



# HOW TO NOTE 2

CONDUCTING AN ECONOMIC  
ANALYSIS AND COST-BENEFIT  
ANALYSIS OF WEATHER AND  
CLIMATE INFORMATION SERVICES

# WEATHER AND CLIMATE INFORMATION SERVICES FOR AFRICA (WISER)

The Weather and Climate Information Services for Africa (WISER) programme is enhancing the resilience of African people and economic development to weather related shocks. The programme aims to improve the generation and use of weather and climate information across Sub-Saharan Africa.

WISER is funded with UK aid from the British people and will deliver maximum value for money by working in partnership and collaboration, capacity building and leveraging funds to ensure long term sustainable delivery and improvement of weather and climate services for Africa.

To find out more about the programme, please visit:

<https://www.metoffice.gov.uk/about-us/what/working-with-other-organisations/international/projects/wiser>

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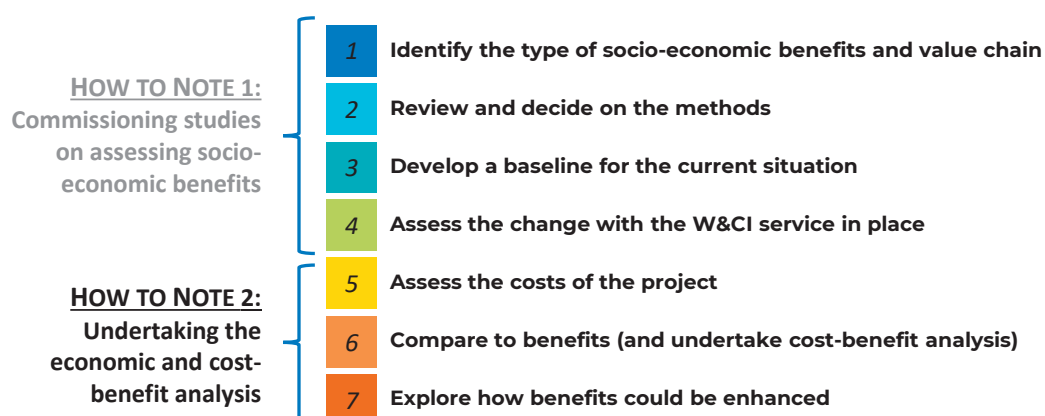
## AIM OF THIS HOW TO NOTE

To compliment the main socio-economic benefit (SEB) guidance by providing more detail on undertaking (1) economic analysis of benefits and (2) cost-benefit analysis (CBA) of weather and climate information (W&CI) services projects. Together, these constitute a SEB analysis.

**Target audience:** Project teams, researchers or consultants conducting the economic and cost-benefit analysis of W&CI service projects.

## UNDERTAKING SEB STUDIES

### The WISER SEB guidance presents a set of seven steps to conduct a SEB analysis (WISER, 2021)



This How to Note focuses on Steps 5, 6 and 7, on **the estimation of SEB and CBA of W&CI service projects**. This information will often feed into project reporting, such as the baseline report of a project and a Project Completion Report, but there is a need to ensure the methodological approach is sound and consistent.

This Note is complementary to How to Note 1 on commissioning SEB studies, which sets out how to gather information ex-ante (without the project) and ex-post (with the project) to estimate benefits (Steps 1 to 4). How to Note 1 and this second How to Note work **together, as benefits assessment and CBA constitute the complete SEB analysis**.

The findings of the ex post evaluation and benefits estimated feed into the CBA. It is thus recommended that the two sets of analysis are linked, with the same team of project staff and/or consultants being involved or undertaking both analyses.

### Undertaking Economic Analysis

A CBA assesses a project by estimating the economic benefits it produces over time, and comparing these to the costs, from a societal perspective, in present-value terms.

For WISER projects undertaking a SEB analysis, the CBA will use the information from survey work (e.g. from baseline and follow-up surveys), in particular the evaluation findings of the incremental benefits resulting from the project, to calculate economic indicators such as **net present values** and **benefit-to-cost ratio** (BCR) of the project, and **value for money** indicators (see the Glossary in the main SEB guidance on page 4).

