 1993; Vorlaufer, 1997). Consequently, local activities in protected areas are often illegal, consisting of wildlife poaching, logging, etc. (McNeely and Dobias, 1991; Wells and Brandon, 1992). Therefore, conserving biodiversity cannot be separated from social and economic development, coinciding with the self-interest of rural communities (McNeely et al., 1990; Wells and Brandon, 1992; Vorlaufer, 1997). This insight is expressed in the shift in protected area management strategies toward integrated development, which allows for conservation compatible sustainable uses (Wells and Brandon, 1992; WWF, 1995).

In general, the loss of an area can only be avoided if the value of conservation outweighs the opportunity costs and the direct costs of protection (resulting from building of infrastructure, payments for administration and staff, educa-

Table 2
Protected areas and tourism in developing countries, 1995[a]

Country	Total area (1000 km²)	Remaining original wildlife habitat[c]		Currently protected area[d]		Population (millions)	GNP per capita (US$)	Debts per capita (US$)	International tourist arrivals (1000)	Tourism receipts (million US$)	Receipts per tourist (US$)	Tourism receipts as % of exports
		1000 km²	% total	1000 km²	% total							
1. Antigua, Barbuda	0.4	–	–	0.0[f]	10.3[f]	0.07	[e]	4828.6[f]	212.0	329.0	1552	598.2[f]
2. Argentina	2767.0	–	–	43.7[f]	1.6[f]	34.70	8030.0	2586.4	4101.0	4306.0	1050	20.5
3. Barbados	0.4	–	–	0.0[f]	0.0[f]	0.27	6560.0	2096.3[f]	442.0	680.0	1538	380.3[f]
4. Belize	23.0	–	–	0.7[f]	3.2[f]	0.22	2630.0	838.6[f]	131.0	78.0	595	68.7[f]
5. Bolivia	1099.0	–	–	92.3[f]	8.5[f]	7.40	800.0	711.6	350.0	146.0	417	13.3
6. Brazil[b]	8512.0	–	–	321.9	3.8[f]	159.20	3640.0	999.6	1991.0	2097.0	1053	4.5
7. Cameroon	475.0	192.5	40.5	20.5[f]	4.4[f]	13.30	650.0	703.0	85.0	50.0	588	2.1
8. Chile	757.0	–	–	137.3[f]	18.3[f]	14.20	4160.0	1800.1	1540.0	900.0	584	5.6
9. China[b]	9561.0	–	–	580.8[f]	6.2[f]	1200.20	620.0	98.4	20 034.0	8733.0	436	5.9
10. Colombia[b]	1139.0	–	–	93.8[f]	9.0[f]	36.80	1910.0	564.1	1400.0	851.0	608	8.7
11. Comoros	2.2	–	–	0.0[f]	0.0[f]	0.50	470.0	368.4[f]	23.0	9.0	391	78.9[f]
12. Congo Dem. R.[b]	2345.0	1051.2	44.8	88.3[f]	3.8[f]	43.85[f]	120.0	299.6[f]	35.0	5.0	143	0.5[f]
13. Costa Rica	51.0	–	–	6.5[f]	12.7[f]	3.40	2610.0	1117.6	785.0	660.0	841	25.3
14. Côte d'Ivoire	322.0	66.8	20.7	19.9[f]	6.3[f]	14.00	660.0	1353.7	188.0	72.0	383	1.8
15. Cuba	111.0	–	–	7.1[f]	6.4[f]	11.00	720	3025.5	742.0	1100.0	1482	84.0[f]
16. Dominica	0.8	–	–	0.1[f]	8.6[f]	0.07	2990.0	1278.6[f]	60.0	33.0	550	58.9[f]
17. Dominican Rep.	49.0	–	–	10.5[f]	21.7[f]	7.80	1460.0	546.0	1746.0	1604.0	919	209.7
18. Ecuador[b]	284.0	–	–	111.1[f]	40.1[f]	11.50	1390.0	1213.7	440.0	255.0	578	5.9
19. Egypt	1001.0	–	–	7.9[f]	0.8[f]	57.80	790.0	590.2	2872.0	2800.0	975	81.5
20. Fiji	18.3	–	–	0.1[f]	0.0[f]	0.78	2440.0	423.1[f]	318.0	312.0	981	57.3[f]
21. F. Polynesia	4.0	–	–	0.1[f]	2.6[f]	0.23	[g]	–	172.0	260.0	1512	107.1[f]
22. Guatemala	109.0	–	–	13.3[f]	12.3[f]	10.60	1340.0	309.0	563.0	277.0	492	12.8
23. Guyana	215.0	–	–	0.1[f]	0.0[f]	0.84	590.0	2307.1[f]	106.0	47.0	443	10.5[f]
24. Haiti	28.0	–	–	0.1[f]	0.4[f]	7.20	250.0	112.1	145.0	81.0	559	73.6
25. India[b]	3288.0	615.1	18.7	143.4[f]	4.8[f]	929.40	340.0	100.9	2124.0	2754.0	1297	9.0
26. Indonesia[b]	1905.0	746.9	39.2	185.6[f]	10.2[f]	193.30	980.0	557.8	4324.0	5228.0	1209	11.5
27. Jamaica	11.0	–	–	0.0[f]	0.2[f]	2.50	1510.0	1708.0	1019.0	1069.0	1049	75.6
28. Jordan	89.0	–	–	2.9[f]	3.3[f]	4.20	1510.0	1891.4	1074.0	696.0	648	39.3
29. Kenya	580.0	296.1	51.1	35.0[f]	6.2[f]	26.70	280.0	276.4	691.0	454.0	657	24.2
30. Lao P. Dem. Rep.	237.0	68.7	29.0	0.0[f]	0.0[f]	4.90	350.0	441.8	60.0	51.0	850	14.7
31. Madagascar[b]	587.0	148.8	25.3	11.2[f]	1.9[f]	13.70	230.0	314.0	75.0	60.0	800	16.5
32. Malaysia[b]	330.0	210.2	63.7	14.8[f]	4.5[f]	20.10	3890.0	1709.1	7469.0	3910.0	523	5.3
33. Maldives	0.3	–	–	0.0[f]	0.0[f]	0.25	990.0	458.4[f]	315.0	210.0	667	606.9[f]
34. Mali	1240.0	158.4	12.8	40.1[f]	3.3[f]	9.80	250.0	312.9	43.0	17.0	395	5.2
35. Mauritius	2.0	–	–	0.0[f]	2.0[f]	1.10	3380.0	1637.3	422.0	430.0	1019	28.0
36. Mexico[b]	1958.0	–	–	98.5[f]	5.2[f]	91.80	3320.0	1805.5	20 162.0	6164.0	306	7.7
37. Morocco	447.0	–	–	3.7[f]	0.8[f]	26.60	1110.0	832.6	2602.0	1163.0	447	24.2
38. Namibia	824.0	444.5	53.9	102.2[f]	12.4[f]	1.50	2000.0	–	399.0	263.0	659	19.4

