MILESTONE REPORT

A REVIEW OF TECHNIQUES TO VALUE ENVIRONMENTAL RESOURCES IN COASTAL ZONES

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This paper provides an overview of environmental valuation techniques. It begins with a brief description of a number of approaches to project evaluation, particularly in relation to economic efficiency considerations, and considers the nature of the valuation information required for each approach. It then provides an overview of a number of environmental valuation techniques, considers the pros and cons of each and the usefulness of these techniques for the requirements of the Cooperative Research Centre for Coastal Zone, Estuary and Waterway Management, hereafter termed the Coastal CRC. One approach to valuation discussed at length is environmental benefit transfer. Of particular interest to the Coastal CRC is the potential for the citizens jury approach, recently promoted by Blamey *et al.* (2000), to go someway towards addressing a number of identified problems with valuations based on surveys. It is proposed that the Coastal CRC could undertake a valuation survey, using a citizens jury, that would be suitable for benefit transfer to a number of policy sites.

1. Introduction

Decision-making with respect to the management of environmental or ecosystem services is complex, commonly involving multiple objectives which could be competing and conflicting. As a result, appropriate evaluation tools or techniques to assist decision-making will be limited to those that have the capacity to incorporate information from a number of disciplines and that can identify an outcome that offers a compromise solution. Management of the coastal and estuary zones in Australia will necessarily involve the identification and reconciliation of the trade-offs between the negative externalities created by urban and industry developments and protection of recreational areas, important natural habitat areas, biodiversity as well as areas of natural beauty.

In a situation where there are competing potential users and uses of a scarce resource, the issue of optimal allocation arises. From an economic perspective, the optimal allocation of a resource relies on the criterion of economic efficiency. Where there is a competitive market functioning, the price mechanism will ensure an economically efficient allocation of resources. Where markets do not exist or there is a failure of the market to value resources, there is a need to intervene and for techniques to be applied that effectively mimic the market by estimating a value for environmental resources. The Coastal CRC is likely to require information about the economic value of environmental resources in coastal areas to assist with identifying the appropriate use to which coastal and estuary resources should be put; to provide justification for management to protect environmental resources; to provide a basis for "polluter pays principles" to deter polluters; to assess the worth of environmental assets and finally to simply stimulate awareness of environmental issues.

Attempts have been made to estimate an economic value of the world's ecosystem goods and services provided by natural capital (Costanza *et al*, 1997). The Costanza *et al*. methodology was adopted to estimate a value for the goods and services provided

by a number of biomes in South Australia (Government of South Australia, 1999). Information about the value of natural capital as an asset is important because it tells us whether the ecosystem is worth preserving. For example, what is the natural capital of Moreton Bay? What are the ecosystems provided by the natural capital and what is the value of the goods and services provided by these ecosystems? Is the natural capital worth preserving by undertaking capital works and implementing management strategies? For the most part, this information is, as yet, unavailable.

More numerous however, are studies attempting to value a change in the quality or quantity of a specific environmental resource, for example, a proposed change in the use for Kakadu National Park. Traditionally, market information is used to value goods or services or to estimate levels of demand as part of a cost-benefit analysis of proposed public sector projects or for research involving consumer choice. The economic concept of value however, encompasses any net change in the welfare of society and is therefore not restricted to benefits derived solely from the direct use of a resource. The total economic value (TEV) of an environmental resource includes use benefits as well as non-use benefits. Use benefits include both direct and indirect uses. Direct use values accrue from the physical use of the good, such as fishing in a river, visiting a national park or production of forestry products. Indirect use values include the service provided by an environmental resource such as water purification, reduced soil degradation, and reduced flood damage. Non-use benefits may be obtained from environmental resources without actually using them. These include existence value, option value, bequest value and vicarious value.[1] Market information measures the value of goods and services which are used: it does not measure the value of potential use so that market information provides incomplete information about the economic value. This notion of an apparent failure of the market to account for non-use values of environmental services has led to a proliferation of studies to develop appropriate techniques to estimate a TEV for environmental resources.

For the most part, evaluations of change in resource use require information about the TEV or welfare change associated with a marginal change in the resource in question. The question that needs to be addressed is: are the costs associated with a proposed development or management policy going to be off-set by the estimated value of the benefits from a marginal change in the environmental resource?

Environmental management requires information to be provided by scientists to verify the extent and magnitude of perceived resource degradation. However, this information is not necessarily sufficient for government agencies to take action to avoid, reduce or minimise the degradation risks. Information is required that would determine if the expected benefits from taking action are at least equal to the costs. The form in which this information is required, qualitative or quantitative, in monetary or non-monetary terms, will be determined primarily by the evaluation approach adopted; most commonly a cost-benefit analysis (CBA) or, a multiple

[1] Existence value is the value of simply knowing that a resource exists, bequest value is the value of knowing that a resource will be available for future generations and option value is the value given a resource when there is a risk associated with future supply and demand. It is the amount of money an individual is willing to pay to ensure that that a resource is available for use in the future. Option value is distinct from quasi-option value which is explained by Dasgupta and Maler (1994) in terms of the irreversibility of a resource use. It refers to the value of information or delay associated with a development decision that would prevent or reduce irreversible damage.

criteria analysis (MCA). There is a real danger that if no quantitative measure of the value of environmental resources is available, then it could be perceived that they have little or no value to society and can therefore be exploited.

