The Clarion Volume 9 Number 2 (2020) PP 65-73

The Clarion
International Multidisciplinary Journal
ISSN : 2277-1697

Economic techniques in conservation and management of environmental resources: A theoretical prerequisite.

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Abstract

Acknowledging how economics can help us conceptualise some general problems in the allocation of resources involving the biosphere and the environment is gradually becoming essential in the present world. The area of the Earth not modified by the activities of humans is now extremely small and continues to shrink so that the reduced availability of natural areas is now a global concern. This paper discusses the ideas and economics of conservation, utilisation and management of natural biological resources, while dealing with economic factors that should be considered in devising appropriate policies for the same. Such factors become increasingly important as our biological resources become scarcer from an economic point of view. Human welfare and its continuing existence invariably depend upon the living environment as, apart from anything else, other species are biologically essential for human existence, for example, via the food chain. As such, biological resources should be taken into account in socio-economic planning and evaluation of economic systems.

Keywords: Utility; Contingent Valuation; Hedonic Pricing; Travel Cost; Environment; Conservation; Environmental Management

1. Introduction

Economic growth and change have modified or radically altered most terrestrial and marine areas of the Earth, and the extent of this modification reflects humankind's increased ability through use of new technology, its effort and investment to transform and utilise nature, as well as the substantial worldwide effects of increasing human population, economic production and consumption. The area of the Earth not modified by the activities of humans is now extremely small and continues to shrink so that the reduced availability of natural areas is now a global concern. There is no single adequate indicator of the extent of loss of natural areas because both qualitative and quantitative dimensions are involved. For example, compared to pre-agriculture times, approximately 13 percent of natural terrestrial areas have been lost to cultivation. While forest cover accounts for just under one-third of the Earth's land area, this cover has been much reduced, especially in temperate zones, and the type of forest cover has been altered. Deterioration in the natural qualities of such areas is much greater than is evident from global land-use statistics.

Interestingly. human welfare and its continuing existence invariably depend upon the living environment as, apart from anything else, other species are biologically essential for human existence, for example, via the food chain (Owen, 1975). As such, biological resources should be taken into account in socio-economic planning and evaluation of economic systems. Conversely, economic analysis can also be of value in helping to determine how to conserve or utilise living resources. This paper is principally concerned with the economics of conservation, utilisation and management of natural biological resources, and deals with economic factors that should be considered in devising appropriate policies for the same. Such factors become increasingly important as our biological resources become scarcer from an economic point of view.

2. Theoretical linkage between environment and economics

Economics has evolved essentially as an anthropocentric subject over the years. Incidentally, conservation of environmental and biological resources

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DOI number: 10.5958/2277-937X.2020.00017.9

is frequently required as a means of maximising human welfare in a world of limited resource availability. The dominant part of its relative theoretical premise consists of the theory of welfare economics. It is based upon the view that wants of individuals are to be satisfied to the maximum extent possible by the allocation of resources. The notion of potential Paretian improvement (sometimes called the *Kaldor-Hicks criterion*) was suggested as a means of dealing with this problem. It suggests that if the gainers from a change in resource-use could compensate the losers from it and remain better off than before the change, the change should be regarded as an improvement. It is essential to note that actual compensation need not be paid to the losers.

The criterion of a potential Pareto improvement underlies much of social cost–benefit analysis which itself has been applied to decision-making involving the environment (Blackorby and Donaldson, 1992). A difficulty with the Kaldor-Hicks criterion is that it may sanction a change in resource-use which seriously worsens the distribution of income. Cases have for example occurred in which land has been acquired for national parks without compensation or adequate compensation to the traditional users of the land who have sometimes been quite poor. In view of the income distribution question, Nordhaus and Tobin (1979) has proposed that a potential Paretian improvement should only be unequivocally regarded as a social gain if it does not worsen the distribution of income. If a potential Pareto improvement is associated with a worsening of the distribution of income, one has to consider whether this is sufficient to offset the net benefits otherwise obtained.

