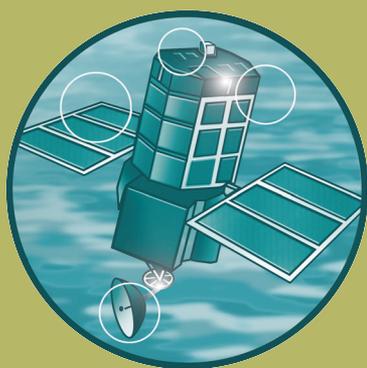


Integrating Cost-Benefit Analysis and Multi-Criteria Analysis of Flood and Coastal Erosion Risk Management Projects

R&D Project Record FD2018/PR2



Joint Defra/EA Flood and Coastal Erosion Risk
Management R&D Programme

Integrating Cost-Benefit Analysis and Multi-Criteria Analysis of Flood and Coastal Erosion Risk Management Projects

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Integrating cost-benefit analysis and multi-criteria analysis of flood and coastal erosion risk management

1. Introduction

Currently, flood and coastal defence (FCD) projects are subjected to economic appraisal, using the cost-benefit methodology described in Defra's *Flood and Coastal Defence Project Appraisal Guidance, Part 3: Economic Appraisal* [henceforth *PAG3*]. In a parallel report, *Developing a Cost-Benefit Framework for the Appraisal of Flood and Coastal Defence Projects* [henceforth *Cost-Benefit Framework*] I investigate the feasibility of changing this appraisal framework from the traditional 'calculus of social costs and benefits' to the 'calculus of willingness to pay (WTP)'. The main virtue of the calculus of WTP is that it allows the impacts of a project to be disaggregated between economic interest groups (e.g. government/taxpayers, businesses, households). This makes it easier to consider the distributional effects of projects and to identify the role of contributions from project partners (e.g. property developers), while retaining the essential logic of cost-benefit analysis (CBA).

A radically different appraisal methodology, *multi-criteria analysis* (MCA), is proposed in the report *Evaluating a Multi-Criteria Methodology for Application to Flood Management and Coastal Defence Appraisals* (Guidance Draft Final Report FD2013, Defra, Science Directorate and Environment Agency, November 2004; henceforth *Evaluating MCA*). The current paper is a preliminary assessment of the compatibility of CBA (using the WTP calculus) with the kind of MCA proposed by *Evaluating MCA*.

2. MCA versus CBA

2.1 *Evaluating MCA.* Relative to CBA, the main merit of MCA is that it provides an explicit method of taking account of project impacts that are not easily given monetary values (often called 'intangibles' in CBA). *Evaluating MCA* emphasises this feature of MCA as a means of taking account of 'social and environmental impacts' of FCD projects (Sections 1.2, 2.1). Two other merits are also claimed for MCA: that it facilitates stakeholder involvement, and that it makes the appraisal and decision-making process more transparent, thereby facilitating audit (Sections 1.2, 2.4.1).

2.2 *MCA Ability.* The ability of MCA to take account of a wider range of project impacts than can CBA is a product of its much looser theoretical structure. In the judgement of most economists (including the present author), it is a major merit of CBA that it is based on well-understood theoretical foundations, derived from more than a century of research in welfare economics. This gives CBA a high degree of internal consistency. Because all cost-benefit studies share a common methodology,

lessons learned in one study (or, indeed, in microeconomics more generally) can be transferred to other studies, allowing the accumulation of expertise.

2.3 CBA. It is particularly significant that CBA has a built-in standard of value: benefits are measured by the maximum amount of money that recipients would pay for them, and disbenefits by the minimum amount of money that recipients would accept as compensation for them. Thus (provided that the assumptions of economic theory hold) the CBA valuation of any given benefit or disbenefit is an absolute amount of money, which the analyst discovers or elicits; it is not defined relative to any particular view about the objectives of the project that creates those benefits or disbenefits. In this sense, CBA does not allow project objectives to be chosen by the government or influenced by stakeholders.

