Annex 3b. Cost Benefit Analysis for two illustrative example subprojects

Programme title: Ecosystem-based Adaptation in the Indian Ocean (‘the Programme´)

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Summary

The Cost Benefit Analysis (CBA) for the two illustrative subprojects was conducted in a Microsoft Excel file submitted as Annex 3 of the Funding Proposal and for which this document serves as a companion narrative.

CBA has been applied to two subprojects that have been chosen as illustrative of the types of subprojects that AFD and CEPF expect Civil Society Organizations (CSOs) to propose for funding. In both cases, the examples are hypothetical but for key parameters we have used data from real examples in countries with similar socio-economic and ecological situations as those found in the Programme countries. The first example is for a mangrove restoration subproject. The second is for a subproject that combines active forest restoration and improved protection of a degraded forested watershed.

The objective of the CBAs is to question whether expected benefits from the subprojects outweigh the expected costs. Since the Programme is focused on Ecosystem based Adaptation, the benefits considered in the CBA have been limited to those that derive from ecosystem services. In practice, however, it is likely that subprojects will also include activities to boost revenues from improvements to livelihoods. As a general principle, where data has not been available for cost and benefits, we have tried to err on the side of using conservative assumptions about the value of benefits that would be derived from the subprojects.

The illustrative mangrove subproject is based on the premise that mangrove restoration will reduce flooding for a coastal community. Mangrove restoration is a natural approach to reducing damage from coastal flooding from storm surges and sea-level rise, as well as strong winds. This “green infrastructure” can reduce coastal flooding that damages homes and other infrastructure as well as reducing coastal erosion and saltwater intrusion into freshwater aquifers, reducing risks to agriculture. Mangroves also support fish and shellfish production (Ronnback 1999) and increased fisheries production is an important co-benefit of mangrove restoration activities. However, it may take up to 10 years to regrow cleared or degraded mangroves to a sufficient height and density to obtain these benefits. Although mangroves may not provide full protection from flooding, this green infrastructure offers multiple benefits that physical infrastructure cannot provide.

The second illustrative subproject focuses on protecting 10,000 hectares of forest and restoring 50 hectares of native tree cover along watercourses in a watershed. The subproject is based on the premise that these actions will reduce flood risk to inhabitants of the watershed, improve agricultural production and improve water quality and quantity for inhabitants.

Protection and restoration of forests are important for the way that watersheds function. Rain falling on a forest interacts with the canopy, forest floor, and soils before leaving the forest in stream flow or groundwater recharge. Most of the rainfall falling on forests directly percolates into the soil. Rainfall absorbed by roots of forest vegetation circulates through the plant, and most is returned to the atmosphere via transpiration, eventually contributing to clouds and rainfall and continuing the water cycle. The remaining water slowly percolates through and is released from the soil providing water for stream flow or groundwater recharge. Forest soils also act as a buffer against heavy storms, slowing the rise of streams and minimizing flooding. This slowing of runoff is especially important in areas with degraded habitats and compacted soils, which otherwise force water quickly into streams and rivers rather than allowing it to be absorbed into the soil for groundwater recharge. Roots of forest trees, including near to watercourses, also physically bind soil and lead to reduced erosion. As a result,

forested watersheds tend to slow water runoff during heavy rainfall and release water into watercourses more gradually. Watercourses in forested watersheds also have less sediment and lower turbidity, which is important for access to clean water for people.

Forested watersheds are also important for agriculture. Natural vegetation retained at the perimeter of farmland is a strong determinant of resistance to soil erosion and retention of soil and moisture. Using a simplified representation of agricultural production, Vogl et al. (2017) estimated financial benefits of increased water retention in soils downhill from areas of native forest as between $68 and $479 per hectare per year in the Upper Tana River Basin, Kenya, depending on the crop grown. Furthermore, when farmers maintain upland vegetation cover, they not only reduce losses from sediment washing off their land, they maintain benefits from organic material-rich sediment that remains on their land.

For each of the two subprojects, the Excel workbook file provided as Annex 3 includes two scenarios: the “without subproject” baseline and a “with subproject” scenario. The assumptions used for the two subprojects are described in this document and can be modified in the Excel file provided as Annex 3 (on the two “Parameters” worksheets). For each subproject, a financial analysis is provided including costs (expressed as per hectare costs) and some of the important expected benefits (expressed as per hectare benefits). For each subproject there are annual summaries of the net benefits from the subprojects and the net incremental benefits (i.e. by comparison to the “without subproject” baseline case). The spreadsheet includes calculations of the Net Present Values (NPV) of the net benefits and also for the net incremental benefits (i.e. by comparison to the “without subproject” baseline case). For the NPV calculations, values using discount rates of 0%, 3%, 7% and 12% are provided by default. The spreadsheet also provides calculations of the Internal Rate of Return (IRR) of the subprojects.