While the above criteria (which can, for instance, be applied to piecemeal decision-making involving the environment) have an individualistic basis, the role of economising is not confined to social orderings having an individualistic basis. As Bergson (1938) has pointed out, a variety of different types of social welfare functions or social orderings are conceivable. They could for example reflect the values of particular individuals. Nevertheless, if one is to engage in economising, one needs at least some preference ordering of the resource-use possibilities of society. Such an ordering need not be complete but if it is complete and transitive, it will allow an 'optimum' allocation of resources to be determined.

By way of theoretical premises, it is essential to acknowledge how economics can help us conceptualise some general problems in the allocation of resources involving the biosphere and the environment. Conceptually, the natural environment or biosphere itself is able to directly produce goods and services, e.g., recreational opportunities, maintenance of a genetic stock of species, clean air and water. But in addition, humans draw upon the resources of the biosphere (uses these as inputs) to produce goods of their own creation, 'man-made' goods. There may therefore be a trade-off between the production of environmental natural goods and man-made goods. The production possibility frontier involving man-made goods and environmental natural goods might be of the type indicated by curve ABCD in Figure 1. This indicates that the provision of natural environmental goods up to a level of x* is complementary to the production of manmade goods. Such complementarity might come about, for example, because the retention of natural tree cover reduces flooding and erosion and helps maintain agricultural output. Given all the techniques available, the production possibility set might consist of the set bounded by OABD. Some techniques of production may for instance be such that the combination at point J results. Given that both more

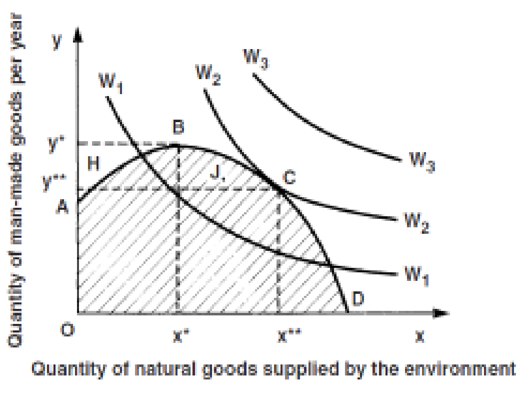

Fig. 1: Choice and trade-off between supply of man-made goods and those provided by the environment

natural environmental goods and more man-made goods are desired, J is an inferior economic position. If welfare is to be maximised, society must adopt a pattern of resource-use that results in its being on its production possibility frontier in the efficiency segment BCD. Not only are combinations below the production possibility frontier socially inferior but in view of the complementarily relationship so too are combinations on the segment AHB. In both these cases it is possible to produce more of all the types of desired goods by reorganising resource-use.

It seems that a complementary production relationship does exist up to a point (a segment like AHB) between the production of man-made goods and goods provided by the natural environment and this on its own would provide an argument for conservation of biological resources. However, humans directly value many goods produced by the natural environment. When this is taken into account, there is an additional economic reason to be concerned with the conservation and management of natural biological resources. Given the preference indicated by the indifference or iso-welfare curves marked W_1W_1, W_2W_2 and W_3W_3 in Figure 1 (and assuming that these curves have the usual properties associated with indifference curves e.g., each indicates combinations giving an equal level of human welfare and higher curves are associated with greater welfare) (Tisdell, 1997), the combination at position C is socially optimal. This involves the production of y** of man-made goods and x** of environmental goods. Consequently, it is optimal to forgo some man-made production for additional goods produced by the natural environment.

A position below the production possibility frontier such as J may come about because of the use of inferior technologies or because of a poor allocation of resources between man-made production and natural production, e.g., some land areas comparatively suited to natural production may be allocated to man-made production and vice versa. A position such as H may be reached because of ignorance or because of common access to natural resources or in general due to deficiencies of societal mechanisms for managing resource-use.

Recognition is growing of the high economic value of goods and services provided by natural environmental systems including those provided by ecosystems (Arrow et al., 2000). Vitousek et al. (1997) have effectively highlighted the large economic and other losses that have arisen, or which may arise, from human impairment of ecosystems given current human domination of these systems. However, social objectives for managing natural environmental resources are not entirely settled.

