



Global Climate Change Alliance Support Facility

Training workshops on mainstreaming climate change in national development planning and budgeting

HANDOUT FOR PARTICIPANTS

MODULE 7

Costing, assessing and selecting adaptation and mitigation options and measures



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MODULE 7 – Costing, assessing and selecting adaptation and mitigation options and measures

TOPICS AND TOOLS COVERED BY THE MODULE:

- Tools for costing and assessing adaptation and mitigation options:
 - o Cost-benefit analysis (CBA)
 - o Cost-effectiveness analysis (CEA)
- Tool for prioritising and selecting adaptation and mitigation options:
 - o Multi-criteria analysis (MCA)

KEY CONCEPTS AND MESSAGES:

1. Mainstreaming climate change in policies, strategies and programmes (see Module 6) leads to the identification of adaptation and mitigation options and measures. These options and measures must be costed, assessed and prioritised, a process that ultimately leads to the selection of the most suitable ones. This process is the topic of this module. It precedes the actual integration of adaptation and mitigation measures in budgets (see Module 8).

Tools for costing and assessing adaptation and mitigation options

2. *Cost-benefit analysis (CBA)* involves the valuation of both costs and benefits over the entire lifetime of an intervention (EC 1997, 2003). This raises the question of which costs and benefits should be considered in the analysis. Traditionally, CBA considers ‘incremental’ costs and benefits, i.e. the difference in costs/benefits between a ‘with intervention’ and a ‘no intervention’ scenario (EC 1997, Belli et al 1998). In this specific case, CBA requires a comparison of costs and benefits ‘with and without adaptation’ or ‘with and without mitigation’ – which in practice can be challenging, given (notably) the existing overlaps between adaptation, development and adaptive capacity enhancement measures (Agrawala & Fankhauser 2008, Fankhauser & Schmidt-Traub 2010, World Bank 2010b), or between mitigation and economic efficiency (McKinsey & Company 2009).
3. The *costs* associated with *climate adaptation* include any extra costs incurred compared with a ‘business-as-usual’ development or investment scenario that would ignore the issue of climate change (but would at least in part address current climate variability).¹ **Box 7.1** presents a method for assessing the incremental costs of adaptation at the national level. In exchange for incurring these extra costs, the following *benefits* can be expected:
 - reduced ‘costs of inaction’, in the form of avoided damage and losses – from climate change but also from current climate variability;²

¹ The business-as-usual scenario is likely to include the kind of measures usually implemented to address current climate variability, but unlikely to provide full coverage of the related risks – in addition to the existence of an ‘adaptation deficit’, there is inevitably an amount of residual risk. The extra costs of adaptation are in principle those that address climate risks associated with climate change, not current climate variability – but in practice making a clear distinction between the two categories is difficult (Agrawala & Fankhauser 2008).

² Measures that address long-term risks from climate change are also likely to mitigate some of the residual risks from current climate variability (Agrawala & Fankhauser 2008).

- extra developmental benefits compared with the 'business-as-usual' scenario – see concept of 'co-benefits' presented in Module 1 (Boyd & Hunt 2006, EEA 2007, Agrawala & Fankhauser 2008, Economics of Climate Adaptation Working Group 2009).

BOX 7.1 – AN APPROACH TO THE CALCULATION OF INCREMENTAL ADAPTATION COSTS AT THE NATIONAL LEVEL

Fankhauser & Schmidt-Traub (2010) propose an interesting and rather straightforward approach to the assessment of the costs of adaptation at the country level. It involves:

- determining the financial resources needed to achieve the MDGs in the absence of significant change to the climate (this information is usually available from studies undertaken in the context of the planning and monitoring of MDG achievement);
- and then calculating the costs of extra measures required for 'climate-proofing' the achievement of MDGs for a given climate change scenario (e.g. based on assumptions found in UNFCCC and other international publications).

These extra measures may include:

- 'doing more – or better – of the same': more development support (e.g. more water storage capacity, increased spending on agricultural extension services and health systems, strengthening of emergency systems, increased coastal protection efforts), or providing the same support at a higher cost (e.g. higher construction standards for new infrastructure);
- undertaking new interventions (e.g. agricultural research focused on addressing climate change impacts on key crops, development of networks of weather and climate monitoring stations);
- and investing in some regional and global goods (e.g. transboundary ecosystem management, participation in regional agricultural research).

