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DRAFT REGIONAL GUIDELINES FOR ECONOMIC VALUATION

1. INTRODUCTION

Mangroves, coral reefs, seagrass and other coastal wetland habitats provide critical ecological, economic, and social services that support the existence of ecosystems and human communities. Coastal habitats support high floral and faunal biological diversity and, coastal human communities depend on these habitats for their livelihood, through extraction of resources directly or indirectly. They collect fish, fruits, vegetables, medicinal extracts, construction materials, timber, firewood, and many other natural products from these habitats.

Despite the fact that these coastal habitats provide such critical services for human beings, they have undergone serious degradation and loss due to industrialization, urban development, tourism, and other destructive human activities. One of the underlying reasons (root causes) for this widespread degradation and loss of coastal habitats is the failure of markets to recognise the economic value of non-market benefits generated by the coastal habitats. This not only results in a lack of understanding of the economic values of these coastal habitats, but also results in the under-valuation of environmental goods and services.. Consequently, the role of the ecological functions of the coastal habitats in sustaining coastal economies has not been properly understood, and the conservation benefits of the habitats have not received due attention. Frequently coastal habitats are considered as lands with low or no use value.

Valuing coastal habitats in economic terms provides a direct tool for environmentalists to persuade government officials to take serious account of the benefits of the ecosystems, in their decision-making regarding the choice of development alternatives.

This manual provides guidelines for individuals with limited economic background to undertake basic economic valuation of habitats. It includes cost benefit analysis, a general valuation framework, details of valuation techniques and the procedures to value the ecological functions of specific habitats, and to value the impacts of land-based pollution on coastal habitats.

Not only is the determination of economic value a critical input to sound decision-making regarding the development and use of coastal habitats but it is also of great importance to the identification of under-utilised goods and services that might provide the basis for development of alternative livelihoods for coastal communities. An activity that is integral to the demonstration site activities undertaken within the South China Sea Project. Determination of economic values, together with an analysis of the costs and benefits of their use by different stakeholders might enable more equitable resource sharing and generate revenues to off-set the costs of sound management.

A further consideration in the framework of the South China Sea Project is the need to justify the costs of any regional programme of interventions addressing the degradation and loss of coastal habitats. Such a regional programme is currently being drafted in the revised Strategic Action Programme the first draft of which contained a section justifying the proposed programme of interventions on the basis of an analysis of the costs and benefits of action compared with non-action in addressing habitat loss and degradation trends. This analysis was based on the assumption that if action were not taken, habitats would continue to be lost at the 1998 rates, and the economic values lost over time were then compared with the costs of the programme and the economic values saved by the proposed investment.

2. GOODS AND SERVICES DERIVED FROM COASTAL WETLANDS

The Regional Working Groups on Mangroves, Coral Reefs, Seagrass and coastal wetlands considered and prepared lists of the goods and services provided by these four coastal habitats to the coastal communities living on the margins of the South China Sea. Table 1 provides a simplified listing of the direct uses of these habitats in this region as discussed and agreed by the respective members of the working groups.

The direct uses of these habitats have been classified, for the purposes of identifying the appropriate valuation techniques into extractive or consumptive uses and non-extractive or non-consumptive uses (see Section XXX below). Extractive uses, if they are to be sustainable must always be limited by the ability of the ecosystem or habitat to sustain the same levels of production, subject to naturally varying, inter-annual limits of production. In fisheries terms such a limit was referred to as the maximum sustainable yield. Unsustainable use or over-exploitation will ultimately result in the decline of natural productivity and potential collapse of the natural system resulting in loss of other goods and services.

Uses of mangroves

Table 1 indicates that extractive use of the mangrove ecosystem includes direct use of the mangrove plants themselves together with direct use of the secondary consumers and decomposers that are dependent upon the mangrove trees primary production. The use of mangrove trees for timber, poles, fuelwood, charcoal production, thatch and fodder are widespread activities throughout the region, whilst the use of mangrove propagules (fruits) for human consumption, bark for tanning, Nipa sap for alcohol, and use of mangrove associates for medicines are more restricted uses, characteristic of certain locations.

Similarly, the direct uses of secondary producers dependent upon the mangrove primary production are widespread throughout the region with the mud-crab, *Scylla serrata,* penaeid shrimp juveniles and a wide variety of fish and shell-fish such as *Crassostrea* species being exploited wherever they are found. The mangrove clam *Gelolina coaxans* and the cockle *Anadara granosa* are eaten throughout the region and are found in muddy substrates, often in close proximity to mangrove areas. In some locations specific organisms are exploited depending upon their distribution and abundance. Hence mangroves backed by freshwater swamp forest often provide abundant wildlife, while honey, sipunculid worms, insect larvae, jellyfish, and in some rare instances zooplankton are directly exploited in mangrove areas. In Thailand, Sesarmid crabs are exploited in the back mangroves for production of “pickled” crabs, an essential ingredient of “*Som Tham*”, (green papaya salad).

Widespread non-extractive uses of mangroves include their use as venues for tourism and recreation, educational and research purposes, and for various types of mariculture of fish, crabs and prawns in the creeks that meander through the mangrove, or in the ocean in front of mangrove areas that do not involve destruction or clearance of the mangrove forest itself. In China pearl farming, takes place along the South China Sea coastline, and the quality and quantity of pearls produced can be directly related to the presence or absence of mangroves along the adjacent coast. Tourism activities include kayaking along the mangrove-lined creeks and nocturnal visits to observe fireflies. Local authorities and community groups in many areas have now constructed boardwalks through the mangroves allowing easy access for both tourists and school parties.

In addition to the direct use of mangrove habitats and their associated resources, mangroves provide a number of environmental and biological services, whilst some areas have particular social, cultural or historical significance, all of these attributes must be valued if a total economic value for a particular mangrove area is to be determined. The importance of mangroves to shoreline protection, prevention of erosion, and flood protection, has been well demonstrated by the impacts of the 2005 tsunami, which were more pronounced in coastal areas where vegetation had been cleared than in areas where intact mangrove stands remained. Where the inputs of allocthonous (land-derived) sediments are high, mangroves may in some instances trap sufficient sediment to cause shoreline accretion and an increase in land area. In addition, mangrove forests provide protection against strong winds, including typhoons, and sequester carbon in the accumulating anaerobic soils and as a temporary sink in the biomass of the trees themselves.

The role of mangroves as a natural filter for land-based materials results from the trapping of fine suspended sediments, and their removal from the water column, as a consequence of the physical slowing of water flow through the mangrove root systems. This leads ultimately to both upward and seaward accretion of the land surface and to, less turbid water immediately in front of mangrove stands. Not only is the suspended sediment trapped within the mangrove system but adsorbed and associated contaminants are trapped leading to an overall improvement coastal water quality. In addition, mangroves can and do remove nutrients from the water column.

Mangroves serve as nursery and spawning grounds for a number of marine fish and penaeid shrimps and the volume of the off-shore trawl catch of shrimp can be directly related to the area of mangroves on the adjacent shoreline. Juveniles of the giant freshwater prawn (*Macrobrachium spp)* may be found in the landward margins of mangrove swamps. Estuarine fish of subsistence and commercial significance in the region include the milk-fish, *Chanos chanos* and the Barramundi or sea bass, *Calcares latifer.* In terms of their biological diversity services mangroves provide habitat to both endangered and migratory species of birds, and in some areas land vertebrates including reptiles such as the estuarine or salt-water crocodile, whilst the diversity of true and associated mangroves species is higher around the margins of the South China Sea than anywhere else world-wide. In some specific locations mangroves have particular social or cultural significance as for example in the vicinity of Fangchenggang, China where mature, *Avicennia marina* are conserved by, the local communities, due to their Feng Shui properties.

Use of Coral Reefs

Coral reefs are one of the most biologically diverse habitats in the world, host to an extraordinary variety of marine plants and animals. Coral reefs provide essential fish habitats, support endangered and threatened species, and harbor protected marine mammals and turtles. They are a significant source of food, provide income and employment through tourism and marine recreation, and offer countless other benefits to humans, including supplying compounds for pharmaceuticals.[1] The uses of coral reefs can be categorised into four kinds of uses: direct uses (extractive and non-extractive uses), environmental services, biological diversity services, and social/cultural significance.

Coastal communities have directly extracted materials and resources from coral reefs for generations. Coral reefs are used as building materials and quicklime. An important aspect of coral reefs to the socio-economic well being of local communities is its contribution to capture fisheries. Corals are known to provide sheltering habitat essential for nursing and as a breeding ground for a variety of fish species. Malaysian national report indicates that approximately 40 percent of the commercial fish in Malaysia caught within the 30 nautical miles from the shore originate from or make use of the coral reefs.[2]

Indirect uses of coral reefs may include tourism/recreation, education and research, and mariculture in coral reefs. Reef-based tourism can be a non-extractive industry that attracts millions of divers and snorkelers each year. Coral reefs provide scientists and researchers a coastal habitat of a diversity of fishes and other species for study, and also serve as an important mariculture base for local communities.

Coral reefs provide significant environmental and biological diversity services for the coastal ecosystems and communities. Coral reefs are important for beach protection and carbon sequestration. Coral formations in different tropical locations can be used to help geologists reconstruct climate and storm patterns of the past. Other biological diversity services of coral reefs include biodiversity storage, secondary producers, and food storage for other biota.

Some coral reef sites have social and cultural significance for human beings due to its aesthetic values. (NEED ELABORATION, TO INCLUDE SOME EXAMPLES).

Use of Seagrass

As in the case of the two habitats previously considered seagrass beds provide the basis for sustainable livelihoods in many coastal communities bordering the South China Sea. The range of uses to which the seagrass itself can be put by, coastal communities, is fewer than in the case of mangroves but includes its use for fertiliser in coastal agriculture, and as raw material for the production of woven handicrafts, including chair seats, mats and baskets. Direct use of seagrass for human consumption is limited in the region being restricted to the experimental production of cookies from seeds of *Halophila* in the Philippines. Seagrass is used directly as a covering for wounds in many coastal communities and some species are used in the preparation of traditional medicines.