Table 2 (continued)

Country	Total area (1000 km²)	Remaining original wildlife habitat[c]		Currently protected area[d]		Population (millions)	GNP per capita (US$)	Debts per capita (US$)	International tourist arrivals (1000)	Tourism receipts (million US$)	Receipts per tourist (US$)	Tourism receipts as % of exports
		1000 km²	% total	1000 km²	% total							
39. Nepal	141.0	53.9	38.2	11.1[f]	8.1[f]	21.50	200.0	111.5	363.0	117.0	322	33.6
40. Panama	76.0	–	–	13.3[f]	17.8[f]	2.60	2750.0	2761.5	345.0	310.0	899	49.6
41. Pap. New Guinea	463.0	–	–	0.8[f]	0.2[f]	4.30	1160.0	565.3	42.0	60.0	1429	2.3
42. Paraguay	407.0	–	–	15.0[f]	3.8[f]	4.80	1690.0	476.7	438.0	248.0	566	30.4
43. Peru[b]	1285.0	–	–	41.8[f]	3.3[f]	23.80	2310.0	1295.4	479.0	520.0	1086	9.3
44. Philippines	300.0	64.7	21.6	6.1[f]	2.0[f]	68.60	1050.0	575.0	1760.0	2450.0	1392	14.0
45. Rwanda	26.0	3.3	12.7	3.3[f]	12.7[f]	6.40	180.0	157.5	1.0	1.0	1000	2.2
46. Saudi Arabia	2.150.0	–	–	62.0[f]	2.9[f]	19.00	7040.0	268.4[f]	3325.0	1210.0	364	2.6
47. Senegal	197.0	35.3	17.9	21.8[f]	11.3[f]	8.50	600.0	452.4	280.0	130.0	464	38.2
48. Seychelles	0.5	–	–	0.4[f]	77.0[f]	0.07	6620.0	2348.6	121.0	100.0	826	193.8[f]
49. Solomon Islands	28.9	–	–	0.0[f]	0.0[f]	0.38	910.0	407.9[f]	12.0	6.0	500	3.6[f]
50. South Africa	1221.0	531.7	43.5	69.7[f]	5.7[f]	41.50	3160.0	771.1[f]	4488.0	1595.0	355	5.7
51. Sri Lanka	66.0	11.0	16.7	8.0[f]	12.3[f]	18.10	700.0	454.7	403.0	224.0	556	5.9
52. Syria	185.0	–	–	0.0[f]	0.0[f]	14.10	1120.0	1511.9	815.0	1325.0	1626	33.4
53. Tanzania	945.0	505.1	53.4	139.4[f]	15.8[f]	29.60	120.0	247.7	285.0	259.0	909	40.5
54. Thailand	513.0	130.0	25.3	70.2[f]	13.7[f]	58.20	2740.0	975.8	6951.0	7664.0	1103	13.6
55. Togo	57.0	19.0	33.3	6.5[f]	11.9[f]	4.10	310.0	362.4	55.0	8.0	145	3.8
56. Tunisia	164.0	–	–	0.4[f]	0.3[f]	9.00	1820.0	1104.2	4120.0	1325.0	322	24.2
57. Uruguay	177.0	–	–	0.3[f]	0.2[f]	3.20	5170.0	1658.4	2065.0	611.0	296	29.0
58. Venezuela	912.0	–	–	263.2[f]	29.8[f]	21.70	3020.0	1651.7	597.0	811.0	1358	4.4
59. Viet Nam	332.0	66.4	20.0	13.3[f]	4.1[f]	73.50	240.0	360.5	1351.0	86.0	64	1.7
60. Zimbabwe	391.0	171.7	43.7	30.7[f]	7.9[f]	11.00	540.0	444.1	1529.0	154.0	101	8.2