4. Similarly, the *costs potentially associated with climate mitigation* include:

- the extra cost of investment in new technologies and infrastructure, compared with other, more emission-intensive available options (McKinsey & Company 2009);
- where relevant, the extra operation and maintenance costs associated with these new technologies/infrastructure (compared with those of other available options);
- where relevant, reduced economic growth opportunities, and the foregone benefits and jobs of development options abandoned or downscaled for the purpose of reducing emissions.

5. On the other hand, the following *benefits* may arise – at the national, sector or local level³ – from the adoption of mitigation measures:

- cost savings, e.g. from energy efficiency (McKinsey & Company 2009) or lower maintenance costs;
- access to additional financial resources from carbon finance mechanisms;
- positive environmental outcomes (where mitigation options are also 'greener' than alternatives) and associated health outcomes (e.g. reduced incidence of respiratory disease as

³ Benefits from mitigation measures are also expected to arise at the global level, in the form of reduced impacts on the global climate, but are not usually included in cost-benefit analysis at the national, sector or local levels, since their allocation to the stakeholders concerned by the analysis is not possible. Financial transfers from more developed to developing countries in support of mitigation efforts (through mechanisms such as the Clean Development Mechanism and carbon markets) do however represent a form of payment for the provision of global environmental services – and should be included in the analysis whenever they accrue to the stakeholders concerned by the analysis.

- a result of cleaner air, where fossil fuel consumption diminishes) or other developmental outcomes (e.g. maintenance or enhancement of livelihood opportunities);
- reduced dependence on imported fuels and energy;
 - earlier adoption of the technologies of the future – which may confer a competitive advantage and lead to higher growth and employment in the medium- to long-term (EC 2009a).
6. The valuation of the costs and benefits of adaptation and mitigation measures requires their *identification*, their *quantification* and then their *valuation* (Niang-Diop & Bosch 2004). In practice, the valuation or even the quantification of some risks, costs and benefits may be difficult, due to a combination of methodological issues and resource constraints.⁴ Some costs and benefits are therefore likely to be excluded from the analysis. For transparency and validity purposes, and to adequately inform decision makers, clear information should be provided, alongside CBA results, on:
- the risks, costs and benefits that are not included in the analysis (Boyd & Hunt 2006) – these should be at least identified and if possible quantified;
 - any important assumptions made in the valuation of costs and benefits;
 - the limits and constraints of the valuation exercise (e.g. methodological limitations).
7. A key feature of CBA (and also of cost-effectiveness analysis, see below) is the use of *discounting*, i.e. the conversion of future costs and benefits to their present value. This technique allows comparing costs and benefits that are expected to materialise at different times, taking account of the opportunity cost of capital (financial analysis) and the social ‘preference for the present’ (economic analysis) (EC 1997, 2003). Discounting involves the use of a discount rate, the choice of which may significantly influence the outcome of the analysis (EEA 2007, de Bruin et al 2009). The choice of a discount rate, especially the ‘social discount rate’ or ‘social rate of time preference’ used in economic analysis (which may differ from the financial discount rate), may be controversial – particularly in analysis with a long time horizon where the ‘preference for the present’ of the current generation has to be balanced with, among other factors, inter-generational equity (see for instance Hepburn 2006, EEA 2007).⁵ In spite of this, the use of a discount rate in CBA can be particularly useful to identify the optimal timing for implementing specific measures (Niang-Dop & Bosch 2004).
8. The outputs of CBA are typically:
- the *cost-benefit ratio (CBR)*, i.e. the ratio of costs to benefits calculated at their present value (the smaller, the better – a measure qualifies as ‘no-regret’ if $CBR < 1$);⁶
 - the *net present value (NPV)*, i.e. benefits minus costs calculated at their present value (the larger, the better);

⁴ The valuation of things that do not have a market value (e.g. health benefits or the degradation of non-commercial ecosystems and ecosystem services) poses specific methodological challenges. Economic valuation techniques exist for assessing non-market values, but their reliable use requires specific expertise and potentially significant resources, and they are not systematically implemented (EEA 2007).

