



Review of environmental valuation methods

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Abstract

To determine the amount of environmental goods and services to provide or preserve, it is necessary to weigh society's degree of preference for the environment. This value measure serves to inform the decision-making and policy-making process and there by justify the allocation of limited resources between competing uses. This paper provides an overview of economic valuation methods for environmental goods, with examples. Valuation methods include both demand and non-demand curve approaches, including the dose-response method, contingent valuation method and hedonic pricing.

Keywords: economic valuation, environmental goods, non-demand curve approaches and demand curve approaches

Introduction

During recent decades, public concern about the protection, preservation and restoration of the environment has increased. Loss of environmental resources is also an economic problem because when environmental resources are degraded, their economic values depreciate as well. Environmental valuation refers to the several methods through which, monetary values could be assigned to the environmental resources which were hitherto 'free' resources and were not 'non-marketed' or 'non- monetized' as a result. Similarly, the damage accrued to environmental resources also needs to be accounted for and quantified so that the monetary value could be assigned to that damage. Only when the damage is measured and quantified in monetary terms, it could lead to a realization of the extent of damage caused to the environment due to the pollution induced by economic activities.

There are various techniques that could be used to estimate and assign monetary values to environmental impacts, especially the non-market impacts. These techniques aim to measure the benefits or costs of environmental degradation on the welfare of individuals and social groups. On the other hand, techniques are also available to measure the impact of the measures and interventions taken for the increase or improvement in environmental resources or a turnaround in the quality and extent of already degraded environmental resources. Environmental valuation could also provide useful evidence to support habitat conservation policies by quantifying the economic value associated with the protection of biological resources. It has been used to determine the benefits and costs relate

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In traditional economic theory, valuation refers to measurement in monetary terms only, i.e. willingness to pay the price for a certain amount of utility derived from a good or a service. However, the utility of environmental goods and services cannot always be measured in terms of money because

they are 'free' gifts of nature and b) their utility may be not be measurable in measurable in finite terms. Besides, environmental goods are often not possible to be traded in the market and hence, the determination of a price for them is not possible through the market forces of demand and supply. Hence, the willingness to pay for environmental resources and the improvement in the quality of the environment have to be discovered through non-traditional techniques. This paper reviews some of the frequently used methods of environmental valuation and discusses their advantages and limitations.

The Total Economic Value (TEV) is made up of two components *viz.* use Value and Non-Use Value as shown in Fig 1.

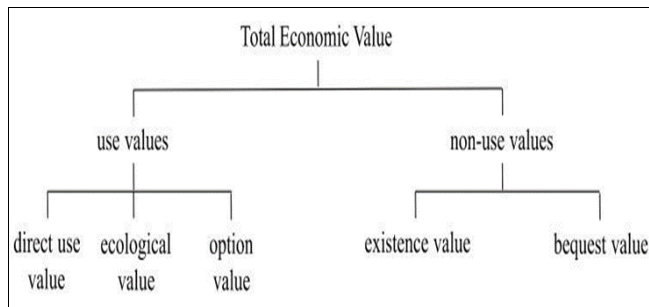


Fig 1

Use values are those derived from the actual use of the resource, while the non-use values are not derived from its present use but are related to its expected use; or use at some point of time in the future. Use values are further classified into i) direct use value, ii) ecological value and iii) option value. Direct use value refers to the value derived from the direct use or exploitation of the environmental good; which could be benefit the user in monetary terms. In other words, the direct use value is derived when a certain environmental good or service is bought and sold in the market in exchange of a price. The ecological value of an environmental good is the benefits it provides in terms of supporting the existence of all forms of life and biodiversity on the earth including that of humans. Option value is related to the prospects of future use of a particular environmental good.

Non-use values are classified into existence value and bequest value. Existence value related to the importance that individuals attach to the mere existence of a particular environmental resource, irrespective of whether it may be useful or otherwise, in the present as well as the future. On the other hand, bequest value is the value of an environmental resource that is estimated by individuals while considering the possible use or uses of that resource at some future point of time.