[a] Source: IUCN, 1990; MacKinnon and MacKinnon, 1986a, MacKinnon and MacKinnon, 1986b; WCMC, 1992, WCMC, 1994; von Baratta, 1997; Weltbank, 1997; WTO, 1997.

[b] Megadiversity countries.

[c] In 1986.

[d] IUCN categories I–V.

[e] Country with middle income ($3036–9385).

[f] Latest available data.

[g] Countries with high income ($9386 or more).

tional programmes, monitoring, etc.) (Dixon and Sherman, 1990; Pearce and Moran, 1994).

A major proportion of the value of biodiversity consists of non-use values. These often accrue to the global community, while single developing countries face the costs for preservation (Myers, 1997a). One way to deal with this problem could be direct money transfers, enabling stakeholders to appropriate the global benefits of conservation. As such transfers at present do not exist and global environmental markets and debt-for-nature-swaps have so far emerged only on a modest scale, direct use values—including tourism—gain an important role in CBA (Page, 1988; Brown et al., 1993).

Basically, the economic value of tourism captured by DCs is often minor (Fig. 2).

At present, the major form of vacation is the package tour, outweighing individual travel by far (Wood and House, 1991). Out of the retail price of such package tours, on average 50% may be spent for services and goods in the developing country. Within the country, a major proportion of the gross revenue is repatriated due to expenditures on tourism-related imports and services, the ownership or financial involvement of the international tourist industry, or credit loans. Losses may be in the order of 40–70% of gross foreign exchange earnings in the initial phase of tourism development, and 20–50% after this phase. Overall, only 20–40% of the retail tourist price will remain within the economy of the destination country (Wood and House, 1991; AG Ökotourismus/BMZ, 1995; Gormsen, 1996; Vorlaufer, 1993, 1996). Entrance fees amount to 0.01%–1% of the total travel costs (Drews, 1997; AG Ökotourismus/BMZ, 1995). Still, apart from opportunity costs, they are expected to cover a range of conservation-related expenditures. At present, most protected areas do not even generate enough financial resources to cover their maintenance costs (Boo, 1990; Wells and Brandon, 1992).

Globally, all tourism earned about $118 518 million (1995) for developing countries (WTO, 1997). In 1988 as much as 4–22% of these revenues were brought in by nature tourism (Lindberg, 1991), with considerable variations between countries (Boo, 1990). A precise estimate of nature-tourism's turnover is difficult, because there is no consistent definition of eco- and nature-tourism, motives to travel are often both eco- and conventional, and the statistical database is poor (Lindberg, 1991; Ceballos-Lascuráin, 1996).

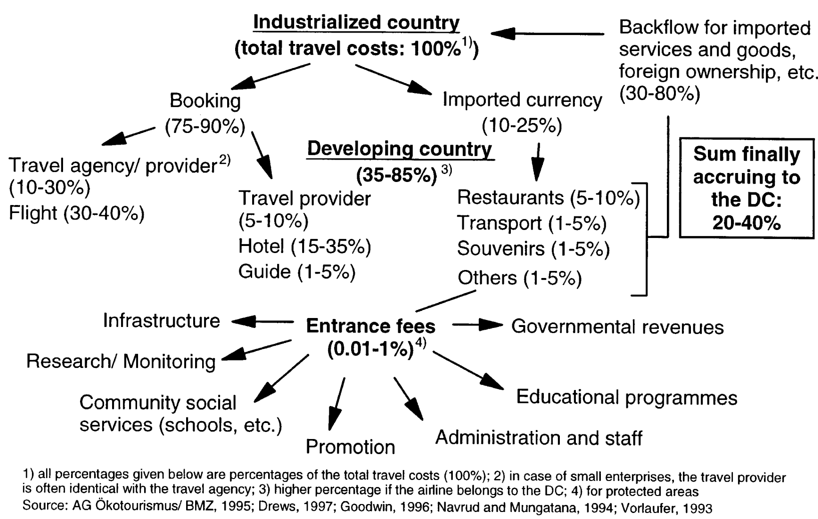

Fig. 2. Flow of money spent for a package tour.