In some circumstances, social objectives may be expressed differently to that considered in Figure 1. A minimum 'standard' or target may be set for the production of natural goods of the environment. Economic considerations then need to be taken into account in an attempt to meet this standard if it is not already being achieved. The objective may be one of maximising some welfare function subject to the target. For example, the objective may be to maximise man-made production subject to a target level of production of goods by the natural environment. The last rule can be illustrated by Figure 2, which has the same interpretation as Figure 1. If the target level of production of environmental goods is a level of not less than x** per year, this constraint can be represented by the line KLM. Position L involving the production of y** of man-made goods and x** of goods from the natural environment is then optimal. Should however, the environmental constraint be below x* (which corresponds to point B) it will be optimal to achieve point B. For example, if the constraint is for production of goods of the natural environment of at least x_ as represented by the constraining line M_K_, it is optimal to achieve point B because of the complementarity relationship. A similar set of considerations will apply if the objective is one of maximising the production of goods from the natural environment subject to a minimum level of production of man-made goods. It is also easy to illustrate the case where a preference function of the type indicated in Figure 1 by indifference curves is to be maximised subject to constraints of the type just mentioned.

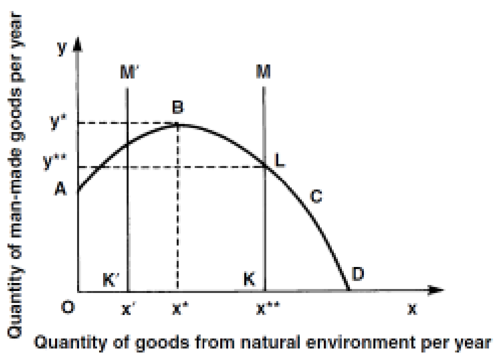

Fig. 2: Making a choice between man-made goods and those provided by the environment subject to a minimum standard

Cases can arise in which simultaneous constraints are placed on manmade production and production from the natural environment. Minimum levels may be set for both types of production. The basic decision-making problem then becomes one of determining whether it is possible given available transformation possibilities for resources to meet these constraints simultaneously. Economic factors need to be taken into account to determine this.

3. Evaluating the utility value of natural resources

Methods of estimating the value of natural resources tend to concentrate on their non-consumptive values i.e., not only on their value for recreation but also their existence, option and bequest values. For the purpose of economic evaluation, several methods are in existence such as the travel cost, contingent valuation and hedonic pricing methods. It should be remembered that most techniques used for this purpose belong to two classes: (i) those that rely on observed behaviour and draw interference about preferences and economic value from this; and (ii) those that rely on the stated preferences or stated values by individuals. The travel cost approach and hedonic price valuation methods belong to the first category and contingent valuation and choice modelling belong to the second category.

3.1 Travel cost method

Developed by H. Hotelling in the 1930s as a means for valuing national parks, it is now widely used in assessing projects involving outdoor recreational elements. For example, apart from its application to national parks, forested areas and similar areas used for recreation, it is frequently used to assess the value of dams or reservoirs which may cater for outdoor recreation such as fishing, boating or picnicking as a part of their benefits.

Basically, the travel cost method uses the costs which individuals incur in travelling to an outdoor area as surrogates for prices of their visits. If visitors are drawn from a large catchment area, the cost per visit of those coming from further afield can be expected to be higher than those located closer to the natural area. This cross-sectional data together with relative frequency of visits can be used to estimate a demand curve for visits to the natural area (Tisdell, 1997).

The catchment area for visitors to a natural area is divided into zones, transition from one zone to another being dependent on the travelling distance to the outdoor attraction. At the entrance to the natural attraction, individuals may be interviewed to determine the origin of their journey so that they can be allocated to a catchment zone. For example, in the simple case shown in Figure 3 where and the space represents travelling distance, the space has been divided into three zones by concentric circles and it is assumed that no visitors come from outside zone 3. Supposing that entry to the outdoor site is free, the average cost of travelling from each zone may be used as an indicator of the effective 'price' to be paid by a visitor for visiting the recreational site.