2.4 CBA benefits. The standard of value used in CBA plays an important part in preventing double-counting of benefits and in screening out special pleading. Because benefits are measured by the amount of money that recipients would pay for them, there can be no benefits that are not benefits *to specific individuals*. This imposes the discipline that a supposedly beneficial project impact cannot be registered in the CBA accounts unless a corresponding class of beneficiaries can be identified, and unless it can be shown that those beneficiaries actually value the impact, i.e. would be being willing to give up other valuable things in order to have it. It is not open to the government, a project sponsor or a stakeholders merely to stipulate that some type of impact is desirable or valuable.

2.5 Standard of value. In contrast, MCA has no built-in standard of value. *Evaluating MCA* treats 'the definition of project objectives' as the first stage of appraisal, in which stakeholders should be involved (Section 3.1.2). It might seem that this feature gives MCA greater flexibility. But meaningful comparisons can be made between appraisals only if they use a common standard of value. *Evaluating MCA* proposes a standard of value that is specific to a project, in two senses. First, the relative weights given to different impact categories are defined separately for each project, to reflect the particular concerns of stakeholders at the project level (Section 5.4). Second, the system for scoring impacts uses project-specific scales, e.g. giving a score of 100 to the option that is best on the relevant dimension and 0 to the one that is worst (Section 5.3). Thus, scores are not comparable across projects, only across alternative options for a given project (e.g. different levels of flood protection at a given site). This prevents the scores from being used in choosing between projects – one of the main functions of appraisal. For the same reason, cross-project inconsistencies in decision-making are made harder to detect – a serious loss of transparency relative to CBA.

2.6 Loss of consistency. Even if MCA takes its objectives and weighting system from the government of the day and applies these consistently to all projects, there still is a loss of consistency and transparency relative to CBA. Because the cost-benefit studies of different governments and different countries use a common standard of value, a much larger set of studies can be used to test the credibility of the findings of any particular one. As experience of CBA accumulates, it becomes

possible to use 'benefit transfer' methods (i.e. to estimate benefits in one situation by extrapolation or interpolation from previous studies of similar situations).

2.7 Recommended appraisal process. It is a reflection of some of these limitations of MCA that, despite proposing the use of project-specific objectives, weights and scoring systems, the methodology recommended in *Evaluating MCA* turns out to make little practical use of these features. The recommended appraisal process generates, for each option, a measure of absolute monetary benefit (summed over those benefits that have been measured in money), a corresponding measure of absolute monetary cost, and an intangible benefit 'score' on a project-specific 0 to 100 scale. However, this score is not comparable with the monetary benefits and costs. Notice that the problem is not that the score is not in monetary units: that problem could be overcome by using a standard 'conversion rate'. (Analogously, cost-effectiveness studies in health economics generate absolute measures of money cost and absolute non-money measures of benefit, e.g. gains of quality-adjusted life years [QALYs]; this allows projects to be ranked in terms of QALYs per £ of expenditure.) The real problem is that the money measures are *absolute* while the score is *project-specific*. In effect, the methodology proposed by *Evaluating MCA* ignores the scores (rightly, since they have no information content relevant to the decision-making task). Instead, it goes back to the absolute quantitative measures of intangible impacts (e.g. hectare-years of flood damage to agriculture, or kilometre-years of damage to railway track), considers what implicit money values of these absolute units of impact would allow the option to achieve the critical value of the benefit/cost ratio, and then asks whether it is 'reasonable' to suppose that the actual values are at least as great as the values required (Section 5.5.4). The examples that are given of tests of 'reasonableness' use benefit transfer from existing CBA studies (Box 5.3). The effect is to ignore the results of the MCA operations in favour of CBA.

2.8 Absolute measure. The project-specific scoring and weighting methodology proposed in *Evaluating MCA* serves little useful purpose. If a project impact cannot be measured in money, what we need is an *absolute* measure of that impact, expressed on some scale that applies across all options and all projects. Ideally, we would have an index analogous with the QALY in health economics, i.e. a single index for an impact category which combines quantity (in the QALY case, years of life) and quality (the quality of health enjoyed). A second best is to have quantity measures for each of a range of quality classes (e.g. in assessing impacts on sites with environmental value, the official status of a site – SSI, Special Protection Area, etc – might be used as an index of quality, and area might be used as an index of quantity). The appraisal framework should be structured so that such impacts can be displayed and taken into account alongside costs and benefits expressed in money.

