The Economics of Developing Irreversible Natural Environments in Developing Countries*

Chung-Huang Huang**
黃宗煌

Abstract

Past experiences explicitly inform us that, in a natural environment which is essentially irreversible, growth and development can be competitors even in the long run. While a lot of major protected areas, biosphere reserves, world heritage sites, and wetlands of international importance are located in the developing countries which cannot use the same kind of reasoning as the industrialized countries do in preserving these environments, proper international aids to the developing countries through well-designed organizations are necessary. The economic benefits that will be shared worldwide from preserving the natural environments are discussed in this paper and so is the decision rule for optimal development.

---

* The draft version of this paper was presented at the Conference on Directions and Strategies of Agricultural Development in the Asia-Pacific Region, January 5-7, 1988, Taipei.

** The auther is an associate professor at Department of Economics, National Tsing Hua University, Hsin Chu, Taiwan, R.O.C.

The Economics of Developing Irreversible Natural Environments in Developing Countries

Chung-Huang Huang

Introduction

Preservation of natural environments did not attract too much attention of the people in Taiwan until recently when they are begining to recognize the importance of natrural environments to themselves and their generations to come. Aparently, the dramatic economic growth in the past few dacades has resulted in significant environmental degradation. Serious pollution and excessive extraction of natural resources (e.g., forestry and underground water) are good examples.

Flammang (1979) in his paper concluded that growth and development are different processes, that they are complementary in the long run but competitive in the short run. Nonetheless, past experiences explicitly inform us that, in a natural environment which is essentially irreversible, growth and development can be competitors even in the long run. While continuous growth requires further development of the irreversible natural environments, considerable economic researches are needed to deal with the problem of how to maintain a dynamic ecological equilibrium.

This paper is divided in three sections. The first section discusses the reasons why natural environments need protection. The second section illustrates how an optimal level of development of natural environments could be determined. Finally, a suggestion for more efficient management of natural environments are proposed from international perspectives.

Why Protecting Natural Environments

Krutilla (1967) argues that for a natural environment we have to decide among (a) scientific research which would not destroy the natural environment, or (b) the use of the area for recreation, and (c) extractive activities which would have adverse consequences for the scenic landscape and the wildlife habitat.

Science is in a state where it is difficult to forecast the path of new discoveries and where the scientists are going to find the sources for their discoveries. This is why natural environments are considered to be important as a source where the scientists can find new fields of research. Therefore, preservation of natural environments for scientific purposes is the most important reason for conservation. For instance, mankind has extracted a lot of medicines from plants and/or animals, and still we do not know how many secrets the natural environment is hiding from us. Animal life and plants contain much information we can learn in the future that can improve the quality of our lives. As such, destroying natural environments means destroying some of the opportunities for learning in the future since this destruction is an irreversible process. Even though it is sometimes argued that extinction of some specieis is a natural evolutionary process that began to occur long before man appeared on earth, this process was surely enhanced dramatically by the industrilization of our economy.

Another good reason to preserve the natural environment is to keep available opportunities for people to enjoy themselves in close contact with nature. In company with higher standard of living, the demand for outdoor recreation is increasing substantially. Many researches have shown that it is positively related to the income per capita not only in industrialized countries, but in developing countries. In the past few years, for example, the rapid growth of outdoor

recreational demands in Taiwan had caused significant congestion problems in many recreation sites. As Krutilla points out: "when we consider the remote backcountry landscape, or the willderness scene as the object of experience and enjoyment, we recognize that utility from experience depends predominantly upon prior acquisition of technical skill and specilized knowledge." (Krutilla, 1967, pp. 782) This implies that the recreational experience of this generation will also increase the demand for natural environments from the next generation, and so on into the future. Without proper preservation of the natural environments, such growing demand will never be met.

Extractive activities are getting intensive recently in some natural environments. Land cultivation and settlement are examples. As a result, not only the natural habitat is disrupted, but the problems of soil erosion, water and soil pollution, landscape destruction, etc. are nearly out of control. For example, the seriously polluted portions of the major rivers in Taiwan has been increasing substantially in the last few years, as shown in Table 1. In spite the fact that technology will increase the supply of man-made commodities as the complements or substitutes of the natural commodities, "it is improbable that technology will advance to the point at which the grand geomorphologic wonders would be replicated, or extinct species resurrected." (Krutilla, 1967, pp. 783) In other words, we have an perfectly inelastic supply of natural environments while the supply of commercial goods and services is relatively elastic. Therefore, the importance of the remaining natural environments is growing as man goes on destroying them, because each year they are becoming more scarce when we compare them with the man-made reproducible products.

