The Economic Value of the Environment

Cases from South Asia

Edited by: Joy E. Hecht

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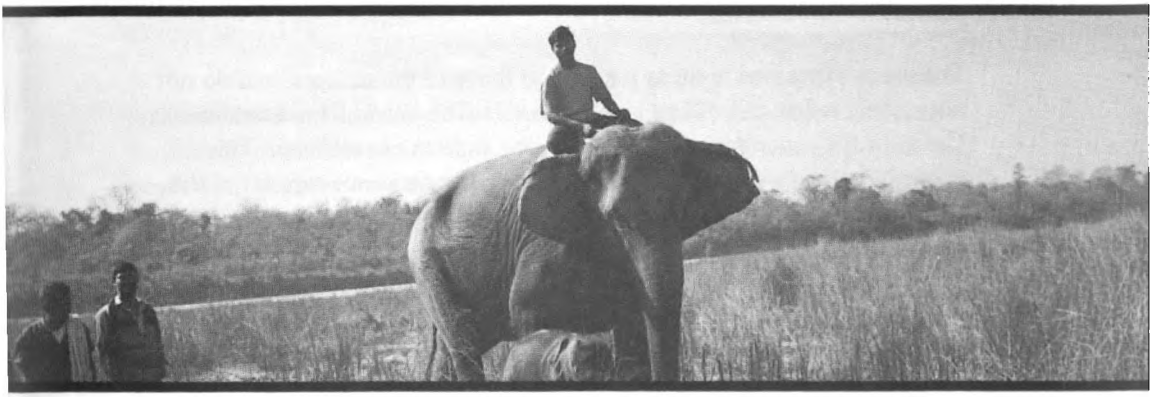
The Economic Value of the Environment



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Preface

The protection of a clean and safe environment is of crucial concern in South Asia. The region is blessed with exceptional natural resources and biodiversity, which are of value both to local communities who depend on them for daily existence and to the world as a whole. At the same time, the region faces rapid urbanization and population growth which threaten the quality of those resources and endanger human health. Justifying the protection of the natural environment when financial resources are inadequate can be difficult, especially when many people still perceive economic development and environmental protection as goals which compete with rather than complement each other.

The field of environmental economics has come a long way in developing methods with which to understand the role of a clean environment in economic well-being, and to assess how much that environment means to the people who live in it. These tools can provide the evidence needed to justify allocating resources to environmental improvement. However, they have been developed largely in the west, and are not as well known in Asia as they should be.

This volume seeks to fill that gap by building understanding of the tools of environmental economics and showing policy-makers how these tools can contribute to resolving important questions in south Asian development. We begin with an overview paper which explains how economists think about the environment and which introduces the tools of valuation, cost-benefit analysis and environmental accounting. The three case studies which follow apply these tools to specific problems of relevance throughout the region, providing information which should inform decisions about investment in resource protection and environmental infrastructure.

This work has been undertaken through the Green Accounting Initiative, a programme of IUCN-The World Conservation Union. The GAI is based in IUCN's United States office, and has worked closely with IUCN offices in Pakistan, Bangladesh, Nepal, and Vietnam. Our activities have been made possible through the generous support of the Charles Stuart Mott Foundation of Flint, Michigan, USA.

A number of individuals have been crucial in building the GAI in south Asia. In Pakistan, Haider Ghani Mian of the Business and Law Unit of IUCN Pakistan has been responsible for GAI activities. In Bangladesh, Aminur Rahman and Asif Iqbal Siddiqui were responsible for GAI activities, which they undertook with invaluable help from Rashiduzzaman Ahmed, Programme Officer at IUCN Bangladesh. In Nepal, Bishnu Bhandari and Bishwambher Pyakuryal have both been responsible for environmental economics work. Ambika Adhikari, IUCN Country Representative in Nepal, continues to provide leadership in building their programme. The publications unit of IUCN Nepal has also undertaken the production of this volume, for which we are grateful. Special thanks are due to Dilip Munankarmi for the layout and design of this publication. Thanks are also due to Jaklien Vlasblom and Bandana Yonzon who helped in the production of this book. Scott Perkin, Head, South and Southeast Asia Regional Biodiversity Programme, has generously assisted in the development of environmental economics programme in South Asia, particularly in Nepal. Finally, Aban Kabraji, IUCN Regional Director for South and Southeast Asia, has provided vision and encouragement for the development of the environmental economics programme in South Asia.

We hope these papers will prove useful to the readers.

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1 Introduction and Overview

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The use of environmental economics tools is often advocated as a means of ensuring the sustainable management of the natural environment. This publication is intended to help public officials and environmentalists understand what those tools are how they can contribute to environmentally-sensitive growth and economic decision-making. It provides a basic introduction to the role of the environment in the economy and explains why the free market will not lead to efficient or environmentally sound resource use. It subsequently describes three related information tools — developed by economists — which can help address this problem; monetary valuation, social cost-benefit analysis, and environmental accounting. Finally, it describes the case studies in the rest of this volume, which illustrate the use of these tools to answer real policy questions in South Asia.

One caveat is important at the start. This publication describes the "pure" economic approach to the environment. This approach is wholly anthropocentric. "Pure" economists would only be interested in the value to humans operating in an economic system, as expressed by their choices between spending their money on the environment and spending it on other goods and services. In purely economic analysis, the concept of the "intrinsic" value of the natural world has no meaning. If no one is willing to pay for the good or service in question, it has no economic value, even though it may be essential for other purposes such as preserving ecological balance or providing life support to non-human species. This does not mean that aspects like biodiversity are entirely left out of our analysis. However, its economic value arises only to the extent that humans are willing to pay for conservation, not for any reasons intrinsic to the natural world.

Economists, being human, recognise that this is a limited concept of the value of the environment; it is merely the concept supported by pure economic analysis. Economic analysis should be only one element in policy decisions about the environment (or about the economy). We must combine it with political, social, moral, and other values-based criteria for analysing the options before us. That being said, economic approaches have a great deal to contribute to making resource management decisions; it is simply necessary to understand their limitations as well as their strengths. Neither this paper, nor most economists, would advocate that decisions be made on purely economic criteria.

Introduction: Economic Functions of the Environment

In the traditional economic framework, output is a function of three factors of production; land, labour and capital. Land is broadly defined to include space for building, fields for cultivation, and natural resources such as forests and water bodies. The main emphasis of economic development strategies has been on labour, capital, and the agricultural use of land. The natural resources associated with land have been treated as meant, to be used for human benefit with little attention to the sustainability of that use. Moreover, economic growth has been given primary importance, with little attention to its impacts on the environment or the sustainability of the resource base.

In the past, this approach was reasonable. Until the industrial revolution and the associated rapid population growth, human impacts on the environment were negligible. Pollution was localised, and resources were generally adequate to provide food and shelter to those who needed them. While life spans were shorter and material well-being lower, that was not due to natural resource constraints or environmental problems. In the past two centuries, it has become increasingly clear that human impacts on the environment may be irreversible and may in time limit our own ability to continue to thrive on earth. Over the past three decades, concern about this problem has grown worldwide. The search is now underway for strategies to minimise our impacts on our surroundings while improving the quality of life of the billions of people living in poverty.

When the environment movement began gaining strength in the 1960s, it was perceived to present a trade-off between improved standards of living and a clean environment. Increasingly, however, both environmentalists and development advocates are recognizing that to maximise living standards in the long run, we must protect the environment. Improvements in the well-being of much of the world's population depend on finding ways to use our resources without destroying them.

The fields of environmental economics and ecological economics are both responses to this challenge. They constitute economists' strategies for ensuring that the decisions of individuals, firms, and governments reflect the economic importance of the environment and that the development paths we choose will be sustainable.

The environment plays four crucial roles in sustaining economic activity:

- life support
- supply of raw materials
- absorption of waste products
- supply of amenity services

Life support: The environment provides the biological, chemical and physical systems within which human life was created and on which human life depends for its survival. This includes, for example, the air which we breath, the hydrological systems on which we depend for water, and the soil fertility which allows us to grow food. While human populations can rebound from slight degradation of these services, they would not be able to survive without them.

Supply of raw materials: The environment supplies the raw materials and energy necessary for economic production and household activity. Some raw materials, such as forests, are renewable; stocks grow naturally, and humans can expect a constant supply if we choose to harvest at sustainable levels. Others, such as minerals and fossil fuels, are nonrenewable; once consumed they cannot be regenerated, so we have to plan for their replacement as we use them up.

Absorption of waste products: The environment acts as a "sink" which absorbs the waste products of economic and household activity. Modest quantities of organic waste can easily be absorbed by the environment and degraded through natural processes. However, there is a limit to the quantity of effluent which natural systems can handle; beyond a certain level ecosystems can no longer disperse, dissolve, or degrade the materials dumped into them. Moreover, wastes such as radioactive materials or some toxic chemicals are difficult or impossible to absorb even in small quantities. If history is a guide, the larger the economy gets, the more waste will be produced relative to the limited capacity of the environment to absorb it.

Supply of amenity services: The environment provides amenity services, such as scenic beauty, which are enjoyed by humans in their outdoor activity. Although important for psychological well-being, these amenities are not indispensable for continued physical existence. Because most people value them, however, they can be a source of revenue which is sometimes sufficient to make it financially viable to ensure that they are protected; thus they can be of substantial economic importance.

Market Failure: The Economic Causes of Environmental Degradation

The field of economics is concerned with how markets allocate scarce resources among users. Several assumptions about how markets work underlie most economic analyses:

- The allocation of resources is based on consumer preferences, the distribution of wealth, and the costs of production.
- Consumers are rational. They choose among goods and services based on prices, the amount they can spend, and their preferences. The value which a consumer places on additional consumption of a good declines with increasing consumption. That is, a consumer who already has a lot of a particular good will not be willing to pay much for more of it, whereas a consumer with none of it might be willing to pay a lot for it. Economic rationality dictates that consumption of a good continues up to a point at which the value placed on an additional unit is equal to its price.
- Firms seek to maximise their profits. This implies that they will minimise their costs in order to produce efficiently.
- Competition among firms forces them to charge prices that are equal to their marginal costs of production. The "marginal cost of production" is the cost of producing one more unit of a particular good. If it is less than the price, the firm can make money by producing and selling more; once it exceeds the price, they would lose money by producing more. Therefore they produce to the level at which price equals marginal cost.
- Most goods sold in markets are "rivalrous;" that is, one person's consumption reduces the ability of others to consume the same good. This is clearly true of ordinary products like food or clothing. It is not true of others, however, such as the system of national defense or a radio broadcast. Some non-rivalrous goods, like defense, are therefore provided by the government. Others, like radio, can be provided privately, but must be funded through advertising.
- Goods in the market are "exclusive;" that is, producers can prevent people from consuming their products if they haven't paid. This is true of most conventional goods purchased in markets.

- Many nonexclusive goods are also non-rivalrous; these characteristics tend to go hand in hand. Our examples of non-rivalrous goods, defense and radio, are also nonexclusive, because there is no reasonable way to prevent those who don't pay from benefiting from them anyway.
- However, there are also cases in which nonexclusive goods are rivalrous. For example, walking on a crowded city street is rivalrous because each additional person imposes more congestion on the others; but it is not usually realistic to exclude pedestrians if they have not paid a toll to be there.

The field of environmental economics exists because the assumptions of the market economy do not always hold where the environment is concerned. Environmental goods and services are often non-rivalrous, nonexclusive, or both, making it difficult to force those who use them to pay for them. *The differences between the "perfect" market and the environment constitute the fundamental reason why economic activity leads to environmental degradation.* These differences create the need for the field of environmental economics, as well as for public policy interventions to allocate environmental resources through non-market means or to correct the market failures.

Externalities

One discrepancy between the theoretical market economy and the way the environment is handled in the real world stems from what economists call "externalities." In the theoretical market, the manufacturer must pay for all of the materials and services used to produce outputs, including the disposal of waste. Similarly, the consumer price at a product covers all of the costs of its production and disposal. In the real world, however, the market system does not work like that. The manufacturer must buy the machinery and raw materials required to produce goods, but typically does not pay the full cost of waste disposal or energy use. The disposal of wastes or burning of energy uses up waste assimilation services of the environment which the manufacturer does not pay for. The same is true of a consumer who drives a personal automobile that emits fumes or who purchases food wrapped in plastic that is then dumped in a landfill site.

Economists refer to these unpaid costs as "externalities" because producers and consumers can make decisions without having to take them into account. More technically, an externality may be defined as the effect of one economic agent on another which is not controlled by market operations. Because the waste disposal services of the environment are usually free, people will consume more of them than they would if they had to pay for them. This is considered to be a market failure, because in the absence of a price, the market allocates these services inefficiently.

The economist's response to this problem is to seek a way to "internalise the externality" – that is, to force those who use the resource to pay a price for it which reflects the cost to society of its use. At that price, people would choose to use the environmental service at an economically efficient level, the level at which price equals marginal cost. Note that the economist is not concerned with preventing all use of the service (i.e. preventing all pollution), nor with preventing all environmental degradation. Rather, the economist's objective is to set the price at the level at which it equals the costs imposed by pollution. This price will permit a modest amount of waste disposal, allocated through the market to those who are willing to pay the price rather than through a regulatory process.

Conceptually, internalizing externalities is an efficient and elegant way to allocate environmental services. In practice, designing mechanisms through which to accomplish this, can be quite tricky. It is difficult to quantify the cost actually imposed by the environmental degradation, a subject which is discussed further below. Politically, it is often impossible to introduce the fee-based measures which can be effective in internalizing externalities. Environmentalists sometimes object to the idea of selling the "right to pollute," preferring that no pollution be allowed. Those responsible for the pollution - both producers and consumers - often object to having to bear the full costs of their actions, arguing that it will cause harm to the economy and hardship to individuals.

Common Property Resources

Common property resources are those which are rivalrous but nonexclusive. That is, it is hard to prevent individuals from using them, but each additional user imposes costs on all the others. Typical examples are marine fisheries and grazing lands. In the case of these natural resources, there is some maximum sustainable yield at which the resource can be harvested without hurting future harvests. If there were only one user who sought to continue using the resource indefinitely, s/he would use it at that sustainable level but no higher. However when there are many users, each has a direct incentive to take as much as possible, even though the overall combined outcome is an unsustainably high level of use which depletes the resource.

This kind of resource issues is a classic case of the prisoner's dilemma. Every user of the resource is better off if they all take less, to keep the total use at the maximum sustainable yield. However, if they don't have perfect information about each other's actions and don't trust each other to practice restraint, then each will assume that the others are going to use as much as they can, will choose the same strategy for themselves, and the resource is depleted. This has been referred to as "the tragedy of the commons," a term coined in a seminal article which described the problem and which has become a classic in the field (Hardin, 1968).

Common property resource use can also impose externalities on others who are not involved with the resource. For example, overgrazing might lead to increased soil erosion, which in turn could cause siltation of nearby rivers and harm to freshwater fisheries. However, the key feature of the common property resource is not the externalities it imposes on non-users; it is the long-run cost to all resource users if a sustainable management strategy cannot be designed.

Analysts of common property resource issues have suggested a number of possible policy responses to the risk of resource depletion (Ostrom, 1990). One is full public sector management of the resource, in a system wherein the government determines who can use the resource and in what quantities, imposing penalties on those who cheat. This approach has been taken in many countries to control access to resources such as forests. It assumes that the government has perfect information about the resource and can administer the system effectively and efficiently; clearly these assumptions are often incorrect.