Both of the examples in Annex 3 show that the subprojects are cost effective and benefits significantly outweigh costs. For example, for the default values of the model, the mangrove restoration subproject has an internal rate of return (IRR) of 34% over a 25-year period. The Net Present Value (with a 12% discount rate) of the mangrove restoration subproject scenario is USD 555,148 higher than the NPV of the ‘without project’ scenario over a 25-year time horizon. The sensitivity analysis included in the model shows that the subproject is robust to changes in costs and benefits. The IRR drops to 20% if total costs are 30% higher than assumed and benefits are 30% lower, and it rises to 57% if costs are 30% lower and benefits 30% higher than assumed in the default model parameters. For the watershed example, the IRR is 28% over a 25-year period, dropping to 20% if costs are 30% higher and benefits 30% lower, and rising to 38% if costs are 30% lower and benefits 30% higher. The NPV over a 25-year time horizon (with 12% discount rate) is USD 1,990,500 higher in the subproject scenario by comparison to the ‘without subproject’ scenario. The models in Annex 3 also allow for comparison of two climate change impact scenarios (a best- and worst-case scenarios). For both subproject examples, the subprojects remain cost effective and have higher NPVs than the ‘without project’ scenarios irrespective of the climate scenario used.

The aim of the CBAs is to demonstrate that the subprojects are cost effective and represent value for money, rather than to provide accurate valuations of all subproject benefits. As such, a conservative approach was used for assigning values for subproject benefits and only a few of the local benefits from ecosystem services were included in the models. For example, although carbon sequestration will be an important global benefit of mangrove and terrestrial forest restoration and protection, this benefit has been excluded from the models. If more of the potential ecosystem benefits of the subprojects were included in the CBA then they would be even more cost effective than the figures presented above suggest.

The illustrative subprojects and assumptions

CBA has been applied to two subprojects that have been chosen to illustrative of the types of subprojects that AFD and CEPF expect CSOs to propose for funding. In both cases, the examples are hypothetical but for key parameters we have used data from real examples in countries with similar socio-economic and ecological situations as those found in the Programme countries. The first example is for a mangrove restoration subproject. The second is for a subproject that combines active forest restoration and improved protection of a forested watershed. The assumptions used for the two subprojects are described below. The objective of the CBAs is to question whether expected benefits from the subprojects outweigh the expected costs. Since the Programme is focused on Ecosystem based Adaptation (EbA), the benefits considered in the CBA have been limited to those that derive from ecosystem services. In practice, however, it is likely that subprojects will also include activities to boost revenues from improvements to livelihoods. As a general principle, where data has not been available for cost and benefits, we have tried to err on the side of using conservative assumptions about the value of benefits that would be derived from the subprojects.

For each of the subprojects, the Excel workbook file includes two scenarios: the “without subproject” baseline and a “with subproject” scenario. The assumptions used for the two subprojects are described in this document and can be modified in the Excel file provided as Annex 3 (on the two “Parameters” worksheets). The CBA for each of the four cases (i.e. 2 subprojects x 2 scenarios each) is provided as a separate worksheet. Each of these worksheets provides a financial analysis including costs (expressed as per hectare costs) and some of the important expected benefits (expressed as per hectare benefits). The two “with subproject” worksheets provide annual summaries of the net benefits from the subprojects and the net incremental benefits (i.e. by comparison to the “without subproject” baseline case). The two subproject worksheets include calculations of the Net Present Values (NPV) of the net benefits and also for the net incremental benefits (i.e. by comparison to the “without subproject” baseline case). For the NPV calculations, values using discount rates of 0%, 3%, 7% and 12% are provided by default and a user-defined discount rate can be entered on the parameters worksheet (which is set at 5% in the default case). The worksheets also provide calculations of the Internal Rate of Return (IRR) of the subprojects. Inflation can be included in all the annual cost and benefit calculations but is set by default at 0%, but this can be modified in the respective Parameters worksheets if required.

For each of the two subprojects, a worksheet (“Sensitivity analysis – mangroves” and “Sensitivity analysis – Watershed”) is provided giving a graphical representation of sensitivity of the models. These are intended to provide a global view of sensitivity to costs and benefits without the need to modify individual parameter values, although that can also be done by modifying values in the “Parameter” worksheets. Graphical representations of the net incremental benefit (i.e. subproject versus no subproject) are provided under the 0%, 3%, 7% and 12% discount rate scenarios. Two fixed graphs (that don’t update when changes are made to the values on the “Parameter” tabs) are provided on these sheets: one representing the net incremental benefit of the subproject in the best case scenario for future climate change and one representing the net incremental benefit of the subproject in the worst case scenario for future climate change. A third graph showing incremental benefit will update based on the user-defined parameters. The “Sensitivity” worksheets also include tables showing how IRR and NPV (at year 25) change if global subproject costs and benefits vary within a range of -30% to +30%. In other words, the extreme displayed in the table shows the situation if costs are 30% higher and benefits 30% lower than the default values provided.

The worksheets allow for multiple costs and benefits to be considered for each subproject. For the examples provided, the default values use conservative estimates of benefits from ecosystem services. In particular, the number of benefits considered is restricted. The objective here is to demonstrate that the net benefits of the subprojects outweigh the net costs rather than to provide accurate estimates of the total benefits. Since the examples clearly show net benefits when just a few ecosystem service values are considered, other types of ecosystem benefits have not been examined in detail, but the worksheet would allow this. For example, in both subprojects the value of carbon stocks (from restoration activities and avoided deforestation due to forest protection) has not been included even though this will be a significant additional benefit of the subprojects.

