Cost-Benefit Analysis

Summary

- Cost-Benefit Analysis (CBA) is an evaluation method which focuses on determining economic efficiency of particular adaptation strategies. It achieves this by comparing the costs associated with carrying out an adaptation option against its benefits, calculating the net benefit.
- The most important strength of CBA for adaptation comes from its structured and thorough consideration of costs and benefits which can be economically quantified to make adaptation related decisions more transparent. It expresses results in a single metric, making it easy to compare adaptation strategies, and choose those which provide maximum social welfare.
- One major drawback of CBA is its need for quantitative and monetized data regarding adaptation costs and benefits. This makes it particularly difficult to apply in adaptation where information and data is limited, uncertainties are large and where non-market values may have an important role (e.g. biodiversity protection, health and protection of natural resources).
- Additionally, CBA often inadequately addresses certain concerns which are of significant importance in adaptation, such as: high uncertainty, distribution and equity, choice of an appropriate discount rate, value judgements about projects and the time and scale of the strategies being compared.
- It is considered good practice to use CBA in conjunction with other methodologies to form a broad evaluation framework for adaptation decision making, e.g. Multi-Criteria Analysis.

What does Cost-Benefit Analysis do?

Cost-Benefit Analysis determines the economic efficiency of a project or policy by comparing the net present value of the costs of planning, preparing and implementing the adaptation intervention to its benefits. Benefits are related to the avoided damage costs or the accrued benefits following adoption and implementation. This is carried out in a quantitative and monetized framing, where costs and benefits are expressed in explicit economic terms. In using a common metric to compare the costs of undertaking a project with the benefits it will provide, it highlights trade-offs and offers a methodology which promotes rational and systematic adaptation policy making.

Ultimately, the goal of CBA in adaptation is to provide a methodical assessment of costs and benefits to ensure that only projects or policies which maximise social welfare against clearly identified sets of climate change impacts are selected. Hence, CBA does not select options that can deal well against a range of potential futures, but rather optimises adaptation options against the most likely set of impacts.

When should I use Cost-Benefit Analysis?

The methodology behind CBA can be applied to virtually any project or policy which offers costs and benefits in quantitative economic terms. However, CBA requires a good understanding and quantification of the variety of positive and negative impacts of adaptation options. It is most appropriate for assessing low and no regret options in market sectors and when uncertainties related to climate risk probabilities are known. It is important to think of CBA as a decision-making guide providing an approximation of societal preferences, and not an expression of the exact economic value of a project or policy. As such, it is best used as a part of a broader assessment process along with other decision support tools, for example those which are able to consider other cultural and social factors in their analysis, such as multi-criteria analysis, or those that frame adaptation in a broader iterative risk framework.

What are the key strengths and limitations of Cost-Benefit Analysis?

Key Strengths

- Attractive methodology for its relative simplicity
- Provides a systematic outlining of monetized costs and benefits, ultimately offering a simple economic value.
- Protect high value investments, infrastructure or properties.

Potential Weaknesses

- Does not explicitly deal with uncertainties.
- Optimises the selection of options against single, pre-defined future scenarios of climate change.
- Choice of time horizon and scales can dramatically change results.
- Limited application for questions of natural resource preservation, irreversibility and intrinsic values.
- Does not easily incorporate distributional or equity issues.
- Choice of discount rate is a matter of on-going contention and debate.

How can you implement Cost-Benefit Analysis?

Cost-Benefit Analysis typically involves a series of steps:

1. Defining the scope of the adaptation intervention and the role of the CBA;
2. Identifying a set of adaptation options and their objectives;
3. Choose a baseline against which the benefits and costs will be measured;
4. Identify relevant cost and benefit components and select and assess the components which can be monetized;
5. Calculate net present value (total benefits minus total costs) and present the proposed selection of options along different decision rule.

In defining the scope of the CBA, one considers the target impact of the CBA on decision-making, and assessing where it aims to raise awareness or it should provide sufficient information to allow decision makers to choose between adaptation options. Also, it is important to decide whether adaptation should address current climate variability or/and longer-term concerns, as well as which types of impacts adaptation (e.g. all impacts or focusing on irreversible impacts). Adaptation options themselves may aim to reduce vulnerability or, alternatively, prevent impacts.

CBA requires the setting of a baseline against which to measure future benefits of an option. Adaptation baseline is comprised of climate change impacts without the adaptation measure, and is calculated via the use of climate change impact modelling. The baseline should include socio-economic scenarios for the discussed time horizon. The choice of baseline involves defining the scale of the analysis, selecting the climate scenario, the type of impacts to consider, selecting the socio-economic indicators, etc.

The calculation of the net present value is based on the calculation of net present costs on the one hand and the net present benefits on the other. Benefits are calculated with respect to the baseline in terms of avoided damages. In most cases, some residual damage (i.e. unavoidable damage which cannot be prevented by the assessed adaptation actions) will remain and these costs should be considered. The prioritisation of adaptation options and their proposed selection should follow a specified decision rule, e.g. one based on the highest net benefits or on the highest benefit:cost ratio (which represent the best value for money or the most cost efficient option). However, the final decision on adaptation options is a societal choice involving political discussions at different levels.

