CHAPTER 2

LITERATURE REVIEW

2.1 Environmental Goods and Market Failure

In a perfectly competitive market, the price of a particular good will increase when there is scarcity and decrease when there is abundant supply due to competition. This is because, in a perfectly competitive market, when one person consumes a good, another person is deprived of utilizing that good. However, for environmental goods, such as a park, the usage of one person does not exclude others from using it. In fact, most environmental goods are `public' goods or only a nominal sum is charged for utilization. Most environmental goods are considered public goods where people have unlimited access to it such as parks. Without property rights attached, this scenario, a characteristic of environmental goods reflects market failure; thereby indicating that classical economic theory needs to be modified to reflect pattern of environmental good. One discipline of environmental economics is valuation of the environment itself. As environmental goods differ from normal marketable goods, valuation of environmental goods is much more complicated and has garnered much interest among resource economists as described in the following sections. Economic research into the monetary valuation of the environmental commodities is still in a state of flux, although considerable progress has been made to date.

2.2 Valuation of Environmental Goods

Environmental goods in this study are referred to as natural resources. Valuation of natural resources is related to the benefits derived by human from utilization of the resources. In recent years, many valuation studies have been undertaken with various objectives. Some of these studies are shown in Table 2.1.

Table 2.1: Some Examples of Valuation Studies for Environmental Goods

Study	Remarks	Value
Lim *et al.*, 1993.	Valuation on individual's willingness to pay (WTP) to use the Forest Research Institute Malaysia's (FRIM), ground for recreational activities in Malaysia.	USD0.12 - USD0.25/ individual/entry
Mohd Shahwahid & Mustapha, 1997.	Valuation of utilisation of wetland plant, animal and fish species by 185 aborigine families in Tasek Bera, Malaysia.	USD185,266/yr
Ghosh & Santra, 1998.	Valuation of wetland plants cultivation, which were used to make handicrafts, mats and decorative ornaments in West Bengal, India.	USD17 - USD334/ha/yr
Dixon & Sherman, 1991.	Valuation of consumer surplus of a national park based on tourist expenditure in Khao Yai National Park, Thailand.	USD2 - USD5/ha/yr
Costanza *et al.*, 1989.	Valuation of commercial fishery and trapping, recreational benefits and storm protection of the Terrebonne Parish Wetlands at the coast of Louisiana, United States of America.	At least USD6,177/ha/yr.
Costanza *et al.*, 1997.	Valuation on the world's ecosystem's services and natural capital.	An average of USD33 trillion (10^{12})/yr.

In Malaysia, Lim *et al.* (1993) estimated user's WTP to use the FRIM's ground for various recreational activities. The estimated WTP ranged from USD0.12 to USD0.25 (RM0.31 to RM0.63) per individual per entry. Mohd Shahwahid & Mustapha (1997) valued the wetland plant, animal and fish species of Tasek Bera, Malaysia. The total economic value estimated based on the utilization of the wetlands by 185 families of the Semelai tribe was USD185,266/yr (RM463,166/yr).

Ghosh & Santra (1998) estimated the benefits of a few types of wetland plant cultivation in West Bengal, India. The aquatic plants (shola [*Aeschynomene aspera*], hogla pati [*Typha elephantina* and *T. domingensis*] and madur kathi [*Cyperus corymbus*, *C. iria*, *C. malaccensis* and *C. tegeteformis*) were used to make handicrafts, mats and decorative ornaments. The study derived values between USD17 to USD334/ha/yr for various types of wetland plant species.

Dixon & Sherman (1990) (cited in Sherman & Dixon, 1991), valued Khao Yai national Park in Thailand based on tourist expenditure. Consumer surplus was estimated at about USD2 to USD5/ha/yr.