An opposite strategy is to privatise the resource fully, so that it is managed through the market as a pure private good. Consider an area of pasture where rain will fall in different areas each year. Dividing the land into private parcels will increase the risk of drought faced by each herder. With one large shared parcel, all herders will have access to some well-watered land, although they may be crowded. With divided parcels, each year some herders will have no grass while others are doing fine. Instead of each animal having a smaller share, some will have excess and others will die. Moreover, for a mobile resource like a fishery, it may be hard to specify exactly what is meant by individual private ownership.

In a third approach, resource users enter into a voluntary binding contract with each other concerning use of the resource, with a designated third party having the authority to enforce it with known consequences for cheating. Ostrom uses detailed case studies to identify the circumstances under which such a strategy could effectively protect common property resources from depletion (Ostrom 1990).

Policy Failure

In addition to market failure, government policy can also be a cause of environmental damage. In some markets, the prices of environmental goods and services are lower than their marginal cost because governments offer subsidies for their use. This creates an incentive for overuse of the resources, thereby damaging the environment. Examples of such "perverse subsidies" include public support for logging roads in the United States, subsidies for expansion of the fishing fleets in many coastal countries, and low prices for imported fuel in many developing countries.

Valuing Environmental Goods and Services

A *Cassia fistula* tree, commonly known as Rajbrikshya, in Makawanpur, Nepal. The decoction of bark, leaves and seed is used as laxative, fruits in rheumatism and roots as purgative and febrifuge.

Because the market system does not set a price for most environmental goods and services, economists have developed techniques for imputing monetary values to them. Such estimates are fundamentally aimed at understanding individuals' potential willingness to pay (WTP) for goods and services which they now receive for free, or their willingness to accept compensation (WTA) for losing such goods and services. The goods and services in question could include a range of aspects; entrance into a park, a pristine view from a mountain top, the right to discharge municipal waste into a river or automobile exhaust into the air, or simply the knowledge that tigers are flourishing somewhere in the world even though one never expects to see them.

Willingness to pay and willingness to accept differ in their assumed baseline. When analysing willingness to pay, it is assumed that the potential buyer (who could be an individual consumer or a producer) currently doesn't have the good or receives it for free, but would have to pay for it in the future. The price he would be willing to pay will depend on his income, how much the item is worth to him, and the price of substitutes. Thus if a country proposes to begin charging admission to its national parks, it will want to analyse how much its citizens would be willing to pay from entry fees. This WTP could be a function both of the income of the citizens and of the cost of other recreation opportunities.

When analysing willingness to accept compensation for loss of a service, the assumption is made that assume the consumer currently has the service, which is proposed to be taken away and compensate for the loss. For example, suppose a coal-fired power plant is emitting carbon into the air without having to pay for the disposal services of the environment. A system of carbon permits is introduced in which the plant is granted free permits equivalent to its current pollution. It can either use those permits and continue polluting, or sell the permits to someone else and reduce its own pollution. The price at which the plant will sell its permits – that is, its willingness to accept compensation for giving up its right to pollute – will depend on the price of equipment with which to prevent the emissions. In order to give up the right to pollute, the plant would have to receive at least enough cash to cover the costs of the substitute, i.e. the pollution control equipment.

What is being valued?

In the first section of this paper four services which the environment provides were listed; life support, raw materials, waste disposal services, and amenities. Conceptually, what is done when an economic value is put on a particular environmental asset such as a forest, is the identification of each of the individual services which it provides, the valuation of them, and the values to calculate the total value of the forest. Of course using some services of the forest may preclude using others. For example, if the forest for timber is cut down, then it cannot provide life support to mammals and birds or amenities such as recreation. The total value must be valid for the forest as used for a given set of goods and services which are compatible with each other.

Economists have organised the services of the environment into a standard presentation in developing a framework for valuation. The point of departure is that the aim is to estimate the total economic value (TEV) of an environmental asset. TEV is broken down into use values and non-use values:

TEV = use value + non-use value

"Use values" are clearly identifiable human uses of the environment. This includes direct use of raw materials, both of marketed products such as timber and of non-marketed products such as gathered fuelwood, most water extraction, soil, and so on. It also includes so-called "indirect uses" of the environment, such as waste disposal, amenities like recreation or scenic vistas, flood protection, water filtration by submerged aquatic vegetation, and so on. By and large the indirect uses are not marketed, though access to parks is a notable exception. Thus:

Use value = direct use value + indirect use value

Non-use values of the environment capture our WTP (or WTA) simply to know that the resource will continue to exist, even though we don't expect to use it – or even see it - at any identifiable point in the future. For example, some people are willing to pay to help ensure the existence of the royal bengal tiger of Sunderbans in Bangladesh. This is called existence value. A related form of non-use value is called option value; this would be the WTP for the option to come see the tigers at some undetermined point in the future. Some economists also identify the quasi-option value. This reflects the expectation that the value of the option will increase over time, as the tiger (or other environmental good or service) becomes more scarce. Yet another non-use value is bequest value; in this example, it would be the willingness to pay to ensure that future generations would be able to see the tigers. Thus:

non-use value = existence value + option value + quasi-option value + bequest value,

and to sum up:

TEV = direct use value + indirect use value + existence value + option value + quasi-option value + bequest value.

The example of a tropical forest is useful for identifying what the different kinds of value might be in practice. The table below lists many possible goods and services which could be obtained from the forest:

Table 1.1: Total Economic Values of a Tropical Forest

DIRECT USES	INDIRECT USES	OPTION VALUES	EXISTENCE VALUES
Timber Wild plants Hunted animals Medicines	Recreation Wind protection Air pollution control Watershed protection Nutrient cycling I Carbon fixation	Future direct & indirect uses	Willingness of inhabitants of western countries to support protection of tropical forests, e.g. based on moral conviction

Table 1.1 gives an idea of the various values associated with an environmental resource. The next step is to estimate the economic value of each of these services.

How can it be valued?

Economists have developed many methods for valuing the non-marketed services of the environment. No method is suited to all services, meets all theoretical criteria, and can always be applied with readily available data. Therefore, it is necessary to choose among methods for each service, based on what is appropriate and feasible.

In discussing valuation, it is important to distinguish between stocks and flows – that is, the valuation of an environmental asset (the stock) and the valuation of the flow of services which comes from that asset. Using the forest example, we can identify a distinct asset and an associated flow of services for each of the values described above. One service provided by a forest – the one which receives the most attention because it happens to be marketed – is timber. The forest could be seen as a productive asset from which some number of trees can be harvested each year for timber without reducing the productivity of the asset in future years. The sale price of these trees would be the value of the flow of services from the timber asset. Alternately, the timber in the whole forest could be given a value; this might be the price at which it would sell on land markets. In an efficient market, the price of the timber asset should be the present value of the income stream which would result from sustainable management of the forest for timber purposes.

This distinction between stock and flow applies to any good or service provided by the forest, whether or not it is currently marketed, just as it applies to timber. Valuation can be done in either stock or flow terms, depending on what is most useful for the analysis. What is essential, however, is that when comparing different management systems or summing the values of different services are not compared with they be in the same terms, so that stocks of one service with flows of another.

One set of valuation techniques depends on using market data for related products to estimate a price for environmental goods and services. These techniques include dose-response analysis, consideration of defensive expenditures and substitute goods, travel demand analysis and hedonic pricing.

Dose response: The dose-response method, borrowed from medical analyses of the health impact of increasing levels of medicine intake, measures the impact on economic output or expenditure of increasing environmental degradation. It is typically used to estimate the impact on agricultural output of increased pollution, soil erosion, or other incremental change. The decrease in the value of crop may be understood as a proxy for the costs of pollution or of farmers' willingness to pay to prevent it.

Defensive expenditures: Defensive expenditures are those made to protect against the impacts of environmental degradation. For example, the cost of boiling and filtering drinking water may be considered a defensive expenditure. These may be understood as a lower bound (or minimum estimate) on the cost of pollution and willingness to pay for preventing it.

Substitute goods: In some cases there is a private market for goods which are also available "free" from the natural environment. For example, in many areas people can either use their time to gather fuelwood, food, and medicinal plants, or they can use their money to purchase close (or identical) substitutes in local markets. The price in the local market is often used as a proxy for the value of the gathered resource. There is a significant income effect at work here, however. People who gather such resources are often living in a largely nonmonetary economy, raising much of their food and other material needs and lacking money with which to buy goods. The price of marketed substitutes therefore constitutes an upper bound (or maximum estimate) on their willingness to pay for the goods, since at that price they are in fact choosing to gather "free" goods instead of purchasing them.

Travel demand: The travel demand method has been developed as a way to estimate willingness to pay for recreational amenities provided by the environment. It involves using data on distances travelled and expenditures for travel to estimate a demand curve for a specific national park or other natural site. From the demand curve, the analyst can estimate the actual willingness to pay for the recreation experience at the site.

Hedonic pricing: Hedonic pricing techniques use regression analysis to determine the contributions of different characteristics of a good to its price. This technique has been refined in the analysis of housing markets. The price of properties is estimated as a function of their different features; number of bedrooms, square footage, lot size, neighbourhood characteristics, and so on. This method can be used to determine the contribution of a clean or quiet environment to the value of a home. It can also be used to identify the wage premium paid to workers in dangerous or polluted environments.

Another set of valuation techniques involves asking direct questions about preferences and willingness to pay for environmental goods and services. These techniques are generally referred to as contingent valuation methods. Interviewees are asked how much they are willing to pay for a given good or service or how much compensation they are willing to receive to tolerate a cost or the loss of an environmental good or service. Respondents indicate the maximum they would be willing to pay for an environmental improvement or the minimum they would willing to accept for the decline in environmental quality if a market existed for the good in question. In the contingent ranking method respondents are asked to rank several alternatives rather than directly expressing a willingness to pay or to accept.

The advantage of contingent valuation methods is that they provide information about exactly the question of interest rather than depending on proxy markets. The disadvantage, of course, lies in the unreliability of respondents' information about their own willingness to pay, either because they simply have no idea and find the survey confusing, or because they are not giving their true opinion in order to influence the study results in one way or another.

Cost Benefit Analysis and Discounting

Cost benefit analysis (CBA) is founded on the simple and rational idea that decisions should be based on comparing the potential advantages and disadvantages of an action. CBA uses market costs and benefits to determine which projects contribute most towards the growth objectives of the economy, independent of who the beneficiaries are.

Social cost benefit analysis (SCBA) tries to improve decision-making by factoring in other issues in addition to market costs and benefits. Such issues may include who benefits from or pays the costs of the proposed project. This is addressed by weighting the costs or benefits to particular groups differently and by factoring in specific impacts such as those on women or other target groups. In addition, SCBA often uses so-called "shadow prices" instead of local market prices to calculate the costs or benefits of proposed actions. Shadow prices are considered to indicate actual willingness to pay for goods and services, whereas local market prices are often fixed, subsidised, or for other reasons do not reflect willingness to pay. Shadow prices may be based on world prices, or they may be adjusted to eliminate the impact of public subsidies.

Environmental valuation studies may constitute the basis for establishing shadow prices for environmental goods and services which are not sold in markets, so that they may be included in SCBA. This makes it possible to compare the different strategies for managing a resource such as a forest, taking into account the fact that not all services of the forest can be used at once. Thus if it is proposed to log a forest, clear the land, and plant crops, the SCBA would compare the set of goods and services available if that plan were put into effect with those available if the forest were managed for sustainable timber production. Some of those goods and services would be marketed, such as the timber (under both scenarios) and the crops (under the clear-cut and plant scenario). Others would not be, such as recreation opportunities in the forest, prevention of soil erosion, habitat conservation, and so on; those would be available only under the sustainable management scenario.

The comparison of the value of the forest under the two different scenarios would tell policy-makers which use of the forest would contribute more to the economy. The results of this analysis will be different from the analysis of the forest owner, who is only interested in private returns and not in broader economic impacts or possible negative or positive externalities from decisions about how to manage the forest. It will also differ from conventional cost-benefit analysis, which considers all marketed impacts on the economy, whether they accrue to the forest owner or others, but does not consider non-marketed impacts.

When the SCBA of proposed forest management strategies is undertaken, the present value of the future income stream from each service of the forest has to be estimated under each management strategy. In the sustainable management scenario, all of the services will be provided each year into the future. In contrast, in the clear-cut and plant scenario, there will be revenue at the start when the timber is sold, an investment at the start in order to convert the land to agriculture, and then an income stream into the future from agriculture. To compare the two strategies, therefore, all income streams are discounted back to the present and a comparison is made between the summed present values for the different scenarios.

This use of discounting raises questions about the choice of discount rate. The basic principle underlying discounting is that money earned today is worth more to us than the same amount earned a year from now, because we could invest today's earnings and they would be worth more in a year than today. Thus $100 today might be worth $105 next year, if the interest rate is 5%. In the same way the promise of $105 next year is worth less than that today – only $100, at the same 5% interest rate. Following this logic, any promised earnings in the future are worth less today than they will be when realised in the future. The return which is expected on the investment determines the amount by which future earnings should be discounted. This is termed the discount rate.

The higher the discount rate, the less future benefits are valued relative to today's benefits. The results of SCBA are therefore very sensitive to the choice of discount rate. An income stream of $2000/year over forty years is worth $34,318 today at a 5% discount rate, but only $19,598 at a 10% discount rate. The $2000 earned in the 41st year would be worth $270 today at 5% but only $40 today at 10%.

This sensitivity to the choice of discount rate tends to work against sustainable use of natural resources when decisions are based on cost benefit analysis. The benefits of selling off natural resources typically occur in the present, whereas the benefits of conserving them take the form of a perpetual income stream. Consequently, discounting can make it hard for sustainable management to compete financially with immediate use. Moreover, when discounting future income streams back to the present, interest is solely taken in the value of the resource to people who are alive today. The preferences of future generations with regard to the use of the resources are not value into account.

If the resources in question are fully renewable, this problem does not exist. If future generations prefer to have forests, for example, they could simply let them grow back instead of continuing to plant crops. Where this is the case, discounting is an appropriate analytical tool. In reality, however, very few resources are completely renewable, and some are not even partially renewable. Once extinct, a species is gone forever and cannot be brought back; once depleted, minerals are gone. While we can grow new forests for timber, it is not clear that we can recreate the complex and diverse ecosystems of old-growth forest. More complex strategies must be developed, therefore, to balance the income needs of the current generation against the rights of future generations to choose whether they wish to receive the benefits of the natural environment. This is essentially a problem of how to put a monetary figure on the bequest value of the environment, that component of non-use value which pertains specifically to future generations.

Environmental Accounting

Environmental accounting (or green accounting) is the modification of the System of National Accounts (SNA) to take into consideration the economic role played by the environment. The SNA is a set of economic accounts which governments routinely compile in a standard format in order to track the activity of their economies. SNA data are used to calculate the major economic indicators of a country, including Gross National Product (GNP), Gross Domestic Product (GDP), savings rates, and income per capita. SNA data are used to track the progress of the economy, to analyse the causes of changes in economic activity, and to develop policy responses to economic problems.

The SNA is compiled using a standard framework developed, supported, and disseminated by the United Nations Statistical Division (UNSD) under the authority of the UN Statistical Commission. The international standardisation of these accounts following the UN methodology is essential in order to permit comparisons across countries. Similarly, the fact that the accounts are calculated routinely, rather than just once, makes it possible to track how a country is progressing over time, and to compare its progress to global or regional trends. This provides a valuable basis for designing public policies to move countries and the world toward desired patterns of growth and development.