Understanding about use and non-use values of the environment is also essential for the sake of informed decision-making about environmental policies, legal measures, rules and regulations about environmental resources as well as the flow of investments into environmental projects or those projects that impact environmental resources.

Public investment of limited funds from the exchequer is justified only if it is targeted towards environmental resources according to the economic value attached to them by individuals, social groups or the society at large. Thus, assigning a monetary value on the intangible aspects of the environment is a necessary precaution to ensure that investment in the name of environmental up gradation is done in an accountable manner and leads the economy on the path of sustainable economic development. The methods of environmental valuation are briefly discussed as follows:

Contingent valuation method (CVM)

Contingent Valuation Method (CVM) is a widely used method for evaluating the willingness to pay (WTP) for a certain expense of environmental improvements on the part of the beneficiaries of the same. It tries to gauge the monetary value ascribed by the beneficiaries on a certain improvement in the environmental quality after incurring an investment on expenditure on the same (Ryan, Mentzakis, Jareinpituk, & Cairns, 2017)^[8]. In other words, this method

puts direct questions to individuals and on the basis of their responses, tries to conclude as to how much they would be willing to pay for an

improved environmental resource; or that how much compensation they would be willing to accept if they were deprived of a certain environmental amenity.

(Rahji & elizabeth, 2009)^[16] conducted a CVM study to investigate the determinants of WTP for creating a private solid waste disposal system by urban households in Ibadan, Nigeria. After conducting a study of 552 households, this study identified the significant variables that influenced the WTP of the households and recommended that the government's intervention was necessary to ameliorate the problems of solid waste disposal and improve the health of citizens.

(Bradley & Syme, 2000)^[3] conducted a survey of storm water pollution abatement by using CVM survey method in four Australian state capital cities. The nature of the intervention made for pollution abatement; the payment regime; the vector of prices used for understanding the choices of consumers; as well as the institution responsible for implementing the system of storm water pollution abatement; differed across these four cities. However, the study concentrated only on the attitudes and responses of consumers regarding their WTP; including their reasons for protesting against having to pay for the intervention of storm water pollution abatement by the state.

Trade-off game method

Trade-off game is similar to the CVM method. Here, individuals are asked to rank different combination of two environmental goods. The individual is required to select one combination from amongst many, in such a way that if she prefers an increased quantity of one, she would receive a reduced quantity of the other. In other words, she trades off the units of one good for a greater number of units of another good. Thus, the trade-off method is a technique that allows users to participate in the decision-making process of provisioning for an environmental good; while at the same time, it educates them about the constraints involved in making these decisions (Howe, Suich, Vira, & Mace, 2014)^[11].

A study on Productivity Trade-off Analysis in Agricultural systems was done in order to evaluate the system-level outcomes of agricultural production which could suggest management-level interventions that were effective in a multifunctional agricultural landscape. This study opined that an individual farmer may face trade-offs between maximizing production in short term on one hand and ensuring sustainable production in the long-term on the other hand. Within the same landscape, different choices could be made by different individuals for selection between competing uses of land. Thus, trade-offs exist both within the same agricultural system as well as between the agricultural and other sectors in order to meet the broader environmental or socio-cultural objectives, across time and spatial scales. This study focussed on the trade-off game method as a variant of the bidding game wherein respondents are asked to choose between two different bundles of goods. The choice made by the respondent indicates his or her willingness to trade between money and an increased level of provision of an environmental good.

Trade-off analysis has become an increasingly important approach for evaluating system-level outcomes of

agricultural production and for prioritizing and targeting management interventions in multi-functional agricultural landscapes. They reviewed the strengths and weakness of different techniques available for performing trade-off analysis, including mathematical programming and participatory approaches that have developed substantially in recent years aided by mathematical advancement, increased computing power, and emerging insights into systems behaviour (Wijk, Kalpwijk, Rosenstock, Asten, Thronton and Giller, 2022) ^[19]. z

The costless-choice method

The costless-choice method is quite similar to the trade-off game technique. It depends heavily on the assumption that people understand the aspects of true market value of various goods and services. Costless-choice method is a CVM technique that provides respondents with an option when

deciding between goods based on their interests (James, 2013; Cristescu & Szentesi, 2008). This method was used in research study of made on landfill sites in Rhode Island, USA. In this study, the made a survey of the residents of the Rhode Island and informed them about the characteristics of few locations and sites that were potentially available to be used as landfill sites. Subsequently, they were asked to choose between pairs of hypothetical locations measuring 500 acres which were to be potentially used as new landfill sites.