As we have seen, many economic investments involving the development of the natural environments will influence the natural environments in a way that is irreversible,

changing the ecological equilibria that once existed. "It is desirable to distinguish two kinds of environmental costs. One is pollution.... The other is the transformation and loss of whole environments as would result, for example, from clear cutting a red wood forest, or developing a hydroelectric project in the Grand Canyon." (Fisher, Krutilla, and Cicchetti, 1972, pp. 605) Clearly, the characteristic of irreversibility deserves more our attention when implementing any investment projects in the natural environments.

Optimal Development of Natural Environments

Irreversibility means that the system will be in such a way that to restore it to the original situation would be technologically impossible, or would be so expensive or take so long that it would make no economic sense. "Consider the conversion of a wilderness ecosystem to meet the demands for the output of extractive industries. If the environmental modification results in the elimination of essential habitat for a given species, e.g., the passenger pigeon or the grizzly bear, restoration is impossible --- or at least incomplete without the fauna dependent on the original plant associatios." (Krutilla and Fisher, 1975, pp. 43) "Environmental modifications that affect a biotic base are even more difficult to contend with. If the basic geological and soil conditions are adversely affected, replacement by perhaps more primitive biotic communities might occur eventually, but restoration of the original biological environment will not be possible in any thing like a time span that is meaningful for human societies." (Krutilla and Fisher, 1975, pp. 44)

Therefore, economists need to take into account all the benefits of preserving natural environments when they evaluate any investment projects to be undertaken in such environments. Only if this information is provided will the

decision maker have a complete view of the impacts of his decision, to invest or not to invest in development, will have on the particular environment. In order to evaluate these benefits, it is necessary to examine the demand for the natural environment which, unfortunately, does not have explicit markets. According to our discussion earlier, there are three types of demand for a natural environment: (1) the demand by those who are currently utilizing the natural environment, and therefore can express their intention in the market, even if they express their demand in a distorted manner due to the public goods aspect of this service; (2) the demand of all who consider themselves or their heirs as potential visitors to these natural environments and who want to preserve the possibility of enjoying them in the future; and (3) the demand for scientific research. The benefits generated by the first demand are referred to as the user benefits, while the second and the third demands are the main sources of the preservation benefits.

The natural environment "may be thought of as producing two outputs: services of an individual-consumption sort to actual users, and stand-by, or option, services of a collective-consumption sort to nonusers." (Weisbrod, 1964, pp. 474) If the nonusers behave as 'economic man' "they will be willing to pay some thing for the option to be able to consume the commodity in the future." (Weisbrod, 1964, pp. 472) As such, this option demand, in addition to the user benefits, must be accounted for in economic evaluation. The preservation of the natural environments also provide a mix of opportunities to enjoy amenities for our generations to come. This will generate bequest benefit which accounts for the major source of preservation benefit. Several empirical studies have shown that the preservation benefits are as many times as the user benefits. For example, an empirical study by Huang (1987) exhibits that existence value and bequest value generated by the four national parks in Taiwan

are far greater than user benefits (see Table 2). 1 Accordingly, ignorance of preservation benefits will lead to wrong dicisions which are irreversible.

There is also a 'quasi-option value' (QOV) which is conceptually different from the option value and the value of information. 2 Just as the option value (OV), QOV may also be very important because of the irreversibility of investments and of uncertainty in regard to future costs and benefits.

At each point of time the decision maker has to decide what level of investment he wants to make, and particularly which investments are to be made. In the economic literature there are two principal approaches for evaluating the different investment options: (1) an intertemporal social utility function, and (2) the cost benefit approach. The procedure for maximizing either one will give the same results if we assume a similar world with perfect competition. Since the existence of the social utility function is questionable, the second appraoch is commonly applied. ". . . the present value criterion tends, more or less, to mimic what the market automatically does. In this sense the present value criterion is an intertemporal version of the efficiency criterion." (Page, 1977, pp. 163)

This knowledge has been incorporated in a model by Krutilla and Fisher (1975), among others (e. g., Fisher, Krutilla and Cicchetti, 1974; Cummings and Norton, 1974, etc.). The underlying decision rules are quite similar in general and can be stated as follows.

