Urban Ecosystem-Based Adaptation Training Programme

Module 3: Natural Resource Valuation for EbA

EbA for Urban and Peri-urban Spaces: Using Nature-Based Solutions as a Key Climate Change Adaptation Strategy for Advancing Sustainable Development in Jamaica

City Adapt
RECONNECTING CITIES WITH NATURE

The Nature Conservancy

gef

UN environment programme

Overview of Module 3: Crash Course in NRV

Module 3 is structured around 5 topics as follows:

- Topic 1: The Importance of Valuing Ecosystems – An Introduction to Natural Resource Valuation
- Topic 2: Linking NRV and EbA – The Importance
- Topic 2: A Review of Environmental Valuation Methods
- Topic 3: Introduction to Undertaking Total Economic Value (TEV) as a means of Assessing the Health of Ecosystem
- Topic 4: Undertaking the TEV of Forests, Watersheds, Coastal Resources, Mangrove Forests, Coral Reefs, etc.
- Topic 5: Introduction to Environmental Valuation Methods

Objectives of Module 3: Natural Resource Valuation for EbA

Understand	The linkages between EbA and natural resources valuation
Define	Ecosystem values
Examine	The importance of placing economic values on ecosystems
Know	The various NRV tools and how to apply them in ecosystem valuations and in EbA
Be	Able to undertake a TEV of a named ecosystem

Topic 1: The Importance of Valuing Ecosystems – An Introduction to Natural Resource Valuation

- How do we justify and decide how to allocate public spending on conservation, preservation, or restoration initiatives?
- How do we compare the benefits of different projects or programmes?
- Which conservation or restoration projects should we prioritize?
- How do we maximize the environmental benefits per dollar spent?

Role of the Natural Environment in Resilience Building – A Recap

- **Regulatory functions**
  - Regulation of the local and global climate
  - Regulation of run-off and flood prevention (watershed protection)
  - Recharging water catchment and ground water
  - Prevention of soil erosion and sediment control
  - Pollution control
  - Pollination
- **Carrier functions**
  - Cultivation
  - Human habitation/settlements
  - Infrastructure
- **Production functions**
  - Oxygen
  - Water
  - Food
  - Genetic resources
  - Medicinal resources

Valuing The Functions Of The Natural Environment

- Can the functions of the natural environment be given economic values?
- The case of pollination – a regulatory function of the natural environment
- Bee colonies cost around $185 to rent during crop season. In 2010, a beekeeper lost 200 colonies due to pesticides. That resulted in an estimated $5M loss to the U.S. economy due to crop loss.

How do we determine the values of the services and of ecosystems?

- Natural Resources Valuation
- An approach that can help determine how much ought to be invested in ecosystems to enhance resilience
- What is NRV?
- What tools/methodologies are you familiar with

Why value natural resources and ecosystems?

- An economic valuation provides a means for measuring and comparing the various benefits of environmental resources and their ecosystems and can be a powerful tool to aid and improve their use and management.
- Natural resource valuation, or environmental valuation, is a series of techniques that economists use to assess the economic value of market and non-market goods, namely natural resources and resource services.
- Economic valuation provides a means for measuring and comparing the various benefits of ecosystems, and can be a powerful tool in environmental management

NRV and the Functions of the Natural Environment

- Economic valuation assesses a resource in terms of its value to humans.
- This is undertaken by determining the Total Economic Value (TEV) of the resource dividing the value of ecosystem goods and services into use and non-use values.
- The total economic value of the environment is made of different types of economic values, each corresponding to the different use that is made of the environment.

Are there any ecosystem services that this country is not fully benefitting from?

The Case Of Wetlands – Essential Services – What are the value of these services?

Filtering of pollutants and soil run-off from upstream sources

Mitigation of negative effects on water from human and agricultural waste and some industrial pollution

Controlling of inland flooding by acting as giant sponges

Forestalling of wave erosion along shorelines

Protection of spawning and feeding grounds for some fish and shellfish

Provision of habitat for birds, crustaceans, reptiles etc.

Defining Natural Resource Valuation

A series of techniques that economists use to assess the economic value of market and non-market goods, namely natural resources and resource services.