The descriptions of these sites also highlighted and compared the loss of natural resources that would occur if each of these sites were to be used as new landfill sites. Each comparison also gave the cost that would accrue per household if the hypothetical landfill sites were relocated at a particular chosen location. The results of this survey were used by the State to understand the preferences of residents with regard to various potential locations of landfill sites. Since the residents were informed about the implications of the costs that they would have to incur for each of the combination selected by them, their responses could be termed as informed choices. Based on the results of this survey as well as other inputs from the perspectives of geological, public health and political considerations; a final decision about expanding and relocating landfill sites was to be made. Thus, this method could be said to be useful while making decisions in situations where bartering one thing for the other; and subsistence production are prevalent.

Delphi method

Delphi method is different than the survey-based approach in the sense that it involves experts rather than consumers. These experts place values on certain environmental resources on the basis of their expertise in dealing with them. For example, they can place values on goods through an iterative process, and this allows feedback among the group between iteration (Brender, 2006; Strosahl & Robinson, 2001).

One particular study made by using the Delphi Method was regarding the development of indicators of well-being and sustainability in the urban areas of Malaysia (Musa, et.al., 2015) ^[10]. It conducted two rounds of a survey of experts and attempted to develop these indicators. A multidisciplinary group of 45 experts was surveyed; which rated the importance of 18 indicators. Since the respondents in the Delphi survey are experts in this field of study, the response rates of were experienced to be quite high at 75.6% in the first round and 91.2% in the second round.

Travel cost method

Travel cost method is an approach that indirectly values the environmental resources. Tourists are found to travel long distances in order to enjoy or witness a particular natural phenomenon, sights, scenery or bio-diversity. They spend a lot of time as well as money in order to travel to a certain tourist destination. The more the tourists value the scenic beauty of a destination, the more they would be willing to pay for travelling to that place. Thus, the willingness of the tourist to pay for enjoying a particular destination is a reflection of the economic value attached to it. Thus, the travel cost method attempts to estimate the economic value of environmental amenities as well as other recreational facilities in a particular destination (Butterfield, Camhi, Rubin, & Schwalm, 2016) ^[6]. This method also attempts to determine the demand for visiting a recreational site (e.g.number of visits per year that a person would like to make to a particular scenic destination). This demand is a function of many economic variables such as the price of the destination (including cost of travel, stay, food, entry fees, opportunity cost of the time spent on the trip etc.) as well as the income, age, family size, tastes and preferences etc. of that person. However, one of the most important variable is also the value that the tourist attaches to the scenic beauty and environmental richness of this destination. Other factors

remaining constant, a destination that is valued more in terms of the latter factors; is expected to witness a higher footfall of tourists.

According to a study by Wills and Garrod (2012) ^[20], there is an inverse relationship between the cost of visiting a recreation site and the number of visits. People living at greater distances from the site and therefore required to incur higher costs on travel to and from that particular recreation site; make makes fewer visits per year to that site. Conversely, people living nearer to a particular recreation site, visit that site more often; as they find it cheaper to visit. Thus, the this makes the demand curve of visiting a particular recreation site, a downward sloping one. However, the Travel Cost Method has a limited scope with regard to its practical application. This is due to various reasons such as tastes and preferences of tourists, special environmental characteristics and attractions that are associated with a particular site, the availability and price of tourist amenities available at a particular site. These variables and the costs associated with them, are not included in the travel costs; but are nevertheless, very important while site-selection for the purpose of recreation. Similarly, the non-use value of a particular recreation site may play a very important role in its selection by the tourist, even though it may not be quantifiable through the travel cost method.