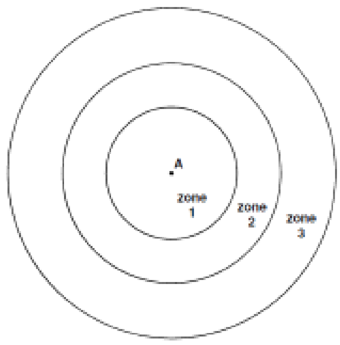

Fig. 3: Zoning of areas depending upon travel distance to an outdoor attraction

The basic procedure can be clarified by a simple example. Suppose that the travel costs per visit from zones 1, 2 and 3 are respectively \$2, \$3 and \$4 and that the respective relative frequency of visits during a period of time from these zones are 0.3, 0.2 and 0.1. Suppose that 100 000 people live in each zone. Where there is no entry fee to the natural area, the number of visits from each of the zones during the selected period of time is found by multiplying this figure by the relative frequency of visits from each zone. This gives 30 000, 20 000 and 10 000 visits from zones 1–3 respectively and a total number of visits of 60 000. If an entry fee to the natural area of \$1 per visit is introduced this will add \$1 to the cost of visits from each of the zones. Now it will cost \$5 to visit from zone 3 and no visits will be made from this zone. The relative frequency of visits from zones 2 and 1 will be 0.1 and 0.2 respectively. So, at this price of entry 30 000 visits should take place per unit of time. At a fee of \$2 per visit to the natural area, the only visitors will be from zone 1 and 10 000 visits per period of time will occur. At a fee of \$3 per visit to the outdoor area no visits will occur. Thus, four points on the demand curve for visits to the outdoor area as a function of the entry fee are identified. These are shown respectively as points A, B, C and D in Figure 4 and consistently show a demand curve. Given that the curve ABCD in Figure 4 represents demand for visits annually, the annual economic value obtained from this natural area for visits is usually measured by the area under the demand curve if there is no entry fee to natural area. It is the amount of consumers' surplus obtained by visitors and is represented by the hatched area in Figure 4. If no other benefits are obtained from the natural area and if no costs are involved in maintaining it, this surplus will provide a measure of the (on-site) net recreational value of the area if the site is preserved in its natural state assuming that it is already in a natural state. This can be compared with the net value of the area for alternative possible uses of the area to decide which form of use provides the greatest economic net value. Thus, it can form the basis for a comparative cost–benefit analysis of land-use.

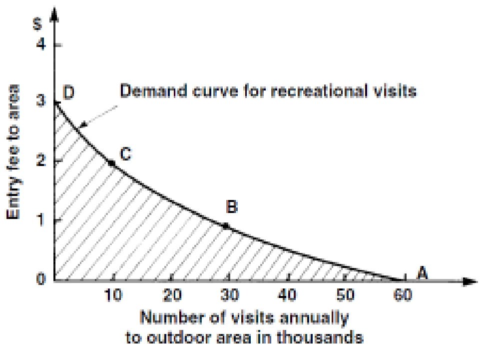

Fig. 4: Demand curve for visits to an outdoor area

3.2 Contingent valuation technique

Contingent valuation methods are widely and increasingly used to value environmental goods including natural areas such as national parks. Usually their purpose is to determine the willingness of individuals to pay to avoid a particular environmental change, to retain an environmental asset, or to bring about a particular environmental change. The payment is contingent upon some desired environmental state occurring. An alternative approach is to ask individuals what payment they would require (willingness to accept payment or monetary compensation) to allow a particular environmental variation to occur. The latter approach appears to be less commonly adopted.

The simplest methods of contingent valuation are so called single-bid games and multiple-bid games. In the former case individuals are asked how much they are willing to pay (the maximum) to ensure that a particular environmental good is provided, e.g. a natural area protected as a national park, or alternatively they are asked how much they would have to be paid as a minimum to forgo such a possibility. The amounts provide two different measures of consumer surplus. In the case of multiple-bid games, the interviewer uses trial-and-error to determine the maximum amount which a respondent is willing to pay for an environmental good, such as a national park, or the minimum amount which must be paid to the respondent to forgo such an environmental good. Other methods of contingent valuation have also been developed but these simple methods highlight the nature of this approach, and its limitations. Note that in all cases that contingent valuation relies on the valuations of the individuals interviewed so, in that respect, it is a 'democratic' method in which all individuals have a chance to count.