2.9 Monetised costs and benefits. Given the merits of CBA as a framework for organising appraisal, it seems highly desirable to retain as much as possible of the structure of CBA within a broader appraisal framework which allows non-monetary impacts to be registered. This can be done in two complementary ways. First, the categories into which project impacts are classified in the Appraisal Summary Table (AST), representing the 'criteria' or 'objectives' of MCA, can be chosen so that, as far as possible, they correspond with a mutually exclusive and exhaustive classification

of costs and benefits that, in principle, are relevant for a CBA. This avoids double-counting and preserves the option of expanding the range of factors that are given monetary values as CBA methodology advances and as data that can be used for benefit transfer accumulate. It also ensures that the monetised entries in the Appraisal Summary Table are the constituent parts of a limited CBA, i.e. a CBA which takes account only of the monetised impacts. This then makes possible the second way of retaining useful elements of CBA. In addition to the AST which records all impacts, there can be a table which re-displays the monetised impacts as an Analysis of Monetised Costs and Benefits. Both of these ways of retaining CBA are features of the current appraisal framework for transport projects, as described in *Transport Appraisal Guidance* [henceforth *TAG*; Department for Transport website www.webtag.org.uk]. The present report follows a similar approach in relation to FCD appraisal.

3. Aligning costs and benefits with MCA categories

3.1 Introduction. This section lists the main items of cost and benefit that would appear in appraisals of FCD projects, if carried out according to current *PAG3* methodology, revised to the WTP calculus as **proposed** in *Cost-Benefit Framework*. (The letter beside each item refers to the classification in *Cost-Benefit Framework*.) Each item is considered in relation to the 'impact categories' in the AST proposed in *Evaluating MCA* (Table 2.3).

3.2. Construction and maintenance costs (a). In most cases, these costs are financed by central or local government agencies (via Defra, the Environment Agency, local authorities or internal drainage boards); occasionally, they are financed by contributions from project partners (e.g. property developers). Oddly, the AST provides no impact category to which these effects can sensibly be attributed. It seems obvious that impacts on taxpayers should be considered alongside other impacts. For comparison, the *TAG* AST has 'public accounts' as an 'objective' (the *TAG* concept which corresponds with 'impact category').

3.3 Changes in risk of damage to buildings (b) and abandonment of buildings (c). These (usually positive) effects of projects accrue to households, businesses and public agencies as owners or occupiers of property. The methodology for valuing these impacts is robust. They belong to the 'assets' category (one of the four 'economic' categories) in the AST.

3.4 Changes in risk of loss of agricultural output (d) and abandonment of agricultural land (e). These (usually positive) effects accrue to agricultural businesses. Typically, they are partly offset by increases in agricultural subsidy payments (a cost to government). The methodology for valuing these impacts is robust. Presumably these effects belong to the 'land use' category (another 'economic' category) in the AST.

3.5 Changes in risk of disruption to trade (f). This item refers to the indirect losses incurred by businesses when trade is disrupted by flooding. Such losses result from a business having to continue to pay rent, wages, capital charges, and so on while its revenue stream is reduced. In principle, these losses have a straightforward monetary value, although information about their magnitude is scanty. They seem to be classified under 'assets' in the AST.

3.6 Effects on transport/ utilities/ emergency services (g). These effects (normally positive) occur when FCD work reduces the risk of disruption to transport or utilities or removes the necessity for abandoning transport or utility infrastructure, or when the reduction of flood/erosion risk reduces the demands made on emergency services. Depending on the case, they may be attributed either to the relevant agency (e.g. highway authority, police service) or to private individuals (e.g. savings in travel time as result of a reduction in flood risks). The valuation methodology is robust, except possibly in the case of health and safety impacts of effects on emergency services. These impacts seem to be classified under 'transport' (an 'economic' category) and 'availability and accessibility of services' (a 'social' category) in the AST.

3.7 Intangible effects of flooding (h). The current methodology uses a notional value per flooding incident to take account of intangible effects (e.g. on health); this is attributed to households. The actual value used does not seem to have any sound theoretical justification. However, there are good grounds for assuming that flooding incidents do impose intangible costs, and 'number of incidents' is a natural if crude measure of quantity. These effects are classified under 'health and safety' in the AST.