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[1] *See Mark D. Spalding, Corinna Ravilious, and Edmund P. Green. 2001. World Atlas of Coral Reefs. Berkeley, California: University of California Press.*
[2] *See National Coral Reefs Report for Malaysia. 2005. UNEP/GEF/SCS National Reports Series (www.unepscs.org).*

Of far greater significance however, is the use of secondary consumers that rely on the high primary productivity and production that characterise tropical seagrass species. These include a variety of resident fishes including many species in the family of Siganidae, echinoderms such as the sea urchin, *Tripneustes gratilla* whose eggs are exploited both for subsistence and commercial production, and molluscs such as the strombid gastropods in particular *Strombus carnarium,* which is widespread along the southern margins of the South China Sea. The sea horses, permanent residents of seagrass beds are commercially threatened are along the northern margins of the South China Sea as primary ingredients in various Chinese and Vietnamese traditional medicines.

Non-extractive uses of seagrass beds include tourism and recreation, research and education although these are generally not as well developed as in the case of coral reefs the generally sheltered lagoon environments in which seagrass beds occur are used as areas for water sports and snorkelling. In some areas seaweed culture is being developed in coral reef and seagrass habitats, whilst in the Philippines healthy seagrass beds are used as grow-out areas in giant clam culture.

Seagrass beds provide a variety of environmental services including reduction in erosion of sub-tidal substrates. Seagrass species trap and stabilise suspended sediment providing benefit to adjacent coral reefs by reducing suspended sediment loads in the water. The dense root systems and extensive rhizomes of some seagrass species form an interlocked mat that prevents erosion of the sub-tidal substratum a service, which may be especially important during storms and hurricanes. As in the case of mangroves the trapping of sediment derived from land-based sources results in significant removal of adsorbed contaminants, which are stored in the sediments.

Seagrass feature high rates of primary production and hence exhibit high rates of oxygen production, which is released to the surrounding waters. Consequently seagrass species can remove elevated levels of nutrients through enhanced primary production. However excessive inputs of nutrients result in fouling of the seagrass leaves by algae and interferes with photosynthesis thus having an adverse impact on primary production and the health of the system. The biomass of some seagrass species decomposes slowly and certain species (i.e. *Posidonia oceanica*) store a significant amount of carbon in the sediment over long periods. Seagrass primary production is only 1% of total primary production in the oceans but seagrass may be responsible for as much as 12% of the total amount of carbon stored in ocean sediments. This suggests that seagrass beds may play a significant role in the regulation of the global carbon cycle.

Seagrass beds serve as nursery and spawning grounds for fish that constitute important constituents of the offshore demeral fish catch. Some species move in and out of seagrass beds over their life history, while others live their entire lives in association with seagrass beds. In addition, seagrass forms the bulk of the diet of the endangered dugong and marine turtle species whilst some seagrass areas are important feeding grounds for migratory bird species. Tiger prawns settle in seagrass beds at the post-larval stage (3-4 weeks) and remain until they become adults while many endeavour prawns also spend their juvenile life stages in the seagrass habitat. Seagrass meadows provide an ideal environment for juvenile fish and invertebrates to conceal themselves from predators, whilst seagrass leaves serve as areas for attachment of larvae and eggs and for filter-feeding animals like bryozoans, sponges, and forams.

While seagrass beds serve as ideal *refugia* for juvenile and small adult fish for escape from larger predators, many infaunal organisms (animals living in soft sea bottom sediments) also live within seagrass meadows. Species such as clams, worms, crabs, and echinoderms, like starfishes, sea cucumbers, and sea urchins, use the buffering capabilities of seagrasses to provide a refuge from strong currents. The dense network of roots established by seagrasses also helps deter predators from digging through the substratum in search of infaunal prey organisms.

As in the case of mangroves the seagrass beds of the South China Sea are the most biologically diverse worldwide, as such they represent a significant store of biological diversity having value of transboundary significance. Whilst many coastal communities use the resources derived from seagrass habitats both directly and indirectly and hence are, to varying degrees dependent upon the health of the system seagrass is not generally associated with particular social, or cultural significance although the organisms associated with the habitat such as dugong and marine turtles may be in some locations.

Use of Wetlands

A consideration of the direct and indirect uses of wetlands their, environmental and biological services and their social and cultural significance is somewhat more difficult than a consideration of the three habitats (mangroves, coral reefs and wetlands) considered above. In part this stems from the broad interpretation of what constitutes a “wetland”, which in the sense of the RAMSAR Convention covers both freshwater and marine habitats to a depth of 6 metres below high tide level. In preparing the tables of direct uses, and the environmental biological services provided by “coastal wetlands” the Regional Working Group on Wetlands attempted to itemise all possible goods and services provided by a variety of wetland types. In consequence the entries in Tables 1 and 2 are too generic to provide guidance for individuals attempting to value for example, non-vegetated inter-tidal mudflats, where in general the resources available for exploitation are generally limited to burrowing molluscs and worms. In addition, as a consequence of the approach taken by this working group, the entries include the uses and services provided by the other three habitats, which have been specifically itemised in the appropriate columns of these tables.

Specific wetland habitats such as, for example, peat forest provide unique goods and services, in this case peat for fuel, that are not provided by habitats such as mangrove or seagrass habitats. Any attempt at economic valuation must take into consideration such unique features that may contribute significantly to the Total Economic Value of a particular habitat type. Similarly it should be recognised that not all wetland types provide all of the goods and services listed in Tables 1 and 2 and the accuracy of the final estimate of Total Economic Value will depend in large part on the correct identification of the specific goods and services provided by each individual habitat type.

Table 1 Summary of Extractive and Non-extractive Direct Uses of Coastal Wetland types. (red, underline JP's amendments)

Extractive Uses	Mangroves	Coral Reefs	Seagrass	Wetlands
Vegetable Products	Timber	Coral (building materials, curio trade)	*N/A*	Timber
	Firewood	*N/A*	*N/A*	Firewood
	Poles	*N/A*	*N/A*	Poles
	Charcoal	Quick lime	*N/A*	Charcoal
	Leaves/palm fronds (*thatch/fodder*)[3]	*N/A*	Handicraft (woven)	Leaves/Thatch
	Fruits/propagules	Algae	Seeds Food	Fruits
	Bark (*Tannin and dyes)*	*N/A*	*N/A*	Tanning Bark
	Medicine	Bioactive substance	Medicine	Medicine
	Sap *(sugar, Alcohol, Acetic acid)*	*N/A*	*N/A*	*N/A?*
	Wood tar	*N/A*	*N/A*	*N/A?*
			Fertilizer	Peat/energy
Animal Products				
	Fish capture	Fish (food and aquarium)	Fish	Fish
	Crab capture		***Swimming crabs***	Crab
	Prawn capture	Crustacean	***Prawn capture***	Prawn
	Shellfish collection	Molluscs	***Molluscs***	Molluscs
	Insect and larvae capture			
	Worms	Echinoderm	***Echinoderm***	Worms
	Wildlife hunting			Wildlife
	Zooplankton (koey)			
	Jellyfish			
	Bees, honey, and wax			
	Seaweed			
Non-extractive Uses	**Mangroves**	**Coral Reefs**	**Seagrass**	**Wetlands**
	Tourism/recreation	Tourism/ recreation	Tourism/Recreation	Tourism/Recreation
	Transport			Transportation
	Education	Education	Education	Education
	Research	Research	Research	Research
	Fish culture	Mariculture		
	Crab culture			
	Prawn culture			
	Shellfish culture			
	Other aquaculture (pearls)			Aquaculture (pearl)
				Agriculture

[3] *Items listed in italics under uses are products derived from a primary resource extracted from the mangrove ecosystem.*

Table 2 Summary of Environmental and biological services, social and cultural significance of coastal wetland types bordering the South China Sea.

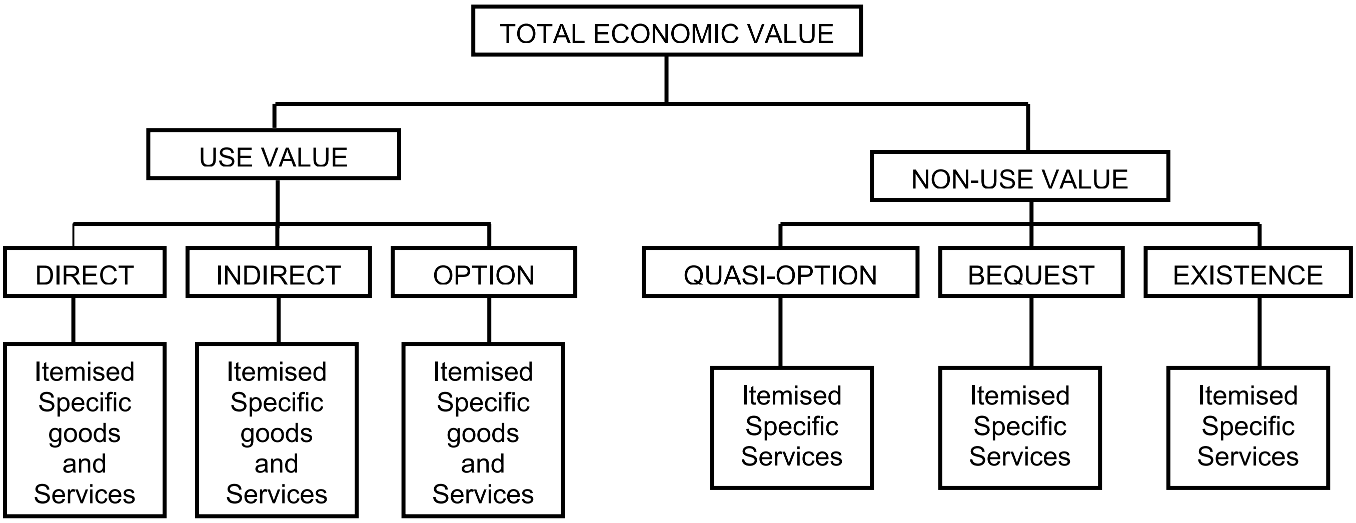
	Mangroves	Coral Reefs	Seagrass	Wetlands
Environmental services	Shoreline/erosion prevention	Beach protection	Shoreline protection Erosion prevention	Shoreline protection
	Flood protection	*N/A*	*N/A*	Flood Control
	Windbreak	*N/A*	*N/A*	Windbreak
	Carbon sequestration	Carbon sequestration	Carbon sequestration	Carbon sequestration
	Water purification (Prevention of saline water intrusion)	*N/A*	Water purification Waste catchment	Water purification prevention of salt water intrusion & ground water recharge
	Sediment, Contaminant, Nutrient removal/storage	*N/A*	Sediment and nutrient retention	Sediment and Nutrient Retention and Export
	Oxygen release (?)	Climate change record	Oxygen release	Oxygen release
	Nursery feeding area	Nursery ground	Nursery area	Nursery area
	Shoreline accretion/Land increase	*N/A*	*N/A*	*N/A*
	N/A	*N/A*	*N/A*	Climate Change Mitigation
	N/A	*N/A*	*N/A*	Water supply (subsistence value)
Biological diversity services	Existence values of species, genes, and communities	Biodiversity Storage	Biological diversity	Biological diversity (existence value of species, genes and communities)
	Migratory species	Secondary producers	*N/A*	Migratory species
	Endangered Species	Food storage for other biota	*N/A*	Endangered Species
	Ecosystem Existence values	Coral reef ecosystem	*N/A*	Wetlands Ecosystem (existence value of the system)
Social/cultural significance	Religious/spiritual significance	*N/A*	*N/A*	Religious/spiritual significance
	Historical importance	*N/A*	*N/A*	Historical importance
	Presence of distinctive human activities	*N/A*	*N/A*	
	Aesthetic	Aesthetic	Aesthetic/culture	Aesthetic