3.3 Hedonic pricing valuation

The hedonic price method of valuation mostly uses cross-sectional data to infer the prices which individuals are willing to pay for environmental goods, even though in some circumstances time-series data can also be used for this purpose (Palmquist, 2001). It relies on the hypothesis that the prices which individuals pay for commodities reflect both the environmental and non-environmental characteristics provided by these. If these characteristics can be identified and measured objectively, then it may be possible from available statistical data to infer how the valuation of a commodity varies as the environmental characteristics made available by purchasing it vary. For example, the prices of houses or dwellings of the same size and quality may vary by neighbourhood with variations in air quality in the different neighbourhoods. From this data it may be possible to infer the household demand for air quality.

This method has not been widely used for estimating the value of natural areas, primarily because it is likely to yield inferior results to other methods when applied to this assessment. For instance, variations in property value in relation to their proximity to a natural area may not reflect or fully reflect the value of the natural area to the community. In fact, agricultural properties in the vicinity of a protected area, other things equal, may be somewhat lower in price if animal 'pests' use the protected area as a refuge and as a result of straying do agricultural damage on nearby properties. While property values may, other things equal, be higher in relation to a natural scenic attraction, e.g. beach or coastal protected area, this extra valuation is unlikely to capture the full value of the natural asset to the community. For instance, it will not capture the value which day visitors place on these attractions and, of course, it will not capture off-site values, such as existence value.

Pearson et al. (2002) provide an example of the application of the hedonic price method to the valuation of an urban national park, Noosa National Park in Queensland. The land values of residential properties were classified by whether they afforded a view of this national park, a view of the ocean and so on. The authors found that a view of the national park had a positive influence on land values but a view of the ocean had a much larger impact. There is growing application of the technique to the valuation of urban environmental amenities.

3.4 Determining social choices about resource use

In making social choices, the total economic value of conserving a resource is only part of the social equation. In addition, the economic opportunity cost of the choice needs to be taken into account. Furthermore, if conservation of an environmental resource involves operating or running costs, for example, the cost of managing a national park, or other costs such as negative externalities (some wildlife have positive values as well as pest characteristics, for instance), its total economic value needs to be estimated net of such costs. If the choice is a dichotomous one involving either the conservation of a particular natural area or its development, then developing the area is socially optimal (from an economic point of view) if the net total economic value of the conservation option is less than the profit from the most profitable development option. Otherwise conservation of the natural area is the best option.

If the size of the area to be protected is variable, the nature of the choice problem can be illustrated by Figure 5. There line ABC represents the marginal profit from the most profitable use of the land for development purposes. No economic values other than private gains are assumed to be obtained with the development option. Curve DBE represents the change in (net) total economic value from conserving the land area and X2 is assumed to be the total available natural land area. It can be seen that it is optimal to conserve X1 of the natural land area and develop X2 – X1 of it from an economic point of view.

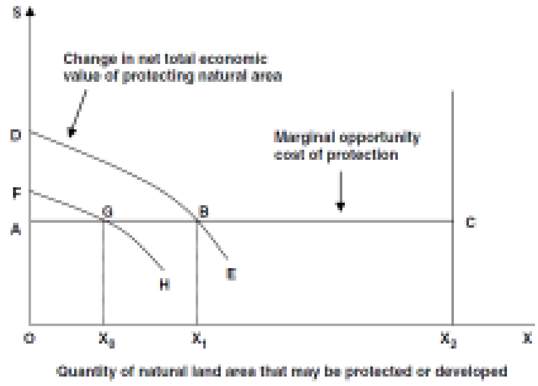

Fig. 5: Evaluation of alternative land-use taking account of total economic values

Unfortunately, in practice, un-marketed economic values may be overlooked or underestimated in social decision-making about resource-use. For example, if only the use value of a natural site for tourism is taken into account, the ascribed marginal social value from conserving its area might be represented by curve FGH in Figure 5. This restricted view would result in an area of only X0 being conserved whereas protection of an area of X1 is economically optimal. Note that, as a rule, the application of the travel cost method and hedonic price methods, will underestimate the total economic value of a natural area and also that of wildlife species. On the other hand, stated preference methods have the potential to measure total economic value. They can also be used in conjunction with methods that rely on observed behaviour or 'revealed' preferences, such as the travel cost method.