Costanza *et al.* (1997) attempted to make a valuation on the world's ecosystem's services and natural capital. The total value was estimated at an average of USD33 (10^{12}) trillion/yr. Earlier on, Costanza *et al.* (1989) also valued the Terrebonne Parish Wetlands in coastal Louisiana, United States by using the WTP and energy analysis-based methodologies. The average value estimated was at least USD6,177/ha/yr. The use values estimated comprised commercial fishery and trapping of muskrat and nutria (for their fur), recreational benefits and storm protection. The energy analysis provided the indirect use value of the ecosystem's potential to provide services for the economy (Costanza *et al.*, 1989).

2.3 Valuation of Mangroves Ecosystem

Barbier (1994), suggested three main categories of assessment that can be applied to a wetland depending on certain particular needs and purposes. They are:

(a) Impact analysis

(b) Partial valuation

(c) Total valuation

2.3.1 Impact Analysis

Impact analysis is carried out to assess the damages inflicted on the wetland ecosystem from a specific environmental impact. It means assessing a specific environmental impact by valuing the changes in the ecosystem resulting from that impact.

2.3.2 Partial Valuation

The partial valuation of a wetland ecosystem is used when one or more development options may lead to alteration or conversion of wetland ecosystem. Based on this valuation, options of diversion, allocation or conversion of wetlands such as mangroves for other uses should be weighed against the opportunity costs of the proposed development in terms of the subsequent loss in mangrove ecosystem benefits.

2.3.3 Total Valuation

Total valuation of a wetland (such as mangrove) ecosystem requires an appraisal of all the net benefits of its ecosystem. According to Barbier (1994), two main objectives that call for total valuation are:

(a) to measure the economic contribution of a mangrove ecosystem to the welfare of society as part of a resource accounting exercise

(b) to evaluate whether a mangrove ecosystem should become a protected area with restricted or controlled use

Table 2.2 shows some of the current studies on the total valuation analysis of mangroves in different parts of the world.

Table 2.2: Some Studies on the Total Valuation Analysis of Mangroves

Study	Resource Information (location, type, area)	Products & Services valued	Total Value USD/ha/yr
Cabrera *et al.*, 1998.	127,000 ha of mangrove forest at Terminos Lagoon, Campeche, Mexico.	Forestry, fisheries, water filtration and biodiversity.	USD2,772/ ha/yr.
Sathirathai, 1998.	400 ha of mangrove forest at Tha Po Village, Surat Thani, south of Thailand.	Local use, fisheries, coastal protection and carbon fixation.	USD3,420/ ha/yr.
Meilani, 1996.	489.1 ha of mangrove forest at Mayangan Village, West Java, Indonesia.	Local use, fisheries, indirect use (protection from erosion, input of organic matter for prawn), option and existence values.	USD3,188/ ha/yr.
Ruitenbeek, 1994.	300,000 ha of mangrove forest at Bintuni Bay, Irian Jaya, Indonesia.	Local use, fisheries, selective commercial forestry and biodiversity.	USD232/ha /yr.
Bennet & Reynolds, 1993.	8,728 ha of mangrove forest at Sarawak Mangrove Forest, Malaysia.	Forestry, fisheries and tourism.	USD2,855/ ha/yr.

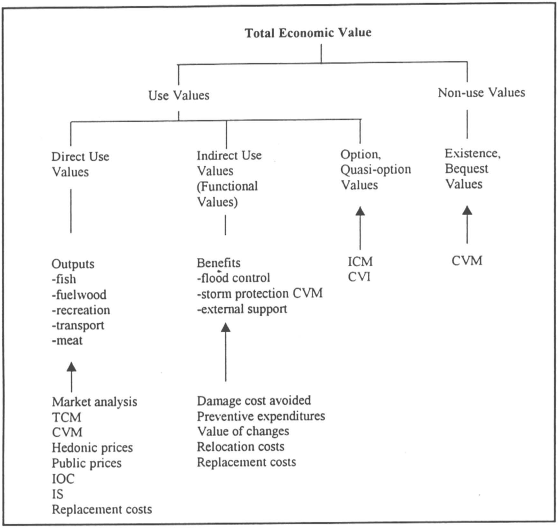
One of the most recent study (Cabrera *et al.*, 1998), estimated a value of about USD2,772/ha/yr for mangrove forest at Terminos Lagoon, Campeche, Mexico. The study valued the economic benefits of forestry, fisheries, water filtration service and biodiversity (critical habitat for threatened species) of the mangrove forest. Sathirathai (1998) valued the mangroves in Surat Thani, Thailand and estimated a value of USD3,420/ha/yr. The study considered the local use of mangrove produce (woods, honey, subsistence fisheries), off-shore fisheries, coastline protection and carbon sequestration to form the TEV.