2. Approaches to evaluation

Cost-Benefit Analysis

CBA is the standard tool used by economists to establish the economic efficiency of investment. It provides a theoretically sound and consistent approach to evaluate investment decisions using the sole criterion of economic efficiency. In essence, CBA requires all of the costs and benefits associated with a proposed project or policy to be identified and valued in monetary terms. A cash flow of the estimated monetary value of all costs and benefits resulting from a project over the expected life of the project is constructed. Frequently, when information is not available to the project analyst to enable monetary values to be estimated for costs or benefits, qualitative statements are provided to describe the nature and magnitude of such items. Because the decision rule for undertaking a project is conventionally stated as accept the project if the net present value (NPV) is > 0 at a particular discount rate or accept if the benefit cost ratio is > 1 or alternatively accept the project if the internal rate of return (IRR) is > than a specified rate of return, there is a strong tendency to overlook negative or positive impacts on a project if they cannot, or have not, been valued in monetary terms. In relation to this, there is an increasing body of literature about the limitations of CBA, including perceived problems with evaluating projects where there are environmental impacts requiring a monetary value to be estimated (see for example Hanley and Spash, 1993). In response to this problem, expenditure is substantial on research projects which have the objective of developing techniques to value environmental resources and on testing the validity of such techniques.

Multiple Criteria Analysis

MCA is promoted in the literature[2] as a tool to complement CBA rather than as a substitute for CBA. It is argued to be particularly appropriate for decision-making for natural resource management where it is important to consider environmental, social as well as economic factors. MCA is promoted as a process approach to project evaluation that facilitates a transparent iterative and interactive approach to evaluation, incorporating information from a number of disciplines. In essence, this approach requires project options to be evaluated against a number of criteria, including economic, environmental and social criteria. Although there is no requirement that the estimated performance of project options is measured against the criteria in monetary terms, where this information is available, it is likely to increase the validity of the results. Specifically, measuring project outcomes in qualitative terms or by using quantitative measures that are not immediately related to a value system could introduce a high degree of subjectivity into project evaluation and reduce the credibility of the findings. In this regard, where research resources are available, estimating a monetary value for environmental impacts could remove some of the subjectivity surrounding the evaluation and improve the validity of the results.

[2] See for example, Robinson (2000)

3. An overview of environmental valuation techniques

A number of approaches that have been developed specifically to value the environment are considered in this section. A problem faced by decision-makers required to make a choice about resource use or resource management, is the lack of information about the value the community or stakeholders place on the environment. Where there is no obvious market for environmental resources, then surrogate or simulated market information is required. Approaches to non-market valuation can be broadly divided into those that attempt to estimate a demand curve for each of the resource's uses and non-uses, and those that estimate a production function linking environmental quality to changes in production relationships or estimate the cost of various regulatory or preventative actions. The demand curve approach is generally considered the better of the two approaches, but there is as yet no consensus on which particular methodology provides the best estimate of a demand curve for a non-market resource.

3.1 Estimation of production function and avoided or preventative cost

Turner *et al.* (1994) categorise these techniques as non-market demand approaches and suggest that these approaches do not provide true valuations or welfare measures paying only lip service to the economic concepts of value; willingness to pay (WTP) or willingness to accept compensation (WTA). The information provided to decision-makers using these techniques is primarily directed towards determining the cost of environmental impacts on production capabilities or, alternatively, the effectiveness of implementing preventative regulations or policy. This information cannot be assumed to measure society's WTP or WTA for a change in the condition of the environment. The production function and avoided or preventative cost techniques are based largely on market prices.

The production function approach includes dose response and effect on production techniques. The effect on production technique estimates the value of a change in the condition of the environment from an associated change in the level of production or from a change in productivity. This can of course work in both directions. For example, an estimate of the change in production for a sugar cane farmer who had established or restored an area for riparian vegetation requiring land to be taken out of production would not necessarily result in an overall increase in cane yield from the farm, at least in the short run. The benefits from establishing riparian vegetation including reduced rat damage and reduced scouring resulting from major rain events might not outweigh the costs associated with establishing a riparian vegetation area. Garrod and Willis (1999) describe the effect on production technique as forming the basis of compensation payments which necessarily assumes that farmers, or affected persons have property rights over the land or natural resource.

The dose response technique is more commonly adopted when information is required about the effect that a pollutant has on the level of economic activity or on consumer utility. When the effect of an emission is readily estimated, for example on crop yield, market information can be utilised to estimate a value for a change in productivity. However, when the emissions affect people's health, for example particulate matter (PM_{10}), estimating the economic consequences of the pollutant requires an estimate of the value of a human life as well as the value of a reduction in morbidity. At this point the cost of avoiding mortality or morbidity is used as a proxy for the value of a human

life and of morbidity. The dose response technique has been adopted for the valuation of reduced agricultural production due to serious levels of air pollution (see for example Kahn and Kemp, 1985).

An estimate of preventative expenditure is frequently adopted as a measure for the value of environmental damage or reduced quality of environmental resources. Typical of this approach is the cost of preventing the damage caused by the disturbance of acid sulphate soils. Farmers in acid sulphate prone areas are estimated to spend large sums of money on lime to treat acidic soils. This preventative or remedial expenditure is frequently adopted as an indication of the value of not disturbing these soils.

Some environmental damage, for example dryland or irrigation salinity, takes a considerable period of time to manifest itself. When the full extent of production loss is a predictive estimate and the effectiveness of preventative expenditure is uncertain, then valuations using this valuation approach should be treated with caution.

Although these techniques provide worthwhile information about the value of lost production and costs associated with preventing or avoiding loss of production or a reduction in consumer utility, they do not provide a measure of consumer surplus. That is, they do not indicate how much the community are WTP or WTA to prevent losses occurring and, as such, are not regarded as sufficient measures of consumer welfare.