3. THE GENERAL/OVERALL VALUATION FRAMEWORK

3.1 Total Economic Value

The *total economic value* (TEV) is the sum of all the benefits that are attributable to the specific resource or ecosystem being valued. The total economic value is composed of (i) *use value* (UV) and (ii) *non-use value* (NUV). *Use value* can be further broken down into direct use value (DUV), indirect use (IUV), and option value (OV). *Non-Use Value,* on the other hand can be further broken down into quasi-option, bequest, and existence value. Figure 1 outlines an economic valuation approach to value coastal habitats, as formulated and developed by the Regional Task Force on Economic Valuation[4].

Figure 1 Economic valuation approach



3.1.1 Use Value

Direct Use: The direct use values of a resource or a system are the tangible or physical aspects of such resources, which can either undergo physical processing or provide direct (personal) utility or satisfaction and which have direct market prices for quantification. According to Bann (1997), these are the "values derived from the direct use or interaction with a (for example) mangrove's resources and services." These direct use values are further categorized as extractive or consumptive, and non-extractive or non-consumptive (Ebarvia, 1999). Examples of extractive or consumptive use values are the use of Nipa fronds and poles from mangroves. Examples of non-extractive or non-consumptive values are the recreational or tourist values of wetlands or coral reef areas.

Indirect Use: Indirect use values consist of the various functions that a natural system may provide, such as shoreline protection functions, carbon sequestration, and nutrient or contaminant retention. These values have no direct market prices but equivalent values can be derived through the use of different valuation methods. The indirect use value of an environmental function is related to the change in the value of production or consumption of the activity or property that it is protecting or supporting (Ebarvia, 1999).

Option Use: Option Use or *option value* is a special category of value, which arises because of an individual's uncertainty about his or her future demand for a specific resource, or the availability of this resource in the future. It is still considered as a "use" value since it still relates to future direct or indirect use of the resource (Barbier, *et. al*., 1997). This concept may be termed or understood as the *potential* direct and indirect uses of a natural system and the *"additional amount that an individual would be willing to pay above the actual current price to maintain the natural resource and to avoid irreversible damage that would inhibit possible future use of the resource*" (Ebarvia, 1999).

[4] *UNEP. 2004. Reversing Environmental Degradation Trends in the South China Sea and Gulf of Thailand. Report of the First Meeting of the Regional Task Force on Economic Valuation. UNEP/GEF/SCS/RTF-E.1/3.*

3.1.2 Non-Use Value

Quasi-Option Use: This non-use value is related to option value such that there is still willingness to pay by the individual for the preservation of the resource, but instead of worrying about its future use, the preservation is for the value that it can presently provide.

Bequest Use: This is an important subset of non-use value that results from an individuals' willingness to pay for the preservation or conservation of a resource so that future generations will still be able to reap its benefits. This may be particularly high among those who are currently enjoying the use of the resource because they may want their heirs and future generations to be able to derive the same benefits from the system.

Existence Use: Existence value can be related to aesthetic, cultural, and moral aspects that a resource may have in that it is the value that an individual places on the resource because of the satisfaction that he or she derives from merely knowing that the resource, ecosystem or species exists, regardless of whether it will be used or not. This is a form of non-use value which is difficult to measure since it involves subjective valuations by individuals unrelated to their own or others' use.

4. THE VALUATION TECHNIQUES

Valuation techniques can be categorised into three groups i.e. market-based value, surrogate market-based value, and simulated survey-based value. Figure 2 outlines the main categories and the specific techniques under each category, while Table 3 provides a listing of techniques for valuation applicable to various types of use and non-use.

Figure 2 Valuation Techniques.

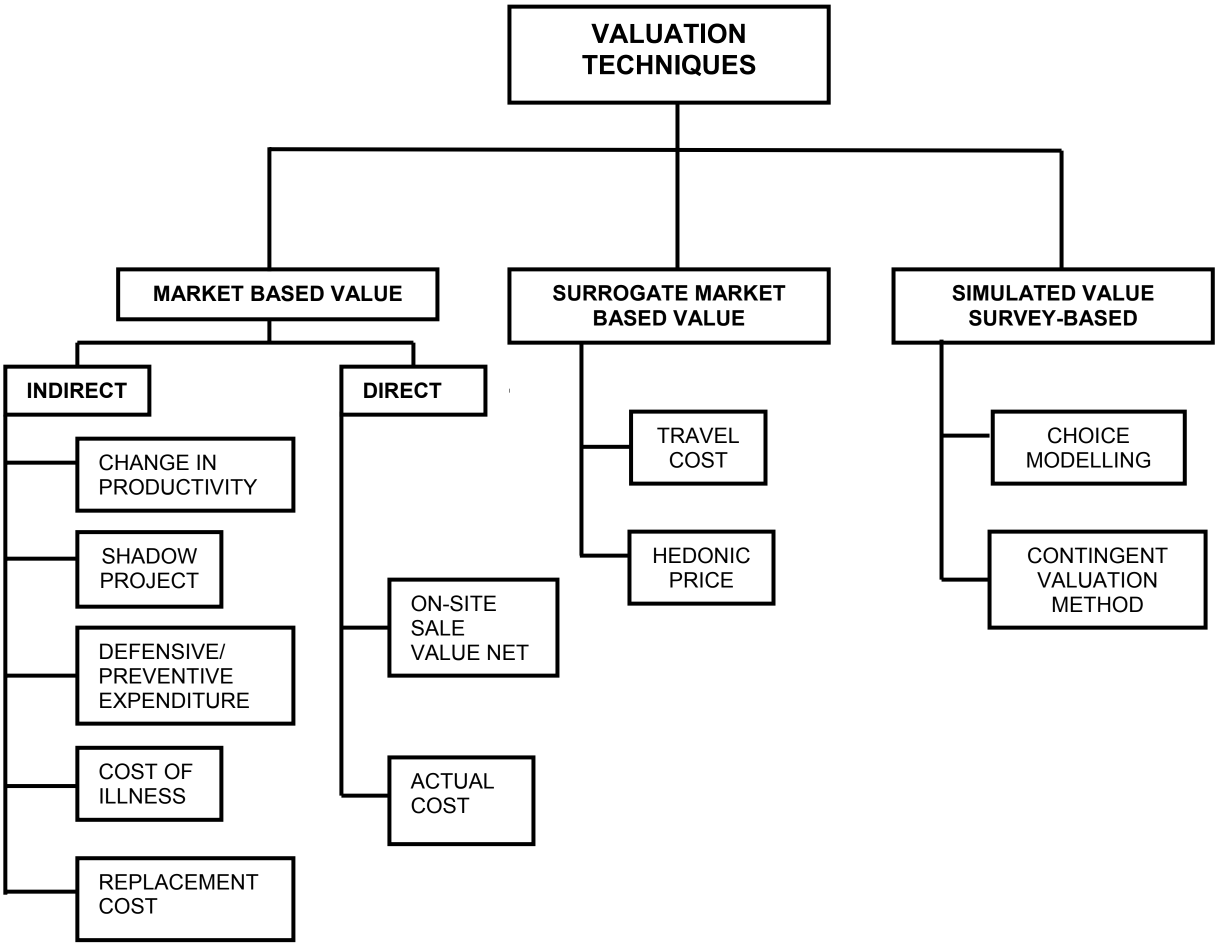


Table 3 Economic Valuation techniques, Indicators, data Requirements and assumptions for various types of use and non-uses of coastal wetlands.

Types of Uses	Valuation Technique	Indicator of Measurement	Data Needed	Notes and Assumptions
Extractive Use	On site sale value for marketed goods. using net price[5] For directly used goods, use market values for equivalent goods. If not available, use indirect opportunity cost approach to assess time spent harvesting in terms of wages foregone.	Total annual value of production for each product ($US).	**For direct valuation:** On site market price of each product ($US/kg). Quantities of product harvested, sold, given away and used within the household (kg/ha/year) Total area of the project (Ha) **For indirect valuation:** The price per unit for equivalent goods ($US/unit). Cost of material inputs ($US). Time spent harvesting/culturing product (hours/week). Equivalent local wage for labour ($US/day) Exchange Rate Year (Date of the data collected)	Market price can be adapted to account for seasonal and other price changes. Market price represents true market value within a competitive market at equilibrium (i.e. prices are not distorted). All externalities are identified and included in the price.
Non-extractive Uses Tourism/recreation	Travel costs: Amount of money and time spent by visitors to the site.	Annual recreational value of the site ($US)	Data from visitor surveys: Socio-economic variables. Geographic origin. Time spent travelling. Expenditures incurred in visiting the site. Frequency and duration of visits. Number of visitor-days for the site.	Access to the site is available to all. Visits have a single purpose. Demand function relationship can be specified. No factors apart from travel cost influence site use. Market prices used in valuation are not distorted.
Transport	Market price of transport using alternative means, e.g. motorcycle. [Substitute price approach]	Total annual value for waterborne transport enabled. ($US).	Frequency of journeys Numbers of travellers and volume of products transported. Distances travelled. Origins and destinations. Market costs of transport using substitute means.	Substitute means of transport is an acceptable substitute. Seasonal variations in transport trends can be accounted for. Market prices used in valuation are not distorted.
Education	Substitute price approach: costs of teaching at other locations. [Actual cost of teaching (?)].	Total annual value for educational activities enabled ($US).	Annual number of educational activities. Costs of conducting activities at alternative locations.	Substitute locations are acceptable/comparable and are within reach. Market prices used in valuation are not distorted.
Research	Substitute price approach: Costs of undertaking research at other locations or through other techniques. [Actual cost of research (?)]	Total annual value for research enabled ($US).	Annual number of research visits. Costs of conducting activities at alternative locations or using alternative techniques.	Substitute locations/ methods are acceptable/comparable and are within reach. Market prices used in valuation are not distorted.