These tasks require economic analysis and require a level of economic expertise. Such economic skills may exist in some organisations, but for others, it will be necessary to include additional researchers or hire consultants.

## STEP 5. ASSESS THE COSTS OF THE PROJECT

The project team, researcher or consultant undertaking CBA should report on the total incremental resource costs of inputs and activities for the intervention as a whole. As set out in the main SEB guidance ([see page 15](#)), this is not just the value of the funding (i.e. the project cost). It also includes the costs associated with the set-up and delivery of the service, including maintenance, and costs across the value

chain. This will include, for example, the costs of communicating information, or the costs of actions taken to increase use of information, such as training. There might also be third-party costs, if co-financing was provided to be a project from another donor for example, which will need to be considered alongside project funding.

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### Benefits

The analysis should then identify the benefits produced by the project. These should be:

- a) Consistent with the project Theory of Change (ToC) and Logframe; and
- b) Produced from information gathered in the evaluation and benefits assessment ([see How to Note 1](#)).

Benefits are the positive (or negative) changes in outcomes resulting from the intervention. As the main SEB guidance presents ([see page 5](#)), they include:

**Market benefits.** These are the direct financial benefits from the W&CI service e.g. reduced damage to buildings, infrastructure, or crops from early warning systems, or enhanced agricultural yields or avoided losses from seasonal forecasts. These can be expressed in units (e.g. increased revenues, reduced damage to buildings and assets (cost savings) or in British pounds (£)).

**Non-market benefits.** These include goods such as environmental and health outcomes, for example, reduced loss of life or injury from early warning, or environmental benefits from improved use of scarce resources (such as water), for which a market does not exist. In these cases, there are no direct monetary values to assess. The physical values of these benefits should be identified first, such as the numbers of avoided fatalities or reduction in emissions, and then they should be monetised. These non-market effects can be valued using

various techniques, including revealed and stated preference methods. For more information, see the guidance on environmental valuation available from the [OECD](#).

However, the valuation of non-market benefits is often challenging, and can require additional expertise, as well as considerable resources if primary studies are needed. Therefore, for many projects, the valuation of physical benefits may have to be made through the use of value transfer, i.e. using values from the literature, but with adjustments to ensure the transferability and applicability to the W&CI service project and context.

**Indirect or spill-over benefits.** These occur when project impacts generated in one sector (for example changes in agricultural production) have an impact on other sectors (such as changes in food security or changes in food industry production).

Ideally, the data to estimate benefits will be derived from the evidence gathered through surveys or other methods on the incremental costs and benefits brought about by the WISER project ([see How to Note 1](#)). If conducted properly, this should provide projects teams or consultants undertaking the CBA with the necessary information concerning benefits generated by the project, for example, per person or per household, relative to a baseline or counterfactual.

In some cases, monetary benefits may have been derived directly, such as through end-user

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surveys of benefits. However, in other cases, benefits will need to be monetised. The projects teams or consultants performing this step will need to ensure the methodology used for the monetisation of benefits is robust, and that any existing estimates are in line with economic appraisal practice<sup>1</sup>.

In a case where ex post evaluation has focused on a limited number of benefits only, such as benefits to agricultural users such as farmers, the CBA will need to make assumptions and/or draw from other sources of evidence (for example previous W&CI or SEB studies<sup>2</sup>) to describe, quantify and, if possible, monetise the full range of benefits resulting from the project. If the project is large, it may also be appropriate to investigate indirect benefits and macro-economic effects, as these will not be assessed through conventional surveys for several reasons:

- Project evaluations typically focus on micro-level impact (on the intervention (i.e. user groups only);
- Indirect and macro-economic benefits are only likely to materialise after a time-lag, and may follow after the main project has been implemented;
- The investigation of indirect impacts (such as on other sectors) requires surveying a higher number of stakeholders and even macro-economic modelling using economy wide models that assess the impact across sectors and on overall economic outcomes, such as GDP.

Further, the investigation of non-market impacts, such as environmental impacts, e.g. changes in greenhouse gas emissions from improved soil health, requires that the research team have specific skills and expertise to collect data or make appropriate transfers of existing estimates to the project context.

