Corporate Ecosystem Valuation
Additional Notes B
Selection & Application of Ecosystem Valuation Techniques for CEV

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Introduction

This interim concept paper on ecosystem valuation techniques complements the World Business Council for Sustainable Development Guide to Corporate Ecosystem Valuation (CEV). The paper provides a basic overview and advice for corporate managers on:

- The main categories of ecosystem valuation techniques available;
- Selecting the most suitable techniques;
- Applying the techniques; and
- Approaches for valuing other environmental externalities.

It is by no means meant to be a definitive or exhaustive guide to ecosystem valuation techniques. There is an abundance of literature available on environmental valuation techniques, some of which are identified in the CEV reference list, also provided on the WBCSD website.

Note that it is strongly recommended that all CEV studies involve an environmental economist in some capacity either to undertake or advise on the valuation steps. They should be familiar with relevant available literature on the subject.

Main categories of valuation techniques

To overcome the problem of evaluating environmental externalities in public decision-making, a range of 'environmental valuation techniques' have evolved over the past fifty or so years that can be used to value ecosystem services. As explained below, four main categories of valuation techniques exist.

These techniques relate to preference based approaches used in neoclassical economics and market theory. Please note that other valuation approaches exist under other disciplines such as political science, resilience theory and industrial ecology/thermodynamics – see TEEB (2010) "Mainstreaming the Economics of Nature: A synthesis of the approach, conclusions and recommendations of TEEB" for more information.

Revealed preference techniques look at the way in which people reveal their preferences for ecosystem services through market production and consumption. Where direct markets for ecosystem goods or services exist – for example, timber or fish – the value people place on the good is revealed directly using '**Market Prices**', either for that or a similar good ('**Substitute Prices**'). Where an impact causes a loss in production (for example, loss of fishery output from damaging coral reefs or wetlands) then '**Effect on Production**' (or '**Change in Productivity'**) can be used. These techniques are often used for valuing provisioning services.

Values can also be revealed by analyzing data on the time and cost incurred to visit an ecosystem ('**Travel Cost Method**') for recreational use, or be based on analyzing how the price of an asset changes with different environmental attributes, such as housing prices with differing number of bedrooms and views of ecosystems ('**Hedonic Pricing**').

Cost-based approaches look at the market trade-offs or costs avoided of maintaining ecosystems for their goods and services. This may include, for example, examining the costs of building a man-made replacement for a degraded ecosystem service ('**Replacement Cost**'), such as filtration of drinking water or shoreline protection from storm damages. Or it can involve estimating the cost of damages to existing property or businesses that might be incurred if the existing ecosystem degrades ('**Damage Costs Avoided**'). They are commonly used for valuing 'regulating services'.

Stated preference approaches ask consumers to 'state their preference' directly for changes to ecosystem services using questionnaire surveys. For example, '**Contingent Valuation**' surveys ask respondents their '**Willingness To Pay**' (WTP) for a service or '**Willingness To Accept**' (WTA) compensation for its loss. These techniques can be especially useful in determining non-use values generated by ecosystems, but can be quite expensive to undertake.

Benefit (value) transfer involves transferring value estimates from existing economic valuation studies to the study site in question, making adjustments where appropriate. This technique has the advantage that it is relatively inexpensive and quick to implement, but must be carefully and transparently applied to avoid significant errors. This is increasingly used due to its cost-effectiveness. Although initially referred to as '**Benefit Transfer**', because the values transferred may also be costs, it is increasingly referred to as '**Value Transfer**'.

In addition, non-monetary valuation of ecosystem services is possible through a range of techniques that include multi-criteria, deliberative or participatory approaches. In particular, '**Habitat Equivalency Analysis**' can be used to determine the quantity of new habitat required (i.e. restored or created) to offset the loss of goods and services from a damaged area of similar habitat.

Selecting ecosystem valuation techniques

Table 1 below indicates which valuation technique is typically used to value different categories of ecosystem service. Note that as the ecosystem services move across the spectrum from *direct use* to *non-use* values, the magnitude of the value typically increases (e.g. non-use values often far exceed the value of ecosystem services in existing markets), while the confidence level in the results typically decreases (e.g. existing market values being the most certain, and stated preferences of survey respondents for non-use values being the least certain).