[5] *Net Price = market price less harvesting/production cost.*

Table 3 ***cont.*** **Economic Valuation techniques, Indicators, data Requirements and assumptions for various types of use and non-uses of coastal wetlands.**

Types of Uses	Valuation Technique	Indicator of Measurement	Data Needed	Notes and Assumptions
Fish culture Crab culture Prawn culture Shellfish culture Other aquaculture (pearls)	On site sale value for marketed goods. For directly used goods, use market values for equivalent goods. If not available, use indirect opportunity cost approach to assess time spent harvesting in terms of wages foregone.	Total annual value of production for each product ($US).	For direct valuation: Market price of each product ($US/kg). Quantities of product harvested, sold, and used within the household (kg/month). For indirect valuation: Replacement prices for equivalent goods ($US). Cost of material inputs ($US) Time spent harvesting/culturing product (hours/week). Equivalent local wage for labour ($US/day)	Market price can be adapted to account for seasonal and other price changes. Market price represents true market value within a competitive market at equilibrium (i.e. prices are not distorted). All externalities are identified and included in the price.
Environmental services Shoreline/erosion prevention	Replacement costs (preventive expenditure): costs of providing alternative engineered sea defences.	Total annual value provided by mangroves in preventing coastal erosion ($US).	Length of coastline protected. Cost of constructing replacement defences ($US/km).	Influence of mangroves in preventing off-site coastal erosion can be identified.
Flood protection Windbreak	Rehabilitation costs: costs of rehabilitating/replacing property and assets protected from flooding/storms (damage costs avoided).	Total annual value provided by mangroves in protecting against floods/storms ($US).	Frequency – severity function for flood/storm events (derived from historical records). Flood maps and models. Property locations and asset replacement values.	Assets could and would be rehabilitated. Protective function can be modelled.
Carbon sequestration	Preventive expenditure (abatement cost).	Total annual value provided by mangroves in fixing carbon ($US) (?)	Price per ton of carbon fixed (?). Carbon sequestration rate for mangrove forests.	Meaningful figures for carbon fixation prices and carbon sequestration rates are available (?).
Water purification (Prevention of saline water intrusion)	Change in productivity: value of lost production for agricultural, water supply, fishery and other uses.	Total annual value provided by mangroves in preventing saline water intrusion ($US).	Area and annual production of agricultural land protected. Number and value of wells/ water supply sources protected. Price of products and services.	Protected area can be identified. Protective function can be modelled. Seasonal influences can be accounted for.
Sediment, Contaminant Nutrient removal/storage	Replacement costs: costs of removing sediment/nutrients/toxicants by other means.	Total annual value provided by mangroves in removing pollutants ($US).	Pollutant loads. Quantity of water treated (flows). Costs of treatment.	Equivalent standard of treatment by each method.
Oxygen release (?)	Replacement costs: Costs of generating oxygen elsewhere.	Total annual value provided by mangroves in generating (oxygen ($US).	Price per ton of oxygen generated. Oxygen release rate for mangrove forests.	Meaningful figures for oxygen generation prices and oxygen release rates are available.
Nursery feeding area	On site sale value, based on contribution of mangroves to commercial fisheries and marine animal catches and swallows nest collection.	Total annual value provided by mangroves in contributing to productivity of fisheries, other marine animals, and swallows nests ($US).	Market prices of fish, marine animals, and swallows nests etc. Volume of fish, marine animals and swallow nests etc. Harvesting cost.	Production function relationship can be meaningfully defined. Mangrove area is limiting factor for productivity.

Table 3 *cont.* **Economic Valuation techniques, Indicators, data Requirements and assumptions for various types of use and non-uses of coastal wetlands.**

Types of Uses	Valuation Technique	Indicator of Measurement	Data Needed	Notes and Assumptions
Shoreline accretion/Land increase	Market price for land based on local prices.	Total annual value provided by mangroves in contributing to land building along the coast.	Annual accretion rate at which new land develops. Prices of land locally.	Market price represents true market value within a competitive market at equilibrium (i.e. prices are not distorted). All externalities are identified and included in the price.
Biological diversity services Existence values of species (migratory; endangered), genes, ecosystems and communities Wilderness	Contingent valuation: willingness to pay for biodiversity functions.	Biological diversity value of mangroves as valued by willingness to pay of users/local residents ($US).	Answers to valuation questions from survey/bidding game technique/dichotomous choice.	Subjects understand choices offered and give meaningful. Honest answers. Subjects have sufficient information to give informed choices. Sample is representative and captures the full spectrum of users who value the mangrove forest. No free riders. No strategic bias/influences.
Social/cultural significance Religious/spiritual significance Historical importance Presence of distinctive human activities Aesthetic	Contingent valuation: willingness to pay for social/cultural significance Contingent valuation: willingness to pay for aesthetic value.	Social and cultural value of mangroves as valued by willingness to pay of users/local residents ($US). Aesthetic value of mangroves as valued by willingness to pay of users/local residents ($US)	Answers to valuation questions from survey/bidding game technique/dichotomous choice.	Subjects understand choices offered and give meaningful and honest answers. Subjects have sufficient information to give informed choices. Sample is representative and captures the full spectrum of users who value the mangrove forest. No free riders. No strategic bias/influences

4.1 Market Based Value

The valuation techniques using market price or Productivity Approach are a basic of Benefit Cost Analysis technique. The value of the ecosystem/environment is based on the market price and these techniques are the same to the extent that they value the current benefits from the uses that would become costs when the uses are no longer possible. Market prices can be used to value products from the habitats that are marketed both directly and indirectly.

4.1.1 Direct Value (On site value)

The direct values can be attributed to both extractive and non-extractive uses of the ecosystem. The benefits and costs can be derived from coastal habitats such as fishery, fuelwood, genetic materials and raw materials while non-extractive direct values include recreation and tourism. The values of both extractive and non-extractive uses are based on market price (accounting price), which can be quantified and monetised from the direct use of coastal ecosystem (Bann, 1997).

FORMULA:

Local direct use value = Net income generated for local use = $\sum \{P_i Q_i - C_i\}$

Where: P_i = prices of product *i*
Q_i = amounts of product *i* being collected
C_i = costs involved in the collection of product *i*

Local direct use value = $\{P_i Q_i - C_i\}$
= {(2.9*69,762) – 76,738.20}
= 202,309.8 – 76,738.20
= 125,571.60

Cost = **Gathering Cost + Transport Cost**
Gathering Cost = 0.9 * 69,762
= 62,785.80
Transport Cost = 0.2 * 69,762
= 13,952.40

Cost = 62,785.80 + 13,952.40
= 76,738.20

- Using the above given assumptions, and following the same procedure used in computing the direct use value of the nipa shingles, the corresponding values for the other mangrove forest products can be computed. Resulting values for each of the identified mangrove forest products can be summed-up to get the resulting total direct use value for mangrove ecosystems.
- Nipa Shingles
  Average Amount of Shingles Gathered and processed in a mangrove area = 1700 pcs
  Price of shingle/pc = actual selling price in the market = 50 cents
  Prevailing minimum wage rate per month = $75.00
  Period to complete gathering and processing = 15 days
  Transport Cost (actual freight+1/2 porterage cost) = 20 cents/100 pcs

  Computation for on-site value of Nipa Shingle
  = $P_i Q_i - C_i$
  = (15)(1760) – (75)(0.50) + 0.20 (1760/100)
  = 880 – (37.50 + 3.50)
  = $838.98 per hectare

4.1.2 Indirect Value

When the values of the coastal habitat/environmental goods or services are difficult to determine using the appropriate market price directly, said values can be estimated by using indirect values.

Change in Productivity

Development plans are designed to affect a habitat in the coastal area, which can increase the physical productivity or prevent its deterioration. Therefore, the value of this change can be calculated in terms of the value of increase in production or the value of the damages prevented or a combination of both.

Change in productivity refers to the minimum value of an environmental change estimated in terms of the resulting loss or decrease in productivity/output, it estimates the negative effects of a degraded environment resource on-site and off-site economic activities. This approach employs production relationships/functions, which include environmental quality as an input (www.deh.gov.au).

FORMULA: $\Delta P = [(Qi^n/N) - Qi^t] * P^t$

Where:

ΔP	=	Change in Productivity
Qi^n/N	=	amount of good ***i*** collected within the timeline being considered
Qi^t	=	amount of good/service being collected at baseline year
P^t	=	unit price of good **Q** at baseline year

EXAMPLE:

1. Average mudcrab gathered per hectare from 1995-20005 = 638 kg/ha/yr
2. Mudcrab gathered in 2006 = 416.7 kg/ha
3. Price of mudcrab in 2006 = $1.50/kg

Computation for Change in Productivity (ΔP)

$$\Delta P = [(Qi^n/N) - Qi^t] * P^t$$
$$= (638\text{kgs} – 416.7\text{kgs}) * \$1.5/\text{kg}$$
$$= 221.3 * 1.5$$
$$= \$\ 331.95$$

Interpretation: The sudden decrease in mangrove forest cover led to a decrease in productivity of mudcrabs, resulting to about 221.3kgs/hectare or an equivalent amount of about $331.95/hectare loss of income from mudcrab catch. It may be concluded that the decrease in forest cover resulted to an environmental cost equivalent to $331.95 per hectare per year.

Shadow Project

Shadow project technique is a special version of the replacement-cost technique which is related with the cost of replacing the entire range of environmental goods/services or by replacing productive assets damaged by improper management practices by using the costs of a hypothetical supplementary project. This approach is essentially the same as the replacement cost approach and is increasingly being mentioned as a possible way of operationalizing the concept of sustainability at the project level. It assumes that there is a constraint to maintain environmental capital intact and therefore could be more relevant when “critical” environmental assets are at risk.

When evaluating projects that have negative environmental impacts, this approach involves the design or costing of one or more “shadow projects” that provide or substitute environmental services to compensate for the loss of environmental assets under the ongoing projects. Here, total cost of the alternative is added to resource cost of the project to estimate full social cost. It likewise assumes that existing market prices reflect scarcity and the optimal allocation of resource (i.e. economic efficiency) (Hoban & Tsunokawa, 1997).

