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**ECONOMIC VALUES AND THE ENVIRONMENT IN THE DEVELOPING WORLD**

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## Preface and Acknowledgments

This volume assesses the state of the art in applying economic valuation techniques to environmental problems in developing countries. It is in fulfilment of a contract between the United Nations Environment Programme (UNEP) and CSERGE, University College London. The volume outlines the available valuation techniques and surveys their application to developing country problems. It offers some guidelines and assesses the gaps in the available information. The general conclusions are that economic valuation is:

(a) extremely useful in raising the profile of the environmental aspects of development projects and policies;

(b) widespread in terms of its applications in developing countries; and

(c) generally successful in its application.

The second and third conclusions are surprising since there is a widespread view that, even if "monetising" costs and benefits works in the developed world, it does not work in the developing world where markets are invariably managed or non-existent. Nothing could be further from the truth, as this volume shows.

## 1 Introduction

### 1.1 The Issue of Choice

Economics is about making choices. Making choices about the environment is more complex than making choices in the context of purely 'private' goods and services. Private goods are goods that are consumed by an individual and the act of consumption precludes anyone else from consuming the goods as well. Private goods tend to be bought and sold in markets. Public goods have the feature that consumption tends to be 'joint' between individuals: consumption by individual A does not preclude consumption by individual B. Moreover, with public goods it is difficult, if not impossible, to exclude others from the act of consumption. To focus the issue, a private good might be an apple or a cinema seat. A public good could be clean air or water. The distinction between private and public goods is blurred: there is a continuum of privateness and publicness.

In the environmental context, what has to be compared is one priced good (the private good) and one unpriced one (the public good) -- as when deciding

to invest in air pollution control rather than new economic output capacity. Alternatively, the comparison may be between two or more unpriced public goods -- air quality versus water quality, for example. In this choice context it is necessary to impute a *value* to the environmental good or service. The discipline of environmental economics has developed techniques whereby such values can be imputed (see Chapter 2). In the market place individuals exercise choice by comparing their *willingness-to-pay* with the price of the product. They purchase the good when their willingness-to-pay exceeds the price, and not otherwise. Imputing values involves finding some measure of willingness-to-pay for environmental quality. This is the essence of the process of economic valuation: it involves finding a willingness-to-pay measure in circumstances where markets fail to reveal that information directly.

This 'market failure' is important for the allocation of resources within an economy. If the production of specific crops involves using agricultural tech-

nologies which give rise to soil erosion, then the damage done by the soil erosion may well not be reflected in the choice of crop or technology. This may be so even where the costs are borne by the farmer growing the crops: future damage to crop productivity through soil erosion may be imperfectly reflected in choices made now. Market failure is more pronounced still when the costs are borne by agents other than the farmer -- perhaps in siltation of rivers, ports and reservoirs for example. Failure to account for these *external costs* gives rise to a misallocation of resources in the economy, in this case through the choice of the wrong agricultural technology. Making better informed choices to avoid this misallocation of resources involves understanding the value of the external costs, and then finding a mechanism for integrating those values back into the original decision to choose a technology. Valuation may be imperfect but, invariably, some valuation is better than none.

The purpose of economic valuation is to reveal the true costs of using up scarce environmental resources. Choosing 'instruments' is the mechanism whereby the resulting values are reflected in decision-making. If the disposal of sewage to inland waters gives rise to loss of wellbeing then the value of that loss should be reflected in the private costs of disposing of the sewage. This might be achieved by taxing the sewage discharger, by setting some environmental standard for the effluent or the receiving waters, or by requiring the discharger to buy permits for the effluent. In general, the choice of instrument -- tax, standard or permit -- will not be affected by the value of the damage done, although the size of the tax, the allowable pollution with the permit or the standard will. The virtues of economic instruments -- taxes, permits and other incentive systems based on altering market signals -- remain even if valuation is not carried out. But valuation is essential if the scale of the tax or strength of the regulation is to be determined. In practice, valuation is the exception and not the rule: environmental standards are often set by criteria that incorporate some features of the valuation process. Health criteria, for example, determine many environmental standards in the developed world. Damage to human health would be an integral part of any valuation process -- people will be willing to pay to avoid health risks from pollution and waste. But as there are often many other forms of damage besides health effects, using health criteria alone could impose its own distortions on resource allocation. A good deal of environmental policy is based on some idea of 'best available technology' whereby a regulator encourages the polluter to use the cleanest technology available, usually contingent upon some qualification about 'excessive cost'. In many other cases, environmental standards

are set without any clear or detailed rationale. Many regulations, for example, are the outcome of responses to environmental scare stories and misinformed perceptions of hazard and risk. In such circumstances, economic valuation is helpful as a check on the criteria implicitly being used.

Valuation is relevant at all levels of public choice. In project appraisal the environmental impacts of any investment need to be estimated and compared to the other costs and benefits. In programme appraisal the value of environmental impacts similarly need to be integrated into the evaluation process. In policy appraisal environmental factors need to be treated on an equal footing with other costs and benefits so that sectoral priorities are not distorted. This is as important as choosing between marginal expenditures on, say, transport or energy, as choosing between conservation and development projects. Similarly, as discussed above, the setting of environmental standards should be informed by valuation analysis. Thus, environmental valuation should be an integral part of sectoral priorities, in determining the balance between conservation and development, and in the choice of environmental standards.

**1.2 Whose Values Count?**

Economic values reflect individuals' willingness-to-pay for benefits or their willingness-to-pay to avoid costs. Typically, the values that count belong to those actually exercising the choice: the current generation. But it is a particular feature of environmental costs and benefits that they often accrue to people in generations yet to come. How are their values to be counted? This is the issue of *intergenerational incidence* of costs and benefits. Counting only the current generation's preferences affects the choice of future generations unless there is some built-in mechanism to ensure that current generations choose on behalf of future generations and take their interests into account. This potential bias arises because future generations are not present to have their votes counted. Whether they are present or not, future gains and losses tend to be played down in economic decision-making because of the practice of discounting. Discounting is the procedure whereby gains and losses to society are valued less the more distant they are in the future, a procedure designed to reflect the general observation that individuals simply prefer their benefits now and their costs later.

An analogous form of bias arises even within a generation: willingness-to-pay is weighted by the incomes of those expressing their willingness-to-pay. The economic votes of the poor count for less in the market place than the economic votes of the rich. This is the problem of *intragenerational incidence*. Because economic votes count more the

higher the income of the individual expressing the vote, economic valuation appears to be distinctly 'unfair'. This is correct up to a point, and, for quite a long period in the development of economic appraisal techniques methodologies were developed for weighting the economic votes in such a way that this income bias was removed. Generally speaking they are not used now, although they could be. A practical reason why they are not used derives from the issue of what exactly one is trying to achieve by making such adjustments for varying incomes. If the aim is to reflect income distribution concerns in all decisions, then an income weighting procedure would appear to be sensible. But is it sensible to use income weighting in this way when society has other, more efficient, means to achieve distributional goals? For example, why build income weights into an analysis of, say, a hydroelectric plant if society can correct incomes for unfairness through the tax system? There do appear, then, to be some sensible practical reasons for not engaging in distributional weighting. Where those reasons are not persuasive, it is possible to introduce distributional weights (see Section 1.7).

Both inter- and intra-generational bias are therefore present in the willingness-to-pay criterion for eliciting economic values. There is no consensus on how to integrate inter- and intra-generational considerations into economic decision-making about the environment. While economists would typically favour the use of positive rates for discounting the future, some argue that there is no particular rationale for discounting future wellbeing. Most economists would probably focus on efficiency gains and losses in project and programme appraisal, but others favour the explicit recognition of multiple social goals or 'multi-criteria' and seek some form of calculus for trading-off between them when they conflict.

## 1.3 Economic Valuation and the Developing World

Discussion of economic valuation and the role of future generations' preferences may seem remote from the concerns of the developing economies. But valuation is fundamental to the notion of *sustainable development*. If sustainable development is very loosely defined in the sense of the World Commission on Environment and Development (the Brundtland Commission, see World Commission on Environment and Development [1987]) as development that:

" ...meets the needs of the present without compromising the ability of future generations to meet their own needs."

then it is clearly fundamental to know what is and what is not a sustainable development path. It should be possible to see that a development path which ignores the environmental consequences of economic change may well be unsustainable. As environments deteriorate, so human health will suffer from environmentally-induced diseases and long-term labour productivity may decline. Degraded environments also impose costs in terms of forgone crop output due to soil erosion, additional energy imports as biomass energy is exhausted, diverted labour time to collect water and fuelwood from more and more distant sources, and so on. Moreover, when properly valued, investment in natural resource augmentation is often found to yield rates of economic return comparable to that earned on conventional capital investments.

Demonstrating that 'conservation pays' in economic development terms is a process that has only really just begun. But it is already possible to point to significant findings. Far from environmental and resource conservation being inimical to sustained economic development, it is in a great many cases integral to the development process.

## 1.4 What is Economic Valuation ?

It is important to understand what is being done when economic valuation is carried out. The economic value of something is measured by the summation of many individuals' willingness-to-pay for it. In turn, this willingness-to-pay (WTP) reflects individuals' preferences for the good in question. So, economic valuation in the environment context is about 'measuring the preferences' of people for an environmental good or against an environmental bad. Valuation is therefore of preferences held by people. The valuation process is anthropocentric. The resulting valuations are in money terms because of the way in which preference revelation is sought -- i.e. by asking what people are willing to pay, or by inferring their WTP through other means. Moreover, the use of money as the measuring rod permits the comparison that is required between 'environmental values' and 'development values'. The latter are expressed in money terms, either in a dollar amount or an economic rate of return. Using other units to measure environmental values would not permit the comparison with development values.

The language of economic valuation is often misleading. Studies speak of 'valuing the environment' or 'pricing the environment'. Similarly, changes in the environment affect health so it is necessary to find some valuations of changes in health status, the ultimate change, of course, being the cessation of life itself. It is commonplace to find references to 'the value of life'. Economists are apt to speak of 'the environment as a commodity' which leaves them open perhaps justifiably to charges that this is all the environment is worth. All these terminolo-

gies generate an unfortunate image as to what the activity of economic valuation involves. What is being valued is not 'the environment' or 'life', but people's preferences for changes in the state of their environment, and their preferences for changes in the level of risk to their lives. There is no dispute that people have preferences for and against environmental change. There is no dispute that people are willing to pay to prevent or secure change: donations to conservation societies alone demonstrate this. The problem arises when this WTP is taken as 'the' value of the environmental change. Many people believe that there are *intrinsic values* in environmental assets. They are of value in themselves and are not 'of' human beings, values that exist not just because individual human beings have preferences for them. There is no reason to reject the idea of intrinsic values because the idea of measuring preferences is adopted. What is being assessed are two different things: the value of preferences of people for or against environmental change (economic values) and the value that intrinsically resides 'in' environmental assets (intrinsic values). Economic valuation is essentially about discovering the *demand curve* for environmental goods and services: the values of human beings for the environment. The use of money as the measuring rod is a convenience: it happens to be one of the limited number of ways in which people express preferences, i.e. through their willingness-to-pay.

Once it is accepted that both forms of value exist, the issue becomes one of which values should inform and guide the process of making public choices. The answer is that since both values are 'legitimate', both are relevant to decision-making. Making decisions on the basis of economic values alone neither describes real world decision-making, nor would it be appropriate given that governments and the other agents involved in the development process have multiple goals. But one difference between the economic and intrinsic value approach is that economic values can, in principle, be measured. Intrinsic values cannot. If decision-makers do not feel the need for quantified assessments of gains and losses, then lack of quantification may not be an obstacle to decision-making. Otherwise it will often prove difficult to make choices between competing projects or alternative policies with differing environmental impacts.

The practical problem with economic valuation is one of deriving credible estimates of that value in contexts where there are either no apparent markets or very imperfect markets. If it is possible to derive such values, then it may well be that some measures of individuals' preferences will, in any event, capture at least part of what might be called intrinsic value. This will be so if the people expressing values for the environmental change in question

themselves possess some concept of the intrinsic value of things. They may then be partly valuing 'on behalf' of the environment as an entity in itself.

Once again, the discussion may seem remote from the concerns of the developing countries. But it can be very important to those concerns. Many of the environmental assets that people generally feel are very important are in the developing world. Notable examples include the tropical rain forests, ecologically precious wetlands, and many of the world's endangered species. Many people feel these environmental assets have intrinsic value. They may express that view by speaking of the immorality of activities which degrade these resources, and of the 'rights' to existence of trees and animal species. Such discussions are important, but at the practical level the 'development and environment' debate is frequently about the very high value placed on development in a context of malnourishment and underemployment. The environment will often be viewed as a luxury to be afforded later, not now while the struggle for development is under way. Bringing discussion of rights and intrinsic values into the policy dialogue can be counterproductive in such contexts: honouring them is perceived as forgoing the benefits of development. If, on the other hand, conservation and the sustainable use of resources can be shown to be of economic value, then the dialogue of developer and conservationist may be viewed differently, not as one of necessary opposites, but of potential complements. The remaining stage rests on finding ways for the developing world to capture the conservation benefits. If environmentalists in rich countries perceive value in conserving a rain forest in a poor country, this is of little consequence to the poor country unless there is a potential cash flow or technology transfer to be obtained.

Economic valuation is therefore a two-part process in which it is necessary to:

(a) demonstrate and measure the economic value of environmental assets -- what we will call the demonstration process;

(b) find ways to capture the value -- the appropriation process.

## 1.5 Total Economic Value

The economic value of environmental assets can be broken down into a set of component parts. This can be illustrated in the context of decisions about alternative land uses for a tropical forest. According to a benefit-cost rule, decisions to 'develop' a tropical forest would have to be justified by showing that the net benefits from development exceed the net benefits from 'conservation'. Development here is taken to mean some use of the forest that would be inconsistent with retention of the forest in at

least approximately its natural state. Conservation could have two dimensions: preservation, which would be formally equivalent to outright non-use of the resource, and conservation which would involve limited uses of the forest consistent with retention of natural forest. The definitions are necessarily imprecise. Some people would argue, for example, that 'ecotourism' is not consistent with sustainable conservation, others that it may be. Accepting the lack of precise lines of differentiation, the benefit-cost rule would be to develop only if the development benefits minus the development costs is greater than the benefits of conservation minus the costs of conservation. Put another way, the development benefits minus both the development costs and the net conservation benefits must be positive.

Typically, development benefits and costs can be fairly readily calculated because there are attendant cash flows. Timber production, for example, tends to be for commercial markets and market prices are observable. Conservation benefits, on the other hand, are a mix of associated cash flows and 'non-market' benefits. This fact imparts two biases. The first is that the components with associated cash flows are made to appear more 'real' than those without such cash flows. There is 'misplaced concreteness : decisions are likely to be biased in favour of the development option because conservation benefits are not readily calculable. The second bias follows from the first. Unless incentives are devised whereby the non-market benefits are 'internalised' into the land use choice mechanism, conservation benefits will automatically be downgraded. Those who stand to gain from, say, timber extraction or agricultural clearance cannot consume the non-marketed benefits. This 'asymmetry of values' imparts a considerable bias in favour of the development option.

Conservation benefits are measured by the *total economic value* (TEV) of the tropical forest. TEV comprises use and non-use values. Conservation is consistent with some sustainable uses of the forest, including sustainable timber harvesting. Direct use values are fairly straightforward in concept but are not necessarily easy to measure in economic terms. Thus minor forest products output (nuts, rattan, latex etc.) should be measurable from market and survey data, but the value of medicinal plants for the world at large is more difficult to measure.

Indirect use values correspond to the ecologist's concept of 'ecological functions'. A tropical forest might help protect watersheds, for example, so that removing forest cover may result in water pollution and siltation, depending on the alternative use to which the forest land is put. Similarly, tropical forests 'store' carbon-dioxide. When they are burned for clearance much of the stored $CO_2$ is released into the atmosphere, contributing to greenhouse gas atmospheric warming. Tropical forests also store many species which in turn may have ecological functions -- one of values of biological diversity.

Option values relate to the amount that individuals would be willing to pay to conserve a tropical forest for future use. That is, no use is made of it now but use may be made of it in the future. Option value is thus like an insurance premium to ensure the supply of something the availability of which would otherwise be uncertain. While there can be no presumption that option value is positive it is likely to be so in the context where the resource is in demand for its environmental qualities and its supply is threatened by deforestation.

Existence value relates to valuations of the environmental asset unrelated either to current or optional use. Its intuitive basis is easy to understand because a great many people reveal their willingness-to-pay for the existence of environmental assets through wildlife and other environmental charities but without taking part in the direct use of the wildlife through recreation. To some extent, this willingness-to-pay may represent 'vicarious' consumption, i.e. consumption of wildlife videos and TV programmes, but studies suggest that this is a weak explanation for existence value. Empirical measures of existence value, obtained through questionnaire approaches (the contingent valuation method), suggest that existence value can be a substantial component of total economic value. This finding is even more pronounced where the asset is unique, suggesting high potential existence values for tropical forests and especially for luxuriant moist forests. Some analysts like to add bequest value as a separate category of economic value. Others regard it as part of existence value. In empirical terms it would be hard to differentiate them.

Total economic value can be expressed as:

TEV = Direct Use Value + Indirect Use Value + Option Value + Existence Value

While the components of TEV are additive, care has to be taken in practice not to add competing values. There are trade-offs between different types of use value and between direct and indirect use values. The value of timber from clear felling cannot be added to the value of minor forest products, but timber from selective cutting will generally be additive to forest products.

Consider how TEV can be used when analysing say a land use decision. Let the options be 'con' for conservation and 'dev' for development. Assume the land in question is a forest area and that development involves clearing the forest. Then, on efficiency grounds, the condition for development to

be socially worthwhile (ignoring time, for convenience) is:

$(B_{dev} - C_{dev}) - (B_{con} - C_{con}) > 0$

Notice that the net benefits of conservation need to be deducted from the net benefits of development for the land use change to be warranted on efficiency grounds. That is, the true *opportunity cost* of development includes the forgone conservation benefits. From the previous discussion we know that the conservation benefits are given by TEV, so that the condition for land use change becomes:

$(B_{dev} - C_{dev}) - (TEV - C_{con}) > 0$

From the standpoint of society, the fact that some components of TEV may not accrue as cash flows is not relevant. It is an artefact that some goods and services are marketed while others are not. But from the standpoint of an effective decision, it is important that TEV be 'appropriated' as a cash flow or flow of real services. For example, if the decision is to conserve the forest because of non-market values in TEV, then the land owner will have to forgo the development benefits which accrue in cash terms. He cannot live off the invisible proceeds of TEV. As such, he will have little incentive to abide by any land use decision based on non-market values. This is why it is important to develop procedures for turning those values into cashable forms. Mechanisms for appropriation are discussed at length in Panayotou [1994].

**1.6 Why Derive Economic Values?**

There are at least five major reasons why economic valuation of environmental goods and services is important in the developing world.

(a) *The Importance of Environment in National Development Strategies*

Environmental damage shows up in two ways as a cost to nations. First, it produces impacts on GNP: GNP is less than it otherwise would be if at least some environmental damage is avoided. Second, it generates costs which are not currently recorded as part of GNP, but which would be if GNP accounts were modified to reflect comprehensive measures of aggregate wellbeing rather than economic activity. Focusing on the first aspect, some evidence is now available to show that environmental degradation results in appreciable losses of GNP. The kinds of impacts that give rise to such costs include:

- forgone crop output due to soil erosion and air pollution;

- forgone forestry output due to air pollution damage, soil contamination and soil erosion;

- impairment of human health with consequent lost labour productivity

- diversion of resources from high productivity

uses to uses such as maintenance of buildings damaged by pollution.

The empirical investigation of these losses at a national level is in its infancy. In the case of crop losses, for example, what is required is some measure of change in the overall level of economic surpluses (consumers' plus producers' surplus are measures of the extent to which willingness-to-pay exceeds the actual amount paid) rather than a more straightforward estimate of crop loss valued at market prices. As an example of the former, the impact of global warming on world agriculture is under continuing investigation. Simpler approaches based on crop responses to soil erosion and pollution have their uses too. Soil erosion is endemic to many developing countries. Soil erodes 'naturally' but lack of investment in conservation, poor extension services, inability to raise credit and insecure land tenure all contribute to poor management of soils. A standard approach to estimating the costs of soil erosion is to estimate soil loss through the Universal Soil Loss Equation (USLE). The USLE estimates soil loss by relating it to rainfall erosivity, R; the 'erodibility' of soils, K; the slope of land, SL; a 'crop factor', C; which measures the ratio of soil loss under a given crop to that from bare soil, and conservation practice P; (so that 'no conservation' is measured as unity). The USLE is then:

Soil Loss = R.K.SL.C.P

The next step is to link soil loss to crop productivity. In a study of soil loss effects in southern Mali, researchers applied the following equation to estimate the impact.

$Yield = C^{-bx}$

where C is the yield on newly cleared and hence uneroded land, b is a coefficient varying with crop and slope and x is cumulative soil loss. Finally, the resulting yield reductions need to be valued. A crude approach is simply to multiply the estimated crop loss by its market price if it is a cash crop. But the impact of yield changes on farm incomes will generally be more complex than this. For example, yield reductions would reduce the requirement for weeding and harvesting. The Mali study allowed for these effects by looking at the total impact on farm budgets with and without erosion.

The procedure described is an example of a 'dose-response' approach to valuation. The 'dose' is soil erosion, the 'response' is crop loss. Another approach would be to look at the costs of replacing the nutrients that are lost with soil erosion. Nutrient losses can be replaced with chemical fertilisers which have explicit market values.

Where it is not possible to engage in detailed assessment of the costs of resource degradation it is still useful to obtain 'best guess' calculations. In

Burkina Faso estimates were made of the total amount of biomass lost each year in the form of fuelwood and vegetation. The resulting losses show up as forgone household energy (fuelwood) which can be valued at market prices for fuelwood; forgone millet and sorghum crops which can be valued at market prices; and reduced livestock yield due to fodder losses. Fuelwood losses amount to some 47 CFAF billion, livestock a further 10 CFAF billion, and cereal losses a further 15 CFAF billion. The grand total amounts to some 9 per cent of Burkina Faso's GNP. It cannot be deduced from this that Burkina Faso's GNP is 9 per cent less than it otherwise would be. This is because resources would have to be expended in order to rehabilitate eroded areas and to prevent further damage. But if the resources required are small, then the 9 per cent figure is a ballpark estimate of the direct loss to Burkina Faso.

Provided they are credible, national environmental damage cost estimates can play a useful role in assessing development priorities. Because environmental damage costs do not show up explicitly in measures of national product, planners have no obvious incentive to treat environmental damage as a priority in development plans. Increasingly, however, environment is entering into development plans as the GNP costs of degradation are being shown to be significant and sometimes very substantial. Arguments of this kind are particularly appropriate at the level of macroeconomic management of the economy: it may be more important that the Ministry of Finance appreciates the costs of environmental degradation than that the Ministry of the Environment does.

(b) *Modifying the National Accounts*

Macroeconomic management makes extensive use of the national economic accounts which record monetary flows and transactions within the economy. The primary purpose of the accounts is to record economic activity, not to measure aggregate wellbeing in the nation. None the less, national accounts are widely used to indicate wellbeing and rates of change, national aggregates such as GNP are widely construed as measures of 'development'. Whether the accounts are designed to record economic activity or measure wellbeing, or both, they are deficient in respect of their treatment of the environment. Economic activity involves the use of materials and energy, and, once transformed into products, those same resources become, sooner or later, waste products. Any measure of economic activity which ignores these materials and energy flows will fail to record important activities which affect the sustainability of the economic activity. In the same way, any measure of wellbeing which ignores the resource and energy flows will fail to

measure *sustainable wellbeing*. For these reasons, there is no widespread consensus that the national accounts need to be modified at least with respect to the way in which environmental 'stocks' and 'flows' are recorded.

Material and energy flows begin at the point of extraction, harvest or use of natural resources. They end by being waste products, i.e. emissions to ambient environments, discharges to water, and solid waste to land or sea. Logically, then, GNP needs to be modified to account for:

any depreciation of natural capital stocks, in the same way that <u>net</u> national income = gross national income <u>less</u> estimated depreciation on man-made capital. This is a measure of the 'draw down' of natural capital;

any damage losses accruing to human wellbeing from the extraction, processing and disposal of materials and energy to receiving environments.

Both adjustments involve economic valuation. The first adjustment involves a valuation of the natural capital stock, the second involves valuation of such things as health impairment, pollution damage to buildings, crops and trees, aesthetic and recreational losses and other forms of 'psychic' damage. National accountants are not agreed on how best to make the appropriate adjustments.

Depreciation on stocks of natural capital also requires valuation and is relevant if the interest is in some measure of sustainable income, the income that a nation can receive without running down its capital base. In the conventional accounts this is partly accounted for by estimating net national product (NNP) which is defined as:

$$NNP = GNP - D_k$$

where $D_k$ is the depreciation on man-made capital (machines, roads, buildings etc.). The further adjustment that is required is:

$$NNP = GNP - D_k - D_n$$

where $D_n$ is the depreciation of environmental assets.

There is a clear role for economic valuation in establishing modified national income accounts.

(c) *Setting National and Sectoral Priorities*

Information on the economic value of policy changes can greatly assist the governmental process of setting policy and sectoral priorities. Estimating damage or benefit figures alone will not be sufficient for this process. It is necessary to compare the benefits of policy with the costs of policy. The presence of net benefits is sufficient to establish that existing or planned policy is potentially worthwhile, though not sufficient to establish that resources devoted to that end would not be better

used elsewhere (net benefits may be greater still if the resources had an alternative use). But if benefits are less than costs then it can at least be inferred that resources should not be devoted on such a scale to the particular goal. This general requirement to review sectoral priorities in terms of benefits and costs has perhaps even greater force in the developing world where government income is at a premium. Indeed, this has always been one of the motives underlying the development of cost and benefit valuation techniques for developing countries. Despite this, the use of sectoral benefit-cost techniques have been used in fairly limited ways in the developed world, and hardly at all in the developing world. Although there are a great many benefit-cost studies of specific policies in both developed and developing countries, few exist for establishing the worth of overall sectoral expenditures.

In the real world of political decision-making, priorities are rarely set by reference to measures of costs and benefits. The greatest influence over policy is in the United States. Outside of the USA very little actual influence has been exerted by cost-benefit analysis. In part this reflects lack of understanding of the techniques involved, but in part it reflects the fact that decision-makers have multiple criteria for deciding on policies (nor, of course, are policies necessarily chosen on a rational basis from the social standpoint: chance, favouritism, patronage, whim and corruption are just as important). Benefit and damage estimation are therefore likely to be part of a wider package of criteria including distributional concerns, human health, and concerns over the quality of environmental impact and the sustainability of resource use.

(d) *Project, Programme and Policy Evaluation*

The traditional role for environmental damage and benefit estimation is in project appraisal. The main manuals that have influenced theoretical and practical work in economic project assessment have not, however, addressed environmental issues. Issues relating to the treatment of environmental factors are not, for example, discussed at all in the main project appraisal technical manuals (see Little and Mirrlees [1974]; Squire and van der Tak [1975]; UNIDO [1972]; Gittinger [1982]). In contrast, assessing environmental impacts has been the subject of a wholly separate set of procedures known as Environmental Impact Assessment (EIA), or Environmental Assessment (EA). EA is important in drawing decision-makers' attention to the many forms of environmental impact. To some extent EA also permits an assessment of the importance of impacts. The main problem, however, is that EA tends to be pursued either as an adjunct to conventional economic appraisal, or as a precursor. In neither case is EA integrated into economic ap-

praisal. Yet comprehensive benefit-cost assessments require EA to be carried out if they are to be truly comprehensive, accounting for environmental impacts.

Extending project appraisal to account for environmental impacts, or to the assessment of purely conservation projects, presents no conceptual problem for benefit-cost approaches. The typical benefit-cost assessment (BCA) calculates measured benefits and costs and converts them into an economic rate of return (ERR). In this process, market prices are adjusted for distortions, i.e. economic values are used (shadow prices). Environmental impacts are simply additional costs or benefits. The necessity for shadow pricing them tends to arise more from the fact that they lack associated markets altogether rather than from the existence of distorted markets. Indeed, economic valuation of environmental impacts is essentially a matter of shadow pricing. In order to focus on the environment, the traditional BCA rule for the potential acceptance of a project can be re-expressed as:

$$\sum_t (B_t - C_t - E_t) \cdot (1 + r)^{-t} > 0$$

where $B_t$ is non-environmental benefit at time t, C is non-environmental cost, r is the discount rate, and E is environmental cost (and the sign would be positive for environmental benefits). Economic valuation is concerned with the monetary measurement of E in this inequality. Environmental issues do, however, raise a further problem, namely the selection of r, the discount rate, in the above inequality.

The environmental implications of projects and programmes should be evaluated, and the overall return to the program should be assessed with reference to the inclusion of environmental enhancement components -- e.g. tree planting, soil conservation, water supply etc. In program analysis ERRs should still be estimated wherever possible, especially where the intermixing of policy changes and projects is liable to make ERRs higher than if projects alone were being evaluated.

Within a programme the issue of choice of technology usually arises. A given development objective may be met by selecting among a range of technological options. The programme objective of meeting a given increment in electricity demand, for example, involves selection of incremental electric power sources which contribute to the overall objective of meeting demand at least cost. Whereas least cost power system planning has typically been couched in terms of the private costs of generation and distribution, environmental considerations require that the criterion be modified to become least social cost, i.e. inclusive of the environmental impacts of different energy technologies.

The 'Polluter Pays Principle' (PPP) requires that those emitting damaging wastes to the environment should bear the costs of avoiding that damage or of containing the damage to within acceptable limits according to national environmental standards. As stated, the PPP does not require that environmental damage be valued in monetary terms, although it could be. Whatever the cost of achieving the national standard, that cost should, in the first instance, be borne by the emitter of waste. That the emitter's increased costs may then be passed on partly to the consumer is still consistent with the PPP. The costs borne by the emitter and the consumer can be thought of as a form of valuation. Regulatory agencies set standards on behalf of the voting population, and the cost of meeting those standards becomes, effectively, a minimum estimate of what the regulator regards the damage to be. Nor is it essential for the general PPP to be implemented via taxation or some other form of 'economic instrument' (tradeable permit, product charge, tax-subsidy etc.). The PPP is consistent with traditional standard setting via 'command and control' policies.

None the less, economic instruments have many attractions over command and control policies. If this approach is used then it is fundamental to their use that any charge or tax should be at least proportional to damage done. Valuation therefore becomes important in giving guidance to the setting of such environmental prices.

Policy changes should also be evaluated using the benefit-cost framework with special reference to environmental implications. The costs of implementing the policy can be compared with the benefits obtained from it.

(e) *Economic Valuation and Sustainable Development*

The need for economic valuation of environmental impacts and of environmental assets arises quite independently of the definition of sustainable development. Simply pursuing efficient policies and investing in efficient projects and programmes requires valuation to be pursued as long as it is credible. At the most general level of intergenerational concern, valuation is still required. If transfers of resources are to be made between generations -- with the current generation sacrificing for the future, or future benefits being lost for the sake of present gain -- then it is essential to know what is being sacrificed and how much it is that is being surrendered. It is not necessary, therefore, to invoke the philosophy of sustainable development, however it is defined, to justify a focus on economic valuation in a development context.

However, if one or more definitions of sustainable

development are to be espoused, the role of economic valuation needs to be investigated. An efficient use of resources need not be a sustainable one. The optimal rate at which an exhaustible resource should be depleted, for example, still requires that the rate of use is positive. In the absence of repeated discoveries of further identical resources, the resource must be exhausted eventually. Every unit of use today is at the cost of a forgone unit tomorrow. Global warming is another example of an activity that impairs the welfare of future generations. 'Sustainability' therefore implies something about maintaining the level of human wellbeing so that it might improve but at least never declines (more than temporarily, anyway). Interpreted this way, sustainable development becomes equivalent to some requirement that wellbeing does not decline through time. The implication for valuation is now somewhat different to what is implied by consideration of efficiency alone. It now becomes necessary to measure human wellbeing in order to establish that it does not decline through time, and since environmental assets contribute to wellbeing it is necessary to measure preferences for and against environmental change.

If the focus is on the conditions for achieving sustainable development, then it may be that wholly non-economic indicators will suffice. For example, computations of the carrying capacity of natural environments could act as early warnings of non-survivability. Other physical measures could include assessments of the rate of resource use relative to the rate of resource regeneration and the rate of waste emissions relative to the assimilative capacity of the environment. It may be, therefore, that some light will be shed on sustainability indicators by non-economic approaches, especially if they can be developed to include other measures of stress and shock to underlying natural resource systems.

The literature on environmental economics tends to suggest that the clues to sustainability lie in the quantity and quality of a nation's capital stock. Part of the intuition here is that nations are like corporations. No corporation would regard itself as sustainable if it used up its capital resources to fund its sales and profits expansion. As long as capital assets are at least intact, and preferably growing, any profit or income earned can be regarded as 'sustainable'. On this analogy nations are no different. Sustainable growth and development cannot be achieved if capital assets are declining. Indeed, some economic growth models suggest strongly that if capital assets are kept intact, one concept of intergenerational equity, -- that of equalising real consumption per capita, -- can be achieved providing population growth does not outstrip the rate of technological change. (This is a big caveat since it is likely to be met in rich countries but not in the

poorest countries).

If a condition for achieving sustainable development is that capital stocks be kept intact, then the problem of how to tell whether a nation is 'on' or 'off' a sustainable development path is partially resolved. It is not necessary to observe real levels of wellbeing as such, but instead to look at the underlying condition and amount of the capital stock. Unfortunately, while this approach solves one problem it raises many others. First, it is necessary to know what it is that counts as capital. Second, it has to be measurable, otherwise 'constancy' cannot be tested (constancy throughout should be read as 'constant or increasing').

The national accounting issue arises again in this context of defining and measuring capital. Capital assets in the national accounts are typically confined to 'man-made' capital -- machines, roads, factories. Some accounts include some measure of mineral wealth as capital. The depreciation on the man-made capital is then deducted from GNP to give NNP. A more comprehensive definition of capital and income would include human capital (knowledge, skills etc) and natural capital (environmental assets). The primary condition for sustainable development would then be that this aggregate stock of capital should not decline. Put another way, depreciation on this capital stock should not exceed the rate of new investment in capital assets.

But how is the capital stock to be measured? For some economies heavily dependent on one or two natural resources it may be possible to use a physical indicator of reserves or available stocks. But for the vast majority of them it will be necessary to find a measuring rod for capital. Typically that means money units -- i.e. it becomes necessary to value capital, including environmental capital. Valuation and sustainable development are again intricately linked. How far this link matters depends in large part on how likely unsustainable development paths are, and, of course, on the value judgement that sustainability 'matters'.

If securing sustainable development has something to do with monitoring and measuring aggregate capital stocks and not allowing them to decline, then there need be no particular role for environmental protection in sustainable development. Environmental assets could decline in quantity as long as depreciation in these assets was offset by investment in other man-made assets or human capital. But even if this view of sustainability is accepted, then valuation is still central to the process. For it is not then possible to know whether offsetting investment has taken place unless there is some measure of the rate of depreciation on natural assets and their forgone economic rate of return. Still

others will want to make a special case for the environment. The acceptability of 'running down' environmental assets provided other assets are built up will depend on relative valuations and on judgments about other measures of sustainability, as well as the moral view about destroying the environment.

Discussing sustainable development in broad terms risks giving the impression that philosophers and economists fiddle while the Rome of underdevelopment burns. But there is nothing in the ideas of sustainable development that lessens the emphasis on development now, or on targeting the most vulnerable. It will risk this if it is used to justify large sacrifices of real income and wellbeing now for very long term gains that are highly uncertain. Eliciting economic values can help guard against the latter risk by showing, as far as possible, where and when environmental protection yields the highest returns.

### 1.7 Economic Valuation and Income Distribution

Section 1.2 raised the issue of the relationship between WTP and income. In general, but not necessarily, WTP for environmental assets will be higher the higher is the income of the individual expressing the preference. Now consider an example of, say, a rain forest which is utilised by local people for fuel, wildmeat, and other forest products. It is a candidate for protection because of its biological diversity value and this value resides mainly with people outside the country in question, say in Europe or North America. If we compare the WTP to keep the forest for the local people's use with the WTP of foreign tourists and WTP in terms of existence value by foreigners, the chances are that the latter will greatly exceed the former simply because of the income difference. Should the forest then be conserved or left to local societies to use as they see fit ? The comparison of WTPs suggests it should be conserved, but this decision appears to be unfairly influenced by the distribution of income between the local and foreign people. The decision appears to be unfair.

There are two reactions to such an outcome. The first is to remember that economic valuation on its own is rarely helpful for policy purposes. The point of the valuation in this case would be to test the WTP of foreigners so that some of that WTP can be 'captured' by local people. Thus the WTP of foreigners can be used to raise entry charges to the forest so that some of the charge revenues can be used to compensate the local people for any foregone benefits, or to create new assets that substitute for those in the forest. In this way both the conservation objective and the distributional objective are served: the local people are no worse off and, in-

deed, could be far better off, and the forest is conserved for sustainable uses such as eco-tourism. Obviously, such a policy measure has to be handled cautiously and, critically, it is dependent on both finding an appropriation mechanism and making sure that those who lose initially really are compensated.

The second reaction is to modify the comparison of the WTPs in some way that lessens the effect of income. 'Equity weights' of this kind are commonly expressed in terms of the 'social value' of an extra unit of income accruing to individuals in specified groups or income classes. If an equity weight of zero were assigned to an individual, this would be equivalent to not giving him standing in the analysis. In practice, economists have generally proposed equity weighting schemes based on a functional relationship between an individual's utility (U) and his income (Y). Two commonly proposed functional forms are

$dU/dY = Y^a$, where a < 0

and

$dU/dY = {}_e (Y/Y^0)$.

where $Y^0$ is the mean income of the population.

The derivative of the function evaluated at a particular income level is termed the 'equity weight'. For example, suppose a person below a certain income level is assigned an equity weight of 2 and his WTP for a policy alternative is $100. Using an equity weighting procedure, his adjusted WTP for the policy alternative would be $200.

If the analyst is uncertain what values to use for equity weights, one approach is to treat the weights as unknowns and solve for the values that would make one policy alternative more attractive than another. For example, suppose that there are only two groups of affected individuals: the poor and everyone else. An equity weight, $v_{poor}$, is required to increase the social value of benefits to the poor, and the weight for other groups is simply equal to one. Let the summation of the willingness-to-pay of poor individuals for policy j be:

$WTP_{poor,j} = B_{poor,j}$

and the summation of the willingness-to-pay of everyone else for policy j be:

$WTP_{nonpoor,j} = B_{nonpoor,j}$.

If policy alternatives 1 and 2 were equally attractive in terms of an economic efficiency criterion, this would imply that:

$v_{poor}B_{poor,1} + B_{nonpoor,1} = v_{poor}B_{poor,2} + B_{nonpoor,2}$

Solving for $v_{poor}$ yields:

$v_{poor} = (B_{nonpoor,2} - B_{nonpoor,1}) / (B_{poor,1} - B_{poor,2})$

If the values of $B_{poor,1}$, $B_{poor,2}$, $B_{nonpoor,1}$, and $B_{nonpoor,2}$

were known, then the last equation could be solved for a value of $v_{poor}$ that would make the two policy alternatives equally attractive. Depending on the values of $B_{poor,1}$, $B_{poor,2}$, $B_{nonpoor,1}$, and $B_{nonpoor,2}$, higher or lower values of $v_{poor}$ would favour one policy alternative or the other. This type of 'break-even analysis' can be quite useful if the analyst is uncertain of the exact value of an equity weight, but is confident that it is above or below a certain value, or lies within a certain range.