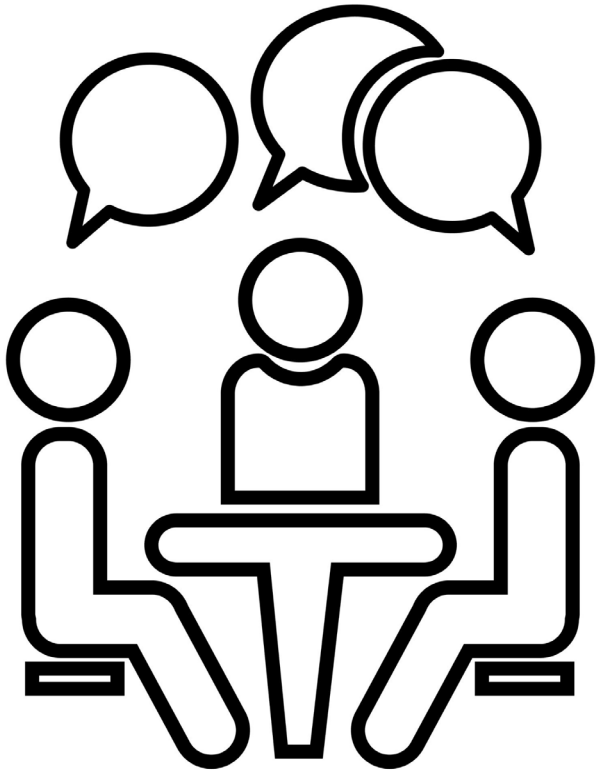
A means for measuring and comparing the various benefits of environmental resources and their ecosystems and can be a powerful tool to aid and improve their use and management and investment in rehabilitation.

It attempts to assign quantitative values to the goods and services provided by environmental resources.

- NRV can play a role in: influencing decision making and policies around economic, social and environmental issues; calculating damages for compensation; and identifying extractable revenues for environmental management.
- In the case of compensation, NRV could bring consensus about compensation among conflicting partners: Where there is debate among those involved in an environmental dispute, economic valuation tools can be used to resolve legal differences.

Tabletop Discussion…

- Do you think that NRV can strengthen the existing EIA process?
- What are some of the uses to decisionmakers of NRV?
- How do you think NRV and EbA are related?



Linking NRV and EbA – The Importance

When undertaking EbA, decisionmakers should be aware of the current economic value of the ecosystem and also the value to be gained by society of restoring and conserving these ecosystems for adapting to climate change pressures (e.g. coral reefs or mangrove restoration for storm protection)

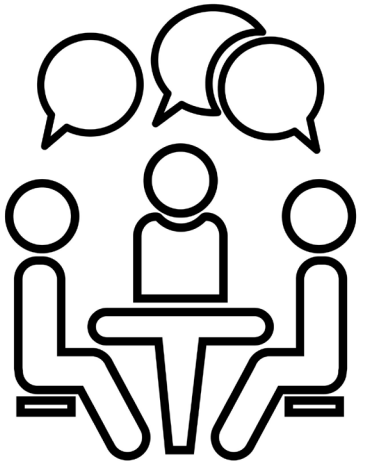
Valuing ecosystems also provide the basis for justifying restoring the resilience, the ecological/economic productivity and the capability of the ecosystems to regenerate and adapt to changes and shocks due to climate shocks.

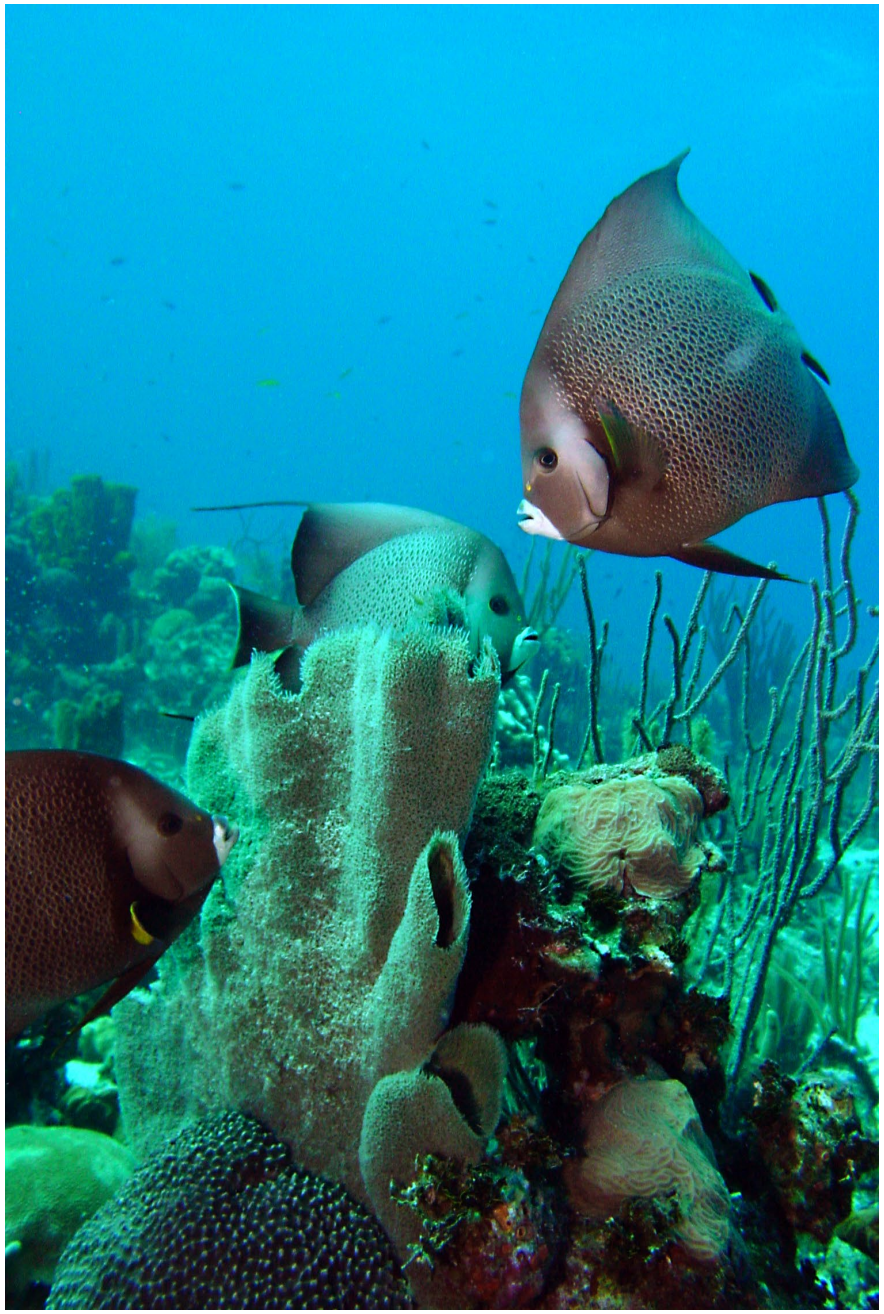
By investing in EbA and knowing the level of investment needed based on the value of the ecosystem, decisionmakers that invest in conserving and increasing the value of natural capital, may also realize several (present and future) other additional positive impacts, beyond climate change adaptation.