More simply put, the Shadow Project Method refers to the costs of providing an equal alternative good or service elsewhere. The possible alternatives may range from asset reconstruction (i.e. providing an alternative habitat site for a threatened wildlife habitat); asset transplantation (i.e. moving the existing habitat to a new site); asset restoration (i.e. enhancing an existing degraded habitat). The cost of the chosen option is added to the basic resource cost of the proposed development project in order to estimate the full cost. Inclusion of shadow project costs gives an indication of how great the benefits of the development project must be in order to outweigh the losses it causes. In other words the shadow project approach provides a minimum estimate of the presumed benefits of programmes for protecting or improving the environment (Panayotou, 1997).

The underlying idea in asset reconstruction (replacement) and asset transplantation (relocation) is that the reconstruction cost approach, by measuring the costs of reconstruction, gives an idea of what would be the benefits from measures taken to prevent damage from occurring. If a development project leads to the destruction of the habitat, one way to measure the benefits from preventing this damage from occurring would be to estimate the cost for reconstruction (Cistulli, 2002).

e.g. an artificial lagoon to replace all services of an estuary (fish breeding, fish catches, bird habitat, and recreational activity) in a flood mitigation project.

(EXPAND THIS EXAMPLE)

Defensive/Preventive Expenditure

Defensive/Preventive Expenditure is a technique that estimates an individual's minimal valuation of habitat/environmental quality. The values of goods or services can be obtained from empirical data showing their willingness to incur cost for avoiding adverse effects on habitat/environment. This approach examines the expenditures that people make to avoid damages that result from environmental degradation (Bann, 1997).

This approach assigns values to perceived negative environmental attributes by looking at how individuals or groups of individuals spend so that these negative attributes will be avoided. In this case, the "negative" has not happened yet. Rather, the individual or group of individuals thinks that these would occur if no measures are done to avoid these.

In the same way, this may be imputed as the costs to maintaining a favorable environment.

FORMULA:

Defensive/Preventive Expenditure follows the following steps:

1. Identification of perceived negative environmental effects or environmental "bads" – those that individuals/groups recognize as undesirable if present in their habitat.
2. Identification of alternative approaches (whether equipment or structures) that would ensure, to some degree, that these bads will be avoided.
3. Identify extent of application/implementation of each approach.
4. Assign equivalent costs to the implementation of these defensive/preventive measures.

EXAMPLE: Mining Operations

1. Perceived negative environmental effect = release of contaminated wastewater (Acid Mine Discharge) into the natural waterways of the adjacent community
2. Alternative approaches to ensuring that this will not happen:
   a. Active AMD Treatment
   b. Passive AMD Treatment
   AMD=Acid Mine Discharge??

3. Extent of application/implementation:
   a. Through dissolution by introducing the water to limestone, hydrated lime, or through precipitation of metals
   b. Through ALD, Aerobic Wetland, or Anaerobic Wetland
   WHAT IS ALD? WHAT ARE AEROBIC/ANAEROBIC WETLAND?
4. Equivalent costs:
   a. $ 0.75 Billion
   b. $ 0.53 Billion

In this example, the cost equivalent of whichever scheme will be implemented by a mining company to ensure that environmental disasters will be avoided will also be the value attributable to the environment.

Cost of Illness

The change on environmental quality can have significant effects on human health. The value of monetary damage to human can be used to monetize the impact of development by using forgone earnings, medical expenses and physical costs.

The Cost of Illness (COI) is an approach which aims to value the change in health or well-being arising from a change in environmental quality.

This consists of the following factors (Kuchler and Gohan, ____):

1. Direct monetary cost of illness such as medical expenditures, costs incurred by medical insurance
2. value of lost time and productivity of ill person (foregone income, foregone leisure)

FORMULA:

Cost of Medical Expenditure + Value of Lost Time

Where cost of medical expenditures can consist of:

- Medical Fees
- Hospitalization Fee
- Cost of Medicine
- Cost of Rehabilitation (if any)

And, value of lost time = lost wages/ earnings

Computation for Cost of Illness Value:

Medical fees	= $200.00
Hospital fee (including laboratory)	= $500.00
Cost of Medicine	= $100.00
Cost of Rehabilitation	= $300.00
Monthly Salary	= $750.00
Number of Months Ill	= 5 months

Cost of Illness = (200+500+100+300) + (750*5)

= 1,100 + 3750

= $4850.00

Replacement Cost

This technique takes into consideration the cost incurred in the replacement of a previously existing environmental resource or a human made good, service or asset. The resulting value reflects the willingness of individuals to pay to continue receiving a particular benefit provided by that environmental resource.

It is the value of changes in the quality of the environment/resource and its services measured in terms of the cost of restoring/replacing the damaged environmental asset.

This technique can be used in estimating the costs of land degradation, such as costs of damaged roads (i.e. cost of replacement of public assets such as roads, rivers, and water storages affected by land degradation damages).

It examines the expenditures people make to correct a problem after the potential impact has occurred.

Derives value through the following (Hoban and Tsunokawa, 1997):

1. Cost of construction of defensive/ preventive structures such as dikes/breakwaters, which substitute for the natural protective functions of previously existing ecosystems.
2. Cost of acquiring equipment/facilities which would help combat/ mitigate level of pollution
3. Cost of all other measures taken by individual or a group of people to reduce effects of poor environmental quality

EXAMPLE:

If, for example, a community in a coastal area that relied on the mangroves along its coastline as protection from strong waves in cases of bad weather finds that it needs additional protection from the sea. The adequate protection that the community previously got from the mangrove stands along its coastline now does not seem enough because unabated cutting of the mangroves for subsistence purposes has decreased the mangroves significantly. The local government then decided, through prodding form the locals, to re-allocate about $20M for the construction of artificial breakwaters to compensate for the now-inadequate protection. The cost of conducting this project will then represent the preventive expenditure cost for the area.

Restoration or replacement efforts may cause more (or less) than the value of the goods and services provided by the damaged environment/resource, hence leads to an overestimation (or underestimation)

4.2 Surrogate Market Based

4.2.1 Hedonic Price

The hedonic price method can be used to value an attribute, or a change in an attribute, whenever its value is capitalized into the price of assets, such as houses. Environmental benefits (e.g. improved water/air quality, scenery) can be measured by looking for surrogate markets where the commodities sold possess the attribute of the environmental benefits. The price of the surrogate commodity is used to value an unpriced environmental good/service.

This technique derives values by getting a certain attribute and then using the change in house prices (for example) resulting from a change in this particular attribute while holding all other factors constant.

This valuation approach rides on the thought that people, if given a choice between 2 similar houses, would prefer buying a house that has a relatively better view, or more pleasant atmosphere (tree shades/canopied walks, a clean stream/water body, etc.), even if it will entail an additional cost. This additional cost can then be assumed to be attributable to the change in scenery and, accordingly, to the implied value of environmental goods/service.

Steps for Hedonic Price Method (HPM):

1. Estimate additional cost of houses with marginally better views, controlling for other variables affecting house prices
2. Estimate WTP for better view, controlling for income and other socio-economic factors

=== or ===

1. Identify the specific environmental quality variable, the surrogate commodity (ask whether this market for the surrogate commodity freely functioning/efficient)
2. Construct an indicator for the environmental quality which people recognize and which is strongly correlated with the price of the surrogate commodity
3. Specify the hedonic price function:

   price of the surrogate commodity = *f* (environmental quality, structural characteristics, neighborhood characteristic)
4. Run the regression and interpret the results. The coefficient of environmental quality provides an estimate of the marginal implicit price of environmental quality, ie, the additional amount of money that must be paid by the individual to move to an identical property but with a higher level of environmental quality.

EXAMPLE:

One application of the HPM is in measuring how the siting of hazardous waste facilities affects prices of nearby properties. A study by Kohlhase (1991), who finds that housing prices in the Houston area are positively affected by distance from a declared Superfund site up to 6.2 miles. According to this research, an additional mile in distance from the site adds $2.364 to a property’s value. In a similar study of single-family homes in Woburn, Massachusetts, Kiel (1995), estimates the analogous marginal benefits to be $1.377 for the period when the waste facilities were declared Superfund sites.

4.2.2 Travel Cost

The willingness to pay of an individual for use of an environmental resource is inferred from travel expenditures of those who visit it. In such cases, an increase in output due to the change is a measure of an increase in benefit, and a decrease in output is a measure of an increase in cost.

FORMULA:

This approach is primarily used to measure the perceived benefits that consumers receive from their use of an environmental good.

Demand for it is not only a function of price/admission fee but also the total cost of going to that place. This also entails the opportunity cost and then adding this to the admission fee to get the total cost or price of going to that particular site.

Opportunity Cost/Explicit Cost

1. Opportunity cost of time allotted for the trip (i.e. wage rate, if travel was done on a weekday)
2. Depreciation cost of vehicle (in cases where private transportation is used)
3. Accommodation cost at site (including meals)
4. Parking fee (if any)

EXAMPLE:

Assumptions: **Admission Price is $ 10.00**
Opportunity cost of time = $9.40/hr
Travel Time = 0.5 hours
Distance = 2 kilometers
Marginal vehicle operating opportunity cost (MVOC)= 15 ¢/km

Travel Cost/person = (Opportunity Cost X Travel Time) + (Distance X MVOC)
Round Trip Cost/person = cost per trip X 2
Total Cost/ person = Round trip cost + admission price

Travel Cost/person **=** ($9.40*0.5) + (2*0.15)
= 4.7 + 0.3
= $5.00
Round trip cost = $10.00
Total Cost = $20.00

Demand for it is not only a function of price/admission fee but also the total cost of going to that place. This also entails the opportunity cost and then adding this up to the admission fee to get the total costs or price of going to that particular site.

Opportunity Cost/Explicit Cost

5. Opportunity cost of time allotted for the trip (i.e. wage rate, if travel was done on a weekday)
6. Depreciation cost of vehicle (in cases where private transportation is used)
7. accommodation cost at site (including meals)
8. Parking fee (if any)

EXAMPLE:

Assumptions: **Admin Price is $ 10.00**

Opportunity cost of time = $9.40/hr

Travel Time = 0.5 hours

Distance = 2 kilometers

Marginal vehicle operating opportunity cost (MVOC)= 15¢/km

Travel Cost/person = (Opportunity Cost X Travel Time) + (Distance X MVOC)
Round Trip Cost/person = cost per trip X 2
Total Cost/ person = Round trip cost + admin price

Travel Cost/person **=** ($9.40*0.5) + (2*0.15)

= 4.7 + 0.3

= $5.00

Round trip cost = $10.00

Total Cost = $20.00

4.3 Simulated Value Survey-Based

4.3.1 Contingent Valuation

The contingent valuation method relies on surveys to ascertain how much respondents would be willing to pay for the preservation or improvement of a certain resource or environment or to accept payment for doing away with said resources or environment (Tietenberg, 1996).