Equity weighting schemes of various types have been proposed by some economists and policy analysts for over thirty years, but they have rarely been used in practice. Nor in our judgment is it likely that they will be used in the future. The reason for this lack of acceptance is not hard to discern: neither decision makers nor the public are interested in the aggregate measures that result from equity weighting procedures. This is in large part because there is no political consensus (in any society) on how such equity weights should be determined. More broadly, such equity weights rarely capture the ethical complexity of policy choices, and thus do not help policy makers or the public think carefully or creatively about the attractiveness of policy alternatives.

## 2 Economic Valuation Methodology

### 2.1 Economic Valuation

In order to make choices between competing wants, democratic societies use two fundamental decision making rules. The first, the Majority Voting Rule, does not take into account the strength of a persons' preferences. A second rule is therefore one where 'benefits exceed costs'. Economists look at this decision rule in terms of changes in the wellbeing or welfare of individuals as described by their 'utility' or 'preference satisfaction'. Because human well-being is rather an intangible concept that cannot be directly measured, economists use a transformation of wellbeing into a more general, single scale numeraire. For a gain in an individual's well-being, it is proposed that the change be measured by the maximum amount of goods or services -- or money income -- that they would be willing to give up or forego in order to obtain the change. Alternatively, if the change reduces wellbeing, it would be measured by the amount of money that the individual would require in compensation in order to accept the change.

This 'economic approach' involves the monetary valuation of changes in environmental quality. The task of monetary valuation of the environment is made more complex by a number of problems. These include the fact that environmental effects will often have no natural units of measurement, and even where physical indices are available these

must be related to individuals' perceptions. Also, environmental effects do not often directly show up in markets due to their externality and public good characteristics. Finally, the forecasting of environmental effects is complicated by the fact that they involve bio-chemical and bio-physical feedbacks which are scientifically not fully understood.

The monetary measure of a change in an individual's wellbeing due to a change in environmental quality is called the Total Economic Value of the change in the environmental quality. It is not environmental quality per se that is being measured then, but people's <u>preferences</u> for changes in that quality. <u>Valuation</u>, as such is anthropocentric in that it is of preferences held by people, and, the <u>value</u> of something is established by an exchange transaction. The sum of willingness-to-pay (or total economic value) for all the individuals affected by an action is given by the area under the demand curve of the good or service that is affected.

Total Economic Value of a resource can be disaggregated into constituent parts consisting of Use Value (UV) and Non-Use Value (NUV). Use values can be: Direct (DUV), such as were an individual makes actual use of a facility, for example visiting a recreation area to go fishing, and is willing to pay for this use; Indirect (IUV), such as where benefits are derived from ecosystem functions; Option Values (OV), which is an individual's willingness-to-pay for the option of safeguarding a facility, such as the already mentioned recreation area, for use at some future date.

Non-Use Values (NUV) on the other hand have proved to be both difficult to define and measure. Non-use values can be subdivided into: Existence Value (XV) which measure willingness-to-pay for a resource for some 'moral', altruistic or other reason and is unrelated to use or option value; Bequest Value (BV) which measures an individual's willingness-to-pay to ensure that their heirs will be able to use a resource in the future.

So, TEV = UV + NUV = (DUV + IUV + OV) + (XV + BV)

Table 2.1 shows an economic taxonomy for environmental resource valuation.

### Table 2.1 Economic Taxonomy for Environmental Resource Valuation

| Total Economic Value | | | |
|---|---|---|---|
| **Use Values** | **Non Use Values** | | |
| **Direct Use** Outputs directly consumable Food, Biomass, Recreation, Health **Indirect Use** Functional Benefits Flood control, Storm protection, Nutrient cycles | **Option Value** Future direct and indirect values Biodiversity, Conserved Habitats | **Bequest Value** Use and Non-Use value of environmental legacy Habitats, prevention of irreversible change | **Existence Value** Value from knowledge of continued existence Habitats, species, genetic, ecosystem |

Source: Pearce et al [1992]

### 2.2 Willingness-to-Pay vs Willingness-to-Accept

The task of valuation is to determine how much better or worse off individuals are (or would be) as a result of change in environmental quality or provision. Economists define the value of a change in terms of how much of *something else* (usually expressed as an amount of money) an individual is <u>Willing-to-Pay</u> to get this change (or how much they would be <u>Willing-to-Accept</u> in order to permit the change to occur). How then are the economic values attached to these changes determined? There are a number of methodologies available. Excellent surveys of these are available elsewhere and so we confine ourselves to a critical summary here. Before we look at this, the question arises as to which measure of value -- Willingness-to-Pay or Willingness-to-Accept -- should be used for benefit estimation. Until recently, it was assumed that in most practical situations the difference between these measures would be small so long as there was an absence of strong income effects.

Willig [1976] developed a precise analytical expression of the size of this potential difference, and showed that in a wide variety of market situations, this divergence between WTP and WTA measures would be very small.

However, a substantial body of empirical evidence has recently been developed that provides convincing evidence that WTP and WTA measures are often quite different (Hammack and Brown, [1974]; Gordon and Knetsch, [1979]; Meyer, [1979]; Rowe,

d'Arge, and Brookshire, [1980]; Schulze, d'Arge, and Brookshire, [1981]; Knetsch and Sinden, [1984]). Typically WTP measures turn out to be substantially less than WTA measures for the same policy change. The reaction of many economists to this evidence was to argue that the WTA results were unreliable and should not be treated seriously (Dwyer and Bowes, [1979]; Kahneman, [1986]). The implication was that monetary estimates of well-being based on WTA measures should be not be used in policy analysis.

However, the difference between WTP and WTA measures has proven to be extremely robust in a wide variety of experiments, and appears to reflect a real difference in individuals' valuation of a policy change depending on how the policy is 'framed' or the individual's 'reference point' (Kahneman and Tversky, [1979]; Tversky and Kahneman, [1981]). Individuals weight (or value) losses from this reference point much more heavily than they do gains, i.e. the loss of $100 from current income will generally be perceived to be much worse than a gain of $100 is perceived to be a benefit. This is not simply because of the declining marginal utility of income. Instead, the utility function appears to be 'kinked' at the reference point.

This finding has three important implications. First, the gains from trade are likely to be overstated because people value highly what they must give up in the trade (Knetsch, [1990]). More generally, most WTP estimates of the value of losses will be too low.

Second, the decision on whether to use compensating or equivalent variation measures -- or WTP versus WTA -- would in many cases take on great practical importance because the losses associated with changes in the status quo -- or the reference point -- would weigh much more heavily than corresponding gains. Individuals tend to view compensation for a loss as two separate events: (1) a loss (which they greatly dislike), and (2) a money payment which is perceived as a gain from their new reference point (Knetsch, [1990]). Policy measures that mitigate or reduce losses may thus be more desirable than those that allow the damage to occur and then compensate the individuals affected.

Third, there is no justification within economic theory for choosing between the WTP and WTA measures.

Recently, Hanemann [1992] has offered another explanation for the divergence between WTP and WTA measures of economic value. He has shown that such differences are consistent with economic demand theory when there are few or poor substitutes for the goods or services in question and when these goods or services are highly valued by individuals. These conditions are likely to be true for many environmental goods.

In summary, good economic analysis will require good judgement on the question of whether to use WTP or WTA measures of economic value.

## 2.3 Valuation Techniques

There are basically two broad approaches to valuation, each comprising a number of techniques. The approaches are the Direct and Indirect approaches. The Direct approach looks at techniques which attempt to elicit preferences directly by the use of survey and experimental techniques, such as the Contingent Valuation and Contingent Ranking methods. People are asked directly to state or reveal their strength of preference for a proposed change. In contrast, Indirect approaches are those techniques which seek to elicit preferences from actual, observed market based information. Preferences for the environmental good are revealed indirectly, when an individual purchases a marketed good with which the environmental good is related to in some way. The techniques included here are, Hedonic Price and Wage techniques, the Travel Cost method, Avertive Behaviour and Conventional Market approaches. They are all Indirect because they do not rely on people's direct answers to questions about how much they would be willing to pay (or accept) for an environmental quality change.

Figure 3 illustrates the various approaches and techniques available.

## 2.4 The Direct Valuation Approach

In the direct approach an attempt is made to elicit preferences by either experiments or questionnaires.

(a) Experiments -- if an analyst wanted to know how much people value a potential new recreation site, the recreation site could be created and an entrance fee charged. The analyst then observes how many people actually use the site, in effect exchanging money for the recreation and aesthetic experience of visiting the site. Alternatively, if the analyst wanted to know how much people would be willing to pay to live in a city with improved water quality, an experiment could be conducted in which water quality standards and property taxes would be raised in some cities and not in others. The analyst could then see how many people found it worthwhile to move to cities with improved water quality and higher taxes. In practice, such large scale experiments of this type are very difficult to design and implement, though small scale experiments have successfully been carried out.

Figure 1 Valuation Approaches and Techniques

(b) <u>Questionnaires</u> (surveys) -- there are two types of questioning that can be undertaken:

Eliciting Rankings -- this is similar to contingent valuation (see below) except that the questioner is content to obtain a ranking of preferences which can later be 'anchored' by the analyst in a real price of something observed in the market. This is known as the *Contingent Ranking Method* (CRM).

*Eliciting Values* -- people are asked directly to state or reveal 'what they are willing to pay for some change in provision of a good or service or to prevent a change' and/or 'what they are willing to accept to forego a change or tolerate the change'. A contingent market encompasses the good itself, the institutional context in which it would be provided, and the way it would be financed. The situation the respondent is asked to value is hypothetical and respondents are assumed to behave in an identical way to that in a real market. Structured questions and various forms of 'bidding game' can be devised involving 'yes/no' answers to questions regarding maximum willingness-to-pay. Econometric techniques are then used on the survey results to find the mean bid values of willingness-to-pay. This is known as the *Contingent Valuation Method* (CVM), and measures precisely what the analyst wants to know -- the individual's strength of prefer-

ences for the proposed change -- and can be used not only for non-marketed goods and services, but market goods as well. If people were able to understand clearly the change in environmental quality being offered, and answered truthfully, this direct approach would be ideal. However the central problem with the approach is whether the intentions people indicate ex-ante (before the change) will accurately describe their behaviour ex-post (after the change) when people face no penalty or cost associated with a discrepancy between the two. This is known as 'Strategic Bias' and occurs if there is a 'free rider' problem.

Interest in CVM has increased over the last decade or so because, firstly, it is the only means available for valuing Non-use values -- the values obtained from Indirect techniques are not aimed at capturing Non-use values. Secondly, estimates obtained from well designed properly executed surveys appear to be as good as estimates obtained from other methods. Thirdly, the design, analysis and interpretation of surveys has improved greatly as scientific sampling theory, benefit estimation theory, computerised data management and public opinion polling has improved.

There are three basic parts to most CV survey instruments:

First, a hypothetical description (scenario) of the terms under which the good or service is to be offered is presented to the respondent. This will include information on when the service will be available, how the respondent will be expected to pay for it, how much others will be expected to pay, what institutions will be responsible for delivery of the service, the quality and reliability of the service.

Second, the respondent is asked questions to determine how much he would value a good or service if confronted with the opportunity to obtain it under the specified terms and conditions. These questions take the form of asking how much an individual is WTP or WTA for some change in provision. Econometric models are then used to infer their WTP for the change.

Third, questions on socioeconomic and demographic characteristics of the respondent are asked in order to relate the answers respondents give to the valuation questions to the other characteristics of the respondent.

### 2.3.1 Elicitation, Bias and Acceptability

A respondent can indicate his/her choice or preference in a number of ways. One way is to answer a question as to whether or not he would want to purchase the service if it cost a specified amount. These are known as discrete or dichotomous choice questions. Another possibility is to ask the respondent a direct question about the most they would be willing to pay for the good or service -- known as continuous or open-ended questions. These two types can be combined in a CV questionnaire to create different ways of eliciting the valuation information, e.g. a bidding game. In addition, respondents may be shown a list of possible answers in the form of a 'payment' card, and asked to indicate their choice, though this requires a careful determination of the range of possible answers. The appropriate choice for a specific problem is a matter of judgement on the part of the analyst.

An assessment of the technical acceptability of CVM involves looking at various methodological issues, which we divide into issues of Reliability, Bias and Validity.

### Reliability

This looks at the degree to which the variance of WTP responses are attributable to random error. The greater is the degree of non-randomness, the less the reliability of the study such that mean WTP answers are of little value. The variance arises as a consequence of true random error (essential to the statistical process); sampling procedure (variance is minimised by ensuring a statistically significant sample size); the questionnaire/interview itself (it is important for reliability to ensure that the CVM scenario is as realistic and familiar to the respondent as possible). In order to assess reliability, a number of practitioners have advocated the use of replicability tests, i.e. repeating an experiment using different samples to see if there is correlation between the variables collected. Although few such tests have been carried out in practice due to their expense, Heberlein (1986), Loehman and De [1982] and Loomis [1989, 1990] have carried out such testing and found significant correlation between WTP in the test and retest.

### Bias

*Strategic Bias* -- the problem of strategic bias has long worried economists. The behaviour necessary for this kind of bias depends on the respondent's perceived payment obligation and his expectation about the provision of a good. Where individuals actually have to pay their reported WTP values then there is the temptation to understate their true preferences in the hope of a free-ride. Or if the price to be charged for the good is not tied to an individual's WTP response, but the provision of the good is, then over reporting of WTP may occur in order to ensure provision. Empirical investigations of strategic bias are well documented. One approach of testing for strategic bias argued that if true WTP bids are theoretically normally distributed then strategic behaviour would bias this distribution towards zero (Brookshire et al [1976]). However this test has been criticised on the grounds that

bimodal distributions can be posited on the income characteristics of the respondent population. Minimisation of occurrence of strategic behaviour can be achieved by framing the CVM questions in an incentive compatible way such that this type of behaviour is not induced. One particular approach is to ask respondents to make bids for a good under three scenarios -- only the highest bidders get the good; everyone gets the good if WTP is above a certain level; everyone with a positive WTP gets the good. The first scenario is assumed to give true WTP, the second has a weak free riding incentive and the third a strong one. Empirical evidence suggests that the two latter scenarios do indeed produce WTP values below their true level. Such findings tend to come from open ended format questions rather than discrete response approaches where free riding behaviour is likely to be minimised. Some authors suggest implementation of a property rights approach, in which respondents receive provision of a good relative to their given WTP in order to remove free riding. This is not applicable for most environmental public goods for which non-use and altruistic values act as a disincentive to free ride anyway. Overall strategic bias problems have not been found to be a significant problem in practice.

*Hypothetical Bias* -- the hypothetical nature of the market in CV studies can render respondents answers meaningless if their declared intentions cannot be taken as accurate guides of their actual behaviour. Some writers have looked at hypothetical bias in terms of increased bid variance and low model reliability whereas others view the use of hypothetical markets as having other distinct problems. Research into hypothetical markets and their predictive ability has looked at the attitude-behaviour relationship, and experiments examining substitution of real for hypothetical markets.

A survey of experimental tests reveals that by using a WTP format instead of a WTA format hypothetical bias, which may be a significant problem in WTA studies, can be reduced to an insignificant level. The tests usually compare the hypothetical bids with bids obtained in simulated markets where real money transactions take place. Results from such studies suggest that the divergence between actual and hypothetical WTP is much less than that for WTA, the reason being that respondents are more familiar with payment rather than compensation scenarios (Hanley [1990]).

*The Embedding Problem* -- there is evidence to suggest that people have problems understanding certain kinds of questions that depend on insights into their own feelings or their memory of events or feelings. This kind of problem will be very apparent in environmental issues because these evoke deeply held moral, philosophical, and religious beliefs.

One particular problem in this vein much looked at, is that respondents may interpret the hypothetical offers of a specific good or service to be indicative of an offer for a broader set of similar goods and services. This is known as the embedding problem since the value of the good being sought is embedded in the value of the more encompassing set of goods or services reported by the respondent. This problem is indicative of an even broader problem with obtaining accurate answers. For a single individual the total amount they are WTP for improved environmental goods and services may be determined by the composition or components of the total set of environmental projects and policies to be funded. However, this information is unlikely to be obtained from the aggregation of values based on a set of CV studies designed to measure individuals' preferences for narrowly defined environmental goods. Kahneman and Knetsch [1992] provide recent empirical support of embedding in a study looking at WTP for maintaining the quality of fishing lakes. Individuals were instead thought to purchase moral satisfaction in their WTP responses. This study was criticised on the grounds of having a poor instrument design -- using telephone surveys, poor information -- a single sentence to describe the good, and problems with the actual question framing rather than the underlying theory, which resulted in embedding. Problems remain with embedding. Willis and Garrod [1991] set the problem in the context of the theory of two stage budgeting, where total income is firstly allocated to broad expenditure categories and then, secondly, subdivided within categories among specific items. Several mental accounts are thus set up each referring to a category. Thus in responding to questionnaires, individuals may not consider the limits to and other demands upon, their relevant mental account. This omission lies at the heart of the problem and is addressed by asking respondents to calculate total yearly budget for all environmental issues. Willis and Garrod [1991] test this for the Yorkshire Dales National Park and find no significant evidence of the problem. This is also supported by other similar studies. A variant of the problem is where WTP for a category group of goods is less than the sum of WTP responses regarding the specific good contents of that category i.e. where WTP is asked in the context of other goods then this amount may tend to be less than if asked in isolation of other goods. Empirical evidence is mixed. Some studies have extended this contextual problem and found an ordering effect such that the higher a good is up a list of goods to be valued, the higher the WTP response.

*Information Bias* -- the quality of information given in a hypothetical market scenario almost certainly

affects the responses received. Empirical evidence suggests only a weak information bias with some studies finding a threshold effect for information build up, below which no bias is detectable but above which a positive and weak effect is found. Other studies have found no significant information bias though bid variance was found to fall as information increased. A number of writers have argued that information will always affect WTP but that this result applies to all goods be they public or private.

*Aggregation Bias* -- there may be problems in aggregating individual valuation responses. Analysts will often wish to summarise respondents' answers to valuation questions in terms of the mean willingness-to-pay for the good or service, or, develop an aggregate benefit estimate for a community or region. Two types of problems here are sampling errors and insufficient sample size. Sampling errors include a non random sample being selected and used. This may result from non-responses to the questions. Non-responses are more likely to occur for certain types of individuals who are not randomly distributed in the population. If the size of the sample is small, there is a risk that the characteristics of the sample will not be representative of the general population thus resulting in findings which suffer wide confidence intervals. Furthermore, non normal WTP distributions can cause the sample mean to be biased by the major tail of the distribution, necessitating the use of truncated means as an aggregate measure of welfare.

Often, on-site surveys will ignore the non-use values held by non-visitors such that additional random sample off-site surveys will be needed to estimate non-use values. Empirical studies have found total non-use value is significant and can even exceed total use value.

*Interviewer and Respondent Bias* -- the way interviewers conduct themselves and the interview can influence responses. This can be minimised by using mail or telephone surveys though this can mean less information is forthcoming and give rise to hypothetical bias. Mail surveys further give low response rates. Another variant of this problem is compliance bias, whereby the respondent tries to guess the 'correct' answer or not give the questions proper considerations. To minimise this problem use of professional interviewers should be undertaken, and they should follow the wording of the questionnaire exactly, with the respondents being offered a choice of prepared responses.

*Payment Vehicle Bias* -- a number of studies have found that WTP varies depending on whether an income tax increase or an entrance fee is used as a payment vehicle (method of payment for the good). To minimise this bias, controversial payment vehicles should be avoided and a method used which is most likely to be used in real life to elicit payment for the good in question.

**Starting Points, Anchoring** and **Discrete Bid level Bias** -- The suggestion of an initial starting point in a bidding game can significantly influence the final bid, e.g. choosing a low (high) starting point leads to a low (high) mean WTP. The use of starting points can reduce the amount of non-responses and the variance in open-ended type questionnaires, though it may also result in respondents not giving their answer serious thought and taking a cognitive short cut in arriving at their decision. One solution to this problem is the use of what is called a "payment card" whereby the respondent selects a bid from a range shown on the card. However this can result in an "anchoring" of bids within the range of bids asked. Optimal bids should be set so that the lowest bid results in all respondents accepting it, and the highest bid results in all respondents rejecting it. Within this range, bid levels should reflect the distribution of bids so that, optimally, each bid interval reflects the same proportion of the population. A recent study by Bateman et al [1992], used a large sample open-ended format WTP question in order to estimate the distribution and range of WTP bids. A bid function was then estimated so that a probability of discrete bid acceptance curve could be mapped out. Eight WTP bid levels were subsequently chosen for a dichotomous choice experiment. The results were compared with an open-ended experiment and it was found that a dichotomous choice respondent was more likely to assent to the question 'are you WTP £x?' than an open-ended respondent is likely to state a WTP of £x or above. It was thought that several factors may have influenced this result including open- ended format studies are subject to free rider problems whereas dichotomous choice are not; dichotomous choice formats may be subject to interviewer bias and are more likely to exhibit anchoring bias thereby biasing upwards the mean WTP. To conclude, open-ended approaches are likely to provide a lower bound WTP estimate below which true WTP is unlikely to lie, while dichotomous choice approaches provide an upper bound WTP estimate above which true WTP is unlikely to lie.

2.3.2 Validity

There are three categories of validity testing used in CVM studies. These are Content, Criterion and Construct validity.

*Content Validity* -- this looks at whether the WTP measure estimated in a CV study accurately corresponds to the object being looked at (the composition). Such testing cannot be formalised resulting in analysts having to decide in a subjective manner whether a CVM has asked the correct questions

appropriately, and if the wtp measure is in fact what respondents would actually pay for a public good if a market existed. Five 'Reference Operating Conditions' have been proposed for enhancing the validity of CV studies by Cummings et al [1986]. It is thought that due to improvements in survey questionnaire design, content validity is not as great a problem as first thought.

*Criterion Validity* -- here the CVM estimates are compared with the 'true' value (the criterion) of the good in question. This is not feasible for many environmental goods (and is why CVM is carried out in the first place). However, experiments comparing hypothetical WTP sums from CVM with 'true' WTP as determined by simulated markets using real money payments have been carried out as mentioned in the earlier section on hypothetical bias. These find that in general WTP format CVM studies give valid estimates of true WTP, though this is not the case for WTA.

*Construct Validity* (including Convergent and Theoretical validity) -- theoretical validity tests whether the CVM measure conforms to theoretical expectations and convergent validity tests whether the CVM measure is closely correlated with measures of the good found using other valuation techniques.

Theoretical validity tests have centred on examining bid curve functions to see if they conform to theoretical expectations e.g. if elasticities are correctly signed and feasibly sized; tests on the significance of explanatory variables (by looking at simple 't' statistic tests, and the explanatory power of bid functions).

Convergent validity compares CVM measures with revealed preference techniques such as Travel Cost and Hedonic Pricing (see later). However, the methods compared are usually measuring different theoretical constructs e.g., CVM measures use and non-use values whereas Travel Cost only measures use values. Furthermore, CVM provides ex-ante measures of WTP whilst hedonic pricing and travel cost estimates are from ex-post contexts. As such the usefulness of convergent validity testing is not as great as at first thought.

### 2.3.3 Analysis of WTP Responses

There are three ways in which CVM information is typically analyzed.

First, analysts examine the frequency distribution of the responses to the valuation questions.

Second, cross tabulations between WTP and socioeconomic variables, etc, are looked at.

Third, multivariate statistical techniques are used to estimate a valuation function that relates the respondent's answer to the socioeconomic character-

istics of the respondent.

These analyses are used to see if respondents answers are consistent with theory and to establish statistical relationships that can be used in the aggregation of sample responses to the overall population under study. Before the analyses can be undertaken, the data must be 'cleaned' by removing 'protest responses' of individuals who reject the hypothetical scenario and refuse to give meaningful answers. This can be done by setting an upper limit on how much a respondents bid could be above the mean bid of the sample, or, seeing if respondents bidding very high or low have the socioeconomic characteristics that one would expect to be associated with such a response. Obviously such judgements are subjective and require careful consideration of field conditions, the questionnaire, and analysis of the data.

*Analysis of frequency distributions of WTP responses* -- answers to open ended valuation questions yield a set of point estimates of WTP. Statistics such as the mean, median, and frequency distributions can be found for data sets of point estimates of WTP. Data such as mean estimates of WTP can provide estimates of total value of the good or service, or, the frequency distribution can be used to estimate the percent of the population that would choose to purchase the good if it were offered at a specific price. Answers for dichotomous choice questions can be summarised in a way that provides similar information to the frequency distribution of point estimates described above. The percentage of respondents that agreed to pay each specified price can be found and then the relationship between these percentages and the price of the good can be graphed.

*Cross tabulations of WTP responses with socioeconomic characteristics of the respondent and attitudes towards the environment* -- when point estimates of WTP are available for respondents, the analyst can calculate the mean WTP bid for different groups of respondents, so as to address the question of who is willing to pay the most for the good and why. If these cross tabulations of WTP bids and socioeconomic or attitudinal information reveal the effects one would expect from demand theory then the analyst has greater confidence in the quality of the data and greater insight into the factors that determine an individual's WTP. Cross tabulations for dichotomous choice questions are also possible but require large sample sizes since there may otherwise not be enough independent observations or degrees of freedom to carry out tests of differences between groups that have much statistical power.

*Multivariate analyses of the determinants of WTP responses* -- here the approach is to estimate a

valuation function that relates the hypothesized determinants with the WTP responses. The determinants typically used include socioeconomic and demographic characteristics of the household and prices and availability of substitute goods and services. Open-ended questions will give a continuous measure of WTP for the good or service such that Ordinary Least Squares (OLS) models can be used to explain the variations in the dependent variable. OLS requires of course that the determinants of the WTP responses be exogenous in order for the parameter estimates to be unbiased and consistent. It is thought that if $R^2$ values for valuation functions fall below 0.15 then the credibility of the values should be called into question. For dichotomous choice questions the responses are discrete and so OLS is unsuitable for estimation of the valuation function. Instead a variety of discrete choice models are available to explain the probability that a respondent will give a yes response to the valuation question. Again, the same kind of independent variables as above are used to explain the respondents answers. Either a logit or a probit model can be used. Such discrete choice models can be used to derive estimates of the economic value of the good and also of the relationship between the percentage of respondents agreeing to pay and the price offered whilst controlling for socioeconomic characteristics of the respondents and other factors.

### 2.3.4 Conclusion on CVM

It is important to get accurate, reliable answers to CV questions. In a report to the US NOAA committee, Arrow et al [1992] have offered a set of guidelines that they believe CV researches should follow in order to ensure that CV studies provide accurate, reliable information (see Annex). The best prospects for use of CVM is in attempting to find WTP for an environmental gain and when familiar goods are being looked at such as local recreational amenities. WTP and WTA for environmental losses are more problematic. Finally, it should be remembered that CVM is the only technique with the potential for measurement of existence value.

## 2.5 The Indirect Valuation Approach

Indirect approaches are those techniques which seek to elicit preferences from actual, observed market based information. Preferences for the environmental good are revealed indirectly, when an individual purchases a marketed good with which the environmental good is related to in some way. The techniques included here are, Hedonic Price and Wage techniques, the Travel Cost method, Avertive Behaviour, Dose-Response and Replacement Cost techniques. They are all Indirect because they do not rely on people's direct answers to questions about how much they would be willing-to-pay

(or accept) for an environmental quality change. The Indirect group of techniques can be divided into two categories. These are: surrogate market approaches and conventional market approaches.

### 2.5.1 Surrogate Markets

Surrogate market techniques involve looking at markets for private goods and services which are related to the environmental commodities of concern. The goods or services bought and sold in these surrogate markets will often have as complements (or attributes) and substitutes the environmental commodities in question. Individuals reveal their preferences for both the private marketed good and the environmental good when purchasing the private good. They leave what is called a "behavioral trail" as they make actual decisions that affect their lives. These techniques are therefore sometimes preferred by policy makers because they rely on actual choices rather than the hypothetical choices involved in the Direct approaches. Surrogate market approaches include Hedonic techniques and Household Production Function techniques. As we shall see, the difference between the two is basically to do with different assumptions about consumer choices, and whether prices are fixed or not.

### (a) Household Production Functions

The Household Production Function (HPF) approach places values on environmental resources by specifying some familiar structural relations (restrictions) between the environmental services of interest and other private goods. The approach argues that the environmental resource and private goods are demanded as intermediaries in a household's production process, together with time, to produce service flows. The approach describes how goods and services are used and so enables us to see how the environment affects the service flows. In a household production function, the environment enters the individual's behavioural/preference function through the restrictions of perfect substitutability and weak complementarity (see Freeman [1979] for explanations of these). The values of the environmental resource are found by looking at changes in the expenditure on goods that are substitutes or complements to the environmental resource.

Perfect substitutability is the basis of the *Averting Behaviour technique*, which looks at how averting inputs substitute for changes in the environmental good of concern. Examples here include: looking at expenditures on improved ventilation in order to reduce the exposure to radon in houses; valuing the costs of siltation from upstream erosion by looking at the expenses that farmers incur when installing protection structures; valuing health hazards from

river water by looking at WTP for bottled water, filtration devices and private well installation.

To undertake such an estimation, data on the environmental change and its associated substitution effects is required. Fairly crude approximations can be found simply by looking at the change in expenditure on the substitute good arising as a result of some change in the environmental commodity of interest. Alternatively, if the marginal rate of substitution between the environmental commodity and the private good, which can be found from known or observed technical consumption data, is multiplied by the price of the substitute, then the value per unit change of the environmental good can be found.

In order to apply this approach the averting behaviour must be between two perfect substitutes otherwise an underestimation of the benefits of the environmental good will occur. Averting behaviours are never likely to involve perfect substitutes and even when they do, bias in the estimation of benefits can still occur. For example, if there is an increase in environmental quality, the benefit of this change is given by the reduction in spending on the substitute market good required to keep the individual on their original level of welfare. However, when the quality change takes place the individual will not reduce spending so as to stay on the original welfare level. There will have been an income effect as well as a substitution effect between environmental quality and the substitute good. Expenditure will therefore be reallocated among all goods with a positive income elasticity of demand and so the reduction in spending on the substitute for environmental quality will not capture all of the benefits of the increase in quality. Further problems with the approach include the fact that individuals may undertake more than one form of averting behaviour to any one environmental change, and, that the averting behaviour may prevent the adverse effects of reducing the environmental good but may also have other beneficial effects which are not considered explicitly, e.g., sound insulation may also reduce heat loss from a home. Furthermore, averting behaviour is often not a continuous decision but rather a discrete one -- a smoke alarm is either purchased or not, etc. In this case the technique will again give an underestimate of benefits unless discrete choice models for averting behaviour are used.

So, simple avertive behaviour models although having relatively modest data requirements can give incorrect estimates if they fail to incorporate the technical and behavioural alternatives to individuals responses to quality changes.

Although the technique has rarely been used, it is a potentially important source of valuation estimates since it gives theoretically correct estimates which are gained from actual expenditures and thus have high criterion validity.

Weak complementarity is the basis on which the *Travel Cost approach* works. The approach has been widely used to measure the demand and benefits of recreation site facilities and characteristics. Travel is used to infer the demand for recreation by virtue of the fact that it is a weak complement to recreation, i.e. when the quality of the recreation site changes, we look at how expenditures on the marketable complement, travel, change. The Travel Cost method estimates the demand function for recreational facilities and finds how visitation to a site changes -- how the demand curve will shift -- if an environmental resource in the area changes.

Information on money and time spent by people in getting to a site is used to estimate willingness-to-pay for a site's facilities or characteristics. The problem here is that recreation sites charge a zero or negligible price which means that it is not possible to estimate demand in the usual way. However, by looking at how different people respond to differences in money travel cost (including transport, admission and the value of time, etc.) we can infer how they respond to changes in entry price, since one acts as a surrogate price for the other and variation in these prices results in variation in consumption.

The Travel Cost demand function is interpreted as the derived demand for a site's services and depends on the ability of a site to provide the recreation activity. Only Use Values are therefore considered, with Existence and Option values being ignored. Since the recreation activity takes place at specific sites that have observable characteristics and measurable travel costs then recreational service flows are described as site specific. The approach can therefore provide us with estimates of the value of the site itself and, by observing how visitation rates to a site change as the environmental quality of the site changes, provide us with values for environmental quality itself.

The travel cost approach makes the central assumption that visit costs can be taken as an indication of recreational value. However, if individuals have changed their place of residency so as to be close to a site then the price of a trip becomes endogenous and the central assumption is violated. The estimated demand curve will lie below the true demand curve and so consumer surplus will be underestimated. A similar challenge to the central assumption also arises in cases where the on-site time is not the only objective of the trip, e.g. where multi-purpose trips are made.

Data Requirements

The data requirements of the approach are fairly substantial. A survey must be carried out to establish the number of visitors to a site, their place of origin, socioeconomic characteristics, the duration of the journey and time spent at the site, direct travel expenses, values placed on time by the respondent (see later), purpose of the visit other than visiting the site (multi-purpose visits raise problems for the technique), and a whole range of environmental quality attributes for the site and substitute sites (see the earlier discussion on environmental quality measures). All of this data collection is expensive and time consuming to carry out.

The socioeconomic characteristics will include things like income, age, a measure of education, sex, race, and perhaps some measure of the subjective strength of preference for the particular type of recreation being offered.

Time Costs

Since the cost of visiting a site consists of the transportation costs plus the costs of the time taken to get to the site and the time spent at the site, the role of time is critical to the estimation of travel costs. Time costs are included because time has an opportunity cost, for example, one could work instead. We need to know what elements of time are to be included in the travel costs, what money values to use for these time costs, and how their inclusion will affect the demand and benefit estimates.

If time costs are ignored then benefits and demand will be biased, since for example, two visitors to a site may have had to travel different distances to the site whilst having equal money travel costs but requiring substantially different times to get to the site. Unless time costs are included, visitation rates may appear to be equal for the two zones and willingness-to-pay for the site will be equal. The effects of both time costs and money travel costs on visitation rates therefore need to be estimated separately, but since the two may be highly correlated asking separate estimation difficult, time costs are given a money value using some shadow price of time and lumped together with the transportation costs. Time at the site should also be included in travel costs because it may not be independent of the distance travelled. The shadow price of time at the site and time getting to the site may, however, be different. Any difference will be due to individuals deriving pleasure from the journey to the site, e.g., by taking a scenic route. If no pleasure or displeasure is forthcoming then the shadow prices are the same.

The marginal wage rate is often used as an appropriate shadow price of time, since this reflects the opportunity cost of time between working and not working. However this trade-off may be distorted by institutional constraints such as maximum working hours, taxation etc; or, using the wage rate may be inappropriate for certain groups such as the unemployed. Previous empirical work has suggested that the shadow price of time may be substantially less than the wage rate and lie somewhere between 1/4 and 1/2 of the wage rate with a value of 1/3 of the wage rate being appropriate (Cesario [1976]). Some studies determine the proportion of the wage rate to use within the estimation procedure, e.g. Common [1973], McConnell and Strand [1981].

Exclusion of time costs in general, will result in a more elastic (flatter) demand curve and bias the benefit estimates downwards. Exclusion of on-site time costs, if they are not independent of distance travelled and vary inversely with it, will result in a less elastic demand curve and an overestimate of benefits.

Specification and Estimation Issues

A trip generating function estimating the number of visits to a site as a function of travel costs and the socioeconomic variables is the first step in specifying a demand relationship. Specification of the functional form is crucial to the benefit estimates obtained. Standard statistical techniques will in general not be able to discriminate in favour of one specification or another. In practice the choice of functional form needs to be determined empirically on an individual study basis. However, a number of studies have found that the visitation rate equation is best estimated using a semi-log form i.e., the logarithm of the number of visits to the site is regressed against travel cost, etc. Generally, it has been found that log-linear and semi-log specifications increase valuations relative to results found using a semi-log for the explanatory variables (Smith and Kaoru [1990]).

The second stage in specifying the demand relationship involves explaining the variation in visitation rates across sites according to site characteristics. One procedure for doing this is to use the two stage Varying Parameter Model of Smith and Desvousges [1986]. Here, a trip generating function is estimated separately for each site, without including any environmental quality variables as above. The second stage is then to explain the difference in the coefficients on the travel cost terms by regressing them on the environmental quality variables. The coefficient on the quality variable then shows how the demand curve shifts as quality of the site changes and thus can be used to estimate the benefits of a change. Using this second stage procedure also reduces the risk of multicollinearity problems especially where sites possess multiple environmental attributes which may be highly correlated. Inclusion of such attributes as separate variables in

a single stage estimation will lead to multicollinearity.

There are a number of major statistical estimation problems with the travel cost approach.

Firstly, misspecification of the functional form can lead to biased parameter estimates.

Secondly, the number of visits to a site can only be a non-negative variable such that continuous estimation techniques such as OLS are inappropriate. Discrete choice models of behaviour such as the multinomial logit model should therefore be used. This looks at the probability that a particular site will be visited, depending on the attributes of that site and other sites, and on the households' characteristics. Since individuals will make no visits to some of the sites then there will be some zero values for the visitation rate variable. Using OLS therefore implies that a change in the quality of a site will have an effect on visitation rates, even if the site is not visited. Clearly this is incorrect and so the logit model is used instead. In this, the benefit per visit of an improvement in site quality can be estimated from the logit equation if a measure of travel cost is included. An increase in quality will increase the probability of visiting a site. The benefit per visit is then found by calculating the compensating increase in travel cost that would leave the probability of visiting the site unchanged. This requires total differentiation of the logit equation. Use of such models also removes the problem of substitute sites, where individuals are faced with the choice of many sites at various distances and with different quality characteristics. Exclusion of the impact of substitute sites on demand will lead to biased estimates.

Thirdly, in any data set we will have information on people who actually have visited the site, but not on non-participants. Non-users need to be included to see what determines participation. This problem is known as Truncation Bias and has been found to have a significant impact on parameter estimates such that the estimated demand curve is flatter than the true one. One suggestion has been to use Maximum Likelihood estimation instead of OLS in order to counter this problem. However the evidence here is mixed (see Smith and Desvousges [1986], Kling [1987,1988] and Smith [1988]). If there are systematic influences on the participation decision then a sample selection problem exists.

In conclusion, we can say the Travel Cost approach is an important method of evaluating the demand for recreational facilities. The techniques used have improved considerably since the earliest studies were carried out both from an empirical and theoretical point of view. There are reservations as to its use, particularly concerning the large amounts of data required which is expensive to collect and process. Furthermore difficulties remain with the estimation and data analysis techniques and so the method is likely to work best when applied to the valuation of a single site, its characteristics and those of other sites remaining constant.

(b) Hedonic Pricing

The Hedonic approach is in fact similar to the Household Production Function approach since both require the weak complementarity assumption. The Hedonic approach differs in that it operates through private good price changes rather than private good quantity changes.

