NE0104: Practical Steps for Valuing Environmental Impacts

Step 1 - Establish the policy good decision-context

This step addresses the following questions:

- Is value transfer the appropriate approach to meet the information needs of the decision-making context?
- Is value transfer possible?
- If yes, what is the appropriate level of effort for the value transfer analysis?
- If no, would a primary valuation study or an approach other than economic valuation be better?

With input from:

- Policy analysts – on the purpose of the policy or project, the need for economic value evidence, and time and resources available to collate this evidence.

Make sure to:

1. Define the decision context:
   - The issue under consideration and the rationale for intervention;
   - The objective of intervention and the intended effects of intervention; and
   - The policy or project options that are to be appraised.
2. Assess if value transfer is both feasible and appropriate:
   - The level of accuracy required in economic value evidence;
   - The availability of information and data concerning the policy good, the change in its provision (e.g. location, timing, duration, scale), affected population and availability of economic valuation evidence; and
   - The time and resources available.

   Value transfer is feasible if:

   - The accuracy requirement is 'low' to 'medium' (e.g. demonstrate the importance of a policy good, assessing the magnitudes of costs and benefits at the early design stages of a project);
   - There is relevant economic valuation literature (e.g. for the same good and type of change, preferably in the UK);
   - The time or budget for a primary valuation study is not considered proportionate (which may change if value transfer shows low accuracy or a large degree of uncertainty in value estimates); and

- Results and assumptions of the analysis are transparently reported such that decision-making is aware of limitations and key caveats.

Value transfer is not feasible if:

- The accuracy requirement is high (e.g. high impact – high profile project, design of an environmental tax);
- There is no sufficiently relevant literature; or
- There is time and budget for primary valuation (and this is determined to be necessary given the scale of policy/project).

3. Consider the alternatives to value transfer:

- A primary valuation study should be preferred when a high level of accuracy is required from economic valuation evidence and there is no appropriate economic value evidence available in the literature
- Other decision support tools (e.g. multi criteria analysis, cost effectiveness analysis, environmental impact assessment, life cycle analysis and so on) can provide input to economic valuation (including value transfer) but they can also be considered as alternatives especially when environmental costs and benefits need not be expressed in monetary terms.

4. Identify the key parameters to be tested in sensitivity analysis.

Step 2 - Define the policy good and affected population Quick Description

This step addresses the following questions:

- What is the good to be valued (the 'policy good')?
- Which characteristics of the policy good are likely to influence its economic value (e.g. size, location, timing, uses and unique features that may lead to non-use values)?
- Who is affected by the change in the policy good and whose values should count?

With input from:

- Policy analysts – on the definition of the good, the characteristics of the good and the affected population.
- Scientists/Technical experts – on the physical, biological and chemical parameters of the good and its characteristics (including the scientific assessment of the availability of substitutes or its unique features) and the affected population.

Make sure to:

1. Define the good in terms of:

- Its ecosystem goods and services - even if they are not valued separately, identification will ensure completeness of subsequent analysis.
- Whether the good (or its individual ecosystem goods and services) is a market or non-market good and the type of use and/or non-use value derived.
- Its physical characteristics, location (including proximity to human populations, substitutes and complements) and timing of its provision.

2. Define the affected population in terms of:
- Who are the users (who will likely hold non-use values as well as use values)?
- Who are likely to be the non-users with a positive value for the good? It is often not possible to know how large the non-user population is for a given good since this partly depends on the scale of the change in the provision of the good. However, assessment of the likelihood that they are significant is needed at this stage to progress with the rest of the analysis.
- The socio-economic characteristics of the user and likely non-user populations.

3. Identify the key parameters to be tested in sensitivity analysis.

Step 3: Define and quantify the change in the provision of policy good

This step addresses the following questions:

- What are the baseline conditions of the policy good (without the change)?
- What is the change described in qualitative terms?
- What is the change measured in quantitative terms?
- Is there supporting data to help with value transfer?