3.2 Estimation of a demand curve

There are basically two generic approaches to the estimation of a demand curve: those that use revealed preference techniques and those that involve the use of stated preference techniques. Revealed preference techniques rely on deriving the costs and revenues from surrogate or related markets, the effects of which closely resemble the environmental resource of interest (Commonwealth Government, 1995: 35). For the most part, these techniques value the use values associated with a resource. Stated preference techniques for valuing the environment are characterised by the use of surveys in which respondents' preferences for various environmental outcomes are identified through construction of a simulated market. Stated preference techniques, including contingent valuation and forms of conjoint analysis such as contingent rating, contingent ranking and choice modelling, can be used to estimate a use and a non-use value, including bequest values, for the environment. Sinden (1994); Commonwealth Government (1995) and Morrison *et al.* (1996) provide an overview of environmental valuation techniques in the Australian context.[3]

The problems associated with conducting valuation surveys and the validity and reliability of results is important information for the Coastal CRC. A number of techniques have been developed to estimate an economic value for non-marketed environmental resources. A number of factors that would influence the choice of technique include: the purpose of the study (whether opportunity cost or direct benefit estimates are required); the particular economic values required (use and or non-use

[3] More detailed discussion about these methods is available in Garrod and Willis (1999); Hanley and Spash (1993); Sinden (1994); and Young (1991).

values, or a sub set); the acceptability of particular assumptions associated with the use of a technique; the importance of statistical errors; robustness of benefit estimates and whether the benefit estimates can be aggregated over the identified population (Garrod and Willis, 1999:11).

Revealed preference techniques for valuing the environment

Revealed preference techniques used for valuing the environment are characterised by the use of surrogate or related markets. Consumer behaviour in the surrogate market provides an indication or reveals consumer preferences for the non-marketed environmental resource. Techniques such as the travel cost method and hedonic pricing are typical of these techniques.[4]

The travel cost technique estimates a value for the environment (such as a national park) by measuring the cost of using the asset as a surrogate estimate of the WTP. Costs of using the resource included items such as cost of travel, entrance fees, and boat hire. For the most part, this method does not attempt to measure the value of a change in the quantity or quality of a specific resource, it simply estimates the direct use value of the resource in its entirety as a demand function.

Zonal travel-cost models are more sophisticated forms of travel cost models, which relate the demand for the recreational area (expressed as visits per unit of population per zone of origin) to a vector of variables including the admission price and socio-economic characteristics (income, age etc) of the residents in each zone. The demand function is commonly expressed as:

$V_{ij}/N_i = f(TC_{ij}, T_{ij,}, Y_i, S_i, Q_j, A_k)$

Where

V_{ij} = trips from zone i to site j
N_i = population of zone i
TC_{ij} = travel costs from zone i to K sites
T_{ij} = travel time from zone i to site j
Y_i = average income in zone i
S_i = socio-economic characteristics of zone i
Q_j = recreation quality at site j
A_k = measure of the cost and quality of substitute site k

Although travel cost techniques have been successfully applied to value environmental resources, for example Driml (1996) estimated the value per domestic visitor to the Wet Tropics World Heritage Area to be A$49, a number of assumptions are relied on which if violated could significantly reduce the reliability of the results. These include, that the travel undertaken is solely for the purpose of visiting the site under investigation and that the costs of travel to the site are fully accountered for and are a reasonable proxy for an entrance fee. In reality, these assumptions rarely hold. For example, travel to a recreation

[4] The hedonic pricing method is commonly used for marketing research, to estimate values for specific product attributes (see Hanley and Spash (1993) for more detailed discussion about these techniques).

site frequently involves multiple stops en route that should be accounted for in the estimated value of the recreation site in question.

The hedonic pricing technique defines an environmental resource as elements of a vector of characteristics which describe a good traditionally marketed. For example, a park could be described in terms of its characteristics such as area of land and access to water, characteristics which would describe any land marketed in an area. The method seeks to find a relationship between the level of the environmental good and the price of the marketed goods. This technique was adopted by Lockwood *et al.* (2000) to estimate a value for remnant native vegetation. The problem encountered by the Lockwood study, a problem frequently reported when hedonic pricing models are applied for environmental valuation, is the lack of data (in this case property sales) to enable a vector of characteristics of the environmental good to be developed and valued.

The most important problem with these techniques and with other revealed preference techniques, is that they do not measure the indirect uses or non-use values, including the value of the option to visit a recreational area in the future; a value for knowing that an area actually exits or the value of an ecosystem to aid water purification or prevent erosion.

Stated Preference Techniques

Stated preference techniques are characterised by the use of surveys which estimate stakeholder preferences by directly asking individual stakeholders about their preferences. These techniques include contingent valuation, contingent rating, contingent ranking and choice modelling. Contingent rating, contingent ranking and choice modelling are forms of conjoint analysis, a survey technique more commonly used for market research but more recently acknowledged as a technique which could be utilised for resource management. Contingent valuation and a variation of this, choice modelling, are discussed in more detail below.