Hedonic pricing model

Hedonic pricing method is one of the approaches used to determine the environmental value of a given residential property. It is a method that captures the willingness of the consumer to pay the price of a residential property depending on the presence or absence of certain environmental attributes attached to it. Proximity to a forest or green cover, water bodies such as a river or a lake, walking paths, hillocks, gardens etc. are attributes that enhance the value of the residential property and result in a willingness to pay a higher price for the same. Contrarily, concentration of pollutants in the air, prevalence of noise,

congestion due to traffic etc. are attributes that degrade the environment surrounding the residential property and reduce its value in the eyes of the consumer and consequently, lower the willingness to pay for it; which in turn, result in a decrease in its demand and hence, the market price (Carson, 2001; Abidoeye & Chan, 2017; Burcharth *et al.*, 2007) ^[1]. Thus hedonic pricing method reveals the preference of the consumer regarding various options available in the property market. It is influenced by the relative environmental attributes of each available option. In so far as the preference of consumers is indicated orally instead of making an actual purchase of the property; this method remains a non-market, observation technique of estimating environmental values of various residential properties (Markandya *et al.* 2018; Carson, 2001) ^[14].

The market value of different properties that differ when it comes to specific environmental qualities. Researchers usually focus on assessing the implicit price of the given environmental amenity attached to a residential property (Abidoeye & Chan, 2017) ^[1]. This is done by observing the behaviour of several buyers and sellers with regard to the importance they attach to the said environmental amenity (Burcharth *et al.*, 2007). Burcharth *et al.*, (2007) and Nijkamp and Van den Bergh (2001) highlights that hedonic pricing method captures the feature of the production function that relates to the changes in environmental amenities. If changes in the production function alters or substitutes the inputs that generate the extent, nature or quality of environmental amenities; the same is reflected in the willingness of consumers to pay for the output generated from that particular product-mix. Thus, hedonic pricing method helps in estimating the product efficiency of properties that are overpriced and those under-priced (Arrondo *et al.*, 2018) ^[2] in terms of the environmental amenities attached to it.

Preventive expenditure method

The preventive expenditure method is a cost based valuation method that uses data on actual expenditures made to avert or avoid all environmental problems. In other words, this approach does not

consider the ex-post costs that may be incurred to alleviate the damage caused by an adverse environmental impact after it has already taken place. It only takes into account, the expenditure that people are prepared make in order to avoid a certain harmful impact of environmental pollution or degradation. A research study that examines preventive initiatives using an integrated methodology for environmental impacts and cost assessment in industrial processes was done with respect to the metallurgical industry in Brazil. This work presents an integrated methodology to perform this evaluation, based on Life Cycle Assessment (LCA) and Activity-Based Costing (ABC) principles towards the environment issue. It identified the stages of the production process which had critical environmental impacts and utmost contribution to increase environmental costs of the company (Da Silva & Amaral, 2009) ^[8].

Cost-benefit method

The cost-benefit technique is a systematic process for finding, valuing as well as comparing costs and benefits of environmental resources (Knapp, 2015; Haveman & Weimer, 2001). This method is based on the main principles

of welfare economics, which considers the wellbeing of the society to be important. This method is generally employed by policymakers in the process of allocating resources across different sectors (Knapp, 2015). Cost-benefit method is important in assessing the economic efficiency of proposed public policies by using a systematic estimation of social costs and social benefits (Haveman & Weimer, 2001). This method provides an appropriate decision rule as well as set of policies that maximize net social benefit (Haveman & Weimer, 2001). The purpose of cost-benefit method is to make better informed and at the same time consistent policy decisions (Boardman, 2015) ^[5]. Cost-benefit method helps in forecasting willingness to pay as well as preferences for public goods revealed by noticeable behaviour by the citizens.