With input from:

- Policy analysts – on the policies and projects that will affect the baseline and that will give rise to the change, and qualitative description of the change.
- Scientists/Technical experts – on the baseline conditions, qualitative description of the change, and the physical, biological and chemical data for quantifying the change.

Make sure to:

1. Define the baseline conditions (without the change) over which the change will be quantified:
- What would happen to the economic baseline (e.g. the numbers of users)?
- What would happen to the environmental baseline (e.g. pollutant concentration)?

2. Describe the change qualitatively in terms of its:
- Scale (whether it is marginal or non-marginal compared to the baseline provision).

- Nature (change in the quality or quantity of provision).
- Direction (improvement or deterioration).
- Timing (immediate, gradual, limited period, in perpetuity).
- Location (in relation to all location parameters identified in Step 2).

3. Asses the change quantitatively in terms of:

- Its nature – units of change for quantity changes (e.g. reduction in tones of emissions, increase in size of species population, reduction in the size of a habitat), parameters of quality changes (e.g. change in the biological oxygen demand (BOD)).
- The risk of a particular change occurring (e.g. flood risk).
- What the measurement of the change means in terms of the ecosystem goods and services that individuals use and/or are aware of - scientific / technical measurements are not always directly valued by individuals (e.g. BOD is not valued in its own right, but by its effect on the availability of fish populations; which could attract use values through commercial fishing and angling, and non-use values through existence, bequest or altruistic motives). Proxy measures can be used for this purpose (e.g. area of habitat can be a proxy for ecosystem service provision).
- The change in the affected population, in particular when (i) the provision of the good remains constant but user access is changed, which may reduce the total use value but could increase non-use value (e.g. conserving a habitat rather than using it for recreation); and (ii) the change in the provision affects the size of user and non-user populations (e.g. improved quality of a recreational site increases the number of users compared to the baseline).

4. Provide supporting data to help select the relevant economic value, adjust it or use value transfer function including:

- Socio-economic and demographic characteristics of the affected population: specific requirements will vary case to case but could include: household income or GDP per capita; socio-economic group; education; occupation status; age profile; household size; number of dependents.
- Patterns and frequency of use (e.g. number of visits).
- Availability of substitutes to the policy good.
- Some sources for supporting data are provided in the main guidelines and case studies.

  It is likely that Step 3 will need to be revisited once data needs have been identified from the review of available valuation evidence in Step 4.

5. Identify the key parameters to be tested in sensitivity analysis.

Step 4: Identify and select monetary valuation evidence

This step addresses the following questions:

- Is there any economic value evidence that matches the policy good, the change and the affected population?
- Is the evidence of sufficiently good quality?
- What is the unit value(s) and/or value function(s) to be transferred?

With input from:

- The analyst – on economic value evidence. But it is good practice to consult policy analysts and scientific / technical experts on the assumptions and selected unit value and value function selected, and to consult with valuation experts to identify the suitable evidence.

Make sure to:

1. Conduct a thorough review of existing studies to ensure that all evidence potentially relevant to the policy good is identified:
   - Sources for value evidence (in particular for non-market goods and services) include existing guidance documents, government or other organisations' reports, value transfer databases, academic publications, working papers, conference papers and consultation with valuation experts.
   - Identify a long list of likely suitable studies.
2. Compare the policy and study good context including:
   - The similarity of the policy good and study good –
     - The physical characteristics of the goods: e.g. the impact, pollutant, habitat, species, resources, etc.; and
     - The types of use and non-use value derived from the goods.
   - The change in provision of the policy good and study good –
     - The nature of the change; e.g. quantity, quality change;
     - The direction of the change; e.g. increase, improvement, decrease, deterioration;
     - The timing of the change; e.g. gradual, sudden, temporary, permanent; and
     - The scale of the change in relation to the baseline provision of the good; e.g. a complete loss, a 'marginal' change, etc.
   - The locations where the policy good and study good are found –
     - Proximity to populations (including accessibility to sites);
     - Proximity to substitutes; and
     - Proximity to complements.
   - The policy good and study good affected populations -
     - The similarity of the population type; e.g. users, non-users, different types of users (specialist groups, general public, etc.); and

- The similarity of the population characteristics; e.g. socio-economic characteristics, frequency of use, etc.
  - The number and quality of substitutes for the policy good and the study good.
  - The policy good and study good market constructs:
- The circumstances of the change;
- The (implied) property rights;
- The economic conditions in which the change occurs;
- The institutional context; and
- The cultural context.