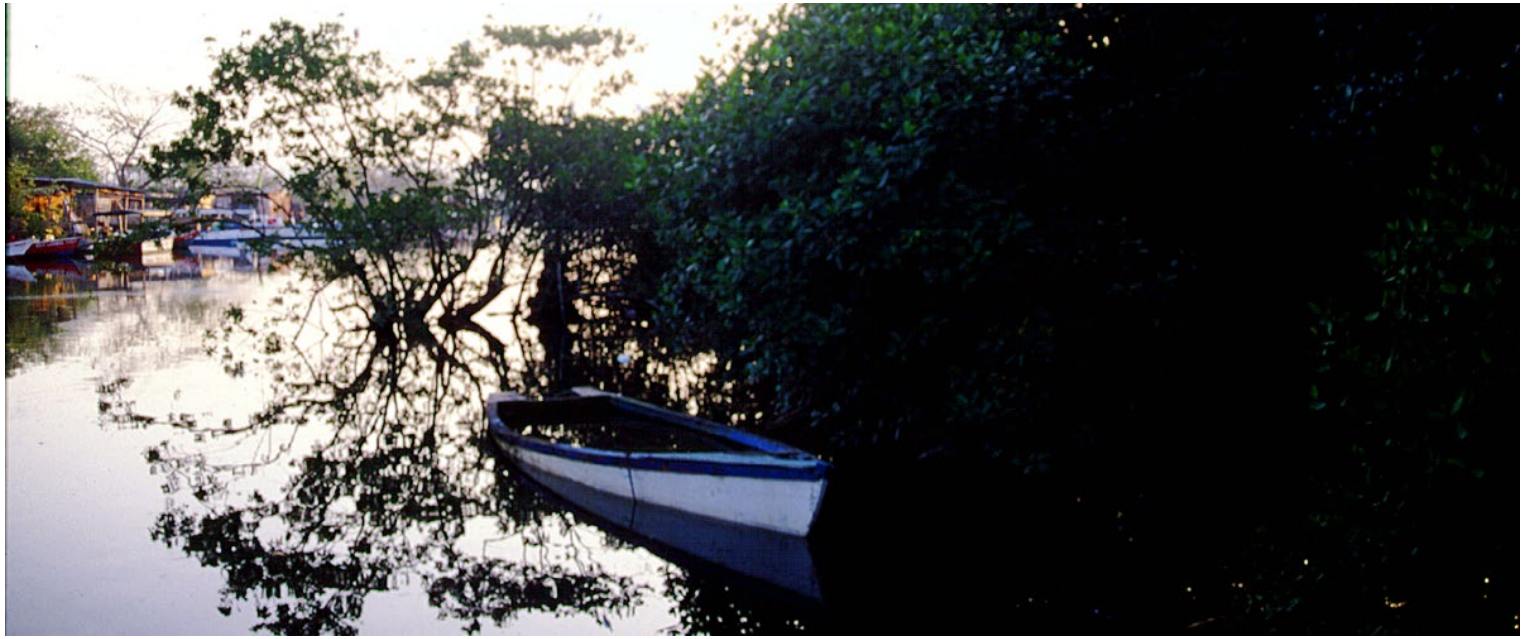
Total Economic Value				
Use Values			**Non-Use Values**	
Direct Use	**Indirect Use**	**Option Value**	**Bequest Value**	**Existence Value**
Outputs directly consumable Direct benefits from use of the primary goods	Functional Benefits	Future direct and indirect values	Use and non-use value of environmental legacy Value for future generations	Value of knowledge of continued existence – value for existence without use
Provisioning Services: ▪ Food ▪ Biomass ▪ Wood products (timber and fuel wood) ▪ Bioprospecting: medicines, biochemicals **Cultural Services:** ▪ Recreation ▪ Tourism ▪ Education/science	**Provisioning Services:** ▪ Fresh water **Regulatory services:** ▪ Flood control ▪ Storm protection ▪ Nutrient cycles ▪ Carbon storage ▪ Erosion control **Supporting Services:** ▪ Soil Quality ▪ Tourism resources	▪ Both direct and indirect use values	**Provisioning Services:** ▪ Freshwater **Regulating Services:** ▪ Carbon storage ▪ Air quality **Cultural Services:** ▪ Scenery ▪ Landscape ▪ Recreation ▪ Science/education **Supporting Services:** ▪ Soil Quality	▪ Habitats and biodiversity ▪ Wildlife ▪ Species ▪ Genetic resources ▪ Ecosystems ▪ Cultural identity