The Hedonic Pricing approach looks at markets in some private good for which the environmental good of concern is again a weak complement (or attribute), in order to infer individuals' preferences for environmental quality. An example of this is the property market, in which one of the attributes of housing influencing an individual's decision to buy or sell, is the level of environmental quality, e.g. air pollution in the surrounding neighbourhood. Another example is in the labour market where the job attribute 'risk of death or injury', is traded against 'price' or the wage.

Given that different locations of property will have different levels of environmental attributes and that these attributes affect the stream of benefits from the property, then the variation in attributes will result in differences in property values (since property values are related to the stream of benefits). The Hedonic price approach looks for any systematic differences in property values between locations and tries to separate out the effect of environmental quality on these values. Consequently, the implicit prices found for environmental quality must be related to consumers' tastes and preferences in order to find the attributes demand function (since the implicit price of the attributes reflect the forces of supply and demand).

To find the demand function relating the quantity of the environmental attribute to individuals WTP it is necessary to first define the market commodity (e.g. housing) and the environmental attribute of the market commodity (e.g. air quality). A functional relationship is then specified between the market price and all the relevant attributes of the market commodity. This is called a Hedonic Price function. The hedonic price function is then estimated using multiple regression techniques from data on property values and the associated attributes of the property. We are thus able to find the hedonic price function coefficient on the attribute of interest (air quality) and this coefficient is known as the marginal implicit price of the attribute. It gives the additional amount of money that must be paid by an

individual to buy an identical market good but with a higher level of the environmental attribute. What we are trying to identify is the slope of the curve AB in the diagram below which shows the relationship between the level of air quality and the price of the property.

The curve AB in the diagram represents the result of a market equilibrium in which individuals buy property at some level of air quality and suppliers (owners or property developers) sell property with various air quality levels. The pollution level axis shows increasing levels of air quality. Individuals will buy property at some level of air quality according to their bid curves and suppliers supply property with this air quality level according to their offer curves, with points of tangency between the bid and offer curves giving equilibrium points on the hedonic price curve.

In benefit estimation we are interested in individuals' willingness-to-pay for better air quality. How does this relate to the previous diagram. Well, say the level of air quality changes from $q_1$ to $q_2$, then individuals' willingness-to-pay for this change is given by the distance ab in the diagram. However, the estimated hedonic price function would tell us that the willingness-to-pay for the change would be the distance ad, and so gives an overestimate of the benefits of the change. To correct for this bias and so estimate the true inverse demand (willingness-to-pay) curve, a second stage to the procedure is used. This second stage of the analysis requires certain assumptions regarding the supply side of the market good in order to estimate the willingness-to-pay curve. This usually takes the form of a fixed supply assumption. A further statistical regression in which the marginal implicit price of air quality is regressed against the socioeconomic characteristics of individuals (including income) is undertaken to estimate the bid function.

This second stage of the analysis is not always necessary. Freeman [1979] shows that if all individuals are identical in all respects such as income, preferences, etc, then the implicit price function over the range of air quality (the slope of the hedonic price function over the air quality range) will give the inverse demand function since the implicit price function shows the locus of points on individuals' inverse demand curves which will all coincide since individuals have the same preferences, income, etc. Although this assumption allows easy benefit estimation from just the hedonic price function it is obviously a fairly unrealistic case.

Alternatively we can make various assumptions regarding the shape of the inverse demand curve in order to estimate the benefits of the quality change. These are considered highly questionable and so we do not consider them further here.

Data Requirements

The data requirements of the approach are substantial. Data from a wide range of different properties is required with information on all features that influence the properties' value such as structural characteristics (number of rooms, size, etc), neighbourhood characteristics ('prestige', closeness to business and amenity areas, etc), and environmental

characteristics (air quality, noise levels, etc), as on the property values themselves. In practice, cross sectional data tends to be used. This removes problems regarding changes in the economic wellbeing of an area which will tend to arise if time series data is used. Socioeconomic data on individuals (such as income, age, education, etc) is also required if the second stage estimation procedure is carried out. Sufficient data of the variety to enable reliable estimation may be difficult to come by, especially in areas and countries containing a large amount of public sector housing. The data on property values should come from actual market data but since only a small percentage of the total owner-occupied housing stock may be sold per year, then collection of a large enough sample of data may be difficult. Care must be taken to account for the effects of property taxation on property values otherwise their use will result in an overestimation of benefits. A further problem is that property prices may be influenced by expected future changes in the property and so the characteristics at the time of a sale may not adequately explain the selling price. Rental price data could be used to overcome this and is in any case the theoretically correct measure to use. However the rental market may be even less perfect than the property market in some countries. As an alternative Real Estate agent valuations could be used.

A major problem with hedonic price studies is that of multicollinearity -- the fact that many of the explanatory variables will be related to one another, e.g., sulphates and particulate measures will be collinear. This will result in difficulty determining which factor is determining movements in house prices. There are a number of ways to overcome multicollinearity. These include separating out the individual effects using statistical tests proposed by Klepper and Leamer [1984], or, formulating all data concerning individual pollutants into one proxy measure. Care must also be taken not to omit important explanatory variables as this will again bias the coefficient estimates.

Turning now to the data on environmental quality attributes we need to know which pollutants are of interest and whether or not measures exist for them. Threshold levels may mean difficulty in measurement, or that pollution effects take a long time to show up. Temporal variations in concentrations may mean that it is best to use annual averages. We also face the same problems regarding objective and subjective measures of quality as we did for the Travel cost approach. Subjective measures are what people's behaviour is based on and so are important for benefit estimation. Objective measures however are more extensively monitored for many pollutants. Will these objective measures coincide with people's perceptions? For measures such as sus-

pended particulates which are readily perceptible and their effects apparent in terms of visibility, etc, there should be no problems. Sulphate pollution level measures are also thought to coincide with perceptions. When a single pollution variable is used, problems may arise with the pollution coefficient which may include the effects of omitted but collinear pollution variables.

Choice of Functional Form

The choice of functional form will have a significant impact on benefit estimates even if statistical tests find all the choices of form acceptable. In order for a preference to be made between functional forms, two questions should be asked about what properties the hedonic price function should possess. These are, whether the marginal implicit price of pollution is independent of the levels of the other attributes of housing and, whether the marginal implicit price depends on the pollution level itself and if so how? With regards to the first question only the Log, and Box-Cox forms impose dependence on the levels of other attributes. The second question relates to the slope of the implicit price function and whether this is linear or not. In practice it is found that non-linear functional forms give better fits for the data, especially the log and semi-log variety. However, some studies use the Box-Cox transformation which allows the data to determine the precise form. Whichever functional form is used, care must be taken when transforming the estimated coefficients back to their original form (e.g., from log back to antilog) since biases can result.

Other Issues

The whole approach relies on the assumptions of a fixed supply of housing and a freely functioning and efficient property market. Individuals have perfect information and mobility such that they can buy the exact property and associated characteristics that they desire and so reveal their demand for environmental quality. In reality the housing market is unlikely to be so. As was mentioned earlier a large part of the housing stock may be in the public sector and so allocated subject to price controls. Furthermore, market segmentation may exist whereby mobility between housing areas is restricted. To get around this problem separate hedonic price functions should be estimated for each segmented area. Mäler [1977] has criticised the fact that the technique implicitly assumes that households continually re-evaluate their choice of location.

Another problem with the approach is that hedonic price includes the consumer valuation of not only present day benefits but also the stream of expected future (discounted) benefits from environmental

quality, and as such will tend to overstate WTP.

Finally, the possibility that mitigating or averting behaviour by individuals may take place to avoid the effects of pollution, such as installing pollution filters, needs to be looked at (see the earlier section on averting behaviour). If this behaviour is unrelated to the characteristics of the property then it will reduce the value of the property and need not be measured separately. If changes do occur to the property then the value of the property will increase and so such changes need to be included in the hedonic equation.

To conclude, the hedonic approach is founded upon a sound theoretical base and is capable of producing valid estimates of benefits so long as individuals perceive environmental changes.

The weak complementarity and perfect substitutability assumptions on which the hedonic and household production function approaches are based are the reason why only use values can be measured by either of the two approaches -- this is because values that do not entail direct consumption cannot be estimated by looking at complements or substitutes.

A further problem with surrogate techniques is that they cannot estimate the value of a new good or service, or of a change in environmental quality outside of current experience, since no situations exist where people have been offered the new level of environmental quality and have revealed their preferences for it.

2.5.2 Conventional Market Approaches

Conventional market approaches are used in situations where the output of a good or service is measurable. These approaches use market prices (which may be adjusted by shadow pricing if market prices do not accurately reflect scarcity), or revealed/inferred prices (if no markets exist) to value environmental 'damage'. Where the damage shows up in changes in the quantity or price of marketed inputs or outputs, the value of the change can be measured by changes in the total 'consumers plus producers surplus'.

Two techniques may be distinguished: the dose-response technique and the replacement cost approach.

(a) The Dose-Response Technique -- this aims to establish a relationship between environmental damage (Response) and some cause of the damage such as pollution (Dose), such that a given level of pollution is associated with a change in output which is then valued at market, revealed/inferred, or shadow prices.

Where individuals are unaware of the impact on utility of a change in environmental quality then

direct WTP/WTA is an inappropriate measure and so dose-response procedures which do not rely on individuals preferences can be used.

The technique is used extensively where dose-response relationships between some cause of damage such as pollution, and output/impacts are known. For example, it has been used to look at the effect of pollution on health, physical depreciation of material assets such as metal and buildings, aquatic ecosystems, vegetation and soil erosion. The approach is mainly applicable to environmental changes that have impacts on marketable goods and so it is unsuitable for valuing non-use benefits.

Damage actually done is found using a 'dose-response function' which relates physical/biological changes in the ambient environment to the level of the cause of the change. The dose-response function is then multiplied by the unit 'price' or value per unit of physical damage to give a 'monetary damage function'.

The Dose-Response approach in its most basic form looks at environmental resources which lead to a marginal change in the output of a good sold on a competitive market and values the impact directly in terms of output changes valued at market prices. More formally, suppose the production function for a single output y is given by:

$$y = F(X, Z)$$

where X is a set of inputs and Z is the input of the unpriced environmental resource. Assume that we can measure the output y and that this output is sold on a market at price s. The price of inputs X is given by the price vector P. Now, if prices are not expected to change when supply of the environmental resource changes, then the economic value of the change in the supply of the resource is the value of the production change accompanying the change in resource availability at constant inputs of the other factors.

If the change in resource supply is large, but leaves prices unchanged, then the value of the resource supply change must be measured as the difference between the profit after the change and before the change, taking all changes in factor use into consideration. If, on the other hand, output price does change, then there is still a change in profit (or producer's surplus), but now there will be an effect on consumer's surplus due to the price change.

So, if prices change, the new price level needs to be predicted. Such prediction of market responses is complicated. Individuals will often change their behaviour and take action to protect themselves against any effects (averting behaviour), for example, by switching to crop varieties whose yields are resistant to a particular form of air pollution in the region, or they may alter the use of other inputs

such as calcium carbonate which mitigates the pollution impact. Also corrosion of materials can be countered by painting the material, switching to substitute materials which are corrosion resistant, or simply replacing the materials more often. Such behaviour implies expenditures which can be used as a measure of willingness-to-pay. Dose-response estimates may need to be linked to a behavioural model of the demand for the products that are affected otherwise biases will result. The changes in profits and welfare that accompany these behavioural responses are indications of their effects on the welfare of producers and consumers. Changes in producer behaviour at different levels of air quality are modelled with the assumption that the producer is a maximiser of expected profits, taking the prices of all inputs and outputs as given. The supply curves for each of the varieties of crops produced in a region can then be derived, given the production technology and the yield response relationship. Supply curves have been estimated on the assumption of profit maximisation and appear to fit well with the actual data. The supply relationships specify the amount that will be supplied of each crop as a function of the prices of all the crops, the prices of the variable inputs, the quantities of the fixed inputs, and the level of air pollution. Hence, if the pollution levels were to fall, the supply of products that were adversely affected by that pollution would be expected to increase and the output of those products whose yields were pollution resistant to decrease. The impact of these supply changes on the prices of the commodities will depend on the market structure that is prevalent. If prices are market determined, they will adjust to bring supply and demand into balance, and the magnitude of the price change will depend upon how many producers are affected by the pollution and how responsive supply and demand are to price changes. If on the other hand, the prices are administratively set, then there is no direct price effect to consider. However, the prices of related commodities that are market determined may be affected.

In order to assess the impact of a change, a model of the markets for the products affected is required, in which specific account is taken of the yield response relationship on the supply side and of the impact of prices on the demand side. Given such a model one can calculate the pre- and post-pollution change prices and quantities for each commodity. The change in the sum of the consumer surpluses plus the change in the profits of the producers, less any increase in government subsidies, is then regarded as an approximation to the economic benefits of the change in pollution levels. Modelling such an interrelated system of markets is an open-ended activity and can be extremely sophisticated or fairly simple. The simpler models can provide

useful estimates provided their shortcomings are recognized.

Furthermore, other price distortions can mean that the use of actual prices gives a misleading picture (for example, where monopoly, price controls or protection exist). Prices should therefore be adjusted to market clearing/competitive levels by shadow pricing.

The specification of the dose-response relationship is crucial to the accuracy of the approach. The pollutant responsible for the damage needs to be identified as well as all possible variables affected. Large quantities of data may thus be required. Often there may be subtle but significant forms of damage e.g., in vegetation studies the dose-response functions will typically relate pollution levels to physical deterioration such as leaf drop or discolouring. However, effects such as reduced plant vigour, lower rates and less resilience to pests may arise. If there is a problem with measuring some of these variables and/or difficulty getting consistent data for them, then other measurable factors which attempt to account for the unmeasurable factors can be used. Often the relationship between a pollutant and effect is not well established. Some effects will be easier to quantify than others and forging links between cause and effect may require making assumptions and transferring data on relationships and sources established elsewhere. Again the discussion on omission of explanatory variables, mentioned for the other valuation techniques, is relevant here, as are the problems of multicollinearity.

There is a further difficulty with isolating the effects of one cause from that of others in determining the impact on a receptor (e.g., Synergistic effects where several pollutants or sources exist), and also isolating other factors such as climate which may vary by area. There is the problem of determining the marginal impact of man-made pollution when both man-made and natural sources combine towards ambient pollution levels. Attributing all damage to man-made sources may overstate the situation and, even if the proportion of emissions attributable to man are known, damage estimates may still be difficult to find if the dose-response function or monetary damage function is non-linear.

Identification of damage threshold levels may be important in the specification of the dose-response relationship as shown in Figure 2. The long term effects of low to medium levels of pollution may be unidentifiable, especially in the case of ecosystem behaviour. Discontinuities in the dose-response function may also exist. All these problems result in difficulty in the empirical specification of the functional form. More research is necessary to over-

come the problems of technical relationship speci-
fication

Figure 2 Damage Thresholds

## Marginal Damages versus Total or Average Damage

In order to be of use in a policy making context, marginal damage valuations are needed. Dose-response relationships are likely to be non-linear with damage rising proportionately more as pollution increases. Even if physical damage increases proportionately, monetary valuation per unit damage may still be non-linear. Valuations based on average physical damage and average valuations will underestimate damage values at high pollution levels and overestimate them at low levels. Damages from each incremental unit of ambient pollution concentration need to be found and linked to changes in pollutant emissions such that we have marginal damages per unit of emissions.

## Unit Values of Monetary Damage

We are still left with the problem of moving from a physical to a monetary damage function. Usually the current market clearing price is used as the unit value of monetary damage. Since dose-response functions are defined in per unit terms then knowledge of the actual quantity of material exposed to pollution is required. This problem is compounded by the trouble mentioned earlier, which was that valuing marketable goods involves taking account of the impact of supply changes caused by pollution on price, and whether or not producers' responses, production methods and costs are affected. If they

are, then any appraisal not taking this into account will overestimate the value of effects. If, on the other hand, an appraisal is carried out after adaptive responses have taken place, then the impact on producer and consumer surplus will be underestimated. Allowance must also be made for distortions in the price level due to market interventions and imperfections.

Non-marketed goods require the use of values from close marketed substitutes or, for subsistence production "border prices" can be used. Revealed/stated preference study estimates are used when other values are not available.

To conclude, the Dose-Response approach is a technique that can be used where the physical and ecological relationships between pollution and output or impact are known. The approach cannot estimate non-use values. The approach is theoretically sound, with any uncertainty residing mainly in the errors of the dose-response relationship, e.g., are there threshold levels before damage occurs, or discontinuities in the dose damage function. It is necessary to allow for the fact that the behaviour of individuals may change in response to changes in the environment. If this is not possible, but the direction of any bias resulting is known then this should be stated. The approach may be costly to undertake if large databases need to be manipulated in order to establish the relationships. If the dose-response functions already exist though, the method

can be very inexpensive, with low time demands, and yet it can provide reasonable first approximations to the true economic value measures.

(b) The Replacement Cost Technique

This technique looks at the cost of replacing or restoring a damaged asset to its original state and uses this cost as a measure of the benefit of restoration. The approach is widely used because it is easy to find estimates of such costs.

The approach is correct where it is possible to argue that the remedial work must take place because of some other constraint such as a water quality standard. Under such a situation the costs of achieving that standard are a proxy for the benefits of reaching the standard, since society can be assumed as having sanctioned the cost by setting the standard. However, if the remedial cost is a measure of damage then the cost-benefit ratio of undertaking the remedial work will always be unitary. That is to say remedial costs are being used to measure remedial benefits. To say that the remedial work must be done implies that benefits exceed costs. Costs are then a lower bound of the true value of benefits.

Information on replacement costs can be obtained from direct observation of actual spending on restoring damaged assets or from professional estimates of what it costs to restore the asset. It is assumed that the asset can be fully restored back to its original state. However, some damage may not be fully perceived, or may arise in the long term, or may not be fully restorable. Benefits will therefore be underestimated. Another problem here is that restoration of damaged assets may have secondary benefits in addition to the benefits of restoration such that replacement costs will underestimate total benefits.

Choice of Valuation Technique

All of the valuation techniques outlined have strengths and weaknesses as we have seen, and the decision on which valuation technique to use for a particular application requires experience and judgement on the part of an analyst. There are, however, some general points to consider when making a choice.

First, the technique should be technically acceptable with respect to its validity and reliability (see the section on the Contingent Valuation Method). Measures obtained from the technique should be consistent and accurate. Methods suffering random errors require reliability checks to judge their predictive capacity. Methods suffering non-random error contain bias problems, thereby reducing reliability and the validity of the measurement results. Validity cannot be assessed solely on the basis of technique methodology but must be considered alongside practical predictive ability.

Reliability problems will occur if the sample size of the data is too small or a survey design is deficient. Reliability is closely related to bias which can vary depending on the good being looked at.

The Hedonic Pricing and Travel Cost approaches have weak validity since they assume the underlying theory is correct in order to generate results, whereas CVM can build in tests for reliability and validity. A more psychological approach can to be taken with CVM, with direct psychometric testing of the validity and reliability.

Second, the technique should be institutionally acceptable such that it fits into current decision making processes. There are differing views as to the acceptability of monetizing the environment.

Third, it is important to consider the needs of the user(s) of valuation studies who may prefer the use of one valuation technique over another. For example, estimates obtained from travel cost or hedonic property value models may be considered too theoretical or too complex. On the other hand it may be felt that contingent valuation estimates are too subjective and unreliable to support policy debate and discussion. The analyst carrying out policy work must be sensitive to such concerns. The technique should also be user friendly in terms of how easy or difficult it is to use in practice.

Fourthly, the financial cost of the study needs to be weighed against the value of the information gained.

Finally, it should be remembered that it will often be possible to use more than one valuation technique and compare the results. The estimates of value obtained from all the methods described will be somewhat uncertain. If the analyst has multiple estimates, then they will have greater confidence in the magnitude of the value of the proposed change. Several of the valuation techniques typically use data from a household survey (e.g., contingent valuation, travel cost model, and hedonic property value model). When the implementation of a valuation technique requires that primary data be collected with a household survey, it is often possible to design the survey to obtain the data necessary to undertake more than one valuation method.

## 2.6 Benefits Transfer

It is not always necessary to initiate a new study in a project area to determine how the wellbeing of individuals is potentially affected by some environmental change. An alternative is to obtain an estimate of the economic value of the economic consequences of a similar change which has occurred in a different location and then to assume that this existing estimate of economic value can be used as an approximation of the economic value of the change in the area of concern.

Suppose that a development project would result in the destruction of a certain number of hectares of wetlands, and an analyst wished to estimate the economic value of the environmental losses associated with this proposed project. Rather than attempt to undertake a new study at the site of the proposed development, the analyst could identify previous studies that had estimated the economic value of wetlands, and then assume that the loss of a hectare of wetland at the proposed development site would be the same as (or similar to) this previous estimate. Such an approach has been termed "benefit transfer" because the estimates of economic benefits are "transferred" from a site where a study has already been done to the site of policy interest. The benefits transferred from the study site could have been measured using either the direct or indirect valuation techniques outlined above.

More formally, suppose the willingness-to-pay (compensating variation) of household i for a change from an initial environmental quality $Q_0$ to an improved environmental quality $Q_1$ is given by:

$$WTPi = f (Q_1 - Q_0, P_{own,i}, P_{sub,i}, SE_i) \quad ...................(1)$$

where

$P_{own}$ price of using the environmental resource ("own price")

$P_{sub}$ price of substitutes for use of the environmental resource

$S_i$ socioeconomic characteristics of household i

Benefit transfer requires three steps. First, we must find (1) a study where this demand relationship has been estimated for an existing site, and (2) values for $Q_1$, $P_{own}$, $P_{sub}$, and S at the new site that we wish to value. The second step is to determine the geographic area over which households will benefit from the change in environmental quality. Third, we must substitute the values of the independent variables for the households at the new site that is being valued into (1) to calculate the benefits to household i at the new site. Then the analyst must aggregate these estimates for all households affected in order to obtain the aggregate benefits at the site.

It is not necessary that an analyst be restricted to the use of just one site as the source of information to be transferred to the new site. Information could be obtained from several sites and summarized for transfer to the new site. For instance, in the example above the analyst could take the average estimate of the value of a hectare of wetland from existing studies. A more sophisticated approach would attempt to explain the determinants in the variation in estimates from existing study sites, and then use this model and values of the independent variables (the determinants of the variation) from the new site to estimate the benefits (value) at the new site.

Most of the existing applications of benefit transfer methods in nonmarket valuation have attempted to estimate the recreational benefits of new projects or opportunities. The advantages of the approach are basically that estimates of economic benefits can be obtained more quickly and cheaply than if a new valuation study is attempted requiring primary data collection and often taking much time to complete.

There are three approaches to Benefits Transfer:

(a) *Transferring mean unit values* -- here we assume that the change in wellbeing experienced by the average individual at the existing sites is equivalent to that which will be experienced at the new site being valued. The previous studies are used to estimate the consumer surplus or average WTP of individuals engaged in, say recreational activities of various kinds. These WTP values of a day spent by a person in a specific type of recreational activity at the existing sites is multiplied by the number of days of such activity forecast to change or occur at the new site as a result of the environmental change, to obtain an estimate of the aggregate economic benefits from the recreational activity at the new site.

A summary of unit values of WTP for days spent in various recreational activities obtained from 287 existing studies is shown in table 2.2. These units values are the estimated amounts that individuals would be willing to pay over and above their current expenditures in order to ensure the continued availability of the resource for recreational use. Both travel cost models and the contingent valuation method were used to obtain these estimates.

The problem with this approach is that individuals at the new site, for a variety of reasons, may not value the recreational activities at the new site the same as the average individual at the existing sites studies on which the unit values are based. More sophisticated benefit transfers can instead be attempted as below.

(b) *Transferring adjusted unit values* -- here the mean unit values of the existing studies are adjusted before transferring to the new site. The unit values can either be adjusted for any biases that are thought to exist, or they can be adjusted in order to reflect better the conditions at the new site. Potential differences that should be looked at between the existing and new site are, differences in socioeconomic characteristics of households, differences in the environmental change being looked at, and differences in the availability of substitute goods and services.

Table 2.2 **Net economic values per recreation day reported by TCM and CVM demand studies from 1968 to 1988, United States (third quarter 1987 dollars):**

| Activity | Number of Estimates | Mean | Median | Standard error | 95% Range of Confidence | Mean Interval |
|---|---|---|---|---|---|---|
| Total | 287 | $33.95 | $27.02 | $ 1.67 | $30.68-37.22 | $3.91-219.65 |
| Camping | 18 | 19.50 | 18.92 | 2.03 | 15.52-23.48 | 8.26-34.89 |
| Picnicking | 7 | 17.33 | 12.82 | 5.08 | 7.37-27.29 | 7.05-46.69 |
| Swimming | 11 | 22.97 | 18.60 | 3.79 | 15.54-30.40 | 7.05-42.94 |
| Sightseeing and off-road driving | 6 | 20.29 | 19.72 | 3.73 | 12.98-27.60 | 10.33-31.84 |
| Boating, Motorized | 5 | 31.56 | 25.67 | 10.36 | 11.25-51.87 | 8.27-68.65 |
| Boating, non-motorized | 11 | 48.68 | 25.36 | 15.85 | 17.61-79.75 | 10.26-183.36 |
| Hiking | 6 | 29.08 | 23.62 | 5.82 | 17.67-10.49 | 15.71-55.81 |
| Winter Sports | 12 | 28.50 | 24.39 | 4.48 | 19.72-37.28 | 11.27 66.69 |
| Resorts, cabins, and organized camps [a] | 2 | 12.48 | | | 3.91-19.93 | |
| Big game hunting | 56 | 45.47 | 37.87 | 3.47 | 38.67-52.27 | 19.81-142.40 |
| Small game hunting | 10 | 30.82 | 27.48 | 3.51 | 23.94-37.70 | 18.72-52.04 |
| Migratory waterfowl hunting | 17 | 35.64 | 25.27 | 5.87 | 24.13-47.15 | 16.58-102.88 |
| Cold water fishing | 39 | 30.62 | 28.49 | 3.24 | 24.27-36.97 | 10.07-118.12 |
| Anadromous fishing [b] | 9 | 54.01 | 46.24 | 11.01 | 32.43-75.59 | 16.85-127.26 |
| Warm water fishing | 23 | 23.55 | 22.50 | 2.46 | 18.73-28.87 | 8.13-59.42 |
| Salt water fishing | 17 | 72.49 | 53.35 | 14.05 | 44.95-100.03 | 18.69-219.65 |
| Nonconsumptive fish and wildlife | 14 | 22.20 | 20.49 | 2.30 | 17.69-26.71 | 5.27-38.06 |
| Wilderness | 15 | 24.58 | 19.26 | 6.10 | 12.62-36.54 | 8.72-106.26 |
| Other recreation activities | 9 | 18.82 | 16.06 | 3.65 | 11.67-25.97 | 6.81-43.39 |

[a] Resorts were 1.83% valued at $19.93 per day; seasonal and year-around cabins were 3.06% valued at $3.91 per day; and organized camps were 1.79% valued the same as camping.

[b] Anadromous fishing estimates included in cold water fishing. Estimated as roughly 5%.

SOURCE: Walsh, R.G., D.M. Johnson, and J.R. McKean, [1992], "Benefit Transfer of Outdoor Recreation Demand Studies, 1968-1988", *Water Resources Research*, Vol. 28, No. 3, March, [Special Section: Problems and Issues in the Validity of Benefit Transfer Methodologies.]

(c) *Transferring the demand function* -- instead of transferring adjusted or unadjusted unit values, the entire demand function estimated at existing sites could be transferred to the new site. More information is passed over in this way. As an example, for a zonal travel cost model, the demand function might be of the form (Loomis [1992]) :

$X_{ij}/POP_i = b_0 - b_1 C_{ij} + b_2 Time_{ij} + b_3 Psub_{ik} + b_4 I_i + b_5 Q_j$ ...................................................................(2)

where

$X_{ij}$ number of trips from origin i to site j

$POP_i$ population of origin i

$C_{ij}$ travel costs from origin i to site j

$Psub_{ik}$ a measure of the cost and quality of substitute site k to people in origin i

$I_i$ average income in origin i

$Q_j$ quality of site j for recreational uses.

The approach requires that estimates of the parameters $b_0$, $b_1$, $b_2$, $b_3$, $b_4$, and $b_5$ are found from existing studies. Data is then collected on (1) population of zones "around" the new site, (2) travel costs from these zones to the new site, (3) the cost and quality of the alternative recreational sites available to people living in the zones designated to be around the new site, (4) the average income of people in these zones, and (5) a measure of the quality of the new site for recreational uses. The values of these independent variables from the policy site and the estimates of $b_0$, $b_1$, $b_2$, $b_3$, $b_4$, and $b_5$ from the study site would be replaced in the travel cost model (2), and this new equation could then be used to estimate both the number of trips from the designated zones to the new site and the average household willingness-to-pay for a visit to the new site (see Cicchetti, Fisher, and Smith [1976] for an early example).

The use of benefit estimates is still in its infancy and so procedures for dealing with problems common to most studies have not been standardised.

**Annex: Guidelines for Conducting Contingent Valuation Studies**

(Adapted from the report of the National Oceanic and Atmospheric Administration Panel on the Contingent Valuation Method, Arrow et. al., [1993])

General Guidelines

1. Sample Type and Size: Probability sampling is essential. The choice of sample specific design and size is a difficult, technical question that requires the guidance of a professional sampling statistician.

2. Minimize Non-responses: High non-response rates would make CV survey results unreliable.

3. Personal Interview: It is unlikely that reliable estimates of values can be elicited with mail surveys. Face-to-face interviews are usually preferable, although telephone interviews have some advantages in terms of cost and centralized supervision.

4. Pre-testing for Interviewer Effects: An important respect in which CV surveys differ from actual referenda is the presence of an interviewer (except in the case of mail surveys). It is possible that interviewers contribute to "social desirability" bias, since preserving the environment is widely viewed as something positive. In order to test this possibility, major CV studies should incorporate experiments that assess interviewer effects.

5. Reporting: Every report of a CV study should make clear the definition of the population sampled, the sampling frame used, the sample size, the overall sample non-response rate and its components (e.g., refusals), and item non-response on all important questions. The report should also reproduce the exact wording and sequence of the questionnaire and of other communications to respondents (e.g., advance letters). All data from the study should be archived and made available to interested parties.

6. Careful Pre-testing of a CV Questionnaire: Respondents in a CV survey are ordinarily presented with a good deal of new and often technical information, well beyond what is typical in most surveys. This requires very careful pilot work and pre-testing, plus evidence from the final survey that respondents understood and accepted the description of the good or service offered and the questioning reasonably well.

Guidelines for Value Elicitation Surveys

7. Conservative Design: When aspects of the survey design and the analysis of the responses are ambiguous, the option that tends to underestimate willingness-to-pay is generally preferred. A conservative design increases the reliability of the estimate by eliminating extreme responses that can enlarge estimated values wildly and implausibly.

8. Elicitation Format: The willingness-to-pay format should be used instead of compensation required because the former is the conservative choice.

9. Referendum Format: The valuation question generally should be posed as a vote on a referendum.

10. Accurate Description of the Programme or Policy: Adequate information must be provided to respondents about the environmental programme that is offered.

11. Pre-testing of Photographs: The effects of photographs on subjects must be carefully explored.

12. Reminder of Substitute Commodities: Respondents must be reminded of substitute commodities. This reminder should be introduced forcefully and directly prior to the main valuation to assure that the respondents have the alternatives clearly in mind.

13. Temporal Averaging: Time dependent measurement noise should be reduced by averaging across independently drawn samples taken at different points in time. A clear and substantial time trend in the responses would cast doubt on the "reliability" of the value information obtained from a CV survey.

14. "No-answer" Option: A "non-answer" option should be explicitly allowed in addition to the "yes" and "no" vote options on the main valuation (referendum) question. Respondents who choose the "no-answer" option should be asked to explain their choice.

15. Yes/No Follow-ups: Yes and no responses should be followed up by the open-ended question: "Why did you vote yes/no?"

16. Cross-tabulations: The survey should include a variety of other questions that help interpret the responses to the primary valuation question. The final report should include summaries of willingness-to-pay broken down into these categories (e.g., income, education, attitudes toward the environment).

17. Checks on Understanding and Acceptance: The survey instrument should not be so complex that it poses tasks that are beyond the ability or interest level of many participants.

## 3 Selected Case Studies in Economic Valuation

### 3.1 Introduction

This chapter takes a closer look at some selected case studies in an effort to illustrate the kinds of procedures needed to derive economic values. The studies illustrate the different methodologies and elicit the various problems of applying those methodologies in the developing world.

### 3.2 Contingent Valuation: Household Demand for Improved Sanitation in Kumasi, Ghana.

Whittington, D, D T. Lauria, A Wright, Ky-Ae Choe, J Hughes, and V Swarna. Household Demand for Improved Sanitation Services in Kumasi, Ghana: A Contingent Valuation Study, *Water Resources Research*, Vol. 29, No. 6, pp. 1539-1560. June, 1993.

### 3.2.1. Introduction

In most cities in industrialized countries, households do not have a choice about whether or not to connect the sanitary facilities in their house to a sewer. Every household may be required by law to connect if access is provided. This regulatory approach can only work, however, when the vast majority of households clearly have sufficient financial resources to pay for the sewerage system and the connection. In many developing countries, this is not the case: issues of affordability and households' willingness-to-pay for improved sanitation services are often much less clear. If households in a city of a developing country are required by law to connect to a sewerage system but the costs of the system including connections are much higher than the majority of households are able and willing to pay, then subsidies from some level of government will be required to cover the deficit. If subsidies are not available, such a regulation typically cannot be enforced.

This situation is now commonplace in many cities in developing countries. Many sewerage systems have been built that people cannot afford to connect to and are thus not being used. Households are often unwilling to pay for even the operation and maintenance of sewerage systems. Because large subsidies for the construction of sewerage systems are increasingly difficult to obtain, user charges in the form of sewer connection fees and monthly tariffs must be relied upon to an increasing extent to finance sanitation improvements. However, the process of establishing a tariff structure requires detailed information on how specific groups of households will respond to various combinations of monthly tariffs and connection fees. Such information on household demand for improved sanitation services is rarely available: it must be collected by the government agencies and donors involved before sanitation planning in developing countries can be improved. This study used the contingent valuation method to gather such information.

### 3.2.2. Field Work and Data Collection Procedures

The field work for this research was carried out over a five-month period from July to November, 1989. An initial version of the household questionnaire was developed over a three-week period of intensive experimentation in July, 1989. Approximately 50 household interviews and open-ended, small group discussions were conducted with respondents throughout Kumasi. The household questionnaire was then pre-tested with 100 households.

The final survey questionnaire had four parts. The first consisted of several questions about demographic characteristics of the respondent and his or her household (such as the number of family members and whether the respondent was head of the household). The second part included questions about the household's existing water and sanitation situation: type of facilities used, monthly expenditures, and household satisfaction with its existing sanitation facility, including perceptions of its cleanliness, privacy, and convenience. The third contained questions about the household's willingness-to-pay for improved sanitation facilities. The final part of the questionnaire contained questions about the socioeconomic characteristics of the household, including such items as education, income, ownership of assets, weekly expenditures, occupation, religion, and housing characteristics.

A two-stage stratified sampling procedure was utilized to select a random sample of 1633 households. Twenty enumerators (16 men and 4 women) were each given one week of intensive training in the administration of the questionnaire. Enumerators were instructed in the precise translation of the questionnaires into the predominant local language (Twi) and were trained in how to ask questions and elicit answers. This training included extensive use of role playing. Each enumerator was observed in

practice interviews and was tested on his or her ability to administer the questionnaires. Field supervisors returned to selected respondents after the enumerator reportedly completed the interview in order to verify that the enumerator had, in fact, interviewed the correct household and that the interview had taken place as reported. Each completed questionnaire was checked by a supervisor for omissions and errors, and where problems were found, the interviewer was instructed to return to the household in order to rectify them.

Out of the 1633 households in the sample frame, usable interviews were completed with 1224 respondents. The overall response rate for those households that could be located was very high: only 4 percent refused to be interviewed (3 percent of the total number of households). Two percent of the completed interviews were discarded because of inconsistencies in the respondent's answers.

Respondents were asked about their willingness-to-pay for five different types of sanitation services: Kumasi Ventilated Pit Latrines (KVIPs), water closets (WCs) with sewer connections, sewer connections for households already with WCs and septic tanks, private water connections, and both a private water connection and a WC with a sewer connection for households currently without water. Each household was not asked its willingness-to-pay (WTP) for all five levels of service but only for those relevant to its particular circumstances. For example, if a household had a water connection but did not have a WC, it was possible to ask the respondent about his/her willingness-to-pay for both a WC with a connection to a sewer and a KVIP. If a household already had water and a WC, it was not relevant to ask how much they would pay for a KVIP; rather, the researchers asked how much the household would be willing to pay to connect the WC to a sewer.

The enumerators described each of the relevant options by reading from a prepared text, and, for some of the options, by showing diagrams and pictures to the respondents. A combination of "YES/NO" questions and a direct, open-ended question was used to elicit the respondent's maximum willingness-to-pay (this question format is termed an "abbreviated bidding procedure with follow-up" ). The respondent was first asked whether or not he would choose to pay a stated monthly fee for one of the specified technologies. In order to test whether respondents' answers were sensitive to the questionnaire design, the starting value of this initial fee was varied among respondents: some received a high starting value and others received a low value. A respondent who received a high starting value for one level of service or technology also received a high value for all subsequent levels of service in the interview.

The iterative bidding procedure had the following three steps, depending on whether the respondent received a high or low initial value:

| Low Starting Value | High Starting Value |
|---|---|
| (1) Ask initial starting value; if NO, go to (3), if YES go to (2) | (1) Ask initial starting value; if No, go to (2), if YES go to (3) |
| (2) Increase the initial value to the high starting value, and ask if respondent is willing to pay; then go to (3) | (2) Decrease the initial value to the low starting value, and ask if the respondent is willing to pay; then go to (3) |
| (3) Ask respondent for the maximum amount he is willing to pay for the service described | (3) Ask respondent for the maximum amount he is willing to pay for the service described |

This question format was used for each of the five services. The order of the questions about different services was the same for all respondents.

Both tenants and landlords were interviewed, and somewhat different introductory statements were required for each. In addition to the different versions for landlords and renters, for households with and without water, and for high and low starting points, the questionnaire was also designed to test whether one subset of respondents (renters with water) bid differently if they were given one day to reflect before giving their answers to the willingness-to-pay questions. In total, ten different versions of the household questionnaire were administered in the field. Which version a specific household in the sample received was randomly assigned;

the enumerators had no control over it.

### 3.2.3 Results of the Analysis

Table 3.2.1 presents means and standard deviations of households' willingness-to-pay bids (based on the follow-up open-ended question) for the five types of service for groups of households with different existing water and sanitation conditions. As shown, households without a WC on average said that they were willing to pay about the same amount per month for a WC as for a KVIP (US$1.40 vs. US$1.45). Households with a WC said they were willing-to-pay slightly less than this for a connection to a sewer (US$1.30). On average, households without water connections said that they were willing-to-pay US$1.52 for a water connection and US$2.57 per month for both a water

connection and a WC. This result suggests that the demand for water and sanitation is largely additive; i.e., that expenditures for one do not substitute for the other.