Mangrove Restoration Subproject

The first illustrative subproject involves restoration of mangroves to reduce flooding for a coastal community. The data used for the costs and benefits of the subproject come primarily from a study by Narayan *et al*. (2017) who examined the costs and benefits of a mangrove restoration project in the Icidua and Mirazane communities of Mozambique (a population of approximately 9,100 spread across 1,817 households). This study was considered to be highly relevant to the proposed Programme given Mozambique's proximity to the Programme region, the similar climatic risks to coastal populations in Mozambique and the Programme region, the similarity of Mozambique's socio-economic situation to Comoros and Madagascar, and the richness of the data that the study provides.

For the CBA of the mangrove subproject we developed and compared two scenarios:

- A "without subproject" scenario with no coastal adaptation measures. This is the business as usual scenario and under this scenario storm damage continued to impact the communities through direct damage to houses;
- A mangrove restoration project involving replanting mangrove seedlings on 22 hectares of riverbank and coastal flood plains near the communities. Under this scenario the communities realise benefits in the form of reduce flood damage to homes and benefits from new fisheries production in the restored mangrove areas.

Key assumptions used:

- **Time period**: A 50-year time horizon was used in the model but for analysis of IRR we considered that a time horizon was of more interest. The model assumes that the benefits of mangrove restoration are low at first and increase as the mangrove trees grow to maturity (assumed after 10 years). Once mature, the benefits stop increasing but remain constant over time.
- **Discount rate**: For sensitivity analyses, discount rates of 0, 3%, 7% and 12% were used. The Excel file also allows users to include a user-defined discount rate. We report NPVs based on the 12% discount rate.
- **Mangrove growth and survival**: Data on mangrove growth rates followed the assumptions made by Narayan et al. (2017) in their study. They based information on mangrove growth rates on literature review and expert judgements. The base case assumed an 80 percent survival rate for seedlings and a 95% survival rate for mature trees. The high mature tree

survival rate was justified by including "enforcement" costs so that the restored areas would be actively protected.

- **Costs**: Cost data used was based on figures quoted by Narayan et al. (2017), which were based on the experiences of the USAID Coastal City Adaptation Project (CCAP). Costs included relate to storm damage to homes (derived from house values and probability of flood risks), mangrove restoration costs and mangrove protection costs over the long term.
- **Benefits**: The benefits included in the analysis were from storm protection and the expected improved production of fish, crabs, shrimp and clams associated with restored mangroves. Values for storm protection were based on the findings of Narayan et al. (2017). Values for fisheries production in mangroves come from a publication by Ronnback (1999) of the economic value of seafood production supported by mangrove systems. The model also allows for including additional benefits that are expected from mangrove restoration such as provision of fuelwood, water filtration, improvements in agricultural production related to better protection against storm surges, and carbon sequestration value. However, by default these benefits were not included in the models. Similarly, existence value and biodiversity value were not included in the CBA. The model also allows for including both the costs and benefits that would be associated with technical support for livelihood support projects. Again, by default these were not included although such activities could well be proposed and would likely further increase the net benefits of such subprojects. For example, in the Mozambique example described by Narayan et al. (2017), both agricultural and apiculture livelihood activities were proposed by USAID's CCAP alongside the mangrove restoration activities, which further enhanced the net benefits of the proposed intervention.

Details of the default values used for each of the parameters in the CBA can found on the "Parameters – mangrove" worksheet in the Excel workbook provided as Annex 3. For each value the source of the data is provided. Full references for publications cited are provided on the worksheet "References" and also listed in the reference section at the end of this document.

Costs

Storm damage costs

Storm damage costs were calculated as follows:

Annual home damage from storm events (cost per hectare) = (Probability of a medium storm event x Home damage caused in a medium event) + (Probability of a large storm event x Home damage caused in a large event)

where

Home damage in a medium event (cost per hectare) = (Number of households x Average house value x % of houses damaged in a medium storm event x % house value lost if there is damage x % of houses in the community at risk of flood damage) / Number of hectares restored

and

Home damage in a large storm event (cost per hectare) = (Number of households x Average house value x % of houses damaged in a large storm event x % house value lost if there is damage x % of houses in the community at risk of flood damage) / Number of hectares restored

Probabilities of flooding events were derived by Narayan (2017) based on flood risk analysis by the Mozambique National Institute for Hazard Management - INGC (2009). The same values were applied to the model and two Sea Level Rise (SLR) climate scenarios can be used (see Table 1). By default, the low SLR (best case scenario) is used in the model as we assume it has less uncertainty associated with it and it provides more conservative estimates of the net benefits derived from the subproject.

Table 1. Probability of medium (3.2 m) and large (4.4m) flooding events under two climate change scenarios.

Sea-level rise scenario	Annual Probability of a 3.8m flooding event	Annual Probability of a 4.4m flooding event
Low SLR (best case)	33%	17%
High SLR (worst case)	100%	100%

Storm damage to homes is included as a cost in the models under both the "without subproject" baseline and the "Mangrove restoration subproject" scenarios. The default values used to calculate average storm damage costs are provided in the table below.