Tabletop Discussion… Plugging in the Economic Values for an Ecosystem

- The Total Economic Value (TEV) framework divides the value of ecosystem goods and services into use and non-use values.
    - The total economic value of the environment is made of different types of economic values, each corresponding to the different use that is made of the environment.
    - The notion of total economic value (TEV) provides an all-encompassing measure of the economic value of any environmental asset. The net sum of all the relevant Willingness to Pay (WTPs) and Willingness to Accept (WTAs) for the outcome of a project or change in policy defines the total economic value of any change in well-being due to a project or policy. It decomposes into use and non-use (or passive use) values, where further sub-classifications can be used if required.

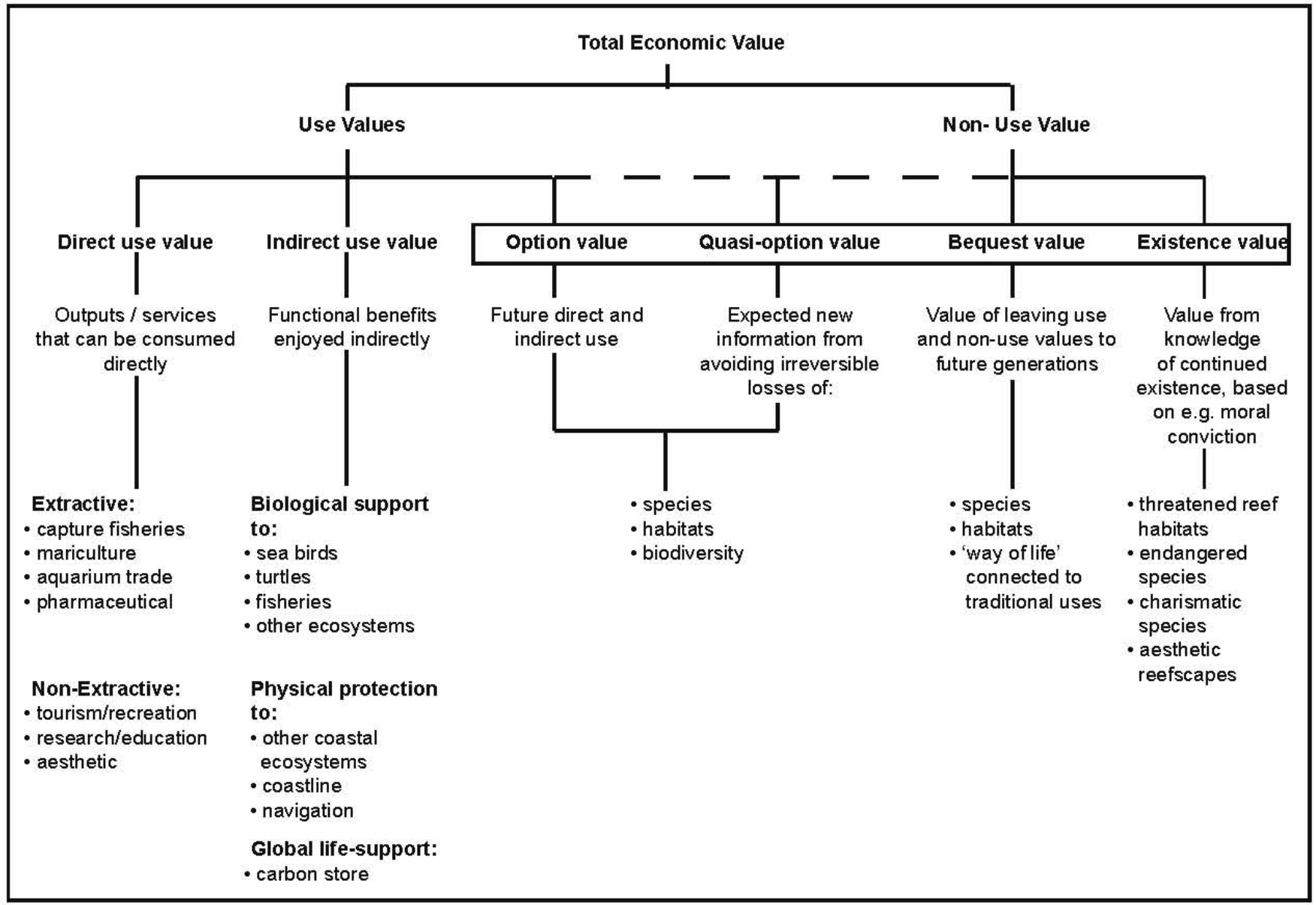






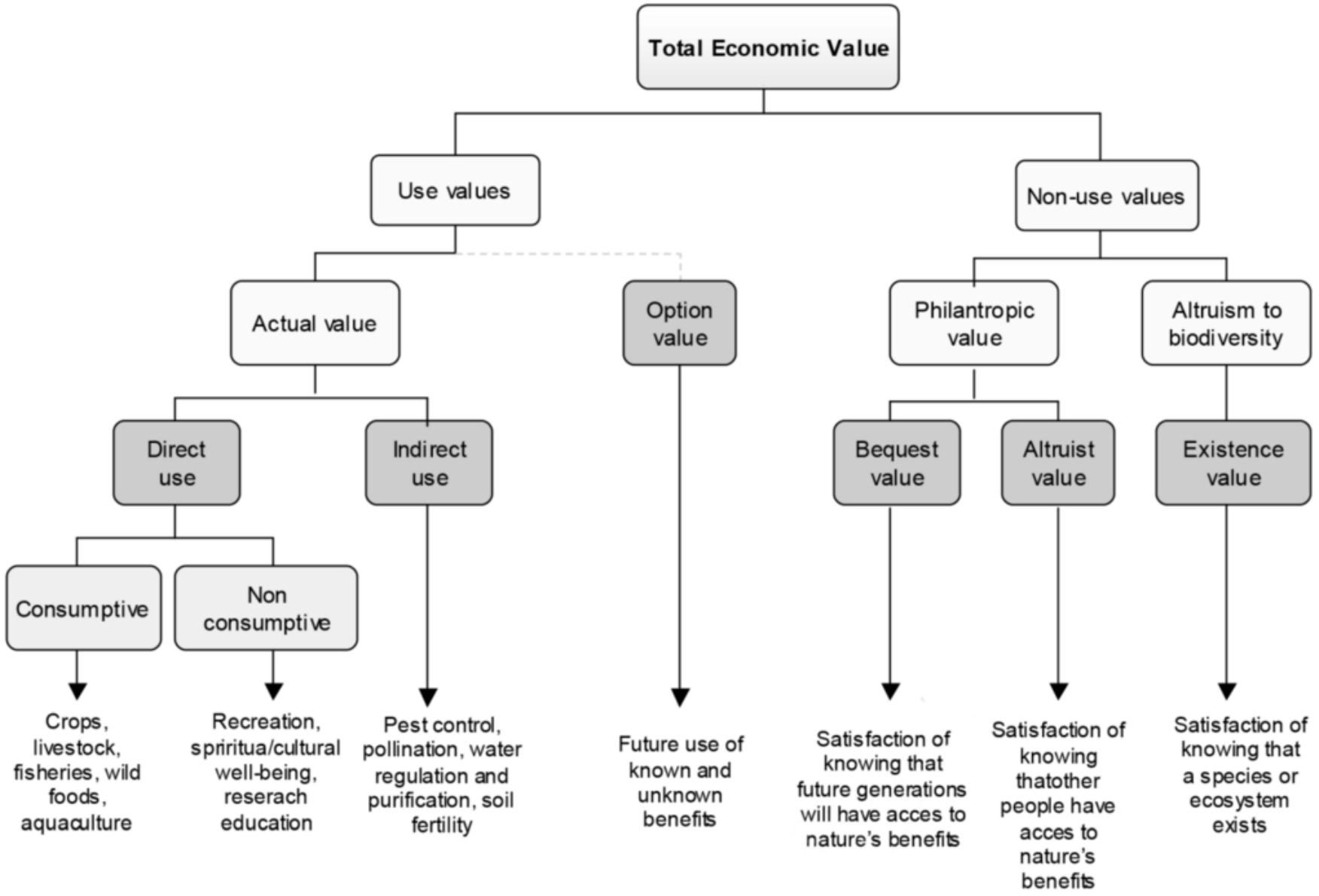
Undertaking a TEV of Two Ecosystems

Example – TEV of a Coral Reef



Source: Barton (1994).