Households with private water connections but without a WC were asked their willingness-to-pay for both a KVIP and a WC with a sewer connection. On average, they were willing to pay about 7 percent more for a WC and sewer than for a KVIP. There were large differences in the mean willingness-to-pay bids for KVIPs between households with water using public latrines and households with water using other sanitation systems. For example, households using public latrines were willing to pay about 37 percent more for a KVIP than households with bucket latrines, which makes sense because households using public latrines are the most dissatisfied with their existing sanitation system and are currently spending the most for sanitation.

Three different types of multivariate models were used to analyze the relationship that describes the determinants of the willingness-to-pay bids. Ordinary least squares (OLS) was used to explain the willingness-to-pay bids obtained in response to the follow-up direct question. The information on willingness-to-pay obtained from respondents' answers to the "YES/NO" questions was analyzed in two ways. First, a respondent's answer(s) were interpreted as defining interval estimates for his willingness-to-pay. In other words, the respondent's willingness-to-pay was assumed to fall into one of the three categories defined by the high and low starting points.

The second method used to analyze the responses to the "YES/NO" questions was an ordered probit model. This approach assumes that the responses to the questions only provide an *ordering* of the preferences of respondents. In other words, if one respondent answered the willingness-to-pay questions with a low bid and another respondent answered with a high bid, the only information that is assumed to be obtained from these responses is that the first respondent was willing to pay less for the improved sanitation service than the second respondent. Each of these three approaches to the multivariate analysis progressively relaxes the assumptions about the precision of willingness-to-pay information that can be obtained from the contingent valuation survey for improved sanitation services.

All three multivariate modelling approaches use the same four types of variables for explaining variation in willingness-to-pay bids for a given sanitation technology: (1) characteristics of the questionnaire (e.g., whether a respondent was given a high or low starting point, or time to think); (2) charac-

teristics of the respondent (e.g., sex, education); (3) socioeconomic characteristics of the household (e.g., income); and (4) household's existing water and sanitation situation.

Overall, the multivariate results from all three modelling strategies were remarkably robust and consistently showed the same independent variables being statistically significant. The results showed conclusively that the willingness-to-pay information obtained from the contingent valuation survey for all five levels of improved service is systematically related to the socioeconomic characteristics of the household and the respondent in ways suggested by consumer demand theory and prior expectations. This is true regardless of the source of willingness-to-pay information (i.e. answers to the "YES/NO" questions in the bidding game or the open-ended final question), the estimation method used, or the exact model specification.

The four explanatory variables with the consistently largest effects on willingness-to-pay have clear economic interpretations: household income, whether the respondent owns the house or is a tenant, how much the respondent's household was spending on its existing sanitation system, and how satisfied the respondent was with his household's existing sanitation system. Households with higher incomes bid significantly more for all types of improved services than households with lower incomes. Owners bid much more for improved service than tenants, indicating a greater willingness to invest in their own property. Respondents who were paying more for and who were dissatisfied with their existing sanitation service bid more for improved sanitation services (both KVIPs and WCs with sewer connections) than respondents who were paying less and were more satisfied.

Perhaps the most surprising finding of these multivariate analyses is how little effect any of the social or cultural variables had on individuals' willingness-to-pay for improved sanitation or water services. More educated respondents generally bid more than less educated respondents, but this effect is statistically significant in only a few of the models and its magnitude is always small. The gender of the respondent and whether the respondent is the head of household are almost never statistically significant, and the direction of these effects is mixed. The only case in which the age of the respondent influences willingness-to-pay is for WCs with sewer connections: older respondents bid less for this type of sanitation improvement than younger individuals.

The experimental design incorporated numerous tests to check the internal consistency and reliability of the households' willingness-to-pay responses, including a test for starting point bias, a `time-to-

think' effect, and the effect of observers listening to the interview. These tests revealed little reason for serious concern about the reliability or accuracy of the willingness-to-pay responses.

The authors do not argue that households' willingness-to-pay bids accurately reflect the public health benefits of improved sanitation in Kumasi because they do not believe that households are fully aware of the health risks to which they are currently exposed by their existing sanitation practices. The willingness-to-pay bids do, however, appear to reflect households' perceptions of the value of improved sanitation options.

Table 3.2.1 **Average Household Willingness-to-Pay for Improved Sanitation Services Based on Existing Water and Sanitation Situation**

| Willingness-to-Pay (US$/mo) for: | | | | | |
|---|---|---|---|---|---|
| Existing Sanitation | KVIP | WC and Sewer | Sewer Connection | Water | WC Water |
| Households with Water | | | | | |
| Bucket latrine | 1.13 (0.92) | 1.24 (1.01) | ... | ... | ... |
| Public latrine | 1.55 (1.13) | 1.66 (1.16) | ... | ... | ... |
| Pit latrine | 1.23 (0.92) | 1.26 (0.90) | ... | ... | ... |
| WC | ... | ... | 1.31 (1.06) | ... | ... |
| Other | 1.34 (0.62) | 1.19 (0.62) | ... | ... | ... |
| Households without Water | | | | | |
| Bucket latrine | 1.49 (1.03) | ... | ... | 1.71 (1.73) | 2.60 (1.59) |
| Public latrine | 1.72 (0.98) | ... | ... | 1.61 (1.20) | 2.72 (1.74) |
| Pit latrine | 1.15 (0.82) | ... | ... | 1.13 (0.76) | 1.78 (1.16) |
| Other | 1.33 (1.02) | ... | ... | 1.32 (0.91) | 2.07 (1.30) |
| *Overall Mean* | 1.45 (0.92) | 1.40 (0.95) | 1.30 (0.98) | 1.52 (1.01) | 2.57 (1.42) |

[Values in parentheses show the standard deviations.]

### 3.2.4 Discussion

This research provides additional evidence that contingent valuation surveys can be successfully conducted in cities in developing countries and that useful information can be obtained on household demand for public services such as sanitation. The multivariate analyses of the willingness-to-pay responses compare very favourably with similar analyses carried out in industrialized countries.

From a policy perspective, the results of the study indicate that conventional sewerage is simply not affordable to the vast majority of households in Kumasi without massive government subsidies. In retrospect this is perhaps not so surprising. What was less apparent before this research, however, was the widespread acceptance of KVIPs and the approximate levels of subsidy which would be required to achieve different coverage goals with a KVIP subsidy programme. The results of the CV survey showed that most households were willing to pay about as much for a KVIP latrine as for a WC connected to a conventional sewerage system. The study also indicated that households' willingness-to-pay for water and for sanitation appear to be approximately the same order of magnitude and

largely separable.

The authors show that if loans were available at a real interest rate of 10 percent for 20 years, essentially no subsidies would be necessary to install KVIP latrines in Kumasi. In other words, if households could engage in financial transactions under terms considered to be more or less normal in industrialized countries, households' willingness-to-pay for improved sanitation would be sufficient to pay the full costs of KVIPs. The authors do not suggest that public authorities should intervene in the financial markets to solve the sanitation problem or offer subsidized loans for the construction of KVIP latrines, but rather point out that household willingness-to-pay for KVIP latrines was in fact quite substantial. It just would not buy much in the capital market conditions prevailing in Kumasi in 1989.

### 3.3 Travel Cost Method: Valuing Ecotourism in a Tropical Rainforest Reserve

Tobias, D. and R. Mendelsohn [1991], Valuing Ecotourism in a Tropical Rainforest Reserve. *Ambio*, 20: 2, 91-93

### 3.3.1 Introduction

In many countries forest loss often derives from the perceived value of the forests resources relative to alternative land uses, particularly agriculture. Prescriptions for forest conservation therefore stress the need to recognize the resource's total economic value. In other words, forests are worth more than their timber. A comparison of relative returns should account for the variety of priced and non-priced goods and services frequently produced, even if these are difficult to quantify. As deforestation accelerates there has been a surge of interest in high profile uses such as the harvest of secondary forest products and tourism. Tobias and Mendelsohn attempt to quantify recreation value applying a zonal travel cost method to domestic visits to the Monteverde Cloud Forest Reserve (Costa Rica). In so doing, they attempt to demonstrate the economic value visitors assign to their visit over and above the price they already pay to access the reserve.

Their finding that the inferred tourist valuation of the reserve can potentially exceed the competing alternative by a magnitude up to two times is indicative of a current bias in economic appraisal which largely ignores non-market benefits.

### 3.3.2 Data Collection and Field Procedures

Costa Rica is one of a number of countries synonymous with environmentally-sound and carefully planned tourism (mainly to its protected areas). Located between 8 and 11 degrees north of the equator, a diverse terrain combined with tempering Pacific and Caribbean climatic influences assures a high biodiversity rating in a relatively small area (Chant 1992). Although wealthy relative to many of its Central and Latin American counterparts, land conversion to agriculture -- mainly coffee, bananas and livestock -- is a constant threat to the country's diverse ecological environments which include 24 National Parks. As is the case in many other developing countries, there is a need to justify resource commitments which are perceived to have a high opportunity cost. Protected areas for the sake of biodiversity alone are rarely a convincing justification for foregone development benefits. The case for Ecotourism therefore needs to be convincing and provide a demonstrable return to the country.

The travel cost method infers the value users place on a recreational experience from their travel behaviour. Tobias and Mendelsohn use the zonal variant which begins with the collection of address information of domestic visitors to the $10,000h^2$ private reserve (1988). Visitors are then zoned according to their canton (state) of origin and an average visitation rate for each zone calculated by dividing observed visits by canton population. Next, zonal average visit cost is estimated. A composite cost estimate is derived based on a standard cost per kilometre (distance measured between the reserve and the main town of each canton), out of pocket costs, a fraction of fixed costs (ie wear and tear) and a value of travel time. The authors do not specify the fraction of the hourly wage rate they use to value travel time, but do emphasise the sensitivity of the final result to these initial cost assumptions. A total of 81 observations (corresponding to the number of cantons) are available to generate a typical demand function relating visitation rate to price (travel cost) plus extra available data on canton population density and literacy which are thought to affect observed visitation rates.

### 3.3.3 Results of the Analysis

Estimating the demand function by regression analysis provides a downward sloping line of best fit in the cost (price), visitation rate (quantity) space (diagram). In deriving this demand curve some variables have greater explanatory power than others and as it turns out, a linear specification omitting the literacy variable best explains observed visits.

For each canton (observation on the price (cost) axis) a measure of the total consumer surplus is derived from the area above the price line and below the fitted demand curve: essentially a measure of the difference visitors from that zone paid to get to the reserve and how much the demand curve indicates they would be willing to pay. Note that the latter assertion is based on the strong assumption that visitors from all zones have identical tastes with respect to the site, and react in the same man-

ner with respect to costs. After calculating the consumer surplus for each canton, the authors sum over all cantons for an annual consumer surplus of between US\$97,500 and 116,200 depending on the constituents of the estimated function (and thus the slope of the curve).

It seems reasonable to suggest that Monteverde Reserve is unique and that its conversion would -- provided the real value of recreation flow remains constant over time -- signify a loss of the estimated surplus in perpetuity. The true economic value of the reserve should thus be represented by this stream of annual benefit collapsed to its present value equivalent using an appropriate discount rate. As time goes by, however, the rarity of rapidly disappearing rainforest suggests that demand for protected areas like Monteverde will increase. Rising demand implies increased visitation rates and a higher consumer surplus. The authors therefore suggest that simply to discount the future stream of benefits by a factor $r$ would underestimate the value of the site by discounting distant benefits at too great a rate. Using a growth rate $a$ as a proxy to increasing visitor value, a net factor $r-a$ of these offsetting rates is taken as the appropriate factor to adjust benefit streams. The complex derivation of this factor is not discussed by the authors who opt for a rate of 4 per cent to translate the estimated consumer surplus perpetuity for Monteverde to a present value of between US\$2.4 and 2.9 million[1]. Alternatively dividing the *annual* consumer surplus estimate by the number of domestic visitors in 1988 yields a value of around \$35 per person.

The estimated values do not include foreign visitor valuation of the reserve. The authors suggest that it is reasonable to assume the domestic valuation as a lower bound valuation by a foreign visitor who travels further and has fewer alternatives at home. On this basis the addition of foreign visitors inflates the site present value estimate to a range of \$2.5 and \$10 million. Opting for \$8 million a value per hectare of \$1250 is obtained by dividing over the 10,000 h$^2$ of the reserve.

### 3.3.4 Discussion

How useful is this per hectare valuation? Conservation of Monteverde competes with agriculture in surrounding areas. The market price of agricultural land can often be interpreted as representing the present value of everything that can be produced on it over time. A current price of land outside the reserve of between \$30 to \$100 per hectare therefore compares unfavourably to the per hectare recreational present value of \$1,250. In other words, conversion to agriculture would incur an economic cost per hectare at least equal to the difference between the two options. Conversely the expansion of the reserve represents a well-justified investment

*from an economic and social perspective.* Including other non-priced elements such non-marketed forest products and biodiversity values may further increase the return to conservation.

There are several caveats to the presented estimates, many of which are related to problems inherent in the travel cost approach. As already indicated, the authors note the sensitivity of consumer surplus estimates to the assumptions underlying the composite cost per kilometre. Small changes to any of the elements that make up this cost affect the slope of the estimated demand curve and therefore estimated consumer surplus. Estimation error is notoriously common in the misspecification of the value of time spent travelling to the site and time on site. This debate hinges on the rationale that leisure time should be valued less than remunerated labour time or even at zero if the opportunity cost so dictates. A related problem alluded to in the paper, is that the benefit estimate derived from the demand curve relates to the whole trip experience and not just the on-site recreational benefit. A crude device often used to disentangle the site value from the value of the whole experience is to ask visitors to assign a percentage of enjoyment or purposefulness to specific visit components. This becomes more complicated when visitors take in several other sites *en route* to the site of interest or simply have difficulty disregarding travel as an essential and enjoyable part of the whole experience. Moreover, the assumption of an identical consumer surplus for domestic and foreign visitors to Monteverde to calculate the aggregate visitor consumer surplus range, seems unlikely. Foreign visitors may indeed incur great cost getting to Costa Rica and have few areas similar to Monteverde nearer home. It is unlikely though that foreign visits are for a single purpose and therefore erroneous to assign the whole travel cost to any single site. Although the authors have assigned a conservative value to foreign consumer surplus, the issue of multipurpose visits needs to be understood to avoid seriously biased benefit estimates.

While it is clear that methodological difficulties noted here need to be further addressed, the current study begins the task of quantifying missing forest values. Only as methods and measurement become more robust will the true value of forest resources be truly appreciated and possibly captured by their owners.

### 3.4 Hedonic Pricing: Willingness-to-Pay for Water in the Philippines

North, J. H., and C. C. Griffin. Water Source as a Housing Characteristic: Hedonic Property Valuation and Willingness-to-Pay for Water. *Water Resources Research*. Vol. 29, No. 7, pp. 1923-1929. July, 1993.

### 3.4.1. Introduction

Billions of dollars are invested every year in potable water supply projects in urban and rural areas of developing countries, but only rarely are these investments subjected to serious economic analysis. In the past, the international donor community and national governments in developing countries have assumed that potable water supply systems -- particularly in rural areas -- must be subsidized because most households are too poor to pay for improved water systems. Most donor agencies and national governments thus exempt water supply projects from the kind of economic analysis routinely applied in other sectors.

This scepticism about the role of economic analysis is deep-seated among professionals working in the water supply sector, most of whom are doubtful that balancing the costs and benefits of a water supply project is a useful exercise. There are two principal reasons for this scepticism. First, many sector professionals believe that clean water should be provided as a basic right, or that it is a 'merit good' that should not be subjected to economic analysis. Second, sector professionals doubt that the economic benefits of water supply projects can be determined with sufficient accuracy for the estimates to be useful for practical purposes. Until recently, there has in fact been surprisingly little empirical work on the economic benefits of water supply projects.

This paper illustrates that it is feasible to use an indirect, non-market valuation technique to estimate the economic benefits that result from improved water supply projects. The authors use the hedonic property valuation method to determine how imputed household rental values in one large rural area of the Philippines reflect households' willingness-to-pay for the different types of water supply services (private connection in the house, a tap in the yard, or a communal source) and distance to the source. The results of this paper are consistent with a growing body of empirical evidence that suggests that people in developing countries are willing to pay substantial amounts for reliable, high quality water supplies in their home. The economic benefits of improved water supplies are likely to be especially large in peri-urban communities where households are already purchasing the majority of their water from vendors. The economic benefits in rural areas of developing countries where water vending is not present are typically much lower.

### 3.4.2. Field Work and Data Collection Procedures

Data for the analysis came from a 1978 survey of 1,903 households in a 14,000 square kilometre area of the Bicol region, one of the poorest parts of the Philippines. The sample was chosen randomly and was designed to be representative of the region in terms of population and income distribution. The data were collected as part of a health policy project, not specifically to estimate a hedonic property value model.

About 90 percent of the sample owned their own homes, and only a quarter of the remaining 10 percent reported paying rent. For the purposes of the authors' analysis, the renters were dropped from the sample. The head of the household was asked to estimate the value of the dwelling, not including any valuation of the land that a household might own surrounding the residence. Monthly rent was imputed as 1 percent of the value of the structure.

The Bicol survey included an extensive list of questions about all possible sources of cash or in-kind income. The authors used a human capital formation model to estimate the permanent income of each household in the sample. These estimates were used to place households into three income categories used in the analysis.

Information from the survey that was used to describe characteristics of the dwelling included water source, number of bedrooms, quality of construction materials, and location. The sample respondents used six primary water sources: (1) a private connection in the house supplied by a community system, (2) a private connection in the house supplied by the household's own pumping system from a deep well, (3) a tap in their yard supplied by a community water supply system or household's own pumping system, (4) public tap, (5) shallow well with water raised by bucket, (6) traditional water source (e.g., spring, lake, or river), and (7) other (purchased water or rainwater collection). The authors used three variables to characterize a household's water situation. The first is a qualitative variable for whether the residence had piped water in the house; the second is a qualitative variable that designated whether a household had a deep well with water pumped into the house or yard. Although only 3 percent of the households in the sample had access to a private water connection with water supplied from a public system, 30 percent were able to approximate this level of service by paying the cost of drilling a deep well on their property and self-supplying. Relative to a public tap or traditional source, the authors hypothesized that each of these would add to the perceived value of the dwelling.

The third set of information regarding water source that the authors used in their analysis was distance to the water source used by the household, which was expected to be negatively correlated with the value of the dwelling (and thus to imputed rent). There was only modest variation in the distance to

the water source for households in the sample. About 75 percent used a water source within 50 meters of the house; 22 percent carried water from distances over 75 metres.

The authors measured the construction quality of the dwelling by creating an index of construction materials. The index took a value of one if the house was made of straw or similar material, a value of two if the house was made of a mixture of straw and cement or wood, and a value of three if it was made entirely out of wood or cement and had a metal roof. Size of the residence is expected to be positively related to imputed rent. Distance to the nearest town in kilometres was expected to be negatively related to rental value.

### 3.4.3 Results of the Analysis

The hedonic model is based on the idea that households choose to rent or purchase a house based on dwelling and community characteristics. A bid-rent function can be formulated that characterizes the trade-offs each household is willing to make between attractive characteristics of the dwelling and community and paying more rent. Regressing the monthly rental value of a dwelling on its characteristics, such as water source, construction materials, number of rooms, and lot size, yields an estimate of the hedonic price function. Marginal willingness-to-pay for each characteristic is the derivative of the hedonic price function with respect to that characteristic. However, only if consumers are all alike would these simple estimates realistically characterize each household's willingness-to-pay.

The authors' approach to this latter problem is to divide the sample into three different income groups, and to estimate a bid-rent function directly for each group. This approach assumes that households in each income group have similar tastes. The problem is formulated as a random bidding model in which the bid-rent parameters are estimated by predicting the type of household likely to occupy a particular house. The modelling approach used by the authors allows them to estimate directly the bid-rent function without having to recover the parameters of the utility function.

The authors estimated households' willingness-to-pay in terms of the capitalized value of improvements to water situations. The households in the sample pay monthly costs associated with the use of different sources. These costs take the form of water charges, electricity, and household members' time. The attached table presents the parameter estimates of the discrete choice bid-rent approach. These coefficients can be interpreted as the marginal willingness-to-pay for each housing characteristic, assuming that tastes are similar within each of the three income groups. Ignoring the intercepts,

13 of the 18 coefficients are significant at or above the 10 percent level for a two-tailed test; most of these are significant above the 1 percent level.

The model results in Table 3.4.1 show that the coefficients of the non-water characteristics generally behave as hypothesized. 'Number of bedrooms' is significant and positive for middle- and upper-income households, but not for the low-income group. Low-income households are willing to pay more, however, for greater proximity to the main town. The middle-income group will not pay anything to be closer to town; the higher-income group will pay to be farther away from town. All income groups are willing to pay more for a house constructed of better materials.

Households in all income ranges are willing to pay about half of their monthly imputed rent to have piped water in the house supplied by a public system. Willingness-to-pay for piped water in the house works out to US$1.95 per month in 1978 for higher income households, US$2.25 for middle-income households, and US$1.41 for low-income households. These amounts are *in addition* to the monthly costs of using these services (including any existing water tariffs). The poorest households are not willing to pay more for water in the yard or house if it is supplied by the household's own well. Middle-income households would pay about US$0.94 per month for the capitalized cost of this option and high-income households would pay about US$0.88 per month for it.

The authors also examined the question of how much households value greater proximity to a communal source. Somewhat surprisingly, they found that willingness-to-pay for a closer water source was statistically significant only for higher-income households. Even for high-income households, the magnitude of the effect of distance on willingness-to-pay was small. This may have been because few households were collecting water from long distances from their home.

### 3.4.4 Discussion

The analysis presented in this paper shows that the housing market in this poor, rural area of the Philippines does place a value on water source and that it is capitalized in the price (imputed rental value) of the house. The authors found high willingness-to-pay for piped, in-house water from community systems by all income groups and somewhat lower willingness-to-pay for water in the yard. These inferences were relative to the excluded communal source. There was almost no measurable willingness-to-pay for greater proximity to a communal source. This finding suggests that a project that either (1) reduces the distance to, or (2) improves

the site of a communal source, would have negligible value to most households. However, a project that provided individual house connections would significantly increase wellbeing.

The authors compared their estimates of households' willingness-to-pay for water supply improvements with cost estimates for water supply systems in the Philippines. They concluded that willingness-to-pay is probably not adequate to cover the capital cost of piped water systems either in the house or yard.

**Table 3.4.1 Results of Bid-Rent Estimations (Dependent Variable Is Imputed Monthly Rent)**

**Discrete Bid Rent: Mean Hedonic Price or Bid-Rent**

| Variable | Lower Income | Middle Income | Higher Income |
|---|---|---|---|
| Intercept | -25.924 | -46.243 | -47.321 |
| | (5.52) | (10.87) | (11.02) |
| Piped water in the house (0=no, 1=yes) | 10.427* | 18.130* | 15.486* |
| | (1.70) | (3.85) | (3.31) |
| Deep well water into the house or yard, or a yard tap (0=no, 1=yes) | -2.147 | 6.948* | 6.459* |
| | (0.57) | (2.42) | (2.25) |
| Distance to water source | 0.001 | 0.0002 | -0.004* |
| | (1.10) | (0.18) | (2.19) |
| Number of bedrooms | 2.194 | 7.967* | 11.290* |
| | (1.38) | (6.21) | (9.77) |
| Distance to central town | -0.834* | 0.011 | 0.396* |
| | (5.81) | (0.51) | (2.04) |
| House materials | 9.863* | 12.734* | 10.321* |
| | (4.18) | (5.98) | (4.97) |
| Scale parameter | | 0.044 | |
| | | (123.96) | |

The *t* statistics are given in parentheses.

* Indicates significance at or above the 10% level for a two-tailed test. The model as a whole is significant at better than the 1% level using a likelihood ratio test.

## 3.5 Contingent Valuation: Water Quality in Barbados and Uruguay

K. E. McConnell and J. H. Ducci. *Valuing Environmental Quality in Developing Countries: Two Case Studies*, Paper presented at Allied Social Science Association, Atlanta, Georgia, December, 1989.

### 3.5.1 Introduction

For much of the period when economists have worked actively on projects and policies in developing countries, the value of services from the environment was ignored. This treatment of environmental services was explained by appealing to the suspected high income elasticity of demand for such services. People with low incomes simply would not pay for environmental services. Several alternatives may explain the occasionally observed low level of environmental quality. For example, the market failure may not have revealed the demand for environmental services.

However, the good and bad environmental consequences of development projects have become increasingly apparent. And increasingly, development agencies seek to measure the economic costs and benefits of these externalities. For development projects which will alter the quality of a resource or the environment, contingent valuation methods have special appeal because they enable researchers to measure the benefits in cases where there are no sources of secondary data or no observable behaviour to exploit.

This paper reports on studies conducted in 1988 and 1989 in two countries in Latin America using contingent valuation methods to measure the value of improvements in water quality. These studies were originally designed to evaluate projects, not to do research on contingent valuation. This paper is concerned with the kinds of problems that arise in doing contingent valuation on environmental problems in developing countries, and not with specific research issues of contingent valuation.

### 3.5.2 Contingent Valuation for the Barbados Sewer System

The project in Barbados, an island country in the Caribbean, involved a study of the benefits and costs of the construction of a sewer system along with collector lines. The system, designed for the south coastal area of Barbados, would require households, non-profit organizations, and businesses to hook up to the lines proposed for construction. The collector lines would feed a plant which would provide primary treatment for waste water. This treated water would then be piped out through a gap in the fringing reef. The system is planned for a small area of Barbados.

For households, the sewer system would potentially provide environmental services. In the sewer district, households currently dispose of their wastewater into the subsurface. For some households, the disposal of waste water into the ground creates occasional problems, such as overflows, and filled septic tanks among other things. However, most households do not suffer any immediate consequences. Barbados is a coral island and the soil has great permeability. The permeability means that waste water gets to the groundwater and into the ocean relatively rapidly. There it is contended that the absence of a sewer has two effects: it pollutes the water used for swimming on the south coast beaches (via higher coliform) and it destroys the fringing coral reefs which surround the island. The coral reefs are apparently impaired by the excess nutrients. Some scientists maintain that there is a secondary effect from the dying reefs. These reefs provide protection for beaches from open ocean waves, and the death of reefs may induce additional beach erosion. However, there is currently not strong evidence that the major beaches in the area to be sewered are polluted although it is contended that coliform counts in the marine waters are occasionally high around large hotels. These beaches are heavily used by residents and tourists and appear to be clean.

Thus the installation of a sewer system potentially creates three kinds of direct services: (1) easier disposal of waste water; (2) cleaner water for swimming and beach use and expected healthier reefs; and (3) knowledge of a healthier marine environment. There is also a potential indirect effect. If the marine waters gain a reputation of being severely polluted, tourist activity, essential to the economy, may be reduced, bringing a decline in employment. However, the environmental returns are in a sense counterfactual. They can be imagined, given the continuing pollution from waste water. But there is currently little evidence (and little perception) that the beach waters are polluted. To estimate the benefits of the sewer system, one must calculate the total willingness-to-pay for a cleaner environment. Those households who live in the sewer district stand to receive all three services, while those who live outside the district will only enjoy service flows from a healthier environment. Consequently, two different contingent value studies were carried out, one for households who live in the sewer district and one for the rest of the households in Barbados.

The contingent valuation survey in Barbados was preceded by two focus groups and several pilot surveys of draft questionnaires. The survey was administered by a firm in Barbados with personnel quite familiar with sample survey techniques. Both the small size of the island and the difficulties with phone or mail techniques suggested an in-person interview. The interviewers were elementary school teachers. They were trained in the technical issues of sewer systems and water quality as well as in the nature of the interview process.

The questionnaire for the households who live outside the sewer district asked only about the environmental aspects of the sewer system. The instrument proceeds by asking a limited set of questions on household characteristics. It then explains briefly the implications of the sewer system. Households are told the potential impact of disposing of waste water into the ground, and the potential of avoiding polluted beach water and damaged reefs by construction of the sewer system.

Then the respondent is offered two choices:

- pay a randomly varied increase on the quarterly water bill to achieve the aims of the sewer system;

or

- not pay and continue the path of potentially polluting the beaches and other environmental consequences of private disposal of waste water.

In responding to this question, households who do not live in the sewer district are being asked to assess the effect of continued disposal of waste water into the ground, and the impact of this disposal on marine water quality. Unless they perceive a connection between water quality and the sewer system, they do not stand to gain.

A two stage sample of households and districts resulted in 432 observations on households for this referendum. The interviewing was conducted by interviewers who were trained for this questionnaire but who had previously been employed on national censuses for population and economic purposes. Part of the training included attending focus groups where the details of the questionnaire were worked out.

To complete the analysis, a model of the responses was estimated.

The following model demonstrates the fitting of the

responses for households not in the sewer district:

(1) probability (yes to the question) = $a_0 + a_1d + a_2age + a_3ctv - {}_yw$

where

d = 1 if household visited relevant beaches more than 15 times a year,

0 = otherwise;

age = age of respondent;

ctv = 1 if household had seen a television show about the relation between the sewer system

and pollution of Barbados beaches,

0 = otherwise;

w = 4 (increment to quarterly water bill).

The water bill is multiplied by 4 to convert to an annual figure. The water bill and all subsequent monetary measures are in local dollars, which exchange two to one for U.S. dollars. The ctv variable represents an increment to knowledge about the sewer system and its impact on the marine environment.

The estimated model in general agrees with prior notions about the utility of waste treatment. Utility is higher in the with-the-sewer-system case for people who use the beaches frequently or who have seen a television show which describes the impact of the sewer system on water quality. (The impact of the ctv variable suggests that there is currently little perception of impaired water quality.) Utility is lower for older people or when a higher charge must be paid. The age variable works because older people tended not to believe that the marine waters could be polluted.

This model can be used to calculate the sample willingness-to-pay for constructing the sewer system. The general expression for this willingness-to-pay is

(2) $Ew = (a_0 + a_1d + a_2age + a_3ctv)/{}_y.$

For the parameter estimates from equation (1), the expected willingness-to-pay, assuming that the parameters are known constants, is

$Ew = (1.04 - .0279age + .3996ctv + .6118d)/.0097.$

This model implies a mean willingness-to-pay for the sample of $US11.

The households who live in the district to be sewered were given a similar referendum, but one that included the services of public wastewater disposal. The interview asked a series of questions about the household characteristics and water disposal. Households were given a description of the sewer system and its role in preserving clean water and protecting coral reefs.

The randomly chosen households were offered the choice of

paying a randomly varied quarterly addition to their water bill and receiving the services of waste water disposal, cleaner beaches and other environmental amenities

or

not paying the increment to the water bill and continuing the private method of waste water disposal and continuing the threat to the environment.

In contrast with the households outside the sewer district, these respondents need not understand the scientific connection between the sewer system and marine water quality. Some households can anticipate receiving direct benefits from the installation by connecting to the sewer system.

A random sample of 277 households was drawn from the approximately 3,200 households in the sewer district. The following model is representative of for those households with the potential to connect:

(3) Probability (yes to the question) = $c_0 + c_1d + c_2age + c_3ctv - {}_yw$

where the variables are the same as for the referendum for the households outside the district except that d = 1 for households who visit the relevant beaches anytime during the year and 0 otherwise.

Estimation of this model showed that it is stronger than the model for households outside the sewer district in several senses. The mean willingness-to-pay to install the sewer system is

(4) $Ew = (1.057 - .0207age + .8744ctv + .6748d)/.00216.$

The mean willingness-to-pay is $US178.

There is some reason for suspicion based on results from households who live in the sewer district. The respondents were asked a series of questions about whether they had problems with their disposal of waste water. For a test of whether households who had problems would be willing to pay more, a dummy variable, `problem' was created. This variable, which took a value of one when the household suffered one of a series of problems that confront people when they are not hooked up to a sewer system, was not significant and did not impact the parameter estimates. The insignificance of this variable is a troubling reminder that respondents may not be considering all the information available to them.

### 3.5.3 A System of Collector Lines in Montevideo, Uruguay

The third contingent value study of interest here involves the construction of lines disposing of waste water in Montevideo, Uruguay. About 80 percent of the households and businesses in the area

are connected to sewer lines. But the lines run into main lines, which are drained directly into the estuarine water of the Rio de la Plata which surrounds the city. The waste water flows directly into waters adjacent to the municipal beaches. The project involves collecting the waste water at the mouth of the drainage pipes into one main outlet pipe and shipping the waste water well out into the estuary. There would be no primary treatment, simply disposing of the untreated water far enough out to eliminate the pollution of the immediate beaches.

In contrast to the Barbados case, the residents of Montevideo are well aware the water is polluted. Households are frequent users of the beaches. Municipal bus lines regularly pass popular beaches on their routes. And many residential neighbourhoods are within easy walking distance of various beaches. Local awareness of the beach pollution arose from extensive publicity surrounding the beaches in 1985. During that time, the level and meaning of the faecal coliform counts at various beaches became a subject of television and local papers. The coliform counts were quite high. The average for all sites for a study in 1978 was about 5,000 per 100 ml. For some sites the average was over 80,000 per 100 ml. In contrast, beaches in the Chesapeake Bay are closed when the count goes above 500 per 100ml.

The specific project to be analyzed in Montevideo concerned the second phase of the sewer project. The first phase, collector pipes for beaches along the eastern part of the Montevideo shoreline, is ready for construction. The beaches to the east are far more popular. They have better sand and wave characteristics. The second phase concerns collectors to the west of Point Carreta. The project involves installing more collectors, after the beaches to the east have been cleaned up. However, the benefit-cost analysis must be done before the initial project is completed and its effects felt on the water quality. Consequently, the contingent valuation must be of a conditional sort. The referendum questions deal with willingness-to-pay for the second project, requiring the respondent to assume that the first project is completed. The respondent is given the following introduction to the referendum:

As you know, the beaches of Montevideo are contaminated. Suppose that the beaches to the east of Point Carreta are cleaned up enough to allow swimming and other water activities.

The respondent is offered the following choices:

pay a randomly varied additional amount for municipal taxes and obtain cleaner water for the beaches west of Point Carreta, assuming that the beaches east have already been cleaned up

or

not pay the additional tax and continue to have highly polluted water in the beaches to be cleaned up by the second phase of the project.

The relevance of the first and second stages is simply the impact of substitutes on consumer surplus. When a good has easily accessible substitutes, its elasticity will be greater and its consumer surplus less. When the eastern beaches are clean, the demand for cleaning up the western beach will be less and the willingness-to-pay for making it cleaner also less.

The questionnaire was given in person to 1,500 randomly sampled households in Montevideo. The questionnaire underwent testing with a focus group and pilot testing of several versions of the questionnaire. The instrument was administered to household heads by experienced interviewers who were employees of a well known survey company.

The model shows how responses to the question were fitted to a relationship:

(5) Probability (yes to the question)

$$= e_0 + e_1 y + e_2 dwest + e_3 d + e_4 age - {}_y w$$

where

$y = 1$ if household income above the low income level;

$dwest = 1$ for households who are planning on using beaches in the western area in the future;

$d = 1$ if the household is a beach-going household;

$age = 1$ if household head is less than 60 years old;

$w = $ randomly varied municipal tax.

This model squares well with intuition. The impact of the proposed payment is negative and strongly significant. Age, income status and being a beach-going household increase the chance of saying yes. The dummy on planned future use of the western beaches, the ones to be cleaned up by the project, is also strongly significant.

The willingness-to-pay is calculated as

$$Ew = (e_0 + e_1 y + e_2 dwest + e_3 d + e_4 age)/{}_y.$$

Using the parameters estimated from equation (6), the mean willingness-to-pay is $US14 per year. This is less than one percent of the median family income. Depending on how individuals view the future, this may be low by the standards of Barbados. It may represent some strategic behaviour induced by the vehicle of a municipal tax. The tax seemed a natural vehicle, but feedback from the interview process suggested that it was an unpopular option.

### 3.5.4 Discussion

Contingent valuation studies in Barbados and Montevideo, Uruguay have estimated the willing-

ness-to-pay for installing various components of a sewer system. In Barbados, the willingness-to-pay for the lifetime of services was estimated to be $US178 while in Uruguay, the annual willingness-to-pay was estimated to be $US14. There is no particular reason why they should be equal, because the services they are purchasing are different. However, at a personal discount rate of 7.86 per cent they are equal. These results require a number of caveats, and one should generalize cautiously. Nevertheless, there are some insights to be gained from these studies.

First, do these studies provide evidence that households in these countries value environmental quality? The studies address the benefits of an improvement in environmental quality. This improvement is valued in most cases because environmental quality is complementary to the recreational commodity consumed by the household. That is, the improvement is valued by the individual for its contribution to utility, and it will not necessarily provide increases in real money income. The answer to this question, which is of course conditioned by one's faith in these particular contingent valuation studies, is affirmative. There are two sorts of evidence. First, in all three studies, households exhibit a mean willingness-to-pay for the environmental services. The second sort of evidence comes from the estimated models. Despite the conditional and uncertain nature of the environmental effect, the two cases share some promising characteristics. The surveys were not designed to test for strategic bias. But there is evidence that the hypothetical nature of the questions did not render the resources purely random. Responses in both fitted models are significantly influenced by access and economic characteristics in expected ways. Random responses would not be significantly related to regressors. However, the explanatory power of turn models, in terms of pseudo $R^2$'s is low, ranging from .23 to .10. Thus there is much about the responses that is not explained.

Some details of the estimated models are systematic. Each model shows that beach users are willing to pay more for the improvement than households who do not use the beach. This specific result, basically an implication of weak complementarity, stems from the significance of d, the beach going dummy, in each equation. In a broad sense, people respond to the referendum questions as if they have preferences for environmental improvements, and these preferences are compatible with what we expect from the simplest economic theory.

Several temporal aspects of contingent valuation studies arise in project analysis in developing countries, and have not been faced by most CV users in the U.S. One of these is the time pattern of the payment. In very large projects such as sewer systems, the present discounted value of the costs is quite high. Only in a well functioning credit market are households indifferent between different paths of payments which have the same discounted value. In many developing economies, credit markets are highly imperfect. One stream of payments is not equivalent to the discounted value of another stream. And because the costs are so high and credit markets so imperfect, households would all reply no to a referendum that queried them about a range of cost figures centred around the mean present discounted cost of the project.

This temporal issue leads to another. Since most households will not pay the present discounted value of the mean cost, the payment must have a time element. For example, the question may ask the household head whether she/he would pay an increment to the water bill for the next three years. Or the question may involve an increase in taxes indefinitely. This time path of payments requires some assumptions about the household's temporal preferences. An even more troublesome problem occurs in countries where the rate of inflation has been historically high. For example, in Uruguay, the annual inflation rate in consumer goods was about 70 percent when the survey was conducted. With high and persistent inflation, people are quite sophisticated about the real value of payments at different times. In such settings, the researcher needs to develop a method to fix the price level at which the respondent evaluates the proposed payment. We can expect that anticipated inflation and personal time preferences will be embodied in the respondent's answers.