Assume that investments in developing natural environments are irreversible. It would be optimal not to make the investment even when it presents a positive discounted net benefit if in the future a less level of development would be desirable. Not investing in the present does not mean that in the future when additional information becomes available the investment cannot be made. Hence, there is

an asymmetric aspect in the investment decision. Deciding to invest is a decision that is irreversible and will be imposed on future generations. Under this circumstance, what should be the optimal level of development if the investment is worthwhile? This can be illustrated by Figure 1.

Without loss of generality, we assume a time domain of two periods. The length of the horizontal axis stands for the total area of a particular natural environment available for development. MBIO and MCIO represent, respectively, the marginal benefit and marginal cost of the development in the curent period, while MBII and MCII the discounted marginal benefit and marginal cost of the investment in the next period. Without considering the marginal user cost (MUC) that consists of the marginal effect of current development on the future investment cost and the marginal preservation benefit foregone due to current development, the desired amount of development will be OD_0. Thus the amount left for future use equals YD_0, which is far below the desired level, YD_1. The optimal allocation is not achieved under this circumstance. Since the desired level of future development is YD_1, marginal user cost begins to occur if the amount left for next period is greater than OD_1. Therefore, efficient allocation requires that MUC be taken into account in the first period in addition to the current marginal investment cost (MCI_0). This will lead to an optimal development identical to OD* for current period and YD* for next period. It can be shown that this optimal development satisfies the

familiar intertemporal principle of equal net marginal benefits. 3 Furthermore, it also indicates that the development D^*D_0 shall not be undertaken even though the underlying MBI_0 significantly exceeds MCI_0.

Unfortunately, such economic criterion is rarely applied in the real world. Many evidences show that user cost is not taken into consideration at all for most development projects implemented in Taiwan and most developing countries, as well. As a result, environmental quality has been seriously damaged. For example, excessively developing steeply sloped lands in Taiwan for cropping has resulted in soil erosion and water pollution that require a lot of real resources to control. Allowing aquacultural fields to expand without proper regulations on underground-water uses has also resulted in serious land subsidence which is physically and technologically difficult to restore in any event.4

Suggestion for More Efficient Management

It may be well argued that inadequate consideration of user cost in project analyses in most developing countries is due to the more practical needs for economic subsistance and growth. In general, when planning a project that may destroy the natural environment people refer only to the positive aspects of the project, for instance, the increased income and employment. What people forget is that

sometimes the increase in income is not sufficient to compensate for the damage that a society suffers in the future due to the destruction of the environment. This is particularly apparent in the low-income groups of society who have always lived in direct contact with the natural environment and, therefore, will not perceive it as a scarce resource. In this case, the decision maker will have difficulty in assessing the preservation benefits. The situation is even worse if these groups of society are not accustomed to monetary exchange or live in an economic environment of pure exchange, because the preservation of the natural environment is simply senseless to them. If this is the case, domestic desire for preserving natural environments will not be adequate from a world-wide view point unless commesurate compensation is paid.

As far as the demands for the preservation of the natural environments are concerned, domestic demands in the developing countries for recreational uses might not be strong enough to urge decision makers to include preservation benefit as an important factor in project analysis. In the countries with very unequal income distribution, domestic demands for natural environment are mainly from the higher income groups who are, however, constitute a small portion of the people. In this situation, the domestic demand for natural environments is still small as compared to the foreign demand. Therefore, preservation benefit is also likely to be ignored.

As a matter of fact, for most developing countries the demands for their natural environments come from abroad, either for recreation or for scientific research. Obviously science in many developing countries is not very well advanced and there are limited economic resources to devote to research. For example, according to the information on the worldwide protected areas (as in Table 3), the biosphere reserves, world heritage sites, and wetlands of international importance (as in Table 4), it is obvious that many natural environments of international importance are located in Africa, Asian, and South America where most people are, relatively speaking, in worse economic position than the industrialized countries.

