Chapter 3
Approach to the Study

3.1 Methodological approaches to environmental valuation

Economic valuation of resources needs to be undertaken, when the market fails to generate the true prices of the resource in question. An economic valuation helps compute the true price of a resource. Market failures are common for environmental resources mainly due to externalities which cause difficulties in valuation. Economic valuation of environmental resources can help make decisions on resource utilization and allocation more meaningful. The price paid for an economic good or service shows the consumer's Willingness to Pay (WTP). An economy provides a mix of marketed and non-marketed goods. Environmental goods and services come under the category of non-marketed goods. Economic valuation means giving monetary values to the non -market goods and services and the economic valuation of the environment means giving monetary values to environmental goods and services. In a market the individual will buy a good when he finds that the WTP is greater than the price. Assigning monetary values for environmental goods means finding a measure of WTP or WTA (willingness to accept a compensation for giving up the benefit) for an environmental good. Economic valuation is all about finding a WTP or WTA measure when market is incapable of providing that information.

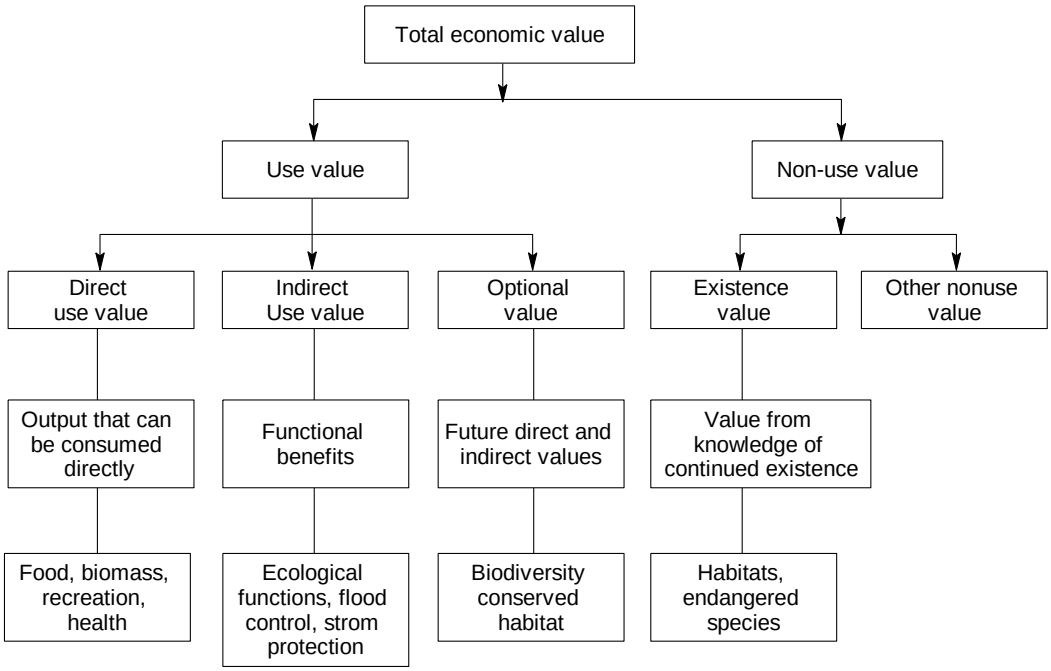
3.2 Economic values of environmental assets.

To find out the economic value of the environment, the concept of Total Economic Value (TEV) is used. Identifying and determining the economic values of environmental resources and measuring these values is a difficult process. The goods and services provided by the environment include recreation and tourism, plant and wildlife habitat, genetic resources, water supply,

protection against natural disasters, etc. Many of these goods and services are not traded on commercial markets and therefore have no market value. The values of non-market goods and services have to be measured and expressed in monetary terms, so that they can be treated as commercially traded components. Figure: 3.1 show the various concepts associated with TEV.