In all cases, the different types of benefits should be presented separately, with a clear description of who the beneficiaries are for each type of benefit, to allow a separate economic analysis for each benefit stream. Further guidance on this is presented in the main SEB guidance (see page 6). The separate benefits streams are then monetised. Benefits should be valued

using market prices, or if market prices are distorted or not available, valued through the use of shadow prices (which provide estimated values).

### Undertake a CBA

Once the cost and benefit data are collated, the next step is to develop the CBA.

First, is to build up the distribution of costs and benefits over time. A table is often the best way to present the time dimension and the distribution of costs and benefits.

It is important when developing this table – and the profile of costs and benefits over time – to develop an accurate and realistic representation of the project, which matches the actual profile of the project.

For example, costs are likely to be borne in the early years as the project is set up, but benefits will only be generated when the service is fully up and running and may increase as more users act with the information. This means there will be a delay between costs and benefits. At the same time, benefits will usually extend beyond the period of project funding. The annual benefit profile should therefore reflect these aspects, for example, to phase up at the start, and to deliver fully during project funding. It is also noted that for some cases, the costs of operation may not be sustained after the project funding has finished. In this case, it is likely that benefits in these years may also be reduced if the project activities are not fully sustained.

It is to be noted that the length of the appraisal period will vary. In WISER, the CBA was undertaken for 10 years, reflecting a three-year project and the continued benefits after project completion. A large project with continued investment could be appraised over a longer period.

The total incremental costs and benefits occurring over time should then be expressed in present value terms, using discounting, outlined in Box 1. As described in the main SEB guidance (see page 16), discounting is a standard approach in economic appraisal and takes account of the fact that individuals and society prefer to receive goods and services now rather than later.

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### Box 1. Discounting

Costs and benefits in economic appraisal are estimated in 'real' base year prices, which means the effects of inflation are removed. Costs and benefits that arise in different future years are adjusted to provide equivalent, directly comparable values by weighting them by **discount factors**. The following formula is used:

$$\text{Discount factor} = 1/(1+r)^n$$

Where

r = discount rate,

n = year

The cost or benefit value in each future year is multiplied by the relevant discount factor for that year. For example, in year 5, with a 10% discount rate, the discount factor is estimated as  $1/(1+0.1)^5$ , which equals 0.62. This value is multiplied by the cost or benefit in this year, i.e. the present value of £1 in year 5 would be £0.62.

The discounted costs in each future year are then added together to give the total present value of costs. The same calculation is undertaken for benefits. These can be combined to estimate a net present value (NPV), which is the total present value of benefits minus the total present value of costs. A positive NPV indicates the project has net economic benefits.

This same information can also be expressed as a BCR, estimates as the total present value of benefits divided by total present value of costs. A BCR greater than 1 indicates the project has net economic benefits.

An example of the calculation of the discount rate over time and its application is shown in Worked Example and in Table 1 on the next page of this How to Note.

The CBA assessments in WISER used a 10% discount rate. This is a typical rate used by development partners in developing country project appraisals and evaluations. However, it is also recommended as good practice to test the CBA results using the standard discount rate used in UK policy appraisal of 3.5% (see HMT Green Book<sup>3</sup>) as good practice as part of sensitivity analysis.

It is stressed that this is an extremely straight-forward example, to demonstrate

the core concepts of CBA, focusing on one user benefit only. Such a simple application might be appropriate for a small and targeted project.

However, a larger project would likely need a more detailed analysis, including a wider range of users, and a very large project should consider indirect effects as well, potentially including wider economic effects. For a very large project, it can also be useful to assess and report on the fiscal impact of the project, for example, changes in public revenues (i.e. taxes and/or duties) at both central and local levels resulting from increased economic activity and exports resulting from the use of a W&CI service.

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### Worked example: a CBA of a W&CI service

The following sets out a hypothetical, simple worked example, with the calculated costs and benefits set out in Table 1. A project worth £600,000 has been funded for three years, with project costs equally split over the three year period. At the same time, a co-funder has contributed £300,000, also split over the same three years.