Another problem that occurs in an international comparison is the difference in the discount rate between the developing countries and the industrialized countries. The former tend to give more consideration to the current generations than the latter. Therefore the discount rates are going to be higher in the developing countries. Consequently, developing countries will implement projects that are going to reduce the welfare of mankind as a whole. In other words, to the mankind as a whole the uncertainty associated with the development projects implemented in the developing countries are great. Much of this uncertainty results from the international aspects of the project rather than from the internal uncertainty which the decision maker has some control over. This fact in conjunction with the weak

statistical and information systems in many of the developing countries makes project analyses and decisions very difficult.

However, if the decision makers of developing countries could shift part of the project costs to those having the most demands for their natural environments, or they could obtain sufficient financial aids to compensate the loss due to giving up the development projects, they might be willing to consider the proposals that could maintain natural environments. In other words, for implementing a more efficient policy costs must be shared since benefits will be shared. Therefore, international aids to the developing countries with unique natural environments are needed if more welfare of human being is desired.

The problem of free rider arises in this international aspect too. The industrialized countries are going to react as most users of public goods do by trying to convince others that their benefits are smaller than they really are. If the decision makers of developing countries do not believe that significant compensation can be obtained from other countries, they are likely to consider only the domestic benefits. As a result, destruction of the natural environment is likely to be greater than the global optimum. To be exempt from such consequence, the coorporation between countries for conservation is surely indispensable. A supernational organization or private fundations may be necessary to help resolve the problems of this sort.

Conclusions

"The strain on the global environment derives mainly from the growth of the industrial economies, but also from that of world's population." (Brandt, 1980, p. 116) Developing countries cannot use the same kind of reasoning as the industrialized countries do because the main benefits of

preserving natural environments are going to go to people outside the country, and in preserving them their opportunities of increasing the income per capita may be lessening. In order to manage more efficiently the natural environments in the developing countries, the paper suggests that proper international financial aids to them through well-designed organizations are necessary. Economic analysts in the developing countries have to try to estimate the foreign demand for natural environments as well as the domestic demand even though it is not an easy task. Not to mention, developing countries need to join together to help the developed countries recognize the value of the natural environments possessed by the developing countries.

Footnotes

1. The concepts of option, existence, and bequest values are clearly described by many economists, e.g., Walsh et al. (1984), Desvousges et al. (1983), etc.
2. The idea of quasi-option value was firstly proposed by Arrow and Fisher (1974). In literature, no systematic distinctions has been drawn for OV, QOV and the value of information. Sometimes they are mistakenly regarded as the same things, e.g., Conrad (1980) argued that QOV is identical to the expected value of information, while Fisher and Hanemann (1986) regarded QOV as OV. We believe that OV and QOV are different at least in two respects. (a) The purpose of paying OV is to have resources preserved so that uncertain future demands will be met, while the existence of QOV is due to the possibilities of increasing net benefits of resource development through information accumulation or learning processes. (b) Previous studies tended to conclude that the sign of OV is indeterminate and that QOV shall be positive in any case.
3. The principle of equal net marginal benefits requires $MBI_1 - MCI_1 = MBI_0 - MCI_0$. Since $MBI_0 = MCI_0 +$ MUC at OD*, and, by the definition of the marginal user cost, $MUC = MBI_1 - MCI_1$, it is obviously that the principle is met.
4. Without paying water fees, aquacultural farmers inefficiently overuse underground water. This results in land subsidence and many other negative externalities in Taiwan. Huang (1989) discussed this issue clearly and empirically valuated such externalities.

References

1. Arrow, Kenneth J. and Anthony C. Fisher (1974). "Environmental Preservation, Uncertainty, and Irreversibility," Q.J.E. 88(2): 312-319.
2. ---------- and Robert C. Lind (1970). "Uncertainty and the Evaluation of Public Investment Decisions," A. E. R. 60(3): 364-378.
3. Brandt, Willy (1980). North-South: A Program of Survival, The MIT Press, Cambridge.
4. Conrad, Jon M. (1980). Quasi-Option Value and the Expected Value of Information," Q. J. E., 94(4): 813-820.
5. Desvousges, W.H., V. Kerry Smith and M.P. McGivney. A Comparison of Alternative Appraoches for Estimating Recreation and Related Benefits of Water Quality Improvements, prepared for U.S. Environmental Protection Agency, 1983.
6. Fisher, A.C. and W. M. Hanneman (1986). "Environmental Damages and Optional Values," Natural Resource Modeling 1(1): 111-124.
7. ----------, J. V. Krutilla and C. J. Cicchetti (1972). "The Economics of Environmental Preservation: A Theoretical and Empirical Analysis," A. E. R. 62(4): 605-619.
8. ----------(1974). "The Economics of Environmental Preservation: Further Discussion," A. E. R. 64(6): 1030-1039.
9. Flammang, Robert A. (1979) "Economic Growth and Economic Development: Counterparts or Competitors?" Econ. Develop. and Cult. Change 28(1): 47-61.
10. Howe, Charles W. (1976) "The Effects of Water Resource Development on Economic Growth: The Conditions for Success," Natural Resources J. 16(4): 939-955.