Figure: 3.1

Concepts associated with TEV



Source: Jepma C.J and M.Munasinghe (1998)

TEV is the sum total of the use and non-use value of the environmental good. The use value refers to the values derived from the actual use of the resource and includes direct use values, indirect use values and the option values. Direct use values refers to the direct use of a protected area, for instance, for activities such as recreation, tourism, natural resource harvesting, hunting, gene pool services, education and research. These activities can be commercial, meaning they are traded on a market or non-commercial, meaning there is no formal or regular market on which they are traded. Indirect use value means the values derived from the indirect use of a protected area and option values are

values derived from using the good in the future. Non-use value refers to the values that are not associated with the actual use of the resource include existence values and bequest values. The existence values is the value derived from the knowledge that a good is existing and bequest values are those which is derived by the fact that others are benefiting or will benefit from the good. Non-use values are particularly difficult to measure. With the emergence of environmental economics the link between ecology and economics is more visible. Economists and ecologists have now a common interest in understanding the economic contribution of the environment.

3.3 Non-market valuation

The valuation of environmental issues like biodiversity loss, global warming, and species extinction is highly complex. Economists have developed new ways for calculating the economic and social values of environment. In the environmental context, it is necessary to impute a value to the environmental good or service. Economic valuation tries to measure human preferences for or against changes in the state of environments (Pearce1992). In economic valuation the theoretical statement is that preferences are already formed and economists try to find out the true underlying preference about environmental goods and services (Clive L.Spash et al 2001). Environmental economics has developed techniques whereby such values can be imputed. In the market place individuals exercise choice by comparing their WTP with the price of the product. They purchase the good when their WTP exceeds the price, and not otherwise. Imputing values involves finding a measure of WTP for environmental quality. Economic valuation involves finding a WTP measure in circumstances where markets fail to reveal that information directly. The purpose of economic valuation is to reveal the true costs of using up scarce environmental resources. Environmental valuation is thus forms an integral part in the determination of the balance between conservation and development and in the choice of environmental standards.

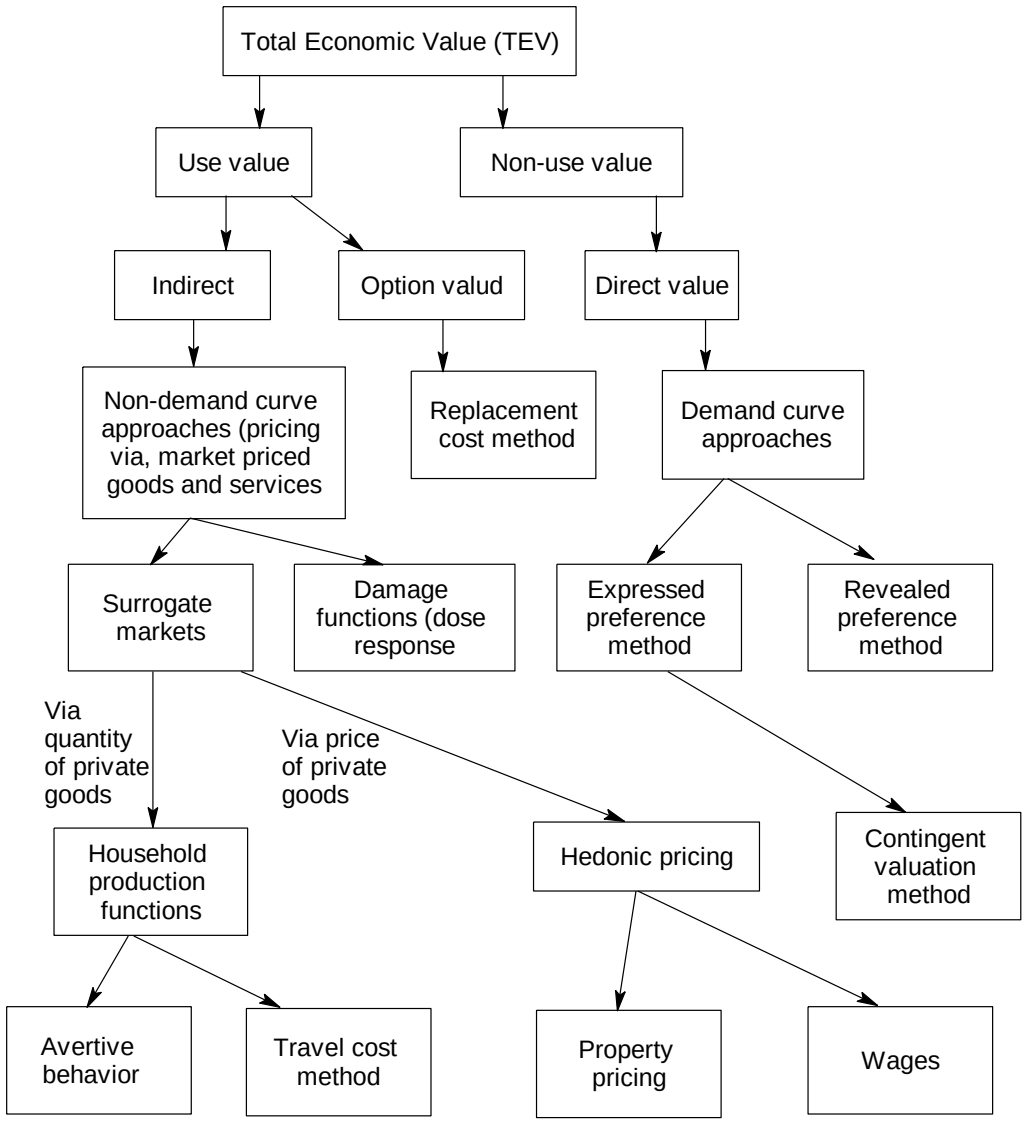
3.4 Overview of methods for environmental valuation.