3. Assess the quality of the valuation evidence – does each potential study:
   - Employ sound data collection procedures;
   - Have representative samples (for survey-based economic valuation methods);
   - Use best practice methods; and
   - Produce results that are consistent with expectations based on the economic theory.
4. Select appropriate valuation evidence to transfer:
   - Unit values (e.g. WTP and WTA estimates);
   - Value functions (to predict the value of the change in the policy good based on a set of explanatory variables);
   - Supporting data (e.g. a distance decay function); and
   - Appropriate ranges for unit values and function coefficients (for the purposes of sensitivity analysis).
5. Identify the key parameters to be tested in sensitivity analysis.

Step 5: Transfer evidence and estimate the value of the policy goods

This Step addresses the following questions:

- Which value transfer approach is to be used?
- What is the transferred value of the change in the provision of the policy good?

With input from:

- The analyst – on economic value evidence. It is good practice to consult policy analysts and scientific / technical experts on the assumptions or selected unit value(s) and/or value function(s).

Make sure to:

1. Choose the value transfer approach on the basis of the availability of the suitable studies and supporting data (in particular whether such data enable value transfer):

- *Unadjusted unit value transfer from a single study*: a mean value estimate (and confidence intervals) is transferred.
- *Unadjusted unit value transfer from multiple studies*: mean value estimates (and confidence intervals) from two or more studies are used to specify a range of values or calculate an average value for the change in the provision of the policy good.
- *Adjusted unit value transfer*: mean value is adjusted to account for the differences between the study and policy goods with regards to one or more factors that are expected to influence economic value. Income is the most common adjustment factor since it is known to influence value and it is easy to find data on.
- *Value function:* this is transferred from the study good context to predict a mean value for the policy good. Adjusted value function approaches are also possible where the function coefficients can be based on multiple data sources (e.g. coefficient values are drawn from multiple studies).
- *Meta-analysis function*: estimated on the basis of results from multiple valuation studies. This approach accounts for a broader base of evidence in predicting the value of the change in provision of the policy good. As with value function transfer, the average values of the explanatory factors in the policy good context are multiplied by the meta-analysis function coefficients.

Table 1 presents some rules of thumb on how to decide which value transfer approach to choose depending on the availability of key information.

Table 1: Some rules of thumb for choosing between value transfer approaches

Selection Criteria ***(See Section 4.2)***	***A <u>selection</u> of possible policy good and study good 'matches'***							
i). The good	✓	✓	✓	✓	✓	✓	X	✓
ii). The change	✓	✓	✓	✓	X	✓	n/a	✓
iii). The location	✓	✓	✓	X	X	✓	n/a	✓
iv). The affected populations (characteristics)	✓	X	✓	X	X	X or ✓	n/a	✓
v). The number and quality of substitutes	✓	✓	X	X	X	X or ✓	n/a	✓

vi). The market constructs	✓	✓	✓	✓	✓	X	n/a	✓
Study quality	✓	✓	✓	✓	✓	✓	n/a	X
Rules of thumb:								
Unit value transfer:	👍	👎	👎	👎	👎	👎	👎	👎
Adjust unit value transfer:	👍	👍	👍	?	?	?	👎	👎
Function transfer:	👍	👍	👍	👍	👍	?	👎	👎

Notes:

Criteria comparison: ✓ = close match between policy good context and study good context; X = not a close match between policy good context and study good context; ✓ or X : Indicates that policy good and study good context match for the criteria is unlikely to be the determining factor for the choice of adjusted unit value transfer or value function transfer; n/a = not applicable.

Rules of thumb:

👍 = Approach likely to be appropriate provided sufficient supporting information is available (for adjusted or value function transfer)

👎 = Approach unlikely to be appropriate

? = Uncertain: will depend on how different the policy good context and study good context are.