⁵ A high discount rate applied to mitigation measures that entail costs in the present in order to generate benefits in the distant future makes such measures appear economically unjustified. The same applies to adaptation costs, although the time horizon for reaping the benefits of adaptation may be shorter than in the case of mitigation. It is now accepted that declining discount rates may be applied to economic analysis where it covers long time periods (Hepburn 2006, EEA 2007).

⁶ Some analysts use the benefit-cost ratio (BCR) instead of the CBR. In this case, the BCR should be > 1 , i.e. discounted benefits should exceed discounted costs, for a project or intervention to qualify.

- the *internal rate of return (IRR)*, a measure of the ‘benefit-generating power’ of the option or intervention (the higher, the better – the IRR should exceed the opportunity cost of capital) (Belli et al 1998, EC 1997 & 2003).
9. *Cost-effectiveness analysis (CEA)* values costs in monetary terms but only quantifies benefits in appropriate ‘physical’ units, without attempting to value them. CEA allows the calculation of unit costs⁷; the unit costs of various interventions producing the same type of benefit can then be compared to select the most ‘cost-effective’ or efficient intervention (EC 1997, Belli et al 1998).⁸ CEA is a suitable method where it is difficult to assign a monetary value to benefits – but it requires identifying a single, all-encompassing measure of benefits, which may be both difficult and reductive. However, considering all the methodological issues associated with the use of CBA for climate change, including the difficulty of accounting for the possibility of extreme and irreversible changes, some economists believe CEA with respect to a given climate target⁹ may provide a better evaluation framework (EEA 2007).
 10. The ‘*global greenhouse gas abatement cost curve*’ (**Figure 7.1**) provides an illustration of the application of CEA. It shows the incremental¹⁰ unit costs, per tonne of abated CO₂ equivalent, of a large variety of technical options for reducing GHG emissions at the global level. (These options belong to three categories: energy efficiency, low-carbon energy supply, and terrestrial carbon-related options – **Box 7.2** provides additional information on the potential of the latter.) Options are ranked from the least expensive (per tonne of CO₂e abated) to the most expensive in global terms. Their cost ranges from –90€ to +60€ / tCO₂e. All options with a negative cost are ‘no-regret’ since the savings they generate are greater than their costs. The width of the bar corresponding to each option indicates its abatement potential (in gigatonnes CO₂e per year), compared with ‘business-as-usual’, if the option is implemented at its full potential. The curve reading shows, for instance, that emissions of about 11 Gt CO₂e/year could be avoided globally just by implementing options that provide a net financial benefit. Reducing emissions just enough to contain global warming below 2°C would cost ‘only’ €200-350 billion/year until 2030 – this is less than 1% of global annual GDP (McKinsey & Company 2009). This research thus comes to similar conclusions to those reached, for instance, in the Stern (2007) review on the economics of climate change.

⁷ CEA can also be used for comparing the costs of various ways of reaching a given objective – even in the absence of unit cost calculation (Niang-Dop & Bosch 2004).