4.1. Tropical rainforests

Tropical moist forests are habitats renowned for remarkably high levels of species diversity (WCMC, 1992), covering about 6% of the earth's land surface (Myers, 1997a). They contain more than half of the species in the entire world, and provide a range of essential ecological services (Myers, 1997a). At the same time, they are the biome in greatest danger, declining by rather more than 150 000 km^2 per year. Less than 5% of tropical forests are protected within parks and reserves (Raven, 1988; McNeely et al., 1990; Myers, 1992; FAO, 1993). For all these reasons, rainforests have been chosen for a more detailed analysis.

In CBA, the benefits of conservation include sustainable uses for timber production, non-timber products, harvest of medical plants, plant genetics, hunting, fishing, tourism and education (direct use values); soil conservation and productivity, material cycling, watershed protection, flood control, microclimatic regulation, buffering disease and pest spreading, and carbon sequestration (indirect use values); option and existence value. Costs include the compensation for foregone development alternatives (opportunity costs), the maintenance of the protected area (Ehrlich and Ehrlich, 1992; Pearce and Moran, 1994; Myers, 1997a), and internalized environmental damage occurring with tourism.

4.2. Direct use values: sustainable consumptive uses

In contrast to conversion, sustainable uses of tropical forests are mutually compatible. Note, however, that truly sustainable uses are difficult, if not sometimes impossible to achieve. Annual net values are in the order of $200–786 per hectare (ha) for forestry systems (Peters et al., 1989; Hartshorn, 1990), $0.4–330/ha for wildlife (Myers, 1988b, 1990a; Bodmer et al., 1994), $1.6–700/ha for non-timber products (Schwartzman, 1989; Anderson and Ioris, 1992; Counsell and Rice, 1992; Gentry, 1992b), and $0.1–166/ha for harvesting of medicinal plants (Ruitenbeek, 1989; Balic and Mendelsohn, 1992; Pearce and Moran, 1994). Overall, the global average net value of non-timber forest products may be in the order of $29/ha per year (Batagoda and Turner, 1998).

4.3. Direct use values: tourism

Visiting rainforests has become an important tourist attraction (Castner, 1990). Revenues are heavily dependent on the area's popularity, uniqueness, accessibility and distance from tourist markets. Accordingly, revenues received from entrance fees vary significantly. Costa Rica earned about $168 000 in 1988, or roughly $0.25/ha of protected area (McNeely et al., 1990). Single popular areas generated a major proportion of the total sum. The Monteverde Cloud Forest Reserve, for example, collected $35 750 in 1987, or about $3.6/ha (Boo, 1990). In Ecuador, entrance fees and licenses for protected areas averaged barely $0.25 in 1993, totaling $2.6 million. Again, a major proportion of this sum accrued to a single park, the Galapagos Islands, while rainforest sites received lower averages. The Reserva Cuyabeno, for instance, earned roughly $0.15/ha (IUCN, 1990; Lindberg, 1991; AG Ökotourismus/BMZ, 1995). In Rwanda, gorilla tourism in the Volcanoes National Park generated direct revenues of $1.02 million annually until 1994, or $68/ha (IUCN, 1990; Wells and Brandon, 1992; AG Ökotourismus/BMZ, 1995).

The value of protected areas rises substantially if indirect benefits are included in the calculation. In Costa Rica, for instance, more than 50% of all tourists visited at least one protected area during their stay in 1988, and about 40% stated that reserves were important or primary reasons for choosing the country as destination (WWF airport survey) (Boo, 1990). For this reason, it can be assumed that protected areas represent a major travel motive. In 1995, Costa Rica received $660 million in tourist revenues (WTO, 1997). Attributing 45% of this sum to tourism connected with protected areas leads to an annual gross value of $297 million, or almost $457/ha. This estimation is possibly conservative, however, as nature- and ecotourism have been growing faster than conventional tourism (Ceballos-Lascuráin, 1996).

Ecuador earned $255 million from tourism in 1995 (WTO, 1997). According to the WWF airport survey (Boo, 1990), 65% of all tourists found protected areas an important or primary reason for their travel choice, and 75% visited at least one protected area. The gross value of protected areas for tourism may therefore be in the order of at least 70% of total revenues ($178.5 million), or $16.1/ha. As stated above, a major proportion of the total is attributed to Galapagos. The Reserva Cuyabeno, for example, yielded only $6.6/ha (1994 gross revenues from services and goods for tourism) (AG Ökotourismus/BMZ, 1995).

In the Volcanoes National Park in Rwanda, entrance fees and indirect revenues accounted for $7–10 million. This amounts to $466.7–666.7/ha per year of protected area (Lindberg, 1991).

Studies of less popular parks indicate lower values. The recreational value of the Mantadia National Park in Madagascar was estimated at $9.0–25.0/ha per year (Mercer et al., 1995), and tourism revenue from admission, lodging, transportation, food and other services in the Khao Yai Park in Thailand brought in $3.85–7.7 million, or $17.8–35.5/ha per year (Dixon and Sherman, 1990; IUCN, 1990).

All revenues represent gross values. As discussed earlier, only a minor proportion of the gross values might finally accrue to the DC, and net direct and indirect benefits from ecotourism may therefore be significantly lower. Note as well that revenues are presented for rather popular ecotourism destinations.