The absence of market data and the need to value environmental components of projects in developing countries will put pressure on researchers to use and improve contingent valuation methods for valuing environmental quality. One of the difficulties for lending agencies stems from the modest success of the trials discussed here. If these studies had failed, then it would be easy to say the method does not work. But there is no evidence of failure, in the sense of outlandish implied results of the model or inability to administer the questionnaire. Typically, contingent value research has been directed towards improving the method, testing the sensitivity to various forms of payment, checking for bias by varying the questions in an experimental design, and so forth. Further, there is a growing sense of how to do studies. But what a lending officer needs is a way to ferret out bad studies from good ones, ex post. For example, the statistical analysis of why people answered yes, no, or refused to respond could prove insightful.

## 3.6 Opportunity Cost Approach and Contingent Valuation: Forest Functions in Madagascar

Kramer, R. A., N. Sharma, P. Shyamsundar, and M. Munasinghe. *Cost and Compensation Issues in Protecting Tropical Rainforests: Case Study of Madagascar*, Environment Department Working Paper, World Bank, Washington DC, 1994.

### 3.6.1 Introduction

Tropical countries in Africa are putting greater emphasis on management and protection of intact rainforests. Preservation of tropical rainforests has significant social, economic, and environmental impacts. Protecting forests gives rise to benefits in terms of conservation of biodiversity and maintenance of environmental services, but there are also negative impacts borne by people living adjacent to protected areas who depend on these forests for their livelihoods. Often traditional use rights to the forest are lost when large areas of tropical rainforests are protected or converted to other uses.

Development projects have often failed to take into account the opportunity costs of people with traditional rights to forests where large forest areas are protected or converted to other land use activities. The failure to adequately compensate or involve people in the establishment and management of protected areas has resulted in poor performance of many projects dealing with reserves and natural parks. In many instances, these parks and reserve areas are vulnerable to open access problems from local populations.

This study analyses the economic and social impacts of establishing the Mantadia National Park in Madagascar on village households living adjacent to tropical rainforests in the Andasibe region. Two methods are used to estimate the economic impacts on the villagers: (1) opportunity cost analysis based on household cash flow models constructed from a socioeconomic survey; and (2) contingent valuation analysis based on direct questioning of villagers about required levels of compensation.

The Mantadia National Park does not have any human settlements within its boundaries, but has villages in close proximity, mainly in the south, east and north east. These villagers are dependent on the forests within the park and immediately around it for forest products and for agriculture. The primary source of livelihood in these areas is shifting cultivation, a major cause of deforestation in the park area. Villagers in this area are also dependent on the forests for a number of other reasons. Fuelwood is collected from the forests on a regular basis, a wide variety of fish and animals are foraged for consumption and a number of different types of grass are harvested and used for assorted purposes. Forest plants and herbs also serve as sources of medicine.

### 3.6.2 Data Collection And Field Procedures

In order to assess the extent of the dependence of villagers on the forests, a socioeconomic survey was conducted of 351 households living near the park. The survey included a series of questions on economic activities related to use of agricultural land, the forest, and household labour. An additional component of the survey was a contingent valuation exercise to assess villagers' willingness-to-accept compensation for loss of access to the park.

This survey was accomplished with the assistance of a local NGO well versed in rural survey techniques. The household survey was refined based on focus group interviews, conversations with various people who were well acquainted with the area, and a pre-test which covered about 25 households. In addition, a shorter questionnaire was administered to village leaders to obtain information on village history, agriculture, and land use practices. To increase the villagers' willingness to participate in the survey, a health team of doctors and nurses was organized to accompany the survey team. The health team provided basic medical consultations and medicines to the villagers who have very little access to health services.

To estimate the opportunity cost to villagers of establishing the Mantadia National Park, cash flow analysis was used. Income from agricultural and forestry activities was estimated for three different groups of villages. The villages were grouped to reflect similar socioeconomic characteristics. Then, depending on the extent to which land in the park had been used by villagers for gathering forest products and practising shifting agriculture (based on analysis of aerial photographs of the park), estimates were made of the income losses associated with the loss of access to park land.

Each of the three cash flow models measured the economic benefits from the forests within the park to the locals *if* they continued to have access to the park. (This is the "without park" scenario.) The regulations under which the park has been formulated indicate that the villagers will not be allowed to use the area within the park for shifting cultivation or forest product harvesting (the "with park" scenario). The cash flows, therefore, estimate the value of land to the average household assuming a "without park" scenario. This value is equivalent to the opportunity cost of establishing the park to the average household. Monte Carlo simulation was used to examine the effects of fluctuations in key variables on the cash flows.

The second valuation method used in this study was the contingent valuation method (CVM). The CVM

questions used a willingness-to-accept format. The pre-test conducted suggested that while property rights over forested land are held by the state, the people in this region have been using forest resources for a long time, and they perceive that they have traditional rights to the land. Willingness-to-accept seemed not only the most appropriate format to use, but also the only way to obtain meaningful responses.

Because several of the villages surveyed had limited involvement in the cash economy, the numeraire used in the survey to obtain WTA bids was rice. Rice is the main crop in this region and its value is well understood. Furthermore, some amount of rice is also sold or bartered, and transactions of rice are thus known and understood by the local people. The unit of measure used was a 'vata', which is a locally-used unit for rice transactions, equalling 30 kilograms of rice.

Prior to posing the contingent valuation question, the respondents were asked a series of questions prompting them to begin thinking about the benefits drawn from the park. These questions probed perceptions on different aspects related to the forests like flooding, soil erosion, ancestral traditions, wildlife as destroyers of crops, availability of primary forests in the future, etc. Respondents were also asked if they knew about the park and about their perceptions on the use of buffer zones as alternatives to the forests in the park.

The contingent valuation question used was:

*Suppose you are asked to use only the buffer zone set aside for collecting forest products and for growing crops and are asked not to use the rest of the forests any more. Suppose in order to make up for asking you not to use the forests in the park, you are given _____ vata of rice every year from now on. Would this make you as content as before when you could use the forest in the national park?*

Respondents were randomly assigned to seven groups, corresponding to different amounts of rice used as the offered bid levels.

### 3.6.3 Results Of The Analysis

The household survey covered a total of 17 villages lying to the east and south of the Mantadia region. The total population covered by the household survey was 1,598, indicating that the average household size in this region is 4.6 persons. Most of the villages do not have access to any medical facilities, running tap water, or electricity. The village children in general suffer from malnourishment. Malaria, chest congestion-related illnesses, and venereal diseases are other significant health problems affecting this population. In general, most of the villages surveyed either had or were within 4-5 kilometres from primary school facilities. However, the survey indicated the average number of years of education per person to be only 2.4 years.

Rice production is the primary economic activity in the area. The average household produces 487 kgs of paddy rice per year worth about US $128. Most households also engage in shifting cultivation. Eighty percent of the households surveyed said that they would add to existing land for cultivation. Other crops grown are maize, beans, manioc, sweet potato, taro, sugar cane, ginger, banana, and coffee.

Based on the data collected on agricultural and forestry inputs and outputs, the cash flow models were used to estimate the opportunity costs borne by the villages as a result of lost access to the forests in the park. Averaging over the results obtained from the three cash flow models, the mean value of losses was $91 per household per year (Table 1). Aggregating over all households living in the vicinity of the park and using a 10 per cent discount rate and twenty year time horizon, the net present value of the opportunity costs was estimated to be $566,000.

**Table 3.6.1 Summary Of Economic Analysis Of Mantadia National Park**

**Estimates of Economic Losses to Local Villagers from Establishment of Mantadia National Park**

| Method Used | Annual Mean Value per Household | Aggregate Net Present Value |
|---|---|---|
| Opportunity Cost | $91 | $566,000 |
| Contingent Valuation | $108 | $673,000 |

The contingent valuation responses were analyzed with an econometric model. The discrete choice responses were used to estimate a bid function in a logistic regression framework. The estimated bid model revealed that a number of socioeconomic variables were systematically related to the probability of accepting offered bids. The bid level itself was a positive and significant explainer of responses. The model correctly predicted 86 percent of the responses, clearly indicating that the elicited responses were non-random. From the estimated bid function, a mean bid was calculated. The responses to the contingent valuation questions indicate that on average, a compensation of rice equivalent in value to $108 per year per household would make households as well off with the park as without (Table 1). Aggregating over the population in the park area, this implies a necessary one time compensation of approximately $673,000 assuming a 10 per cent discount rate and twenty year time horizon.

### 3.6.4 Discussion

The Mantadia National Park has been established with the intention of preserving Madagascar's unique biological heritage. While the benefits of conserving the fauna and flora and the biological diversity within the park are large, some very significant opportunity costs must be considered, as a necessary condition, to avoid open access problems that will threaten the existence of the park in the long run. Approximately 3,400 people in three sets of villages will be negatively affected by the park. The results suggest that an annual compensation of approximately $100 per household would be required. Such compensation could be made in the form of education, health facilities, alternative income earning enterprises in the buffer zone, or other development activities. These compensation costs appear to be a significant part of the true cost of implementing protected area projects and should be built into project design at an early stage. Without adequate compensation and active cooperation of local residents, natural resource management projects are more likely to fail.

The cash flow approach used in this study is a relatively simple, but data-intensive form of analysis. It is a powerful tool for understanding the inter-relationship among microeconomic factors relating to use and management of parks. In this study, contingent valuation was also used to estimate the welfare change perceived by local residents as a result of loss of access to lands currently within the Mantadia National Park. The analysis indicates that CVM, rigorously applied, can be effectively used in the developing country context. The econometric analysis undertaken indicates a systematic association between various socio-economic variables of interest and the expressed WTA compensation. Also, the opportunity cost (or market based) approach and the CV method provided remarkably comparable estimates of costs borne by villages. All this is encouraging evidence to support the use of CV in such a context, but further research is required to improve its widespread applicability.

Several lessons can be drawn from this study. This research has involved a survey of village households, collection of data on various quantities and prices, and rigorous quantitative analysis. Research of this kind is time-intensive. It is apparent that there is a strong need for a significant amount of pre-survey work to draft a useful survey instrument. There is a need for focus groups and a formal pre-test to sharpen the wording of the questions so that the desired information can be collected. For example, it was found that units of measure for forest products varied between villages only a few kilometres apart. There is a need for involving local sociologists and cultural anthropologists (as was done in this study) who can ensure that the questions are posed appropriately for the local cultural context, and to advise researchers on the appropriate protocol for approaching local village leaders to ensure their cooperation. In this instance, it was found advantageous to provide an incentive for survey participation by arranging to have a health team accompany the interviewers Of course, careful translation into local languages is also a necessary step, as is thorough training of interviewers. The study team worked with an experienced rural survey group, but found that extensive training was still necessary. This was in part due to the fact that they were unfamiliar with the contingent valuation method. Despite the considerable effort required to collect the data gathered for this village study, this information is critically important for implementing conservation projects, and can be collected when baseline information about residents within or around conservation areas is gathered.

### 3.7 Random Utility Model: Water Supply in Pakistan

Altaf, M. A, H Jamal, J. L. Liu, V. Kerry Smith, and D. Whittington, *A Random Utility Model for Connections to Public Water Systems in Developing Countries: A Case Study of the Punjab, Pakistan*. Working Paper. Department of Economics, North Carolina State University, Raleigh, North Carolina. June, 1991.

### 3.7.1 Introduction

Water utilities typically need a high percentage of households to connect to a piped water supply system so that revenues are sufficient to cover capital and operating costs. In industrialized countries the vast majority of households that are offered the option of connecting to a piped water supply system choose to do so, and such households usually use water from this piped system as their sole source of supply. In many developing countries this is not the case. For a variety of reasons, many households decide not to connect to piped water systems and, even if they do, also use other sources of water. Sound water supply planning in developing countries thus requires an understanding of the factors that influence a household's decision on whether or not to connect to a piped water system.

Little systematic empirical research has, however, been undertaken on this subject. Water supply planners often simply assume that a household will connect to a piped water system if the monthly tariff is less than 3-5 percent of income. This rule of thumb has proved to be a poor predictor of household behaviour. This paper reports the first economic analysis of a household's decision to connect to a public piped water supply system based on a behaviourally consistent theoretical framework. A

random utility model (RUM) was used that described the connection decision as a discrete choice: whether to connect or not to an existing public water system. This model considered the effects of cost factors and demographic and attitudinal variables on these decisions. Because the model is consistent with constrained utility-maximizing behaviour, it was also used to estimate households' consumer surplus from piped water connections.

### 3.7.2 Data Collection And Field Procedures

The data used in this research came from 378 household interviews conducted in five villages in the Punjab, Pakistan. All of the villages had piped water systems. Some households had decided to connect, and others had not. These connection decisions took place over a fourteen year period. Connection involved multiple costs for a household: a one-time connection fee, the private cost of connecting to the distribution line and installing the associated indoor plumbing, and a monthly tariff. The prices faced by households varied with each village, as well as with the time they made their decisions.

The five study villages were located in two districts of the Punjab: Skeikhupura and Faisalabad. Historically, public open wells were the primary source of drinking and cooking water in both districts. Over the last couple of decades, both districts have experienced a transition in households' water supplies: community wells have been replaced by private handpumps inside the home. For villages in the Sheikhupura (or "sweetwater") district, groundwater is readily available and is universally perceived to be of good quality. The Faisalabad district has experienced the same transition to private handpumps as the Sheikhupura district, but the Faisalabad district has poor quality ("brackish") groundwater. Here 54 percent of the households with the option to connect to a piped system rely on water sources other than groundwater from private handpumps for their drinking and cooking water. In the Faisalabad district water from private handpumps is used largely for washing and for animals. Some households in both districts (nearly 20 percent in Sheikhupura and 50 percent in Faisalabad) have electric motors to pump water into an overhead tank for distribution throughout the house via indoor plumbing.

A house connection to a piped water system is considered to be an increment to a household's existing handpump (and/or electric motor) systems for water in the home. For households in the sweetwater district, a private connection to a public water supply system allows installation of indoor plumbing for those without electric motors, and it may improve the reliability of their overall water supply. In the brackish district a private connection

will provide the same opportunities to introduce indoor plumbing and improve overall reliability, but it will also provide high-quality drinking and cooking water in the home.

Piped water systems have been available for different lengths of time in each of the villages in our sample. In the sweetwater district, the average time was about twelve years. In the brackish district, one village in the sample had a piped water system introduced only seven months before the survey. Respondents were asked in the survey when their household connected (if they had) and the prices and costs incurred at that time. Because households connected at different times and the nominal tariffs and connection fees were largely constant for each system, the real prices households paid to connect varied considerably because of general inflation. This change in real water tariffs and connection fees allowed the authors to observe how connection decisions were influenced by the relative prices of access to piped water.

The personal interviews were administered in the Punjabi language to an adult male, usually the head of the household, during March and August, 1988. The surveys collected information on each household's economic and demographic profile and patterns of water use, as well as other information about their attitudes and valuation of public piped water supplies. Because tariff collection and cost recovery practices in the study villages were erratic, in most cases the authors used household reports for the three components of the costs of connection: the tariff (and the frequency with which it was collected), the connection fee paid at the time of connection, and the costs to bring the water from the distribution line into each house. For some households the officially stated terms for the tariff and connection fees were used.

While the cost of bringing water from the distribution line to the house would be known by households connecting, non-connecting households might be expected to have incomplete information on these costs. In the survey these households were asked to estimate these costs. The cost estimates provided by connecting and non-connecting households were each regressed on the distances respondents reported for the distance from the distribution line to their homes. Actual costs were found to bear a strong relationship to distance, while estimated costs did not. The authors assumed that all of the households faced the same cost function per metre for these services and used distance as a measure of this component of the connection cost. Both the monthly tariff and the connection cost were deflated using the International Monetary Fund's consumer price index for Pakistan.

### 3.7.3 Results

Probit models were used to explain the households' decisions on whether or not to connect to the piped water systems as a function of the costs of connection, socioeconomic and demographic characteristics of the household, respondents' attitudes, and the households' existing water supply situation. The results indicate that in both districts all three components of costs -- the tariff, connection fee, and hookup costs (as measured by distance) -- are statistically significant negative influences on connection decisions. Moreover, as expected, the one-time costs have a smaller effect on the likelihood of connection than the tariffs, reflecting some form of annualization of these costs over the perceived lifetime of the system.

The model results for the demographic and attitudinal variables offer a number of interesting insights. First, education is a positive and generally significant determinant of the connection decision in both the sweetwater and brackish districts. Second, in both districts family size is a positive, significant influence on the connection decision. This is consistent with *a priori* expectations.

Third, the measures used to describe the household's labour supply available to collect water from sources outside the home (i.e., the proportion of children and women in the household) have quite different effects on connection decisions in the two districts. In the brackish district both the proportion of women and the proportion of children variables are negative influences on the connection decision, but only the latter is statistically significant. In contrast, in the sweetwater district the proportion of women and proportion of children variables are positive influences on the connection decision. (The latter is statistically significant in only some of the models.) The negative, significant effect of the proportion of children in the brackish district would be consistent with an expectation that household members not involved in market work would have responsibility for fetching water from alternative supplies.

The models for both districts included a qualitative variable indicating whether a household feels that the government should provide the water supply free. In both cases this has a negative effect on connections, as expected. The models for the brackish district included a variable that indicated whether the respondent felt that metering household water supplies was a good idea. A positive attitude toward metering had the expected positive and significant effect on the connection decision.

The authors used the parameter estimates from the probit models of the determinants of the connection decision to evaluate how the three components of the costs of a piped water supply affected the economic benefits households realized from connecting to piped water systems. To construct consumer surplus measures for access to piped water systems, the authors assumed that the measures correspond to the maximum amount the household would be willing to pay for the service annually, given the terms on which private connections were available in each district. In other words, it was the excess willing to pay over and above the costs of a connection. This corresponds to the annual tariff increment that would make a household indifferent between connecting or not connecting. Estimates of consumer surplus were calculated for each household in the sample.

Table 1 reports the results based on the parameter estimates from one of the probit model estimations (the consumer surplus estimates were quite stable over model specifications). Average estimates of consumer surplus are presented for households in both the brackish and sweetwater districts and for connecting and non-connecting households. As shown, willingness-to-pay estimates were approximately comparable across districts. (Note that since prices are different in the two districts, the incremental willingness-to-pay estimates are measured with respect to different baseline costs). As expected, some of the estimates are negative, and more negative estimates result for households that chose not to connect.

### 3.7.4 Discussion

The findings from this study suggest that household demand for piped water supplies in developing countries can be effectively modeled using a random utility framework. In this specific application, both one-time connection costs and monthly tariffs were found to influence connection decisions. The study results showed a difference in the effect of one-time connection costs and monthly tariffs on household connection decisions.

The authors emphasize the policy importance of any difference in the time horizon and rate of time preference between the water authority and the household. If the water authority and the household do not have similar planning horizons and discount rates, then household welfare can be improved simply by adapting to this difference. For example, if the water authority has better access to capital markets than rural households, there is scope for arbitrage based on the differences in annualization adjustments between the water authority and households. In practice, this would mean that the water authority should borrow to provide financing for households to pay connection fees and connection costs over time.

For example, if it is assumed that the water author-

ity considered its time horizon to be indefinite (i.e., greater than 70 years) and faced a 10 percent real rate of discount, then an annual tariff of 10 rupees would be equivalent, from the water authority's perspective, to a fixed charge of 100 rupees. To determine whether their model results indicated an opportunity for arbitrage, the authors considered this kind of information in relation to what a household perceives as equivalent changes in its fixed versus annual charges. Their model results for households in the sweetwater district suggest that the implicit annualization of capital charges makes one-time connection charges a more significant deterrent to connection than the tariff. The results for households in the brackish water district suggest the opposite.

The authors argue that in order to correctly evaluate alternative water pricing policies, one must consider the importance of tariffs versus one-time charges, a household's time horizon, rate of time preference, and borrowing and lending rates in local credit markets, as well as these same issues from the perspective of the water authority. Available studies in industrialized countries on how households evaluate one-time capital charges versus continuing tariffs imply high rates of discount to "rationalize" ex-post observed decisions. However, from the perspective of a decision maker in the water authority, the time preferences of different households should be considered largely unknown. In this case a strong argument can be made that the water authority should offer households financing for one-time connection charges at a non-subsidized rate. If some households choose to accept this offer, the water authority has provided these customers a valuable service: these households benefit from the transaction and the water authority has not incurred any costs to itself.

**Table 3.7.1: Estimates of Annual Household Consumer Surplus for Connection to Piped Water System (in 1985 Rupees)**

| Annual Consumer Surplus[1] for Households that... | | |
|---|---|---|
| | Connected to a Piped Water System | Did **Not** Connect to a Piped Water System |
| Sweetwater District | | |
| Mean | 78 | 26 |
| Min | -0.6 | -38 |
| Max | 282 | 108 |
| Standard Dev. | 54 | 30 |
| N | 121 | 61 |
| Brackish Water District | | |
| Mean | 43 | 19 |
| Min | -21 | -94 |
| Max | 133 | 54 |
| Standard Dev. | 24 | 24 |
| N | 148 | 50 |

[1] The calculations for these estimates of consumer surplus used the individual household characteristics and reported values for all variables except the tariff. For both districts the tariff was set at the average value. For the sweetwater district this was 102 rupees per year, and for the brackish district this was 119 rupees per year.

**3.8 Contingent Valuation: Water Quality in the Philippines**

Choe, K. A., D. Whittington, and D. T. Lauria. *Household Demand for Surface Water Quality Improvements in the Philippines: A Case Study of Davao City.* The Environment Department, World Bank. Washington D.C., 1994.

**3.8.1 Introduction**

Until recently, the conventional wisdom in the development community has been that most people in developing countries do not value improvements in environmental quality, either because they are unaware of the problem or because they cannot afford to pay for it. It was thus argued that investments in such areas as water pollution control either had to be postponed until per capita incomes were substantially higher, or would have to be heavily subsidized by central government.

The wisdom of the latter course was generally questioned by economists, who believed that the benefits of such investments were likely to be small because environmental quality improvements were a low priority for poor households.

However, over the last few years environmentalists

and many members of the development community have questioned whether investments in environmental quality improvements should wait until incomes rise. They have argued that economic development and improvements in environmental quality are in fact complementary, not competing objectives. This argument that environmental quality should not be sacrificed for economic growth was the principal message of the United Nations Conference on Environment and Development in Rio de Janeiro in 1992.

This paper examines the question of the magnitude of household demand for environmental quality improvement in the context of a specific proposal: the clean up of the river and sea near Davao City, Philippines.

Davao City, the second largest city in the Philippines, is located on the island of Mindanao. The city is primarily in a strip of coastal plain alongside the Gulf of Davao. The Davao River and other rivers and streams run through Davao City into the Gulf. Most households have water-sealed toilets for their exclusive use; these empty into septic or holding tanks. Less than 1 percent of the population of Davao City is connected to a sewage collection system; the few small existing systems service a handful of upper income subdivisions. Mean monthly household income in Davao City was about 5100 pesos (US$204) in 1992.

Davao City has great potential for both domestic and foreign tourism. There are many beautiful tropical beaches located on several small islands in the Gulf of Davao, and numerous beach resorts have been built on these islands for picnicking, fishing, snorkeling, and overnight stays. However, these island resorts are too expensive for the majority of the population of Davao City. Until 1992 most residents of Davao City used the local beaches very near the urban areas, the most popular of which was Times Beach. Travel time to Times Beach is only about 10 minutes by bus or taxi from most parts of Davao City. The sea at Times Beach is polluted by the nearby discharge of the Davao River, which carries silt, stormwater drainage, and household and industrial waste water from the Davao City. Human waste from coastal squatter settlements near the mouth of the Davao River also contributes to the pollution.

In the past, literally thousands of residents of Davao City would use these nearby local beaches for picnicking and swimming on weekends. However, in early 1992 the City Health Department found very high levels of faecal coliforms and pathogens in the water and issued a series of warnings to the public about the health risks of swimming at the beach. There was much publicity in the local media about this problem, and most people stopped using Times

Beach. In November and December, 1992, a contingent valuation survey was carried out to determine how much households in Davao City would be willing to pay for improved water quality in nearby rivers and the sea; these improvements would result in increased recreational opportunities and possible public health improvements for residents of Davao City.

### 3.8.2 Field Work And Data Collection Procedures

In order to implement the contingent valuation survey, thirty individuals from local universities and government agencies were trained to administer household questionnaires. All were experienced in conducting household surveys in Davao City or neighbouring areas. Three faculty members from the University of Mindanao, all with survey experience, were hired to supervise these enumerators.

The household questionnaire itself was developed over a two-week period of intensive collaboration with the enumerators and field supervisors. The enumerators and field supervisors actively participated in decisions on which questions to include and their wording and translation. Interviews were conducted in Cebuano. Numerous focus groups were held to discuss water pollution problems. Several pretests of the questionnaire were carried out with about 200 households before the questionnaire was finalized.

All of the versions of the survey instrument included an introductory section with questions about the household's and respondent's demographic characteristics after which there followed five basic parts. The first and second parts focused on the household's existing water and sanitation situation, and its level of satisfaction with these services. The third part sought information on the respondent's priorities for environmental improvements, use of beaches near Davao City, and knowledge and level of concern about water pollution problems. The fourth part included questions about the household's willingness-to-pay for improvements in water pollution problems if these were offered at different prices. Finally, the fifth part of each questionnaire included questions about the socioeconomic characteristics and housing conditions of the household.

A referendum question was used to measure household demand for water quality improvements. Respondents were asked to assume that there was a city-wide plan to clean up the rivers and sea and make Times Beach safe again for swimming. They were not told specifically what this plan would entail. Households were told that if this hypothetical plan were adopted, each household would be required to pay a monthly fee and that industries would also do their fair share to reduce waste water

discharges to the river. Respondents were then asked to vote on whether their household would support such a plan at the specified monthly price. Different monthly fees were randomly assigned to different households. Households with private water connections were told that this monthly fee would be added to their water bill.

A total of 581 in-person interviews were completed with respondents throughout Davao City in which this kind of referendum question was asked about a city-wide plan to improve water quality. The overall response rate was 65 per cent. Thirty-two per cent of the households in the sample could not be located by enumerators. Only 3 per cent of the total number of households in the sample refused to be interviewed.

### 3.8.3 Results Of The Analysis

Statistical methods were used to examine how respondents' answers to the referendum questions were influenced by different randomly assigned monthly fees. Figure 1 shows the relationship between the probability of the respondent voting for the city-wide plan for improving water quality and the monthly fee proposed for two different assumed distributions of the responses (Weibull and log-normal). As illustrated, for both assumed distributions, the support for the water quality improvement plan falls sharply as the monthly fee increases. At a price of 25 pesos per month (US$1), one half of the sample households would support the plan. At a price of 50 pesos per month, 25 per cent of the households would vote for the water quality improvement plan.

Multivariate techniques were used to see how respondents' answers to the referendum questions were related to socioeconomic characteristics of the household and to estimate the mean willingness-to-pay of different types of households. The results show that household willingness-to-pay for water quality improvements is low, both in absolute terms and as a percentage of income. Not only was household willingness-to-pay for improved water quality low in Davao City, but 15 per cent of the respondents refused to pay anything at all.

Several results from the research suggest that these low estimates of willingness-to-pay for surface water quality improvements are likely to reflect respondents' true preferences. First, the statistical analysis of respondents' answers to the referendum questions unambiguously indicate that the respondents' answers to the first referendum question asked depended on the monthly price offered. For example, not a single respondent who was offered the plan for 200 pesos per month voted for it. These results suggest that the estimates of household willingness-to-pay are not likely to be biased by

respondents agreeing to pay prices they cannot afford.

Second, the results of multivariate analyses of the determinants of the responses to the referendum questions show clearly that households with higher incomes are willing-to-pay more for environmental improvements than households with lower incomes. If the income of the average respondent in Davao City were to double, household willingness-to-pay for water quality improvements would increase by about 20 per cent. Also, households that used Times Beach were willing to pay about 30 pesos per month (about 0.6 percent of mean household income); non users were willing-to-pay almost nothing. Such findings provide further evidence that respondents considered their personal circumstances and budget constraint when answering the willingness-to-pay questions.

Third, these low estimates of household willingness-to-pay are consistent with information collected in the household survey about households social and environmental attitudes and priorities. The answers respondents gave to attitudinal questions concerning environmental priorities confirm that reducing water pollution is not a high priority for residents of Davao City. When asked to select their first priority for government action from a list of eight environmental problems, less than 10 per cent of the respondents selected water pollution in rivers and along the seashore. (This is true even for households living near the sea and along the river.) Although water pollution is not perceived to be a pressing problem, people are aware of water pollution problems and have taken actions to avoid the risks associated with this environmental contamination. For example, a large majority of respondents reported that the water quality of the sea near Davao City had become 'much worse' and that the 'suitability of the sea near Davao City for swimming and bathing' had become 'much worse' over the last twenty years. Over 90 per cent of the respondents said that they had heard about pollution problems in Times Beach. Eighty percent of the respondents said that they had not gone swimming or bathing at Times Beach since the public health alert, and almost 40 per cent of these respondents said that the reason they had not been to Times Beach in the past year was because *it was too dirty*. About 10 per cent of the sample respondents reported that they do not eat seaweed or shellfish collected from the sea near Davao City *because of concerns about contamination.*

### 3.8.4 Discussion

When willingness-to-pay for pollution abatement is low, it is often argued that subsidies are required due to the presence of externalities and lack of knowledge of public health risks. In Davao City

these arguments seem less compelling. The externalities associated with lack of waste water treatment do not fall on downstream communities but largely on the residents themselves. Thus the damages from water pollution are largely borne by the community creating the problem and are thus already "internalized". Moreover, the reason willingness-to-pay is low is not because households are unaware of the problems caused by water pollution. Indeed, many residents of Davao City have already changed their behaviour significantly to avoid the risks of water pollution. This finding suggests that public education campaigns or social marketing efforts designed to increase household demand for sewer connections are not likely to have a dramatic effect on willingness-to-pay.

The analyses of the data collected in this contingent valuation survey in Davao City confirm the conventional wisdom about household demand for environmental improvements in developing countries. Water pollution control is simply not a high priority for residents of Davao City; households are willing to pay very little of their income for water quality improvements and beach clean-up, both in absolute terms and as a percent of their income.

People do feel that they have lost valuable recreational opportunities as a result of water pollution, and many are concerned about possible food contamination. But these are not major problems in their lives compared to other more pressing concerns. Because households' willingness-to-pay for water quality improvements in Davao City is much lower than the costs of providing such improvements, and because other environmental problems such as deforestation and poor solid waste collection and disposal appear to deserve higher priority, the appropriate strategy appears to be to wait until incomes are higher and willingness-to-pay has risen before embarking on a large water pollution control investment program.

### 3.9 Production Function Analysis: Afforestation Benefits in Nigeria

D.Anderson, *The Economics of Afforestation: a Case Study in Africa*, Johns Hopkins University Press, 1987; and D. Anderson, 'Economic Aspects of Afforestation and Soil Conservation Projects', in G. Schramm and J. Warford, *Environmental Management and Economic Development*, Johns Hopkins University Press, Baltimore, 1989, 172-184.

### 3.9.1 Introduction

Careful examination and measurement of the environmental benefits of afforestation can greatly increase the 'economic rate of return' to forestry investments. One study in northern Nigeria assessed the benefits of afforestation in northern Nigeria as:

- halting the future decline of soil fertility (since trees typically reduce soil erosion);
- raising current levels of soil fertility;
- producing tree products -- fuelwood, poles, fruits;
- producing fodder both from raised productivity of soils and from forest fodder.

### 3.9.2 Methodology

The methodology involved tracing each of the uses of local forests and valuing the relevant outputs at market or shadow prices. Thus, the leaves of the trees in the forest provided fodder for livestock. The fodder was collected for 'free' or could be sold in the market place. The value of the fodder could therefore be estimated directly by looking at market prices, or indirectly by estimating the effect of the fodder on livestock weight and hence livestock value. Not all forest benefits can be related so directly to market values, however. The trees in the agroforestry systems act as windbreaks, thus raising crop productivity. However, there is then no obvious market in that windbreaks are not bought and sold in the marketplace. But provided the resulting increase in crop productivity can be estimated, the economic value of the trees can be estimated via the effect on the output, and hence on the money value of crops.

### 3.9.3 Results

The net present values (NPVs) and economic rates of return (ERRs) that resulted for shelterbelts (planting trees mainly for wind protection) and farm forestry (intermixing trees and crops) were:

Shelterbelts Farm Forestry

|  | NPV | ERR | NPV | ERR |
| --- | --- | --- | --- | --- |
| Base case | 170 | 14.9 | 129 | 19.1 |
| Low yield, High cost | 110 | 13.1 | 70 | 14.5 |
| High yield | 221 | 16.2 | - | - |
| No erosion | 108 | 13.5 | 75 | 16.6 |
| More rapid erosion | 109 | 13.6 | 60 | 15.5 |
| Soil restored + yield jump | 263 | 16.9 | 203 | 21.8 |
| Wood benefits only(*) | -95 | 4.7 | -14 | 7.4 |

(* wood and fruit for farm forestry)

Calculation of timber costs and benefits alone in the Kano area have tended to show rates of return of around 5 per cent, which has to be compared with the cut-off rate which is usually much higher, at around 10 per cent. In other words, afforestation does not pay. But once the other benefits are included, dramatic increases in rates of return can be secured.

### 3.9.4 Discussion

The analysis shows that counting 'wood benefits' only produces negative net present value and correspondingly low economic rates of return. But if allowance is made for the effects of trees on crop yields, and for expected rates of soil erosion in the absence of afforestation, the picture is transformed for both farm forestry and shelterbelts.

### 3.10 Production Function Analysis of Health Costs of Air Pollution in Brazil

Seroa Da Motta, Ronaldo, and Ana Paula Fernandes Mendes, *Health Costs Associated with Air Pollution in Brazil*, Working Paper, Applied Economic Research Institute (IPEA), Rio de Janeiro, Brazil, April 1993

### 3.10.1 Introduction

The air quality in many cities in developing countries has deteriorated dramatically over the last few decades, and many efforts are currently being considered to address this problem. There are, however, very few estimates of the economic benefits that would result from air quality improvements in developing countries. Not only are there few estimates of the economic value of air quality improvements, but there are also few studies of the effect of air pollution on human health in developing countries.

This paper first presents an analysis of the relationship between air pollution in Sao Paulo and mortality rates. This dose-response relationship is then used in an analysis of the health care costs associated with air pollution in Sao Paulo and in two other Brazilian cities (Rio de Janeiro and Cubatao).

### 3.10.2 Data Collection Procedures

The analyses presented were based on secondary data available from several sources. Brazilian environmental law regulates emissions of particulate matter, carbon monoxide, ozone, sulphur dioxide, nitrogen oxide, nitrogen dioxide, hydrocarbons, and methane. (Concentrations of total particulate matter in Sao Paulo average 140 $\mu g/m^3$, well above the primary national air quality standard of 80 $\mu g/m^3$.) Daily times series data were available from the Environmental Sanitation Technology Company (Companhia de Tecnologia de Saneamento Ambiental) for particulate matter and sulphur dioxide at eleven air quality monitoring stations in Sao Paulo and for carbon monoxide and ozone, and nitrogen oxide at two stations. Because of the low number of deaths per day by district and subdistrict, a quarterly average of each of the air pollutants was calculated from daily air quality reports.

Data on mortality rates and average educational levels of residents in Sao Paulo were obtained from the State Data Analysis System Foundation (Fundacao Sistema Estadual de Analise de Dadaos) by district and subdistrict for the period 1983-1991. Data were also collected on the number of hospital beds by sanitary district and subdistrict in Sao Paulo. Data on the average number of hospitalizations per death and the average cost of hospitalization for respiratory system diseases were obtained from the Integrated Strategic Series Statistical Treatment System (Sistema Integrado de Tratamento Estatistico de Series Estrategicas).

### 3.10.3 Results of the Analysis

Statistical analyses were first done to examine the correlations between levels of various air pollutants. There was a strong correlation between the nitrogen compounds ($NO_x$, $NO$, and $NO_2$). A moderate correlation was found between carbon monoxide and nitrogen monoxide. With regard to the other pollutants, the correlations were not found to be significant. Based on these results, the authors decided to focus their analysis of the relationship between air pollution and health effects on five pollutants: inhalable particulate matter (PM10), carbon monoxide, ozone, sulphur dioxide ($SO_2$), and nitrogen dioxide.

Two linear regression analyses were conducted relating death rates from respiratory diseases to air quality, social and economic, and meteorological variables. Education was used as a proxy for all socioeconomic differences in residents in the different districts and subdistricts in Sao Paulo. The first regression analysis related the death rate from respiratory diseases in a district or subdistrict to particulate matter and sulphur dioxide. The results showed that particulate matter (PM10) was a statistically significant determinant of the death rate from respiratory disease, but that sulphur dioxide was not. The authors note, however, that for most of the period over which data were available, San Paulo was in compliance with sulphur dioxide ambient standards and that sulphur dioxide concentrations had fallen over time. The average temperature had a statistically significant and negative correlation with death rates from respiratory diseases.

Based on the coefficients from the first regression, the authors estimated that an increase of 10 $\mu g/m^3$ of inhalable particulate matter implies an average increase in the mortality rate from respiratory diseases of 1.6 percent. These results are consistent with findings from other countries. The authors calculated that a drop in the PM10 concentration from 89 $\mu g/m^3$ to the primary standard of 50 $\mu g/m^3$ would reduce the death rate from respiratory disease by about 6 percent.

Second, death rates from respiratory diseases were related to concentrations of carbon monoxide, ozone, and nitrogen dioxide. The authors found a

positive and statistically significant relationship between death rates and ozone concentrations. The authors estimated that a 1 percent reduction in ozone concentrations would lead to a 0.23 percent reduction in the mortality rate from respiratory disease.

The authors used the first regression (based on data from Sao Paulo) to estimate mortality rates from $PM_{10}$ and sulphur dioxide in three other Brazilian cities (Rio de Janeiro, Belo Horizonte, and Cubatao). These estimates were then compared with the actual death rates from respiratory diseases in these cities. Applying the functional relationship from Sao Paulo to Rio de Janeiro, the authors estimated a total of 1252 deaths due to respiratory disease in 1984. This was very close to the actual number recorded of 1273. The results for Belo Horizonte and Cubatao were similar. The authors thus concluded that the dose-response function estimated for San Paulo was applicable to other municipalities with different levels of air quality.

The next step in the authors' analysis was to estimate the health costs associated with air pollution in different Brazilian cities. These costs were assumed to have two main parts: (1) the monetary costs associated with patients' hospital stays due to respiratory diseases resulting from air pollution, and (2) the income lost by people from missed days of work and premature death due to respiratory diseases resulting from air pollution. No attempt was made to estimate the loss in human wellbeing caused by air pollution in terms of discomfort or pain suffered by city residents.

To calculate the hospital costs due to air pollution, the cost of a hospitalization resulting in a death was multiplied by the number of deaths associated with air pollution. This involved estimating the number of hospitalizations per death and the average length of each hospitalization. Table 3.10.1 summarizes the authors' estimates of the number of deaths from respiratory diseases associated with air pollution,

the hospital cost per death, and the total hospital costs due to air pollution, for Rio de Janeiro, Cubatao, and San Paulo. The total hospital costs resulting from air pollution in Sao Paulo for 1989 were estimated to be US$785,000.