Meilani (1996) studied the TEV for a mangrove area in West Java, Indonesia and derived a value of USD3,188/ha/yr. The study comprised of direct local use of mangrove produce (woods, subsistence fisheries, wildlife meat), indirect use in terms of shrimp harvest and coastal protection and, option and existence values. On the other hand, a study by Ruitenbeek (1994), derived a value of only USD232/ha/yr for a mangrove forest at Bintuni Bay, Indonesia. The study considered local use, fisheries, selective commercial forestry and biodiversity in the estimation. Another study in Sarawak, Malaysia by Bennet & Reynolds (1993) estimated a value of USD2855/ha/yr for a mangrove forest. The estimation included fisheries, forestry and tourism benefits.

An important feature of the TEV is that it expressively incorporates the linkages between various types of exploitation as well as protection of stocks, environmental functions and biodiversity attributes of an ecosystem. These include the linkages between mangrove conversion, offshore fishery productivity, traditional uses and the benefits of erosion control and biodiversity maintenance functions. Some of the direct and indirect uses become mutually incompatible as exploitation of mangroves become more intensive through forestry options.

According to the study by Ruitenbeek (1994) in Bintuni Bay, Indonesia, the `optimal' forest management option will depend on the strength of the environmental linkages. The study concluded that there is little economic advantage of cutting significant amounts (more than 25%) of the 300,000 ha of mangrove area in Bintuni Bay, Indonesia due to the existence of environmental linkages.

The framework of total economic valuation of a mangrove ecosystem is shown in Figure 2.1. Since the total economic value of the ecosystem comprises of many components, the approach is to analyze and value each component. However, since each component may differ from each other (for example, use values and non-use values), various valuation techniques should be used to value each component based on their suitability.



Notes: ICM = individual choice models
CVI = conditional value of information
CVM = contingent valuation method
TCM = travel cost method
IOC = indirect opportunity cost approach
IS = indirect substitute approach

Figure 2.1: Use of Various Techniques in the Total Valuation of a Mangrove Ecosystem. (Adapted from Barbier, 1994)

2.4 Use Values

2.4.1 Direct Use Values

Direct use values are values derived from direct use or interaction with an ecosystem's resources and services. Direct uses of a mangrove ecosystem include both consumptive and non-consumptive uses. Examples of consumptive uses are mangrove pole collection, forestry activities, using water in the mangroves, hunting and fishing. Non-consumptive uses are based on the mangrove ecosystem's services such as recreation, tourism, *in situ* research and education, and navigation along watercourses.

Direct uses of a mangrove ecosystem could consist of both commercial and non-commercial activities. Commercial uses are basically important in terms of economic to both domestic and international markets. Exploitation of mangroves for commercial purposes includes harvesting of poles for construction works or charcoal processing. Non-commercial activities are more important for the subsistence needs of local population. They include activities such as collecting mussels, crabs and fishing in small-scale. Harvesting for daily consumption is often done individually and privately and therefore, the amount and value of harvest are normally not recorded.

There are some studies of wetland valuation that concerned the fisheries sector as shown in Table 2.3.

Table 2.3: Some Studies of Wetland Valuation on Economic Benefits of Fisheries

Study	Remarks	Estimated Value
Constanza *et al.*, 1989.	Based on production of shrimp, blue crab, oysters and menhaden of Gulf Coast, Louisiana, United States.	USD62.7/ha/yr.
Bennet & Reynolds, 1993.	Based on capture fisheries adjacent to Sarawak Mangrove Forest, Sarawak, Malaysia	USD2,417/ha/yr
Janssen & Padilla, 1996.	Capture fisheries (inshore and offshore) for a preserved mangrove forest in Pagbilao, Philippines.	USD60/ha/yr
Barbier & Strand, 1997.	Compared fishery productivity with deforestation of mangrove forest in Campeche, Mexico.	USD143/ha/yr.