A variety of economic techniques and models have been developed for environmental valuation. Valuation methods can be classified as follows.

1. Physical linkage methods(Scientific)
2. Abatement cost methods(Technical)
3. Behaviourial linkage methods(Economic)

A large number of techniques have been developed over the years for the purpose of environmental valuation. Figure:3.2 shows the various methods used for the valuation of the environment.

Figure:3.2 Methods for valuation and pricing ecological goods and services



Source: V. Santhosh et al

Different methods for eliciting both market and non-market values from people for environmental goods and services have been developed over the last few decades. The widely used methods include

a) Hedonic Pricing
b) Travel Cost Method
c) Contingent Valuation method.

3.5 Hedonic Pricing Method (HPM)

This method uses existing markets like housing or labour markets to determine the value of an environmental good. The basic assumption of the method is that property values or wages shows a stream of benefits, some of which are attributable to the environmental good. The main task is to isolate that value which is attributable to the good. Hedonic pricing can be used to establish aesthetic values of biodiversity, value environmental damages and their effects on property values or wages. The HPM attempts to estimate an implicit price for non-marketed environmental attributes by looking at real markets in which those characteristics are effectively traded. Thus, clean air and peace and quiet are effectively traded in the property market since purchasers of houses and land do consider these environmental dimensions as characteristics of property (Pearce and Moran, 1994). Hedonic pricing is data intensive and becomes difficult where alternative markets are distorted or where information about environmental products is not widespread especially in developing countries.

3.6 Travel Cost Method (TCM)

The Travel Cost Method uses existing markets, determining a person's value of an environmental good from what they spend on traveling in terms of time, travel expenditures and entry fees. TCM is based on the assumption that observed behavior can be used to derive a demand curve and to estimate value for an unpriced environmental good by treating travel costs as the surrogate price for the non-market asset. The area under the demand curve represents the consumer surplus. However, TCM is data intensive, they rely on restrictive assumptions about consumer behavior and they are highly sensitive to the statistical methods used.

3.7 Methodology used in the study: Contingent Valuation Method (CVM)

Valuation of environment is a disputable issue among statisticians and economists. While the accounting approach prefers to record only the actual financial transactions, the economic approach prefers to go beyond this, like in the case of health damages, the statisticians would prefer the cost of illness method (actual expenditure or illness), while economists also account for the loss in human capital that calls for disability adjusted life years (DALY) or statistical value of life (SVOL) or known loss of IQ in children (eg. due to pollution). Even loss of work or output due to absenteeism because of illness is valued in economic approach. For these, economists would like to consider opportunity cost approaches or an even subjective approach such as the contingent valuation method (CVM).