The second component of the health costs, the foregone output from morbidity and mortality due to air pollution, was estimated based on the length of hospital stay and the average income of the patient, for different educational levels. The authors also had to determine the mortality rate curve for respiratory diseases due to air pollution using the estimated dose-response function. Data on the average income of the economically active population by education level was used to estimate the output lost from both lost work days and reduced longevity. The authors' estimates of the economic losses from morbidity and mortality due to air pollution are presented in Table 3.10.2.

By dividing foregone output due to air pollution mortality by the number of deaths associated with pollution from PM10, the authors calculated what they term an average 'statistical life value' for each of the cities studied. In 1989 US dollars, the estimated statistical life value for Sao Paulo was about US$7,700, US$5,000 for Rio de Janeiro in 1984, and US$25,000 for Cubatao in 1988. The authors report that these estimates are lower than similar calculations for water pollution that they have done.

### 3.10.4 Discussion

The authors conclude that the health care costs and productivity losses associated with air pollution in Brazilian cities are considerable. They argue that their estimates of the health-related costs of air pollution are necessary for policy deliberations on air quality control options in Brazil. The authors also suggest that these kind of estimates of the economic costs of air pollution are necessary for setting priorities among various environmental problems.

**Table 3.10.1: Hospital Costs per Death and Total Hospital Costs Due to Air Pollution, by City**

| Year | Municipality | Deaths Associated with Air Pollution | Hospital Costs per Death | Total Hospital Costs |
|------|--------------|--------------------------------------|--------------------------|----------------------|
| 1984 | Rio de Janeiro | 40 | US$3775 | US$151,000 |
| 1988 | Cubatao | 29 | US$4896 | US$142,000 |
| 1989 | Sao Paulo | 139 | US$5647 | US$785,000 |

**Table 3.10.2: Costs Associated with Air Pollution (US$/yr)**

|  | Sao Paulo (1989) | Rio de Janeiro (1984) | Cubatao (1988) |
|---|---|---|---|
| Hospital Costs | 785,000 | 151,000 | 142,000 |
| Morbidity Costs | 351,000 | 65,000 | 71,000 |
| Mortality Costs (discount rate =5%) | 1,073,000 | 201,000 | 725,000 |
| Total | 2,210,000 | 417,000 | 939,000 |

## 3.11 Production Function and Implicit Willingness-to-Pay for Unique Rainforest: Cameroun

J. Ruitenbeek, The Rainforest Supply Price: a Tool for Evaluating Rainforest Conservation Expenditures, *Ecological Economics*, Vol.6, No.1, July 1992, 57-78.

### 3.11.1 Introduction

Korup National Park lies in Southwest Province, Cameroun. It contains Africa's oldest rainforest, over 60 million years old, with high species endemism. There are over 1,000 species of plant, and 1,300 animal species including 119 mammals and 15 primates. Out of the total listed species, 60 occur nowhere else and 170 are currently listed as endangered. Continued land-use changes are putting substantial pressure on the rainforest. The World-wide Fund for Nature (WWF) initiated a programme of conservation, centred on a management area of 126,000 hectares plus a surrounding buffer sound of 300,000 hectares. A similar programme was initiated for Oban National Park just across the border in Nigeria (see map).

### 3.11.2 Methodology

Economic valuation of the rainforest's benefits was carried out in order to assist with the process of raising development aid funds to conserve the area. Estimating benefits was done via the production function approach, i.e by looking at the individual functions of the forest and valuing them at market or shadow prices.

The forgone forest benefits include timber from potential commercial logging (the #%# million CFA) and some forgone traditional uses of the forest, mainly hunting, that would be forbidden within a designated national park, and which cannot be offset by diverting activity elsewhere (the 223 million CFA). This proscription of traditional uses affects some 800 villagers within the national park boundaries. In the long run, however, other residents, mainly some 12,000 people on the periphery

will be able to continue their traditional use of the forest, which they would not be able to do if deforestation continued.

Thus, while one group loses benefits another, larger, group gains (the 354 million CFA). The tourism figure is conjectural and is based on an eventual 1,000 visitors p.a by the year 2,000 and their expected expenditure adjusted for the shadow wage rate. The fisheries item is important. Rainfall in the forest feeds several rivers which feed into large mangrove areas rich in fish. The mangroves prosper on the basis of freshwater inundation in high water periods and saltwater in low water periods. If the forest was to disappear, peak flows from the forest would increase and there would be added sediment and less salinity.

Basically, the mangrove swamps would no longer function as the habitat for the rich fish species that make up both the on and offshore fisheries. Since the link between the rainforest and the offshore fishery is less established than the link to the inshore fishery, only damage to the onshore fishery was estimated. This was valued at the market value of fish and, as a check, at the income derived from the fishery.

The flood alleviation benefits were calculated by looking at the expected value of the income losses that would accrue if there was a flood. The soil fertility benefits were based on a broad brush assessment that, if the forest disappeared, cash crop yields would decline by 10%.

Benefits of conservation were then compared to the costs of the conservation project plus the forgone timber revenues. While the framework for analysis was the total economic value concept, existence and option values were not directly estimated. The procedure involved estimating direct and indirect use values to the Cameroun and then seeing what the existence and option value would have to be in order to justify the project. Since it was thought that the non-use values would mainly reside with people

outside the Cameroun, the focus of attention for non-use values was on seeing what international transfers might be needed.

### 3.11.3 Results

The results were as shown in Table 3.11.1 below.

From the standpoint of the Cameroun, the project appears not be worthwhile because there is a negative net present value of some 1852 million CFA at 8 per cent discount rate, although there is a modest positive net present value if the discount rate is lowered to 6 per cent. But the analysis covers only some of the components of total economic value. What of existence and option values? These were not estimated directly. Instead, the issue therefore becomes one of asking whether the rest of the world would be willing to pay 1,852 million CFA (in present value terms) to the Cameroun to reflect these option and existence values. One way of testing this is to look at existing conservation transfers through debt-for-nature swaps. Translated into a per hectare basis, the required transfer for the Cameroun is just over 1,000 ECUs per km$^2$. Debt-for-nature swaps have implied various valuations ranging from as low as 15 ECU per km$^2$ (Bolivia) to around 1,600 ECUs per km$^2$ (Costa Rica). Given the high species endemism and diversity of Korup, values of 1000 ECUs or more would seem justified. The conservation of Korup forest becomes justified in economic terms provided this transfer actually takes place.

**Table 3.11.1** - **Benefits and Costs to the Cameroun** (Present values, Million CFA, 1989 prices)

(Discount Rate = 8%)

Costs of Conservation Project:

| | |
|---|---|
| Resource costs: | - 4475 |
| Forgone forest benefits timber: | - 353 |
| forest products | - 223 |
| | - - - |
| | - 5051 |

- - -

Benefits of Conservation Project:

Direct Use Benefits

| | |
|---|---|
| Use of forest products | + 354 |
| Tourism | + 680 |

Indirect Use Benefits

| | |
|---|---|
| Protection of Fisheries | + 1770 |
| Flood control | + 265 |
| Soil productivity | + 130 |
| | - - - |
| | + 3199 |

| | |
|---|---|
| | - - - |
| Net Benefits to Cameroun | - 1852 |
| | - - - |
| Economic Rate of Return | 6.2% |
| Net Benefits to Cameroun if the discount rate is 6% | + 319 |

The resource costs are based on budgets and plans in the Korup National Park Master Plan, net of compensation payments (which are internal transfers) and other costs regarded as being not attributable to the conservation project.

The implicit minimum requirement for an international transfer (the so-called 'rainforest supply price') was estimated by taking the present value of net costs (the 1,852 million CFA) and dividing by the present value of the hectarage that could be identified as being protected by the conservation project -- some 500,000 'hectare years'. This produces the value of 3,600 CFA per hectare per year, or some 1,060 ecus/km$^2$.

### 3.11.4 Discussion

Notable omissions from the study are twofold: no attempt was made to assess the value of the forest to local people over and above its use value; and no attempt was made to estimate the net contribution to $CO_2$ emissions from deforestation. Both omissions are likely to reduce the net present value deficit shown in the table. But only the former will lower the rainforest supply price because $CO_2$ benefits are likely to attract a negligible if not zero willingness-to-pay on the part of Cameroun citizens. The $CO_2$ benefits will, however, make it <u>more</u> likely that the rest of the world will pay for rainforest conservation (i.e. it affects the rainforest demand price).

## 4 Guidelines for Economic Valuation

### 4.1 Introduction: Scepticism on Valuation

This chapter offers some brief guidelines on valuation techniques and their areas of application. There is both great interest and great scepticism in attempts to put monetary values on environmental goods and services -- to quantify what many people believe is best left unquantified. The interest in valuation techniques arises in part from concern that efforts to protect and improve the environment be cost effective. The scepticism has two somewhat different sources. First, some people feel that it would be useful to know the economic value of environmental goods and services, but do not believe that it is possible to measure it accurately. Second, others feel that it is possible to measure economic value, but do not believe that this is relevant information for making public decisions regarding the environment.

These differences in perspective result in the four categories depicted in Table 4.1. Individuals in cell A believe that it is possible to develop reasonable estimates of the economic value of environmental goods and services, and that such information is useful for policy making. We would throw our lot in with individuals in this category. Individuals in cell B believe that estimates of economic value would be useful if they were available, but feel it is unlikely that current measurement techniques are sufficiently accurate and reliable to generate usable information for policy purposes. We are sympathetic with this perspective; many environmental valuation problems pose thorny methodological and theoretical difficulties. But our view is that individuals in cell B should be convinced that valuation techniques have advanced to the point where it is often worth the effort to try to estimate economic values.

Individuals in cell C do not doubt that economists can assign values to environmental goods and services, but do not believe that this is relevant or useful information for setting environmental policy. Individuals in cell D do not believe economists can estimate economic values accurately, but they do not consider this much of a problem because, like individuals in cell C, they do not think this infor-

mation is of much use. It may be impossible to convince anyone in cells C and D to change their mind about either the feasibility of environmental valuation techniques or the utility of information on economic values. It is important to understand that economists tend *not* to believe that information on individuals' preference satisfaction is the only relevant information on which to base environmental policy decisions. But we do believe that human wellbeing matters and that people are usually the best judges of their own wellbeing. Given this, it makes sense to measure the criterion of preference satisfaction as best we can.

## 4.2 Types of Valuation Techniques

The valuation task is to determine how much better or worse off individuals are (or would be) as a result of a change in environmental quality. Economists define the value of a change in terms of how much of *something else* an individual is willing to give up to get this change (or how much they would accept in order to permit the change to occur), but conceptually, how can an analyst ever *know* what an individual would be willing to give up (or to pay) in order to have a specified change in environmental quality occur? There are five broad ways to try to address this question.

**Table 4.1 Perspectives on Measuring Economic Values of Environmental Goods**

| Economic Values of Environmental Goods and Services | | |
|---|---|---|
| | Can be Measured Accurately and Reliably | Cannot be Measured Accurately and Reliably |
| Economic Values of Environmental Goods and Services are: | | |
| Useful for Policy Making | Cell A | Cell B |
| Not Useful for Policy Making | Cell C | Cell D |

*First*, one could experiment. If an analyst wanted to know how much people value a potential new national park, the park could be created and an entrance fee could be charged. An analyst could then observe how many people *actually* used the park, in effect exchanging money for the recreation and aesthetic experience of visiting the park. Or if an analyst wanted to know how much people would be willing to pay to live in a city with improved air quality, an experiment could be conducted in which air quality standards and property taxes would be raised in some cities and not in others. The analyst could then see how many people found it worthwhile to move to cities with improved air quality and higher taxes. In practice, of course, such large scale experiments of this kind are exceedingly difficult to design and politically impossible to implement. Other ways must be used to determine how people value environmental goods and services.

A *second* approach is simply to ask people how

much they would be willing to give up (i.e., how much they would be willing to pay) to have a specified environmental quality improvement happen. This is known as the 'stated preferences', or 'contingent valuation method', and was described in Chapter 2. It is also termed the 'direct approach' because people are directly asked to state or reveal their preferences. If people were able to understand clearly the change in environmental quality being offered, and answered truthfully, this direct approach would be ideal. It measures precisely what the analyst wants to know -- the individual's strength of preference for the proposed change -- and could be used not only for non-market goods and services, but market goods as well. Chapter 7 describes many practical difficulties with this stated preferences approach, but the central problem is whether the intentions people indicate *ex-ante* (before the change) will accurately describe their behaviour *ex-post* (after the change) when people face no penalty or cost associated with a discrepancy between the two.

Economists in particular have been very concerned that stated intentions will not correspond to behaviour, and have thus traditionally used a *third* approach for measuring the value of non-market goods: surrogate markets. To use this technique, economists try to find a good or service that is sold in markets and is related to or 'bundled with' the non-market service. In this situation the individual may reveal his or her preferences for both the market and non-market service when he or she purchases the market good. For example, when making a decision on what house to buy or apartment to rent, an individual may consider many factors, such as the size and age of the house, its proximity to schools, shopping, and place of employment -- and perhaps the air quality in the neighbourhood. Chapter 2 described this 'hedonic property value model'.

All of these surrogate market methods rely on the 'behavioral trail' left by individuals as they make actual decisions that affect their lives. Individuals reveal their preferences through their actual behaviour. The estimates obtained of the value of non-market goods are based on information on what people actually did and on a set of maintained assumptions about *why* they did them -- not what people said they would do under a set of hypothetical conditions.

This third approach is not, however, without disadvantages. For example, it is not feasible to use surrogate market methods to estimate the value of a new good or service, or of a change in environmental quality outside of current experience because no situations exist where people have been offered this new level of environmental quality and have revealed their preferences for it. Even if the non-market good or service has been available, there may never have been any significant variation in its quality, so that everyone in a particular area must "consume" the same amount (level) of it. In such a case, it is impossible to infer how people in the area would respond to a change in quality. Finally, to implement any of the surrogate market methods, the analyst must impose a theoretical framework in order to interpret the information on individuals' decisions within a valuation context. The estimates of value derived will thus depend upon a series of assumptions that remain largely untested.

A fourth approach is available. For changes in environmental quality that reduce individuals' wellbeing, an analyst can attempt to determine the damages an individual will suffer. A deterioration in environmental quality could cause a loss of productive assets or loss in earning power. An individual could be 'made well' or restored to their initial state of well-being by being compensated in money or other goods or services by the amount of the loss. This is termed the 'damage function' or 'production function' approach and was described in Chapter 2.

The damage function and surrogate market techniques are termed 'indirect' valuation approaches because neither relies on people's *direct* answers to questions about how much they would be willing to pay (or accept) to have a change in environmental quality occur.

The fifth approach to obtaining estimates of the value of environmental goods and services takes a somewhat different tack. Rather than developing new estimates of value for the environmental good or service of interest, the analyst finds estimates of value for the same or similar good or service in other locations, and then *transfers* these estimates -- perhaps after some adjustment to the location of interest. The analyst can transfer estimates of value developed using any of the other approaches described above. This 'benefit transfer' approach was discussed in Chapter 2.

### 4.3 Lessons from an Overview of the Literature on Valuation Techniques

Tables 4.2-4.6 list some of the existing valuation studies by area of application and location, for different valuation techniques. Applications are classified as 'zero-few', 'some' and 'many', where 'some' means up to 10, and many means more than 10. The list includes applications in developed and developing countries. An examination of the tables reveals several things.

*First*, the non-market valuation techniques described in Chapter 2 are not untested: several have been used in both industrialized and developing countries in a wide variety of sectors and areas of application.

*Second*, much of the valuation literature is very recent. For all of the valuation techniques, in all areas of application, and in all parts of the world, the majority of the work has been done since 1980. This recent surge of interest in valuation work throughout the world is due to several factors. In the United States in 1981 President Ronald Reagan signed Executive Order 12291, which required that all 'major' federal regulations pass a cost-benefit test. U.S. government agencies responsible for the management and protection of the environment and natural resources found that they needed non-market valuation techniques to estimate the benefits of regulations designed to improve environmental quality. Perhaps even more important than Executive Order 12291, in 1980 the U.S. Congress passed the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). This legislation established that 'potentially responsible

parties' could be liable for the costs of clean up and the damages caused by their spill or release of hazardous or toxic substances. The federal and state governments were designated as the 'trustees' of the nation's natural resources and could sue corporations or individuals who damaged such resources. The U.S. federal government was charged with developing regulations to determine how the magnitude of these damages should to be assessed. The regulations and procedures were slow in coming, but after they were finally promulgated, they were quickly subject to legal challenge.

The most famous of the natural resources damage assessments to end up in court has been the federal and state suits against Exxon for its role in the Prince William's Sound Oil Spill in Alaska, but there have been many other cases. The litigation process surrounding natural resource damage assessment in the United States has focused attention on the strengths and weaknesses of non-market valuation techniques in a manner largely unprecedented in 'normal'" academic debate. In the Exxon-Valdez case in particular, parties to the litigation sponsored large research projects on non-market valuation in order to support or discredit the estimates of environmental damage prepared by other parties.

The result of these two developments has been a period of major innovation and research in the United States during the 1980s on the theory and methods of non-market valuation. In Europe heightened awareness of the importance of environment issues has sparked a renewed interested in policy instruments that can be used to improve environmental quality. Valuation techniques are central to this effort.

As the tables show, work on valuation applications in Europe began more recently than in the United States, but increased rapidly. To date, the majority of applications in Europe have been in Norway, Sweden, and the United Kingdom, but research and applications are accelerating throughout both eastern and western Europe. Most of the applications in developing countries are even more recent than in Europe.

*Third*, the majority of applications of all of the valuation techniques have been carried out in the United States and Canada, followed by Europe. Not surprisingly, the fewest applications have been done in developing countries. However, interest in valuation work in developing countries is growing rapidly in Africa, Latin America, and Southeast Asia because both development banks and national governments seek to incorporate environmental concerns into policy and project appraisals.

*Fourth*, comparing the number of applications of

the different valuation techniques, there are a surprisingly large number of applications of the contingent valuation method. This is in part because the contingent valuation method is flexible in terms of data requirements and can be applied to many different kinds of valuation problems. There are in fact large numbers of studies in the United States using the travel cost model to estimate the value of recreational sites and activities and the value of water quality improvements. Studies using hedonic property value models have largely focused on measuring the value of air and water quality improvements and the value of urban amenities. But these surrogate market methods have been largely used in the United States and Canada; applications in developing countries are still rare. Production function approaches using 'dose-response' relationships and valuing outcomes at market or shadow prices are commonplace in the developing world, reflecting the prevailing problems of soil erosion and deforestation.

*Fifth*, for all the valuation techniques the major areas of application in the United States have been air and water quality, recreation (including fishing, hunting, parks, wildlife preservation), health risks, and water supply (including groundwater protection). With a couple of exceptions, European applications have followed a similar pattern. In Europe there seem to be more applications of valuation techniques, in relative terms, in the areas of forestry and transport than in the United States. In developing countries the applications were initially confined to three sectors: (1) water and sanitation, (2) land degradation and agricultural productivity, and (3) recreation (tourism, national parks). This is principally due to the interest and commitment of the World Bank in these areas. The same interest has now led to a marked expansion into other areas, notably air pollution and health. The growing interest in modified national income accounts has also led to a marked increase in 'quick' valuation techniques.

## 4.4 Choosing Valuation Techniques

All of the valuation techniques have strengths and weaknesses, and the decision on which valuation technique to use for a particular application requires experience and judgment on the part of the analyst. Some general points for the analyst to consider when making this choice are as follows :

*First*, it is often possible to use more than one valuation technique and compare the results. The estimates of value obtained from all the methods described will be somewhat uncertain. If the analyst has multiple estimates, he or she will have greater confidence in the magnitude of the value of the proposed change.

Several of the valuation techniques typically use data from a household survey (e.g. contingent valuation, travel cost model, and hedonic property value model). When the implementation of a valuation technique requires that primary data be collected with a household survey, it is often possible to design the survey to obtain the data necessary to undertake more than one valuation method. Particularly in developing countries, reliable secondary data are rarely available for carrying out valuation work. Household surveys are required for contingent valuation, opportunity cost and travel cost studies. Such surveys need to be designed with the goal of developing value estimates with multiple methods.

*Second*, different valuation techniques may measure different things. In this sense they should be considered complimentary, not competing tools. For example, the contingent valuation method is the only available technique for measuring non-use (or passive use) values. Suppose that estimates of use value of a national park and wildlife reserve were obtained using a travel cost model and estimates of non-use value were obtained from a contingent valuation survey. These value estimates are not substitutes for one another; both are useful for policy makers.

Similarly, revealed preference methods measure the *perceived* benefits to individuals; they do not capture the value of effects of which people are unaware. For example, if individuals do not know that a cancer-causing substance is in their drinking water, they obviously will not take action to avoid this risk. There will thus be no 'behavioural trail' that an analyst can follow to determine how much they would be willing to pay to avoid such a risk. However, using the damage function approach, an analyst could estimate the reduced cancer deaths that would result if the carcinogenic substance was removed from the water supply.

*Third*, it is important to consider the needs of the user(s) of valuation studies. In some cases clients have preferences for the use of one valuation technique over another. For example, estimates ob-tained from travel cost or hedonic property value models may be considered too theoretical or too complex. A particular client may feel that contingent valuation estimates are too subjective and unreliable to support policy debate and discussion. The analyst carrying out policy work must be sensitive to such concerns.

*Fourth*, the analyst should consider not only the client's needs, but also the needs of the public. Information elicited on people's values for environmental improvement is often of great interest to a wide variety of groups in society. In choosing a valuation technique, thought should be given to how the information obtained will be received by the public and interested parties other than the immediate client. Information from valuation studies need not, of course, contribute to democratic dialogue or a participatory political process; it could easily be used in a "top-down" hierarchical planning process. However, the use of a technique such as contingent valuation often bears a resemblance to a referendum or voting process. The final decision on a policy or project may not be determined by an election, but the process of eliciting information on people's preferences involves a certain degree of participant involvement in the decision making. Analysts need to be sensitive to the political implications and consultative nature of the valuation task, and choose techniques that inform and facilitate public debate. One useful step is often to hold public hearings or meetings with local community leaders to explain the findings of valuation studies.

*Fifth*, the cost of carrying out a valuation study or set of studies must be weighed against the value of the information in helping to make a better policy or project decision. Clearly more money could be spent on a valuation study than a policy decision warrants. But it is also important to keep in mind that many policies and projects have large-scale environmental implications that extend far into the future. In this case there is a substantial risk that *too little* money will be spent on the use of valuation techniques.

**Table 4.2 - Applications of Contingent Valuation Studies**

| Area of Application | USA & Canada | Europe | Developing Countries |
|---|---|---|---|
| Agriculture | Some | Few | |
| Air Quality | Many | Many | |
| Climate Change | Zero-few | Few | |
| Energy | Many | Few | Zero-few |
| Fishing Commercial | Some | Few | Zero-few |
| Fishing Recreational | Many | Few | |
| Forestry | Some | Many | |
| Health Risks | Many | Many | |
| Recreational hunting | Many | Some | |
| Parks, Nature Reserves & Wildlife | Many | Many | Some |
| Roads/Transport | Few | Few | |
| Water Quality | Many | Many | Some |
| Water Supply & Sanitation (including Groundwater Protection) | Many | Some | Many |
| | | | |
| | | | |

Source: Carson, Richard T., Nancy Carson, Anna Alberini, Nicholas Flores, and Jennifer Wright [1993], *A Bibliography of Contingent Valuation Studies and Papers*, Draft, January, Natural Resource Damage Assessment, Inc., La Jolla, California, 97 pages; and authors' estimates.

**Table 4.3 - Applications of Hedonic Property Value Studies**

| | USA | Europe | Developing Countries |
|---|---|---|---|
| Agriculture | Few | | |
| Air Quality | Many | | Some |
| Health Risks | Few | | |
| Hunting | Few | | |
| Noise | Many | | Many |
| Parks, Nature Reserves and Wildlife | Many | | Some |
| Water Quality | Few | | |
| Water Supply and Sanitation | Few | Few | Few |

**Table 4.4 - Applications of Travel Cost Models**

| | USA | Europe | Developing Countries |
|---|---|---|---|
| Fishing: Recreational | Many | Many | |
| Parks, Nature Reserves and Wildlife | Many | Many | Many |
| Water Quality | Many | Some | Few |
| Water Supply, Sanitation | | Few | Few |

**Table 4.5 - Applications of Damage Function Studies**

|  | USA | Europe | Developing |
|---|---|---|---|
| Agriculture | Many | Some | Many |
| Air Quality | Many | Many | Some |
| Fishing: Commercial |  | Few | Many |
| Health Risks | Many | Some | Many* |
| Materials Damage | Many | Many |  |
| Water Quality | Few |  | Few |
| Water Supply, Sanitation |  | Few | Few |

(* inclusive of the Economies in Transition)

**Table 4.6 - Applications of Benefit Transfer Studies**

|  | USA | Europe | Developing Countries |
|---|---|---|---|
| Forestry | Few |  |  |
| Recreation | Many |  |  |
| Water Quality | Some |  |  |
| Air Quality | Few |  |  |

### 4.5 Summary of Valuation Techniques and Their Relative Strengths

To conclude this chapter on guidance for the analyst we set out below brief summaries of each technique and its relative strengths and weaknesses.

#### 4.5.1 Contingent Valuation

Range of Applicability

Extensive since it can be used to derive values for almost any environmental change. This explains its attractiveness to 'valuers'. Only method for eliciting non-use values. Successfully applied in developing countries to water supply, water quality, forest access.

Procedure The method involves setting up a carefully worded questionnaire which asks people their WTP and/or WTA through structured questions. Various forms of 'bidding game' can be devised involving 'yes/no' answers to questions and statements about maximum WTP. Resulting survey results need econometric analysis to derive mean values of WTP bids. Literature tends to suggest that most sensible results come from cases where respondents are familiar with the asset being 'valued'.

Validity The literature has identified various forms of potential bias. 'Strategic bias' arises if respondents make bids that do not reflect their 'true' values. They may do this if they think there is a 'free rider' situation. But there is limited evidence of strategic bias. Hypothetical bias arises because respondents are not making 'real' transactions. Expense usually limits the number of experiments involving real money (criterion validity), but some studies exist. Convergent validity is good. Construct validity -- relating values to expectations about values of other measures -- is debated, especially the marked divergence in many studies between WTP and WTA.

Reference Case material is extensively reviewed in R.Mitchell and R.Carson, *Using Surveys to Value Public Goods: the Contingent Valuation Method*, Resources for the Future, Washington DC, 1989.

#### 4.5.2 Contingent Ranking

Range of Applicability

Unknown. Limited number of studies exist for environmental context and are confined to 'private goods', i.e. goods purchased in the market place. It is unclear how extensive the application could be for environmental goods but this is under investigation in the context of house location decisions. Application in developing economies unlikely.

Procedure Individuals are asked to rank several alternatives rather than express a WTP. Alternatives tend to differ according to some risk characteristic and price. Idea could be extended to a ranking of house characteristics with some 'anchor' such as the house price being used to convert rankings into WTP.

Validity Not widely discussed in the literature but

appears theoretically valid. Too few studies to test other validity measures but initial results suggest CRM WTP exceeds CVM WTP.

Reference W.Margat, W.Viscusi, J.Huber, 'Paired Comparisons and Contingent Valuation Approaches to Morbidity Risk Valuation', Journal of Environmental Economics and Management, Vol.15, 1987.

### 4.5.3 Damage Functions (including opportunity cost approaches)

Range of Applicability Extensively used where 'dose-response' relationships between pollution and output or impact are known. Examples include crop and forest damage from air pollution, materials damage, health impacts of pollution, output losses from soil erosion, sedimentation from soil erosion. Limited to cases where there are markets or where shadow prices can be easily estimated, i.e. cannot estimate non-use values. Replacement cost approach, also widely used because it is often relatively easy to find estimates of such costs. Replacement cost approaches should be confined to situations where the cost relates to achieving some agreed environmental standard, or where there is an overall constraint requiring that a certain level of environmental quality is achieved. Opportunity cost approaches very useful where a policy precludes access to an area, e.g. estimating forgone money and in-kind incomes from establishment of a protected area. Extensive application in developing countries.

Procedure Dose-Response: take physical and ecological links between pollution ('dose') and impact ('response') and value the final impact at a market or shadow price. Most of the effort usually resides in the non-economic exercise of establishing the dose-response links. Multiple regression techniques often used for this.

Replacement Cost: ascertain environmental damage and then estimate cost of restoring environment to its original state.

Opportunity Cost: ascertain functions of displaced land use and estimate in kind and money incomes from those uses. May require detailed household surveys to establish economic and leisure activities in the area in question.

Validity Dose-response : theoretically a sound approach. Uncertainty resides mainly in the errors in the dose-response relationship: e.g. where, if at all, are threshold levels before damage occurs; are there 'jumps' (discontinuities) in the dose-damage relationship? An adequate 'pool' of studies may not be available for cross-reference.

Criterion validity not relevant since presence of 'real' markets tends to be a test in itself, i.e. revealed

preferences in the market place are being used as the appropriate measure of value.

Replacement Cost: validity limited to contexts where agreed standards must be met.

Opportunity Cost: sound measure of damage done by a given land use that precludes other activity. More sophisticated estimates would include lost consumer surplus.

Expense Dose-response can be costly if large databases need to be manipulated in order to establish dose-response relationships. If D-R functions already exist, method can be very inexpensive and with low time demands.

Replacement cost is usually very inexpensive as standard engineering data often exist.

Reference US Environmental Protection Agency, *Costs and Benefits of Reducing Lead in Gasoline: Final Regulatory Impact Analysis*, EPA-230-05-85-006, Washington DC, February 1985

### 4.5.4 Household Production Functions: Avertive Expenditures

Range of Applicability

Limited to cases where households spend money to offset environmental hazards, but these can be important, e.g. noise insulation expenditures; risk-reducing expenditures such as smoke-detectors, safety belts, water filters etc. Application in developing countries uncertain -- probably small.

Has not been used to estimate non-use values though arguable that payments to some wildlife societies could be interpreted as insurance payments for conservation.

Procedure Whilst used comparatively rarely, the approach is potentially important. Expenditures undertaken by households and designed to offset some environmental risk need to be identified. Examples include noise abatement, reactions to radon gas exposure, e.g. purchase of monitoring equipment, visits to medics etc. Technique needs to be managed by experts as significant econometric modelling is usually required.

Validity Theoretically correct. Insufficient studies to comment on convergent validity. Uses actual expenditures so criterion validity is generally met.

Expense Econometric analysis on panel and survey data usually needed. Fairly expensive.

Reference M.Dickie, S.Gerking, M.Agee, 'Health benefits of Persistent Micropollutant Control: the Case of Stratospheric Ozone Depletion and Skin damage Risks', in J.B.Opschoor and D.W.Pearce (eds), *Persistent Pollutants: Economics and Policy*, Kluwer, Dordrecht, 1991.

### 4.5.5. Household Production Functions: Travel

**Cost Method**

Range of Applicability

Generally limited to site characteristics and to valuation of time. Former tends to be recreational sites. Latter often known as discrete choice, e.g. implicit value of time can be estimate by observing how choice between travel modes is made or how choice of good relates to travel time avoided (last case has been used to value women's water collection time in developing countries).

Cannot be used to estimate non-use values.

Procedure Detailed sample survey needed of travellers, together with their costs of travel to the site. Complications include possible benefits of the travelling, and presence of competing sites.

Validity Theoretically correct, but complicated where there are competing sites and multi-purpose trips. Some doubts about 'construct validity' in that number of trips should be inversely correlated with 'price' of trips, i.e. distance travelled. Some UK studies do not show this relationship. Convergent validity generally good in US studies. Generally very acceptable to official agencies and conservation groups.

Reference K. Willis and J. Benson, 'Valuation of Wildlife: A Case Study on the Upper Teesdale Site of Special Scientific Interest and Comparison of Methods in Environmental Economics', in R.K.Turner (ed), *Sustainable Environmental Management: Principles and Practice*, Belhaven Press, London, 1988.

### 4.5.6 Hedonic Property Pricing

Range of Applicability

Applicable only to environmental attributes likely to be capitalised into the price of housing and/or land. Most relevant to noise and air pollution and neighbourhood amenity.

Does not measure non-use value and is confined to cases where property owners are aware of environmental variables and act because of them (as with avertive behaviour).

Procedure Approach generally involves assembly of cross sectional data on house sales or house price estimates by estate agents, together with data on factors likely to influence these prices. Multiple regression techniques are then needed to obtain the first estimate of an 'implicit price'. Technically, a further stage of analysis is required since the multiple regression approach does not identify the demand curve directly. Often this stage of the analysis is omitted because of complexity.

Validity Theoretically sound, although final estimate is not of a demand curve as such (see above). Markets often may not behave as required by the

approach. Data on prices and factors determining prices often difficult to come by. Limited tests of convergent validity but reveals encouraging results.

Reference D.Brookshire et al., 'Valuing Public Goods: A Comparison of Survey and Hedonic Approaches', *American Economic Review*, Vol.72, No.1, 1982.

### 4.5.7 Hedonic Wage -- Risk Estimation

Range of Applicability

Limited to valuation of morbidity and mortality risks in occupations. Resulting 'values of life' have been widely used and applied elsewhere, e.g. in the dose-response approach.

Procedure As with HPM, the approach uses multiple regression to relate wages/salaries to factors influencing them. Included in the determining factors is a measure of risk of accident. The resulting 'wage premium' can then be related to risk factors to derive a so-called value of a statistical life.

Validity Theoretically sound. Convergent validity may be tested against CVM of risk reduction, but wage-risk approach measures WTA not WTP.

Case Study A.Marin and G.Psacharopoulos, 'The Reward for Risk in the Labour Market: Evidence from the United Kingdom and a Reconciliation with Other Studies', *Journal of Political Economy*, Vol.90, 1982.

## 5 Remaining Problem Areas in the Application of Valuation Techniques in Developing Economies

Chapters 1 to 4 have assessed the 'state of the art' in the application of economic valuation techniques in developing economies. Probably the most significant finding is that valuation techniques are extensively applied, despite the fact that their development, even in developed economies, is a comparatively recent phenomenon. This chapter looks at the remaining problem areas.

### 5.1 Data Problems

These applications exist despite the fact that many developing economies operate with administered markets in which the price mechanism is not allowed to function fully. This explains why techniques requiring well-functioning markets -- notably the hedonic property and hedonic wage techniques are the least cited examples of valuation in the developing world (see summaries in Chapter 4). Nonetheless this should not be taken to mean that these techniques have no application. Markets in land do work well in most countries. The usual problem is that records of sale prices are not kept in any detail and hence there are serious data problems.

Data problems also exist for the most widely used technique -- 'production function' techniques. However, these data problems usually relate to the nature of the dose-response functions rather than the required market or shadow prices. The latter are invariably of the nature of crop prices, timber values, local market prices etc. and these are either available centrally or through careful inspection of local markets. The importance of field work is thus emphasised. The opportunity cost approach also tends to require careful fieldwork in the form of household surveys to find out what uses households make of given land areas, e.g. forests.

The attraction of contingent valuation, discrete choice and travel cost techniques is that they generate their own data through the survey technique. This perhaps explains their evident success in being applied to developing economy problems, i.e., by and large, they avoid the use of secondary data sources.

Overall, as with all behavioural studies, data remain a problem but the evidence on existing applications shows that data problems can often be overcome, sometimes at a price, but often at a very modest price.

## 5.2 Rapid Appraisal vs Intensive Surveys

The analyst will quickly face one major issue in the application of valuation techniques. If, as Section 5.1 argued, those valuation techniques which generate their own data are often the most attractive, then what is the cost of such surveys? Discussion with those who have carried out survey work shows that the cost of contingent valuations has varied from under $10,000 to perhaps $200,000. Given the need for careful questionnaire design, pre-testing and large sample (1000 +) requirements, it is clear that a *good* CV study will cost perhaps $50,000-200,000. It is also clear that few agencies will agree to spend this much. Only one or two European CV studies, for example, have cost more than $40,000 - - the vast majority have cost a few thousand dollars. While economies can be made by using 'cheap' survey staff (e.g. students), the fact remains that there will be a trade off between the quality of survey results and cost.

Wherever possible, more expensive studies are to be preferred. There are three reasons for this.

First, even at $100,000, say, a CV study will account for only a fraction of a per cent of the cost of the project in question. Agencies and governments are not easily persuaded of the sense of this observation, but the analyst should persist.

Second, the cost of a survey should be weighed against the social importance of the outcome. Where large numbers of people's livelihoods are at stake, expenditure on a CV study is likely to be small relative to the social importance of its findings. This observation is reinforced by the third factor:

CV studies serve several functions. While the focus in this volume has been on the resulting *values*, it is worth remembering that CV uncovers considerable amounts of information about what local people want. It also serves as a vehicle for *public participation*. At a time when it is now recognised that many investments 'fail' because of a lack of consultation and assessment of local wants and needs, this role for survey techniques should be emphasised. The cost of a CV study thus needs to be compared to the multiple benefits of surveys.

Ultimately, there will be a trade off, and the issue will arise as to whether low cost, 'rapid appraisal' techniques are reliable. The analyst must judge. Criteria for judgement are likely to include reference to similar cases in the literature, as listed in Chapter 6.

## 5.3 Time and the Discount Rate

This volume has not been concerned with project evaluation generally, only with the issue of environmental valuation. Nonetheless, there remain problems in project appraisal which have not been satisfactorily resolved. The main one in this respect is the choice of discount rate. This is one more 'price' or 'value' in that it signals the rate at which present and future consumption is to be traded.

The emergence of the sustainable development concept has focused attention again on the discount rate. High rates appear to discriminate against the future, and hence against sustainability. Low rates favour the future, but are perhaps inimical to immediate economic development unless analysts are sure that they have 'scoped' most of the available high return projects in a country.

High rates (10 per cent and above, in real terms) tend to be justified by reference to the opportunity cost of capital, i.e. the rate of return that could be earned on a marginal project in the developing economy. However, investments tend to displace both consumption and investment, so that the relevant discount rate should be that which relates to consumption flows and this should be applied to flows of benefits and costs converted to consumption units. That is, the numeraire is consumption and the discount rate is the consumption rate of interest (CRI). Values of the CRI tend to be based on the 'standard' formula:

$$CRI = a + bg$$

where 'a' is the pure time preference rate, 'b' is the elasticity of the marginal utility of income function, and g is the expected growth rate in real consumption. Values of the CRI are unlikely to exceed 4 to

6 per cent in most developing countries. Even then, the extent to which such rates adequately account for concerns about inherited environmental problems for future generations can be questioned.

The discount rate problem remains and none of the recent developments in the literature will assist the analyst in resolving the problem in any clear-cut fashion.

## 5.4 Training and Environmental Economics

Valuation techniques require skills for their interpretation and application in developing economies. It is little surprise that most valuation exercises are carried out by experts from North America and Europe -- comparatively few are led by economists within the developing economies. In part this reflects the absence of any detailed and adequate manual for valuation assessment, but it mainly reflects the state of education in environmental economics in developing economies. By and large, environmental economics is not taught in developing economy universities nor are agency and government staff trained in the subject.

There are several solutions to this situation. The first is 'in place training' whereby staff are taught in the countries in question from short courses provided by institutions in developed economies. This is the option pursued, for example, by the United Nations University which has hosted training sessions in Malta, India, the West Indies and parts of Africa. One problem with this approach is that the training is effective at the time but staff quickly lose the incentive to use the training once the sessions have ended. This can only be overcome by continued involvement, probably through an actual project. Above, commitment 'from the top' is essential.