Table 2. Default values used for parameters related to home storm damage costs

Parameter	Default value	Source of information
Number of households	1817	Based on household surveys as reported by Narayan et al. 2017
Number of hectares of mangrove restored	22	Based on example in Mozambique as reported by Narayan et al. 2017.
Value per house (USD)	915	$915 based on household surveys as reported by Narayan et al. 2017
% homes damaged in medium events: without subproject	80%	Studies on the impact of a tsunami in 2004 indicated that in areas where the mangrove forests were degraded, damage reached 80-100 percent of villages. As reported in UNEP 2011
% homes damaged in large events: without subproject	100%	(See above)
% homes damaged in medium events: with mangrove restoration subproject	7%	Studies on the impact of a tsunami in 2004 indicated that in an area with an intact mangrove belt only 7 percent of the villages were severely affected. As reported by UNEP 2011.
% homes damaged in large events: with mangrove restoration subproject	7%	(See above)
% of houses in community at risk of flood damage	25%	Estimate set for illustrative subproject

% of house value lost if damaged	10%	Estimate set for illustrative subproject
Home damage in medium events: baseline without subproject (USD/ha)	1511	Derived from default values above
Home damage in large events: baseline without subproject (USD/ha)	1889	Derived from default values above
Home damage in medium events: with mangrove restoration (USD/ha)	132	Derived from default values above
Home damage in large events: with mangrove restoration (USD/ha)	132	Derived from default values above

Mangrove restoration and protection costs

Mangrove restoration costs were based on actual costs from the USAID's CCAP and reported by Narayan et al. (2017). The expenditures included hydrological restoration, buying seedlings, labor for planting, maintenance costs, technicians costs and travel costs. Narayan et al. (2017) provided total annual costs for hydrological restoration (year 1), initial planting costs in years 1-4, maintenance costs in years 1-4, and travel costs (by CCAP staff) associated with supporting the mangrove restoration. These figures are provided in the Excel worksheet "Parameters Mangrove" of Annex 3. The figures are derived from the detailed costs presented in the table below. The long-term enforcement costs were assumed to be equivalent to 5% of the time of a mid-level staff member from USAID's CCAP. For our subproject we have used the same cost figure but assume that the enforcement would be done through a form of community enforcement. The cost would likely be absorbed by the community as an opportunity cost. We note that Narayan et al. (2017) highlighted that during interviews, community members valued mangroves highly and understood the need to protect them to derive their benefits.

Table 3. Mangrove restoration costs calculated for restoration of 22 hectares in the peri-urban area of Quelimane city (Icidua and Mirazane communities), Mozambique.

Description	Units	Cost per Unit ($)	Number of Units per Month	Number of Months	Total Project Cost ($)	Cost per ha ($)
Hydrological restoration – labor	Total cost	NA	NA	NA	$3,107	$141
Hydrological restoration – materials and equipment	Total cost	NA	NA	NA	$5,105	$232
Maintenance after restoration	Person-days	$3	15	18	$686	$31
Seedlings	Plants	$0.29	10,000	18	$50,339	$2,288
Seedling maintainance	Person-days	$3	225	23	$13,157	$598
Mangrove planting labor	Person-days	$3	250	4	$2,542	$116
Safety equipment	Boots, masks, and gloves, for 150 people	NA	NA	NA	$1,637	$74
Transport of seedings from the nursery	Truck rental	$193	1	11	$2,119	$96
Plastic bags for seedlings	Bags	$0.03	180,000	1	$6,102	$277
Boat rental	Boat rental	$1,271	1	2	$2,542	$116
Senior-level staff time	Person-days	$119	10%	45	$31,500	$1,432
Mid-level staff time	Person-days	$68	50%	45	$90,000	$4,091
Junior-level staff time	Person-days	$42	50%	45	$56,250	$2,557
Travel costs	Trips	$15	8	45	$1,558	$71

Source: Narayan et al. 2017

Benefits

Protection from storms

The value of protection to homes from storm damage appears in the model as a cost as described in the costs section above. For the "mangrove restoration subproject" case, the costs of damage to homes are reduced from year 6 because a smaller proportion of homes are assumed to get damaged (see Table 2. Default values used for parameters related to home storm damage costsTable 2 above).

Fish production

Other than the reduction of storm damage, the other main benefits of the mangrove restoration that are included in the model are through the expected improvements in fisheries production. The value of fisheries catch is provided globally for the main expected products (fish, shrimp, clams and crabs) based on interviews conducted by Narayan et al. (2017) in the Icidua and Mirazane communities in

Mozambique. Default values of fisheries production (kg/hectare/year) for fish, shrimp, clams and crabs are taken from the literature (Ronnback, 1999). The default values used for each parameter are provided in the worksheet “Parameters -mangrove” of Annex 3 and are summarized below in Table 4.