FORMULA:

A survey-based technique for eliciting preferences for non-marketed goods (e.g. environmental assets, amenities, services, etc.). A sample of individuals is directly asked to state their preferences (Willingness to Pay or Willingness to Accept) regarding a certain environmental quality/good or any non-marketed attribute of the good.

Steps:

1. Identify the environmental impact, its direction and the policy issue
2. Identify the affected or prospective respondent population covered by the environmental impact or policy
3. Construct a sample frame, determine where and how to interview
4. Design the survey instrument/questionnaire

EXAMPLE:

Communities A, B and C are situated alongside along the coast. Not far from these communities is four hectares of old-growth mangroves. These mangrove stands, however, are slowly thinning because of unsustainable subsistence cutting. Interviews with the residents of the three communities were done. The questionnaire included questions regarding their household size, and a series of questions regarding how much they value their surrounding mangrove forests, ending with a question regarding their willingness to pay an amount for the rehabilitation of the mangrove forest.

The gathered date were analyzed and put in a table as follows:

	COMMUNITY A	COMMUNITY B	COMMUNITY C	TOTAL
# OF HHs	115	73	165	353
PER CAPITA POPULATION	648	389	1,033	2,070
AVERAGE HH WTP (USD)	1.35	2.15	1.63	---------
TWTP per HH per month (USD)	155.25	156.95	268.95	---------
TWTP per HH per year (USD)	1,863.00	1,883.40	3,227.40	6,973.80

Where: HHs = Households
Per Capita Population – total number of individuals in each community
Average HH WTP (per month) – computed by getting the total willingness to pay for all households in the same community and dividing it by the number of households in that community
TWTP per HH per month (USD) – computed by multiplying the AVERAGE HH WTP with the total number of HHs in same Community i.e., for Community A, TWTP per HH per month = 1.35*115 = 155.25
TWTP per HH per year (USD) – computed by multiplying the resulting TWTP per HH per month by 12, such that for Community A, TWTP per HH per year = 155.25*12 = 1,863.00

VALUE OF MANGROVES/HA/YR = TWTP per HH per year/ no. of hectares of mangrove stands
= USD 6,973.80 per year /4 hectares
= USD 1,743.45/ha/year

Interpretation: The communities that are situated in the vicinity of the mangrove stands value this ecosystem at USD 1,743.45/ha/year as shown by their willingness to pay for rehabilitation of the mangrove areas.

Contingent Valuation Method (additional)

THE ADDITIONAL TEXT SHOULD BE INTEGRATED INTO THE ABOVE TEXT OF THE SECTION ON CVM.

Contingent Valuation Method (CVM) is a method that enables economic values to be estimated for non – marketed goods (eg. environmental assets, amenities, services, etc...). CVM relies on surveys to ascertain respondents' preferences regarding an increase or decrease in the level of environmental quality.

FORMULA: a sample of individuals is asked to state what they are willing to pay (WTP) for the preservation or improvement of a particular resource or environment; or to accept (WTA) compensation for doing away with said resource or environment, in a carefully structured hypothetical market (Tietenberg 1996, Hanley 1994)

STEPS:

1. Preparation: set up hypothetical market
   - Identify the environmental impacts, its direction and the policy issues
   - Identify the affected or prospective respondent population covered by the environmental impact of policy
   - Construct a sample frame, determine what to ask (WTP or WTA), where and how to interview
   - Design the survey instrument/questionnaire
2. Survey: survey methods include on site (face to face), house to house, or mail/telephone (remote)
3. Calculate measures of welfare changes: mean/median bids after cleaning data by removing outliers, protest bids

Derive a bid function, for example: $WTP_i = f(Y_i, E_i, A_i, Q_i)$

Where:

i: indexes respondents

Y: income

E: education

A: age

Q: variables measuring the environmental quality being bid for

4. Aggregation: calculate total WTP/WTA from mean WTP/WTA. For example by multiplying the sample mean WTP/WTA of visitors to a site by the total number of visitors per annum.
5. Study appraisal: testing the validity and reliability of the estimates produced

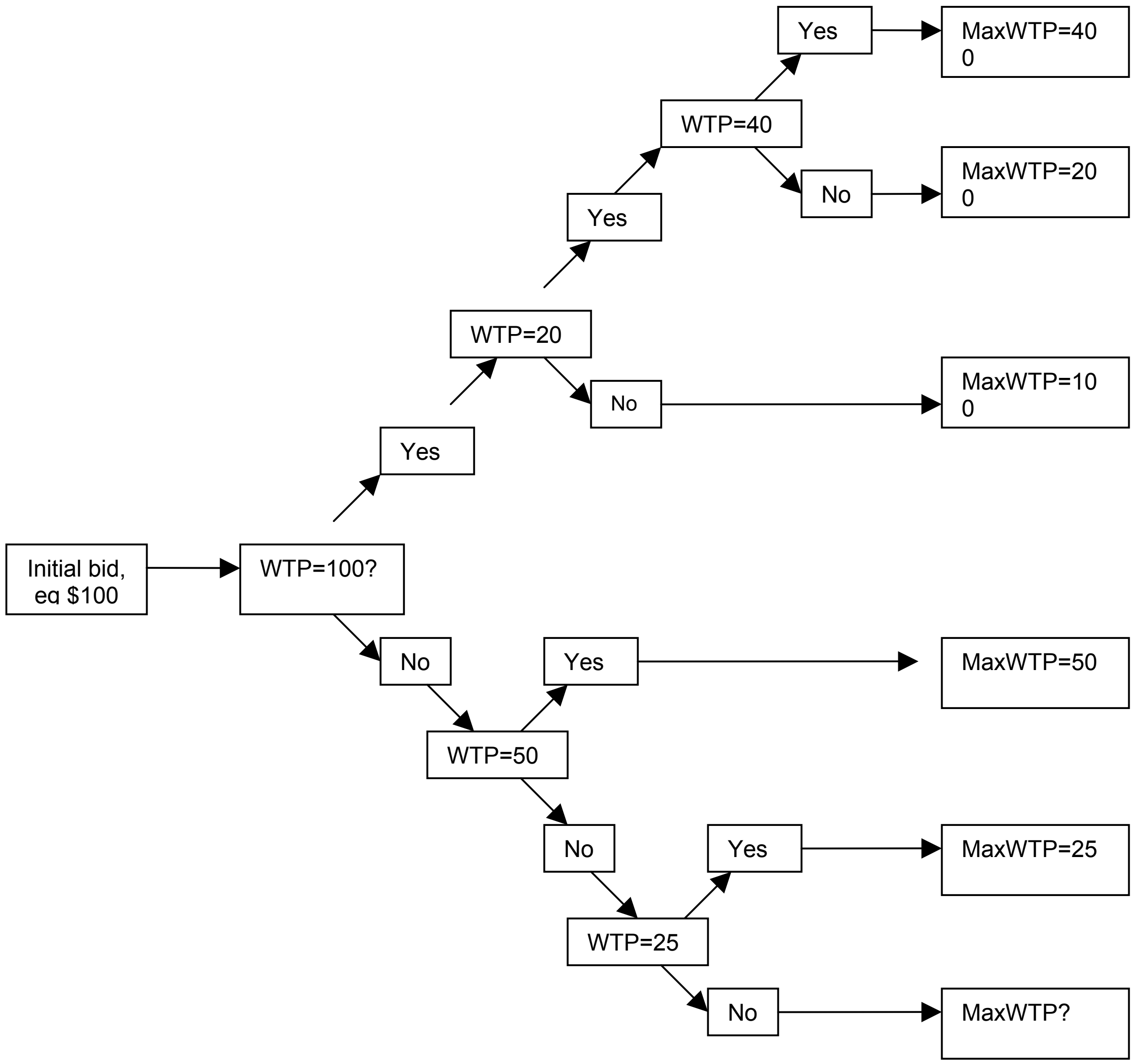
Methods for obtaining bids:

- Open – ended questions: respondents are asked for their maximum WTP/WTA with no values being suggested to them.
- Closed – ended referendum: ask respondents whether they agree or disagree with a suggested single payment
- Dichotomous choice referendum: interviewer selects random values from a range, respondent then accepts or rejects
- Payment card: offer respondents a range of values (2 4 6 8 10) on a card for them to select highest WTP/WTA

In fact, people have a tendency to state a lower WTP than the actual WTP, and a much higher WTA than the actual amount.

EXAMPLE: Estimate recreational values of a mangrove area

A sample of 2051 respondents was asked whether they are willing to pay for the protection of the mangroves. An initial dichotomous choice question was supplemented with up to two further dichotomous questions after which an open – ended WTP question were asked as illustrated in the figure below:



The best fit model for the above bidding tree was as follows:

LnWTP = 2.104 + 0.373LnBID + 0.000005INC + 0.176FISH + 0.172ENV – 0.122FIRST

Where:

LnWTP: natural log of respondents final WTP statement

LnBID: natural log of the amount presented to respondents in the first dichotomous choice questions

INC: household income

FISH =1 if respondent does participate in some fishing activity (=0 otherwise)

ENV = 1 if respondent is a member of an environmental group (=0 otherwise)

FIRST = 1 if respondent is on his/her first visit to the area (=0 otherwise)

The final mean WTP calculated was $74.91 per household per year. Multiply this by the total number of visitors per annum, say 76,000, we have the total WTP per year is $5,693,160. This amount is the estimated recreational and amenity values of the site.

Note: This is a very simplified description of CVM in order to provide readers with general understandings of environmental valuation techniques.

4.3.2 Choice Modelling

Choice modelling is a technique, which predictively models choices (such as consumption decisions) that cannot be represented by a continuous variable. It estimates the likelihood of a consumption choice based upon preferences of the subject (user) and the attributes of the elements of the set containing the choices.

When using CM, respondents are presented with various\alternative descriptions of a good, differentiated by their attributes and their levels, and then are asked to rank, rate or choose their most preferred among the choices.

FORMULA:

Choice modelling follows the following steps:

1. Selection of attributes
Identification of relevant attributes of the good to be valued. Literature reviews and focus groups are used to select attributes that are relevant to people while expert consultations help to identify the attributes that will be impacted by the policy.