4. Managing open-access resources

A number of policy measures or economic instruments have been suggested in the economic literature for correcting the economic problems associated with open-access resources. While the use of economic instruments may be intended to increase the economic efficiency of resource-use, they may also be used purely for conservation reasons. In the latter case, the measures may be designed to limit or to stop economic trade in the open-access resource in order to conserve it, for instance, at not less than a safe minimum level (Bishop, 1978).

One way to control the harvest or utilisation of an open-access resource is to impose a tax on its use.

If in Figure 6 curve SaSa represents the supply curve of the 'harvest' under open-access and ScSc represents the supply curve assuming an efficient allocation of resources, economic efficiency can be theoretically achieved by imposing a tax of BF on each unit of the harvest, assuming no differences in productivity and costs by area of origin of the harvest. This would result in market equilibrium altering from E1 to E2 and the level of the harvest per period falling from X3 to X2.

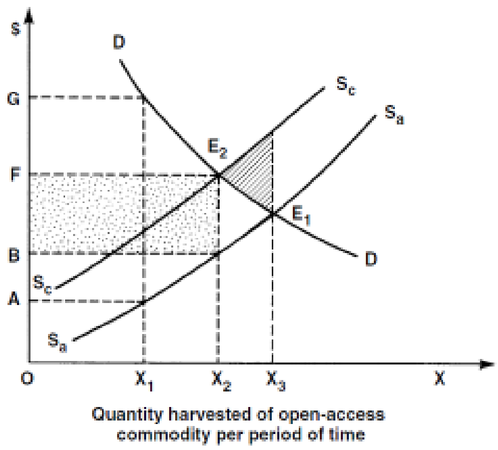

Fig. 6: Utilisation of an open-access resource

Theoretically this result could also be achieved by having a quota on the maximum per period harvest equal to X2 and the government making this quantity available by bidding or tendering. This method involves the creation of a market in harvesting rights or permits. Under competitive conditions, the right to harvest one unit of the resource would sell for an amount BF and lead to the same result as with a per unit tax of that amount. In either case the government would obtain revenue equal to BF X2. But if this government revenue is absorbed by the government in higher administration costs, the costs of promoting greater allocative efficiency may be a reduction in the level of economic production and a reduction in economic welfare. For example, the net economic benefit of costless optimal regulation of the harvest is as indicated by the hatched area in Figure 6. But if all the government revenues obtained (as indicated by the dotted rectangle) are used up in administering the regulatory system, e.g. monitoring, enforcing and improving the regulations, undertaking research on the regulations and so on, the value of production forgone elsewhere as a result of resources drawn into these activities may be equal to this dotted rectangle. In the case shown, the 'allocative' benefit of the regulation (the hatched area) is less than the dotted area. Thus, the value of production forgone as a result of administration costs for the scheme could exceed its allocative benefits. In some cases, the costs of monitoring and enforcing the above solutions may be so high as to make these measures uneconomic.

Note that the above regulations (taxes and marketable or tradeable permits) do not ensure efficiency in investment or in husbanding an open access resource for the future. If a large number of economic agents can share in the future harvest of the industry, no individual has an incentive to increase that harvest by forgoing current profitable harvesting actions. For this reason, the above measures are often supplemented by additional measures, e.g. regulations on the minimum size of fish to be taken.