**Table 1. Illustrative simple CBA of a W&CI service**

Discount Rate	10%										
Year	0	1	2	3	4	5	6	7	8	9	10
Discount Rate Factor	1.00	1.10	1.21	1.33	1.46	1.61	1.77	1.95	2.14	2.36	2.59
Inverse DR Factor	1.00	0.91	0.83	0.75	0.68	0.62	0.56	0.51	0.47	0.42	0.39
<i>Values in £thousands</i>											
<b>Project costs</b>		200	200	200							
Third-party costs		100	100	100							
W&CIS operating costs		0	0	50	50	50	50	50	50	50	50
User-costs		0	0	3000	5000	5000	5000	5000	5000	5000	5000
Total costs (undiscounted)		300	300	3350	5050	5050	5050	5050	5050	5050	5050
Total costs discounted (cost*DF)			273	248	2517	3449	3136	2851	2591	2356	1947
Present value costs (sum of discounted cost)	21509										
<b>Project benefits</b>		0	0	9000	15000	15000	15000	15000	15000	15000	15000
Total benefits discounted (benefit* DF)		0	0	6762	10245	9314	8467	7697	6998	6361	5783
Present value benefits (sum of discounted)	61628										
<b>Net present value (NPV benefits – NPV costs)</b>	<b>40119</b>										
<b>BCR (NPV benefits / NPV costs)</b>	<b>2.9</b>										

This funding has been used to purchase two new meteorological stations, and training for national authorities and radio broadcasters on developing impact-based forecasts for farmers in two climate-vulnerable sub-regions of a country, reaching 100,000 farmers at the end of the value chain as the users of the information. To move to a fully operational service will cost on average a further £50,000 per year. These annual costs cover all the necessary activities to operate and maintain the infrastructure, to conduct regular software updates and regular training for staff, and to update and maintain the website where impact-based forecasts are published online. They also include the costs borne to send information via SMS to farmers.

The farmers' costs as the users of the information include costs to access the service and the costs of the actions they subsequently take. Costs to access the information includes

<sup>1</sup> Note that a higher social discount rate is used by development partners (e.g. FCDO) for appraisal in developing countries, as compared to the social discount rates used for an OECD country such as the UK. This is due to several factors, but includes the higher social costs of capital / higher growth rates and greater risks.

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the annual charge farmers pay for receiving SMS directly to their phones. The survey has also collected data on the additional costs incurred by farmers in response to the information received, which included storing water ahead of drought warnings, and building defences ahead of flood warnings. The survey and subsequent analysis has estimated these costs are on average £50 per annum per farmer. For the CBA it is therefore estimated that for a population of 100,000 farmers, annual user costs are £5 million.

The additional benefits of taking action include cost savings from avoided flood damage and yield losses due to water scarcity. These were found to be worth on average £150 per annum per farmer, giving total benefits for 100,000 farmers of £15 million per annum.

The CBA was undertaken using a 10% discount rate which gives a net-present value of £40 million, and BCR of 2.9, shown at the bottom of Table 1. This shows the project has a highly positive outcome, as benefits considerably outweigh costs. This is shown by a positive net present value and a BCR that is greater than 1.

### Assess attribution

For some projects, WISER funding will be the sole source of funding. There might however also be other contributors, such as existing support and funding from other organisations or agencies. In this instance, there is a need to attribute the specific contribution of WISER as compared to other funding sources or activities. This means that the project team and/or consultant undertaking the CBA will need to assess the proportion of benefits attributable to the WISER project vis a vis other organisations or projects.

Two alternative cases are possible:

- 1) WISER is a co-financier of the project under consideration; or
- 2) WISER is the only financier of the project, but other projects might have contributed to benefits as well.

In the first case, the default should be to present the benefits of the project pro-rata for the estimated benefits, based on the WISER proportion of the overall value of inputs to the project.

The second case is different, as it requires an understanding of other donors' activities that support the W&CI service in the same country or region, and the identification of those that are likely to have contributed more signifi-

cantly to WISER project benefits. This could occur when different projects have provided support to different stages in the value chain, and thus have together contributed to final benefits.

Attribution assessment can be challenging to undertake. As such, it is recommended the analysis identifies and considers only those projects that have played a significant role in contributing to benefits. Such qualitative assessments can then be used to justify a precautionary and reasonable estimate of the share (i.e. percentage) of benefits fully attributable to the WISER project under consideration.