2. Assignment of Levels
The attribute levels should be feasible, realistic, non-linearly spaced, and span the range of respondents' preference maps. Focus groups, pilot surveys, literature reviews and consultation with experts are instrumental in selecting appropriate attribute levels. A baseline 'status quo' level is usually included.

3. Choice of experimental design
Statistical design theory is used to combine the levels of the attributes into a number of alternative scenarios or profiles to be presented to respondents.

4. Construction of Choice Sets
The profiles identified by the experimental design are then grouped into choice sets to be presented to respondents. Profiles can be presented individually, in pairs, or in groups.

5. Measurement of Preferences
Choice of a survey procedure to measure individual preferences: ratings, rankings, or choices.

6. Estimation Procedure
OLS regression or maximum likelihood estimation procedures (logit, probit, ordered logit, conditional logit, nested logit, panel data models, etc.). Variables that do not vary across alternatives have to be interacted with choice-specific attributes.

Furthermore, Choice Modeling can be of 4 various types:
1. Choice experiments
   Choose between 2 or more alternatives, wherein one is the status quo
2. contingent ranking
   Rank a series of alternatives
3. contingent rating
   Score a series of alternatives on a scale of 1-10
4. paired comparison
   Score pairs of scenarios on a similar scale

EXAMPLE:

Example of a Choice Set from the Macquarie Marshes Questionnaire (table taken from Morrison, et.al., 1998).

Outcome	Option 1: Continue Current Situation	Option 2: Increase Water to the Macquarie Marshes	Option 3: Increase Waster to the Macquarie Marshes
Your water rates (one-off increase)	No change	$20 increase	$50 increase
Irrigation related employment	4400 jobs	4350 jobs	4350 jobs
Wetlands area	1000 km^2	1250 km^2	1650 km^2
Waterbirds breeding	Every 4 years	Every 3 years	Every year
Endangered and protected species present	12 species	25 species	15 species
__ I would choose option 1			
__ I would choose option 2			
__ I would choose option 3			
__ I would not choose any of these options because I would prefer more water to be allocated for irrigation			

Respondents were asked for their preferred choice from each of the 4 options: Option 1 – Status quo, Option 2 and 3 – improvements in wetland quality, Option 4 – not choosing any of the first three options because the preference is for more water to be allocated for irrigation. The percentage of respondents of the target population that chooses each option can be projected to the whole of the same population.

Computation for the equivalent amounts would be the indicated increase in water rates (whether zero for Option 1 and 4, or $20 and $50 for Options 2 and 3, respectively). For this study, a total of 986 questionnaires were processed, with 25 percent choosing option 2, 35 percent for option 3, and the remaining 40 percent for options 1 and 4. Equivalent WTP totaled to $4940 (247 respondents*$20) for option 2, $17,250.00 for Option 3 (345 respondents*$50), and zero for Option 1 and 4 (394 respondents * $0). This results in a total of $22,190.00 for the sample population or an average of $22.51 for each respondent.

Assuming that the total population affected by plans to improve the environmental quality of the 3,000 km^2 wetland is approximately 3,341 individuals, the total WTP is equivalent to $45,132.55 (2,005*$22.51) (2,005 individuals, or 60% of population who are willing to have an increase in irrigation for a better environmental quality of the wetland) or about $15.04 per km^2/year of wetland.

5. COST BENEFIT ANALYSIS

THIS SECTION NEEDS EDITING ON THE HEADINGS AND TITLES

Cost-benefit analysis is a common analytical tool used by economists to evaluate environmental decisions and development plans. In a cost-benefit analysis, both the costs and the benefits of a policy or programme are measured and expressed in comparable terms. The benefits of some proposed actions are estimated and compared with the total costs that society would bear if that action were undertaken. For example, in the context of developing national action plans, the cost-benefit approach implies that we need to consider both the benefits and the costs of environmental programmes and policies contained in national action plans measured in terms of economic value.

A cost-benefit analysis involves measuring, adding up and comparing all the benefits and all the costs of a particular public project or programme. There are essentially four steps in a cost-benefit analysis:

- Specify clearly the project and programme;
- Describe quantitatively in economic terms the inputs and outputs of the programme;
- Estimate in economic terms the social costs and benefits of these inputs and outputs;
- Compare these benefits and costs.[6]

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[6] *See Barry C. Field. 1994. Environmental Economics. New York: McGraw-Hill, Inc. p. 113 – 117.*

Each of these steps incorporates a number of components. The very first step is to decide on the perspective from which the study is to be done. Step 1 should also include a complete specification of elements such as location, timing, groups involved, connections with other programmes etc.

After the basic project or programme has been specified, the next step is to determine specific inputs and outputs of the project or programme. It is also important to recognize the importance of time. Environmentally related projects or programmes do not usually last for a single year, but are spread out over long periods of time. So the specification of inputs and outputs will involve prediction of future events.

The next step is to put values on input and output flows; that is, to measure costs and benefits. Normally, benefits and costs are measured in monetary terms.

Finally, costs and benefits need to be compared to calculate the net benefits of a project or programme. There are usually two ways to compare total benefits and costs. One way is to subtract the total costs from total benefits to get "net benefits." The other is to calculate the benefit-cost ratio of the project or programme. This will show the benefits the project or programme will produce for each dollar of the costs. There are two types of the approach that is an ordinary cost benefit analysis or financial analysis and extended cost benefit analysis or economical analysis.

5.1 Ordinary cost benefit analysis : financial analysis

The ordinary cost benefit analysis is the approach that considers all of the costs and benefits. The cost and benefit analysis defines costs and benefits in particular way, and it goes beyond the idea of an individual's balancing of cost and benefit. The cost and benefit analysis defines costs and benefits in particular way, and it goes beyond the idea of an individual's balancing of cost and benefit. The so-called *"benefits"* and *"costs"* derived from different benefits from coastal area are as followings:

(1) Annual benefits, **Annual benefits**, which will be considered in monetary term and just considered in ***use value: consumption use benefit and non-consumption use benefit***, consisting of direct use benefit as following;

Consumption use benefit: product value of final products from coastal resource in both for sale and for household consumption ($B_{1..}$ $B_{11)}$ for local use as well as following example in table xx.

Non-consumption use benefit**:* product value of final products from coastal resource (B_{12}) for non-consumption use*** such as recreation value as following example in table xx.

Table xx Total benefit for financial analysis

Products	Symbol
Direct use value	
Consumption use benefit	
Firewood	B_1
Poles	B_2
Charcoal	B_3
Fruit/propagates	B_4
Bark (tanning & dyes)	B_5
Medicine	B_6
Sap (sugar, alcohol, Acetic acid)	B_7
Wood tar	B_8
Insect and larvae collection	B_{10}
Worms (polychaetes)	B_{11}
Non-consumption use benefit	
Recreation	B_{12}
Total benefit	$\sum$ ***B1..B12***

(2) Annual costs, which will be considered in monetary term, consisting of investment cost and operation cost as following;

(2.1) Construction cost for land development for conservation/keeping of coastal area

(2.2) Operation and maintenance cost

Table xx Total cost for financial analysis

Cost	**Symbol**
1) Construction cost	C_1
2) Operation and maintenance cost	C_2
Total cost	$\sum C_1..C_2$

(3) Annual net benefits, which will be the difference between total inflow and total outflow. The annual net benefit in the first few years may be negative because there would be higher in investment cost for land development and water supply, but in the long run net benefits would be increasing.

Net benefit for financial analysis = total benefit - total cost

$$= \sum B_{1..}B_n - \sum C_1..C_n$$

5.2 Extended cost benefit analysis: economical analysis

In term of economics aspect the coastal zone area is very important for economics, social and environment. The financial cost benefit considers only the value monetary term which it does not consider about the benefit and cost of the external coastal and benefit of the coastal area. The extended benefit consists of the ordinary benefit (direct use benefit) and the extended benefit (indirect use benefit) as following.

It can be call as extended benefit and extended cost as following:

(1) Annual benefits, which will be considered in monetary term in both **use value and non-use value**, consisting of use value: direct use benefit and indirect use benefit as well as option and non-use value: existence value and value as following;

1.1 Direct use value

1.1.1 ***Consumption use benefit***: product value of final products from coastal resource in both for sale and for household consumption ($B_{1..}$ $B_{10)}$ for local use as well as as following example in table 3.

1.1.2 Non-consumption use benefit*:* product value of final products from coastal resource (B_{11}) for n***on-consumption use*** such as recreation value as following example in table 3.

1.2 Indirect use value

Indirect use values consider value from coastal resource such as nursery fishery, carbon sequestration, oxygen release, recreation value and off-shore fishery linkage (EB1.. $EB_{4)}$ as in table XX.

Table XX Total benefit for economical analysis

Products	**Symbol**
1. Direct use value	
1.1 Consumption use benefit	
Firewood	B_1
Poles	B_2
Charcoal	B_3
Fruit/propagates	B_4
Bark (tanning & dyes)	B_5
Medicine	B_6
Sap (sugar, alcohol, Acetic acid)	B_7
Wood tar	B_8
Insect and larvae collection	B_9
Worms (polychaetes)	B_{10}
1.2 Non-consumption use benefit	
Recreation	B_{11}
2. Indirect use value	
Nursery fishery	EB_1
Carbon sequestration	EB_2
Oxygen release	EB_3
Off-shore fishery linkage[7]	EB_4
Total benefit	$\sum B1..B11 + EB_1.. EB_4$

(2) Annual extended costs, which will be considered in monetary term, consisting of ;

2.2.1 Construction cost for land development for conservation/keeping of coastal area

2.2.2 Operation and maintenance cost

2.2.3 Opportunity cost for land development for conservation or keeping of coastal area.

Table 4 Total cost for economical analysis

Cost	**Symbol**
Construction cost	C_1
Maintenance cost	C_2
Opportunity cost	EC_1
Total cost	$\sum C_1..Cn + EC_{1..} EC_n$

(3) Extended net benefits, which will be the difference between total inflow and total outflow as well as external cost and benefit. The annual net benefit in the first few years may be negative because there would be higher in investment cost for land development and water supply, but in the long run net benefits would be increasing.

Net benefit for economical analysis = total extended benefit - total extended cost

$$= \sum B_1 . .B_{11} + EB_1 .. EB_4 - \sum C_1..Cn + EC_{1..} EC_n$$

7 Suthawan Sathirathai 1998

Project analysis is the analysis to evaluate the cost and benefit of natural resource uses. There are three approaches for consideration of natural resources value that is economic valuation as explained following.