Example - TEV of a Wetland



Environmental Valuation Techniques

NRV Methods

Ecosystem Service	Valuation Method
Food, timber , fuel wood	Market prices
Water filtration	Replacement cost, net factor income, production function
Water storage	Replacement cost, net factor income, production function
River flow control	Replacement cost, damage cost avoided, production function, net factor income
Coastal protection	Replacement cost, damage cost avoided, production function, net factor income
Support to fisheries	Net factor income, production function
Recreation site	Market prices, contingent valuation, travel cost, hedonic pricing, choice modelling
Visual aesthetics	Contingent valuation, hedonic pricing, choice modelling
Biodiversity	Contingent valuation, choice modelling
Non-use/existence values	Contingent valuation, choice modelling

Valuation Method	Approach	Application	Examples	Limitations
Market prices	Observe prices directly in markets	Environmental goods and services that are traded directly in markets	Timber and fuel wood from forests, clean water from wetlands	Market prices can be distorted e.g. by subsidies. Environmental services are often not traded in markets
Replacement cost	Estimate cost of replacing environmental service with man-made service	Ecosystem services that have a man-made equivalent that could be used and provides similar benefits to the environmental service	Coastal protection by mangroves; water filtration by wetlands	Over-estimates value if society is not prepared to pay for man-made replacement. Under-estimates value id man-made replacement does not provide all the benefits of the environmental service
Damage cost avoided	Estimate damage avoided due to ecosystem service	Ecosystems that provide protection to houses, communities or other assets	Coastal protection by mangroves/reefs; river flow control by wetlands	Difficult to relate damage levels to ecosystem quality
Net factor income	Revenue from sales of environment-related goods minus cost of other inputs	Ecosystems that provide an input in the production of a marketed good	Filtration of water by wetland; commercial fisheries supported by coral reef	Over-estimates ecosystem values

Valuation Method	Approach	Application	Examples	Limitations
Production function	Estimate value of ecosystem service as input in production of marketed good	Ecosystems that provide an input in the production of a marketed good	Filtration of water by wetlands; commercial fisheries supported by coral reef	Technically difficult; high data requirements
Hedonic pricing	Estimate influence of environmental on price of marketed goods	Environmental characteristics that vary across goods (usually houses)	National parks, air pollution, proximity to landfills	Technically difficult; high data requirements
Travel cost	Travel costs to access a resource indicate its value	Recreation sites	National parks, marine protected areas	Technically difficult; high data requirements
Contingent valuation	Ask survey respondents directly for WTP for environmental service	Any environmental good or service	Species loss, natural areas, air pollution	Expensive to implement
Choice modelling	Ask survey respondents to trade-off environmental and other goods to elicit WTP	Any environmental good or service	Species loss, natural areas, air pollution	Expensive to implement; technically difficult
Value transfer	Uses values estimated	Any environmental good	Species loss, natural	Possible transfer errors.

Market Pricing

The most straightforward and commonly used method for valuing any good or service is to look at its market price, i.e. how much it can be bought or sold for.

Market prices are therefore useful for valuing environmental goods and services that are directly traded in markets, for example products such as timber, fuel wood, fish, and other foods.

The major advantage of this technique is that it is relatively easy to apply, as it makes use of generally available information on prices and only requires simple modelling and few assumptions. The market price method is straightforward and inexpensive to apply and is relevant for environmental valuation when market prices exist for ecosystem goods and services.

A major disadvantage is that many environmental goods and services are not traded directly in well-functioning markets and so readily observable prices for them are not available.

Market Pricing

Step 1	**Collect data on or specify the change in the quantity of the good or service** **Potential sources of data on both the quantity and price of marketed goods include government statistics, income and expenditure surveys, and market research studies. If secondary sources of data are not available, it may be necessary to collect data directly by means of a survey of consumers and producers. It should be noted that prices and quantities of the good/service being researched might vary by season and location. Care should therefore be taken to collect data that covers an adequate period of time and sample of locations in order to account for such variations.**
Step 2	**Collect data on its market price. Identify if price is distorted and if necessary correct distortions by finding comparable product or services in similar circumstances at undistorted prices;**
Step 3	**Multiply price by the change in quantity to determine the value of the change.**

Replacement Cost

The replacement cost method estimates the value of ecosystem services as the cost of replacing them with alternative man-made goods and services.