Table 1: Application of valuation techniques for different categories of ecosystem service

	Total Economic Value	**Ecosystem Services**		**Revealed preference**				**Cost-based**	**Stated preference**	**Benefit transfer**
				Market prices	Effect on production	Travel costs	Hedonic pricing			
Confidence? / Value?	Direct use	Provisioning		✓	✓					✓
	Indirect use	Regulating			✓		✓	✓		✓
	Direct use	Cultural	Recreation	✓		✓			✓	✓
	Non-use	Cultural	Aesthetic						✓	✓

However, in many situations there is a choice of technique, and it then depends on the study context and circumstances as to the preferred technique. **Table 2** summarizes some of the key features of the main ecosystem valuation techniques which can be used to inform selection of the appropriate approach.

For example, aspects such as accuracy required, as well as budget, data and time availability may play a role. Note that the budgets (including data costs), timelines, and skills required can vary significantly depending on the data already available, the nature of the issue and who is involved in undertaking the study.

It may be that the first CEV studies a company undertakes are more expensive in order to develop an approach that the company can replicate more cost-effectively for other products or projects, etc.

Valuation studies can be either be relatively crude and low cost (for example using a benefit transfer approach) or more detailed, comprehensive, accurate and expensive (especially if primary studies such as stated preference surveys are involved).

Benefit (value) transfer approaches are appropriate when the nature of the impact or asset being valued is quite commonly valued (e.g. recreational visits to forests) and the accuracy of the values elicited is not critical (e.g. when multiple sites are being assessed and only a high level assessment is required). Use of this approach is restricted to valuing changes that have been valued previously in other studies. Unless there are extensive similar valuation studies available, it is usually not possible for this approach to determine subtle changes between similar options. Great care is needed to apply this technique to ensure that the values used are appropriate. Unfortunately, there have been many instances of applying this approach incorrectly. It is important not only to use the right value estimate, but also to apply the value to the correct population (e.g. visitors or households within a region that are likely to have a value for what is being valued).

Stated preference studies are often a key requirement of valuation studies if the objective is to assess recreational and non-use values. These are typically among the most valuable ecosystem services. Stated preference surveys are recommended when accuracy is important to the outcome of the study and there are no suitable benefit transfer studies available. It is also worth bearing in mind whether the resulting values could be used in other similar circumstances for the company (e.g. for future benefit transfers). If there is a prevalent issue for a company in many slightly different circumstances (e.g. growing biofuels), it may be worth carefully designing a stated preference survey so that the results can be applied in many different contexts using a value transfer approach.

Table 2: Comparison of ecosystem valuation techniques

Category	Tech-nique	Description	Data required	Time / Budget (US$)	Skills required	Advantages	Disadvantages
Revealed preference approaches	Market prices	How much it costs to buy an ecosystem good or service, or what it is worth to sell.	Market price of ecosystem goods or services. The costs involved to process and bring the product to market (e.g. processed timber).	Days / Low ($ 100s – 1,000s)	Basic	+ A readily transparent and defensible method since based on market data. + It reflects an individual's willingness to pay (WTP).	- Only applicable where a market exists for the ecosystem service and data is readily available.
	Effect on production	Relates changes in the output of a marketed good or service to a measurable change in ecosystem goods.	Data on changes in the output of a product. Data on cause and effect relationship (e.g. loss of fisheries due to loss of seagrass or coral habitat).	Days / Low ($ 100s – 1,000s)	Basic	+ If data is available, it is a relatively straightforward technique to apply.	- Necessary to recognize and understand the relationship between the ecosystem service and output of product. - Can be difficult to obtain data on both change in the ecosystem service and effect on production.
	Travel costs	Using information on the amount of time and money people spend visiting an ecosystem for recreation or leisure purposes to elicit a value per visit.	The amount of time and money that people spend visiting an ecosystem for recreation or leisure purposes. Motivations for travel.	Weeks – months / High ($ 10,000s)	Questionnaire design, interviewing and econometric analysis	+ Based on actual behavior (what people do) rather than a hypothetically stated WTP. + The results are relatively easy to interpret and explain.	- Approach is limited to direct use recreational benefits. - Difficulties in apportioning costs when trips are to multiple places or are for more than one purpose. - Considering travel costs alone ignores the opportunity cost of time while travelling.
	Hedonic pricing	The difference in property prices or wage rates that can be ascribed to the different ecosystem qualities or values.	Usually data relating to differences in property prices or wage rates that can be ascribed to the different ecosystem qualities (e.g. a landscape view, air quality).	Weeks / Medium ($ 1,000s – 10,000s)	Econometric	+ Readily transparent and defensible method since based on market data and WTP. + Property markets are generally very responsive so are good indicators of values.	- Approach is largely limited to benefits related to property. - The property market is affected by a number of factors in addition to environmental attributes, so these need to be identified and discounted.
Cost-based approaches	Replace-ment costs	The cost of replacing an ecosystem good or service with artificial or man-made products, infrastructure or technologies, in terms of expenditures saved.	The cost (market price) of replacing an ecosystem good or service with a man-made equivalent (e.g. replacing sea grasses as a juvenile fish nursery with fish farms).	Days – weeks / Low ($ 100s – 1,000s)	Basic	+ Provides surrogate measures of value for regulatory services (which are difficult to value by other means). + A readily transparent and defensible method when based on market data.	- Can overestimate values. - Does not consider social preferences for services or behavior in the absence of the services. - The replacement service probably only represents a proportion of the full range of services provided by the natural resource.
	Damage costs avoided	The costs incurred to property, infrastructure and production when ecosystem services which protect economically valuable assets are lost, in terms of expenditures saved.	Data on costs incurred to property, infrastructure or production as a result of loss of ecosystem services. Damages under different scenarios including 'with' and 'without' regulatory service.	Weeks / Low ($ 100s – 1,000s)	Engineering and bio-physical processes	+ Provides surrogate measures of value for regulatory services that are difficult to value by other means (e.g. storm, flood and erosion control).	- The approach is largely limited to services related to properties, assets and economic activities. - Can overestimate values.