3.8 Changes in environmental and heritage value (i). Where a FCD project leads to the conservation, loss or gain of a significant environmental or heritage asset, the *PAG3* methodology normally values that asset at the lowest of (i) the cost of creating a similar asset elsewhere, (ii) the cost of relocating the asset to another site, and (iii) the cost of local protection. If the least-cost option would *in fact* be used to preserve the asset, the cost should be attributed to the agency which bears the cost; if in fact the asset would be lost, the cost should be attributed to individuals as 'consumers' of the services provided by environmental and heritage assets. The costs of *actual* re-creation, relocation or protection are measurable in a straightforward way. However, the methodology of using these costs as a proxy measure of environmental disbenefit when relocation would not in fact take place is much more questionable. In defence of this methodology, it might be argued that the cost of relocation sets an upper bound on the disbenefit caused by the loss of the asset. The problem with this argument is that it implicitly assumes that the decision about whether or not to relocate is justified on cost-benefit grounds. But if we do not know what value is placed on the asset by its 'consumers', we cannot know whether that decision is justified or not. This is a case in which the current CBA methodology tends to obscure the actual impacts of projects. In the AST, there is an 'environmental' class of impact category, with six subsidiary categories. This

provides a great deal of scope for describing the environmental effects of projects. However, because there is no 'public accounts' category, there is no place to classify actually-incurred relocation costs.

3.9 Changes in recreational value (j). The *PAG3* methodology measures these by stated preference methods and 'benefit transfer' based on visitor numbers. That is, visitor numbers are estimated for the relevant sites, and then multiplied by generic 'values of enjoyment per adult visit' taken from stated preference studies of recreation sites of a similar kind. These valuations should be attributed to individuals in the role of consumers of recreation. Many economists (myself included) regard stated preference methods as less robust than the revealed preference methods used in other areas of CBA, but for the measurement of use value (e.g. recreational visits), the values they generate can probably be treated as rough but reasonably reliable indicators. The benefit transfer methodology has the further merit of ensuring consistency across appraisals. However appraisals are structured, we need an index of impacts on recreation. A money valuation arrived at by multiplying numbers of visits by 'values per visit' inferred by benefit transfer seems to be about the best currently feasible option. In the AST, 'recreation' is one of the 'social' categories.

3.10 Intensification of land use (k). In the *PAG3* methodology, these benefits are not measured. *Cost-Benefit Framework* proposes that development benefits are measured by increases in land values and included in the cost-benefit accounts but classified under a heading of 'non-FCD benefits'. It is not clear how such benefits would be classified in the AST; presumably they belong to one of the economic categories 'assets', 'land use' or 'business development'.

3.11 Changes in tax revenue and subsidy payments (l). This item does not appear explicitly in a CBA which uses the calculus of social costs and benefits, but it is an essential part of the calculus of WTP. Because the AST has no 'public accounts' category, it provides no classification for these impacts.

4. Aligning MCA categories with costs and benefits

4.1 Introduction. This section reverses the order of comparison. It considers each AST 'impact category' proposed by *Evaluating MCA*, and locates it in relation to CBA.

4.2 Economic categories: assets, land use, transport. These categories correspond with items (b) to (g) in CBA (but see paragraph 4.7 below).

4.3 Economic categories: business development. This category is treated as 'economic' in the sense of 'affect[ing] the local, regional [or] national economy'. It includes 'regeneration/ development' and 'competitiveness'. 'Regeneration/