The Contingent Valuation Method (CV)

The stated preference technique which is commonly regarded as superior to the others in terms of its validity and reliability for valuation of the environment is contingent valuation. This technique directly assesses WTP or WTA for a particular environmental outcome in a carefully constructed hypothetical or simulated market. One of the strengths of the technique is that it measures both use and non-use values of an environmental resource. It involves providing a description of the existing situation and the possible changes to the environment which are expected to result from proposed changes in management or use to a sample of the population and then directly asking about how much they are WTP or willing to accept WTA to prevent the proposed change in the environment. The payment vehicle is important as respondents could register a protest bid if they object to the method by which the payment would be made. For example, respondents tend to object to a payment in the form of an increase or an additional tax. Recently, payment vehicles in the form of a payment into a trust account that would be dedicated to the environment have been adopted. Responses are regressed against a number of socio-economic and attitudinal characteristics of respondents, the availability of substitutes as well as price in cases where a discrete choice format is used. The demand function is commonly expressed as:

$WTP_i = f(A_i, E_i, Y_i, M_{i,,} S_i)$

Where WTP_i = the willingness to pay for environmental resource i
A_i = the age of the respondents
E_i = the level of education of respondents
Y_i = the income level of respondents
M_i = the level of environmental awareness of respondents
S_i = the availability of substitutes

The estimated demand function is subsequently used to estimate the mean or median Hicksian surplus. In response to a number of criticisms of this technique primarily resulting from poor survey design, Mitchell and Carson (1989) provided a number of recommendations to improve the reliability of the results.

Choice Modelling or Choice Experiments using Conjoint Analysis

"The term, 'conjoint analysis' means decomposition into part-worth utilities or values of a set of individual evaluations of, or discrete choices from, a designed set of multiattribute alternatives" (Louviere, 1988: 93). It is a technique commonly used in marketing studies to design, implement and analyse judgement data, where judgement data are defined as "evaluative rankings or ratings of a set of multiattribute alternatives obtained from individuals" (Louviere, 1988: 94). Conventional conjoint analysis relies on experimental design techniques to construct combinations of attributes about which respondents are asked to state their relative preferences. For example, if a good B is described by N attributes or criteria, each with criteria i, ($i = 1 \ldots N$) varying across L_i levels, there are $L_1, L_2 \ldots L_N$ possible descriptions of B. The number of descriptions of B can be significantly large.

Although commonly used in marketing research, this analytical technique has more recently been adapted for environmental valuation. Contingent rating, contingent ranking, and choice modelling or choice experiments are forms of conjoint analysis that require the respondent to rank or rate (as the case may be) two or more resource uses or resource management options for which a dollar value to the household has been assigned for its implementation. The respondent is required to make a series of choices, selecting one from a number of possible choice sets where one choice set is always the 'no change' scenario. The data are analysed using a conditional multinomial logit regression model, from which values for the resource's individual services or attributes as well the aggregate value of the resource are derived.

Although choice modelling surveys provide valuable information about the value of specific attributes of a resource they suffer from many of the criticisms that have been levelled at stated preference surveys.

Criticisms of stated preference techniques reliant on survey data, include bias in the quality and quantity of information supplied to respondents (Cummings *et al.*, 1986), on the welfare measure used WTP or WTA, a bias in the design of the bidding, for example, whether an open-ended question about WTP, a closed-ended question, a dichotomous choice an iterative bidding or, a series of dichotomous choice questions, and on the acceptability of the payment vehicle to respondents (Blamey, 1998).

Bergstrom *et al.* (1989) cite psychological studies to support their argument that the way information is presented to respondents during contingent valuation surveys is likely to have an influence on the response. It is realistic to acknowledge that the information supplied, including the quality of the information about the management changes expected to take place as well as the payment vehicle adopted, will influence the response.

A concern first expressed by Sagoff (1988) regarding the distinction between the survey responses of respondents acting as citizens or consumers and since taken up in the literature by Blamey *et al*. (1995), suggests that more care needs to be taken when interpreting the results from contingent valuation studies. Gans (1999) argues that obtaining information about non-use values from individuals with little judgement experience in valuation of environmental resources may be impossible but that experts on the other hand may be able to learn to make the required trade-offs and provide the necessary information for appropriate collective choices. Blamey *et al.* (2000) take up discussions of this nature when they support the "need for methods of public participation with stronger emphasis on information and deliberation" (p.7). Blamey *et al.* (2000) suggest that referenda-type surveys be replaced with citizens' juries, where citizens act in the position of jurors representing the interests of others and are therefore assumed, "ceteris paribus, to feel greater responsibility to make a well-informed and deliberated decision than referendum voters" (Blamey *et al.* 2000: 13).

Studies by Blamey *et al*. (1999) and Loomis *et al.* (2000) suggest that choice modelling techniques are useful alternatives to contingent valuation surveys because they provide information about the value of specified attributes of an environmental resource, given the inclusion of a cost attribute within the choice sets. In addition, choice modelling is regarded as better suited to the economic evaluation of multiple mutually exclusive policy options (Blamey *et al*.1999: 339).

4. Benefit transfer

Economic valuations for a number of environmental resources in the coastal zone are likely to be required for evaluation of management of this area. Due to time and research funding constraints, it is unlikely that all of these resources will be subject to individual and explicit valuation. It is therefore necessary to consider the opportunities that are available for the use of environmental value transfer, more commonly referred to as benefit transfer (BT).

BT is defined as transferring values that have been estimated for one environmental attribute or group of attributes from one site or location (termed the study site) to assess the benefits of a similar site or location (termed the policy site) (Devousges *et al.* 1992). According to Smith (1992), because it is not possible to observe all the factors that influence people's preferences, applied models that use empirical information to predict people's preferences are inherently wrong. BT, because it uses existing empirical models to estimate people's preferences for another site, can only be regarded as an approximation. If we can acknowledge that a completely correct model does not exist, then the objective becomes one of balancing or trading-off the errors. The objective of BT can be expressed as estimating the value of an environmental resource for a policy site such that the mean square errors (MSE) are

minimized subject to time and research funding constraints. Devousges *et al*. express this objective as:

$$MinimiseMSE(\hat{\theta}) = Var(\hat{\theta}) + (Bias(\hat{\theta}))^2$$

subject to $AF = AF^0$ and $AT = AT^0$

Where $\hat{\theta}$ is the estimated benefit
AF is the available funds
AT is the available time

The bias component addresses the question of the validity or credibility of the benefit estimation method, and the variance component addresses the concept of reliability or accuracy of the benefit estimation method.