Category	Tech-nique	Description	Data required	Time / Budget (US$)	Skills required	Advantages	Disadvantages
Stated preference approaches	Contingent valuation (CV)	Infer ecosystem values by asking people directly what is their willingness to pay (WTP) for them or their willingness to accept (WTA) compensation for their loss saved.	Stated value that people place on an ecosystem good or service (e.g. existence of a species, cleanliness of a beach); demographic and biographical information on survey respondents. Obtained through survey questionnaires.	Weeks – months / High ($ 10,000s – 100,00s)	Questionnaire design, interviewing and econometric analysis	+ Captures both use and non-use values. + Extremely flexible - it can be used to estimate the economic value of virtually anything. + Gives a much more accurate outcome than benefit transfers.	- The results are hypothetical in nature and subject to numerous different biases from respondents. - e.g. respondents may express a positive WTP to promote a 'warm glow' effect, overestimating value. - e.g. if the cost is perceived as a tax, respondents may express a negative WTP, underestimating value. - It is resource intensive.
	Choice experiments (CE)	Presents a series of alternative resource or ecosystem use options, each defined by various attributes set at different levels (including price), and asks respondents to select which option (i.e. sets of attributes at different levels) they prefer (e.g. numbers of species present and percentage coral cover).	As for CV above, although CE contrasts several different scenarios. An appropriate set of 'levels' are required for the different parameters (eg ranging from 0% coral cover to 100%).	Weeks – months / High ($ 10,000s – 100,000s)	Questionnaire design, interviewing and econometric analysis	+ Captures both use and non-use values. + Provides theoretically more accurate values for marginal changes (e.g. values per % increase in coral cover). + Gives a much more accurate outcome than benefit transfers.	- The results are subject to bias from respondents and are hypothetical in nature. - It is resource intensive. - Can be mentally challenging for respondents to truly weigh up the alternative choices given to them in the time available.
Benefit transfer	Benefit transfer	Involves transferring value estimates from existing economic valuation studies to the study site in question, making adjustments where appropriate.	Valuations from similar studies elsewhere. Data on key variables from different studies (e.g. GDP per person).	Days / Low ($ 100s – 1,000s)	Basic or econometric analysis if using bid functions	+ Low cost and rapid method for estimating recreational and non-use values.	- The results can be questionable unless carefully applied. - Existing valuation studies may be more robust and numerous for some services than for others.

Applying ecosystem valuation techniques

This section provides further details for corporate managers on four of the more common valuation techniques. The aim is to help managers better understand how the techniques work and know what some of the key features are. This should help when commissioning valuation studies either internally or externally. Further techniques exist, but the only techniques covered here are:

- Effect on production
- Replacement costs
- Stated preference surveys
- Benefit (value) transfer

1. Effect on Production

What does it do?