Environmental accounts provide data which highlight the role of the natural environment in economic well-being. They provide analytical information with which to assess claims about the costs of both environmental protection and environmental degradation. This can provide a more objective foundation for evaluating proposals which have an impact on the environment and for understanding what their actual impacts will be on the economy. The detailed data which underlie the accounts can help identify policy choices which further both environmental protection and economic growth.

Problems with the SNA

Several deficiencies in the national income accounts have received attention in recent years. Environmentalists and social critics argue that although the production of goods and services is recorded in the national income accounts, the harm caused to the environment by that production is not taken into account. Hence the major macroeconomic aggregates of the accounts are not an accurate indicator of well-being.

Statisticians and national income accountants counter this argument by pointing out that such measures as GNP and GDP are not designed to measure well-being; they are designed merely to measure the activity of the economy. In their view, therefore, the error is not in the calculation of such aggregates as GDP per capita, but in use of those aggregates as if they indicated our material well-being or even our happiness, when in fact they only indicate the level of economic activity.

Critics from both environmental and statistical perspectives point out a number of other problems with the accounts. One is that expenditures to protect the environment from degradation or to mitigate the negative environmental impacts of production increase the major indicators rather than decreasing them. Thus if water pollution forces us to spend additional resources on treating our drinking water, the national income accounts show us having more economic activity than we would if our water were not polluted in the first place. While water treatment does indeed create jobs, this is nevertheless somewhat counter-intuitive. Such defensive expenditures could be disaggregated within the accounts to highlight the costs incurred to prevent or mitigate environmental degradation, even if they are not subtracted out of income indicators like GDP.

Another problem is that, while the SNA subtracts the depletion of man-made capital as depreciation rather than counting it as income, the depletion of natural resources is accounted for as income. For example, a forest may be understood to be a productive asset from which an annual income can be derived through sustainable management. Cutting down one fourth of the forest each year for four years would bring in a high income in the short run, but would not be sustainable. However the accounts would simply show this as income, rather than showing that high revenues came in but the natural capital was depreciated rapidly as well. Similar depreciation should be recorded for soil erosion, fisheries, and other natural resources if they are managed unsustainably.

The SNA also does not usually record goods supplied by the environment which are not sold but which are nevertheless of value, such as fuelwood gathered in the forests, meat and fish captured for consumption, and medicinal plants. (Many national accounting systems do, however, estimate the value of agricultural produce which is consumed by the farmers rather than sold.) Similarly, the SNA does not include unsold services of the environment, such as watershed production by a forest or water filtration by submerged vegetation.

Changing the SNA

There has been considerable discussion over the past thirty years of strategies for modifying the SNA in order to address these problems. A number of different approaches have been advocated, and a variety of issues addressed in these debates.

- **Physical vs. monetary accounts:** Physical accounts provide data about the stock of natural resources and their use; the size of forest or mineral reserves, the quality of water and air, the depth and chemical composition of the soil, etc. Monetary accounts, in contrast, place an economic value on those characteristics or their use, so as to understand the role they play in the economy. While physical accounts avoid the need for monetary valuation, they do not lend themselves to economic analysis or comparison. They are not a prerequisite to monetary accounts, but if they exist they will greatly facilitate monetary valuation of the environment.
- **Integrated vs. satellite accounts:** Integrated accounts change the calculation of GNP, GDP, and other key national indicators. Satellite accounts (of which physical accounts are one example) are linked to the SNA, but do not change either the calculation of key indicators

or the central framework of the account. The advantage of satellite accounts is that they allow national income accountants to violate some of the conventions of the SNA in ways quite useful for environmental data, without threatening the consistency of the information in the conventional accounts. However, because they do not change GNP or GDP, they do not correct the distortions inherent in those indicators.

- **Methods of calculating natural resource depreciation:** True economic depreciation is the change in the present value of the future income stream from an asset from the beginning of the accounting period to the end. This is difficult to measure, however, so other measures have been developed as proxies. The "net benefit" method estimates annual depreciation as the change in the physical stock of the resource during the accounting period multiplied by the net revenue from extraction (average price less extraction cost). This method has been used to estimate depreciation of marketed products such as timber, as was done in the environmental accounts for Indonesia and Costa Rica developed by the World Resources Institute (Repetto et al. ,1989; Repetto, Cruz, et al., 1991). The "user cost" method, which has been proposed for measuring the depreciation of non-renewable resources, identifies the share of revenue from sale of the resource which must be reinvested in order to maintain a permanent income stream equivalent to the return on the value of the resource. Any revenue above that may be considered income.
- **Inclusion of maintenance costs:** Maintenance costs are the expenditures that a country would have to make for its use of the environment to be sustainable. Some experts on environmental accounting argue that maintenance costs should be deducted from the accounts to get a correct level of "green" economic activity. Others are wary of this approach because such estimated costs are highly subjective. Moreover, subtracting them from indicators like GDP to derive a "sustainable GDP" can mislead users of the resulting indicator into thinking that those expenditures have actually been made, when in fact they have not.
- **Valuation of non-marketed environmental services:** Due to the difficulty and subjectivity of valuation, most environmental accounting pilot activities do not value non-marketed services. However, this is of great interest to environmentalists in many countries, so its inclusion warrants consideration, if only on an experimental basis in satellite accounts.

If green accounting is such a good idea, why isn't everyone doing it?

Modifying the SNA to integrate the environment could lead to significant improvements in environmental data and policy-making. However, a number of constraints have kept this from being done on a routine basis in most countries. First, an array of unresolved methodological issues must be addressed one way or another to build the accounts. Individual countries can and have chosen strategies for handling these questions in building pilot accounts. However, one great strength of the SNA is that the same methods are used worldwide, permitting international comparisons. Until the U.N. Statistical Commission officially endorses a set of methods for environmental accounting, or standards are accepted in some other way, many countries will not be willing to invest in routine production of environmental accounts, because they will risk being incompatible with a future UN system.

For some ten years the UN Statistical Division has been leading an effort to develop methods for environmental accounting which may eventually lead to such an endorsement. In 1993 UNSD published a proposed methodology referred to as the System of Integrated Economic and Environmental Accounting, or SEEA. This came out in conjunction with the official 1993 revisions of the SNA, but is only a preliminary work. National income accountants from a number of developed countries have been working for several years on refining the SEEA methodology, under the auspices of the so-called London Group, comprised of national income accountants and statisticians from developed countries. In 1998 the U.N. Statistical Commission asked the London Group to work towards producing a revised version of the SEEA, which is now underway. However it is still likely to be some years before the Statistical Commission endorses a methodology for environmental accounting.

A second constraint on the introduction of environmental accounting, particularly in the developing world, is the state of the conventional accounts and the lack of data on which to build environmental accounts. Many developing countries have been unable to put as much effort as they would like into the development of their conventional income accounts, nor have they been able to invest substantially in building the primary databases which would be inputs into environmental accounts. Consequently, their first priority is often the strengthening of their conventional accounts and data systems rather than expansion into the more experimental environmental accounts.

Environmental accounting can also have political impacts. Detailed data on resource-based sectors can highlight their unsustainability, and subtracting the depreciation of natural capital from GNP and GDP can make the country's growth path look much worse than it appears from conventional indicators. These outcomes can lead the public to question national development strategies, while they can also generate strong pressure from resource-based industry groups to prevent further accounting work. This occurred in the United States in the early 1990s, when initial work on the minerals sector was met with strong opposition from industry groups, who successfully lobbied Congress to prevent the work from continuing. Accounting work in Chile was also halted when data were released that showed that the country's forest-based development strategy was not sustainable.

SEEA Methodology

Work on the design of environmental accounts has been underway since the 1970s. Some accounting projects have focused only on physical data, seeking to avoid the uncertainties associated with valuation. Others have included monetary data, but have been organised primarily to provide input into sectoral policy analysis rather than to modify the national accounts. Where monetary values have been used, some pilot projects have been limited to depreciating marketed resources, such as timber, while others have also ventured into valuation of non-marketed goods and services.

The UN's SEEA is an effort to integrate many of the different approaches being developed and tested around the world into a broad modular framework which offers a range of choices for how to implement environmental accounts. The SEEA includes:

- **Natural resource accounts:** These include physical and monetary data on stocks of natural resources and changes in those stocks due to natural processes and human use – that is, depreciation of natural resources such as forests and soil. Such data may be used to answer questions about the contribution of natural resources to economic output, the impact of environmental catastrophes on the economy, the rate at which stocks are being depleted, and so on.
- **Emissions accounts:** These use the framework of the National Accounting Matrix including Environmental Accounts (NAMEA), developed in the Netherlands. NAMEA structures the conventional accounts in matrix form and extends the matrix to identify pollutant emissions by sector. The physical data in the NAMEA format are used to assess the impact of different growth strategies on pollution and environmental quality.
- **Disaggregation of conventional national accounts:** Among the items which are identified in this module of the SEEA are expenditures on environmental protection, production and trade of

environmental protection products, capital formation for environmental protection, and environmental charges and subsidies. The disaggregation of such data provides more detail than is in the conventional accounts without changing any of the totals. These data are used to observe links between changes in environmental policy or environmental quality and costs incurred by industry, government and households. They also highlight the development of new industries producing environmental protection equipment.

- **Value of non-marketed environmental services:** These include such uses of the environment as water filtration, waste absorption, recreation services, etc. This is a relatively controversial module, as some analysts believe that it moves too far from the structure of the conventional SNA to be included in an accounting activity, and it should more properly be part of a modelling study. Others argue that if we leave out the value of services, we are including the costs of protecting the environment but not the benefits.
- **Environmentally adjusted GDP:** The SEEA calculates environmentally adjusted net domestic product as follows:

conventional NDP	
less	**depletion of non-produced economic and environmental assets**
less	**the cost of environmental degradation**
equals	**environmentally adjusted NDP**

While the inclusion of this item is not particularly controversial, most people working on accounting minimise emphasis on "green GDP" or "sustainable GDP" because it is not clear what it means and it places undue emphasis on a single indicator rather than use of the underlying data for policy purposes. However such measures have clear appeal as a flag to draw attention to environmental issues.

The SEEA does not respond to all problems faced by countries in addressing the incorporation of the environment into their national accounts. In particular, it does not address global or transborder environmental problems such as pollution, biodiversity loss, and other international externalities. These might more properly be linked to the balance of payments accounts as unpaid negative flows to the rest of the world. Moreover, inherent in any national income accounting is that is does not necessarily involve the development of regional or local environmental data, nor does it link to efforts to build environmental considerations into corporate accounting.

Applications

This chapter has provided a brief explanation of why the field of environmental economics has emerged. It has explained how valuation, social cost-benefit analysis, and environmental accounting can help economic decision-makers understand how to integrate the value of environmental assets, goods, and services into economic decision-making. The papers which follow illustrate the application of some of these tools, based on case studies from Pakistan and Bangladesh. All three cases focus on valuing environmental goods and services. This is an appropriate starting point for the use of these tools, because it is a fundamental building block for both social cost-benefit analysis and environmental accounting.

The first case, by Samina Khalil of Pakistan's Applied Economics Research Institute, explores the many goods and services provided by the mangroves in the coastal area near Karachi. Mangroves are a rich and complex ecosystem, receiving attention from both biologists and environmental economists worldwide. This paper uses market prices as a proxy to estimate the economic value of two major products of the mangroves, fuelwood and fodder.

The second paper, by Md. Rumi Shammin of the North South University in Bangladesh, uses the travel cost method to estimate willingness to pay for the Dhaka Zoo. The zoo provides both recreation services to the visitors and wildlife conservation services to the world as a whole. Since it is more feasible to charge for recreation than for wildlife conservation, it is important to understand how much visitors might be willing to pay for the opportunity to visit the zoo. This paper also demonstrates that using the travel cost method is quite practical in a country like Bangladesh, so it may easily be applied to evaluate other assets as well.

The third paper, by Nasima Tanveer Chowdhury of the University of Dhaka, uses contingent valuation to estimate willingness to pay for publicly supplied drinking water in Dhaka's slums. Basic infrastructure to eliminate the health problems caused by urban pollution is one of the most pressing environmental needs in developing country cities throughout the world. However, the needed investments are often held up because revenues are expected to cover the costs. The application of contingent valuation to assess how much the beneficiaries of such projects would actually be willing to pay for them is an important step forward.

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A nursery for mangrove saplings at the coastal areas of Karachi, Pakistan.

2

Economic Valuation of the Mangrove Ecosystem

Along the Karachi Coastal Areas

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Abstract

The mangroves of the Indus River Delta in the Karachi, Pakistan coastal areas provide a wealth of goods and services to people who live and work among them. However, these products are not sold in established markets, so their economic importance goes unrecognised. As a result, the expansion of regional industry, agriculture, and population are permitted to threaten the sustainability of the mangrove ecosystems. This study describes the broad array of goods and services provided by the mangroves, and uses market data to estimate the economic value of a few of them. It then argues for the importance of more thorough mangrove valuation studies as a crucial input into policy decisions which will affect the viability of mangrove ecosystems in the future.

Introduction

This study focuses on economic valuation of the mangrove ecosystem along the Karachi coastal areas. The mangrove ecosystem of the Indus Delta coastal zone is a vital wetland area of great ecological and economic significance. The location of Pakistan's mangrove forests in a temperate zone is unique, as the tidal forests of most other countries are in tropical areas.

The mangroves of Pakistan occur mainly in the Indus Delta in the provinces of Sind and Baluchistan along the Arabian Sea coast. As recently as the early 1980s, mangroves grew all along the 240 km coastline, occupying an area estimated at 600,000 acres, approximately 40% of the entire tidal belt and 10% of the Indus Delta fan. At that time they were among the largest mangrove forests in the world and certainly the largest in an arid climate. The Indus Delta mangroves are dependent upon forest water discharges from the Indus River, as are other mangroves in deltaic regions of the world, because they grow better in low salinity water and soft alluvial substrate.

Mangrove ecosystems are complex, diverse and important. Their complexity and importance pertain not only to their role in the biosphere, but also to the broader sphere of human-mangrove interactions. Understanding their economic value is therefore important in the search for strategies to protect them.

Economic Importance of the Mangrove Ecosystem

From an economic point of view, Pakistan's mangrove ecosystems are important for a variety of reasons. For countries like Pakistan, where population and economic pressures on the coastal zone are high, mangrove forests could be considered a primary natural resource. Not only are the forests themselves of direct value to the economy, but they also protect and sustain other key coastal resources.

The mangrove forests have vital economic importance in sustaining the productivity of inshore and offshore fisheries. They provide shelter and nurseries for commercial fishery species and some coastal species such as shrimps. Pakistan's thriving shrimp fishery, which almost entirely depends upon the mangrove ecosystem, earns some US $100 million annually.

Many of the fish species which contribute to domestic and foreign consumption are directly harboured by the mangroves during a part of their life cycle, and they remain dependent on the mangrove food web throughout their life cycle. This is particularly the case with panarid shrimp, which comprise the most valuable commercial species in Pakistan.

The following tables list the direct and indirect uses of mangrove products.