Contingent Valuation is the subject of an immense literature. CVM is used generally for the valuation of public goods especially environmental valuation (Ciriacy-Wantrup, 1947, Davis, 1963, Mitchel and Carson, 1989). The origin of the concept of contingent valuation can be traced to 1947 when Ciriacy-Wantrup considered the question of obtaining values for public goods and a survey method was suggested to obtain such values. The method was not used much till the 1960's as the validity of the values was questioned by economists. The first recorded study using contingent valuation was done by Davis in 1961(Mitchell and Carson 1989). This was followed by a study done in 1969 (Hammack and Brown 1974).

CVM involves directly asking people, in a survey, how much they would be willing to pay for a specific environmental service or what they are willing to accept by way of compensation to tolerate a cost. Although it can be used to estimate both use and non-use values, it is used widely for estimating non-use values. This method involves creating a hypothetical market for a non-

market good and invites the respondents to operate in that market. The willingness to pay (WTP) will reflect the value of the particular environmental quality (Ciriacy-Wantrup, 1947, Davis, 1963, Walsh et al, 1984, Brookshire et al, 1983, Mitchell and Carson, 1989, Choe et al, 1996). This method is also known as the stated preference technique, as the people are directly asked to state their value rather than inferring values from the actual choice. The main aim of the C.V survey is to create a hypothetical market, as close to a real market, to obtain hypothetical bids that conform to actual bids if the actual market had existed. According to the contingent valuation literature, WTP should reflect the value the community is having for a better environmental quality. The WTP of an individual is found to be dependent on several factors like income, attitude towards environment, level of knowledge etc. (Mitchell, R. C. et al 1989, Hanemann 1991, Cummings et al, 1986). It is assumed that a positive preference for something will show up in the form of a WTP for it. WTP differs from one individual to another since each one has different set of priorities. To secure a total WTP, an average of the aggregate WTP should be calculated. The hypothetical market- the questioner, questionnaire, and the respondent - must therefore be as close as possible to a real market. The respondent should be familiar with the good in question. The questioner should provide the respondent with the proper description of the resource and its potential benefits. The respondent must also be familiar with the hypothetical means of payment, say a local tax, an entry fee etc.

CVM has helped solve a serious problem in environmental policy analysis like the need to assign a value to non market goods and services. Surveys are used to provide analysts with the ability to ask direct questions about the economic value of environmental resources, thereby providing information that can be used as part of Cost Benefit Analysis of project program alternatives or economic assessments of resource losses. CVM is now the most widely used economics survey approach (Gregory, 2000). Contingent valuation is particularly attractive because it can estimate values where markets do not

exist or where market substitutes cannot be found. CVM is widely used to measure existence values, option values, indirect use values and non-use values.

CV method, which is a simple and flexible non-market valuation method, has been severely criticized mainly on two aspects, the validity and reliability of the results and the effects of biases and errors (L.Venkatachalam, 2003). The major sources of bias are

i) Strategic bias: The strategic bias is similar to the" free rider" problem. It occurs when the respondents of CVM deliberately understate or overstate the monetary value of the good in order to manipulate the policy decision in their favour It is suggested that questionnaires should be designed in such a way that the respondents are unable to behave strategically (Mitchell and Carson1989, Hoovenagel 1990). However, most CVM studies have not found strategic bias to be significant (Pearce & Turner, 1994).

ii) Hypothetical bias: Since the market created in the CV method is hypothetical, it will create hypothetical bias which is defined as the difference between the real and hypothetical payments (Cummings et al, 1986).

iii) Design bias: The design bias arises from three sources. The first is the starting point bias or the initial bid bias. When the questioner suggests the first bid, the starting point, it is possible that this will influence the respondent in some way by suggesting the range over which the bidding game will be played (Pearce & Turner, 1994). The second source of the design bias is the vehicle bias or the instrument of payment, used in the approach. The respondent might be sensitive to some ways of payment, such as taxes, entrance fees, donations. The third source of the design bias is the information bias. The information quality and sequence, given to the respondent, regarding the resource in question, will influence his answers significantly.