development' is glossed as 'impacts on the creation of sustainable communities'; 'important indicators' of this include 'creation (or not) of jobs', 'enhancement of local environment', and 'enhancement of social and leisure opportunities'. 'Competitiveness' is glossed as including 'impacts to businesses (their costs, investment, market structure, etc)'. I find this category highly unsatisfactory. Some elements are clearly double-counting. 'Enhancement of local environment' is an environmental effect, and will be classified in the 'environmental' categories. 'Enhancement of leisure opportunities' seems to refer to recreational effects, for which there is a separate category. It is not clear what other 'social opportunities' are enhanced by FCD projects and not classifiable under specific benefit headings (e.g. 'transport'). The direct impacts of FCD projects on businesses are recorded in the 'assets', 'land use' and 'transport' categories. A firm is competitive by virtue of having low costs. If an FCD project reduces a firm's costs (e.g. by reducing the risk of flood damage), it makes that firm more competitive; but that cost reduction is already recorded under the other 'economic' impacts. In a competitive labour market, 'creation of jobs' is not an item of benefit at all. If an FCD project makes an area of land suitable for development, the benefit is the increase in the value of that land, which belongs in the 'asset' category. As far as I can tell, what *Evaluating MCA* means by 'business development' is essentially *a change in the geographic distribution of economic activity*. Given the conventional background assumption of a competitive market, there is no reason to take any explicit account of such geographical effects. I think the right approach is the one taken in *TAG*. *TAG* recognises 'wider economic impacts' as a benefit category, but imposes two strong restrictions on the definition of such impacts. First, 'wider economic impacts' are relevant only to the extent that they impinge on 'regeneration areas', understood as specific, narrowly-defined geographical areas in which market failures have led to specific problems, particularly high unemployment. Second, the inclusion of alleged 'confidence-boosting' effects of projects is strongly discouraged. In principle, such effects can be relevant in the case of regeneration areas, because of specific market failures. However, these effects are difficult to predict and very easy to exaggerate. *TAG* focuses on those 'wider impacts' that take the form of *specific* increases in employment *in areas of high unemployment*.

4.4 Environmental categories: physical habitats, water quality, water quantity, historic environment, landscape and visual amenity, natural processes. These are impacts which, in most cases, are inadequately dealt with in the current CBA methodology. Some of these impacts correspond with (i) in CBA but, as noted above, the CBA treatment of these impacts is weak. With some exceptions (e.g. effects on 'designated bathing waters', which may be picked up as recreational impacts) these are real costs and benefits, not taken into account under other AST headings. They are difficult to value in money, either because their impacts on individuals are diffuse (e.g. effects on downstream water quality), or because they involve existence value (e.g. the value individuals attach to particular landscape features).

4.5 Social categories: recreation. This corresponds with (j) in CBA.

4.6 Social categories: health and safety. This partly corresponds with (h) in CBA but, as noted above, the CBA treatment of health impacts is weak.

4.7 Social categories: availability and accessibility of services. This category is glossed as including ‘impacts on availability and accessibility to public services such as education, housing, emergency and cleaning services, health, cultural facilities and other’. In Table 4.3, the ‘type of quantitative information’ that is suggested as relevant is: ‘numbers/ types of services disrupted (schools, hospitals, shops, businesses, roads), population affected (based on no. of properties affected, for example)’. There is a risk of double-counting here. An FCD project impacts on the ‘availability’ and ‘accessibility’ of services in two main ways – through its effects of transport (e.g. if roads are closed because of flooding, the accessibility of services is reduced) and through its effects on the buildings from which services are supplied (e.g. schools and shops may be forced to close during flood episodes). CBA provides a robust methodology for valuing the first type of effect in terms of transport costs (item [g] in CBA, and the ‘transport’ impact in the AST). The second type of effect, in so far as it impinges on service providers, is counted in CBA under ‘risk of damage to buildings’ (b) and ‘disruption of trade’ (f). If there are disbenefits to consumers of services that cannot be valued in money, it seems better to treat them as ‘disruption of services’ alongside ‘disruption of trade’. This would reduce the risk of double-counting.

4.8 Social categories: equity. This is glossed as including ‘distribution impacts (consideration of interest of all groups of stakeholders), impacts on vulnerable groups (such as the elderly, children, etc) and social tensions (rise of serious divisions and conflicts within the community)’. Social tensions seem unlikely to be relevant for FCD projects. Distributional impacts are *not* a type of impact additional to the ones already considered. To the extent that it is genuine, each of the impacts already considered is an effect *on a specific group of individuals*; the array of these effects *is* the distributional impact of the project. When CBA is structured in terms of the calculus of WTP, each cost and benefit is attributed to some group of individuals. The distributional effects of a project can be seen by disaggregating costs and benefits according to the groups affected. Whatever distributional categories are deemed relevant should be incorporated into the classification of impacts. (E.g. ‘risk of damage to domestic buildings’ could be broken down between effects on owners, effects on occupiers and effects on insurers; effects on owners and occupiers might be further broken down by the income groups of the relevant individuals.)