Constanza *et al.* (1989) estimated the economic benefits of fisheries supported by the Terrebonne Parish Wetlands, Louisiana, United States to be about USD62.7/ha/yr. The estimation includes shrimp, blue crab, oysters and menhaden caught in the Gulf Coast near Louisiana. In Sarawak, Malaysia, Bennet & Reynolds (1993) estimated a value of USD2,417/ha/yr for capture fisheries. According to Janssen & Padilla (1996), preservation of mangroves can yield about USD60/ha/yr of capture fisheries (inshore and offshore) in Pagbilao, Philippines. A study by Barbier & Strand (1997), indicated an annual loss of USD143 in revenue of fishery with a deforestation of one hectare of mangrove forest in Campeche, Mexico; using a model, which emphasized on open-access fisheries.

Mangrove products are another essential component of the mangroves and have been exploited for economic benefits by humans. Some studies on estimation of the economic benefits of local use of mangroves are presented in Table 2.4.

Table 2.4: Some Studies on Valuation of Mangroves based on Local Use

Study	Remarks on local use	Estimated Value
Lal, 1990.	Capture fisheries of mangrove-dependent species in Fiji.	USD765/ha/yr.
Ruitenbeek, 1994.	Harvest includes on-site fisheries, woods and meat from wildlife in the mangrove forest in Bintuni Bay, Indonesia.	USD33/ha/yr.
Meilani, 1996.	Harvest includes on-site fisheries, woods, honey, snakes, birds and eels in mangrove forest of Mayangan Village, West Java, Indonesia.	USD2,417/ha/yr.
Sathirathai, 1998.	Harvest includes timber, fuelwood, birds and crabs in mangrove area of Tha Po Village, Surat Thani, Thailand..	USD141/ha/yr.

A study of mangroves in Fiji by Lal (1990), indicated an annual harvest of 331 kg./ha/yr of mangrove-dependent fish and non-fish products or a value of USD765/ha/yr. Ruitenbeek (1994), estimated a value of about USD33/ha/yr for traditional gathering, hunting and fishing activities in the mangrove forest in Bintuni Bay, Irian Jaya, Indonesia. In West Java, Indonesia, Melani (1996) estimated the total mangrove products inclusive mangrove poles, fisheries and wildlife utilized by the locals to have a value of USD765/ha/yr. In Surat Thani, Thailand, Sathirathai (1998) estimated the mean value of mangrove utilization by the locals to be about USD141/ha/yr.

Besides fisheries and mangrove produce, recreational benefits of mangroves have received much attention by resource economists. Table 2.5 shows some of the valuation studies on recreational benefits of wetlands including mangrove forests.

Table 2.5: Some Studies on Valuation of Recreational Benefits of Wetlands Including Mangroves

Study	Remarks on recreational benefits	Estimated Value
Costanza *et al.*, 1989.	Estimated economic benefits of Terrebonne Parish Wetlands, Lousiana, United States. Methods used are Travel Cost Method (CM) and Contingent Valuation Method (CVM).	USD11-15/ha/yr. Mean WTP = USD104/household/yr.
Zuraidah, 1996.	Estimated economic benefits of mangrove forest recreation in KSNP, Malaysia. Methods used are TCM and modified Travel Cost Demand.	USD5/ha/yr. Consumer surplus = USD8/visit.
Mohd Esa, 1997.	Estimated economic benefits of mangrove forest recreation in KSNP, Malaysia. Method used is TCM.	USD612/ha/yr. Consumer surplus = USD31/visit.
Jamal & Redzuan, 1997 (cited in Mohd Esa, 1997).	Estimated economic benefits of mangrove forest recreation for fireflies in Kg. Kuantan, Malaysia. Methods used are TCM and CVM.	Gross benefit = USD1,161-1,768/ha/yr. Consumer surplus = USD25-48.