Each calculation entails a number of assumptions as to which cost and benefit components to include in the analysis, which largely depends on sufficient data availability for the monetization. How these various issues are considered and treated need to be presented in a transparent way and ideally discussed with stakeholders. Methodological decisions include the treatment of uncertainty, lack of data, the choice of discount rate, distributional issues, consideration of wider economic costs and ancillary benefits, the inclusion of non-market values, and cross-sectoral linkages,. In Econadapt, a detailed application of CBA in adaptation at project level was carried out.

The impact of uncertainties on CBA results can be considered via specific techniques, with standard approaches being for example sensitivity analysis and probabilistic modelling. In Econadapt, several approaches were developed including in impact assessment and integrated modelling.

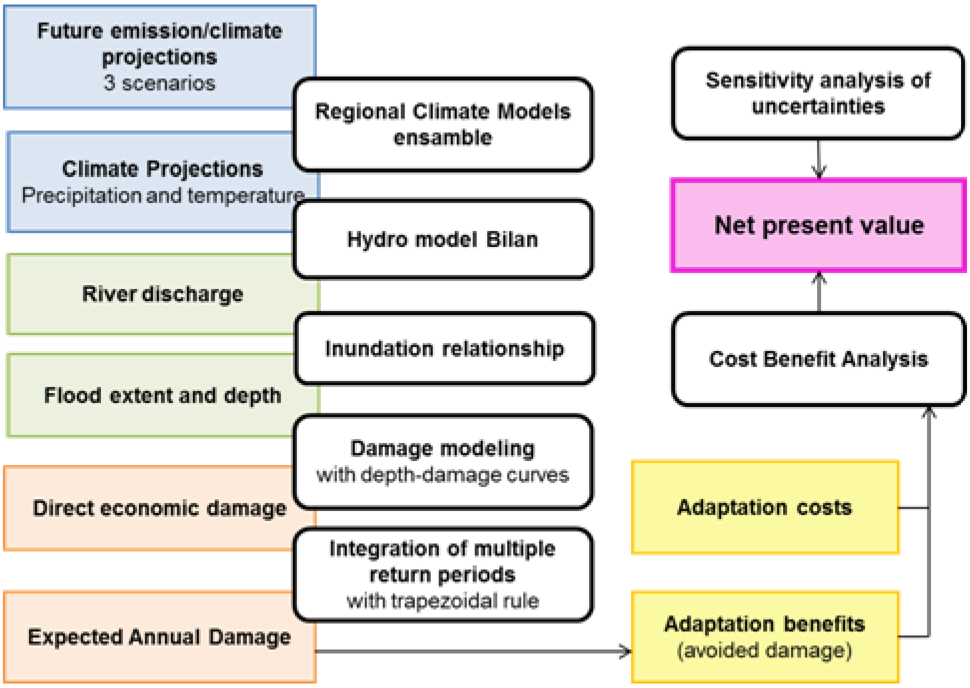
Adaptation being mostly a local intervention, lack of data can be a major issue. This may be related to information on climate impacts, typical unit cost of specific interventions, and non-market values. In Econadapt, guidance has been prepared on using climate information, transferring costs and benefits across scales and general guidance on dealing in incomplete information. Finally, reviews on the costs and benefits for the water sector, health, infrastructure, energy, agriculture, biodiversity and coastal zone management were carried out in Econadapt.

One long-standing issue in the adaptation field is the choice of the discount rate. Discount rates are factors used to increase the weight of costs and benefits occurring the shorter term, hence they are a representation of how society values the future. Discount rates currently used by many governments and businesses tend to largely undervalue the future and use high discount rates, which tends to profit to technical-type measures with clearer, short-term benefits. In addition, discount rates are stationary, and do not account for changing preferences of future generations. In Econadapt, methodologies have been developed to improve the consideration of option value in discounting and better account for changing preferences.