Opportunity cost method

The opportunity cost method emphasizes the valuation of benefits of environmental protection when it comes to what is being foregone to achieve it (Parsons, 2013; Markandya *et al.* 2018; Mahanta, 2014) ^[14]. In most cases, this method forms the basis of compensation payment, especially for the compulsory purchase of property or land made by the government under the law concerning purpose of public welfare (Haveman & Weimer, 2001). Opportunity cost method considers that when it comes to using of land and natural resources, the property rights of the government in favour of the society as a whole are greater than that of the owners of that property. However, the property owners must be compensated for foregoing their right to use the land for private purposes for the sake of allocating it for public purposes (Boardman, 2015) ^[5].

Fleming (1983) ^[9] studied the indirect opportunity cost of fuel wood gathered from the forests of Nepal *viz a viz* the estimated damage that was caused due to the activity of gathering fuel wood. The preservation of the forest land along with a sustainable provision of fuel wood and fodder was attempted through the Phewa Tal Watershed Development Program. This programme aimed at meeting the needs of the local population while at the same time, also arresting the indiscriminate destruction of natural forest areas.

Relocation cost method

The relocation cost method attempts to estimate the monetary value of environmental damages. If the natural environment in a particular place is in danger; it needs to be relocated physically and needs to be re-established in a different location. There are costs involved in the physical relocation, as also in the re-establishment of the elements of the environment in the new location while retaining its earlier quality and properties.

Relocation cost method is similar to the direct asset replacement technique in which the actual expense of physical relocating of a given facility is used to calculate the benefit-cost assessment of

whether the replacement should be undertaken or not (Rothengatter, 2018) ^[17]. In the context of environmental resources, relocation cost method is useful, especially in cases where relocation of a facility is necessary (Shogren, 2013). For example, the technique can be used to estimate the cost of moving a residential water supply facility that is exposed to pollution by runoff that may be caused by the new road. The cost of relocating the water supply facility to

another location *viz.* a *viz.* the cost of shifting the route of the new road is compared to each other. On the basis of this comparison, a decision of relocating either of the two, is taken.

Replacement cost method

This is a cost-based approach that focuses on measuring the potential expenditure needed to replace or restore a productive asset. If an environmental resource (asset) is compromised due to the impact of various economic activities in a given area, its quality and quantity may be degraded. In order to rehabilitate this resource, replace and restore its quantity and quality, a certain cost is to be incurred. This cost is termed as replacement cost. The replacement cost is to be compared with the cost of preventing the initial estimated damage that could result from the economic activity which is to affect it. Thus, the cost of replacing and restoring the qualities of that asset which have been lost due to economic activity; helps us to determine the alternative that is more efficient in terms of that environmental resource (Jackson, 2014) [13].

For instance, if an environmental resource which has been compromised in one way or the other is likely to be replaced in the near future by a different asset that offers the same services, then the cost of replacement can be used as a proxy for the given environmental damage (Valero *et al.*, 2013). In most cases, this happens when it is assumed that the benefits from former resource are at least as important as the replacement expenses. Various researchers have used the replacement cost method while studying the quantity of the direct consumption value of sites for indigenous substance and aquatic species in Austrian tropical river catchments (Jackson, 2014) [13]. Results in their study were based on the assessed socio-economic impact of hydrological and ecological changes from water resource development.

(Clark, Man, White, & Stocking, 1996) [7], estimated the value of annual soil nutrient loss per acre in Sri Lanka. They opined that this method of environmental valuation of nutrients in the soil was inconsistent with an approach that considered only the cost-benefit analysis of environmental conservation programmes implemented on a large landscape such as the whole country at a stretch. This method requires information on the degree of substitution between market good and the natural resource, which may be impossible for a resource such as soil, which is spread in a large space and affected by many kinds of human and non-human interventions continuously and simultaneously.

Conclusion

Thus, an overview of various methods of environmental valuation shows that even as the monetary value of environmental resources is extremely difficult to discover, various indirect methods are available to assess the economic value of the environment. The realization that environmental impact of economic activities are significant enough to be measurable in monetary terms is in itself, a stepping stone towards environmental conservation and prevention of pollution of the environmental resources.

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