Constanza *et al.* (1989) estimated the recreational value of wetlands in Louisiana, United States to be in the range of USD11-15/ha/yr. In Malaysia, Zuraidah (1996) estimated net economic benefits from recreational activities at KSNP, Selangor to be about USD5/ha/yr. Consumer surplus was estimated at USD8/visit. However, Mohd Esa (1997) estimated recreational benefits at the same site (KSNP) and found the recreational benefits to be much higher, about USD612/ha/yr. Consumer surplus was estimated at USD31/visit.

Another study by Jamal & Redzuan (1997) (cited in Mohd Esa, 1997) calculated the economic benefit of firefly viewing in Kg. Kuantan, Selangor, Malaysia. Gross economic value was estimated around USD1,161 - 1,768/ha/yr while consumer surplus was estimated to be in the range of USD25 - 48/visit.

2.4.2 Valuation Techniques for Direct Use Values

Valuation techniques for direct use values have been based on Hufschmidt *et al.* (1983), Dixon & Hufschmidt (1986), Pearce & Turner (1990) and Dixon *et al.* (1994).

(a) Market Value or Productivity Approach

This is a straightforward benefit cost analysis, which emphasize on environmental quality effects on natural or human-built systems. The effects are reflected in the production of the systems where the products derived from the systems enter into market transactions. Examples of the products are fisheries, forestry and agriculture. Generally, there are 3 ways to estimate the value of a product:

(i) direct approach - the market price of the product is used.

(ii) indirect approach (substitute method) - the value of a substitute closest to the product is used.

(iii) indirect approach (opportunity-cost method) - the product is valued based on the time spent sourcing the product.

(b) Contingent Valuation Method (CVM)

The CVM uses a direct approach by asking people their WTP for a benefit and/or their willingness to accept (WTA) compensation to tolerate a cost. The main purpose is to get the respondent's personal valuations for increases or decreases in the quantity of some good, conditional upon a hypothetical market. The process of asking respondents can be conducted through surveys or questionnaires. CVM is a very `open' method in the sense that it is technically applicable to all circumstances. The two major characteristics of CVM are:

(i) it will frequently be the only technique of benefit estimation

(ii) it should be applicable to most contexts of environmental policy

The main objective of CVM is to express valuations or bids, as close as possible to those revealed if a real market exist. Therefore, the question, questionnaire and respondent in the hypothetical market must be as close as possible to a real market. It is important that the respondent is familiar with the good in question. This can be achieved by using aids such as photographs or diagrams to ensure that the respondent is really clear on the good in question. Next, the respondent must also be clear on the hypothetical mode of payment (payment vehicle) such as local tax or direct entry charge.

CVM is applied with the questioner suggesting the first bid (starting point bid or price). The respondent agrees or disagrees whether he/she will be willing to pay the price. Next, an iterative procedure follows where the starting point bid is increased in stages to estimate the maximum WTP. At this stage, the respondent is not willing to pay the extra increment in the bid. If the respondent disagree with the starting point bid, then the price is lowered in stages until it reaches the minimum, which is the minimum WTP. On the other hand, estimation of WTA is carried out by lowering the bids until it reaches the respondent's minimum WTA.

(c) Travel Cost Method (TCM)

TCM is a way to value unpriced goods where it is used to derive a demand curve for environmental goods such as outdoor recreation. It is initially developed to value the benefits received by consumers from using environmental goods. Usually, such goods are provided either free or for a very low entrance fee such as in a park. However, the benefits or utility derived from a park is often much greater. Therefore, revenues collected for the use of the facilities is not a good indicator of the value of the site or the actual users' WTP to use the park. The real value of the site actually include the users charges and total consumer surplus enjoyed by the users.

The TCM is based on the basic assumptions listed below:

(i) The recreational site is a desired environmental good and no fee is charged for use.