The BT approach is regarded as useful not only because surveys are expensive and because many evaluation projects are time constrained but also because there are many instances where an indicative value for the resource is all that is required for environmental planning purposes. However, the validity of BT is debated extensively in the environmental literature. For the most part, BT is acknowledged as a feasible approach for many applications but, the message is clearly one of proceeding with caution. Brouwer (2000) notes that, to date, testing of environmental value transfer has been unable to validate the practice and, more importantly, no study has, to date, been able to show under which conditions BT is entirely valid.

Despite the extensive discussion about the reliability of BT, BT is applied routinely by environmental protection agencies. It is implicitly assumed by regulatory agencies controlling the level of waste emissions into a watercourse or into the atmosphere. If the same standard for emissions, for example waste water quality, is applied across an entire geographical area encompassing a number of environmental sites, then it can be argued that authorities have assumed that equivalent environmental benefits are available at all sites and locations in the area. As a general rule, BT is regarded as relevant if it provides broad information for policy formation, such as setting emission standards but it is not regarded as relevant for studies requiring specific valuation for uses such as determining compensation or for studies where there is expected to be a large environmental impact. However, Boyle and Bergstrom (1992) argue strongly that these conditions for relevance "do not guarantee valid and reliable benefit transfer estimates" (p.657).

Ultimately, the decision context for estimating values for environmental resources will determine the appropriateness of BT estimates. For example, if BT of an estimated value were to be used in a CBA where it was possible to conduct a sensitivity or risk analysis over the range of possible values to provide information about the effect of the different values on the estimated outcome of a project, then BT might be considered appropriate. However, if BT was adopted for an estimate of the value of resource degradation (for example) to be used for subsidies or compensation payment where one monetary estimate was required then the reliability of BT would be questionable.

Increasing the validity of benefit transfer

McConnell (1992) puts forward two observations that he believes characterise the decision environment and which he argues impact on BT estimates. The first observation is that natural resource services are not provided in a market clearing setting. This means that similar resources in different regions will provide different total and marginal values, suggesting that BT across regions is not likely to be reliable. The second observation is that non-market valuation seeks to estimate values that are rarely observed. According to McConnell, this places considerable emphasis on the demand model and requires judgements to be made about the behaviour of the model for other sites, for which there is little basis other than introspection. Both of these observations lead to the conclusion that BT cannot be mechanical, that transferred estimates will require informed judgements.

Numerous studies undertaken in recent years and dealing with the reliability of BT suggest a protocol for its use.[5] The literature identifies a number of fundamental conditions that are essential for BT to be meaningful. These include:

- The environmental good (or service) in both sites, including any proposed change in provision levels should have approximately the same characteristics.
- The population in both areas should have similar characteristics, including income, education level and culture.
- The values estimated for the study site should not be dated as preferences could change over time.
- The availability and price of substitutes should be the same.
- The relative prices of other goods and services should be the same.
- The technical quality of the study site, including adequate data, sound economic methods and appropriate analytical techniques needs to be determined. Studies being considered for BT to a policy site should provide regression results.
- The constructed or hypothetical markets for estimating the value of environmental resources, including the distribution of property rights, should be the same at both the study site and the policy site.

In addition, to test the validity of a BT estimate Loomis (1992); McConnell (1992) and Kirchhoff *et al.* (1997) suggest a pilot study on the policy site or inter-site studies to compare the results with those found for the study site. A pilot study would provide information about the accuracy or statistical validity of BT and the extent of any bias. A number of tests are recommended, these include:

- Comparing the BT values with primary data values obtained from the policy site. If the BT estimates from the policy site are not statistically different from the study site value estimates, then convergent validity may be concluded. The extent of bias can be determined by measuring the deviation between the two estimates.
- Determining whether the different populations have the same preferences for the same non-marketed good, after controlling for differences in socio-economic characteristics such as income and level of education.

[5] See for example Desvousges et al. (1992); Kirchhoff et al. (1997) and Brouwer (2000)

- Determine whether transfers are stable over time. A number of studies have concluded that value estimates are relatively stable only over a few years.

BT is not simply a technical solution to a valuation problem where a previous study is identified that has undertaken a valuation of an environmental resource with similar characteristics to the policy site, and then transferring the value to the new site. An important consideration for BT is to identify which valuation approaches provide the most valid estimates for BT. Specifically, what properties make one valuation approach more or less amenable for valid BT? Desvousges *et al*. (1992) recommend that research is required to establish the validity of existing valuation studies with a view to their adoption for BT. The question of how the previous study was undertaken and what the estimated values actually reflect, that is, the framing of the study needs to be considered carefully.