3.8 Approaches used to elicit preferences.

Generally four basic approaches are used to elicit the preference of he individuals. Although four methods are available, the choice of any method depends on the individual judgment (Bishop et al 1990).

i) bidding game technique: In a bidding game, individuals are asked to evaluate a potential change under a hypothetical situation and to express their WTP or WTA for a change in the level of provision of an environmental good or service. These individual estimates of WTP may be summed to provide an estimate of aggregate WTP—and hence total economic value. There are two types of bidding games—single-bid games and iterative-bid games. Single-bid games ask respondents to indicate the maximum price they would be willing to pay for an environmental good or to indicate the minimum amount of compensation they would accept for doing without that good. In the iterative or converging bid games, individuals are asked whether they would pay a given amount for the environmental good or service. The amount is then varied iteratively until a maximum WTP or a minimum WTA is reached. The responses are then averaged and extrapolated to arrive at the aggregate WTP or an aggregate level of compensation.

ii) open ended: In the open-ended question format the respondents are left to devise their maximum values without the aid of additional information or bidding. The respondent is free to state any amount on being asked.

iii) dichotomous choice: It offers different amounts to its respondents and asks them to say if they would be willing to pay for the amount stated in a "yes" or "no" format (Nunan, 1996). It is the first round of a bidding game.

iv) payment card format: The method involves that respondents are offered a payment card which contains a list of potential willingness to pay amounts. Also included on the payment card are so-called benchmarks, giving the respondent an indication of how much money is currently being spent by their type of household on other public goods.

3.9 Sample design

For the analysis, the focus is on the municipality of Alappuzha. To conduct the CV survey, a pre tested questionnaire was used. The unit of analysis is the individual household. As the Municipality consists of 50 wards, 20 households each from each ward were taken at random and the total sample size was 1000. A house to house survey was undertaken. The data relating to WTP were collected using the iterative bidding format.

The interview was structured in the following way

i) Socio-economic information: questions were asked to find out the income, education, occupation, children, environmental ethic and gender of the respondent.
ii) impact information: questions were asked about the health impacts (signs and symptoms, occurrence of the specified diseases, the treatment expenses), economic impacts (decrease in residential land value) social impacts (disamenities) and environmental impacts (water quality deterioration).The aim was to get an idea about the individual perception of the problems and also to create a background for the valuation exercise.
iii) project information: two sets of hypothetical projects one to be done by the municipality and other by private agency and the characteristics and the benefits were explained in a general way.

The aim was to inform the person about the product he or she is paying for.

iv) valuation--the questions related to the valuation were asked. The person was asked about his specific WTP using the bidding format for the improved solid waste management programme.

The questionnaire was prepared by giving adequate consideration to the suggestions given by the National Oceanic and Atmospheric Administration (NOAA) panel. The most important points considered were about conducting interview personally, the payment made should be for a future event and the facts hypothetical projects be made clear and understandable(NOAA 1993). The variables evaluated in the questionnaire include the presence of a list of signs and symptoms and diseases that are normally associated with environmental pollution. These were evaluated for the last three years. They are:

i) Signs and symptoms: cough and cold, fever, headache, diarrhea, skin infection and eye irritation.
ii) Diseases: cholera, jaundice, typhoid, dengue fever, rat fever, chicken guinea, intestinal parasitism.

The following were the indicators used for identifying the disamenities associated with the solid waste management.

i) foul odour.
ii) increased population of flies, vermin, pests, particulate air pollution.
iii) visual impacts (dirty surroundings, litters)

Table: 3.1 Variables evaluated in the questionnaire

Variable	Notation	Concept	Characteristics
willingness to pay	WTP	willingness to pay for the project	continuous and quantitative
house ownership	Hs	owned (1), rented (0)	dichotomous
gender of the respondent	Gen	male (1), no(0)	dichotomous
education	Ed	no formal education (0) primary education (1) secondary education (2) higher education (3)	--
children	Cd	have (1) no (0)	dichotomous
income	AMI	average monthly family income	continuous and quantitative
environmental ethic	Ea	consider environmental project as important (1), no (0)	dichotomous

From the questionnaire, the average WTP of the sample households was calculated.