2. If an unadjusted value transfer approach is applied:

- The unit value of policy good = the unit value of study good.
  - The units could be £ per tonne (e.g. timber), £ per fish, £ per hectare (e.g. agricultural land), £ per tonne emissions (e.g. air pollutants), £ per visit (e.g. recreation), £ per household (e.g. non-use value).
- If required use standard values such as guidance for valuing carbon.
- Adjust values to current prices (for studies before the year of analysis), and convert to £ if from a non-UK study.

3. If adjusted value transfer function approach is applied:
   - Identify the factor(s) to control for (from Step 4).
   - Collect data for the value of the factor for adjustment for the policy good (from Step 3) and for the study good (from Step 4).
   - Establish the relationship between the factor and the economic value (from the literature reviewed in Step 4).
4. If value transfer function approach is applied:
   - Interpret the function(s) selected:
   - Identify the estimation method and type of model (e.g. OLS, logit, etc.).
   - Assess the overall validity of model: goodness of fit and tests of model significance.
   - Note the definition of the dependent variable (e.g. WTP per household per year): identify any transformations (e.g. using the natural log of WTP is a typical transformation in econometric analysis).
   - Note the definition of the explanatory variables: identify continuous, categorical or dummy variables and identify any transformations.
   - Note the interpretation of the coefficient estimates for the explanatory variables: the sign of the coefficient (positive or negative), the statistical significance of the coefficient and accordance with prior expectations (or reasonable explanation of departure from prior expectations).
   - Determine if the 'full ad-hoc contextual' model is appropriate for transfer or whether a 'limited' function (based on expectations from economic theory) is more appropriate.
   - Use the selected function(s):
     - Collate data for the policy good values of the explanatory variables (e.g. average household income for the affected population) (see Step 3).
     - Omit any explanatory variables for which the coefficient estimate is not found to be statistically significance (or consider their inclusion in sensitivity analysis) – note that generally a 'best fit' function will include only statistically significant parameters.
     - Consider confidence intervals for coefficient estimates for sensitivity analysis; this will permit a range of economic values to be estimated for the change in provision of the policy good.
5. Identify the key parameters to be tested in sensitivity analysis.

Step 6: Aggregation

The tasks for estimating the aggregate value of the change in provision of the policy good are:

- Aggregate the unit value across the type of value and policy good; *and*/*or*
- Aggregate over the affected population;

then

- Aggregate over time.

Spatial and temporal variation in unit values should be taken into account as much as possible.

Whether (i) and/or (ii) is appropriate depends on the unit in which the change is measured (Step 3) and valued in economic terms (Step 4).

6.1 Aggregation of economic values

Estimating the aggregate value of the change in provision of the policy good

The estimated aggregate value of the change in the provision of the policy good is the 'headline' result that is inputted to decision-making. It can be used to demonstrate the importance of an issue, estimate likely damage in a liability case or, as is used often, inputted into a cost-benefit analysis or an Impact Assessment.

There are three dimensions to aggregation:

- *Aggregation over type of value and policy good:* Where value transfer is applied to estimate the value of a number of costs and benefits for appraisal, the values for each need to be aggregated. There could be:
  - More than one type of value (e.g. adding benefits for different visitor types to a recreation site, or adding benefits of flood protection to benefits of water quality improvements as a result of a wetland conservation project, to provide an estimate of the total monetary benefit of the a project[1]);
  - More than one type of policy good (e.g. improvements in quality of soil *and* quality of water); and
  - Some benefits (e.g. increase in recreational opportunities) and some costs (e.g. increase in carbon emissions).

- *Aggregation over the affected population*: Summing unit economic value (use and non-use) per household or per individual over the *affected population*. When aggregating over the affected population *spatial variation* in economic values (e.g. the existence of a 'distance-decay' relationship) may need to be accounted for. When the unit value is expressed as £ per units of the type of benefit or good (e.g. £ per hectare, £ per tonne of emissions etc.), aggregation over the affected population is not necessary.