The value of fisheries production is given by:

Annual value of fisheries production (USD per hectare) = Price of fisheries products (USD) x Annual fisheries production (kg/ha/year)

This annual value is modified to reflect the ecological state of the mangroves and therefore their ability to support fisheries production. For the first 10 years of the subproject we assume that annual value of fisheries production is reduced in proportion to its state of maturity (as measured by height and described in Table 5). Hence in year 4 of the subproject, when mangroves are assumed to be at 67% of their full height, the annual fisheries production is multiplied by 67%. This figure is then further reduced to account for seedling mortality, which is set at 50% for the first 10 years. From year 11 onwards, when the mangrove is assumed to be mature, the annual fisheries production is multiplied by 95% to account for some tree mortality. This is certainly an oversimplification of the processes involved in determining fisheries production in mangroves but given the objectives of this CBA we believe it sufficiently captures the nature of expected increasing fisheries production as the mangrove matures.

Table 4. Parameters and default values for fisheries production in mangroves used in the model

Parameters	Default values	Data source
Price of fisheries products per kg	$2.47	Based on interviews conducted with fishermen and reported by Narayan et al. 2017
Shrimp production per hectare mangrove (kg/ha/yr)	224	Ronnback (1999)
Crab production per hectare mangrove (kg/ha/yr)	26	Ronnback (1999)
Fish production per hectare mangrove (kg/ha/yr)	1887	Ronnback (1999)
Clam production per hectare mangrove (kg/ha/yr)	743	Ronnback (1999)
Fisheries products from mangroves (crab, shrimp, clams, fish) kg/ha/year	2880	Derived from default values above

Table 5. Assumed growth (in height) of restored mangroves.

Year	1	2	3	4	5	6	7	8	9	10
% of full growth	7%	27%	47%	67%	80%	93%	97%	99%	99%	100%
Height (m)	1	4	7	10	12	14	14.5	14.8	14.9	15

Note: Derived from Trettin et al. (2015)

Results

Table 6 shows the estimated costs and benefits for the first 10 years on the mangrove restoration subproject. Actual costs of such a subproject would vary depending on the site conditions, need for site preparation/hydrological restoration work, seedling planting and maintenance etc. As explained in previous sections, the cost and benefit information used is mostly based on an example of a mangrove restoration project in Mozambique where socio-economic and ecological conditions are similar to the Programme region. The costs and scale of this subproject example are therefore considered to be illustrative of the type of subprojects that CSOs are likely to propose to CEPF for funding under the Programme. In this example, the main benefits come from reducing the costs associated with storm damage (from year 6 of the subproject) and financial benefits from improved fisheries production. The improved fisheries are of significant value to the communities in this case and this is not a benefit that would arise if an infrastructure solution such as a coastal dyke was used to reduce coastal flooding risk. Also, by providing additional income to this fishing community, household resilience to climate change will be improved since increased incomes are very important for improving households' ability to deal with shocks from natural disasters (e.g. Harvey et al., 2014). Overall, the model shows that the net incremental financial benefits (i.e. net benefits by comparison to the baseline "without subproject" case) of the subproject are positive and significant. For example, in year 10, the net benefits for the community are estimated at USD 4,240 per hectare, or USD 93,280 over the 22 hectares of restored mangrove.

Table 6. Estimated per hectare costs and benefits (USD/hectare) of the mangrove restoration subproject

Year		1	2	3	4	5	6	7	8	9	10
Costs											
Home damages after storm events		$820	$820	$820	$820	$820	$66	$66	$66	$66	$66
Hydrological restoration		$373	$0	$0	$0	$0	$0	$0	$0	$0	$0
Initial mangrove planting		$2,800	$1,096	$37	$27	$0	$0	$0	$0	$0	$0
Maintenance/replacement of non-surviving plantings		$369	$333	$37	$27	$0	$0	$0	$0	$0	$0
Travel costs		$71	$71	$71	$71	$0	$0	$0	$0	$0	$0
Enforcement		$71	$71	$71	$71	$71	$71	$71	$71	$71	$71
Total Costs		$4,505	$2,390	$1,035	$1,017	$891	$137	$137	$137	$137	$137
Benefits (by comparison to the baseline, year zero, situation)											
Fish production from mangroves (crab, shrimp, clams, fish)		$249	$960	$1,672	$2,383	$2,845	$3,308	$3,450	$3,521	$3,521	$3,557
Total benefits		$249	$960	$1,672	$2,383	$2,845	$3,308	$3,450	$3,521	$3,521	$3,557
Net benefits		-$4,256	-$1,430	$637	$1,366	$1,954	$3,171	$3,313	$3,384	$3,384	$3,420
Net incremental benefits (with mangrove restoration - without) and no carbon price benefits		-$3,436	-$610	$1,457	$2,186	$2,774	$3,991	$4,133	$4,204	$4,204	$4,240

The incremental financial Net Present Value (NPV) for the mangrove restoration subproject over a 25-year time horizon is USD 25,234 per hectare at a 12% discount rate. The Internal Rate of Return (IRR) over 25 years is 34%. The positive NPV at a relatively high discount rate and the high IRR of the subproject demonstrate the overall cost effectiveness of the illustrative subproject and support the investment case.