4.9 Social categories: sense of community. This is glossed as including ‘impacts on the local community, level of satisfaction with the neighbourhood, social networks and community expectations’. In Table 4.3, the types of qualitative information suggested as relevant are ‘impacts on social networks, rate of exodus from locality, levels of satisfaction with neighbourhood, etc’; the relevant types of quantitative information are ‘numbers of types of population affected (based on no. of properties affected, for example) by flooding and erosion’. Reading between the lines, one gains the impression that the authors of *Evaluating MCA* are at something of a loss about what ‘sense of community’ is, let alone how to measure how FCD

projects affect it. The presumption seems to be that a sense of community is a good thing, that it is positively associated with a positive evaluation of the relevant geographical area, and hence negatively associated with the risk of flooding. These assumptions are not self-evidently true. In fact, there are good reasons for thinking that community cohesion is fostered by common exposure to hazards (the concept of 'common fate' in social psychology, 'the Dunkirk spirit' in popular mythology). But if FCD projects affect the sense of community in an area merely by providing FCD benefits in that area, 'sense of community' is redundant as an impact category: it is merely a redescription of the other impacts, in so far as they impinge on individuals as residents of the affected area.

5. Reconciling MCA and CBA

5.1 Introduction. In the light of analysis in Sections 3 and 4, I offer some suggestions for integrating the approaches of MCA and CBA, following the principles sketched in paragraph 2.9.

5.2 AST. The AST should be structured so that it includes the full range of project impacts considered in *Evaluating MCA*, subject to the proviso that there is no double-counting. To avoid double-counting, the 'business development' category should be redefined so that it corresponds with the much narrower 'wider economic impacts' objective of *TAG*. 'Availability and accessibility of services' should be dropped; all accessibility-related effects should be treated as components of impacts on transport, businesses and services. 'Equity' should not be treated as a separate impact category: information about distributional impacts should be provided through appropriate disaggregations of the information provided in the other impact categories. 'Sense of community' should be dropped as a redundant category. 'Impacts on public accounts' should be included as an additional category, so that construction and maintenance costs, and effects of indirect taxes and subsidies, can be reported.

5.3 Methodology. For each impact category (i.e. each row in the table), the AST should give summary statistics of the *absolute* impact in relevant physical units, standardised across appraisals. (The 'public accounts' category is an exception: here, there is no need for a non-monetary summary statistic.) A separate column should report the money value of each impact in all cases in which current methodology (i.e. *PAG3* adapted to the WTP calculus) allows this, irrespective of the robustness of the valuation method. Where monetary valuation is not possible, there should be a blank entry – *not* a project-specific MCA score: project-specific scores should not be used at all, for the reasons explained in Section 2. If summary statistics and CBA valuations are reported alongside one another, the reader has the option of using or not using those valuations as he or she judges appropriate. The limitations of CBA methodology are presented fairly, as blanks in the relevant columns, without ruling out the possibility of future improvements in that methodology.

5.4 AST structure. If the AST is structured in this way, the components of a 'cost-benefit spreadsheet' on the model of Table 1 of *Cost-Benefit Framework* will appear as the non-blank entries in the column of monetised values. There will be blank entries for the valuation of 'wider economic impacts' and for some or all of the environmental categories, depending on how the existing CBA methodology for valuing environmental/ heritage value is deemed to map on to the environmental categories. (As that methodology is weak, it is probably best to classify environmental effects into the categories that environmental scientists find most appropriate, rather than to use the economic categories that are most relevant for CBA.)

5.5 Analysis of monetised costs and benefits. Alongside the AST, there should be an Analysis of Monetised Costs and Benefits, on the analogy of the corresponding table in *TAG*. This analysis should be structured along the lines of Table 1 of *Cost-Benefit Framework*. It should be clear that the main entries in this analysis correspond with the entries in the 'monetised values' column of the AST.

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