4.4. Indirect use values

Indirect use values of ecosystems represent the most substantial benefits. The value of carbon sequestration, for example, is in the order of $2000–4000/ha (at $20 per tonne for global warming related damage, and deforestation related carbon release of 100/200 t/ha in secondary/primary tropical forests after allowing for carbon fixation by alternative land uses) (Faeth et al., 1994; Fankhauser, 1994; Pearce and Moran, 1994). Soil conservation benefits of tree cover within India's forests have been calculated at $100–240/ha per year (Chopra, 1993). Other indirect use values include watershed protection, flood-control, soil-erosion control and protection of fishing grounds, all of them having substantial values of up to $80/ha per year (Ruitenbeek, 1989; Adger et al., 1995; Pimentel et al., 1995; Daily et al., 1997).

4.5. Non-use values

Rainforests have considerable existence values which may be in the order of $0.03–18.9/ha per year (Ruitenbeek, 1992; Adger et al., 1995; Hadker et al., 1997).

In the long run, option value is substantial (Aylward, 1993; Myers, 1997a,b). Adger et al. (1995), for instance, calculated the option value of pharmaceuticals from Mexico's moist tropical forests at $1.0–$90.0/ha per year.

4.6. Opportunity costs

Opportunity costs of conservation vary significantly. The conversion of tropical forests may yield net present values as high as $1000–2500/ha for unsustainable forestry or timber clear cutting (Peters et al., 1989; Pearce and Moran, 1994), and, for subsequent uses, from $148/ha per year for cattle pasture (Buschbacher, 1987; quoted in Peters et al., 1989) to $1034.1/ha per year for cultivation of cash crops (Gunatilake et al., 1993).

4.7. Maintenance costs

Maintenance costs of protected areas are most often paid for by governments, which in most cases results in severe underfunding (Boo, 1990; McNeely and Dobias, 1991; Wells, 1993). On average, initial capital investments for adequate management programmes may be in the order of $5–10/ha per year, and $1–3/ha per year in recurrent budgets (McNeely et al., 1990). This compares favorably with data available for the Monteverde Cloud Forest in Costa Rica. Total expenses for the park maintenance were in the order of $34 913, or roughly $3.5/ha per year (Boo, 1990). Data for the whole country, however, indicate significantly higher costs. According to IUCN (1995), annual maintenance costs were on the order of \$12 million. Calculated per hectare, this amounts to about \$18.5/year. In Volcanoes National Park in Rwanda, guides and guards alone accounted for annual costs of \$150 000, or \$10.0/ha (IUCN, 1990; Lindberg, 1991). Additional costs may arise from social projects which have to be implemented to maintain conservation aims (for a review of 23 protected areas see Wells and Brandon, 1992).

4.8. Environmental damage costs (EDC)

In 1995, 53% of the roughly 168 million international tourist arrivals to developing countries were by means of air transport (WTO, 1997). Globally, 6% of all petrol is used for aviation, and, because of other sources, flying contributes about 2.6% of all CO_2 from the burning of fossil fuels to global warming (Schumann, 1994). Therefore, environmental damage due to resource consumption has to be internalized into CBA.

Depending on the total distance, the type of airplane and the number of passengers, flying consumes 2.5–8.0 kg of fuel per person and 100 flight-kilometers, with an average of about 5.0 kg (Bach and Gössling, 1996; Egli, 1996). Based on data from the International Civil Aviation Organisation (cited in WTO, 1997), developing countries received about 89.2 million tourists by air in 1995, accounting for 366 863 million passenger kilometers, or an average of about 4110 km per tourist. Thus, on global average, every international tourist arrival to a developing country entails a fuel consumption of 205.5 kg, leading to CO_2 emissions of roughly 650 kg (emission factor: 3.150 kg CO_2 per kg fuel, Schumann, 1994).

Fankhauser (1994) has estimated the social costs of CO_2 emissions in the order of \$20/tC for the period 1991–2000. This implies that every tourist traveling by air creates \$3.5 of environmental damage. This estimate is conservative, as air traffic causes additional trace gas emissions (NO_x, SO_2, CO, HC, H_2O), which have a substantial global warming potential, or, transformed in physico-chemical processes, severe impacts on ecosystems (Fabian and Kärcher, 1997). Moreover, costs of resource and energy consumption for planes, airports, etc. are not included in the calculation. Actual costs may therefore be in the order of more than three times the figure given above.

As stated above, Costa Rica's protected areas may have earned an annual gross value of at least \$297 million in 1995. For this estimate, 45% of tourist arrivals and revenues were related to protected areas. Statistically, the ratio of hectares of protected areas to tourists was 1:0.54. Applying the average global environmental damage costs (\$3.5) to this ratio results in costs of about \$1.9/ha in 1995. Similar calculations for Ecuador lead to environmental damage costs of slightly more than \$0.1/ha.

Table 3 presents costs and benefits of rainforest conservation.