Sensitivity Analyses

To examine the sensitivity of the model, three tools are provided on the worksheet "Sensitivity Analysis – mangrove". First there is a graphical representation of the relationship between the NPV of the annual net incremental benefit (i.e. net benefit of the subproject versus no subproject scenario) and the discount rate used. Figure 1 shows that the incremental benefits are sensitive to discount rate. This is because the benefits in terms of storm protection and fisheries production peak as the mangroves mature and then plateau off (as illustrated by the line for the 0% discount rate in Figure 1).

Figure 1. Sensitivity of the annual net incremental benefit of the mangrove restoration subproject under different discount rates.

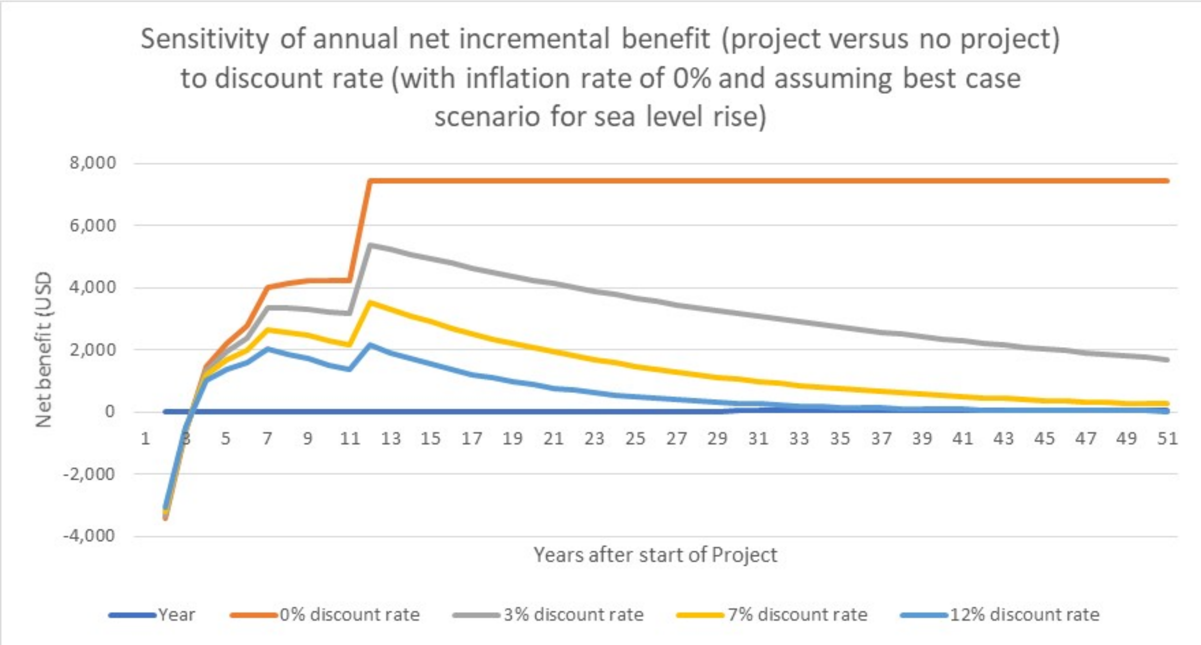

Table 7 shows how the Internal Rate of Return of the subproject varies for a range of different cost and benefit scenarios. To create the table, the overall cost values were varied from -30% to +30% by comparison to the default values described in this document and provided on the "Parameters-mangrove" worksheet of Annex 3. Similarly, the overall values of the benefits of the subproject were varied by -30% to +30% of the default values. The analysis shows that even if the cost values are 30% higher than we have estimated in the model and the benefits are 30% lower, the IRR will still be 20%. At the other extreme, the IRR will reach 57% if the benefits are actually 30% higher and the costs are 30% lower. This analysis shows that there is a large margin of error for both costs and benefits within which the subproject would still remain a highly cost-effective investment.

Table 7. Table showing how the Internal Rate of Return of the mangrove subproject over 25 years varies with changes to the values of costs and benefits.

	IRR (over 25 years)						
		Changes to benefit values					
		-30%	-20%	-10%	0%	10%	20%	30%
	30%	20%	23%	25%	27%	29%	32%	34%
Changes	20%	22%	24%	27%	29%	31%	34%	36%
to	10%	23%	26%	29%	31%	34%	36%	39%
cost	0%	25%	28%	31%	34%	36%	39%	42%
values	-10%	27%	31%	34%	37%	40%	43%	46%
	-20%	30%	34%	37%	40%	44%	47%	51%
	-30%	34%	38%	41%	45%	49%	53%	57%

Note: IRR values above 30% are indicated in pale green, values from 20-29.99% are indicated in yellow and values under 20% would be indicated in red.

A similar analysis on NPV of the net incremental benefit of the mangrove restoration subproject is provided in Table 8. As with the analysis above, this shows that despite applying a relatively high discount rate of 12%, the subproject continues to have a positive net incremental benefit even if costs are actually 30% higher and benefits are 30% lower than assumed in our default analysis.

Table 8. NPV of incremental net benefit at year 25 (USD per hectare) of the mangrove restoration subproject using a 12% discount rate.