When there is significant co-financing, it is good practice to adjust the reported benefits, if these are being reported by the funder (as is the case in WISER). Benefits can be reported first as the total project benefits, and then also reported taking account of attribution, with the second values adjusted down based on the pro-rata contribution of costs. In the example in Table 1 above, the main funder has provided £600,000 over three years, and at the same time, a co-funder has also contributed £300,000 over the same three-year period. In this instance, when attributing the benefits to the main funder for reporting, these should only be 2/3rds (or 66.7%) of the total benefits, i.e. 2/3rds of the present value of benefits ( $0.67 * £61,628,000 = £41,085,000$ ).



## STEP 7. SENSITIVITY ANALYSIS

The final step is to test the robustness of the CBA. Ideally a study should consider biases and uncertainties, potential omissions, and undertake sensitivity analyses for key variables, testing how these affects the results. This analy-

sis can also be used to explore how benefits could be increased. Guidance on undertaking sensitivity analysis is included in the main SEB guidance (see page 18). This section expands the guidance with a worked example.

### Worked example: sensitivity testing in CBA

An example of sensitivity testing is presented below in Table 2, building on the previous worked example of CBA shown above. As highlighted in the main SEB guidance, it is good practice to test key assumptions in a project. This can include the use of alternative discount rates, or assumptions and values for costs and benefits. In the example in Table 2, a sensitivity test has been run to test how the project performs if future funding is lower than expected, influencing the project's sustainability.

**Table 2. Sensitivity analysis for a CBA of a W&CI service**

Discount Rate	10%										
Year	0	1	2	3	4	5	6	7	8	9	10
Discount Rate Factor	1.00	1.10	1.21	1.33	1.46	1.61	1.77	1.95	2.14	2.36	2.59
Inverse DR Factor	1.00	0.91	0.83	0.75	0.68	0.62	0.56	0.51	0.47	0.42	0.39
<i>(Values in £ thousands)</i>											
Project costs		200	200	200							
Third-party costs		100	100	100							
W&CIS operating costs		0	0	50	40	30	20	10	0	0	0
User-costs		0	0	3000	5000	3500	2450	1715	0	0	0
Total costs		300	300	3350	5040	3530	2470	1725	0	0	0
Total benefits (gross)		0	0	9000	15000	10500	7350	5145	0	0	0
Total net benefits (undiscounted)		-300	-300	5650	9960	6970	4880	3420	0	0	0
Total net benefits (discounted)		-273	-248	4245	6803	4328	2755	1755	0	0	0
<b>BCR</b>	<b>0.9</b>										

In Table 2, there is a decrease in operational and maintenance costs assumed from year 4 (highlighted in yellow), with an interruption to the service in year 8. This would reduce benefits from year 4 (for example in terms of accuracy and reach), followed by the early end of the service in year 8. In the CBA, this is assumed to lead to a gradual decrease (30% per annum) of users from year 4, and no benefits from year 8. In this case, the NPV and BCR are significantly reduced, and BCR would fall below 1, to 0.9 as shown in Table 2. This shows that in order pass a VfM test (see page 22 in the main SEB guidance), the sustainability of the project is critical, and might require greater attention in project design and implementation.

## FINAL RECOMMENDATIONS

This How to Note focuses on Steps 5, 6 and 7, on undertaking the CBA of W&CI service projects. The results of a CBA can provide the economic case for a project. It can also feed into the VfM analysis, as set out in the main SEB guidance ([see page 22](#)).

However, many of the tasks require economic expertise to undertake, and it is important that the project team include staff with the right competence and expertise for such analysis, or bring this expertise into the project, such as by contracting a consultant.

## REFERENCES

- 1 There is more detailed technical guidance on methods in the WMO [Valuing Weather and Climate: Economic Assessment of Meteorological and Hydrological Services](#) and in UK economic appraisal guidance in the [Green Book](#).
- 2 There are also more technical descriptions – and reviews of previous applications for different project types – in [Soares et al. \(2018\)](#), [Vaughan et al., \(2019\)](#), and in the Asia Regional Resilience to a Changing Climate (ARRCC) report on [Valuing climate services](#) (Suckall and Soares, 2020) which includes consideration of advantages and disadvantages of different approaches.
- 3 HMT (2020). The Green Book. <https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-government/the-green-book-2020>