For example, the value of a wetland that acts as a natural reservoir can be estimated as the cost of constructing and operating an artificial reservoir of a similar capacity.

The replacement cost technique assumes that the costs incurred in replacing lost environmental assets with man-made alternatives can be interpreted as an estimate of the value of the goods and services received from the environmental asset.

It is assumed that the amount of money society spends to replace an environmental asset is roughly equivalent to the lost benefits that asset provides to society.

The replacement cost method is particularly useful for valuing ecosystem services that have direct man-made or artificial equivalents, such as water storage or wastewater processing. The method is also relatively simple and inexpensive to apply. It does not require the use of detailed

Replacement Cost

Step 1	Identify the services provided by the ecosystem being valued and assess the scale at which these services are utilized. It is important to assess the extent to which ecosystem services are actually used rather than the total capacity of the ecosystem to provide those services.
Step 2	Identify man-made goods, services, or infrastructure that can replace the ecosystem services at the scale at which they are utilized. The replacement infrastructure should provide an equivalent level of service as the ecosystem and be a feasible option.
Step 3	Estimate the costs of the man-made replacement goods, services, or infrastructure. Data on the cost of alternative man-made goods, services, and infrastructure should be collected from secondary sources or ascertained through expert consultation and professional estimates.

Damage Cost Avoided

Ecosystems frequently provide protection for other economically valuable assets.

The damage cost avoided method uses either the value of property and assets protected, or the cost of actions taken to avoid damages, as a measure of the benefits provided by an ecosystem.

For example, if a coral reef provides protection to coastal areas from storm damage, the value of the coastal protection function of the reef may be estimated as the damages avoided or by the avoided expenditures by coastal residents to protect their properties.

The damage cost avoided method is particularly useful for valuing ecosystems that provide some form of natural protection.

Damage Cost Avoided

Step 1	**Identify the protective services provided by the ecosystem and assess the extent to which protection levels would change under the specific ecosystem loss scenario being considered. This involves obtaining information on the likelihood of a damaging event occurring and the extent of damage under different scenarios of ecosystem loss.**
Step 2	**Identify the infrastructure, properties, or human population that would be affected by this change in protection, and determine the boundary beyond which effects will not be analyzed.**
Step 3	**Estimate the additional scale of damage under the ecosystem loss scenario.**
Step 4	**Estimate the cost of these damages using information on the value of the assets at risk.**

Net Income Factor

The net factor income method estimates the value of ecosystem services as an input in the production of a marketed good. It estimates the value of an ecosystem input as the total surplus between revenues and the cost of other inputs in production.

For example, the value of a coral reef in supporting reef-based dive recreation should be calculated as the revenue received from selling diving trips to the reef, minus the labour, equipment and other costs of providing the service.

This method is likely to be useful for valuing many ecosystem services such as the support of tourism, fisheries, and other similar industries. It is a relatively simple method to apply and uses generally available data.

Net Income Factor

Step 1	Identify the ecosystems and services under consideration.
Step 2	Identify the production process(es) to which the ecosystem provides inputs.
Step 3	Calculate the revenue from production by multiplying the output by the market price.
Step 4	Calculate the cost of production by multiplying the unit cost of each input by its quantity.
Step 5	Calculate the net factor income by subtracting the cost of production from the revenue.

Production Function

- The production function method estimates the value of a non-marketed ecosystem product or service by assessing its contribution as an input into the production process of a commercially marketed good.
- This method is different from the net factor income method in that it estimates a functional relationship between inputs and output, i.e. shows how output changes with changes in input.
- The net factor income method, on the other hand, takes the quantities of outputs and inputs as given.
- A production function describes the relationship between inputs and outputs in production.
- For example, the production of fruits and nuts from a forest may be described as a function of hours spent harvesting (labour) and the area and quality of the forest. A change in the availability of an ecosystem input may result in both a change in total output and a change in the use of other inputs. For example, a reduction in the area of forest may result in either a decrease in the harvest of fruit or an increase in the number of hours spent harvesting a given quantity. Either way the harvester suffers an economic loss. By calculating the change in the value of production (the surplus between revenues and the cost of production) given a change in ecosystem input, you will be able to observe the value of that input.

Production Function

Step 1	Identify the ecosystems and services under consideration.
Step 2	Identify the production process(es) to which the ecosystem provides inputs.
Step 3	Estimate the production function(s) using data on production inputs (labour, capital, materials, ecosystem input etc.) and outputs, using statistical analysis.
Step 4	Estimate the net revenues (or producer surplus) before the change in environmental service input – i.e. by plugging the original level of inputs into the estimated production function. The original revenue should be calculated by multiplying output by the market price; and the cost should be calculated by multiplying the unit cost of each input by its quantity.
Step 5	Estimate the net revenues after the change in environmental service input in the same way.
Step 6	Calculate the change in net revenues by subtracting the new net revenues from the original net revenues.