3.10 Econometric model

The information obtained from the questionnaire was used to test a model, which explained the WTP as a function of variables like average monthly income, education, children, gender, environmental ethic and house ownership. The following econometric model was used

$$WTP = \beta_1 + \beta_2 AMI + \beta_3 Ed + \beta_4 Cd + \beta_5 Gen + \beta_6 Ea + \beta_7 Hs + u$$

Where, AMI = average monthly income of the household

Ed = education of the respondent.

Cd= children in the family.

Gen= gender of the respondent.

Ea = environment ethic.

Hs= house ownership.

β_1, β_2, β_3, β_4, β_5, β_6, β_7 are constants and u is the disturbance term.

3.11 Ordinal regression

Regression methods such as linear, logistic and ordinal regression allow researchers to identify the explanatory variables that determine the outcome variables. The use of linear, logistic and ordinal regression depends mainly on the measurement scales of the dependent variables and the validity of the assumptions of the model. Linear regression analysis is used when the dependent variable is measured on a continuous scale and logistic regression is applicable for the binary outcome. The two methods assume normality and constant variance. To understand the effects of the explanatory variables on all levels of the ordered categorical outcome, ordinal regression method will be appropriate. The design of Ordinal regression is based on the methodology of McGullagh (McGullagh 1980).

In our analysis, we used an ordinal regression model to examine the relationship between the WTP for an improved solid waste management system and the various explanatory variables. Ordinal Regression allows one to model the dependence of a polytomous ordinal response on a set of predictors, which can be factors or covariates. Ordinal regression does not require the assumption of normality and constant variance but requires the assumption of parallel lines

which is assuming that the effect of the independents is the same for each level of the dependent. Ordinal regression is used with ordinal dependent variables, where the independents may be categorical factors or continuous covariates. Ordinal regression models are sometimes called cumulative logit models. Ordinal regression generally uses the logit link function, though other link functions are available. Ordinal regression with a logit link is also called a proportional odds model, since the parameters of the predictor variables may be converted to odds ratios, as in logistic regression. The estimated coefficients reflect how changes in the predictors affect the response. The response is assumed to be numerical, in the sense that changes in the level of the response are equivalent throughout the range of the response.

The main features of the ordinal regression model are i) the dependent variable is a grouped and ordered category ii) the model uses a link function to explain the effect of the independent variables on the ordered category so that the normality and constant variance assumptions are not required iii)the model assumes that the relationship between the independent variables and the dependent variables is independent of the category(Scott et al 1997,McGullagh and Nelder,1989,Bender and Benner 2000).

The models used in ordinal regression are cumulative probabilities, which are the probabilities that the response *Y* (in this case, willingness to pay) falls in a category *j* or below, for each possible *j*. The j^{th} cumulative probability is

$$P(Y \leq j) = \exp(\alpha_j + \beta x) / \{1 + \exp(\alpha_j + \beta x)\}$$

$$j = 1, 2 \ldots J.$$

The model is given by,

$$P(WTP \leq j) = \exp(\alpha_j + \beta_1 AMI + \beta_2 Ed + \beta_3 Cd + \beta_4 Gen + \beta_5 Ea + \beta_6 Hs) / \{1 + \exp(\alpha_j + \beta_1 AMI + \beta_2 Ed + \beta_3 Cd + \beta_4 Gen + \beta_5 Ea + \beta_6 Hs)\}$$

Where *j = 0, 1, 2, 3.*

The cumulative probabilities reflect the ordering, $P(Y \le 0) \le P(Y \le 1) \le P(Y \le 2) \le P(Y \le 3) = 1.$ Models for cumulative probabilities do not use the final one, $P(Y \le 3)$ since it necessarily equals 1. In this study, Y=0 denotes unwillingness to pay, Y=1 denotes willingness to pay less than the specified amount, Y=2 denotes willingness to pay the specified amount and Y=3 denotes willingness to pay greater than the specified amount. The model in detail is given in the analysis chapter.

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