The **Effect on Production** method relates changes in the output of a marketed good or service to a measurable change in ecosystem services. For example, it is possible to estimate the reduction in commercial fish species related to the loss of mangrove or seagrass nursery habitat. While the cause-effect relationship can be technically difficult to determine, one can apply 'rules of thumb' to estimate rough values, or draw upon estimates calculated in other similar studies. For example this could be that there is a 20% reduction in offshore fishery productivity if mangroves are cut down, or that crop yields improve by 25% with Xm3 more water.

Key steps

1) **Identify the relevant ecosystem service to be valued.** This technique can be used to value many direct and indirect values (i.e. provisioning and regulating services). To use this technique there needs to be a well established link between the level of benefit provided and the quantity or quality of the ecosystem. A tool that can help with this step is the Corporate Ecosystems Service Review (WRI, WBCSD, 2008).
2) **Identify the production process** for which the ecosystem service is an input (e.g. commercial fish production or crop yields).
3) **Estimate the production function.** Collect data on the quantity and unit cost of production inputs (labor, capital, materials, transport, ecosystem services, etc.) and outputs (final good or service at current market price). Alternatively, one can refer to other previous references where similar assessments have been made, and use similar assumptions (adjusted as necessary for any key differences in context).
4) **Create before and after scenarios**. Measure or estimate current ecosystem conditions and model or estimate future conditions.
5) **Estimate net revenues *before* the change in ecosystem input.** Account for all inputs and outputs, including ecosystem inputs, into the production function.
6) **Estimate net revenues *after* the change in ecosystem input.** Repeat step 5, but incorporate the estimated change in ecosystem input, as well as other changes considered likely (e.g. price of the good).
7) **Calculate the change in net revenues.** Subtract net revenues after the change in ecosystem function from net revenues before the change.

Key issues and best practices

- The results of the analysis will be in terms of a predicted change in net revenues. For example, a loss of x hectares of coastal mangroves is expected to result in a loss of $xx per year in snapper catch. The nursery service of mangroves is thus estimated to be worth $xx per hectare per year.
- It will be important to distinguish between changes in quantity that are large enough to result in changes in price (e.g. reduced outputs may increase prices) and those that will be absorbed by the market.

- It is possible to apply rules of thumb from similar studies or expert opinion to estimate the change in outputs (as long as the assumptions are made clear).

For an example of best practice guidance see: Dixon at el (1994) or van Beukering et al (2007).

2. Replacement Cost

What does it do?

This technique estimates the cost of replacing an ecosystem service with artificial or man-made products, infrastructure or technologies. For example, the value of a coral reef or mangrove in reducing wave impacts on the shoreline can be estimated as the cost of replacing it with a man-made breakwater or seawall.

Key steps

1) **Identify the ecosystem service to be valued.** Replacement cost is typically used to value regulating services such as water filtration, flood protection, and other services that are not typically accounted for in existing markets until a man-made replacement must be used.
2) **Assess the scale and extent of use of the ecosystem service.** It is important to value the current extent of use, rather than the full potential of service provision, as the former should be a more accurate reflection of the willingness of the community to pay for a replacement.
3) **Identify man-made goods, services or infrastructure** that could replace the ecosystem service at the current scale of use.
4) **Estimate the cost of the man-made replacement.** Data on replacement costs may be available from similar studies elsewhere, from local government, or from consultation with professionals.

Key issues and best practices

- It is important to couch replacement cost values in the context of the wider bundle of services provided by an ecosystem (e.g. a coral reef provides several cultural and provisioning services in addition to its value in protecting the shoreline).
- The quality or level of service of the replacement should reflect that provided by the ecosystem service. So if a wetland only provides a partial water filtration function, its value is not the equivalent of a high specification filter plant, but one that filters water to the same level of service as the wetland.
- It should be the least cost man-made solution that is used as the value (although note that other changes in ecosystem services should be accounted for).
- Remember to include adequate maintenance costs of the man-made solution over the lifetime being assessed.

3. Stated Preference Approaches

What do they do?

Stated preference approaches involve questionnaire surveys to ask a representative sample of a specific population what their preferences are. They are highly flexible, and can be used to assess both use (e.g. recreation) and non-use (e.g. cultural) values provided by an ecosystem. Indeed, they are the only primary valuation method capable of determining non-use values. There are two commonly used types of stated preference surveys.