Table 2.1: Direct Products from Mangrove Forests

USES	PRODUCTS
Fuel	Firewood for cooking, heating Firewood for smoking fish Firewood for smoking sheet rubber Firewood for burning bricks Charcoal Alcohol
Construction	Timber for scaffolds
Fishing	Timber for heavy construction (e.g., bridges) Railroad ties Mining pit props Deck pilings Beams and poles for buildings Flooring, panelling Boat building materials Fence posts Water pipes Chipboards Glues
Agriculture	Fodder Green manure
Paper Production	Paper of various kinds
Foods, Drugs and Beverages	Sugar Alcohol Cooking oil Vinegar Tea substitutes Fermented drinks Desert topping Condiments from bark Sweetmeats from propagules Vegetables from propagules, fruit or leaves Cigarette wrappers Medicines from bark, leaves and fruits
Household Items	Furniture Glue Hairdressing oil Tool handles Rice mortar Toys Matchsticks Incense
Textile and Leather Production	Synthetic fibres Dye for cloth Tannin for leather preservation
Other	Packing boxes

Table 2.2: Indirect Products from Mangrove Forests

SOURCE	PRODUCT
Fish (many species)	Food Fertilizers
Crustaceans (prawns, shrimp, crabs)	Food
Mollusks (oysters, mussels, cockles)	Food
Bees	Honey Wax
Birds	Food Feathers Recreation (watching, hunting)
Mammals	Food Fur Recreation (watching, hunting)
Reptiles	Skins Food Recreation
Other Fauna (e.g., amphibians, insects)	Food Recreation

This wide range of products is the basis for the mangrove-dependent economies of many coastal peoples and contributes significantly to the national economy. Identifying the economic value of the marketed mangrove-based products is relatively straightforward. It is more difficult, however, to identify the economic contribution of those products which can be termed as free. These free good and services would cost a tremendous amount of money if other resources were utilised in their place. Since this is usually not addressed, conventional accounting practices underestimate the total value of the mangrove resource.

Functions of the Mangrove Ecosystem

Mangrove ecosystems provide a number of distinct services which are not sold or priced through the market:

- The presence of the species Avicennia mavina along the shore ensures the firm and stable formation of shorelines and creeks. These trees serve the vital but almost unquantifiable function of protecting the coastline from wind and ocean currents. The location of Port Qasim, Pakistan's second largest port in the vicinity of the Korangi/Phitti creek system, may be attributed in large measure to the natural protection it gets from mangroves.

- The pollutants and waste discharge from industrial activities in and around Karachi find their way to the natural sink of the mangrove ecosystems. Karachi's ever-growing population generates a huge amount of domestic effluent which is also absorbed by the mangrove ecosystem.
- Coastal communities benefit from a host of products and services of the mangrove ecosystem. Fishing is the primary source of income for the majority of the fishermen residing in villages along the coast line and these fisheries depend upon mangroves for regeneration.
- The mangrove wood and leaves serve many purposes. They are used as fuel, as fodder for camels, cattle and goats, and to build houses and furniture.

Degradation and Depletion of Pakistan's Mangrove Ecosystems

Deforestation and degradation are common among mangrove ecosystems all over the world. The increase in coastal population, together with rapid economic expansion, has brought about an increase in consumption of forest resources. Mangroves are under pressure to supply wood and other forest products. Pakistan's mangroves face serious threats which jeopardise their sustainability and their very existence.

Decreased Indus River Flow

Decreased flow in the Indus River is probably the most serious problem facing the mangroves of the Indus Delta. Their productivity increases proportionately with the availability of freshwater. A decrease in freshwater supply means retardation in their growth.

There has been a continuous decrease in Indus River discharge ever since the creation of Pakistan some five decades ago. The population of the country was low and dispersed at that time. Since then, population has increased steadily due to immigration from neighbouring India and to high birth rates. This has called for increased agriculture in the country. As a result, dams and barrages have been constructed to use the Indus water for irrigation, decreasing the river's discharge gradually over the years. Now only a trickle is available to the delta, except during monsoonal floods. Salinity has therefore increased dramatically in the deltaic region; at present a level of 40 parts per thousand or more is common in some mangrove areas. No records exist of salinity in the area prior to the last few decades. However, it must have been appreciably lower, since rice was once cultivated in Keti Bunder in the vicinity of mangrove stands. Due to this hypersalinity, a decline in mangrove growth is now visible everywhere.

The upstream damming of the Indus River has also stopped the flow of much of the nutrient-rich alluvium. According to one estimate, annual alluvial flow has decreased from 200 million tons in 1955 to a current flow of less than 50 million tons at the Kotri. Lack of sediment also affects the mangroves negatively.

The ideal solution to these problems would be to restore the normal flow of Indus river to the delta. However, this is not a practical option, when one considers the increasing demand for agriculture in the country. Recently, an Indus Water Accord by Government of Pakistan apportioned the use of Indus water between provinces and allowed a meagre amount of 10 million acre-feet to be discharged into the delta. This amount will be less than the 35 million acre-feet now available and much less than 150 million acre-feet available decades ago before the construction of the dams. Thus the situation is likely to worsen with time. The government may be prevailed upon to increase the amount to some extent. However, coastal scientists first need to determine the minimum freshwater required by the mangroves. Only then can one argue the case strongly with the authorities. Such studies would be an obvious undertaking for a coastal management program.

Grazing and Harvesting

Mangrove leaves are eaten by cattle and camels and are considered to be very nutritious. As many as 16,000 camels and 11,000 cattle may browse on mangroves in the Indus. The animals seem to have adjusted well to the diet. Mangroves are also harvested as fuel wood by local habitants at the rate of 173 kg of wood per month per household and 18,000 tons per year for the entire delta area (IUCN 1992). There is the problem of overfishing in the creeks, which is not only affecting the delta but also the coastal waters.

Harvesting may be as significant as hypersalinity in contributing to the decline of the mangrove ecosystems. In order to manage mangrove utilisation properly, it is important to assess the damage caused to mangrove cover annually from this source. IUCN surveyed local consumption of mangrove wood for fuel in the Korangi Creek area (IUCN 1992) and the Sindh Forest Department surveyed the grazing and stall feeding by camels and cattle respectively in the delta region. Neither study provides quantitative estimates of the rate of loss of mangrove cover over time attributable to such activities.

In any case, a number of strategies may be suggested to address these problems. Browsing by camels and stall feeding by cattle may either be completely stopped or allowed only within the sustainable yield. At present, the revenues collected from sale of mangrove products are minimal; they should be discouraged completely. Laws must be strictly implemented and poachers heavily fined. A two-month ban on fishing may be reintroduced to prevent declines in the fishery.

One solution to the problem is to provide alternate sources of fuel and fodder to the local inhabitants who now use the wood from mangroves because they are cheap and easy to obtain. Provision of natural gas, which is cheap and plentiful in Pakistan, may be the best choice. Similarly, if local inhabitants are encouraged to take up professions other than fishing, it may improve the situation markedly.

Urbanisation

The city of Karachi is constantly growing, both in population and in geographic area. Its population was estimated to be over 10 million in 1995. Pakistan's second largest port, Port Qasim, was recently established in the Korangi Creek area at the expense of thousands of acres of mangrove forest. Both the port and a nearby steel mill are supported by a new town, which houses people working in the two giant complexes. Thermal pollution and solid wastes originating from these sources are a direct threat to the mangroves. Dredging operations in the channels and creeks leading to the port, while needed for navigation, have a detrimental effect on the young seedlings and pneumatophores of mangroves as sediment cover cuts off their oxygen supply.

An immediate step to prevent further destruction of the mangrove vegetation must be to regulate coastal development in the area and restrict it to areas that will do the least harm. Coastal erosion can also be prevented by planting selected mangrove species on the banks. The dredged material must be disposed of far away from the mangroves, with experts on mangrove ecosystems consulted at every step.

Pollution

According to one estimate, there are more than 6,000 small and large-scale industrial units in the Karachi area, all of which discharge untreated effluent directly or indirectly into the Indus Delta. The major flow of industrial and domestic pollution comes through the Lyari River, whose spillway lies close to Karachi harbour. The other is the Malir River, spilling into Korangi Creek. Industrial pollutants include all types of heavy metals and hazardous chemicals. As many as 170 tanneries have also been established in Korangi, discharging large amounts of chromium into the nearby creeks.

In addition, the steel mill is a source of iron pollution in the area. Agricultural pollutants including fertilizers, pesticides, and herbicides also make their way into the delta as the river collects these hazardous substances along its course through the country. Fertilizers result in eutrophication and are responsible for abnormal phytoplankton blooms resulting in high fish mortality. Organometallic compounds and chlorinated hydrocarbons are other toxic pollutants present in the Delta.

Oil may be the most serious threat to the mangroves. It physically covers the pneumatophores and prevents access of oxygen to the roots, thereby killing the plants by suffocation. Oil pollution in Karachi harbour and Korangi Creek area originates mostly in the sea. According to one estimate, some 20,000 tons of oil find their way to Pakistani beaches, harbours and fishing grounds annually. There are four major sources of this oil; near-shore bilge cleaning, leakage from vessels, accidental spills and refinery effluents.

Additionally, the steel mill, Port Qasim, Korangi Power Plant, West Wharf Power Plant and Sindh Alkalis are sources of thermal pollution in the area. They collectively discharge some 1500 million cubic meter of warm water annually.

Organic pollution may not be a serious problem for mangroves, as they can resist doses of domestic, industrial and agricultural effluents. There are even suggestions to use them as bio-filters for land-based pollution entering into the sea. Domestic sewage seems to encourage the growth of mangroves because of its heavy load of nutrients and fresh water.

However, even though the different types of pollutants may not be affecting the mangrove growth, they are certainly toxic to animals living in the ecosystem and may, therefore, eventually destroy it. The only way to avoid this catastrophe is to treat the effluents before they enter the area. As yet, there are no treatment facilities for pollutants in the region, except for some domestic sewage treatment plants in the Karachi area. These are quite inadequate to handle the entire city's load, which includes more than 2000 tons of biological oxygen demand (BOD) per day.

An important aspect of combating pollution in the region is the regular monitoring of the levels of pollutants in the substrate and organisms of the area. Marine pollution is an international problem and, therefore, cooperation with international organisations may be sought to combat it.

Sea-Level Rise

The response of mangroves to the threat of sea-level rise depends on the balance between the rate of the rise and the rate of sedimentation or peat accumulation in the mangrove areas. If the former exceeds the latter, then the mangroves will retreat or disappear as they have on the Atlantic Ocean island of Bermuda. In Bermuda the local sea level had been rising at a rate of 28 cm/100 years whereas the rate of peat accumulation was only 8.5 to 10.6 cm/100 years. As a result, the mangroves perished. If, however, the rate of sea level rise equals the rate of sediment accumulation, then the mangroves can continue to flourish.

The recent estimate of sea level rise of 1.1 mm/year around Karachi between 1960 and 2000 is well below the average global rate. No meaningful estimates of sedimentation rates in the Indus Delta mangroves are available. However, due to continuous decrease in sediment loads of the Indus these rates must be small and it is likely that the mangrove forests of the Indus Delta will be overrun by the rising sea.

Socio-Economic Issues

Poverty, with its associated deprivations, seems to be the source of all socioeconomic problems along the coast, including the overexploitation of mangrove resources. The local dwellers, if provided with alternatives to fishing and harvesting mangroves, will tend not to overexploit the ecosystem. If these job opportunities are related to the mangrove ecosystem itself, they may not only prevent misuse but also guarantee continuous management of the mangroves by people who actually live beside them. Establishment of marine parks, ecotourism, mariculture facilities, and honeybee farming are some of the alternatives that may be offered to the local people.

Mangrove areas in the delta which offer landforms unusually rich in wildlife could be treated as marine parks, completely protected from human interference. The objectives of such parks would be: 1) protection of the mangrove ecosystem along with its biodiversity, 2) research areas for scientists and 3) recreation and education for the public. The local people should be given priority for jobs in the parks.

However, caution is needed in introducing other economic uses of the mangroves, as their excessive and indiscriminate use could overwhelm the ecosystem. The best policy is to use only the barren or less-populated areas for this purpose. In Pakistan, a certain proportion of barren areas may be used for pond culture of shrimps. This could be economically viable, not only covering the management expenses, but also provide job opportunities for the local people.

Apiculture, or honeybee farming, is a venture which could have beneficial effects for the mangroves as it encourages cross pollination. Mangrove forests are noted for high quality honey production. India and Bangladesh are major producers of mangrove honey. This profession needs little investment and may be ideal for the local people as a side occupation. The product is a renewable resource and is non-perishable.

Lack of Public Awareness

Lack of public awareness about ecological and environmental issues may underlie the plight of deteriorating coastal ecosystems around the world. In the case of economically-important systems such as the mangroves of the Indus Delta, such ignorance is self defeating. Until recently these areas were considered wastelands with nothing to offer to mankind. If their importance had been realised by planners and policy makers at an early stage, perhaps there would not have been such a drastic cut in the Indus flow into the delta. Though educated people now seem to be better aware of the economic and ecological importance of mangroves, following a number of public fora and articles in the press, the villagers of the delta are not. Even today, they believe that mangroves would never perish no matter how much they are harvested. They are also ignorant of the relationship between the mangroves and the fisheries.

Economic Valuation of Mangrove Ecosystem Products

As we have seen, mangroves are a unique ecosystem which combine land, water, trees, animals and humans to provide multiple goods and services. They are also fragile ecosystems and a change in one part of the system may have profound effects on the rest. This interdependence of uses and production traditionally has been hard to communicate to policy makers, who see the mangroves as a low value resource to be exploited but not conserved. It is precisely because of this multiplicity of uses and interdependencies that a complete economic analysis is imperative in order to evaluate both the benefits and the costs of mangrove conservation.

Some of these goods and services are sold in markets where they have observable prices. Others are not marketed. They may be thought to have little or no value or their market value is difficult to quantify. The first category of goods and services often is referred to as pecuniary goods; that is, they can be exchanged and valued using existing market prices. The second category may be termed environmental materials or resources. These include such goods and services as the biological production of food that supports mangrove-dependent plant and animal species and the role of mangroves as nursery areas for finfish and shellfish. Although these goods and services are not priced, they still are valuable. The economic valuation of such goods and services presents many interesting challenges.

The environmental and resource economics literature illustrates a number of techniques that have been used to value such difficult-to-measure goods and services. For example, the value of mangroves in preventing storm damage can be calculated from an analysis of damage with and without the presence of mangroves. The value of damage prevented by retaining the mangrove barrier is an implicit valuation of one of the benefits of mangroves.

In this study, an attempt has been made to value some mangrove products used in the coastal villages along Korangi Creek, southeast of Karachi. We rely on secondary data available in the "Natural Resource Use Survey ", Korangi/Phitti Creek, 1992, Volume I and II, by the Pakistan office of IUCN-The World Conservation Union. The time and resource constraints for this study do not allow a comprehensive natural resources survey of the mangroves of coastal areas of Pakistan. However, a rough estimation is done to put value on certain important goods available in the area.

The data available in the IUCN studies allow us to value two mangrove products, wood and fodder. The valuation uses the "market price" method and a simple exercise of multiplying the quantity consumed with the average market prices of the goods. Although some of these goods are traded in markets, these sales appear not to be recorded in the national income accounts.

The IUCN study interviewed users of mangrove wood and fodder to quantify the consumption level of these goods in the survey area. The respondents were from 100 households in four coastal villages in the Korangi Creek area. These four villages appear to include most of the population of the Indus Delta, according to the IUCN study, and therefore may represent the total use of the delta's mangroves. The table below provides estimated population and number of households in each village in 1992.