	NPV of net incremental benefit at year 25; discount rate 12%						
		Changes to benefit values					
		-30%	-20%	-10%	0%	10%	20%	30%
	30%	$330	$370	$410	$450	$489	$529	$569
Changes	20%	$326	$366	$406	$446	$485	$525	$565
to	10%	$322	$362	$402	$442	$481	$521	$561
cost	0%	$318	$358	$398	$438	$477	$517	$557
values	-10%	$314	$354	$394	$434	$473	$513	$553
	-20%	$310	$350	$390	$430	$469	$509	$549
	-30%	$306	$346	$386	$426	$465	$505	$545

Forest Restoration and Forest Protection

The second subproject included in the Excel workbook provided as Annex 3 is for another illustrative example of a potential subproject that could be envisaged for investment by CEPF under the Programme. The example is for a 10,000-hectare degraded forest watershed, where flooding risk is elevated and water supply is reduced because of the watershed condition. 15,000 people are assumed to live downstream of the watershed and are dependent on it for water for their direct use and for agriculture. The proposed subproject will protect the degraded forest of the watershed and will also restore 50 hectares of forest along watercourses to act as riparian buffers. As the restored forest matures and degraded forest regenerates, it is expected to slow water entry into watercourses and reduce erosion and siltation of watercourses. The climate related risks come from occasional flooding events due to fast runoff from the watersheds. These damage homes and agriculture. Under the best-case scenario for future climate, a medium flooding event is expected to occur every three years and an extreme flooding event every 5 years. Under the worst case, high flooding scenario, both medium and extreme flooding events are expected to occur every year. The subproject is expected to reduce flood damage to homes and make modest improvements to agricultural production and water provision for households.

Key assumptions are:

- **With-project scenario**: The subproject will involve protecting 10,000 hectares of degraded forest, which is expected to recover, improving its water provision services, protection against erosion, absorption of water into groundwater supplies and slowing the passage of water into watercourses, thereby reducing flood risk. The subproject will also involve restoration of 50 hectares in riparian buffers, which will also help to reduce erosion around rivers and streams and reduce flood risk. In all the cost calculations for the subproject, the per hectare cost has been derived by considering only the hectares to be restored, not the protected forest areas. Hence for example, when expressing the flood damage to homes per hectare, the total estimated flood damage has been divided by 50 hectares. The area to be protected has only been included in the costs related to enforcement (see explanation under the costs section below).
- **Time period**: The CBA covers a 50-year period although the first 25 is of greater interest and used for analysis of Net Present Values of net benefits.
- Discount rates: Like the mangrove example, the CBA provides analysis of NPVs using discount rates of 0%, 3%, 7% and 12%. The 12% rate is used as the default for examining cost effectiveness and sensitivity of the model to discount rate. The model allows users to define a specific discount rate under the parameters worksheet.
- **Costs:** Cost information comes from a variety of relevant published sources covering the Programme region or countries in similar socio-economic and ecological situations, which are identified in the text that follows and on the “Parameters – watershed” worksheet in the Excel file.
- **Benefits**: Estimated benefits come from a variety of sources, where available, and have been estimated for the purposes of providing an illustrative example for this type of subproject where they are not available. We have only focused on a few ecosystem service benefits (water provision for households, agricultural benefits related to reduced flooding risk and

better water provision) to keep the model simple although many others are also relevant such as carbon sequestration, fuelwood provision, wild food provision, medicinal plants etc.

Costs

Flooding damage to homes

For the baseline "without subproject" scenario, flood damage to homes is the only cost included in the model. The both the "with" and "without" subproject scenarios, flooding damage cost has been estimated as follows:

Annual home damage from flooding events (cost per hectare) = (Probability of a medium flooding event x Home damage caused in a medium flooding event) + (Probability of an extreme flooding event x Home damage caused in an extreme flooding event)

where

Home damage in a medium flooding event (cost per hectare) = (Number of households x Average house value x % of houses damaged in a medium flooding event x % house value lost if there is damage x % of houses in the community at risk of flood damage) / Number of hectares restored

and

Home damage in an extreme flooding event (cost per hectare) = (Number of households x Average house value x % of houses damaged in an extreme flooding event x % house value lost if there is damage x % of houses in the community at risk of flood damage) / Number of hectares restored

Probabilities of flooding events were estimated based on published case studies of flood risk in degraded forest watersheds in Fiji (Brown et al., 2014). Probabilities for flood risk under future climate scenarios were also estimated but kept similar to the flood risk information provided for the mangroves example that was based on risk analysis by the Mozambique National Institute for Hazard Management - INGC (2009). By default, the low flooding risk (best case scenario) is used in the CBA as it gives more conservative estimates of the net benefits derived from the subproject.

Table 9. Flood risk scenarios used for the Watershed CBA

Flood risk scenario	**Event descriptions**	**Annual Probability of Medium Flooding event**	**Annual Probability of an extreme flooding event**
Low Flooding (best case)	Medium flooding event occurs every 3 years. Extreme flooding event every 5 years	33%	20%
High Flooding (worst case)	Multiple flooding events annually	100%	100%

	due to extreme rainfall		

Storm damage to homes is included as a cost in the models under both the "without subproject" baseline and the "Watershed subproject" scenarios. The default values used to calculate average storm damage costs are provided in the table below.