The harvesting of a species may be limited not primarily to attain economic efficiency but to ensure that the population of the species survives or survives at a minimum degree of abundance. In the case illustrated by Figure 6, the last-mentioned conservation goal might be achieved if the level of harvesting per period is not allowed to exceed X1. Theoretically, this aim could be met by imposing a tax of AG on each unit of the harvest or by introducing an aggregate quota of X1 on the annual harvest which could be auctioned to achieve efficiency. However, as mentioned before, such measures can be costly or difficult to enforce especially in developing countries.

5. Tourism as a means of appropriating gains from conservation

A number of conservationists see international tourism based on natural resources as a means of appropriating gains from conservation and encouraging it. The role of tourism in conservation is complicated because in some cases tourism destroys tourism and conserved resources as well. It can also have undesirable cultural effects. Furthermore, some would argue that international tourism in developing countries is frequently controlled by multinational companies and becomes a part of the dual economy with little benefit to the indigenous people. While international tourism brings in foreign exchange, it can impose a large drain on reserves of foreign exchange – imports are needed to varying degrees to satisfy foreign tourists. Nevertheless, tourism still provides a means, but not a costless means, of appropriating gains nationally from conservation, and it can be an inducement for the conservation of living resources in the Third World. However, government policies are required to ensure that benefits from tourism are in fact married with conservation. There is no automatic link between tourism and greater conservation because the prisoners' dilemma problem seems to apply. In fact, the greater the gains from tourism the more quickly living resources are sometimes destroyed.

The scope of developing and less developing countries (LDC) in encouraging foreign tourists is limited by the poor social infrastructure of many (for example, poor communication systems and inadequate utilities), health and similar risks in some countries and the distance of some LDCs from the developed countries of the world. Nevertheless, as the amount of wilderness in the world dwindles, the number of foreign tourists visiting LDCs can be expected to increase. In some LDCs, substantial rises in the number of foreign tourists has already occurred and have posed serious management problems. For example, difficulties have arisen in Indonesia, Thailand, the Caribbean and Latin America. In Indonesia, the development of the island of Bali for foreign tourists has resulted in environmental damage to coral reefs as has also occurred in Phuket, Thailand. In the Indonesian case, plans to contain tourism, as recommended by French advisers, within a limited area or restricted pockets, have proven to be difficult to maintain in practice. Areas not sharing in economic gains from foreign tourists have demanded foreign tourism development and over the long term the Indonesian government has been unable to resist such pressures.

There is also widespread coral reef damage in the Caribbean as a result of tourist pressures. In addition, Cuban scientists observe that on the north coast of Cuba, the government is pushing to build beachfront hotels in prime habitat regions for dozens of unique birds, rodents and iguanas, and although scientists can sometimes persuade the government to delay or even halt construction for the benefit of wildlife, the island's need for hard currency is so pressing that the scientists' efforts often fail. Similarly, the development of Cancun in Mexico for tourism has had adverse ecological consequences. For instance, hotel construction in Cancun threatens the breeding grounds of sea turtles. These examples indicate that foreign tourism is not universally a magic road to economic success and to enhanced conservation of nature.

Achieving a social economic optimum in the Kaldor-Hicks sense is not always politically possible and its obsessive pursuit can be irrational given political and social realities. For example, in order to generate political support for the preservation of a natural area, it may be necessary to allow more tourism development than is compatible with the maximisation of total economic value. Moreover, if it is found that tourism is more effective than alternative uses of a natural area in generating local expenditure, then it is likely to gain the support of the local community.

6. Conclusion

As stressed in the World Conservation Strategy (1980) and Brundtland Report (1987), a strong case exists for biological conservation, even on economic grounds alone. Economics is vital in wildlife conservation and use, pest control, agriculture, forestry, fisheries and living marine resources, the preservation and use of natural areas such as national parks and tourism-based on natural resources. Notably, these activities have further environmental consequences for humankind. While markets cannot be relied on to conserve wildlife and natural resources optimally from a social point of view, neither can government. Nevertheless, government intervention can sometimes bring about social improvement and result in more nature conservation than would occur in its absence. There is probably no institutionally perfect and universal means of ensuring an optimal degree of conservation. Our existing institutional systems, therefore, need to be subjected to continual scrutiny and we must search continually for ways to improve them.

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