(ii) Although no fee is charged, there is cost involved in getting to and from the site.

(iii) The further away potential users of the recreational site live, the less is their expected use and vice versa.

(iv) In terms of consumer surplus, the user most distant with the highest travel cost have the lowest (or no) consumer surplus and vice versa.

The TCM is site-specific. The surrounding areas are divided into zones of increasing distance - representing increased travel cost. A survey is normally conducted to determine users' zone of origin, visitation rates, travel costs and various socioeconomic variables. The information generated are then analyzed and a demand curve derived. Consumer surplus is then calculated based on the demand curve of the recreational site.

2.4.3 Indirect Use Values

Indirect use values are indirect support and protection provided to economic activity and property by the ecosystem's natural functions, or regulatory environmental services. The indirect use value of an environmental function is related to the change in the value of production or consumption of the activity of property that it is protecting or supporting.

These contributions of ecosystem's natural functions are non-marketed, financially non-rewarded and are only indirectly related to economic activities. Therefore, these indirect use values are relatively more difficult to value as compared to direct use values. However, based on a few valuation studies on key environmental functions in tropical wetlands, it was discovered that the economic value of regulatory environmental functions could be highly significant (Barbier, 1994).

A study by Kim & Dixon (1982) (cited in Hufschmidt *et al.*, 1983) in Korea revealed that soil conservation measure is environmentally and economically more beneficial compared to a non-conservation measure as nutrients in soil has to be replaced and incur higher cost.

Within the framework of use values is the option value. Option value is regarded as the value of the environment as a potential benefit as opposed to actual present use value. It is an expression of preference or a willingness to pay, for the preservation of an environment in exchange for the probability that the individual will make use of it at a later period.

Quasi-option value is the value of preserving options for future use given some expectation of the development of knowledge or information with time. For example, a mangrove ecosystem is under threat by a coastal development. At the present moment, the mangrove ecosystem contains a wide range of diverse species that may have future value in scientific and commercial purposes such as certain plant species with pharmaceutical value. On the other hand, the coastal development also has a certain value in terms of people's WTP for its outcome. At the present moment, there are uncertain benefits from preservation of the habitat. However, the benefits could become more certain through time as information accumulates about the uses of the plant species. Nevertheless, if the development takes place, then, this source of potential pharmaceutical species is lost forever. The loss, converted into monetary terms represents the quasi-option value.

2.4.4 Valuation Techniques for Indirect Use Values

(a) Replacement Cost

The basis of the replacement-cost approach involves the cost of replacing productive assets damaged by a lowered environmental quality or by improper site management practices. The replacement costs are the true costs of replacement if damage has actually occurred. Examples of replacement costs are costs of replacing trees damaged by water pollution and buildings lost through land subsidence.

(b) Contingent Valuation Method (CVM)

Option value can be estimated by using CVM (see Section 2.4.2)

2.5 Non-use Values

Non-use values are values derived neither from current direct or indirect use of an ecosystem. One of the most obvious is the intrinsic values which suggest the values in the real nature of an entity (a being or an ecosystem) and unassociated with actual use. This intrinsic value can be explained in terms of human preference where it is captured by people through their preferences in the form of non-use value. This values are entities that reflect people's preferences, but include concern for, sympathy with, respect for the rights or welfare of non-human beings and the values of which are related to human use. The main category of non-use value is the existence value.

2.5.1 Existence Value

Existence value is a value placed for an environmental good and which is unrelated to an actual or potential use of the good. What they value is the *existence* of the environmental goods such as the mangrove forest or wildlife in the forests; a value, which is unrelated to use.

A study at Khao Yai National Park, Thailand, by Dixon & Sherman (1991) estimated total option/existence value at approximately USD24/ha/yr. The option/existence value was estimated based on the WTP to ensure the continued existence of elephant in the park. The maximum individual WTP of park users was USD7.24/yr. Ruitenbeek (1994) calculated the biodiversity value of mangroves in Bintuni Bay, Irian Jaya, Indonesia, to be at USD15/ha/yr. Meilani (1996) estimated a value of USD1,770/ha/yr for a mangrove forest in West Java, Indonesia.