'Contingent valuation' surveys typically involves asking consumers to directly state their willingness to pay (WTP) for alternative options which provide different levels of ecosystem service. 'Choice experiment' surveys offer respondents a set of choices of alternative options that include price as one parameter. Through econometric modeling, it is possible to elicit the monetary values of different levels of each parameter.

Undertaking comprehensive and robust stated preference surveys can be time consuming and expensive. However, there can be value in undertaking relatively small scale or 'quasi' contingent valuation studies using smaller sample sizes and without focus groups, to provide an indication of willingness to pay values. These would ideally be supported by a value transfer exercise.

Key steps

1) **Initial Research.** This should explore exactly what question is being asked and what impact is being valued.
2) **Choice of survey method and valuation technique.** This should determine what survey method should be used (e.g. face-to-face, mail, telephone). Should a contingent valuation or choice modeling study be selected?
3) **Choice of population sample.** The target population needs to be defined. This includes all people who may be affected by the impact, for example total visitors visiting a site, or total households in a catchment, county, island or country. An appropriate sampling method will also need to be determined (e.g. random and/or stratified) to cover the target population.
4) **Questionnaire design.** What form of questions, elicitation format (open ended WTP, payment ladder, dichotomous choice) and payment vehicle (e.g. tax, donation, fees, car park charges etc) should be used?
5) **Testing the questionnaire.** Ideally focus groups are required if the topic is new to the population affected and has not been tested before in stated preference surveys. Pilot tests should be conducted to check the wording and understanding of the questionnaire, leading to redesign if necessary.
6) **Conduct the main survey.** It is recommended that around 250 questionnaires are completed (assuming a target population of up to 1 million people and a 95% confidence interval). However, sample sizes of around 100 could still yield useful results, given appropriate caveats.
7) **Econometric analysis.** Code the data and give to an econometrics expert to analyze (particularly if choice experiments are being used). Identify outliers (e.g. extreme high bids) and protest bids (e.g. they do hold a value but are not willing to pay because they believe others should pay, or they do not trust that the money will be spent in the right way), and deal with them appropriately.
8) **Validity and reliability testing.** Check that the results meet validity and reliability tests.
9) **Aggregation and reporting.** Aggregate the sample results to the target population.

Key issues and best practices

- Ensure that the sample used for the survey is representative of the target population.
- Make sure the selected sample size is appropriate and fully justified.
- Make sure that adequate means have been made to overcome the majority of such biases (e.g. hypothetical, information, strategic, starting point and payment vehicle bias).
- Be conservative in your assumptions.
- Make sure an experienced person is used to design and analyze the stated preference survey. Although it appears to be simple, it is very easy to design a questionnaire that yields meaningless results. Poor analysis and incorrectly dealing with biased responses can also lead to results of limited use.
- Try to use simple but effective visual information to help explain what exactly is being valued.
- Make the payment scenarios as realistic as possible.

For an example of best practice guidance see: UK Department of Transport (2002).

4. Benefit (Value) Transfer

What does it do?

Benefit (or value) transfer involves transferring value estimates from existing economic valuation studies (typically from stated preference surveys) to the study site in question, making adjustments where appropriate to allow for key differences in the context (e.g. the level of change, the importance of the ecosystem affected, socio-economic factors of the population affected).

Key steps

1) **Identify the change in ecosystem goods and services to be valued at the 'policy site'** (i.e. where the impact occurs).
2) **Identify the affected population at the policy site.** This includes all people who may be affected by the impact, for example total visitors visiting a site, or total households in a catchment, county, island or country. Bear in mind the relative importance of the ecosystem or biodiversity in question (e.g. local, national or international).
3) **Conduct a literature review to identify relevant primary studies.** Adequate references should be available from valuation databases such as EVRI and ENVALUE. These studies can be supplemented by a country or habitat specific database (if it exists) and additional Google and scientific paper searches.
4) **Assess the relevance and quality of 'study site' values for transfer.** Preference should be given to more recent, scientifically sound, contextually relevant and rich in detail valuation studies. Start by looking for studies from the same country and habitat type undertaken in the past few years.
5) **Select and summarize the data available from the study site(s).** Select the most appropriate values, then summarize the key aspects of the study (e.g. values, target population, country, description of what is being valued etc).
6) **Transfer the value estimate from study site(s) to the policy site, making adjustments where appropriate.** If values are from a different country and year, the ideal is to convert values to the local currency in the year of data collection. Use Purchase Power Parity (PPP) corrected exchange rates in the year of data collection, and then use the local Consumer Price Index (CPI) to update to current currency values. For differences in the quality of the good being valued, use adjustment factors where possible based on scientific comparison or expert judgment. Using adjusted unit values is increasingly being accepted as a valid practical and transparent approach.
7) **Calculate total net present value benefits or costs.** This is the same as Step 8 of the CEV.
8) **Assess uncertainty and acceptability of transfer errors.** This feeds into Step 9 of the CEV.