BT is generally approached as either direct benefit transfer (DBT) or benefit function transfer (BFT). DBT involves the transfer of mean WTP values from a study site to a policy site. BFT involves the transfer of the estimated bid function or demand function for a study site to a policy site. Frequently, the demand function would have been modified to more closely represent the attributes of the policy site. The findings from a study by Kirchhoff *et al*. (1997) to evaluate the performance of DBT and BFT were consistent with the findings of Loomis (1992) rejecting the transfer of mean site benefit estimates or DBT. However, Kirchhoff *et al.* suggest that the information commonly incorporated in bid functions is not sufficient for BFT, especially when the market conditions for the resource being valued are not close substitutes for one another (p.91). In short, economists contemplating undertaking BT should be attentive of the qualities of the resource requiring valuation. This is likely to require specific contact with stakeholders at both the study and policy sites to identify what could be critical differences in the resource as well a number of inter-site studies to identify significant site characteristics.

BT has, and will continue, to attract valid criticism if it is used indiscriminately. In this regard Smith (1992) has recommended the establishment of a database of valuation studies to facilitate meta-analysis but which would serve also as a review process of valuation studies. The next sections review and discuss a number of commonly used valuation techniques, including meta-analysis, and their amenability for BT.

4.1 Amenability of valuation techniques for benefit transfer

Travel cost studies

The large volume of studies that have estimated the value of recreation areas using the travel cost approach (TC) has provided a useful database of studies for BT.

Travel-cost models estimate a demand function for a recreational area and as such provide the detail required for adoption for BT. BT is undertaken when the benefits to consumers from proposed facilities are estimated by transferring the demand functions from existing facilities, where the proposed facility is expected to closely resemble the existing facility. In this way each site has its own matrix of own price

and substitute prices. The transfer of demand functions would be applicable as long as the two sites were not close substitutes.

It is suggested in the literature that the lack of homogeneity of site characteristics, may be addressed by valuing recreational activities offered at different sites separately and then aggregating them, for example the value of fishing at one site and hunting from another. However, the sum of the parts may well be substantially different from the whole, particularly if site attributes are complementary.

Problems with adopting TC valuations for BT may originate from technical problems with the initial estimation of the demand functions and the derivation of the environmental benefit. Problem areas include:

- Choosing the wrong functional form. Different functional forms, for example semi-logged function or a linear model, produce very different estimates of consumer surplus.
- Measuring arguments incorrectly. For example, estimates of consumer surplus vary depending on whether access costs are based on petrol costs only or include a component for depreciation and service costs associated with vehicle usage.
- Measuring the dependent variable with error, for example, the frequency of visits is important for TC.

Loomis (1992) assessed the validity of the transferability of TC benefit estimates by comparing site-specific benefit estimates with those derived from transferring TC demand functions. A multi-site TC demand function for fishing in Oregon was estimated for *n-1*of the Oregon rivers. The function was used to estimate the *nth* river. The percentage difference between total recreation benefits estimated from the full multi-site TC and from the transferred model was around 17%. Loomis reports that transferring the function to the policy site rather than using the benefits per trip average over all *n* rivers from the full model, provided a better indicator of benefits from the site.

Benefit transfer using results from contingent valuation studies

Brouwer (2000) cautions that the explanatory power of the statistical models used for contingent valuation (CV) are low, accounting for between 30 – 40 per cent of the variability found in WTP amounts. With this in mind, the problem that needs to be addressed if CV estimates of environmental resources are to be considered for BT, is the reason for the level of explanatory power of these models. More specifically, there is a need to consider a number of factors that could effect the valuation including the framing of the preferences.

The framing effects in environmental valuation are described by Garrod and Willis (1999) as “compositional” problems. They describe landscapes as a complex blend of natural and man-made features and, that our response to them depends on the composition and configuration of these features (p.341). Garrod and Willis consider that because CV studies do not routinely decompose the attributes of the environmental resource being valued, BT using CV is restricted to the adoption of the mean or median value (DBT).

Other problems associated with CV and which could affect the validity of studies for BT are discussed by Garrod and Willis (1999, p. 341). These include:

- Employing ex post values in an ex ante project appraisal of a proposed scheme that may lead to biased estimates. The existing utility for a good is not the same as the expected utility for another good or more of the same good (a bird in the hand is worth two in the bush).

- That BT needs to address scale problems. If the new good or policy site is identical to the old and lies within the same market area, then it represents an additional quantity of the good which, in theory, ought to be valued less than the existing good at the study site. This is similar to the problems expressed earlier in relation to BT of TC estimated values when a number of recreation sites being valued are in the same catchment and are therefore likely to be substitutes.

- Where goods are substitutes or complements, the sequence in which a particular good is provided in relation to others determines its value, for example, because the interaction of landscape attributes affects valuation, the value of a particular conservation scheme is not necessarily the sum of the individual attribute changes. If attributes are independently valued and then summed, the result will be biased upward as the sum of the parts is likely to be greater than the whole if the attributes are substitutes.

Kirchhoff *et al.* (1997) conclude from their study of BT that transferring benefits from a study site to a policy site using DBT could be misleading or inaccurate. Brouwer (2000) cites one of the advantages of BFT as enabling more information to be transferred and adjusted to address the possible instability of values over time. This is consistent with the recommendations of Loomis (1992).

Benefit transfer using choice modelling studies

The proponents of choice modelling surveys argue that this CV valuation technique is more suited to BT than other CV studies because it provides information about consumer preferences for individual site characteristics from which a demand function can be derived.

Morrison and Bennett (2000) report the validity of BT of two studies conducted to estimate the value of two wetland areas in NSW (the Macquarie Marshes and the Gwydir Wetlands). The study reports the validity of BT (using convergent validity) across the two sites as well as the validity of BT across populations. The results for the transferability of benefits across sites revealed that the implicit prices were equivalent, except for the site characteristic concerning the frequency of waterbird breeding. However, for the transfer across populations the implicit prices were equivalent except for area.