Table 2.3 – Korangi Creek Village Populations

VILLAGE	POPULATION 1992*	HOUSEHOLDS 1992
Ibrahim Hydari	61,442	6,904
Chasma	7,303	769
Rehri	23,612	2,951
Lat Basti	2,898	326
TOTAL	**95,255**	**10,950**

* Estimated

Mangrove Wood as Fuel

Mangrove wood is the primary source of fuel in the four villages. While the data available from the survey are rough and contain some errors, they do provide useful information about the level of use of the wood and its economic value.

The study estimates total consumption of wood by the 10,950 households in the four villages at about 1,400,000 kg/month (p. 18). This is roughly consistent with its overall estimate of regional consumption per year at 18,000 tonnes (p. 12). These figures suggest that daily household use of mangrove wood is about 4.5 kg.[1] The study gives an average price of mangrove wood of 1.34 Rs. per kg. At this price, the total economic value of the fuelwood is about 22.5 million Rs per year.

If the value of marketed fuelwood is, in fact, not included in the national income accounts, this is the amount of economic activity which is omitted. If the value of marketed fuelwood is estimated in the accounts, then they only reflect the quantity collected directly by the households.

While the data are inexact, the survey does provide some information with which to estimate the amount collected by households. Among the 100 households surveyed, 76 purchase all of their wood, 20 collect all of their wood themselves, and 4 do some of each. If these figures are representative, then some 2,190 of the region's 10,950 households might be expected to collect all of their own wood. Those who collect wood appear to use it at a significantly higher rate than those who purchase it. The average collector for household use gathers 432 kg. per month, according to the survey. This means that 946,020 kg. are collected for individual use per month, or 11,352,240 kg. per year. Applying the market price to value the non-marketed wood, this comes to about 15.2 billion Rs per year which have been omitted from the income accounts.

Mangrove Leaves as Fodder

The leaves of the mangrove tree Avicennia marina are used for animal fodder by households in the Indus Delta. The residents of coastal areas purchase or collect mangrove leaves to feed domestic animals such as cattle, sheep and goats. The survey interviewed 92 households which kept domestic animals and used mangrove leaves as one source of fodder. On average, fodder consumption per animal unit was found to be 3.82 kg/day,

[1] This figure is not consistent with the estimated daily household use of 7.7 kg/day given in Table 1.5 of the second volume of the study. Because the 7.7 kg/day figure cannot be reconciled with the other data and calculations in the report, we have used the 4.5 kg/day figure for our estimates.

of which 1.22 kg were mangrove leaves; thus mangroves represent some 32% of domestic animal feed.

The study indicates that total monthly consumption of fodder in the delta sums upto 535,650 kilos. Applying the ratio above of mangrove fodder to other sources of feed, this gives a monthly consumption of 171,000 kg of mangrove leaves, or 2,052,000 kg per year. The price of mangrove fodder averages Rs 1.25 per kilo, which allows us to estimate the annual value of the fodder provided by the mangroves at about Rs. 2,560,000. The data in the study do not let us estimate how much of this fodder is purchased rather than directly collected by the user. However, if in fact none of the marketed fodder is included in the national income accounts, then all of this should be added to correctly reflect this service of the mangrove forests.

Mangrove Fishery Resources

Fishing is the primary economic activity and source of income for the coastal village communities. The fishing industry accounts for 0.8% of Pakistan's GDP, and is the country's sixth largest foreign exchange earner.

Data on the economic value of the mangrove-based fisheries in the Indus Delta area are not available. However, since employment and income in the region depends heavily on this resource, its contribution to the local economy is significant. Much of this contribution may already be included in the national income accounts; however it is important to be able to disaggregate it in order to identify the economic costs of any degradation of the mangroves.

Conclusion

These indicative results from the valuation of a few services of the mangrove ecosystem suggest that this resource is of significant economic importance to the region and to the country as a whole. While our calculations are rough, they highlight the need for more research both on the physical productivity of the mangrove-dependent systems and on their contribution to the local economy. This must be complemented with further study of the impact of incremental changes in the ecosystems and their productivity due to decreased river flow, overuse, pollution, and other pressures. This information could lead to better estimates of the values of the goods and services provided by the mangroves and their contribution to the regional and national economy.

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A mangrove forest in the coastal areas of Karachi, Pakistan

3 Application of the Travel Cost Method

A Case Study of Environmental Valuation of Dhaka Zoological Garden

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Abstract

This paper uses the travel cost method (TCM) to determine willingness to pay for the services of the Dhaka Zoological Garden. Every year three to four million people visit the zoo to enjoy both entertainment and educational experiences. In addition, the zoo provide a protected habitat for endangered and extinct species and offers opportunities for captive breeding and preservation of genetic diversity. A questionnaire survey was conducted to collect information on visitors and their expenses to visit the zoo. The data were analysed to find out the origin of visitors, distances travelled, income groups represented, and travelling expenses. Visitors were zoned in concentric circles on the basis of distance from site. The willingness to pay per visitor day was calculated from the sample data. Several demand curves were generated using regression analysis to describe the relationship between travel costs and number of visits. Additional information on mode of transport used by the visitors and income groups represented has been compiled. The features that attracted the visitors have been identified and listed. Problems of the zoo as identified during the survey from key informant interviews have been documented and recommendations have been made in the light of the results of this case study. Comments have been made about the potential to apply TCM to other cases in Bangladesh.

Dhaka Zoological Garden: An Overview

The Dhaka Zoo was first conceived of in 1950 when the former Pakistan Government passed a resolution to establish a zoological-cum-botanical garden in the suburbs of Dhaka. The current site at Mirpur was selected in 1960 and officially designated in 1964. After that, little progress was made during the Pakistan period except moving the tiny zoo that had been located in the High Court Mazar area to the new location. After independence, the zoo was officially opened to the public on June 23, 1974. It is the only major zoological garden in Bangladesh. Its total area is 213.41 acres, with two water bodies, four restaurants, three pagodas, one animal museum and one fish aquarium. Public facilities such as toilets and card phones are available in the premises.

Total visits to the zoo per annum range between two and three million. The zoo provides recreation and education for the visitors by housing a wide variety of common, exotic, rare and endangered species of animals. Captive breeding is carried out for selected species and often surplus animals are offered for private ownership. Reintroduction of species to their natural habitats is also under consideration. The Dhaka Zoo is the only facility in the country for the preservation of animal genetic diversity.

The Dhaka Zoo is operated by the Government of Bangladesh under the jurisdiction of the Ministry of Fisheries and Livestock. The chief of the zoo is the Curator (Deputy Secretary rank), who is accountable to the Director General (DG). The DG communicates with the Ministry when higher level decisions are required. The zoo has a workforce of 213 regular employees in addition to temporary day labourers and 20 Ansars (security people). The types of animals housed in the Zoo are summarised in the following table.

Table 3.1: Zoo animals by category

CATEGORY	NUMBER OF SPECIFS	TOTAL NUMBER
Mammal	69	570
Reptile	14	49
Bird	96	915

The annual operating budget of the zoo is between 15 and 20 million (1.5 and 2 crore) taka. About half of this is spent for salaries and the rest for food and care of the animals (7 to 8 million, or 70 to 80 lakh) and miscellaneous expenses (1 to 1.5 million, or 10 to 15 lakh). The zoo generates a major portion of its revenues from entry fees, parking, and rent for the restaurants inside the zoo, which are leased through open tenders. From these sources, the zoo may generate about 15 million (1.5 crore) taka. In the 1996-97 period, entry fees generated 12 million (1 crore 20 lakh) taka. Another source of income is the selling of poultry, fish and fruits grown inside the facility. The remaining expenses are subsidised by the government.

This subsidy, as well as the fact that the zoo occupies 214 acres of high-value land in close proximity to Dhaka, raises the question of the economic justification for the zoo. For this reason, we are interested in estimating its actual value to the visitors. Such a valuation exercise can influence policy decisions on future allocation of funds for the development of the zoo. Like most other public recreational facilities around the world, the Dhaka Zoo offers an array of environmental, ecological, zoological and recreational services whose value is not reflected in the small entry fee charged to its visitors (Tk. 5.00 per person per visit). A valuation study on the Dhaka Zoo is therefore a useful exercise, an important input to national accounting, and an aid to policy makers and development planners.

Travel Cost Method (TCM): An Overview

Several methods of valuing environmental goods and services have evolved in recent years. One of them, the travel cost method (TCM) has been used extensively around the world to value public recreation sites with minimal or no admission charges. TCM is now well established as a technique for valuing the non-market benefits of outdoor recreation resources (Hanley and Spash, 1993). It originated in a letter from Harold Hotelling to the director of the US Park Service in 1947, but was formally introduced in the writings of Wood and Trice (1958) and Clawson and Knetsch (1966). The method is often referred to as the Clawson-Knetsch approach. Numerous applications exist in the US, Europe, and Australia. In the USA, government agencies have used it to model demand for national parks, national forests and other recreational facilities. In the UK, the Forestry Commission have started to use it quite extensively (Willis and Benson, 1989). In recent years, several studies have been conducted in developing countries, such as Kenya, Costa Rica, Madagascar, and Thailand (Markandya, 1992).

The travel cost approach is based on the theory of consumer demand. The fundamental principle of TCM is that the value people attach to a location of environmental significance can be inferred from the cost they incur in travelling to it. Value is placed on non-marketed environmental goods by incorporating the patterns of consumption in related markets. Such costs of consuming the services of an environmental asset include travel costs, entry fees, on-site expenditure, outlay of capital expenditure necessary for consumption, and the opportunity cost of time. The method assumes a complementarity between an environmental asset and consumption expenditure, and thus can also be applied to determine the marginal utility of quality improvements. Therefore, if consumption expenditure becomes zero, the marginal utility also becomes zero. For example, if the travel cost to a national park becomes so expensive that the number of visitors is zero, then the marginal social benefit of an increase or decrease in quality is also zero. TCM has also been applied to determine the willingness to pay (WTP) for sites where the cost of visiting substitute sites is also taken into account.

In general, the total cost for each individual "i" to visit a given site "j" can be represented by the following function (Hanley and Spash, 1993):

$$C_{ij} = C\ (DC_{ij}, TC_{ij}, F_j)\ \textbf{where, } i = 1 \ldots n$$

where, C_{ij} = Total cost for individual "i" to visit site "j"

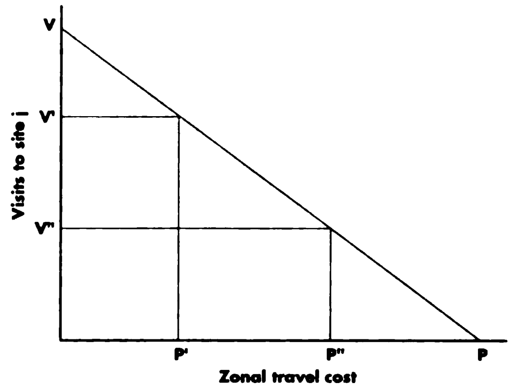
DC_{ij} = Distance costs for each individual dependent on the distance the person has to travel and the cost per mile of travelling.

TC_{ij} = Time costs which include the time spent in travelling to the site, the time spent inside the site and the value of the individual's time.

F_j = Entrance fee to the site

Wood, Trice, Knetsch and Clawson used an approach to TCM known as the zonal model. In this approach, the area around the site is divided into several zones and travel costs for each zone are calculated to generate the demand curve. The surrounding area of the site is divided into concentric circles of specified distance with some reference to the administrative districts. The demand curve is estimated by regressing the number of visits from each zone against the travel costs. People's willingness to pay for the given site is expressed as cost per visitor day. Another model for generating the demand curve is to take the number of visits made by each individual as the dependent variable, rather than number of visits per zone (Hanley and Spash, 1993.) In this case study the zonal model has been used.

In order to estimate willingness to pay for an increase in quality for a site, a trip generating function (TGF) is used where number of visits from each zone is divided by the zonal population as the dependent variable. The TGF is used to derive the demand curve, which



shows the number of visits in relation to a change in price. In any case, the key assumption is that, as the travel costs increase, the number of visits falls. A typical TCM demand curve is shown below:

In the above graph, we see that as cost per visit increases, the number of visits decreases. At price P, the cost of travel will be so high that no one will visit the site.

Methodology

Literature Review

A comprehensive literature review was carried out at local libraries. Results and experiences of similar case studies from around the world were studied and the methodology for this specific case study was developed. Official documents and other related literature regarding the features, attributes and services of the Dhaka Zoo were collected.

Field Survey of Visitors of the Zoo

The TCM requires information about the visitors to a recreational site. This information was collected by conducting an on-site survey of visitors to the Dhaka Zoo. The survey questionnaire, prepared in both Bengali and English, asked about origin of the visitors, mode of transportation used, travel expenses, miscellaneous expenses at the site, income group, time spent at the zoo and other data required for the travel cost analysis. Experienced surveyors were hired to carry out the task under direct supervision of the author. A sample size of 1,000 was selected. However, the actual survey produced information on 2347 visitors, as single questionnaires were used to interview groups with one earning member. The survey was carried out in the third week of October over seven days, to account for variations in the composition of visitors on weekdays and weekends. The time of year represents an average season in terms of the number of visitors. Random sampling of the visitors was done throughout the day to capture variations in the origin of visitors at different times of the day.

Key Informant Interviews

Key informant interviews were conducted with the Curator of the zoo to extract information about the budget, expenses, current problems, future development plans and major constraints of the zoo. Representatives of the contractors who operate the admissions booths were also interviewed to extract information on the number of visitors during the sampling period.

Analysis

Data from the questionnaires were entered into a spreadsheet to calculate travel costs for each visitor. Administrative districts of the Government of Bangladesh were selected as the computation level for the zonal model. Number of visitors per district, income groups represented by the visitors and travel costs were calculated. Measures were taken to minimise the common biases of the TCM. The sample included visitors from 58 out of the 64 administrative districts. Distances have been taken from the midpoint of the districts concerned to the midpoint of Dhaka district. A summary of the data by district is given in Table 3.2.