11. ---------- (1979) Natural Resource Economics: Issues, Analysis and Policy, John Wiley & Sons, New York.
12. Huang, Chung-Huang (1989b). "Economic Valuation of Underground Water and Man-Induced Land Subsidence in Aquaculture," Applied Econ. (forthcoming).
13. ---------- (1988). Economic Valuation of the External Costs due to Underground Water Use in Aquaculture, paper presented in the 20th International Conference of Agricultural Economists, Buenos Aires, Argentina, August 24-31.
14. ---------- (1989a) Methods of Evaluating Economic Benefits Generated by Recreational Resources, Department of Economics, National Tsing-Hua University. (in Chinese)
15. Krutilla, John V. (1967). "Conservation Reconsidered," A. E. R. 57(4): 776-786.
16. ---------- and A. C. Fisher (1975). The Economics of Natural Environments, the Johns Hopkins University Press, Baltimore.
17. Page, Talbot (1977). Conservation and Economic Efficiency: An Approach to Materials Policy, the Johns Hopkins University Press, Baltimore.
18. Walsh, R.G., John B. Loomis and R.A. Gillman. "Valuing Option, Existence, and Bequest Demands for Wilderness," Land Econ. 60(1): 14-29, 1984.
19. Weisbrod, Burton A. (1964) "Collective-Consumption Services of Individual-Consumption Goods," Q. J. E. 78(3): 471-477.
20. World Resources Institute (1986). World Resources 1986: An Assessment of the Resource Base That Supports the Global Economy, Basic Books, Inc., New York.

Table 1. Percentages of Various Pollution Levels Associated with the Major Rivers in Taiwan: 1983-1987

	Pollution Levels*			
Years	Unpolluted	Lightly	Heavily	Seriously
1983	73.93%	3.36%	16.65%	5.69%
1984	74.45	5.43	15.39	4.73
1985	69.85	8.43	16.17	5.55
1986	73.64	3.82	12.31	10.23
1987	71.57	5.78	9.12	13.54

* The underlined levels are classified by using a complex pollution index which is constructed based on four indicators: DO, BOD, NH3-N, and suspended solids.

Sources: estimated from the Annual Reports of Water Quality of the Rivers in Taiwan (1983-1987).

Table 2. Economic Benefits Generated by the Four National Parks in Taiwan

(Unit: NT$/year, person)

	National Parks			
	Yangmingshan	Tailuka	Yushan	Kenting
User Benefit	128-190 (159)*	148-238 (193)	143-213 (178)	153-215 (184)
Existence Value	158-318 (238)	187-355 (271)	180-342 (260)	197-373 (282)
Bequest Value	404-2,810 (1,607)	462-3,004 (1,733)	444-2,860 (1,652)	478-3,142 (1,801)

* Values in parentheses are average values.

Source: Huang (1989a). User benefits were estimated by the travel cost method while existence and bequest values by the contingent valuation method.

Table 3. Major Protected Areas in the World, 1985

	Protected Areas (thousand hectares)	% of Territory Protected	Protected Area per Thousand Population (hectares)
Africa	88,662	3.0	160
N. America	161,860	6.9	404
S. America	50,060	2.9	186
Europe	17,239	3.6	35
Asia	52,414	2.0	19
USSR	15,111	0.7	54
Oceania	38,232	4.5	1,540
Antarctica	195	0.0	NA*
Total	423,773	3.2	88

Source: World Resources (1986). pp.
*NA = Not applicable.