Hedonic Pricing

- The hedonic pricing method should be used to estimate economic values of ecosystem services that directly affect the price of marketed goods.
- The basic premise of the hedonic pricing method is that the price of a good is related to its characteristics, including its environmental characteristics.
- The hedonic pricing method is often used to value environmental amenities that affect the price of residential properties (hedonic property value studies).
- For example, a house that is close to an aesthetically pleasing natural area may be worth more than a similar house that is further away.
- Such differences in house characteristics and prices may be used to identify the value of natural amenities using statistical methods.

Hedonic Pricing

Step 1	**Identify the ecosystems and services under consideration.**
Step 2	**Collect data on residential property sales in the region of the natural area being valued. The required data include house prices and locations; and structural, neighbourhood, accessibility and environmental property characteristics.**
Step 3	**Statistically estimate a function that relates house prices to property characteristics, including the distance to the natural area. The function indicates how much more a property close to the natural area is valued compared to a similar property that is located further away.**

Travel Cost Method

Step 1	Identify the ecosystems and services under consideration.
Step 2	Define a set of zones surrounding the recreational site being valued. These may be defined by concentric circles around the site, or by geographic divisions that make sense, such as parishes surrounding the site at different distances. Travel costs to the site should be approximately equal for any location within each zone.
Step 3	Within each zone, sample visitors to collect information about the costs incurred in visiting the ecosystem , motives for the trip, frequency of visits, site attributes and socio-economic variables such as the visitor's place of origin, income, age, and education .
Step 4	Calculate the average travel cost from each zone using the average round-trip travel distance and the cost per km, and the average travel time and cost per hour.
Step 5	Estimate a demand function for visiting the site using statistical analysis and the data collected. This function relates the number of site visits to the cost of visiting. The higher the cost of visiting the site, the less likely it will be that tourists will visit the site from these far zones .
Step 6	Collect information on the number of visitors from each zone, and the number of visits made in the last year.
Step 7	Estimate the total economic benefit of the site to visitors by calculating the consumer surplus, or the area under the demand curve at the current number of visits.

Contingent Valuation

Step 1	Define the valuation problem in terms of which ecosystem services are to be valued and what the relevant population is.
Step 2	Design the survey. This involves a number of steps including deciding what type of survey will be used (mail, telephone, face-to-face), the question format, payment vehicle, the WTP question, and pre-testing.
Step 3	Survey implementation. This includes selecting the survey sample, which in most cases should be a random sample from the relevant population.
Step 4	Analyzing the results. This includes cleaning the data and dealing with non-responses to the survey and protest bids. Mean WTP per person should be calculated from the cleaned data – and extrapolated to the relevant population size to give a total value for the ecosystem in question.

Choice Modelling

Step 1	Define the valuation problem in terms of which ecosystem services are to be valued and who the relevant population is.
Step 2	Design the survey. This involves a number of steps including deciding what type of survey will be used (mail, telephone, face to face), determining the choice set (i.e. what characteristics will respondents be required to choose between), choosing the payment vehicle (the monetary characteristic), and pre-testing. Ideally, focus groups followed by pre-testing should be used to set and test the relevant levels of the characteristics used.
Step 3	Survey implementation. This includes selecting the survey sample, which in most cases should be a random sample from the relevant population.
Step 4	Analyzing the results. The statistical analysis for contingent choice is generally more complicated than that for contingent valuation and requires the use of statistical analysis to infer willingness to pay from the tradeoffs made by respondents. The average value for each of the characteristics included in the choice set should be estimated, and this is then extrapolated to the relevant population in order to calculate a total value for the ecosystem site under different scenarios.

Benefits Transfer

- Value transfer involves borrowing an estimate of WTP from one site (the study site) and applying it to another (the policy site). What is borrowed is a mean value that is unadjusted or a mean value that has been modified to ‘suit’ the new site. The attraction of value transfer is that it avoids the cost and time involved in conducting primary valuation studies.

Tabletop Discussion…

- Define the Total Economic Value (TEV) of a forest, watershed, or coral reef, making reference to both use and non-use values.
- Having identified the TEV, describe the valuation techniques you would use to obtain values for the elements included in the TEV.
- What is the value of conserving the ecosystem?
- To whom does the value accrue?
- How does degradation and loss of natural resources lead to costs to different segments of society?
- Who gains and who loses when a natural resource is conserved or degraded?
- Discuss how NRV should be mainstreamed in policy, planning and decision making – and the potential impacts it can have to achieving SDGs 13, 14, 15 and 1