Table 3.2: District wise travel costs and other TCM related data

DISTRICT	NUMBER OF VISITS	DISTANCE FROM SITE	POPULATION	TRAVEL COST
Bagerhat	11	370	1,489,250	813.03
Bandarban	6	338	246,301	662.50
Barguna	5	361	804,964	399.22
Barisal	42	277	2,299,382	514.38
Bhola	13	317	1,532,361	516.38
Bogra	35	228	2,798,798	536.43
Brahmanbaria	28	102	2,267,632	253.71
Chandpur	40	169	2,149,820	363.56
Chapai Nawabganj	6	320	1,231,596	402.96
Chittagong	76	264	5,743,969	724.71
Chuadanga	2	267	843,981	438.89
Comilla	35	97	4,263,538	341.68
Cox's Bazar	2	415	1,502,067	821.67
Dhaka	1210	0	6,163,045	101.41
Dinajpur	8	414	2,371,183	599.58
Faridpur	78	145	1,558,211	372.03
Feni	16	151	1,158,117	502.99
Gaibandha	27	301	2,040,940	733.31
Gazipur	39	37	1,682,990	195.09
Gopalganj	5	232	1,097,003	645.00
Habiganj	14	179	1,611,334	799.69
Jamalpur	23	187	1,942,752	266.29
Jessore	27	273	2,192,138	706.05
Jhalakathi	6	290	694,071	812.96

Jheneidah	18	228	1,419,759	508.95
Joypurhat	7	280	801,903	576.71
Khulna	23	335	2,130,373	474.54
Kishorganj	15	140	2,388,348	312.70
Kurigram	11	394	1,680,660	449.19
Kushtia	17	277	1,562,504	418.37
Lakshmipur	8	216	1,391,324	314.44
Madaripur	4	220	1,106,551	251.25
Manikganj	21	68	1,216,763	238.61
Moulovi Bazar	9	214	1,454,000	824.81
Munshiganj	17	27	1,229,389	221.27
Mymensing	30	122	4,096,486	493.75
Naogaon	4	233	2,250,600	605.03
Narail	8	307	681,800	605.03
Narayanganj	70	17	1,818,944	327.13
Narshindi	15	52	1,709,992	123.37
Natore	6	223	1,455,197	287.96
Netrokona	10	159	1,790,785	741.28
Noakhali	19	191	2,347,010	632.71
Pabna	45	161	2,016,627	513.68
Panchagar	4	494	745,978	700.69
Patuakhali	24	319	1,322,662	623.00
Pirojpur	7	304	1,103,894	273.73
Rajbari	8	136	865,556	213.88
Rajshahi	6	272	1,988,061	573.31
Rangpur	72	335	2,269,516	765.03
Satkhira	10	343	1,659,911	949.61
Shariatpur	15	238	986,027	389.04
Sherpur	10	203	1,178,921	395.56
Sirajganj	21	142	2,373,912	418.12
Sylhet	34	278	2,281,903	1216.96
Tangail	20	98	3,108,085	202.67
Thakurgaon	2	459	1,059,522	649.72
Foreign	3			

Zonal Model: Actual Visits

The zonal data model was developed using concentric circles at 50 km intervals from the site. This resulted in 10 different travel zones. Data for foreign visitors have been ignored in the analysis. The total number of visitors to the site over the seven day survey period was 82,200. Therefore the sample can be converted to real data by multiplying the observed number of visitors by a factor of (82,200/7)/2344 = 5. The TCM data compiled for these zones are shown in Table 3.3.

Table 3.3: Zonal model of the TCM analysis

ZONE	DISTANCE FROM SITE (KM)	POPULATION (P)	OBSERVED VISITS (V)	ACTUAL VISITS (V_R)	TRAVEL COST (TAKA)
A	0 - 50	10,894,368	1336	6680	117.50
B	51 - 100	10,298,378	91	455	251.36
C	101 - 150	13,550,145	180	900	367.32
D	151 - 200	13,016,445	167	835	493.77
E	201 - 250	15,890,298	114	570	491.62
F	251 - 300	19,284,801	217	1085	725.65
G	301 - 350	16,451,892	196	980	663.81
H	351 - 400	6,390,108	27	135	588.17
I	401 - 450	3,873,250	9	50	644.00
J	451 - 500	1,805,500	6	30	683.70

Statistical regression was carried out on the zonal model with the actual number of visits (V_R) as the dependent variable. The output shows the results of fitting a curve to describe the relationship between zonal travel costs and number of visits. The results of the regression are shown in Box 3.1. A plot of the fitted model of the demand curve generated through the regression is shown in Figure 3.1.

Box 3.1

Dependent variable	VISITS
Method	INVERSE
Multiple R	.91814
R Square	.84298
Adjusted R Square	.82335
Standard Error	829.84057

Analysis of Variance:

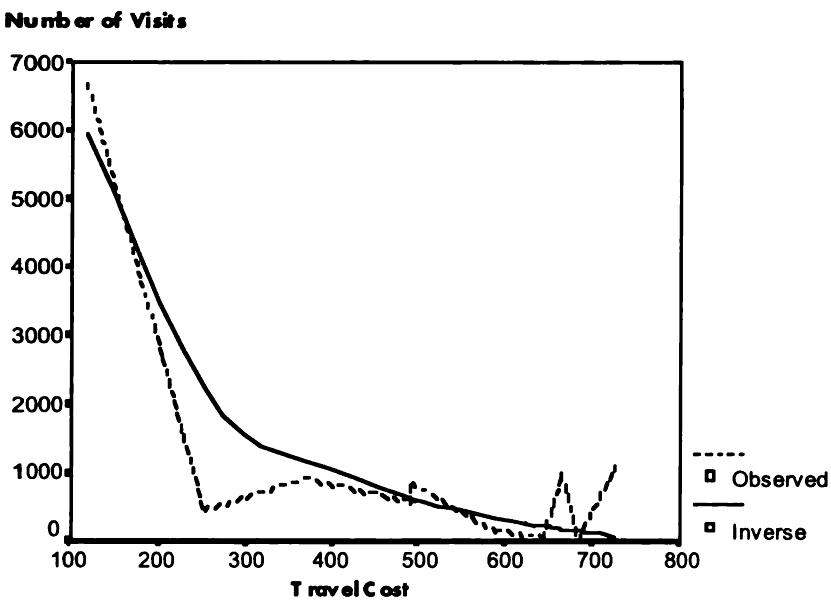
	DF	Sum of Squares	Mean Square
Regression	1	29575877.0	29575877.0

continued...

...continued

Residuals	8		5509083.0		688635.4
F = 42.94853 Signif F = .0002					
Variables in the Equation:					
Variable	B	SE B	Beta	T	Sig T
TC	826331.073161	126089.7930	.918139	6.554	.0002
(Constant)	-1048.424909	428.554286		-2.446	.0402

Figure 3.1: Demand curve of visits to the Dhaka Zoo



Equation of the curve: Number of Visits = 826331.073/Travel Cost - 1048.43

Zonal Model: Visits per Population

The demand curve in Figure 3.1 is biased by the fact that the furthest zones falling in the outermost circles may include areas outside of the national boundaries. To account for this, visits per population were calculated for the above zones as shown in Table 3.4.

The regression was carried out on the zonal model with the actual number of visits (V_R) per population as the dependent variable. The output shows the results of fitting a curve to describe the relationship between zonal travel costs and V_R /P. The regression results are shown in Box 3.2 and the plot of the fitted model of the demand curve generated through the regression is shown in Figure 3.2.

Table 3.4: Visits per population from different travel zones

ZONE	DISTANCE FROM SITE (KM)	POPULATION (P)	ACTUAL VISITS (V_R)	V_R /P (X.00001)	TRAVEL COST (TAKA)
A	0 - 50	10,894,368	6,680	61.32	117.50
B	51 - 100	10,298,378	455	4.42	251.36
C	101 - 150	13,550,145	900	6.64	367.32
D	151 - 200	13,016,445	835	6.41	493.77
E	201 - 250	15,890,298	570	3.59	491.62
F	251 - 300	19,284,801	1,085	5.63	725.65
G	301 - 350	16,451,892	980	5.96	663.81
H	351 - 400	6,390,108	135	2.11	588.17
I	401 - 450	3,873,250	50	1.29	644.00
J	451 - 500	1,805,500	30	1.66	683.70

Box 3.2

Dependent variable	VAR00001
Method	INVERSE
Multiple R	.93762
R Square	.87912
Adjusted R Square	.86401
Standard Error	6.70245

Analysis of Variance

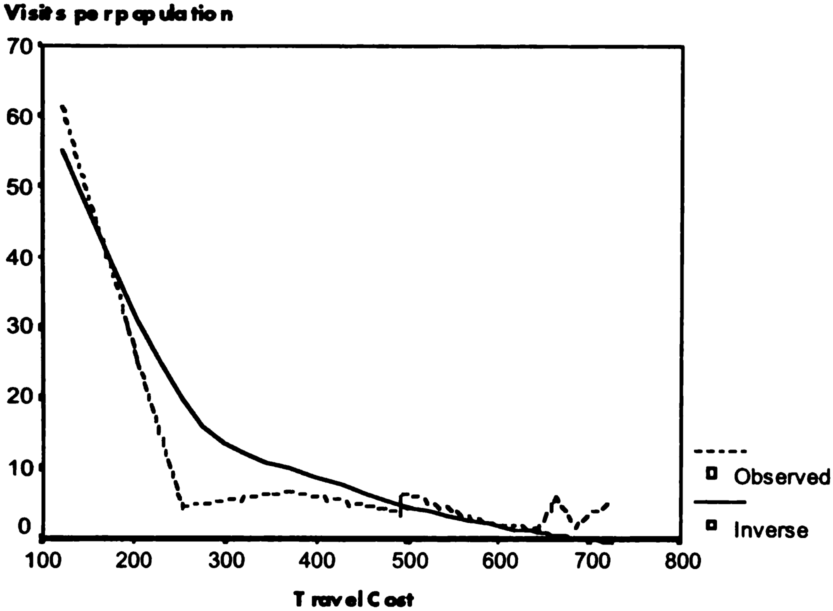
	DF	Sum of Squares	Mean Square
Regression	1	2613.7577	2613.7577
Residuals	8	359.3831	44.9229

F = 58.18321 Signif F = .0001

Variables in the Equation

Variable	B	SE B	Beta	T	Sig T
VAR00002	7768.155863	1018.401679	.937616	7.628	.0001
(Constant)	-10.970724	3.461346		-3.169	.0132

Figure 3.2: Demand curve of visits per population to the Dhaka Zoo



Equation of the curve: Number of Visits per Population = 7768.15/Travel Cost - 10.97

Zonal Model: Travel Cost Ranges

The demand curves in Figure 3.1 and 3.2 are both biased by the fact that more than half of the observed visitors (1336) came from the first travel zone. This is because 1210 of the visitors surveyed came from Dhaka city to visit the zoo. To account for this bias, a separate analysis was carried on the entire dataset where travel costs were divided into ranges. The range intervals were determined by looking at the histogram and frequencies of the data. Data on the number of visits for different travel cost ranges are given in Table 3.5. We call this the travel cost ranges model.

The regression was carried out on the travel cost ranges model with the actual number of visits (V_2) as the dependent variable. The output shows the results of fitting a curve to describe the relationship between V_2 and travel costs at the midpoint of the ranges. The results of the regression are shown in Box 3.3 and a plot of the fitted model of the demand curve generated through the regression is shown in Figure 3.3.

Table 3.5: Number of visits to the zoo for different travel cost ranges

TRAVEL COST RANGE AT MIDPOINT	TRAVEL COSTS VISITS V_1	OBSERVED VISITORS V_2	ACTUAL
0 - 100	50	729	3645
101 - 200	150	561	2805
201 - 300	250	227	1135
301 - 400	350	206	1030
401 - 500	450	130	650
501 - 600	550	100	500
601 - 700	650	81	405
701 - 800	750	117	585
801 - 900	850	83	415
901 - 1000	950	11	55
1001 - 1100	1050	66	330
1101 - 2500	1850	28	140
2500 - 6500	4500	5	25

Box 3.3

Dependent variable	VISITS
Method	INVERSE
Multiple R	.91995
R Square	.84630
Adjusted R Square	.83233
Standard Error	448.87468

Analysis of Variance

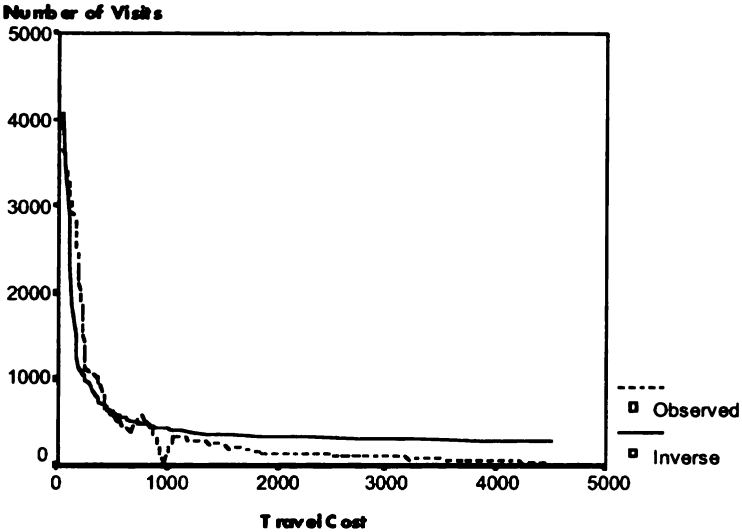
	DF	Sum of Squares	Mean Square
Regression	1	12203895.9	12203895.9
Residuals	11	2216373.3	201488.5

F = 60.56870 Signif F = .0000

Variables in the Equation

Variable	B	SE B	Beta	T	Sig T
TC	191371.791961	24589.73147	.919946	7.783	.0000
(Constant)	248.220862	150.153427		1.653	.1265

Figure 3.3: Demand curve of visits to the Dhaka Zoo for different travel cost ranges



Equation of the curve: Number of Visits = 191371.79/ Travel Cost + 298.22

This demand curve is biased by the fact that the fitted curve differs significantly from the observed data on the right end. This may be corrected by replacing the constant (298.22) with the observed lowest value (25).

Assumptions to Eliminate TCM Biases

The travel cost method has some common biases which were accommodated in the calculation of travel costs for each individual. The value of time has been taken as one-third of the regular wage (McConnell and Strand, 1981; Markandya, 1992). Also, time spent inside the zoo by visitors has been recorded and incorporated in this calculation. Sometimes visitors come to Dhaka for multiple purposes – one of them being to visit the zoo. In this case, the cost of travel and the discounted cost of time have been halved for purposes of the analysis. It may also be noted that statistically the dependent variable is truncated since only visitors to the site have been sampled and no information was available on the determinants of the decision to visit the site. The calculation of time cost may also be biased by two facts. First, one-third of the daily wage has been used based on TCM studies carried out elsewhere in the world and may not be correct. Second, there are no plausible alternate sites on which to base opportunity costs. To account for this bias, willingness to pay was also calculated without considering the opportunity cost of time. Both results have been given to enhance the scope of this report for future use.

Summary of Findings

The survey and analysis have produced the following findings:

- People's average willingness to pay (WTP) for the services and attributes of Dhaka Zoo as derived from the sample data is:

WTP = Tk. 300.64 (App. US $ 6.46) per visitor day

1 US Dollar = 46.55 Taka (as of April 29, 1998). According to the 1995 exchange rate, WTP = US $ 7.46 per visitor day

- Average number of visitors per day = 11,743
- Total number of visitors per year = 4,286,195
- Revenue from gate ticket = 21,430,975 Taka
- Yearly willingness to pay by consumers based on this study = 1,288,601,665 Taka
- Yearly willingness to pay by consumers for the features and services per acre of land in the zoo = 6,021,503 Taka
- People's average willingness to pay for the services and attributes of Dhaka Zoo as derived from the sample data without considering the opportunity cost of time is:

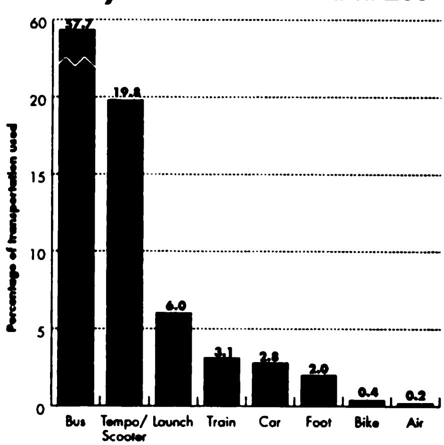
WTP = Tk. 267.91 (App. US $ 5.76) per visitor day

1 US$ = 46.55 Taka

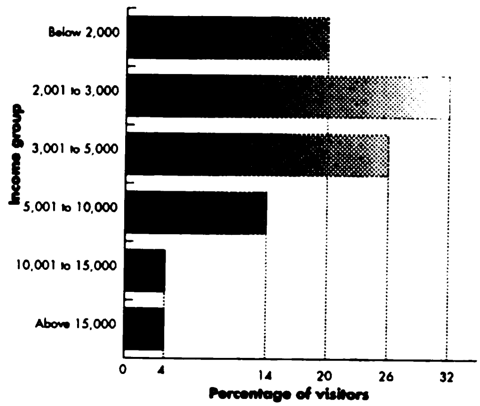
Adjusted for purchasing power parity, this would be equivalent to a willingness to pay of US$ 51.47 per visit.