The findings from the Morrison and Bennett (2000) study support the recommendations reported earlier (section 4) with respect to the protocol for selecting a study site suitable for BT. Valuations from choice modelling valuation techniques

are recommended to be more useful for BT, and in particular for BFT, because, unlike many CV studies, they have the ability to allow for modification of the attributes of environmental quality.

The most obvious conclusion to be drawn from this discussion about the applicability of specific valuation techniques for BT is that those techniques that provide disaggregated information about the characteristics of the market, preferences of consumers for a range of attributes of the resource including landscape considerations, as well as information about the socio-economic characteristics of the respondents are more amenable to BT that those techniques that provide a mean WTP estimate. In addition, where possible the source and extent of possible bias in WTP estimates should be indicated to enable possible manipulation of values for the policy site.

5.0 Meta–analysis

Meta-analysis introduces precision into the review of previous research. To some extent it provides a way of documenting some of the problems encountered by Desvousges *et al.* (1992) when selecting appropriate studies for transfer to a policy site. It summarises empirical findings in different studies and treats the results from these studies using a common methodological framework. Smith and Kaoru (1990) proposed that, in light of the increasing number of quality studies undertaken to value environmental resources, the adoption of meta-analysis to provide a consistent reviewing process to synthesise research findings would be appropriate.

The proposal from Smith (1992) for a meta-analysis recommends that the summaries of valuation studies should be used as models for the modelling process. He argues that economic models are approximations relying on econometric methods to provide statistical summaries of outcome estimates. The statistical summaries of estimates for a study site are recommended by Smith as providing a valuable source of information about the resource's attributes or characteristics, the sampling techniques and any modelling assumptions that might influence the results and indicate its suitability for transfer to a policy site.

At a more general level, the EPA NSW (1995) has developed a database of environmental valuation studies, *ENVALUE*, with a view to encouraging valuation of the environment in economic evaluations for policy development and decision-making.[6] EPA NSW set out guidelines for BT, recommending a number of procedures to be followed by prospective users to ensure a reasonable degree of accuracy. The EPA NSW valuation database provides summaries of previous studies dealing with a specific resource but does not necessarily provide information about the direction or magnitude of the modelling effects on estimates.

A review of *ENVALUE* to determine the availability of recent studies estimating the value of an improvement in water quality of a tidally influenced river system, information that would be valuable for the Coastal CRC, revealed that although a number of studies had been undertaken in the past on improved water quality, the

[6] Two other databases of environmental valuation studies have recently been developed. The Environmental Valuation Resource Inventory (EVRI) was developed by Environment Canada in association with the US Environmental Protection Agency and the New Zealand Non-market Valuation Database was released in 2000. Morrison (2001) reviews both of these databases.

information provided about these study sites was non specific. Information for the study site, including the specific attributes of the river and the socio-economic characteristics of the population initially surveyed was limited. For the most part, information to enable a demand function to be derived was incomplete. In addition, detailed information about the statistical analysis of the results was general and, for the most part, the analysis was dated.

Valuation studies are not all of the same quality and do not provide the same level of information about the analysis undertaken and possible sources of bias in estimates (Morrison, 2001). A number of considerations that would need to be addressed for construction of a meaningful and useful meta-analysis are suggested by Smith (1992, p.692). These include:

- Identification of the criteria to be used to identify comparable studies.
- How should the quality of different studies be judged? What are the criteria for determining the quality of a study? Once a judgement has been made, how is this information to be used?
- What measure should be used to summarise estimates across studies? A number of measures might be available including discrete measures such as consumer surplus, price elasticity of demand or the mean estimate. If a mean estimate is reported this could lead to indiscriminate use of the data base to simply choose a number that best suits the study being undertaken with little or no regard for the quality of the original study.
- Is it possible to combine estimates from studies using different modelling strategies?
- How feasible is it to compare estimates of a resource using indirect valuation techniques such as travel cost with those that directly solicit a value such as contingent valuation or choice modelling?
- How should the uncertainty inherent in estimates be incorporated in these analyses?

More recently, Morrison (2001) reviewed databases from North America and from New Zealand. Morrison concentrated his review on the scope of the reported studies and on the range of information provided about each study including detail about the socio-economic characteristics of the respondents and the site attributes as well as the quality of the reporting of the statistical analysis.

It is interesting to note that, although EPA NSW recommends the transfer of the demand function as a whole from a study site to a policy site as providing access to more detailed information about the study site rather than the transfer of a mean value, the information provided in the database makes access to mean values a relatively simple exercise. This could encourage the transfer of a mean value with little or no regard for the reliability or credibility of the source study.

6. Benefit transfer using expert opinion

Expert opinion is frequently sought for project evaluation, for example, to populate the effects matrix derived for evaluation of projects or policy using MCA. However, expert opinion will only be as good as the information informing the experts and the

skill of the experts. With respect to environmental valuation, the integrity of the expert opinion needs to be established as it could seriously impact on the degree of credibility and reliability of the valuation. Garrod and Willis (1999) describe the use of expert judgement and intuition for BT as "perhaps the most ubiquitous form by which BT is accomplished" (p.334).

Garrod and Willis (1999:334-335) describe two instances where expert opinion has been used to adjust a demand function or an estimated mean value for BT. In the 1970s-1980s the US Forest Service adopted an approach termed the "unit day value" to estimate a value for recreational use. Values for recreational use were determined on a per day basis for different standards of recreation. When applied to a new site, the values were adjusted on the basis of the demand functions of site visitors. Demand was assumed to be determined by a number of site characteristics, which it was acknowledged would not be the same across all sites. Because it could not be expected that these characteristics would be the same across all sites, expert judgement was used to adjust the estimated value to a new site.