Values that can be captured by different uses vary significantly. Non-timber products, for instance, may yield \$1.6–\$700/ha per year. Both upper and lower figures are unrepresentative, though, with a net average value for sustainable consumptive uses approx. \$29/ha per year (Batagoda and Turner, 1998). Basically, forestry systems, wildlife crop, non-timber products and medical plants harvests are compatible, even though there is a risk of aggregation and averaging (Turner et al., 1998). The total benefits are heavily influenced by minor forest and non-timber products, but these values are often bound to local markets and consequently cannot be applied to an infinite area.

Rainforest tourism has a high direct use value, if both direct and indirect benefits are included in the calculation. Gross values for popular areas can range from \$6.6/ha per year for the Reserva Cuyabeno (Ecuador) to \$666.7/ha per year for the unique Volcanoes National Park in Rwanda. Net values, however, might be significantly lower, while direct income from admission fees does often not even cover the maintenance costs.

Indirect use values yield the highest benefits of all. Carbon sequestration alone accounts for as much as \$2000–4000/ha per year. Other substantial values in the order of \$80–240/ha per year arise from soil conservation, watershed protection, flood control, protection of fishing grounds, etc. Existence value may be approximately \$0.03–18.9/ha per year globally, and option value at \$1–90/ha per year for pharmaceuticals alone.

Table 3
Costs and benefits of rainforest conservation

Benefits (local, national and global)	Amount ($/ha per year)	Source
Direct use values		
Sustainable consumptive uses (net values)		
Forestry systems	200.0–786.0	Hartshorn, 1989; Peters et al., 1989; Pearce and Moran, 1994
Wildlife	0.4–330.0	Myers, 1988b, Myers, 1990a; Bodmer et al., 1994
Non–timber products	1.6–700.0	Schwartzman, 1989; Anderson and Ioris, 1992; Counsell and Rice, 1992; Gentry, 1992b
Medical plants	0.1–166.0	Ruitenbeek, 1989; Balic and Mendelsohn, 1992; Pearce and Moran, 1994
Average value for sustainable uses	29.0	Batagoda and Turner, 1998
Tourism		
Direct benefits (admission fees)		
Average for protected areas, Costa Rica	0.25	McNeely et al., 1990
Monteverde Cloud Forest Reserve, Costa Rica	3.6	Boo, 1990
Average for protected areas, Ecuador	0.25	Lindberg, 1991; WCMC, 1994; WTO, 1997
Reserva Cuyabeno, Ecuador	0.15	IUCN, 1990; Lindberg, 1991; AG Ökotourismus/BMZ, 1995
Volcanoes National Park, Rwanda	68.0	IUCN, 1990; Wells and Brandon, 1992; AG Ökotourismus/BMZ, 1995
Direct and indirect benefits (gross values)		
Average for protected areas, Costa Rica	457.0	Boo, 1990; WCMC, 1994; WTO, 1997
Average for protected areas, Ecuador	16.1	Boo, 1990; WCMC, 1994; WTO, 1997
Reserva Cuyabeno, Ecuador	6.6	AG Ökotourismus/BMZ, 1995
Volcanoes National Park, Rwanda	466.7–666.7	Lindberg, 1991
Mantadia National, Madagascar, recreational value	9.0–25.0	Mercer et al., 1995
Khao Yai Park, Thailand	17.8–35.5	Dixon and Sherman, 1990; IUCN, 1990
Funding, donations by tourists	Substantial	Boo, 1990; Lindberg, 1991
Indirect use values		
Carbon sequestration in tropical rainforests	2000.0–4000.0	Fankhauser, 1994; Faeth et al., 1994; Pearce and Moran, 1994
Soil conservation benefits	100.0–240.0	Chopra, 1993; Pimentel et al., 1995
Watershed protection, flood control, protection of fishing grounds	Up to 80.0	McNeely and Miller, 1984; Ruitenbeek, 1989; Adger et al., 1995; Daily et al., 1997
Non-use values		
Existence value	0.03–18.9	Ruitenbeek, 1992; Adger et al., 1995; Hadker et al., 1997
Option value (here for pharmaceuticals)	1.0–90.0	Adger et al., 1995 (Aylward, 1993; Myers, 1997a, Myers, 1997b)
Costs (local, national, and global)	Amount ($/ha per year)	Source
Opportunity costs		
Unsustainable forestry, timber clear cutting (NPV)	900.0–2500.0	Peters et al., 1989; Pearce and Moran, 1994
Cattle pasture, cultivation of cash crops	148.0–1034.1	Buschbacher, 1987 (quoted in Peters et al., 1989); Gunatilake et al., 1993
Maintenance costs		
Maintenance costs, average	1.0–3.0	McNeely et al., 1990
Maintenance costs, Monteverde C.F.R., Costa Rica	3.5	Boo, 1990
Maintenance costs, average for Costa Rica	18.5	IUCN, 1995
Guides and guards, Volcanoes N.P., Rwanda	10.0	Lindberg, 1991
Costs for projects to maintain conservation aims	0.4–120.0	Wells and Brandon, 1992
Environmental damage costs		
Protected areas in Costa Rica	1.9	Fankhauser, 1994; Schumann, 1994; WCMC, 1994
Protected areas in Ecuador	0.1	WTO, 1997

Opportunity costs for foregone development alternatives are high, with timber clear cutting or unsustainable forestry yielding net present values of up to \$2500, and subsequent uses (cattle pasture, cultivation of cash crops) earning up to \$1034/ha per year. As stated for sustainable uses, upper values will in fact be unrepresentative.