The zoo primarily serves the people of Bangladesh and more specifically the people of Dhaka city. 52% of the visitors sampled were from Dhaka followed by Faridpur, Chittagong, Rangpur, and Narayanganj – each claiming about 3%. Only 3 visitors (0.12%) sampled were expatriates. The primary mode of transportation used is bus. The breakdown by mode of transportation is shown in Figure 3.4.

Figure 3.4: Mode of transportation used by the visitors of Dhaka Zoo



The zoo is a main source of entertainment to people belonging to lower income groups. 78% of the visitors of the zoo have monthly income less than Taka 5,000 (US $ 107). The different income groups represented by the visitors of the zoo are shown below:



People visit the zoo to enjoy a variety of features. The survey revealed the consumers preferences about the features and services of Dhaka zoo as shown in Table 3.6.

Table 3.6: Consumer Preferences for Zoo Features

FEATURE/SERVICE	PERCENTAGE	ACTUAL VISITS PER YEAR
All	62.39	1135150
Bear	0.60	10950
Birds	2.21	40150
Camel	0.20	3650
Chimpanzee	0.40	7300
Crocodile	0.60	10950
Deer	0.70	12775
Dolphin	4.71	85775
Elephant	0.40	7300
Fish	0.20	3650
Giraffe	1.50	27375
Gorilla	0.50	9125
Hippo	2.21	40150
Horse	0.10	1825
Lion	1.40	25550
Monkey	1.30	23725
Nature	0.60	10950
New	8.53	155125
Porcupine	0.10	1825
Recreation	1.81	32850
Rhino	0.30	5475
Snake	0.50	9125
Tiger	7.92	144175
Zebra	0.80	14600

Visits to the zoo and interviews with zoo officials and visitors revealed several problems that need to be addressed to improve the operation and attractiveness of the zoo. Most of these problems are related to budget allocation issues. These include:

- The entry fee is too low and does not generate any surplus for financing the development plans for the Zoo.
- The Ministry gives low priority to the zoo and bureaucratic processes necessary for planning and development are too complicated.
- The allocation for procuring new animals is scanty; in the current development plan, only 5.8 million (58 lakh) taka has been allocated.
- The budget for developmental activities is inadequate. The 60 million (6 crore) taka development plan currently underway will alleviate some of the problems.
- Living conditions of the animals are not satisfactory - cages looked small and dirty, food quality and health care arrangement appeared to be inadequate. No animal waste disposal facility was observed.
- Many of the signs and notices in the zoo are damaged or illegible. They should be renovated in both Bengali and English.
- There are only two poorly maintained rest rooms for women and children.
- There are occasional security problems within the zoo, as its man-power is limited.

Recommendations

The zoo has great potential as a holiday and recreational site. The Curator, Dr. Afsar Ali is very hopeful that some of the potentials mentioned below will be explored soon, such as renovating the children's park. Other improvements will require long term commitment by the government.

- The entry fee to the zoo may be raised to 10 taka. This would immediately generate enough additional revenue to cover the operating and maintenance expenses of the zoo. This study suggests that people will be willing to pay a much higher price for the zoo.
- Since visitors to the zoo come from a variety of income groups, the zoo may consider developing several levels of service with progressively higher fees. The simplest option is to allow the visitor a self guided tour. The next level may include a briefing at the information centre with a documentary on the zoo that will help the visitors make a better plan. At the third level, the package may include a fully guided tour along with refreshments. The idea is to cater to the

needs of the visitors of differing socioeconomic and cultural backgrounds.

- Additional funds for maintenance and renovation may be allocated to improve the quality of the facilities of the zoo.
- Introduce luxury bus service between Dhaka City and the zoo. The busses currently in operation are less likely to attract people of higher income groups. Also, offer package tours in collaboration with travel agencies for large groups and distant visitors. The study findings indicate that people are willing to pay a sufficient price to render these feasible.
- Currently the zoo houses only 14 species of reptiles and one fish aquarium. The zoo should expand in both these areas, especially in aquatic and marine creatures. They are not easily visible in their natural habitats, so introduction of such species should attract a large number of new visitors. According to the survey, only 0.2% and 0.5% of the visitors to the zoo consider fish and reptiles of the zoo as the main feature of attraction.
- Finally, the information in this study on willingness to pay, composition of visitors by income, mode of transportation used, and features of attraction should be used in the national budget, in preparing development plans for the zoo, in identifying areas of weaknesses, and in assessing the benefits derived from the Dhaka Zoological Garden.

Conclusions

The Dhaka Zoo can be a major holiday attraction to the millions of people who visit it every year. Because of resource constraints and bureaucratic complications, however, its development has been hindered for too long. The time has come for major restructuring, to develop the zoo as a self-sustaining nature conservation project.

This case study produces interesting information about the value people attach to Dhaka Zoological Garden. While the entry fee remains at Tk. 5.00 per visit, people's WTP is Taka 300.64, about 60 times higher. This provides economic justification for the government planners to place a higher priority on the maintenance and development of this site.

This case study may serve as a reference for other similar studies in the future. Comparative studies of the national parks and other recreational sites around Dhaka city will provide interesting information. Case studies to determine people's willingness to pay for quality improvements of these environmental goods will also be useful.

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Although invasive to wetlands, water hyacinth (in the foreground) can be used to make compost.

4 Willingness to Pay for Water in Dhaka Slums

A Contingent Valuation Study

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Abstract

Safe drinking water is a basic need for the urban poor. However, in Dhaka's slums, as in many developing country cities, the public sector is unable to finance the provision of drinking water, because the prices charged are not sufficient to cover the costs. This study uses the contingent valuation method to estimate Dhaka slum-dwellers' willingness to pay for safe drinking water. The study serves two purposes. First, the results obtained show that slum dwellers are willing to pay enough for water to cover the costs of providing it, suggesting that higher water charges would be a financially viable way to generate funds for water system investments. Second, the study shows that contingent valuation is an effective tool for estimating willingness to pay for a variety of public services, which should be used to inform public decisions about a range of urban infrastructure in addition to water supply systems.

Background

Water Supply in Dhaka Slums

Dhaka is one of the world's fastest growing cities. It is also one of the poorest. In 1981 the population of Dhaka was about 3.5 million; by 1991 it had increased to about 6.95 million. In 1989 0.34 million people, 7% of the city's population, were thought to live in Dhaka's slums. In terms of basic amenities, these slums are among the worst in the world.

Safe water is a basic need, yet millions of urban poor do not have legal access to it. In Dhaka alone, 70% of the estimated 2 million squatter dwellers are deprived of it. Consequently, they spend much of their time and resources buying water from local water lords, offices, factories, and other sources. Legal, financial and institutional obligations do not allow formal agencies such as Dhaka Water Supply and Sewerage Authority and Dhaka City Corporation to consider squatter settlements as legal entities eligible for basic urban services.

Objective

This study estimates Dhaka slum-dwellers' willingness to pay for safe water. It tests whether contingent valuation surveys can be used to estimate the water demand relationships which are suggested by the consumer demand theory. Demand for a good is a function of the price of that good, the prices of substitute and complementary goods, income, and preferences. Whether or not households choose to purchase water from the public water system depends on its price. If the charge is higher than a given household's maximum willingness to pay (WTP), the household chooses not to use the new water system. Maximum willingness to pay varies from household to household and should be a function of all of the variables which determine demand except the price of the good itself. The households' WTP bids are thus expected to be positively related to income and the cost of obtaining water from other sources, and negatively related to perceptions of the quality of water available from other sources.

Methodology

If water projects are to be made both sustainable and replicable, an improved planning methodology is required which includes a procedure for eliciting information on the value placed on different levels of service. Water prices must be set so that at least operating and maintenance costs, and preferably capital cost as well, can be recovered. If people are willing to pay the full costs of a particular service then it is clear that the service is valued and will probably be used and maintained. In such a case, it should be possible to generate the funds required to sustain and even replicate the project. It is therefore essential to estimate willingness to pay for water, so that water projects can be designed in a way which is likely to permit cost recovery and project replication.

Often it is not possible to estimate consumers' WTP by inference from actual behaviour. Rather, one may have to measure preferences in hypothetical situations or in artificially created markets. Two basic theoretical approaches are used for making reliable estimates of willingness to pay. The indirect approach uses data on observed water use behaviour (such as quantities used, travel time to collection points, and perceptions of water quality) to assess the response of consumers to different characteristics of an improved water system. The techniques used to do this include varying parameter demand, hedonic price analysis and the travel cost method. The direct approach is simply to ask an individual how much he or she would be willing to pay for the improved water service, for example a public water standpoint. This is called the contingent valuation method (CVM).

CVM uses surveys to elicit information about individuals' (or households') preferences for a good or service. Respondents to the survey are asked how much they value a good or service. The technique is termed "contingent" because the situation in which the respondent is asked to state his or her willingness to pay is hypothetical. This measure seeks to obtain a monetary measure of the change in well being that an individual would obtain from the provision of a particular good or service. Contingent valuation research typically focuses on preferences for public or mixed private-public goods.

Interview Techniques in Contingent Valuation (CV) Surveys

The interviews for a CV study can be conducted by mail, telephone, in person, or in some combination of these. Each type of interview is appropriate under certain conditions. In developing countries, in-person interviews are typically the only option because a substantial portion of the population does not have a telephone and is not able to read (or return) a mail questionnaire. For this reason, in-person interviews were used in this study to assess slum dwellers' WTP for water.

Contingent Valuation Bidding Games

One of the most common CV survey methods is the bidding game. In a bidding game, each individual is asked to evaluate a hypothetical situation and to express his or her willingness to pay for certain changes in the level of provision of a good. There are two major types of bidding games: single bid games and iterative (or converging) bid games. In iterative bidding games the respondent, rather than being asked to name a sum, is asked whether he would pay a given amount for the situation or good described. This amount is then varied iteratively until a maximum willingness to pay (or a minimum willingness to accept compensation) is reached. One objection to the iterative technique is the potential existence of "starting point bias". This is the idea that the interviewer may bias the respondent's answer by establishing a reference point for an acceptable range of bids. Another disadvantage is that although single bid games can be conducted either in person or through a mail survey, iterative bidding games can take place only in face-to-face interviews. An advantage of iterative bidding games, however, is that answers often have a lower standard deviation around the mean as compared with single bid games.

Hypothetical bias is another problem inherent in bidding games and in survey techniques in general. People may not give answers which reflect their true values, particularly if they have no incentive correctly to answer questions which take time and thought. Another kind of bias may arise if people try to act strategically, based on what they feel will be done with their answers. If they actually expect to pay the amount they answer, they may undervalue their true response. If they expect high responses to bring about changes that they would like to see, but know they will not actually have to pay for, they may overstate their willingness to pay.

It is commonly thought that problems due to the hypothetical nature of CVM questions arise more frequently and are more serious when the choices are between goods with which people are not familiar. As a result, contingent values elicited for private goods such as improved water supply are expected to exhibit greater reliability and predictive validity than those elicited for public goods such as biodiversity conservation.

Testing for Biases and Errors in Contingent Valuation Studies

CV researchers respond to the risk of error or bias in two ways. First, they have devised ways of minimising the occurrence of some type of errors and biases. This can be done by constructing a hypothetical market scenario that would make it difficult for a respondent to determine how to behave strategically. One of the principal criteria for choosing among survey instruments is, in fact, how well they address the opportunity or incentive for respondents to act strategically.

Second, even if the probability of error or bias cannot be reduced, finding out whether it is present can reduce the cost of being misled by poor quality estimates. It may also be possible to estimate the magnitude of the bias and adjust WTP accordingly. This could be done by dividing the sample of respondents into two groups. The analyst could present one group with a statement that encourages strategic behaviour and the other with a statement designed to minimise it. If the results differ, they allow the researcher to estimate the magnitude of the bias and adjust the estimates of WTP to correct for it.

Many kinds of experiments can be designed for CV surveys in which split samples of respondents are given different questionnaires so that analysts can check to see whether variations in the questionnaire result in different willingness to pay responses. The results are then used as input for multivariate analyses of the determinants of the valuation responses. In other words, the analyst examines how the respondent's willingness to pay varies with changes in the socioeconomic variables suggested by the demand theory, such as income, education, family composition, housing conditions, etc.

Analysis of Willingness to Pay Responses

The information obtained from contingent valuation surveys is typically analysed in three increasingly sophisticated ways. First, one can examine the frequency distribution of the responses to the valuation questions. Second, analysts can look at cross-tabulations between WTP responses and such variables as socioeconomic characteristics of the respondent and attitudes toward the environment. Third, one can use multivariate statistical techniques to estimate a valuation function that relates the respondent's answer to the socioeconomic characteristics of the respondent and attitudes toward the environment. These analyses serve two broader purposes. First, they allow the researcher to assess whether respondents' answers are consistent with both economic theory and common sense, in order to increase confidence in the results. Second, they establish statistical relationships or models used to aggregate sample responses to the overall population or to develop forecasts of benefits under alternate scenarios.

Multivariate Analysis of the Determinants of WTP Responses

Multivariate analysis can provide more insight in the determinants of WTP than simple cross-tabulations. The general approach is to estimate a valuation function that relates the hypothesized determinants to the WTP responses. The decision on what determinants of WTP should be included in the valuation function is typically based on the consumer demand theory. Socioeconomic and demographic characteristics of the household (SE) and prices and availability of substitute goods and services (PS) are commonly used. The valuation function thus takes the form:

$$\mathbf{WTP_I = (SE_I\ ,\ PS_I)}$$

where I is an index of households in the sample.

Since the answers to open ended questions provide a continuous measure of willingness to pay for the good or service, ordinary least-squares regression models (OLS) can normally be used to explain the variations in the dependent variable WTP. OLS techniques have the advantage of being widely used, and the parameter estimates are easy to interpret. OLS requires that the determinants of the WTP responses be exogenous in order for the parameter estimates to be unbiased and consistent.

Design of the Dhaka Study

This study involved a CVM survey in two slums located in the southeastern part of Dhaka City.

TT Para slum is adjacent to the container yard of Bangladesh Railway at Kamlapur. It falls under ward 31 of the Dhaka City Corporation, and the Sabujbag Police Station. The number of households in the slum ranges from 1200 to 1500. There is no electricity, and the few sanitary latrines installed by an NGO some years back are inadequate for the current population. There are only two tubewells, so most residents fetch water from adjacent areas — mathorpotti, bazaar, mosque and other slums. Just before this survey, an illegal connection was set up to the tap water supply, which has relieved the water crisis to some extent for those who can access it.

Sonar Bangla is another typical slum, with about 304 households. The residents are mainly riverbank erosion victims who have migrated from the southern part of the country. The water supply situation is even worse here, as there are no water points at all in this slum. Residents therefore rely on outside sources.

Research Design

This study tests whether WTP for water is systematically related to the variables suggested by economic theory. We chose a bidding game format because it works better than direct, open-ended questions. Moreover, it is familiar and easily understood because it is similar to ordinary bargaining in local markets. The survey design includes tests for the existence and magnitude of strategic bias, starting point bias, and hypothetical bias.