1) Net present value (NPV)

This net present value (NPV) approach presents the net benefits of mangrove area where it compares to that of an alternative use.

Discount rate: in order to compute net present value, it is necessary to discount future benefits and costs. This discounting reflects the time value of money. Benefits and costs are worth more if they are experienced sooner. All future benefits and costs, including non- monetized benefits and costs, should be discounted. The higher the discount rate, the lower is the present value of future cash flows. For typical investments, with costs concentrated in early periods and benefits following in later periods, raising the discount rate tends to reduce the net present value.

In case of financial analysis, using borrowed bank rate is used.

In case of economical analysis, using the *shadow price of capital* to value benefits and costs is the analytically preferred means of capturing the effects of government projects on resource allocation in the private sector. To use this method accurately, the analyst must be able to compute how the benefits and costs of a program or project affect the allocation of private consumption and investment.

The basic formula of the NPV is ;

$$\text{NPV for financial analysis} = \sum^{T} \frac{B_t - C_t}{((1+r)^t}\ \text{private/market rate}$$

$$\text{NPV for economical analysis} = \sum_{t=1}^{T} \frac{EB_t - EC_t}{(1+r)^t}\ \text{social discount rate}$$

If	B	=	benefit of the project
	C	=	cost of the project
	r	=	interest rate
	t	=	project years

The NPV rule for the both cases is that for any project, the NPV should be positive.

2) Benefit-cost ratio (B/C ratio)

$$\text{B/C ratio for financial analysis} = \frac{\sum_{t=1}^{T} \frac{B_t / C_t}{(1+r)^t}\ \text{private/market rate}}{\sum_{t=1}^{T} \frac{EB_t / EC_t}{(1+r)^t}\ \text{social discount rate}}$$

B/C ratio for economical analysis =

The B/C ratio rule for the both cases is that for any project, the B/C ratio should be more than one.

3) Internal rate of return (IRR)

The internal rate of return (IRR)

IRR for financial analysis $= \dfrac{\sum^{T} B_t - C_t}{(1+r)^t_{\text{private/market rate}}} = 0$

IRR for economical analysis $= \dfrac{\sum^{T} B_t - C_t}{(1+r)^t_{\text{social discount rate}}} = 0$

The IRR rule for the both cases is that for any project, the IRR should be more than interest rate.

4) Sensitivity Analysis.

Major assumptions should be varied and net present value and other outcomes recomputed to determine how sensitive outcomes are to changes in the assumptions. The assumptions that deserve the most attention will depend on the dominant benefit and cost elements and the areas of greatest uncertainty of the program being analyzed.

For example, in analyzing a mangrove development program, one would consider changes in the number of beneficiaries, future wage growth, inflation, and the discount rate. In general, sensitivity analysis should be considered for estimates of: (i) benefits and costs; (ii) the discount rate; (iii) the general inflation rate; and (iv) distributional assumptions. Models used in the analysis should be well documented and, where possible, available to facilitate independent review.

6. VALUATION OF THE IMPACTS OF LAND BASED POLLUTION ON ECOSYSTEMS

Similar to the determination of the values of goods and services provided by the various ecosystems, there is a need for setting uniform valuation methods to determine the effects of land based pollution to these ecosystems. The Regional Task Force on Economic Valuation therefore likewise prescribes the following valuation methods to value the effects of land based pollution on mangrove, wetlands, seagrass, and coral reefs and the goods and services that they provide. This chapter is structured to account for the impacts of specific types of pollutant to the productivity, to amenity value of the ecosystem, and to the human welfare of the various ecosystems.

NEED EXPANSION/ELABORATION OF THIS PART

Annex : Case study

Table 1.1 Financial Analysis : Net Present Value (NPV) for Mangrove Forest (Private) Case : Open Access Situation for Off-shore Fishery Linkage

Net Return (For Year 1-20)	Tha-Po Village Case Study	General Case With Charcoal	General Case Without Charcoal
Local Use Value	562.16	4,237.16	1,937.98
Total	562.16	4,237.16	1,937.98
NPV at 10% discount rate	2,131.03	16,062.17	7,346.47

6.26 rai = 1 hectare
39.00 baht = 1 us dollar

Table 1.2 Financial Analyses: Net Present Value (NPV) for Commercial Shrimp Farms (Private)

Items	Year				
	1	2	3	4	5
Benefits (baht/rai) Returns per rai	229,550	229,550	229,550	229,550	229,550
Costs (baht/rai) Variable costs from operation Fixed costs from operation	82,818 19,149	82,818 19,149	82,818 19,149	82,818 19,149	82,818 19,149
Net Present Value (NPV) At 10% discount rate	97,104.95				

6.26 rai = 1 hectare
39.00 baht = 1 us dollar

Table 1.3 Cost of Water Pollution from Shrimp Farms

Based on loss of farm income on rice production From salt water released from shrimp ponds	145.62 Baht/rai
Based on costs (preventive expenditure) of wastewater Treatment	1,315.00 Baht/rai
Total	1,460.62 Baht/rai

6.26 rai = 1 hectare
39.00 baht = 1 us dollar

Table 1.4 Costs of Forest Rehabilitation

Costs of rehabilitating abandoned shrimp ponds	55,000 Baht/rai
Cost of replanting mangrove forest	3,785 Baht/rai
Cost of maintaining and protecting mangrove forest	757 Baht/rai

Source: RFD

6.26 rai = 1 hectare
39.00 baht = 1 us dollar

Table 1.5 Economical Analyses: Net Present Value (NPV) for Commercial Shrimp Farms (Society)

Item	Year						
	1	2	3	4	5	6	Year 7 to 20
Benefit (Baht/rai) Returns per rai	229,550	229,550	229,550	229,550	229,550	229,550	229,550
Costs (Baht/rai) Variable costs from operation	73,891.29	73,891.29	73,891.29	73,891.29	73,891.29		
External cost of pollution	18,758.12	18,758.12	18,758.12	18,758.12	18,758.12		
Costs of forest rehabilitation *	1,460.62	1,460.62	1,460.62	1,460.62	1,460.62	52,735	757
Net Present Value (NPV) at 6% discount rate	87,598.61						
Net Present Value (NPV) at 8% discount rate	85,929.46						

* Consist of costs of rehabilitating abandoned shrimp ponds costs of replanting mangrove forest including costs of maintaining and protecting forest (Source:RFD)

6.26 rai = 1 hectare
39.00 baht = 1 us dollar

Table 1.6 Financial Analysis: Net Present Value (NPV) for Mangrove Forest (Private) Case : With Community Management on Off-shore Fishery.

NET RETURN PER RAI (FOR YEAR 1-20)	THA-PO VILLAGE CASE STUDY					GENERAL CASE WITHOUT CHARCOAL					GENERAL CASE WITHOUT CHARCOAL				
	D = -10	D = -2	D = -1	D = -0.5	D = -0.1	D = -10	D = -2	D = -1	D = -0.5	D = -0.1	D = -10	D = -2	D = -1	D = -0.5	D = -0.1
LOCAL USE VALUE	562.16	562.16	562.16	562.16	562.16	4,237.16	4,237.16	4,237.16	4,237.16	4,237.16	1,937.98	1,937.98	1,937.98	1,937.98	1,937.98
INDIRECT USE VALUE - Off–shore Fishery Linkage	333.8038	331.9656	331.223	330.6249	329.9062	333.8038	331.965	331.223	330.6249	329.9062	333.803	331.965	331.223	330.6249	329.9062
TOTAL	895,9638	891.1256	893.383	892.7849	892.0662	4,570.964	4,569.12	4,568.38	4,567.785	4,567.066	2,271.78	2,269.94	2,269.20	2,268.605	2,267.88
NPV at 10% discount rate	3,396.41	3,389.44	3,386.62	3,384.36	3,381.63	17,327.55	17,320.5	17.,317	17.315.50	17312.77	8611.85	8604.88	8602.06	8559.80	8597.07

6.26 rai = 1 hectare
39.00 baht = 1 us dollar

Table 1.7 Economical Analysis: Net Present Value (NPV) for Mangrove Forest (Society) Case : Open Access Situation for Off-shore Fishery Linkage.

NET RETURN PER RAI (FOR YEAR 1-20)	THA-PO VILLAGE CASE STUDY					GENERAL CASE WITHOUT CHARCOAL					GENERAL CASE WITHOUT CHARCOAL				
	D = -10	D = -2	D = -1	D = -0.5	D = -0.1	D = -10	D = -2	D = -1	D = -0.5	D = -0.1	D = -10	D = -2	D = -1	D = -0.5	D = -0.1
LOCAL USE VALUE	562.16	562.16	562.16	562.16	562.16	4237.16	4237.16	4237.16	4237.16	4237.16	1937.98	1937.98	1937.98	1937.98	1937.98
INDIRECT USE VALUE - Off–shore Fishery Linkage	133.1877	2722364	332.012	381.1565	440.9302	133.18775	272.236	332.012	381.1565	440.9302	133.187	272.236	332.012	381.156	440.9302
- Coastal Protection	1244.33	1244.33	1244.33	1244.33	1244.33	1244.33	1244.33	1244.33	1244.33	1244.33	1244.33	1244.33	1244.33	1244.33	1244.33
I.TOTAL (Economic Value)	13139.68	13278.7	13338.5	13387.65	13447.42	16814.68	16953.7	17013.5	7062.65	17122.42	14515.5	14654.5	14714.3	14763.47	14823.24
OTHER INDIRECT USE VALUE															
- Carbon Fixation	341.89	341.89	341.89	341.89	341.89	341.89	341.89	341.89	341.89	341.89	341.89	341.89	341.89	341.89	341.89
II.TOTAL (Economic Value)															
- with Carbon Fixation	13481.57	13620.6	13680.3	13729.54	13789.31	17156.57	17295.6	17355.3	17404.54	17464.31	14857.3	14396.4	15056.2	15105.36	15165.13
1.NPV at 6% discount rate	146614.05	148165.58	148832.56	149380.92	150047.88	187620.13	189171.65	189838.64	190387.00	191053.96	161965.61	163517.14	164184.12	164732.48	165399.44
without Carbon Fixation															
2.NPV at 8% discount rate	126188.20	127523.57	128097.63	128569.59	129143.63	161481.43	162817.79	163390.86	163862.82	164436.86	139401.02	140736.39	141310.46	141782.42	142356.46
without Carbon Fixation															

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