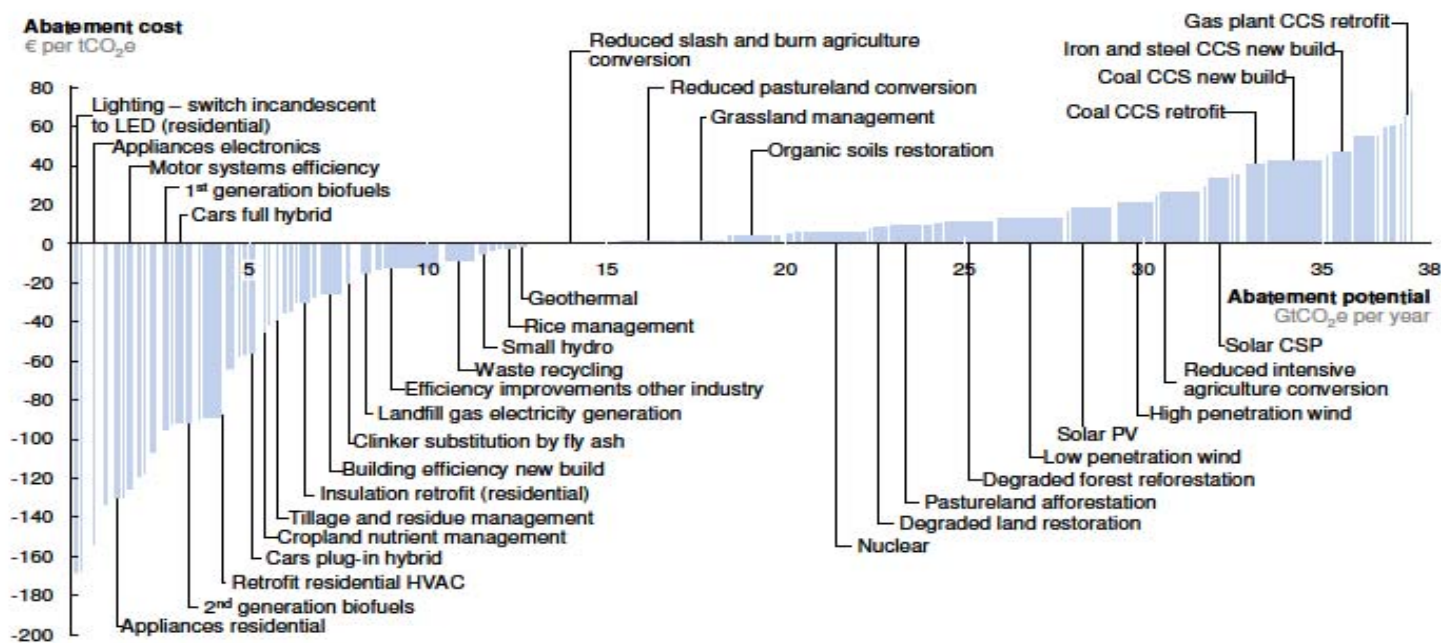
⁸ The unit cost of a given intervention can also be compared with ‘benchmark costs’ for similar interventions, where they are available.

⁹ e.g. the policy objective of limiting average global warming to 2°C with respect to pre-industrial temperatures.

¹⁰ i.e. extra costs compared with a ‘business-as-usual’ baseline.

Figure 7.1 – Global greenhouse gas abatement cost curve

Global GHG abatement cost curve beyond business-as-usual (v2.1) – 2030



Note: The curve presents an estimate of the maximum potential of all technical GHG abatement measures below €80 per tCO₂e if each lever was pursued aggressively. It is not a forecast of what role different abatement measures and technologies will play.
 Source: McKinsey & Company: The impact of the financial crisis on carbon economics – Version 2.1 of the Global Greenhouse Gas Abatement Cost Curve

Source: McKinsey & Company (2009) *Pathways to a Low-Carbon Economy: Version 2 of the Global Greenhouse Gas Abatement Cost Curve*, Exhibit 8, p. 17 of full report (or p. 15 of executive summary).

BOX 7.2 – LAND USE-RELATED OPTIONS FOR GHG ABATEMENT AND COST-EFFECTIVENESS

Terrestrial ecosystems have significant potential as ‘carbon sinks’. The main natural (terrestrial) sinks are:

- forests (which store carbon both in tree biomass and in soil organic matter);
- peatlands – the largest and most efficient terrestrial store of biomass carbon;
- grasslands, which act as net carbon sinks if they are not degraded or over-exploited;
- and, potentially, cultivated systems, which act as both a sink and a source of GHGs and can be a net sink with adequate agricultural practices (Trumper et al 2009).

Curbing deforestation, and conserving/restoring peatlands, are considered to be among the most cost-effective ways of reducing GHG emissions. Approximately one-third of the total potential for reducing GHG emissions at a cost not exceeding €60 per tCO₂e is related to *land use measures* (forestry and agriculture). As a matter of fact, 90% of the abatement opportunities associated with these sectors are located in developing countries – and agriculture- and forestry-related measures generally have low capital intensity (i.e. do not require particularly high extra upfront investment), while entailing low (sometimes negative) abatement costs. Considering the capital constraints that bear on developing countries and may act as a barrier, lower capital intensity (compared, for instance, with renewable energy options) is a significant advantage that should lead policy makers to consider seriously land use-related mitigation options¹¹ (McKinsey & Company 2009).