Strategic bias could influence answers in either of two ways. Suppose an individual is asked how much he would be willing to pay for a water point in his slum. If he/she thinks the water agency will provide the service if the responses are positive, but that someone else will ultimately pay for it, there will be an incentive to overstate his/her WTP. On the other hand, if the individual believes the decision has already been made to install waterpoints and the survey serves to set the charges, he/she will have an incentive to understate true WTP.

We estimate the magnitude of this kind of bias by dividing the sample into two groups of 116 households. One group was told that an NGO had already decided to build the new water point and the people would get water free of charge. The other was told that a community water committee would be set up for monitoring and collecting fees based on water use. The hypothesis is that if individuals act strategically, then bids from those who receive the second statement would be lower than bids from the first, because they would fear that a high bid would result in a higher charge by the community water committee.

Starting point bias occurs when the respondent interprets the initial price suggested by the interviewer as a clue to the correct bid. To test for starting-point bias, two different versions of the questionnaire were randomly distributed, each with different initial prices (Tk 0.50 and Tk 1.50) in the bidding game.

Hypothetical bias may arise for two reasons. First, the respondents may not understand or correctly perceive the characteristics of the good being described by the interviewer. This is a particular problem when the contingent valuation method is used to measure individuals' WTP for changes in environmental quality. Such bias is not likely in this case, since respondents are familiar with public water points or private water connections. The second source of hypothetical bias is the possibility that the respondents do not take the questions seriously and will respond by giving whatever answer first comes to mind. The test for this is the same as for the applicability of consumer demand theory: are bids systematically related to the variables suggested by economic theory?

Field Procedure

Following interviews with the key informants, the enumerators completed 232 in-depth household interviews throughout the two slums described above. Among the key informants were local shopkeepers and teachers of a school in the slum. The household interview consisted of two sections. The first part included questions about socioeconomic characteristics such as occupation and monthly income and water-related questions such as the location of each water source, the time spent fetching water, and daily water use. In the second part, the enumerator read one of the statements used to test for strategic bias and then asked about willingness to pay for water.

Sample Design

To select the survey sample, the 1800 households in the two slums were stratified first by location and then according to occupation. This led to the selection of 184 respondents in TT Para and 48 in Sonar Bangla. The 232 respondents were divided by occupation as shown in the table below, reflecting the distribution of occupations in the slum populations as a whole. The four questionnaires were then distributed randomly among the interviewees.

Table 4.1: Breakdown of respondents by occupation

OCCUPATION	RESPONDENTS
Rickshaw Pullers	96
Day Labourers	76
Housemaids	20
Garment Workers	14
Vendors and Shopkeepers	14
Others (beggars, etc.)	12
Total	**232**

Results

The monthly average WTP for water was found to be Tk 82.62 per household. Five percent of the respondents said, "I don't know" in response to the willingness to pay questions. The average travel time spent fetching water was just under 3 hours, and the average daily water use per household is at least 6.6 buckets (one bucket = 5 litres approximately). The average household size was found to be 5.14.

The first model used to analyse determinants of WTP (called Model A) used ordinary least-squares regression to estimate WTP as a function of household size, income, occupation, availability of other water sources, daily water use, time spent fetching water, and whether the respondent expected to pay for water. The OLS estimates of the coefficients, standard errors, and t-ratios for each variable are reported in the table below.

Table 4.2: Willingness to pay for water in Dhaka slums, Model A

VARIABLE	DESCRIPTION	COEFFICIENT (B)	STANDARD ERROR	T-RATIO	SIG. T
Constant		953.291	129.99	7.566	0
Free	1=if water is free 0= if water is not free	-31.06	28.02	-1.109	.269
Low	1=if bidding game uses low starting point 0=if bidding game uses high starting point	-2.33	17.72	-/132	/895

H	Household size	-7.6	5.59	-1.36	.175
I_1	1=if household income is Tk.1500 and below per month 0=otherwise	-913.83	110.29	-8.28	.000
I_2	1=if household income is between Tk.1501 and Tk.3000 per month 0=otherwise	-920.13	108.6	-8.47	.000
I_3	1=if income is between Tk.3001 and 5000 per month 0=otherwise	-981.49	111.69	-8.78	.000
I_4	1=if income is between Tk.5001 and 7000 0=otherwise	-995.36	138.63	-7.18	.000
O_1	1=if the respondent is a rickshawpuller 0=otherwise	30.359	29.528	1.028	.305
O_2	1=if the respondent is a day labourer 0=otherwise	-42.988	24.02	-1.79	.075
S	1=if TT para slum 0=otherwise (sonar bangla)	33.02	33.49	.986	.325
T_1	1=tapwater 0=otherwise	-69.33	35.19	-1.97	.05
T_2	1=tubewell 0=otherwise	-52.72	36.71	-1.44	.152
T_3	1=other nearby source 0=otherwise	-53.32	37.63	-1.42	.158
W	Daily water use (no. of buckets)	23.18	3.8	6.09	.000
X	Hours spent fetching water	-4.22	5.36	-.78	.432

r^2= .57 adjusted r^2 = .54 F=18.30 (significance F = .000) df = (15, 204)

The dependent variable WTP is willingness to pay in Tk per month calculated from WTP per bucket multiplied by each household's monthly water requirement. In this model all independent variables are binary except for household size (H), daily water use (W) and hours spent fetching water (X). Daily water use has a positive impact on WTP, as expected. Household size and time spent fetching water were also expected to have a positive impact on WTP, but they both negative and insignificant. One explanation is that water use is positively related to household size, while time spent fetching water depends on both of the two variables. So there is a possible collinearity among these variables. Also, respondents may overestimate actual time spent fetching water. The negative sign of household size may be due to the fact that households in the high income groups with large family size tend to be willing to pay less than other households.

The variable "free" is introduced to determine whether strategic bias affects WTP. The value of the variable is 1 if households surveyed are promised free water and 0 if they are told they will pay for it. The bias would exist if the regression coefficient turns out to be significant. The t-statistic is insignificant, from which we may conclude that there is no strategic bias. Similarly, the variable "low" is designed to identify starting point bias. The survey used two starting points, Tk .50 and Tk 1.50 per bucket, in asking willingness to pay for water. As the t-statistic for this variable is also insignificant, there is no starting point bias in the survey either.

Income is a key independent variable in determining WTP. As it is difficult to elicit exact information on household income, five ranges of monthly income were set, identified by four dummy variables and a control group:

Table 4.3: Income Ranges

INCOME GROUP	INCOME RANGE (TAKA)
I_1	< Tk 1500
I_2	Tk 1501-3000
I_3	Tk 3001-5000
I_4	Tk 5001-7000
Control group (all dummies = 0)	> Tk 7000

We would expect, *a priori*, that the higher the income, the higher the WTP for water would be. However, we find that higher income households are willing to pay less than lower income households, although all four regression coefficients are highly significant.

Income and occupation are assumed to be independent. Two major occupation groups O_1 (rickshaw pullers) and O_2 (day labourers) were assessed to see if there is any variation in their WTP. Rickshaw pullers are willing to pay more than day labourers, but the coefficients are not significant. There is no difference in WTP as far as the two different slums are concerned. The availability of other sources of water also makes little difference. Those who do not have access to tapwater or a tubewell and rely on sources outside the slum (T_3) are willing to pay more than the tapwater users (T_1), whose willingness to pay is the lowest. Tubewell users (T_2) are willing to pay the most. However, all of these variables are found to be insignificant.

From the ANOVA table we see that R^2 is 0.54, which is a reasonably good fit with respect to cross section data. The F statistic is also very significant, indicating the overall significance of the multiple regression model.

In the next formulation (model B) household size and time spent fetching water were excluded, and only household size was retained. The occupational and water source variables were also omitted. A good reason to exclude them is to reduce any multicollinearity introduced by their inclusion. Estimates are less precise if the redundant variables are retained in the model. In this analysis the variables "free" and "low" were again insignificant. The t-statistic for the income variables and water use has improved. We then obtain model C by dropping "low" and "free." In this formulation all the remaining variables have extremely significant coefficients, so model C was used for final interpretation.

Table 4.4: Willingness to Pay for Water in Dhaka Slums, Model C

	COEFFICIENTS	T - RATIO	SIG. T
Constant	923.937	8.093	.000
I_1	-964.993	-9.141	.000
I_2	-957.763	-9.187	.000
I_3	-1015.23	-9.571	.000
I_4	-1025.49	-7.576	.000
W	17.54	6.334	.000

Adjusted R^2 = 0.523 F = 51.724 (signi F = .000) DF = (5, 226)

The variables included in the final model explain 52.3% of the variation in WTP, which is quite reasonable for a cross-sectional study. The value of the F-statistic, a formal test for the goodness of fit, is extremely good. All the income group coefficients are still highly significant but have negative signs. This is not surprising because the control group contains income earners who earn more than I_1, I_2, I_3 and I_4. Income and daily water requirement prove to be crucial determinants of household WTP for water in this study. Within each income group, WTP will vary according to daily water needs. The following table presents the major findings of this study in the two slums of Dhaka.

Table 4.5. Major Study Findings

INCOME GROUP	MONTHLY INCOME, TK.	SHARE OF POPULATION (%)	DAILY WATER USE IN BUCKETS	MONTHLY WTP IN TK.
I_1	1,500 and below	34.91	5.88	62.08
I_2	1,501 to 3,000	55.60	6.55	81.06
I_3	3,001 to 5,000	7.76	7.80	45.52
I_4	5,001 to 7,000	.86	7.50	30.00

From this table we see that households earning between Tk 1501 and Tk 3000 per month, which constitute more than half of the slum population, are willing to pay the most on average for water.

Policy Implications

Surveys of willingness to pay for water supply allow us to assess the financial viability of investments in public utilities. It is often argued that governments and utilities are reluctant to connect new customers because water prices are too low to allow them to recover their investment. Indeed, a survey of water projects financed by the World Bank showed that the average price charged for water covered only a third of the cost of supplying it, with the gap filled by government subsidies. Since resources are insufficient for such subsidies, many people remain unserved even if they are willing to pay.

Since the government is unable to meet the water needs of the slum people, one alternative that has emerged in recent years is the intermediation of NGOs. They work with communities to form user groups, design water points, and formulate rules on water access and cost sharing. They provide technical inputs and initial construction funds, and they mediate with the public sector utilities. The key principle of their projects is to respond to demand for water indicated by a willingness to pay for it.

With this in mind, consider a slum in Dhaka city with 500 households where income distribution is such that 35% of them are in income group I_1, 56% are in I_2 and the rest is in I_3. If the daily water requirement is 5 buckets per household for all income groups, monthly WTP per household would be Tk 53, 62, and 29, respectively, for I_1, I_2 and I_3, based on the monthly WTP figures shown in the table above. The total monthly willingness to pay for 500 households, calculated on the basis of the income distribution and water use data in our survey, would be about 35,000 Tk per month. This compares with an average cost incurred by NGOs for water supply to slum area from Tk 30 thousand to Tk 40 thousand (personal communication).

These figures suggest that such investments may often be financially viable, and may justify either public or private sector construction of new water projects.

The results of this study show that contingent valuation surveys are a feasible method for estimating willingness to pay for water in Dhaka slums. A more comprehensive study along this line would provide useful guidelines to the government and NGOs about the cost effectiveness and profitability of such projects. It would also prove to be a viable method for collecting information on individuals' willingness to pay for a wide range of other public infrastructure projects and services in Bangladesh and elsewhere.

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Appendix - Four Bidding Game Variants

1. Free Water: High Starting Price

An NGO will be working with the people of this area to install water points for safe water. I am going to ask you some questions in order to know how much your household would be willing to pay each month to ensure the success of setting the project in your neighbourhood. We would appreciate if you give your answer after a careful thought on it. This NGO has decided to help the people of this village by installing a water point. Ultimately they will not demand any money from you but we are asking you to know your willingness to pay for safe water. We would appreciate if you facilitate the success of the project by telling the truth about your willingness to pay.

a) If one bucket costs Tk. 1.50, then how many buckets do you need on a daily basis? Would your household be willing to Tk. 1.50 per bucket to have access to water from new source in your neighbourhood?

   YES — go to (b)   NO — go to (c)   I don't know — go to (f)

b) If the committee decides for each household to pay Tk. 3.00 per bucket, would your household be willing to pay this?

   YES — go to (f)   NO — go to (d)   I don't know — go to (f)

c) If the organizing committee decides for each household to pay Tk. 0.75 per bucket, would your household be willing to pay this?

   YES — go to (e)   NO — go to (f)   I don't know — go to (f)

d) Would your household be willing to pay Tk. 2.25 per bucket?

   YES — go to (f)   NO — go to (f)   I don't know — go to (f)

e) Would your household be willing to pay Tk. 1.10 per bucket?

   YES — go to (f)   NO — go to (f)   I don't know — go to (f)

f) Think for a while, what is the maximum amount would your household be willing to pay per bucket to use new source of water?

   Amount of money:

   I don't know.

2. Pay for Water: High Starting Price

An NGO will be working with the people of this area to install water points for safe water. I am going to ask you some questions in order to know how much your household would be willing to pay each month to

c) If the organizing committee decides for each household to pay Tk. 0.25 per bucket, would your household be willing to pay this?

YES — go to (e) NO — go to (f) I don't know — go to (f)

d) Would your household be willing to pay Tk. 0.75 per bucket?

YES — go to (f) NO — go to (f) I don't know — go to (f)

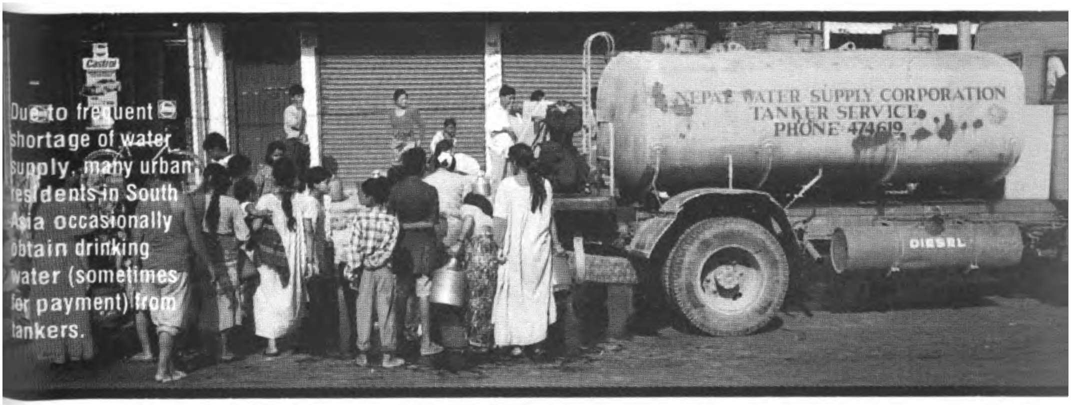
e) Would your household be willing to pay Tk. 0.40 per bucket?

YES — go to (f) NO — go to (f) I don't know — go to (f)

f) Think for a while, what is the maximum amount would your household be willing to pay per bucket to use new source of water?

Amount of money:

I don't know.



Due to frequent shortage of water supply, many urban residents in South Asia occasionally obtain drinking water (sometimes for payment) from tankers.

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FRONT: A mangrove forest in the outskirts of Karachi, Pakistan

BACK: A wetland situated in Nepal's Tarai.

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