Table 4. Biosphere Reserves, World Heritage Sites, and Wetlands of International Importance, 1985

	Biosphere Reserves (hectares)	World Heritage Sites (number)	Wetlands of International Importance (hectares)
Africa	11,761,499	20	1,310,548
N. America	12,927,433	19	10,380,014
S. America	10,856,377	6	14,877
Europe	73,213,585	7	1,977,797
Asia	4,598,638	6	1,450,883
USSR	36,838,654	0	2,880,100
Oceania	4,723,130	5	1,290,780
Total	154,919,316	63	19,304,999

Source: World Resources (1986), pp. Program of UNESCO.

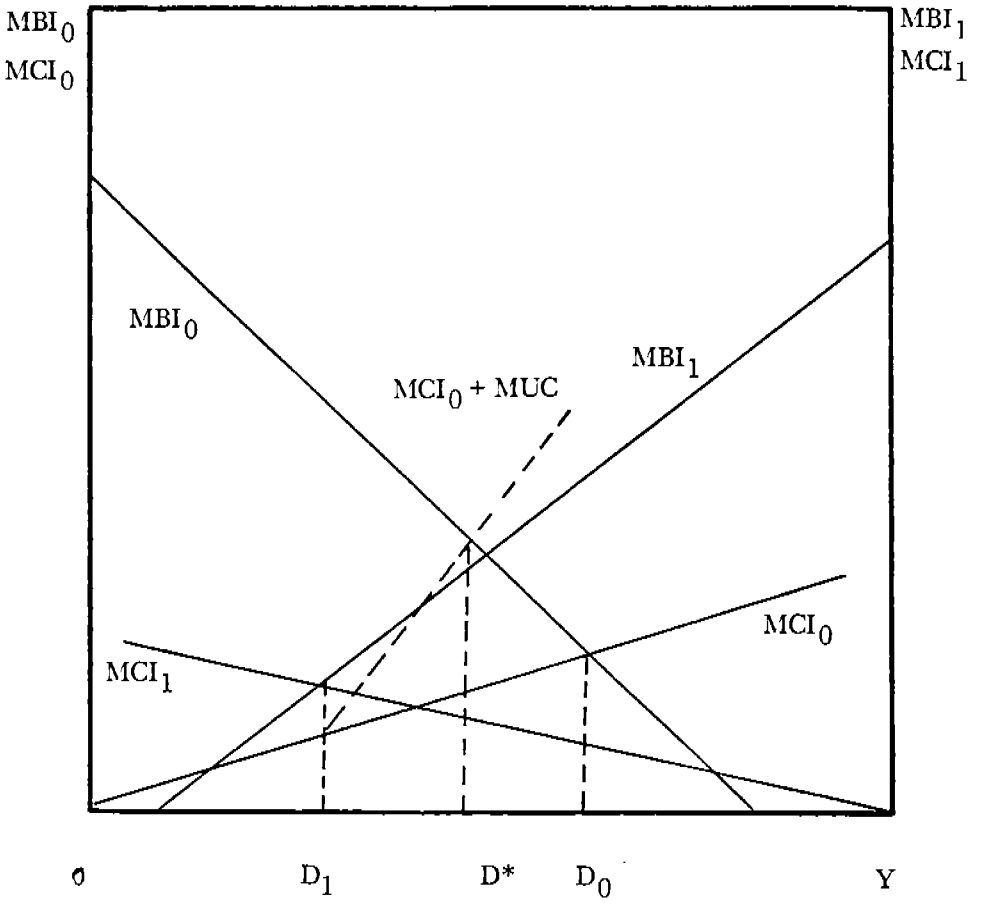

Figure 1. Determination of the Optimal Level of Environmental Development

開發中國家自然環境開發的經濟分析

黃 宗 煌

摘 要

過去歷史的經驗告訴我們：在不可復原的自然環境中，經濟成長與環境資源開發在長期中亦可能是互爲競爭的。由於世界上有許多重要而應受保護的自然資源、生態資產及文化資源分佈於若干開發中國家，而這些國家在從事保育或開發計畫時，所擬採行的準則與工業化先進國家均不相同，致使環境資源的保育成效不彰。因此，透過組織完善的國際機構來支援這些開發中國家，以協助改善其保育行動，實乃刻不容緩，因其產生的利益係爲全世界所共享。本文分析了這些可能的效益來源，並說明資源開發的最適準則。

* 作者爲國立清華大學經濟系副教授