The second solution is the release of staff to training institutions, usually universities, in developed economies. The advantage of this is that individuals gain greater exposure to training staff, meet with other trainees from different countries, and may be able to secure longer term assignments. The disadvantage is that expectations may be raised too high relative to the institutional capacity in the trainee country. There are also risks of trainees finding opportunities to work in agencies in the developed economies, thus defeating the object of the exercise.

The reality is that those responsible for guiding decisions -- usually civil servants -- are not well trained in environmental economics in most developed economies. It is therefore rather optimistic to expect major advances in the developing economies. Moreover, environmental economics as it applies to developing economies remains a subject practised by comparatively few economists. The answer here is a combined sponsorship and encouragement of institutional capacity in both developed and developing countries.

## 6 Annotated Bibliography

This chapter lists the available case studies on valuation in developing countries. Also included are selected references to assist readers in placing the studies in their context, or which offer guidance on the problems of economic valuation. The bibliography reports only studies relevant to the monetary valuation of environmental costs and benefits in *developing countries.*

The references are coded as follows:

C = case study involving report of empirical estimates of willingness-to-pay (WTP) or willingness-to-accept.

G = general

M = methodological contribution

N = national accounting exercise

No detailed manual exists (1994) on the application of valuation techniques in developing countries. But useful chapters on procedures for valuation can be found in D.W. Pearce, D. Whittington, S. Georgiou and D. James, *Project and Policy Appraisal: Integrating Economics and Environment*, OECD, Paris, 1994.

### 6.1 General References

#### (a) Texts on Valuation

Bentkover, J. D., V. Covello and J. Mumpower [1986], *Benefits Assessment: The State of the Art*, Dordrecht, Netherlands: D. Reidel Publishing Company.

Braden, J. B. and C. D. Kolstad [1991], *Measuring the Demand for Environmental Quality*, Amsterdam: North-Holland. This is one of the most thorough and wide ranging texts on the theoretical foundations and applications of economic valuation.

Freeman, A. M. III [1979], *The Benefits of Environmental Improvement: Theory and Practice*, Baltimore: Johns Hopkins University Press. Now dated, and superseded by Freeman, A.M. III [1993] *The Measurement of Environmental and Resource Values: Theory and Methods,* Baltimore: Resources for the Future. This is perhaps the most recommended text on valuation along with Braden and Kolstad above.

Johansson, P.-O. [1987], *The Economic Theory and Measurement of Environmental Benefits*, Cambridge: Cambridge University Press.

Mäler, K.-G. [1991], *Measuring Environmental Damage -- The Production Function Approach,* Beijer Institute, Stockholm, mimeo.

Mitchell, R.B. and R.T. Carson. [1989], *Using Surveys to Value Public Goods: The Contingent Valuation Method*, Washington DC: Resources for the Future. This is the 'classic' reference for contingent valuation.

Pearce, D. W. and A. Markandya [1989], *The Benefits of Environmental Policy: Monetary Valuation*, Paris: OECD. Contains brief overviews of each technique.

Pearce, D.W., D. Whittington and S. Georgiou [1994], *Project and Policy Appraisal: Integrating Economics and Environment*, Paris: OECD. Contains chapters on each of the valuation techniques and pays attention to applications in both developed and developing economies.

**(b) General Material Relating to Developing Countries**

G Barbier, E. [1993]. Valuation of Environmental Resources and Impacts in Developing Countries, in R.K. Turner (ed), *Sustainable Environmental Economic and Management: Principles and Practice*, Belhaven Press, London, 319-337.

G Bojö, J., Mäler K-G and L. Unemo. [1992], revised edition. *Environment and Development: an Economic Approach*, Dordrecht: Kluwer.

G Dixon, J., Carpenter, R., Fallon, L., Sherman, P. and Manipomoke, S. [1986]. *Economic Analysis of the Environmental Impacts of Development Projects*. London: Earthscan Publications. Substantially revised and extended edition: Dixon, J., Carpenter, R., Scura, L., Sherman, P. *Economic Analysis of the Environmental Impacts*, 1994, Earthscan, London.

Proposes economic valuation methodologies of the impact of development projects on the environment. Calls for the systematic evaluation of all the intentional and unintentional consequences of development initiatives.

G Dixon, J. and Hufschmidt, M. [1986]. *Economic Valuation Techniques for the Environment: A Case Study Handbook*. Baltimore, USA: The John Hopkins University Press.

The authors present detailed case studies to demonstrate application of techniques to value the environmental effects of development. A hypothetical case study illustrates important differences between market and shadow prices. Actual case studies follow.

G Dixon, J. and Sherman, P. [1990]. *Economics of Protected Areas: A New Look at Benefits and Costs*. London: Earthscan Publications.

Assesses the costs and benefits associated with maintaining protected areas, and discusses methods for assigning monetary values to natural environmental assets. Specific case studies for several developing countries are also presented.

G Dixon, J., D. James and P. Sherman [1990], *Dryland Management: Economic Case Studies*, London, Earthscan.

G Evenson, R. [1991]. *Valuing Environmental Benefits in Developing Economies*. Proceedings of a Seminar Series held in Feb-May 1990 at Michigan State University.

A collection of case studies reviewed individually elsewhere in this volume.

G Hufschmidt, M., D. James., A. Meister., B. Bower and J. Dixon. [1983]. *Environment, natural Systems, and Development: an Economic Valuation Guide*, Baltimore: Johns Hopkins University Press.

M Mäler, K-G. [1992]]. *Production Function Approach in Developing Countries*. Stockholm Sweden: Beijer Reprint Series No. 6.

This paper analyzes valuation problems connected with environmental resources in terms of the production function and warns of the dangers of adopting inaccurate measures, misunderstanding microeconomic principles and making conceptual errors.

G Munasinghe, M. [1993a]. *Environmental Economics and Sustainable Development*. World Bank Environmental Department, Paper No. 3, Washington, D.C.

The paper explains the key role played by environmental economics in facilitating the more effective incorporation of environmental concerns into development decision making. Concepts and techniques of valuation of environmental impacts and key related aspects are explicitly considered. Two case studies (Madagascar and Sri Lanka) are discussed, and a number of other case studies are summarised.

G Munasinghe, M. (ed) [1993b], *Environmental Economics and Natural Resource Management in Developing Countries*, Committee of International Development Institutions on the Environment (CIDIE), World Bank, Washington DC.

Collected papers on theory and application of valuation techniques in developing countries.

G Munasinghe, M. and E. Lutz [1993]. Environmental Economics and Valuation in Development Decisionmaking (sic), in Munasinghe [1993b].

G,C Pearce, D.W., Barbier, E. and Markandya, A. [1990]. *Sustainable Development: Economics and Environment in the Third World*. London: Earthscan Publications.

The book offers a definition of 'sustainable development' in terms of not depleting resources, and then examining its economic implications. The importance of discount rates and economic ap-

praisal is emphasised. The bulk of the book contains six case studies of major developmental issues in the Third World.

G Pearce, D.W. and Markandya, A. [1992]. *Marginal Opportunity Cost as a Planning Concept in Natural Resource Management*, in Schramm, G. and Warford, J. (ed) *Environmental Management and Economic Development*. Baltimore, USA: The Johns Hopkins University Press.

In the context of non-sustainable use of renewable resources Marginal Opportunity Cost functions as an organizing concept. Because expectations have to be formed about future resource exploitation and the likely environment then, estimation of MOC requires extensive information. The results are an essential tool in the planning and management of natural resources.

G Pearce, D.W. [1993]. *Economic Values and the Natural World*. London: Earthscan.

The book deals with how and why economic values are attributed to environmental features. Economic analyses and different methods of valuing people's preferences for environmental quality provide an economic rationale for dealing with global environmental problems. Numerous case studies are presented to illustrate the economic approaches for placing monetary values on people's preferences for environmental quality.

G Pearce, D.W and Turner, R.K. [1992]. *Benefits, Estimates and Environmental Decision Making*, Organisation for Economic Cooperation and Development, Paris.

The book assesses the reasons why valuation methodologies are not widely used in practice. The results are based on surveys carried out in six developed countries.

G Schramm, G. and Warford, J. (ed) [1989]. *Environmental Management and Economic Development*. Baltimore, USA: The Johns Hopkins University Press.

This volume shows that much environmental damage is the result of either shortsighted policies or lack of knowledge. The focus is on how developing countries can protect and improve their natural environment while *simultaneously* improving the welfare of their people. Environmental protection and economic development do not necessarily stand as opposed choices. Rather they often go hand in hand. The authors look at the analytical and methodological questions, illustrate many of the problems, and point to possible solutions.

C Spurgeon, J. and Alyward, B. [1992]. *The Economic Value of Ecosystems: 4 - Coral Reefs*. London Environmental Economics Centre Gatekeeper Series, 92-03.

G Winpenny, J. [1991]. *Values for the Environment: A Guide to Economic Appraisal*. London: Her Majesty's Stationery Office.

Aimed at economists and practitioners, this practical guide to the economic treatment of the environment in project appraisal uses cost-benefit analysis as the decision framework.

## 6.2 Biodiversity

G Alyward, B. [1991]. *The Economic Value of Ecosystems: 3 -- Biological Diversity*. London Environmental Economics Centre Gatekeeper Series 91-03.

G Alyward, B. and Barbier, E. [1992]. *What is Biodiversity Worth to a Developing Country? Capturing the Pharmaceutical Value of Species Information*. London Environmental Economics Centre Discussion Paper 92-05, London.

G Aylward, B. and Barbier, E. [1991]. *Valuing Environmental Functions in Developing Countries. Biodiversity and Conservation*, London Environmental Economics Centre, London.

The authors detail the challenge presented by valuing environmental functions to ecologists and economists and synthesizes the methodological advances that have occurred. Using tropical forests, wetlands and biodiversity as illustrations, the application of this methodology to valuing the functions of complex natural systems is investigated and existing studies reviewed.

C Aylward, B. [1993], *The Economic Value of Pharmaceutical Prospecting and Its Role in Biodiversity Conservation*, Discussion Paper 93-05, London Environmental Economics Centre, International Institute for Environment and Development, London.

Reveals large negative returns to biodiversity conservation for the provision of biotic samples only, using Costa Rica case study.

M Aylward, B., J.Echeverria., L.Fendt and E.Barbier [1993], *The Economic Value of Species Information and Its Role in Biodiversity Conservation: Costa Rica's National Biodiversity Institute*, Discussion Paper 93-06, London Environmental Economics Centre, International Institute for Environment and Development, London.

Develops a framework for analysing the economic value of biodiversity as a source of information for pharmaceutical companies.

G Barbier, E., Burgess, J., Swanson, T. and Pearce, D.W. [1990]. *Elephants, Economics and Ivory*. London: Earthscan Publications Ltd.

The authors develop a database on the ivory trade, analyse the trade in terms of the determinants of demand and supply, and recommend a controlled

trade as one of the means of ensuring future survival of the African elephant.

C Barnes, J. [forthcoming], *Economics of Wildlife Utilisation in Botswana*, Ph.D., University College London, London.

Analyses rate of return to various land uses including wildlife tourism, hunting, crocodile and ostrich farming in Botswana. Cattle ranching is shown to have very low rates of return.

C Brown, G. and Henry, W. [1989]. *The Economic Value of Elephants*. London Environmental Economic Centre Discussion Paper 89-12, London. Estimates willingness-to-pay of visitors to East African game parks to ensure seeing elephants.

C Brown, G., Swanson, T., Ward, M., and Moran, D. [1994], *Optimally Pricing Games Parks in Kenya*, CSERGE, University College London, *mimeo*.

Using travel cost method and contingent valuation to estimate demand for parks and reserves in Kenya. Consumer surplus ranged from $77 to $134 per day using the travel cost approach, and $52 to $86 per day on the contingent valuation approach. The entry charge which maximises park/reserve revenues is some $43 to $64 more than existing charges.

C Dixon, J. [1993]. Meeting Ecological and Economic Goals: Marine Parks in the Caribbean, *Ambio*, vol. 22, No. 2-3.

The paper examines issues of protection of endangered marine ecosystems and the biodiversity they support, and the trade-offs that exist between protection and use in the context of Caribbean marine parks. Initial results indicate that proper management can yield both protection and development benefits but questions of ecosystem carrying capacity and national retention of revenues raises important issues for longer term sustainability.

G Mäler, K-G. [1993]. *The Economics of Biodiversity Loss* in Sandlund, O. and Schei, P. (ed). *Norway/UNEP Expert Conference on Biodiversity*. Hosted by the Norwegian Ministry of Environment and the UNEP.

C Menkhaus, S. [1993], *Measurement of Economic and Other Benefits of Wildlife Preservation: a Case Study of Keoladeo National Park, Bharatpur, India*, Institute of Economic Growth, Delhi University, Delhi, *mimeo*. And M.N. Murty and S. Menkhaus [1994], *Economic Aspects of Wildlife Protection in the Developing Countries: a Case Study of Keoladeo National Park, Bharatpur, India*, Institute of Economic Growth, Delhi University, Delhi, Paper No. E/163/94.

Uses contingent valuation and travel cost to assess benefits of protecting wildlife in a national park in India. While benefits exceed costs, the gainers tend to be higher income groups and the losers the low income groups. With adjustments for income utilities, the net social gains from conservation are shown to be negative. The focus is then on ways in which economic value can be captured to compensate low income groups.

G McNeely, J. [1988]. *Economics and Biological Diversity*. Gland, Switzerland: International Union for Conservation of Nature and Natural Resources.

This book focuses on sustainable forms of economic development to contribute positively to the conservation of biological diversity and the more fundamental issue of the distribution of benefits from the optimal utilization of biological resources.

C Moran, D. [1994], Contingent Valuation and Biodiversity: Measuring The User Surplus of Kenyan Protected Areas, *Biodiversity and Conservation*, 3.

Using a contingent valuation survey, estimates non-use values for Kenyan protected areas at $450m p.a., around twice the estimated opportunity costs of the conservation of these areas. Other use values would need to be added to this non-use value total.

G Munasinghe, M. [1993]. Environmental Economics and Biodiversity Management in Developing Countries, *Ambio*, vol. 22, no. 2-3.

Environmental economics and valuation can play a key role in helping to incorporate concerns about biodiversity loss into the traditional decision making framework. A case study from Madagascar examines the impact of a new national park on tropical forests by using both conventional and newer techniques. A Sri Lankan study presents an energy-environmental analysis to eliminate projects with unacceptable impacts and to help redesign others.

G Munasinghe, M [1992]. Biodiversity Protection Policy: Environmental valuation and Distribution Issues, *Ambio*, Vol.21, No.3, May, 227-236.

C Mungatana, E.D and Navrud, S. [1994], Environmental Valuation in Developing Countries: The Recreational value of Wildlife Viewing, *Ecological Economics*, forthcoming.

Estimates recreational value of wildlife viewing at Lake Nakuru, Kenya using CVM and TCM approaches. Annual value estimated at $7 to $15 million p.a., with flamingos accounting for about one-third of this value.

G Pearce, D.W. [1993]. The Economy -- Biodiversity Interface in Sandlund, O. and Schei, P. (ed). *Norway/UNEP Expert Conference on Biodiversity*. Hosted by the Norwegian Ministry of Environment and the UNEP.

The paper discusses the fundamental forces underlying biodiversity loss. The central issues are rising population, assignment of property rights, market failure, intervention failure, and global appropriation failure. Also discusses ways to get around these problems with a special emphasis on creating global environmental markets.

G Pearce, D.W., and Puroshothaman, S. [forthcoming]. Protecting Biological Diversity: the Economic Value of Pharmaceutical Plants, in T.Swanson (ed), *Intellectual Property Risks and Biodiversity Conservation*, Cambridge University Press, Cambridge.

The authors examine the global commercial value of medicinal plants and calculate the likely value of one hectare of representative land for medicinal plants. If this value could be captured and appropriated, it would provide some incentive to conserve plant habitats, and prevent unsustainable exploitation and loss of global biodiversity.

G Pearce, D.W. and Moran, D. [1994]. *The Economic Value of Biological Diversity*. London: Earthscan Publications. Expanded version of a report to the International Union for the Conservation of Nature.

This book is concerned with two fundamental characteristics of the process of comparing economic values of sustainable use of biodiversity and the value of alternative resource use that threatens biodiversity: demonstration of values not reflected in the market process and realisation of those values through changes in institutional design and behaviour. The divergence between the social and private costs and benefits of biodiversity, and government and market failure explain why it is being eroded.

G Perrings, C., Folke, C. and Mäler, K-G, [1992]. *The Ecology and Economics of Biodiversity Loss: The Research Agenda*. Beijer Institute, Stockholm, Sweden: Beijer Reprint Series No. 8.

Combining the insights from the disciplines of economics and ecology, this paper outlines the most urgent questions for research in the area of biodiversity loss. The nature of the linkage between ecological and economic systems is discussed in the context of informational, institutional, ethical and cultural conditions. The paper emphasizes the interdisciplinary approach to biodiversity and the gains from collaborative research.

M Polasky, S and Solow, A. [1993], Measuring Biological Diversity, Harvard Discussion Papers, *mimeo*.

Shows how biological diversity can be measured in terms of 'genetic distance' between species, and how such a measure of diversity can be related to the incremental probability of discovering commercially valuable compounds.

M Reid, W., Laird, S., Meyer, C., Gàmez, R., Sittenfeld, A., Janzen, D., Gollin, M., and Juma, C. [1993]. *Biodiversity Prospecting*. World Resources Institute, USA.

The essays in this book explore the strands of thought and theory that come together in the new industry -- biodiversity prospecting. Although this 'gene-rush' could damage ecosystems and the people that live in or near them, bio-prospecting can bolster economic and conservation goals while underpinning the medical and agricultural advances needed to combat disease and sustain growing populations. The central concern of the book is how to manage the process correctly.

M. Simpson, R.D., Sedjo, R and Reid, J. [1994], *Valuing Biodiversity: an Application to Genetic Prospecting*, Resources for the Future, Washington DC., Paper 94-20.

Argues that the 'genetic value' of the marginal hectare of the marginal species is likely to be insignificant and hence the benefits of genetic prospecting as a basis for conserving habitat should not be exaggerated.

M Solow, A., Polasky, S., and Broadus, J. [1993]. On the Measurement of Biological Diversity, *Journal of Environmental Economics and Management*, 24, 60-68.

Develops measures of biodiversity based on genetic distance.

M Weitzman, M. [1992]. On Diversity. *Quarterly Journal of Economics*, CVII, 363-406.

Original source for practical measurement of diversity in terms of genetic distance.

M. Weitzman, M. [1993]. What to Preserve ? An Application of Diversity Theory to Crane Conservation. *Quarterly Journal of Economics*, CVIII, 157-184.

### 6.3 Climate Change

(Only research reporting damage estimates to developing countries).

C Ayres, R and J.Walter. [1991]. The Greenhouse Effect: Damages, Costs and Abatement. *Environmental and Resource Economics*, Vol.1, No.3, 237-270.

C Fankhauser, S. [1992]. Global Warming Damage Costs: Some Monetary Estimates. *Centre for Social and Economic Research on the Global Environment, Working Paper* GEC 92-29, University College London and University of East Anglia.

C Milliman, J.D., Broadus, J., and F.Gable. [1989]. Environmental and Economic Implications of Ris-

ing Sea Level and Subsiding Deltas: The Nile and Bengal Examples, *Ambio*, 18. No.6. 340-345.

C Asian Development Bank. [1994]. *Climate Change in Asia: Eight Country Studies*, Asian Development Bank, Manila.

Reports estimates of economic value of damage to various countries in Asia from global warming. Sea level rise alone might give rise to losses equal to 5 per cent of GNP in Bangladesh; 1 per cent in India; relocation of some 800,000 households in Indonesia at a cost of some $8 bn, and marked health impacts from increased malaria, diarrhoea and dengue fever etc.

C Pearce D.W., Cline, W., Achanta, A., Fankhauser, S., Pachauri, R., Tol, R., Vellinga, P. [1995]. *The Social Costs of Climate Change: Greenhouse Damages and the Benefits of Control*, CSERGE, University College London.

Draft material for IPCC Working Group III. Summarises available economic impact studies including those covering developing countries.

**6.4 Discount Rates**

C Cuesta, M., Carlson, G and Lutz, E. [1994], *An Empirical Assessment of Farmers' Discount Rates in Costa Rica and Its Implication for Soil Conservation*, World Bank, Environment Department, *mimeo*.

Represents the only rigorous attempt to date to measure individuals' discount rates in a developing country. Uses contingent valuation of farmers who were asked if they would invest in an investment yielding Q+r given an initial endowment of income Q, where the time horizon also varies. Results suggest that the discount rate is around 18.5 per cent (real) on average; with a spread covering 95 per cent of farmers equal to 15-22 per cent. Actual market rates are embraced by these estimates.

**6.5 Forest Function**

C Ahmad, N. [1993], The Rural Development and Environmental Protection Project in the Day Forest in Djibouti: a Case Study, in Munasinghe, M. (ed) [1993b], *Environmental Economics and Natural Resource Management in Developing Countries*, Committee of International Development Institutions on the Environment (CIDIE), World Bank, Washington DC.

Evaluates benefits of a forest in terms of wood, forage and charcoal production.

C Anderson, D. [1987]. *The Economics of Afforestation: A Case Study in Africa*. World Bank Occasional Paper No. 1 / New Series, Washington, D.C.

Evaluates the benefits of afforestation in terms of fuelwood and fodder supply, wind protection and impacts on crops generally. Shows that high eco-nomic rates of return can be expected from agro-forestry and windbreaks when full benefits are accounted for.

C Anderson, D. [1989]. Economic Aspects of Afforestation and Soil Conservation Projects, in Schramm, G. and Warford, J. (ed) *Environmental Management and Economic Development*. Baltimore, USA: The Johns Hopkins University Press.

Presents a simple approach to estimating the economic benefits of afforestation and soil conservation projects in farming areas. Summarises Anderson [1987].

Appasamy, P.P. [1993], *Role of Non-timber Forest Products in a Subsistence Economy: the Case of a Joint Forestry Project in India,* Economic Botany, 47(3), July-September.

C Balick, M. and Mendelsohn, R. [1992]. Assessing the Economic Value of Traditional Medicine from Tropical Rainforests, *Conservation Biology*, vol. 6.

G Barbier, E., Burgess, J., Alyward, B. and Bishop, J. [1991]. Timber Trade, Trade Policies and Environmental Degradation. London Environmental Economics Centre Discussion paper 92-01, London.

G Barbier, E., Bishop, J.,Alyward, B. and Burgess, J. [1992]. *The Economics of Tropical Forests Land Use Options Methodology and Valuation Techniques*. London Environmental Economics Centre, London.

C Barbier, E. [1992]. Rehabilitating Gum Arabic Systems in Sudan: Economic and Environmental Implications, *Environmental and Resource Economics*, vol. 2.

The paper explores the issues of gum arabic management in the Sudan through a crop profitability analysis of gum and other crops combined with financial and economic analysis of six representative gum arabic production systems. Only if many other factors can be maintained, will essential investments by farmers in cultivating gum be viable. The gum comes from Acacia senegal, an environmentally important tree in the Sahelian zone.

C Bennett, E and Reynolds, C. [1993]. The Value of Mangrove Area in Sarawak. *Biodiversity and Conservation*, 2, 359-375.

Estimates economic value of marine fisheries in Sarawak Mangroves Forest Area at $21 m p.a., timber products at $0.12m pa, and tourism at $3.7 m.p.a. Threats to the area include aquaculture ponds and palm plantations. Loss of the mangrove would also necessitate extensive engineering works to prevent flooding etc.

C Bojo, J. [1993]. Economic Valuation of Indige-

nous Woodlands, in P.N.Bradley and K.McNamara (eds) [1993], *Living with trees: Policies for Forestry Management in Zimbabwe*, Technical Paper No.210, World Bank, Washington DC.

Analyses market imperfections relating to indigenous woodlands in Zimbabwe. Despite serious data problems, the paper suggests that only significant international transfers can reduce the rate of loss of Zimbabwe's woodlands due to the immediate imperative of rapid population growth,

C Brown, K. and Pearce, D.W. [1994]. The Economic Value of Non-Market Benefits of Tropical Forests Carbon Storage, in S.Weiss (ed), *The Economics of Project Appraisal and the Environment*, Edward Elgar, London.

The paper reports estimates of economic values of carbon storage with special reference to the Amazon rainforest, and shows how carbon credits and debits affect decisions to invest in developmental land uses. The value of tropical forests as carbon stores is seen to be substantial relative to land values for agriculture.

K. Chopra [1993], *The Value of Non-timber Forest Products: an Estimation for Tropical Deciduous Forests in India,* Economic Botany, 47(3), July-September.

C Convery, F., and K. Tutu. [1993]. *Estimating Gross Costs of Environmental Degradation -- Sectoral Analysis: a Ghana Case Study*. Department of Economics, University College Dublin, Dublin.

Estimates cost of forest loss due to clearance, mainly through burning, in Ghana using market price approach. Timber losses are put at $33 million p.a.

C Current, D., E. Lutz, and S. Scherr (eds). [1993]. *Economic and Institutional Analysis of Agroforestry Projects in Central America and the Caribbean*, World Bank, *mimeo*.

Collation and analysis of performance of agroforestry projects in Central America and the Caribbean. Shows estimates of benefits of such schemes in terms of wood products, manure, soil conservation etc.

Godoy, R., R. Lubowski, and A. Markandya [1993], *A Method for the Economic Valuation of Non-timber Tropical Forest Products,* Economic Botany, 47(3),

July-September.

Ganesan, B. [1993], *Extraction of Non-timber Forest Products, Including Fodder and Fuelwood*, in Mudumalai, India, Economic Botany, 47(3), July-September.

C Grimes, A., Loomis, S., Jahnige, P., Burham, M., Onthank, K., Alarcón, W., Cerón, C., Neill, D.,

Balick, M., Bennett, B. and Mendelsohn, R. [1993]. *Valuing the Rain Forest: The Economic Value of Non-Timber Forest Products in Ecuador*, unpublished.

Through ethnobotanical and market surveys, the annual harvest levels, market prices and extraction costs of seven fruits, three medicinal barks and one resin in the Upper Napo Region of the Amazonian Ecuador are measured. The present value of net revenue from the non-timber forest products is about $1,257 to $2,830, which is significantly higher than the returns from alternative land use in this area.

C Gutman, P. [1992]. *Venezuela Natural Resources Management Project, National Parks: Costs and Benefits of the Project*, World Bank, Washington, D.C.

Sanatilake, H.M., D. Senaratne and P. Abeygunawardena [1993], *Role of Non-timber Forest Products in the Economy of Peripheral Communities of Knuckles National Wilderness Area of Sri Lanka,* Economic Botany, 47(3), July-September.

Gunatilleke, I., C. Gunatilleke and P. Abeygunawardena [1993], *Interdisciplinary Research Towards Management of Non-timber Forest Resources in Lowland Rain Forests in Sri Lanka,* Economic Botany, 47(3), July-September.

M Hartwick, J.M. [1993]. Forestry Economics, Deforestation, and National Accounting. In E. Lutz (ed) *Toward Improved Accounting for the Environment*, World Bank, Washington DC.

C Hosier, R. and Bernstein, M. [1989]. *Woodfuel Use and Sustainable Development in Haiti*. Centre for Energy and the Environment, University of Pennsylvania.

Looks at Haiti's energy sector to see how its environmental problems can be reduced. Their analysis shows that what is needed is simultaneous investments in enhanced woodfuel supplies, improved energy efficiency, and improved management of existing energy resources.

C Kishor, N and L.Constantino [1993a]. *Forest Management and Competing Land Uses: an Economic Analysis for Costa Rica*, Latin America Environment Division, World Bank, Washington DC.

Although primarily concerned with an explanation for deforestation in Costa Rica, this paper estimates the value of sustainably managed forests vis-a-vis cattle ranching and plantation forestry. Since sustainable forestry is found to be privately *unprofitable*, the environmental values are very important. These are estimated to be high at around $1,200 to $2,500 per hectare, with carbon sequestration dominating.

C Kishor, N and L. Constantino [1993b]. *The Costs

*and Benefits of Removing Log Export Bans: Evidence from Two Countries*, Latin America Environment Department, World Bank, Washington DC.

Using case studies of Canada and Costa Rica, the authors provide some preliminary estimates of the costs and benefits of removing log export bans. Benefits are about $20m p.a. in Cost Rica and $180m p.a in Canada. The environmental costs could be significant, but can be offset with careful policies.

C Kramer, R., Munasinghe, M., Sharma, N., Mercer, E. and Shyamsundar, P. [1992]. *Valuing a Protected Tropical Forest: A Case Study in Madagascar.* Prepared for IVth World Congress on National Parks and Protected Areas, Caracas, Venezuela, 1992. Center for Resource and Environmental Policy, Duke University, Durham, North Carolina.

The authors highlight the importance of economic analysis in making difficult decisions regarding development v/s conservation. They focus on Madagascar because of its economic poverty but genetic mega-diversity. The severe loss of species endemism has initiated a lot of concern from the government of Madagascar as well as the international community to control forest degradation and protect biodiversity.

C K. Kumari. [1994], *Sustainable Forest Management in Malaysia*, Ph.D Thesis, University of East Anglia, Norwich, UK.

Estimates conservation values of tropical forests in Malaysia at $1,000 ha, carbon storage at $2,400 ha, non-timber products at $100 to $500, ecotourism and recreation at $13 to $35, and pharmaceuticals at $1 to $100.

C Lutz, E. *et al..* [1993], *Interdisciplinary Fact Finding on Current Deforestation in Costa Rica*, Environment Department Working Paper No.61, World Bank, Washington DC.

C Lynam, T., S. Vermeulen and B. Campbell [1991], *Contingent Valuation of Multipurpose Tree resources in the Smallholder Farming Sector, Zimbabwe*, Paper presented to AFSRE Symposium, October.

C Maille, P., and R. Mendelsohn, Valuing Ecotourism in Madagascar, *Journal of Environmental Management*, 1994, forthcoming.

C Mercer, E., Kramer, R and N. Sharma [1993], *Estimating the Nature Tourism Benefits of Establishing the Mantadia National Park in Madagascar*, Center for Resource and Environmental Policy Research, Duke University, Durham, North Carolina.

See study by Kramer et al in Chapter 4.

C Newcombe, K. [1989]. An Economic Justification for Rural Afforestation: The Case of Ethiopia, in Schramm, G. and Warford, J. (ed) *Environmental Management and Economic Development.* Baltimore, USA: The Johns Hopkins University Press.

Dung and crop residue have alternative value as fertilizer and soil conditioner; retaining these uses and providing agroforestry programs is then a highly attractive, long-term strategy for supplying household fuelwood, yet increasing agricultural output.

G Panayotou, T. and Ashton, P. [1992]. *Not By Timber Alone: Economics and Ecology of Sustaining Tropical Forests.* Washington, D.C.: Island Press.

Overview of the economics of tropical forest conservation, including reference to the economic values of forest use and 'global market' value.

C Pearce, D.W. [1990]. An Economic Approach to Saving the Tropical Forests, in Helm, D. (ed) *Economic Policy Towards the Environment.* London: Blackwell.

The concept of total economic value offers a comprehensive framework within which to value tropical forests. There is some evidence that use values alone favour forest conservation. Existence values are at least $8 per adult in the advanced economies which could readily amount to $3 billion, or a quarter of the entire GDP contribution of classic Amazonia to Brazil's GDP, inclusive of mineral extraction, timber, and agriculture.

C Pearce, D.W., [1991], *Deforesting the Amazon: Toward an Economic Solution,* Ecodecision.

C D.W.Pearce. [1994], *Global Environmental Value and the Tropical Forests: Demonstration and Capture*, CSERGE, University College London, *mimeo.*

Argues that economic values of tropical forest conservation are dominated by carbon storage values and existence values, with sustainable use values being relatively unimportant.

C Pearce, D.W., Adger, N., Brown, K., Cervigni, R. and Moran, D. [1993]. *Mexico Forestry and Conservation Sector Review Substudy of Economic Valuation of Forests.* Report prepared by CSERGE, University of East Anglia and University College London to World Bank Latin America and the Caribbean -- Country Department II (LA2).

The study identifies and quantifies in monetary terms the environmental values associated with forest conservation and management. These values are typically not captured by private decision makers due to the lack of property rights in many of the forests' functions and are not considered in their

production decisions. The study concludes that efforts should be made through institutions to capture global benefits.

C Peters, C., Gentry, A. and Mendelsohn, R. [1989]. Valuation of an Amazonian Rainforest, *Nature* 339.

The authors argue that tropical forests can generate substantial market benefits if the appropriate resources are managed and exploited properly. Exploiting non-wood resources while conserving the Amazon forests could prove profitable.

C Pinedo-Vasquez, M., Zarin, D. and Jipp, P. [1992]. Economic Returns from Forest Conversion in the Peruvian Amazon, *Ecological Economics*, No.6.

The economics of timber extraction, swidden agriculture, and the harvesting of fruits and latex from the intact forest are examined and compared within a single village near Iquitos. The analysis indicates that rural populations in the area can be expected to continue converting forested land to swidden agriculture unless alternative land uses become more attractive economically.

C Ruitenbeek, H.J. [1990a]. *Evaluating Economic Policies for Promoting Rainforest Conservation in Developing Countries.* Ph.D Thesis, London School of Economics. See Ruitenbeek [1992a].

C Ruitenbeek, H.J. [1990b]. *Economic Analysis of Tropical Forest Conservation Initiatives: Examples from West Africa.* World Wide Fund for Nature, Godalming. See Ruitenbeek [1992a].

C Ruitenbeek, H.J. [1992]. The Rainforest Supply Price: A Tool for Evaluating the Rainforest Conservation Expenditures, *Ecological Economics*, 6.

To help decide whether international resources should be used to protect specific rainforests, the calculation of a rainforest supply price is proposed. A cost-benefit analysis of a conservation project to protect Korup from increased land use suggests that it is not in Cameroon's interest unless a 5.4 million ECU inducement is transferred to Cameroon, equivalent to 1060 ECU per $km^2$ per year; inducements that are within the range that conservation interests are apparently willing to mobilize.

C Ruitenbeek, H.J. [1994]. Modelling Economy-Ecology Linkages in Mangroves: Economic Evidence for Promoting Conservation in Bintuni Bay, Sarawak, *Ecological Economics*, 10, 233-247.

Presents a strong economic case for conservation of mangroves against threats of exploitation for wood-chip exports. Traditional non-commercial uses of the mangrove are estimated to be worth $10 million p.a for Bintuni Bay; commercial fisheries at $35 million; and selective mangrove cutting at $20 million p.a. Sustainable cutting of 25 per cent of the harvestable mangrove is estimated to be worth $35m more in present value terms than the alternative of clear-cutting.

C Shyamsundar, P and R.Kramer. [1993]. *Does Contingent Valuation Work in Non-Market Economies ?*, Center for Resource and Environmental Policy Research, Duke University, Durham, North Carolina.

Uses contingent valuation to assess householders' preferences for access to a forest area in Madagascar.

C Shyamsundar, P., R.Kramer and N.Sharma. [1993]. *Estimating the Costs to Local Inhabitants of Establishing the Mantadia National Park in Madagascar*, Center for Resource and Environmental Policy Research, Duke University, Durham, North Carolina.

C Tobias, D. and Mendelsohn, R. [1991]. Valuing Ecotourism in a Tropical Rain-Forest Reserve, *Ambio*, vol. 20.

Using the travel cost method, the study estimates the value of ecotourism in a Costa-Rican rainforest site. The study reveals that the present value of the site per hectare based on domestic and foreign use alone is 1 to 2 times greater than the purchase price currently paid by the reserve for acquisition of new lands. This value does not include other potential preservation benefits like the harvesting of commodities, watershed protection, and protection of wildlife habitat and rare species.

C World Bank [1992]. *Costa Rica: Forestry Sector Review.* World Bank Report, Washington, D.C.

C World Bank [1992]. *Malaysia: Forest Sector Review.* World Bank Report, Washington, D.C.

**6.6 Health**

C Convery, F., and K. Tutu. [1993]. *Estimating Gross Costs of Environmental Degradation -- Sectoral Analysis: a Ghana Case Study.* Department of Economics, University College Dublin, Dublin.

Estimates additional health expenditure costs (drugs and medical expenditure) plus forgone output of environmentally related diseases in Ghana at 1.67 billion cedis, or about $5.1 million. No comment is made on this surprisingly low figure.

C Krupnick, A., K. Harrison., E. Nickell and M. Toman [1993], *Assessing the Health Benefits of Improved Air Quality in Central and Eastern Europe,* Resources for the Future, Washington DC, Discussion Paper ENR93-19 and *Resources*, Fall, 1993.

Assesses potential benefits of improving $SO_2$, particulate and lead emissions in Eastern Europe to EC levels. Mortality is valued by taking USA valuations of statistical lives and adjusting them (a) by

income ratios and (b) income ratios adjusted for the income elasticity of demand. Nearly all health benefits accrue from particulate control. Low estimates of benefits are 1 to 4 per cent of GDP and middle-range estimates are 4 to 12 per cent.

C Ostro, B. [1994], *Estimating Health Effects of Air Pollution: A Methodology with an Application to Jakarta*, Office of Environmental Health Hazard Assessment, California EPA, *mimeo*.

Summarises consensus dose-response functions for health impacts of various air pollutants and applies them to Jakarta, Indonesia. Ostro shows that significant health benefits could accrue from air pollution reduction, including around 1,400 avoided deaths p.a. if particulate emissions are reduced to WHO guideline levels.

C Parikh, K., Parikh, J., Muraleedharan, T and Hadker, N. [1994], *Economic Valuation of Air Pollution in Chembur, Bombay*. Indira Gandhi Institute of Development Research, Bombay [1994]

Uses dose-response functions for health and hedonic property model for general air pollution impacts. The dose-response function links mortality to SO2 rather than particulate matter. Value of statistical life is estimated on the basis of human capital approach (124m Rs); wage differentials (93m Rs) and the implied value in the Workman's Compensation Act (69m Rs). Work days lost are linked to particulate matter and morbidity costs are estimated using medical and hospital costs. The hedonic property price study also found links between particulate matter and rentals.

C Seroa da Motta, R., and A.P. Fernandes Mendes [1993], Health Costs Associated with Air Pollution in Brazil, Applied Economic Research Institute, Rio de Janeiro, April, mimeo.

Evaluates mortality response to inhalable particulate matter, sulphur dioxide, ozone, carbon monoxide, and nitrogen dioxide, using a production function approach. Ozone and particulates are strongly linked to respiratory system disease. Dose-response functions are found to predict officially ascribed deaths extremely well. Valuation was based on hospital costs and foregone output. At 5 per cent discount rate costs in Sao Paulo are $2.2 million, in Cubatao $0.9 million and in Rio $0.4 million. The implicit `values of statistical lives' are around $7,000, compared to values of $20,000 estimated by the author for water pollution.

### 6.7 Marine and Coastal Areas

(see also wetlands)

C Dixon, J. [1993]. Economic Benefits of Marine Protected Areas. *Oceanus*, Vol.36, No.3, Fall, 35-40.