Another study that adopted the judgement of experts was the estimation of the environmental externalities arising from the proposed Third London Airport (Commission on the Third London Airport, 1970). The Commission supported adopting expert real estate agents' opinion about the effect of noise on real estate on the grounds of their professional skill and knowledge-base. However, there are a number of studies refuting these claims referring to large discrepancies between estate agents valuation of the same property. Where valuations using expert opinion is used to direct policy towards environmental protection, the use of expert opinion might be capable of providing appropriate order-of-magnitude information. However, where information is likely to be used to estimate compensation payments, such as in the case of real estate valuations for the Third London Airport, then the use of expert opinion might be regarded as open to bias.

The use of expert opinion is not fully endorsed in the literature. It is suggested that more objective estimates are likely to provide a more accurate estimate of environmental values. Interestingly though, the literature is not explicit about how objective estimates might be arrived at other than by resorting to a full survey.

Stakeholder participation in environmental benefit transfer

Brouwer (2000) puts forward an interesting proposal for formulating appropriate environmental valuations and for BT that bears some similarity to the use of expert opinion to adjust BFT discussed previously and to the recent work of Blamey *et al* (2000) with citizens' juries.

Brouwer suggests a process which appears to be designed to improve the transparency of the valuation exercise to stakeholders. Unlike the Blamey *et al.* (2000) process where expert opinion is formally sought as an intricate part of the valuation process, the Brouwer process seems to require stakeholders to hold a considerable knowledge-base prior to consultation from which they can select appropriate studies for BT, validate value estimates or modifying the estimates from previous studies. Blamey *et al.* have acknowledged two important shortcomings of stated preference techniques for environmental valuation in their development of a citizens jury approach to

environmental management which could be particularly useful for BT using stakeholder participation. The first is undertaking valuations when the respondents have limited information. The second is distinguishing between respondents who respond as citizens and respondents who respond as consumers. Both of these situations could lead to biased results.

Stakeholder participation in resource management, and this includes valuation of environmental resources, is an increasingly acceptable way to empower communities to be involved in decision-making. If BT was perceived as an approach to value environmental resources that would provide the information required for decision-making, then a citizens jury could well provide the framework for meaningful community involvement. By selecting a jury as a stratified random sample of the affected population and informing the jury that their decisions will count and provide the direction for environmental management, it might be possible to considerably reduce the biases inherent in general survey work. In addition, by calling in experts to provide "evidence" to the jury and allowing discussion and feedback to take place between the jury and the experts, greater use is likely to be made of the available information. This approach might go someway towards addressing some of the problems that the Brouwer (2000) approach might encounter and is flagged as a worthwhile course to investigate further for BT.

7. Recommendations to the Coastal CRC

This paper has provided a review of a number of techniques for valuing environmental resources. The approach to valuation, will be largely determined by the nature of the information required about the resource in question. For example, if the value of natural assets is required to determine whether or not assets are worth preserving, then information about the value of ecosystems and ecosystem goods and services will be required. On the other hand, if a specific project is proposed, requiring an evaluation of alternative courses of action, then the value of a change in the quality or quantity of the resource will be required as input into a CBA or MCA.

All of the techniques for valuing a change in the environmental resource have positive as well as negative elements. One factor that is common to all the techniques, whether directed towards estimating an effect on production or estimating a demand function is that they require time as well as research dollars. In addition, the values estimated for the environment are largely estimated outside of the market. By undertaking surveys using surrogate markets or directly asking the community their WTP is a second best solution to a value determined through a freely operating market.

Given funding and time constraints and the relatively large volume of environmental resources, it is recommended that the Coastal CRC invests its resources into undertaking a number of studies that would be specifically designed for BT to a number of policy sites. The protocol for undertaking BT studies suggests a number of features of the study site and the policy site that would need to match for a good fit. Current research into BT is directed towards identifying valuation techniques that have been adopted for study sites that indicate minimum bias in the results and in addition are reliable. For the most part, the research has indicated that those valuation approaches which estimate a demand function for the environmental resource where the variables include a range of environmental attributes as well as the socio-

economic characteristics or the respondents, are more amenable for transfer to a policy site because there is some opportunity for modification of the site attributes and socio-economic characteristics to more accurately reflect the policy site.

One particularly interesting recent development in environmental valuation has been to adopt a citizens jury approach to valuation. This approach is advocated as going someway towards addressing problems of information bias encountered in some valuation techniques. In particular, by subjecting respondents to intensive information provided by a number of experts working on the environmental resource in question, it would be possible to use all of the available information as well as facilitate a discursive approach to the valuation exercise. In addition, by selecting respondents as a stratified random sample of the affected population, the sample could be reduced to relatively small numbers, perhaps 20 or 30 people. This is likely to reduce the costs of a survey as well as reduce the incidence of no-responses.

The valuation technique recommended for the Coastal CRC is a citizens jury approach to a choice modelling exercise. It is envisaged that if the choice sets were carefully prepared in cooperation with a number of experts, then the attributes of the environmental good at the study site, for example improved water quality in the Bremer River, would be similar to the attributes at a number of policy sites elsewhere in the Moreton Bay area. The demand function resulting from the choice modelling study would be relatively easily modified for a number of policy sites within the coastal zone requiring waterway management. This approach would not only address a number of problems encountered in the valuation technique itself, but would improve the credibility and reliability of the study for BT.

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