11. Both CBA and CEA support:

- *financial analysis*, which considers the ‘monetary’ costs and benefits (or equivalent) accruing to parties directly concerned by a project or programme, at their ‘face value’;
- *economic analysis*, which broadens the analysis to more accurately reflect costs and benefits to society, for instance by correcting prices to reflect true economic values, and by taking account of additional costs and benefits, typically non-monetary ones, that may accrue to third parties (the so-called ‘externalities’ of an intervention).

Private sector stakeholders make decisions on the basis of *financial* ratios/indicators. Public sector stakeholders should make decisions on the basis of *economic* ratios/indicators (EC 1997, 2003).

12. For the assessment of robustness and the integration of uncertainty, CBA and CEA can be combined with a variety of techniques, including:

- the use of *multiple scenarios* (e.g. various climate change and development scenarios, see Module 4) (EC 2003, World Bank 2010c);
- *sensitivity analysis*, i.e. testing of the effect of changes in scenario assumptions or discount rate on the CBR, NPV, IRR or unit costs (EC 1997, Belli et al 1998, EC 2003);
- *risk analysis*: ‘risk probability analysis’ includes the probability of occurrence of various cost and benefit outcomes in calculations, resulting in the calculation of probability-weighted ‘expected costs’ and ‘expected benefits’ over a range of possible outcomes and the determination of an expected NPV and IRR¹² (Belli et al 1998, EC 2003, Agrawala & Fankhauser 2008, Economics of Climate Adaptation Working Group 2009).

¹¹ Consideration of the potentially high labour intensity of these options (opportunities for creating ‘green jobs’) could also add to their attractiveness.

¹² Note that this approach requires the probability of different outcomes to be known, which is by far not always the case with climate change scenarios.

Tools for prioritising and selecting adaptation and mitigation options

13. Both CBA and CEA support the prioritisation and selection of measures that offer the best ‘*value for money*’ – a key aspect in situations of budgetary constraints. On the other hand, they are limited to *financial and economic assessment*, and decision makers may want to have access to additional types of assessments (e.g. technical feasibility, social and/or environmental impact assessment) before selecting options. Multi-criteria analysis may usefully complement financial and economic analysis (EC 2003).
14. *Multi-criteria analysis (MCA)* is an approach to decision support that uses more than one criterion to assess performance and rank various options or interventions (see **Table 7.1** for an example). The term actually covers a wide range of methods, some of which rely more on establishing qualitative hierarchies, while others rely more on quantitative methods. Typically:
- various options or interventions are assessed against a pre-determined set of criteria;
 - qualitative ratings or quantitative scores are given to each option or intervention against each criterion;
 - then rules are applied to rank the assessed options/interventions; where numerical scores are used, they can be added up to calculate a total score (with the possibility of applying different weights to different criteria) (EC 2003, Niang-Dop & Bosch 2004).

Table 7.1 – Example of multi-criteria analysis matrix

Option	Effective-ness	Cost or CBR (*)	Technical feasibility	Social & cultural acceptability	Environ-mental impacts	Total score
Option 1						
Option 2						
Option 3						
Option 4						

(*) CBR = cost-benefit ratio
 Scores: from 1 (poorest performance) to 4 (highest performance). As far as cost is concerned, a scale should be established, with scores corresponding to a given cost range or cost/unit range.

Adapted from: USAID (2007) *Adapting to Climate Variability and Change: A guidance manual for development planning*. Exhibit 12, p. 18.

15. At the time of assessing and selecting possible adaptation and mitigation measures, the question may arise whether to use *CBA/CEA, MCA or both*. In fact, MCA can be used on its own, notably where no valuation of costs and benefits is available – or it can be combined with a financial and economic assessment based on CBA or CEA. One of the advantages of MCA over CBA/CEA is that it allows stakeholder participation (Niang-Dop & Bosch 2004). MCA is typically less data- and resource-intensive than either CBA or CEA, so in situations of resource constraints, it may be used alone – however, a robust assessment would still require the collection of enough data and good expertise. CBA/CEA and MCA can also be used in combination:
- In the ‘CBA/CEA then MCA’ approach, CBA/CEA is used first to eliminate financially or economically unviable options, after which MCA allows making the final selection on the basis of other criteria (e.g. technical, social, environmental criteria).

- In the 'MCA then CBA/CEA' approach, MCA is used first to select the most attractive options on the basis of multiple criteria, after which CBA/CEA is used to determine which of the pre-selected options are financially or economically most attractive.

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