Key issues and best practices

- When determining non-use values, use appropriate justification for the correct population to use when multiplying up average willingness to pay. Bear in mind that values will reduce with distance (i.e. distance decay).
- Select the WTP value based either on per adult or per household.
- Consider substitution effects (i.e. are there other similar ecosystems that provide a similar service nearby). For example, if your site is protecting one lake when there are numerous others nearby, the value is likely to be less than if it was the only lake. You may need to adjust the value downwards in accordance with this.

For a simple overview of best practice see Navrud S. and Brouwer R. (2007). For a more comprehensive overview see Bateman et al (2009).

Valuing other environmental externalities

Carbon related greenhouse gas (GHG) externalities are often expressed as a dollar-value societal cost per ton of carbon equivalent emitted. These costs typically include an agglomeration of costs associated with various impacts including, amongst others, ecosystem services. As carbon equivalents are effectively a global pollutant (i.e. one ton emitted in one country has the same economic impact as one ton emitted in another country), standard 'transfer values' are commonly used for the societal cost. However, there is considerable debate as to the correct societal value of carbon to use. With the introduction of carbon trading and carbon taxes, carbon emitted increasingly has a financial value (a market price) that can directly affect a company's bottom line. In effect, this internalizes at least a proportion of the environmental externality. However, most commentators agree that current carbon prices are too low to cover the full societal cost of GHG pollution.

So what carbon price should be used? There are several options for companies in terms of what the best value for them to use might be:

i. Use the average carbon market price in the country of question. Note that in some cases, GHGs related to certain sectors or types of emission (direct as opposed to indirect) may be covered by a particular market price, while others may not be.
ii. Use the average carbon market price in another similar country if no market price exists in the country you are in (i.e. a proxy market price).
iii. Use an estimate of the marginal abatement costs of dealing with carbon in your country or sector (or use a proxy value based on another similar country or sector). Note that this is the current approach adopted by the UK government in their assessments of the cost of carbon (see reference).
iv. Use an estimate of the societal cost of carbon, based on the latest international research. Adopt a national government agreed value if available (as is the case of France).
v. Determine the 'switching value' for your particular business aspect being assessed (i.e. identify the value that carbon would need to be to change the decision, such as switching from a negative to a positive benefit:cost ratio – or vice-versa).
vi. Decide upon some other well argued or arbitrary price of carbon and state clearly what you have used and why (e.g. to show some level of commitment to carbon reduction).

Other air quality related environmental externality impacts that are sometimes valued include air emissions such as NOx, SO_2, particulates, VOCs, etc. Societal costs associated with these typically relate to the cost of health impacts on humans, and, to a far lesser extent, impacts to ecosystems. Unlike carbon, these pollutants typically have a more localized impact, and as a result, associated societal costs should ideally reflect the nature of the environment into which they are released and disperse.

Other water quality related environmental externality impacts that are sometimes valued include discharges and diffuse pollution such as ammonium, nitrates, phosphorous, organic matter, metals, etc. Societal costs associated with these typically relate to the cost of health impacts on humans, and impacts to organisms and ecosystems. Again, these pollutants have a localized impact ideally requiring a more context specific assessment of impacts.

Valuing localized impacts of environmental externalities. Valuing the overall environmental and societal impacts of localized environmental externalities can be undertaken in one of several alternative ways:

i. A transfer value can be ascribed to each unit of pollutant (e.g. say US$ X per ton of NOx emitted) based on studies conducted elsewhere. Transfer values exist for certain countries, for example air pollutant externality values in Europe.
ii. Adjusted transfer values can be ascribed, altering the values used depending on key factors such as stack height, distance from populations, whether they are urban or rural areas etc.
iii. Detailed valuation studies can also be undertaken that involve determining pollutant 'dispersion functions' and dose-response relationships between the pollutant and impacts such as human health.