- *Aggregating over time*: Estimating the present value of the change in the provision of the policy good over time involves discounting the annual stream of the total value of the change in the provision of the policy good over time.

The first two dimensions of aggregation estimate the total annual value of the change in the provision of the policy good. Once the total annual value is calculated, it should then be aggregated over time (over the policy or project lifetime, or appraisal time horizon) to estimate the present value of the change in the policy good.

The complexity of the aggregation step depends on the overall scope of value transfer. For unit (or adjusted unit) value transfer, aggregation is straightforward, while it can be more complex for value transfer incorporating spatial distribution of values.

Profile of annual costs or benefits over time

Analysts will need to determine the profile of annual benefits or costs over time including:

- the change;
- the unit value; and
- the affected population.

One reason why the affected population may change is, for example, that the improvement in the quality of a policy good many increase the user population. The task for analysts is to determine if new users have transferred their use from a substitute good or service (effectively a transfer of welfare) or if they are genuinely new users (a net gain in welfare). This will require empirical data (e.g. from user surveys that include details of visits to substitute sites) or use of assumptions that can be tested via sensitivity analysis.

In many appraisal cases, annual costs and benefits are assumed to be constant. In other cases the nature of the baseline provision of the policy good (*without* the policy or project) may imply non-constant annual values. If the baseline conditions are assumed to decline over time, an improvement in future will generate higher benefits (the change is greater) in undiscounted terms. If the baseline is predicted to show gradual recovery over time in the absence of intervention, the benefit of intervention will decline over time. Overall the specification of the profile of annual benefits or costs needs to reflect scientific and technical understanding of the baseline and change from Step 3.

With respect to marginal economic values over time, the default assumption is usually that these are constant in the short to medium term – although an exception to this is the

treatment of carbon emissions, where analysts should follow DECC guidance (DECC, 2009). If changes in relative values are assumed, this should be supported by empirical evidence.

Step 7: Sensitivity analysis

This step addresses the following questions:

- Which key parameters affect the transferred value the most?
- What is the nature and significance of such effects?
- What is the switching value or benefit threshold?

With input from:

- Policy analysts and scientists/technical experts on the assumptions they would think as key and would like to see tested through sensitivity analysis.

Make sure to:

1. Identify the key parameters for sensitivity analysis:

- These should be identified through Steps 2-6. A list of these factors to consider is also included in Step 7 of the main guidelines and summarised in the Checklist.
- Consult with policy colleagues and technical experts to determine key parameters for testing in relation to the overall decision-context.

2. Select the appropriate approach to sensitivity analysis:

- Changing one key parameter at a time to see the effect on the resulting value estimate;
- Using scenarios to account for sensitivity in multiple parameters;
- Assigning probabilities to outcomes; and
- Using Monte Carlo analysis to account for sensitivity in multiple parameters especially when there are significant uncertainties, where possible; and
- Switching values and benefits thresholds (see below)

3. Estimate the switching value or benefits thresholds:

- A switching value calculates by what percentage the benefit estimate needs to decrease or the cost estimate increase to change the NPV (or CBA) 'recommendation'. The higher the switching value, the greater the 'comfort' there should be around the cost or benefit estimates.

- Benefits threshold measures the difference between (financial) costs and environmental benefits (or other aggregate costs and benefits depending on the context). It considers whether estimated benefits are less than the policy or project cost of providing them, and if so, whether any environmental benefits that could not be estimated in monetary terms are at least worth the difference. The larger the value of the benefits threshold, the greater the need for further monetary estimation of benefits (or stronger qualitative or quantitative arguments for non-monetary benefits).

Step 8: Reporting

Reporting is the culmination of all steps in the analysis. It should present results and their interpretation, assumptions and limitations and gaps, and discussion of each of the Steps 1 – 7:

- Transparent reporting is essential for informing decision-making of the likely accuracy of evidence provided. Transparency is aided by documenting all assumptions and data sources.

- It is good practice for policy analysts and technical experts to comment on the style and content of the reporting as well as the results.

- The main guidelines provide a checklist that is intended to help with clear reporting, and establishing an audit trail.