Maintenance costs range somewhere between \$1 and \$18.5, with additional costs arising from social projects. Environmental damage costs can be as high as maintenance costs, and have been calculated at \$0.1 and \$1.9 for Ecuador and Costa Rica, respectively.

Overall, it is not intended to compare uses in terms of absolute gains. In fact, such calculations have to be done separately for the area in question.

5. Carrying capacities and the future of tourism

Any kind of tourism basically qualified for conservation must meet the requirements of ecotourism. As no form of tourism is entirely without impact, one way to deal with this problem is to define the limits of acceptable change in terms of interrelated carrying capacities (O'Reilly, 1986). These can be physical, perceptual, social, and economical. Physical carrying capacity is characterized by the limits beyond which environmental problems arise. Perceptional carrying capacity is the subjective view that travelers have on the conditions of an area (for example its environmental quality or socio-cultural conditions), and which limits their willingness to travel to that area. Social limits arise from the host population's willingness to tolerate visitors, and the acceptable levels of social change. Economic carrying capacity is the ability to absorb tourist activities without displacing or disrupting traditional local activities. Overall, the concept of carrying capacities is extremely difficult to apply (if not sometimes impossible) and does not provide data on absolute limits, since we are living in complex dynamic systems. It does, though, foster consideration of limits to development, and may be the best approach at present (Hunter and Green, 1995). For methods and discussion see Martin and Uysal (1990), Wolters (1991), Hunter and Green (1995), and Obua (1997).

Tourism impacts on the environment, society, and economy are complex (Kuss et al., 1990; Hunter and Green, 1995). The IUCN (1992) lists tourism as the second major threat to protected areas. Ecotourism can minimize or even avoid most negative effects, if carefully planned, managed and controlled. Still, even if a destination becomes completely self-sufficient in its resource requirements and thoroughly managed, some major problems will remain.

One of these unsolved problems is the distribution of the benefits. Often, a greater proportion of tourism revenue becomes profit for only a few individuals or families because well-connected persons monopolize the opportunities for guiding, transporting or hosting visitors (Ceballos-Lascuráin, 1996), while others have to bear the costs, like rising prices for goods and services. This may alter community structure and unity, and force infrastructure development due to changes in consumption patterns. Both these effects have rarely been investigated, but there is some evidence (Wells, 1993; Godoy et al., 1995; Yu et al., 1997) that nature resource consumption may even increase with higher income, and thus be contradictory to protection aims. As development is a continuous process, the question arises which effects tourism may have in the long run.

Another aspect in this context is scale. Small-scale development seems to be essential in ecotourism, as it assures slow development, allows for maximum local participation and stakeholdership, contributes direct and indirect macro- and microeconomic effects locally, mobilizes local money reserves, reduces leakages, and induces local re-investment. Small-scale development can handle seasonality and involves local residents in protection issues, thereby establishing social control mechanisms and reducing open access regimes (Boo, 1990; Hunter and Green, 1995; Vorlaufer, 1996). Quantitative analyses on this, however, are missing.

At present, three basic trends characterize the global development of tourism.

First, while there is some evidence that carrying capacities for many protected areas have been reached (McNeely and Dobias, 1991; Brüggemann, 1995), ecotourism and related forms of tourism (like culture, adventure, activity, travel etc.) are expected to outpace the growth of conventional tourism by far, with growth rates of up to 15% per year, and developing countries becoming more and more popular destinations (Boo, 1990; Lindberg, 1991; Wood and House, 1991; WTO, 1993, 1997; Goodwin, 1996).

Second, with the growth of nature-tourism, demand for undegraded nature will increase. Nature tourism is often related to sensitive and remote areas, and therefore potentially more destructive than mass tourism. This development will put substantial pressure on ecosystems (Lindberg, 1991; Hunter, 1995; Ceballos-Lascuráin, 1996).

Third, more and more developing countries turn to tourism to generate economic benefits, often after other options have been exhausted, and without adequate planning. Competition for tourist arrivals will lead to fundamental neglect of sustainability goals, while developing countries are especially sensitive to tourism development (Vorlaufer, 1996). To control this calls for measures.

5.1. Limitation

While some protected areas may not be attractive at all for tourists, others have seen continuously rising visitor numbers, with carrying capacities frequently being reached (McNeely and Dobias, 1991; Wells and Brandon, 1992; Brüggemann, 1995). For these, a limitation of tourist numbers is essential. Such concepts, often accompanied by maximized revenues through high-price politics, have worked out well in Bhutan (Kohl, 1990; Lindberg, 1991), Ecuador (de Groot, 1992), Kenya (Vorlaufer, 1997) and Rwanda (Lindberg, 1991).