Looks at costs and revenues from protected marine areas in the Caribbean: Virgin Islands national park, Saba Marine Park in the Netherlands Antilles and Bonaire Marine Park. Recommends user charges.

C Dixon, J., L. Fallon Scura and T. Van't Hof. [1994], Ecology and Microeconomics as 'Joint Products': the Bonaire Marine Park in the Caribbean, in C.Perrings *et al. Biodiversity Conservation*, Amsterdam, Kluwer.

G Hamilton, L., J. Dixon and G. Owen Miller. [1989]. Mangroves: an Undervalued Resource of the Land and of the Sea, in E.M. Borgese *et al.*, *Ocean Yearbook 8*, Chicago: Chicago University Press.

C Hodgson, G. and Dixon, J. [1988]. Measuring Economic Losses due to Sediment Pollution: Logging versus Tourism and Fisheries, *Tropical Coastal Area Management*, April, 5-8.

Assesses cost of fisheries losses in the Philippines due to sedimentation arising from logging. The net benefits to the combined total of logging, fishing and tourism is found to be highest when there is a hypothesised logging ban.

C Dixon, J. and G. Hodgson. [1988]. Economic Evaluation of Coastal Resources: the El Nido Study, *Tropical Coastal Area Management*, August, 5-7.

Extends Hodgson and Dixon [1988].

C Dixon, J. and P.N. Lal. [1994], The Management of Coastal Wetlands: Economic Analysis of Combined Ecologic-Economic Systems, in P. Dasgupta and K-G. Maler (eds), *The Environment and Emerging Development Issues*, Oxford, Clarendon Press.

Surveys previous estimates of economic values for coastal wetlands.

G Dixon, J., L. Fallon-Scura and T. Van't Hof [1993], Meeting Ecological and Economic Goals: Marine Parks in the Caribbean, *Ambio*, Vol.22, No.2, May, 117-125.

C Fallon -- Scura, L. and T. Van't Hof [1993], *The Ecology and Economics of Bonaire Marine Park*, Environment Department, World Bank, Divisional Paper 1993-44.

Assesses ecological thresholds for numbers of divers per year before coral reef damage occurs, and estimates costs and benefits of protecting the marine park.

### 6.8 National Accounting

(including aggregated national environmental costs).

C Adger, W.N. (1992) Sustainable National Income and Natural Resource Degradation in Zimbabwe, in

R.K.Turner (ed), *Sustainable Environmental Economics and management: Principles and Practice*, London: Belhaven Press, 338-359/

The study estimates the rents from deforestation in Zimbabwe in 1987, soil erosion in 1990 and mineral extraction for 1990-91. Given their high dependency on primary production the relevance of national accounts adjusted for resource depletion is stressed in developing countries. Figures for soil erosion show that depreciation of natural capital in 1987 was equivalent to nearly 30 per cent of agricultural GDP and 5 per cent of aggregate GDP. Fuelwood depreciation was 9 per cent of agricultural GDP.

G Ahmad, Y.J., El Serafy, S. and Lutz, E. eds. [1989]. *Environmental Accounting for Sustainable Development,* The World Bank, Washington D.C.

C Bartelmus, P., Lutz, E. and Schweinwest, S. [1992]. *Integrated Environmental and Economic Accounting: A Case Study for Papua New Guinea*, Environment Working Paper No. 54, World Bank, Washington D.C.

The study points out where problems might arise in building an SEEA (System of Environmental and Economic Accounts). Public environmental expenditure is a relatively small 0.27 per cent of GDP from 1986-1990, but it is increasing and is a 0.74 per cent of total government budget.

C Crowards, T. [1994]. *Natural Resource Accounting for Zimbabwe*, CSERGE, University College London, forthcoming.

Estimates rentals to woodlands, soils and minerals in Zimbabwe at 3.3% of GDP in 1980 and 1.7% in 1989. These rentals are equivalent to the value of depreciation in the relevant sectors.

C Cruz, W. and Repetto, R. [1992] *The Environmental Effects of Stabilisation and Structural Adjustment Programs: The Philippines Case*, World Resources Institute, Washington DC.

Resource depreciation is estimated for forestry, soil erosion and coastal fisheries; combined they average 4 per cent of GNP and 20 per cent of gross domestic investment from 1970-1987. This was greater than external debt, increasing at a rate of 3.2 per cent of GDP. The authors see this increasing liability as symptomatic of the worsening balance sheet for natural assets.

G Hamilton, K.E. [1993]. *Resource Depletion, Discoveries and Net National Product*, Centre for Social and Economic Research on the Global Environment UCL and UEA, University College London, *mimeo*.

G Hamilton, K.E. [1992]. *The Basic Identities of Environmental National Accounting*, Centre for Social and Economic Research on the Global Environment UCL and UEA, University College London, *mimeo*.

C Hartwick, J.M., and Hageman A.P. [1991]. *Economic Depreciation of Mineral Stocks and the Contribution of El Serafy*, Environment Department Working Paper No.1991-27, World Bank, Washington DC.

C Lallement, D. [1990]. *Burkina Faso: Economic Issues in Renewable Natural Resource Management*, Sahelian Dept, World Bank, Washington DC.

G Lutz, E., Munasinghe M. and Chander R. [1990]. *A Developing Country Perspective on Environmental Accounting*, Environment Department Working Paper 90-12, World Bank, Washington DC.

G Lutz, E. (ed). [1993]. *Toward Improved Accounting for the Environment*, World Bank, Washington DC.

G Mäler, K-G. [1991]. National Accounts and Environmental Resources, *Environmental and Resource Economics*, 1: 1-15.

G,C Parikh, K., Parikh, J., Sharma V.K. and Painuly J. [1992]. *Natural Resource Accounting: a Framework for India*, Indira Gandhi Institute of Development Research, Bombay.

Sets a framework for modified income accounting for India. It includes approaches to estimating non-market sector activities as well as natural resource accounts. The report recommends an action plan based on immediate priorities. This includes assessing the physical environmental impacts of selected production and consumption activities including the informal sector, and physical accounts for soil, air, water, forests, biodiversity, and various non-renewable resources. Economic valuation should be investigated with the aim of securing integrated economic and environmental accounting.

M Peskin, H.M. [1989b]. *Accounting for Natural Resource Depletion and Degradation in Developing Countries*, Environment Department Working Paper No. 13, World Bank, Washington DC.

Provides an adjusted account that imputes a value for the depletion of forest resources in Tanzania due to firewood collection. The value of physical depreciation of forests in Tanzania is about 5 per cent of conventionally measured GDP in 1980 and considerably greater than the marketed imputation for fuelwood production in that year.

C,G Repetto, R. Magrath, W. Wells, M. Beer, C. and Rossini, F. [1989] *Wasting Assets: Natural Resources in the National Accounts,* World Resources Institute, Washington DC.

Changes in the stocks of natural resources such as oil, forests and soil for Indonesia are considered in

the capital account as well as the changes in man-made capital. Optimal paths for extraction following the Hotelling Rule and the net price method is used.

C Sadoff, C.W. [1992]. *The Effects of Thailand's Logging Ban: Overview and Preliminary Results*, Thailand Development Research Institute, Bangkok.

In spite of the logging ban in Thailand, deforestation continues, so environmental benefits are limited. Sadoff claims that the rates of logging in neighbouring countries have increased. A more efficient policy would be to combine sustainable management practices where logging is permitted, and a tightening of the ban elsewhere.

C Seroa Da Motta, R., and Young, C.E.F. [1991]. *Natural Resources and National Accounts: Sustainable Income from Mineral Extraction*, Instituto de Planejamento Economico e Social, Rio de Janeiro.

C Seroa Da Motta, R., and May, P.H. [1992]. *Loss in Forest Resource Values Due to Agricultural Land Conversion in Brazil*. Texto para Discussão No.248, Instituto de Planejamento Economico e Social, Rio de Janeiro.

C Seroa Da Motta, R., Mendes, A.P.F., Mendes, F.E., and Young, C.E.F. [1992]. *Perdas e Serviços Ambientais do Recurso Água para Uso Doméstico*, Texto Para Discussão No.258, Instituto de Planejamento Economico e Social, Rio de Janeiro.

C Solorzano, R., de Camino, R., Woodward, R., Tosi, J., Watson, V., Vásquez, A., Villalobos, C., Jiménez, J., Repetto, R. and Cruz, W. [1991]. *Accounts Overdue: Natural Resource Depreciation in Costa Rica,* World Resources Institute, Washington DC.

Focuses on forestry, soil erosion and fisheries. All expected future damage is capitalized into present values and added to the depreciation figures. The figures are deducted from the gross product of the sector to get the net product.

M United Nations [1977]. *Provisional International Guidelines on the National and Sectoral Balance Sheet and Reconciliation Accounts of the System of National Accounts*, Series M, No. 60, United Nations Statistical Office, New York.

G United Nations [1990]. *SNA Handbook on Integrated Environmental and Economic Accounting, Preliminary draft of part I: General Concepts*, United Nations Statistical Office, New York.

M United Nations [1992] *Revised System of National Accounts. Chapter XXI. Satellite Analysis and Accounts*, (provisional), United Nations Statistical Office, New York.

C Van Tongeren, J., Schweinfest, S., Lutz, E., Gomez Luna M., and Guillen, F. [1991] *Integrated Environmental and Economic Accounting: A Case Study for Mexico*, Environment Working Paper No. 50, World Bank, Washington DC.

This case study is the first empirical experience with the overall analytical framework developed in the United Nations Statistical Office. The main innovation is the enlargement of the asset boundary, including oil depletion, degradation concerns, land use concerns and deforestation. The results presented in an input-output scheme show not only the macro-effects of depletion and degradation but also identify the economic use of natural resources and environmental protection expenses made by different sectors.

C Young, C.E.F. [1992]. *Renda Sustentável da Indústria Extrativa no Brasil*, IEI/UFRJ,

Rio de Janeiro.

## 6.9 Recreation and Ecotourism

C Abala, D. [1987]. A Theoretical and Empirical Investigation of the Willingness-to-Pay for Recreational Services: A Case Study of the Nairobi National Park, *Eastern African Economics Review* 3, No. 2.

The study uses the contingent valuation method to estimate the factors that influence an individual's willingness-to-pay for using the Nairobi National Park. Results show that education, income, physical attributes of the park, and other factors significantly influence willingness-to-pay.

C Ahmad, S., Sabri, W. and Rashid, R. [1990]. Benefit Valuation of Outdoor Recreation Resources, in *Research and Publications 1988/89*, Faculty of Forestry, Universiti Pertanian Malaysia, Serdang, Selangor, Malaysia.

The authors use the contingent valuation method to estimate the value of outdoor recreation at Semenyih Dam in Peninsular Malaysia.

C Durojaiye, B. and Ikpi, A. [1988]. The Monetary Value of Recreational Facilities in a Developing Economy: A Case Study of Three Centers in Nigeria, *Natural Resources Journal* 28(2):315-328.

The travel cost technique was used to value three recreational facilities in Nigeria. The values were significant to the economies of the two cities concerned, and much larger than the alternative land use values.

C Grandstaff, S. [1986]. Tongonan Geothermal Power Plant Project in Leyte, Philippines, in Dixon, J. and Hufschmidt, M. (ed) *Economic Valuation Techniques for the Environment*. London: The Johns Hopkins University Press.

A cost-effectiveness approach was employed to

choose the least costly alternative among several waste water disposal schemes taking into account both treatment costs and environmental damage costs. By clearly defining the range of possible impacts of the alternative geothermal fluid disposal systems available, and by placing monetary values on these impacts where possible, a more informed and environmentally sensitive project design is possible.

C Grandstaff, S. and Dixon, J. [1986]. Evaluation of Lumpinee Park in Bangkok, Thailand, in Dixon, J. and Hufschmidt, M. (ed) *Economic Valuation Techniques for the Environment: A Case Study Workbook*. Baltimore, Maryland: John Hopkins University Press.

Lumpinee is an urban park used for short visits, as against longer trips to national parks that most studies have focused on. The travel cost method and contingent valuation were used to place a monetary value on benefits received by both park users and non-users. Estimates of users' willingness-to-pay were nearly identical under the travel cost and contingent valuation approaches.

C Maille, P. and Mendelsohn, R. [1993]. Valuing Ecotourism in Madagascar, *Journal of Environmental Management*, 38, 213-218.

Travel cost analysis of foreign visitors is used to determine the value per visitor of tropical biological reserves in Madagascar. The value per visitor is estimated to be between $276 and $360.

C Mercer, D.E. and Kramer, R.A. [1992]. *An International Nature Tourism Travel Cost Model: Estimating the Recreational Use Value of a Proposed National Park in Madagascar.* Presented at Association of Environmental and Resource Economics, University of New Orleans.

An international nature tourism travel cost model is derived. The model provides a conceptual framework for rigorous policy analysis of the potential nature tourism benefits accruable from allocating scarce resources to biodiversity preservation through the creation of national parks. See Kramer *et al.* [1993].

C Moran, D. [1994]. Contingent Valuation and Biodiversity Conservation in Kenyan Protected Areas. *Biodiversity and Conservation* (forthcoming).

A contingent valuation survey of foreign visitors to Kenyan parks and reserves. Using a discrete choice question format the survey reveals an expected mean WTP of $72 per day on the part of foreign visitors for the purpose of park maintenance.

C Tobias, D. and Mendelsohn, R. [1991]. Valuing Ecotourism in a Tropical Rain-Forest Reserve, *Ambio*, vol. 20.

Estimates local willingness-to-pay for visits to a forest area in Costa Rica.

## 6.10 Sanitation

(see also water quality)

C Darling,A., C. Gomez and M. Niklitschek [1993], The Question of a Public Sewerage System in a Caribbean Country: a Case Study, in M. Munasinghe [1993], *Environmental Economics and Natural Resource Management in Developing Countries*, Committee of International Development Institutions on the Environment (CIDIE), World Bank, Washington DC.

Uses contingent valuation for the 'swimmability' of coastal waters, and risk analysis of the pollution-health link to assess the feasibility of a public sewerage system for an unnamed Caribbean island.

C Whittington, D., Lauria, D., Wright, A., Choe, K. and Swarna, V. [1992]. *Household Demand for Improved Sanitation Services: A Case Study of Kumasi, Ghana*. UNDP-World Bank Water and Sanitation Program, The World Bank, Washington, DC, May. 118pp.

This contingent valuation study found that most households were willing-to-pay more for improved sanitation than they were currently paying but in absolute terms the potential revenues are not large, confirming that conventional sewerage is not affordable to the vast majority. On the other hand, improved ventilated pit latrines, which are much cheaper, would need only modest government subsidies.

C Whittington, D., D. Lauria., A. Wright., K. Choe., J. Hughes and V. Swarna. [1993], Household Demand for Improved Sanitation Services in Kumasi, Ghana, *Water Resources Research*, Vol.29, No.6, 1539-1560.

A contingent valuation study was conducted to estimate households' willingness-to-pay for two types of improved sanitation services: improved ventilated pit latrines and water closets connected to a sewer system. Most households were willing to pay more for improved sanitation than they were currently paying for the existing sanitation system (mostly public and bucket latrines), but potential revenues from households are not large. The study confirms the view that conventional sewerage systems are not affordable to the vast majority of households without massive government subsidies. However, only modest subsidies are required for on-site sanitation (ventilated pit latrines): willingness-to-pay is about as high as it is for water closets, and ventilated pit latrines are much cheaper to supply.

C Whittington, D., D. Lauria., A. Wright., K. Choe., J. Hughes and V. Swarna. [1993], House-

hold Sanitation in Kumasi, Ghana: a Description of Current practices, Attitudes and Perceptions, *World Development*, Vol.21, No.5, 733-748.

A survey of 1,200 households in Kumasi revealed a dangerous public health risk from the existing sanitation system. Only 10 per cent of generated human waste is removed from the city. Expenditure on sanitation services was only $1.50 per capita per year and, correspondingly, households were getting very poor service. Households were quite open to the idea of simple, low cost, on-site solutions to their sanitation problems.

## 6.11 Soil Erosion and Land Degradation

G Bishop, J. [1992]. Economic Analysis of Soil Degradation. London Environmental Economics Centre Gatekeeper Series, 92-01, London.

C Bishop, J. [1990]. *The Cost of Soil Erosion in Malawi*. Consultant Report, Country Operations Division, Southern Africa Department, The World Bank, Washington, D.C.

The study finds a link between soil loss and crop yields. Economic losses are about 4 per cent to 26 per cent of composite net farm income for Malawi as a whole.

C Bishop, J. and Allen, J. [1989]. *The On-Site Costs of Soil Erosion in Mali*. Environment Department Working Paper No. 21, The World Bank, Washington, D.C.

For Malawi as a whole, the study estimates a mean current rate of soil erosion of 20 t/ha/yr on gross arable land. The on-site cost of soil erosion is expressed in terms of reduced crop yields, resulting in mean annual yield losses between 4 per cent and 25 per cent. For Mali, gross annual losses are estimated to be between 0.5 per cent and 3.1 per cent of 1988 GDP.

C Bojö, J. [1986]. *Cost-Benefit Studies of Soil and Water Conservation Projects: a Review of 20 Empirical Studies,* in K. Tato and H. Hurni (eds), Soil Conservation for Survival, Soil and Water Conservation Society, 1992, (7515 Northeast Ankeny Road, Iowa, 50021-9764).

The purpose of this paper is to shed some light on the extent to which theoretical cost-benefit analysis has been applied to soil and water conservation projects, what the major difficulties have been, and what policy conclusions can be derived from those experiences.

G,C Bojö, J [1990?], *The Economics of Land Degradation: Theory and Applications to Lesotho,* Published Ph.D. dissertation, EFI, Stockholm School of Economics, Box 6501, 113 83, Stockholm.

C Convery, F. and K. Tutu. [1993]. *Estimating*

*Gross Costs of Environmental Degradation -- Sectoral Analysis: a Ghana Case Study*. Department of Economics, University College Dublin, Dublin.

Estimates, very approximately, the costs of lost soil nutrients due to land degradation in Ghana. A figure of $80 million is suggested for crop loss and $8.4 million for reduced livestock production due to nutrient loss.

C Cruz, W., Francisco, H. and Conway, Z. [1988]. The On-Site and Downstream Costs of Soil Erosion in the Magat and Pantabangan Watersheds, *Journal of Philippine Development*, Vol.15, No.1.

C Fleming, W. [1983], Phewa Tal Catchment Program: Benefits and Costs of Forestry and Soil Conservation in Nepal, in L.S. Hamilton (ed), *Forest and Watershed Development and Conservation in Asia and the Pacific*, Westview Press, Boulder.

C Golan, E.H. [1992], *Soil Conservation and Sustainable Development in the Sahel: a Study of Two Senegalese Villages*, World Employment Programme, International Labour Organisation, Geneva, Working Paper WEP 2-22/WP.235.

Applies a micro (community level) Social Accounting Matrix to simulate crop choice, soil conservation efforts and income effects of alternative tax/subsidy schemes on an erosive crop (groundnuts) and other conservation interventions.

C Grohs, F. [1992], *Monetarising (sic) Environmental Damages: a Tool for Development Planning? A Case Study of Soil Erosion in Zimbabwe*, Paper presented to International Society for Ecological Economics Conference, Stockholm. See Grohs [1993].

C Grohs, F. [1993], *Economics of Soil Degradation, Erosion and Conservation: a case Study of Zimbabwe*, Ph.D Thesis, University of Hohenheim, Stuttgart.

Assesses the economic costs of soil erosion to small-holder farmers in Zimbabwe through the productivity loss approach. The methodology uses the Soil Loss Estimation Method for Southern Africa (SLEMSA) for field level estimation, and a GIS aggregation for aggregate costs. Off-site costs in small dams are estimated. The results suggests a high 3 per cent yield decline per 1cm of soil lost; smallholder farm income losses for 1989 of $Z 4.4 million, and $Z 1.7 million losses for the large scale sector. These are considerably below those estimated by Stocking (see Stocking [1986]).

C G. Hodgson and J. Dixon [1988], *Logging versus Fisheries and Tourism in Palawan*, Occasional Paper No.7, East-West Center, Hawaii.

C Kim, S-H. and Dixon, J. [1986]. Economic Valuation of Environmental Quality Aspects of the

Upland Agricultural Projects in Korea, in Dixon, J. and Hufschmidt, M. (ed) *Economic Valuation Techniques for the Environment*. The Johns Hopkins University Press, Baltimore.

C Knowler, D. [1993]. *Economics and Planning for Improved Land management: Two Cases from West Africa*. Unpublished mss. FAO Investment Center, Rome.

Uses change of productivity approach to estimate the cost of soil erosion in Ghana and Nigeria.

G Lutz, E., S. Pagiola and C. Reiche (eds). [forthcoming]. *Economic and Institutional Analyses of Soil Conservation Projects in Central America and the Caribbean*, Environment Department Working Paper, World Bank, Washington DC.

C Lutz, E., S. Pagiola and C. Reiche [1994], *Cost-Benefit Analysis of Soil Conservation in Central America and the Caribbean*, World Bank Environment Paper No.8, Washington DC, and *World Bank Research Observer*, forthcoming.

Estimates yield losses due to soil erosion in various areas of Central America and the Caribbean. The edited volume consist of 18 chapters on various issues relating to soil erosion. Damage cost studies are summarised by the editors. Rates of return to soil conservation measures range from 16 to 84 per cent (with two exceptions of negative rates of return). Measured against high private discount rates the effects are varied with some schemes having very short pay-back periods and others have very long pay back periods. As the authors note: 'these results of the economic analysis suggest that it can be perfectly rational for farmers not to adopt proposed conservation measures'.

C Margulis, S. [1992]. *Back-of-the-Envelope Estimates of Environmental Damage Costs in Mexico*. Working Paper, The World Bank.

For developing countries that may not be able to afford an in-depth study of every environmental issue, rough estimates of economic costs of various environmental problems are needed to help rank the issues. Valuation methods are presented along with their limitations. Some damages such as the loss of biodiversity are, however, too complex and are not quantified.

C Magrath, W. and Arens, P. [1989]. *The Costs of Soil Erosion on Java: A Natural Resource Accounting Approach*. The World Bank, Environmental Department Working Paper 15, Washington.

C Norse, D. and R. Saigal. [1993]. National Economic Cost of Soil Erosion in Zimbabwe, in Munasinghe, M. (ed), *Environmental Economics and Natural Resource Management in Developing Countries*, Committee of International Development Institutions on the Environment (CIDIE),

World Bank, Washington DC.

Uses replacement costs of fertiliser to value soil loss in Zimbabwe and estimates annual cost to be $150 million on arable lands alone, or 13 to 60 per cent of the gross returns per hectare.

M Pagiola, S. [forthcoming]. Cost Benefit Analysis of Soil Conservation. In Lutz, E., S.Pagiola and C.Reider (eds). [forthcoming]. *Economic and Institutional Analyses of Soil Conservation Projects in Central America and the Caribbean*, Environment Department Working Paper, World Bank, Washington DC.

C Pol, F.van der. [1992]. *Soil Mining: An Unseen Contributor to Farm Income in Southern Mali*. Royal Tropical Institute Bulletin 325, Amsterdam.

Uses a nutrient loss approach to value soil degradation in southern Mali.

C Shah, P., Schreier, H., Browns, S. and Riley, K. [1991]. *Soil Fertility and Erosion Issues in the Middle Mountains of Nepal*. Workshop Proceedings, Jhikhu Khola Watershed. sponsored by the International Development Research Centre, Ottawa, Canada.

This workshop discusses the results of research on the Middle Mountains of Nepal, monitoring the resources dynamics in the region. The aim is to integrate this work, to understand the resource problems of the Middle Mountains, identify research priorities, determine appropriate avenues for implementation of policies and gain feedback for the next phase of the Jhikhu Khola Soil Fertility and Erosion Research Project.

C Stocking, M. [1986]. *The Cost of Soil Erosion in Zimbabwe in Terms of the Loss of Three Major Nutrients*, Consultants' Working Paper No.3, Food and Agriculture Organisation, Rome.

Replacement costs of soil erosion in Zimbabwe are estimated at up to $Z1.5 billion, based on erosion estimates from the Universal Soil Loss Equation Model (USLE). These estimates are more than double the value of net agricultural output in the same year.

C Veloz, A., D.Southgate., F.Hitzhusen and R.Macgregor [1985], The Economics of Erosion Control in a Subtropical Watershed: a Dominican Case, *Land Economics*, Vol.61, No.2, May.

**6.12 Statistical Life**

See under Health for Parikh et al., and da Motta.

**6.13 Water Supply**

C Altaf, M.A., Jamal, H. and Whittington, D. [1992]. *Willingness-to-Pay for Water in Rural Punjab, Pakistan*. UNDP-World Bank Water and Sanitation Program, Water and Sanitation Report, no. 4.

The study aimed at determining the willingness of households to pay for improved service levels, the determinants of willingness-to-pay, preferences regarding the management of water delivery systems, and the appropriateness of existing government policy on the provision of water in rural areas.

C Altaf, M.A., D. Whittington, H. Jamal, and V.K. Smith [1993], Rethinking Rural Water Supply Policy in the Punjab, Pakistan, *Water Resources Research*, Vol.29, No.7, July, 1943-1954.

Analyses public policy on rural water supply in the Punjab, Pakistan. Using household survey data, it shows that policies have not kept pace with rapid economic development. In the absence of adequate public investment, households find private sector alternatives for their water needs, often at high economic and environmental cost. Contingent valuation results indicate that household willingness-to-pay for water supply is much higher than generally assumed. Full cost recovery is shown to be quite feasible in many areas.

C Boadu, F. [1992]. Contingent Valuation for Household Water in Rural Ghana, *Journal of Agricultural Economics*, vol. 43.

C Briscoe, J., Castro, P., Griffin, C., North, J. and Oslen, O. [1990]. Towards Equitable and Sustainable Rural Water Supplies: A Contingent Valuation Study in Brazil, *The World Bank Economic Review*, Vol.4, No.2.

The study shows that surveys of actual and hypothetical water-use practices can provide policy-relevant information on willingness-to-pay, varying according to household socioeconomic characteristics, and the characteristics of the existing and new supplies of water. In rural Brazil, tariffs for yard taps can be increased substantially before a significant number of households would choose not to connect to an improved system, whereas provision of free water at public taps can protect the poor without jeopardizing the financial viability of the scheme.

C Lovei, L. and Whittington, D. [1993]. Rent-Extracting Behaviour by Multiple Agents in the Provision of Municipal Water Supply: A Study in Jakarta, Indonesia. *Water Resources Research*, vol. 29, No.7, 1965-1974.

A framework is presented for the analysis of rent-extracting behaviour by multiple agents involved in the provision of municipal water supplies in Jakarta, Indonesia. It is shown that such behaviour can dramatically affect the terms and conditions under which water service is offered to the public. A water supply system based on limited numbers of public taps, relatively few house connections, and water vendors can generate substantial monopoly rents that can be appropriated by both public and private agents. Rather than serving the public interest, agents involved in the water delivery system may pursue strategies designed for private gain which can have important and pervasive implications for how a water system is actually designed and operated.

C MacRae, D. and Whittington, D. [1988]. Assessing Preferences in Cost-Benefit Analysis: Reflection on Rural Water Supply Evaluation in Haiti, *Journal of Policy Analysis and Management*, vol. 7.

This article examines an area of cost-benefit methodology which has come under increasing philosophical scrutiny in recent years: the appropriate treatment of individuals' preferences. The authors illustrate some of these problems using a concrete example: the evaluation of a rural water supply project in southern Haiti.

C Seroa da Motta, R., Filho, G., Mendes, F. and Nascimento, C. *Current Status of Water Pollution Control in Brazil*. Research Institute of Applied Economics, Instituto de Planejamento Economico e Social, Rio de Janeiro.

This paper attempts to discern the effectiveness of abatement policy and the status of current water quality in Brazil. It presents the results of a study on indicators of water quality for 13 states where systematic monitoring is undertaken. A regional, sectoral and sustainability analysis of water quality and policy are also presented.

C Mu, X., Whittington, D. and Briscoe, J. [1990]. Modelling Village Water Demand Behavior: A Discrete Choice Approach, *Water Resources Research*, vol. 26.

Presents a discrete choice model of householders' water source choice decisions in developing countries. The model is estimated with data from 69 households in Ukunda, Kenya, a small town south of Mombasa. The results suggest that source choices are influenced by the time it takes to collect water from different sources, the price of water, and the number of women in the household. Household income did not, however, have a statistically significant effect. The same data were used to estimate a traditional model of household demand. The results of the discrete choice and traditional models are then compared.

G Munasinghe, M. [1990]. *Managing Water Resources to Avoid Environmental Degradation.* World Bank Environment Department Working Paper No. 41, Washington, D.C.

C North, J. and Griffin, C. [1993]. Water Source as a Housing Characteristic: Hedonic Property Valuation and Willingness-to-Pay for Water, *Water Resources Research*, July.

The study estimates the determinants of the rental

value of dwellings using the bid-rent approach to the hedonic price model with data from a region in the Philippines. The study finds that most households value an in-house piped water source highly, relative to other attributes. Middle- and high-income households value a deep well or piped water in the yard although less than piped water in the house. Somewhat surprisingly, households appear to gain little from having a communal source of water closer to their homes.

M Paul, J. and Manskopf, J. [1991]. *Cost-of-Illness Methodologies for Water-Related Diseases in Developing Countries*. Water and Sanitation for Health Project, Technical Report No. 75.

The report develops a methodology for the use of the cost-of-illness approach for water related projects in developing countries with a focus on potential health benefits from water supply and sanitation interventions, taking into account potential direct cost savings in the form of productivity gain in a population no longer affected by the disease or illness.

C Singh, B., Ramasubban, R., Bhatia, R., Briscoe, J., Griffin, C. and Kim, C. [1993]. Rural Water Supply in Kerala, India: How to Emerge from a Low-Level Equilibrium Trap, *Water Resources Research*, July.

Discusses the problems faced by rural water systems in India in particular, and in the developing world in general. The analysis suggests that it is indeed possible for the system to rise out of its current trap. The study traces out a 'new' path for water supply planners involving a few but critical policy changes; for example the critical ingredient is perceptions about the financing and purpose of public water supply systems.

C Whittington, D., Lauria, D. and Mu, X. [1991]. Paying for Urban Services: A Study of Water Vending and Willingness-to-Pay for Water in Onitsha, Nigeria, *World Development*, vol. 19.

Discusses many of the questions involved with Third World water supply systems: where the water comes from, how much households get, what uses the water is put to, how much households pay for water, and how much they would be willing to pay for improved water services. The lack of data on water demand appears to be one of the causes of the wide gap between expectations and accomplishments of urban water schemes.

C Whittington, D., Mu, X. and Roche, R. [1990]. Calculating the Value of Time Spent Collecting Water: Some Estimates for Ukunda, Kenya, *World Development*, vol. 18.

Two procedures for estimating the value of time spent collecting water in developing countries are

presented to derive estimates of the value of time for households in Ukunda. The value of time is high, suggesting that the economic benefit of improved water services in developing countries may be much higher than is commonly realized.

C Whittington, D. [1989]. *Water Vending and Development: Lessons from Two Countries*. USAID Water and Sanitation for Health Project, Washington, D.C.

C Whittington, D., Okorafor, A., Okore, A. and McPhail, A. [1989]. Strategy for Cost Recovery in Rural Water Sector: A Case Study of Nsukka District, Anambra State, Nigeria, *Water Resources Research*, Vol.26, No.9, 1899-1913.

In-depth interviews were conducted with 395 households in three rural communities in Nsukka district of Anambra State, Nigeria, concerning their household water use practices, water expenditures to vendors, willingness-to-pay for improved water supplies, and household socioeconomic characteristics. Since households are shown not to want to pay for water in advance, nor to make fixed monthly payments, a system involving payment for water actually received when it is wanted is required. Householders did not trust government to supply such a service. Kiosk systems, or kiosks with metered private connections to some households, are the most promising way to improve cost recovery and meet consumers' cash flow needs.

C Whittington, D., Briscoe, J., Mu, X. and Barron, W. [1990]. Estimating the Willingness-to-Pay for Water Services in Developing Countries: A Case Study of the Use of Contingent Valuation Survey in Southern Haiti, *Economic Development and Cultural Change* 38, no.2.

The results of the study suggest that it is possible to carry out a contingent valuation survey among a very poor, illiterate population and still obtain reasonable and consistent answers.

C Whittington, D., Mujwahuzi, M., McMahon, G. and Choe, K. [1988]. *Willingness-to-Pay for Water in Newala District, Tanzania: Strategies for Cost Recovery*. Water and Sanitation for Health Project Field Report No. 246, USAID, Washington, DC.

The paper presents a case study of a water planning problem in the Newala District which collapsed when diesel necessary to run the pumping station could not be provided. The aim of the WASH study was to estimate the willingness of households to pay to keep the system running, so as to save themselves the hours of waiting to collect water from traditional sources.

C Whittington, D., Smith, K., Okorafor, A., Okore, A., Liu, J. and McPhail, A. [1991]. Giving Respondents Time to Think in Contingent Valuation Stud-

ies: A Developing Country Application, *Journal of Environmental Economics and Management*, vol. 22.

A study was conducted in Nigeria as part of an evaluation of rural households' willingness-to-pay for public taps and private connections to improve drinking water systems. It finds that respondents who were allowed time to evaluate the proposed water system bid significantly less than those who do not have that time. Moreover, this conclusion held for both public taps as well as private connections.

G Whittington, D. and Choe, K. [1992]. E*conomic Benefits Available from the Provision of Improved Potable Water Supplies: a Review and Assessment of Existing Evidence. Prepared for Water and Sanitation for Health Project*, U.S. Agency for International Development, Washington, D.C.

This report summarises the existing literature on the economic benefits of potable water supplies in developing countries, price elasticities of demand for water, and households' willingness-to-pay for improved water supplies.

## 6.14 Water Quality

(see also sanitation)

C Darling, A., C. Gomez and M. Niklitschek [1993], The Question of a Public Sewerage System in a Caribbean Country: a Case Study, in M. Munasinghe [1993], *Environmental Economics and Natural Resource Management in Developing Countries*, Committee of International Development Institutions on the Environment (CIDIE), World Bank, Washington DC.

C McConnell, K. and J. Ducci [1989], *Valuing Environmental Quality in Developing Countries: Two Case Studies*, Paper read to Association of Environmental and Resource Economics Session on Valuation Surveys in Developing Countries, Atlanta, Georgia. Department of Agricultural and Resource Economics, University of Maryland, *mimeo.*

Values waste water treatment in a Caribbean island (see Darling *et al.*[1993]) and a South American city (both unnamed) using contingent valuation.

G Munasinghe, M [1990], *Managing Water Resource to Avoid Environmental Degradation,* Environment Department, World Bank Working Paper No. 41.

## 6.15 Wetlands

C Adams, W.M. and Hollis, G.E. [1989]. *Hydrology and Sustainable Resource Development of Sahelian Floodplain Wetland.* Prepared for Hadejia-Nguru Wetlands Conservation Project, Nguru, Nigeria.

C Aglionby, J. [1993], *Determining the Optimal Size of a Small Scale Wetland Development Project in the Light of Environmental Costs: a case Study at Fete, Ghana*, Centre for Social and Economic Research on the Global Environment, University College London, *mimeograph.*

Develops a 'rapid appraisal' methodology for the valuation of the environmental impacts of small scale wetlands development projects in Ghana. The valuation is used to determine the optimal scale of the development.

C,G Barbier, E. [1993]. Sustainable Use of Wetlands Valuing Tropical Wetland Benefits: Economic Methodologies and Applications, *The Geographical Journal,* vol. 159.

The paper points out the importance of economic valuation of tropical wetlands and natural systems in economic development decisions. Consequences of not assessing economic impacts could often be irreversible, and borne by economies that can least afford them. A general methodological approach for valuing wetland benefits is described and fits neatly into the cost-benefit approach that can be used to analyse development policies and investments.

G Barbier, E. [1992]. Valuing Environmental Function: Tropical Wetlands. London Environmental Economics Centre Discussion Paper 92-04.

G Barbier, E., Costanza, R. and Twilley, R. [1991]. *Guidelines for Tropical Wetland Evaluation*. Report for CATIE, Turrialba, Costa Rica.

C Barbier, E., Adams, W. and Kimmage, K. [1991]. *Economic Evaluation of Wetland Benefits: The Hadejia-Jama'are Floodplain, Nigeria*. London Environmental Economics Centre Discussion Paper 91-02, London.

The floodplain possesses substantial economic value given its multi-faceted functions. The paper concludes that water developments that divert water from the wetlands should not proceed unless it can be demonstrated that the net benefits gained from these developments exceed the net benefits forgone through wetland loss in the floodplain.

G Barbier, E. [1989a]. *The Economic Value of Ecosystems: 1 -- Tropical Wetlands*. London Environmental Economics Centre Gatekeeper Series No. GK89-02.

G Barbier, E. [1989b]. *Economic Evaluation of Tropical Wetland Resources: Applications in Central America*. Prepared for International Union for the Conservation of Nature and CATIE, London Environmental Economics Centre Discussion Paper, London.

C Dixon, J. and P.N. Lal. [1994], The Management of Coastal Wetlands: Economic Analysis of Com-

bined Ecologic-Economic Systems, in P.Dasgupta and K-G. Maler (eds), *The Environment and Emerging Development Issues*, Oxford, Clarendon Press.

Surveys previous estimates of economic values for coastal wetlands in Thailand, Indonesia, Fiji, Malaysia and Ecuador.

G Maltby, E. [1986]. *Waterlogged Wealth: Why Waste the World's Wet Places?* London: Earthscan Publications.

C Ruitenbeek, H.J. [1992]. *Mangrove Management: An Economic Analysis of Management Options with a Focus on Bintuni Bay, Irian Jaya.* Environmental Management Development in Indonesia Project, Environmental Reports, no. 8.

The analysis shows that strong economic arguments exist for conservative mangrove clearing. Where strong ecological linkages occur, severe restrictions on clearing activities will prove economically optimal. Where ecosystem dynamics are uncertain, programmes reducing linkage effects will minimize potential economic losses.

C Thomas, D., Ayache, F. and Hollis, T. [1990]. Use Values and Non-Use Values in the Conservation of Ichkeul National Park, Tunisia. *Environmental Conservation*, 18, 120-130.

Shows that the economic gains from taking measures to prevent the degradation of the Ichkeul National Park by releases of water from the dams outweigh the economic benefits from the use of water in agricultural irrigation.

G Turner, R.K [1991]. Economics and Wetland Management, *Ambio* 20(2).

G Turner, R.K. and Jones, T. [1991]. *Wetlands: Market and Intervention Failures.* London: Earthscan Publications.

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Creel, M. and J. Loomis [1992], "Recreational Value of Water to Wetlands in the San Joaquin Valley: Linked Multinomial Logit and Count Data Trip Frequency Models", *Water Resources Research*, Vol. 28, No. 10, pp2597-2606.

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Hanley, N.D. [1990], "Valuation of Environmental Effects: Final Report -- Stage One", Industry Depatment of Scotland and the Scottish Development Agency, Agency.

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1. The authors do indicate that visitation to the reserve has grown 15 per cent a year for the past five years (prior to 1988), such that the net discount factor may be negative (i.e. a growth factor).