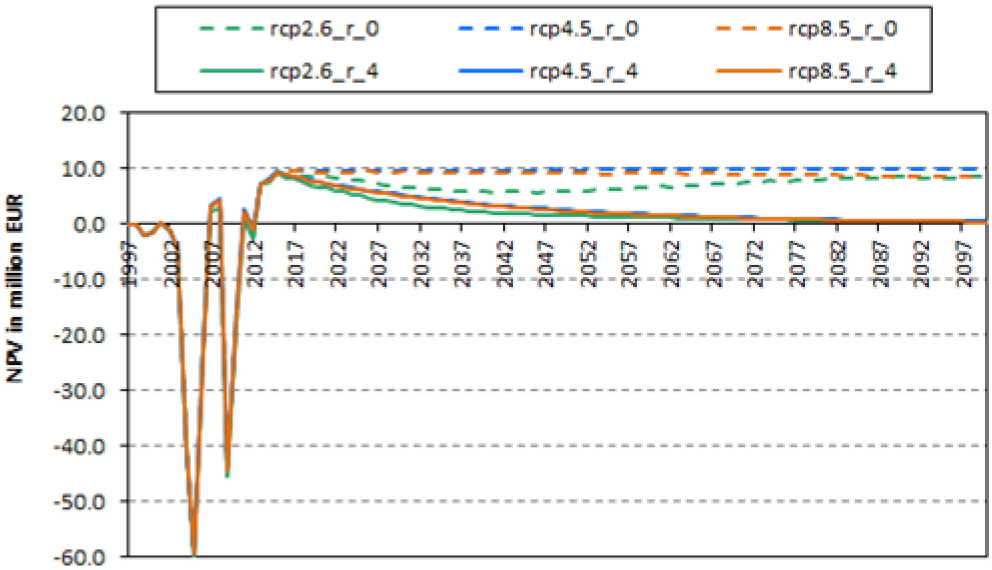
Another matter of consideration in adaptation CBA is how distributional and equity issues are incorporated in the analysis. In its conventional form, CBA aggregates costs and benefits accruing to different actors. This is a significant problem in adaptation as climate change impacts may disproportionately affect the most vulnerable communities and groups. In Econadapt, methodologies have been developed to account for distributional issues in CBA.

Case Study: Appraisal of adaptation options to river flood at the Vltava river, Prague

The study aimed to carry out an ex-post appraisal of adaptation options to flood risks in the city of Prague. The flood protection project consisted of several types of measures built between 1997 and 2014: fixed anti-flood earth dikes, reinforced concrete walls, mobile barriers and back-flow control. The costs were understood as the investments into flood protection and operating costs. These were calculated at 256 million EUR from data provided by the City Hall of Prague. Benefits were calculated as avoided Expected Annual Damage (average until year 2100) following the steps presented in the diagram. Benefits represented the differences between the status-quo situation (with a flood protection as before year 1997) and the situation with the adaptation investment (a 500-year protection realized in the period of 1999-2014)..



The study then estimated economic efficiency through the expected net present value (ENPV), with special regard to sensitivity analysis measuring the influence of changes in key input parameters in CBA when other parameters are held constant. The graph below displays the annual ENPV of flood protection measures in Prague according to different climate conditions (represented by RCP scenarios) and discount rates. The dashed lines represent a discount rate of 0%, while the solid lines are discounted at 4%. The average value of ENPV for all RCP scenarios is € 626 million, if we assume 0% discount rate. The differentiation between RCPs will have a moderate impact on ENPV, the RCP2.6 scenario will decrease the value by 30%, RCP4.5 will increase ENPV by 6% and RCP8.5 decreases by 4%. When considering 4% discount rate, then the effect of RCPs on ENPV is larger, the change is -107%, 14% and -7% for RCP2.6, RCP4.5 and RCP8.5, respectively.



The results of sensitivity analysis with respect to several discounting approaches indicated that the choice of the pure rate of time preference and consumption elasticity in the Ramsey formula of discount rate dramatically influenced CBA results, whereas the choice of the RIRA coefficient in discounting under intertemporal risk aversion had a negligible effect. The sensitivity analysis evaluated also the uncertainties in other CBA components such as damage calculation, infrastructure costs or methods of EAD calculation; the changes in these factors appear to have lower impact on the results of CBA.

Overall, results of the study showed that the flood protection measures provide a positive ENPV in the order of millions of Euros, depending on data and assumptions. The investments are thus efficient across scenarios of changing future climate. However, the study also showed that the selection of discounting approach and discount rate is a critical decision in the cost-benefit analysis: using a constant discount rate of up to 3% results in a positive ENPV, while a discount rate above 4% means the project is no longer efficient.

Further information: Sainz de Murieta E., Galarraga I., Abadie L.M., Kaprová K., Melichar J., Scussolini P., Kuik O. (2016). *Description of uncertainties associated with planned investments and incorporation in decision rules*. Deliverable 6.3, Econadapt FP7 research project.

Econadapt insights
Water and flood management: Costs and benefits of adaptation
Health: costs and benefits of adaptation
Energy: costs and benefits of adaptation
Infrastructure: costs and benefits of adaptation
Agriculture: costs and benefits of adaptation
Coastal zones: costs and benefits of adaptation
Applying alternative discounting rules: The equivalency principle
Integrating distributional objectives in the cost:benefit analysis of adaptation options
Assessing flood risk management: United Kingdom
Assessing flood risk management: Austria
Assessing flood risk management: Czech Republic
Integrated uncertainties and risk management for robust decision making
Appraisal of adaptation to river flood at the Vltava river, Prague
Dealing with changing preferences over time
Uncertainties and causes of uncertainties in climate change adaptation
Uncertainties and causes of uncertainties in climate change adaptation
Prioritisation of adaptation in the development context: Zanzibar
Prioritisation of adaptation in the development context: Rwanda
Sourcing and using climate information for economic assessments of adaptation