To reduce both long-haul mass tourism and to improve the positive effects of ecotourism, it is necessary to put a substantial tax on fuel, possibly internationally (Fabian, 1995). This way, environmental costs could be internalized, and overcapacities in the aviation sector be reduced. At least part of the taxes could be used to finance conservation or reforestation programmes. Moreover, increased prices would change environmental awareness.

5.2. Promotion/information/education

Environmentally, the tourism industry is stuck somewhere between being supply-led and demand-led (Wood and House, 1991). This gives it a chance to promote green packages and to force ecotourism, while profiting from existing demand.

Information and education for both local residents and tourists are essential for ecotourism. They have to become an integral part of future tourism development, and a major secondary goal of protected area management (Lindberg, 1991; Wells and Brandon, 1992). With the opportunity to experience nature, e.g. through engaged guides and visitor information centers, travelers may gain insight into natural processes and become more aware of ecosystem services and their overall value (Budowski, 1976; Hunter, 1995). This in turn will help to resolve problems in formulating environmental policies, which often stem from the lack of recognition of the crucial roles that ecosystems play (Daily, 1997).

5.3. Planning/management/control

Effective planning, management and control are a precondition for a sound relationship between protected areas and tourism (Boo, 1990; Hunter and Green, 1995; Yu et al., 1997). Local communities have to participate in these processes, and to receive a share of the financial benefits (Vorlaufer, 1997). Guiding may be a key issue as well. While creating additional jobs, it maximizes the knowledge tourists can gain. Moreover, guides control visitor behavior in protected areas, and thereby increase carrying capacities.

As stated above, unsustainable local activities may not necessarily decrease with rising income from tourism (Wells, 1993; Godoy et al., 1995; Yu et al., 1997). Control measures are therefore requested (Wells and Brandon, 1992).

5.4. Donations/rising admission fees

The economic potential of ecotourism has remained largely unrealized so far. Many protected areas do not charge admission fees at all, and governments have given little consideration to the question of increasing revenues (McNeely et al., 1990; Wells, 1993, 1994). Considering the fact that only 0.01–1% of travel costs are spent for entrance fees, while visiting protected areas often is one of the main objectives for traveling, one way of capturing higher economic benefits may be to increase fees and charges. This hypothesis is supported by studies of Tobias and Mendelsohn (1991), Maille and Mendelsohn (1993), Navrud and Mungatana (1994), Mercer et al. (1995), and Menkhaus and Lober (1996) who discovered large unrealized consumer surpluses and remarkable willingness-to-pay for nature resources and conservation.

Costa Rica, for instance, raised admission fees by a factor of 10 in 1994 (from $1.5 to $15 for foreign visitors). In consequence, visitor numbers plummeted by an average of 44% in the following year (Ratermann, 1997), but total revenues increased substantially. This way, it was possible to combine the maximization of economic benefits and reduce the pressure on ecosystems. Admission fees are a means to keep the number of visitors within an ecosystem's carrying capacity (McNeely et al., 1990), or to limit growth rates, so that planning, management and control measures are not outpaced by the development (Lindberg, 1991).

To ask tourists for donations may be another way to increase revenues. Many tourists will voluntarily pay, if they see that they can contribute to the preservation of nature. Tour operators could also redistribute part of their income to the protected area they visit (Boo, 1990; Lindberg, 1991; Mustart and Cowling, 1996).

6. Conclusions

Biodiversity has essential values, which are rarely taken into account in CBA. This is due to a lack of markets for ecosystem services, questionable governmental incentives for conversion, insecure land property rights and use policies. Thus, any strategy to conserve biodiversity will have to neutralize these failures in the first place.

Developing countries pay the major costs of biodiversity conservation, while benefits often accrue to the global community. Therefore, mechanisms for direct money transfers, debt relief and debt-for-nature-swaps (DFNS) should continue to be established and promoted (Page, 1988; Brown et al., 1993).

Non-use values have the highest values of all, but CBA is at present usually restricted to direct use values. For this reason, tourism gains a more important role as a conservation incentive.

As has been shown for tropical forests, sustainable uses and ecotourism may outweigh the costs of conservation. Clearly, a range of species and ecosystems would no longer persist without tourism (Barnes et al., 1992; Wells, 1994; Vorlaufer, 1996, 1997).

Due to flying, tourism causes significant environmental damage costs. These have to be integrated in CBA. In the long run, strong sustainability demands a minimization of air travel.

Strictly positive examples of ecotourism are still rare, while its dangers are present. With carrying capacities hard to define, integrated approaches specifically designed for the area in question have to be worked out.

The role that ecotourism can play in the conservation process varies between countries, and is influenced by the distance from markets, modes, and the accessibility and uniqueness of the area in question.

Direct revenues from tourism accruing to protected areas are minor at the moment and need to be increased (Brown et al., 1997).

The positive development of ecotourism is dependent on successful strategies to limit tourist numbers, inform and educate both visitors and locals, and to manage and control the area efficiently.

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