Existence value is not readily explained by conventional motives (maximum utilization of a good) but is based on some form of altruism; which means caring for other people or other beings. The WTP for the existence of an environmental good can be explained by different motives which includes sympathy, rights and stewardship motives.

2.5.2 Bequest Value

Bequest value relates to the idea of willing a supply of natural environments to one's heirs or to future generations in general. Although this value is categorized under the non-use values (for the current generation), there are possibilities of the natural environments being used in the future. However, Pearce & Turner (1990) categorized bequest value as a motive under existence value. However, for the purpose of this study, the TEV by Barbier (1994) was adopted and bequest value is used instead of bequest motive.

2.6 Willingness To Pay (WTP) and Willingness To Accept (WTA)

When buying goods, we express our WTP by exchanging money for the goods, and in return, our WTP must reflect our preferences. The concept of benefit can be explained as what people want or individual's preferences. A positive preference for something is reflected in the form of WTP for it. However, individual's WTP will differ. To know what is socially desirable, we aggregate individual's WTP to secure a total WTP. The WTP concept gives an automatic monetary indicator of preferences.

While we can assume individual will not pay for something they do not want, we cannot be sure that the WTP as measured by the market price accurately measures the whole benefit to either individuals or society. This is because there may be individuals who are willing to pay more than the market price. If so, the benefit received is higher than the market price indicates. This excess is known as consumer's surplus and is shown in Figure 2.2 below:

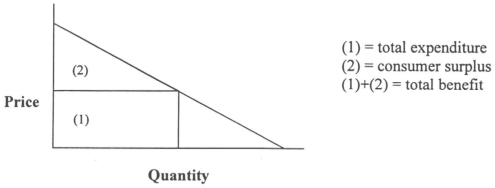


Figure 2.2: A Demand Curve for Environmental Goods

Based on the economic theory, WTP and WTA should not differ significantly. However, it was found that WTA compensation normally far exceeds WTP especially for goods without close substitutes and/or which individuals have legal or customary property rights. Based on a study by Adamowicz *et al.* (1993), it was found that the difference between WTP and WTA is significant with or without substitutes. According to Kahneman & Knetsch (1982 a,b) (cited in Dixon *et al.* 1994), this behaviour has strong psychological roots, where an individual will value a good more highly than they would be willing to pay for the same item if they are granted the ownership.

There are also opinions that the differences may be due to biases in data collection, interviewing technique and questionnaire design. However, empirical work could not confirm that the differences are due to the biases (Rowe *et al.*, 1980; Brookshire *et al.*, 1980; Schulze *et al.*, 1981; Thayer, 1981) (all cited in Adamowicz *et al.*, 1993).

Various studies showing the differences between WTA and WTP are shown in Table 2.6.

Table 2.6: Disparities between WTP and WTA. (from Cummings *et al.*, 1984, cited in Pearce & Turner, 1990; Adamowicz *et al.*, 1993)

Study	WTP (USD)	WTA (USD)
Hammack & Brown, 1974.*	247.00	£1,044.00
Banford *et al.*, 1977.*	43.00	120.00
	22.00	93.00
Sinclair, 1976.*	35.00	100.00
Bishop & Heberlein, 1979.*	21.00	101.00
Brookshire *et al.*, 1980.*	43.64	68.52
	54.07	142.60
	32.00	207.07
Rowe *et al.*, 1980.*	4.75	24.47
	6.54	71.44
	3.53	46.63
	6.85	113.68
Hovis *et al.*, 1983.*	2.50	9.50
	2.75	4.50
Knetsch & Sinden, 1983.*	1.28	5.18
Adamowicz *et al.*, 1993.	WTA is 3 to 5 times larger than WTP	

* all cited in Pearce & Turner, 1990.

2.6.1 Valuation Techniques for WTP and WTA

Valuation of WTP and WTA can be carried out using CVM (Section 2.4.2).