Selection of which approach to use will depend on the purpose and context of the assessment (e.g. value transfers being appropriate for initial feasibility and screening studies), and what transfer values are available.

Linked to the above approaches are a number of other specific valuation techniques. For example, the 'cost of illness', 'loss of earnings', and 'Quality Adjusted Life Years' are examples of valuation techniques for valuing the health impacts associated with other environmental externalities.

Useful references

Companion WBCSD documents:

WRI, WBCSD and Meridian Institute (2008): 'The Corporate Ecosystem Services Review' (ESR). The ESR is a structured method that helps managers develop strategies related to the risks and opportunities arising from their company's dependence and impacts on ecosystems.

WBCSD (2009a): 'Corporate Ecosystem Valuation: A Scoping Report'. This provides an introduction to ecosystem service valuation and examples of past CEV applications.

WBCSD (2009b): 'Corporate Ecosystem Valuation: Issue Brief'. This explores the broader context and concepts underlying CEV.

WBCSD (2009c): 'Corporate Ecosystem Valuation – Building the Business Case'. This provides ten reasons why companies should carry out corporate ecosystem valuation.

Valuation guidelines:

Bateman et al (2009): 'Valuing Environmental Impacts: Practical Guidelines for the Use of Value Transfer in Policy and Project Appraisal'. Report to Defra. http://www.defra.gov.uk/environment/policy/natural-environ/using/valuation/documents/vt-guidelines.pdf

Business and Biodiversity Offsets Program (BBOP) (2009): 'Biodiversity Offset Cost-Benefit Handbook'. http://bbop.forest-trends.org/guidelines/cbh.pdf

Department of Energy and Climate Change (2009) Carbon Valuation in UK Policy Appraisal: A Revised Approach http://www.decc.gov.uk/assets/decc/what%20we%20do/a%20low%20carbon%20uk/carbon%20valuation/1_20090715105804_e_@@_carbonvaluationinukpolicyappraisal.pdf

Defra (2007): 'An introductory guide to valuing ecosystem services'. http://www.defra.gov.uk/environment/policy/natural-environ/documents/eco-valuing.pdf

Dixon et al (1994): 'Economic analysis of environmental impacts'. Published in association with the Asian Development Bank and the World Bank.

HM Treasury (2004): 'Green Book' for undertaking economic appraisals. http://www.hm-treasury.gov.uk/data_greenbook_index.htm

Pearce D., Atkinson G. and Mourato S. (2006): 'Cost Benefit Analysis and the Environment: Recent Developments'. OECD http://www.oecd.org/document/39/0,3343,en_2649_34281_36144679_1_1_1_37465,00.html

Navrud S. and Brouwer R. (2007): 'Good practice guidelines in benefit transfer of forest externalities'. Draft report for EuroForex. http://www.medforex.net/E45/4.LaPalma/BT%20guidelines%20281107.pdf

UK Department of Transport (2002): 'Economic valuation with stated preference techniques: a manual'. http://www.communities.gov.uk/documents/corporate/pdf/146871.pdf

van Beukering et al (2007) Valuing the Environment in Small Islands : an environmental economics toolkit. Report to Joint Nature Conservancy Council. http://www.jncc.gov.uk/page-4065

Valuation databases:

Benefits Table (BeTa): a database developed for the European Commission to estimate externality costs (health and environmental) of air pollution in Europe.
http://ec.europa.eu/environment/enveco/air/pdf/betaec02a.pdf

Envalue: a database provided by the New South Wales Government
http://www.environment.nsw.gov.au/envalueapp/

Environmental Valuation Reference Inventory (EVRI): currently the most comprehensive database of ecosystem service values with the greatest coverage of UK studies. http://www.evri.ca

ExternE: database of energy-related externality values in Europe. http://www.externe.info/

National Oceanographic and Atmospheric Administration (NOAA): provides databases and annotated bibliographies for coastal and marine resources.
http://marineeconomics.noaa.gov/bibsbt/welcome.html

National Ocean Economics Program provides valuation studies predominantly for the US
http://www.oceaneconomics.org/nonmarket/valEstim.asp

Natural Resource Conservation Service (NRCS), US Department of Agriculture: a database and listing of unit value estimates for different recreational activities.
http://www.economics.nrcs.usda.gov/technical/recreate

Review of Externality Data (RED): a listing of studies related to environmental costs (from a life cycle perspective) of energy and other sectors. http://www.red-externalities.net