Table 10. Parameters and default values for storm damage estimates

Parameter	Default value	Source of information
Number of households	15,000	User defined
Area of forest restoration within the watershed	50	User defined
Value per house (USD)	915	Same as for the mangrove example, assuming a basic house construction. USD 915 based on household surveys as reported by Narayan et al. 2017
% homes damaged in medium events: without subproject	80%	Estimate informed by case studies of flood risk in watersheds in Fiji as reported by Brown et al., 2014
% homes damaged in large events: without subproject	100%	Estimate informed by case studies of flood risk in watersheds in Fiji as reported by Brown et al., 2014
% homes damaged in medium events: with mangrove restoration subproject	7%	Estimate informed by case studies of flood risk in watersheds in Fiji as reported by Brown et al., 2014. Applies from year 11 in the "with subproject" scenario
% homes damaged in large events: with mangrove restoration subproject	14%	Estimate informed by case studies of flood risk in watersheds in Fiji as reported by Brown et al., 2014. Applies from year 11 in the "with subproject" scenario
% of houses in community at risk of flood damage	5%	Estimate informed by case studies of flood risk in watersheds in Fiji as reported by Brown et al., 2014
% of house value lost if damaged	10%	Estimate set for illustrative subproject
Home damage in medium events: baseline without subproject (USD/ha)	1098	Derived from default values above
Home damage in large events: baseline without subproject (USD/ha)	1373	Derived from default values above
Home damage in medium events: with mangrove restoration (USD/ha)	96	Derived from default values above
Home damage in large events: with mangrove restoration (USD/ha)	192	Derived from default values above

Forest Restoration Costs

Forest restoration costs were based on a published estimate from Madagascar that was based on a study of 13 real natural forest restoration projects (Busch et al., 2012). The published estimate of USD 1521 per hectare was adjusted to 2019 dollars by applying an assumed 3.5% annual inflation rate since 2012. These costs typically include the costs of plant production (materials, creating and maintaining small tree nurseries near to planting sites), labor costs and costs of some technical staff from the CSO responsible for the subproject. To allocate the costs between subproject years, we assumed 10% of the costs were incurred in year 1 as part of planning and preparation. 63% of planting costs were incurred in year 1, 25% in year 2, 1% in year 3 and 1% in year 4. Years 3 and 4 are mostly for filling in small identified gaps in planting. In addition, we assumed that some maintenance and replacement of non-surviving plants would be needed. This was estimated at 10% of planting costs in year 1, 7.5% of planting costs in year 2, 1% in year 3 and another 1% in year 4. These allocations are based on the descriptions of forest restoration projects in Busch et al. (2012) and the author's own experience of running forest restoration projects.

We also assumed that some travel costs for supervision of the subproject by the CSO would be needed and applied the same travel costs as were used for the mangrove restoration example, which had been derived from a real-world project example (USAID's CCAP).

Enforcement of Forest Protection

Forest protection costs per hectare have been derived from a study from Madagascar that examined the costs of forest protection activities in Madagascar's expanded protected area system (MacKinnon *et al*., 2009). The country's new protected areas are typically managed by CSOs of various types, like in the proposed subproject, and the study explored the relationship between per hectare management costs and protected area size. Based on the study's findings, management costs (in Malagasy Ariary) can be derived from the relationship:

$Log_{10}\ (cost/hectare) = 7.2149 - 0.7506 \times log_{10}Area$

The Ariary to dollar exchange rate was estimated at 3,700.

The total enforcement costs (in dollars) for the 10,050 hectares of forest (10,000 hectares of existing plus 50 hectares restored) are expressed in the model as a "per hectare restored" cost by dividing by the *number of hectares restored* (i.e. 50 by default).

Benefits

Three types of benefits have been included in the model: reduced damage to homes due to flooding, agricultural production improvements and improvements in water provision to households due to more reliable groundwater and cleaner (less sediment) surface water supplies.

Reduced damage from flooding

The value of reduced flood damage is integrated into the model by reducing the costs associated with flooding damage. This is done by assuming that a lower proportion of homes are damaged by flooding events in the "with subproject" scenario. From year 11, a lower proportion of homes are damaged in the subproject scenario: 7% damaged in medium flooding events and 14% damaged in extreme flooding events (see Table 10). The application of this benefit only from year 11 is an acknowledgement that the planted forests and regenerating protected forests need time to mature before the improvements in water provision services they provide are likely to be realised. In practice, this is an oversimplification and the benefits are more likely to accrue over time up until maturity rather than suddenly be applied from year 11. However, we consider that it ids a close enough approximation for the purposes of this model.

Agricultural Production benefits

In the model, agricultural production benefits start to accrue in year 6 as the trees in the restored riparian areas are growing and the degraded protected forest starts to regenerate. From year 6 a modest 0.1% increase in agricultural production is assumed due to the improved provision of quantity and quality of water and better flood regulation that means that crop damage is less likely. Each subsequent year for 20 years there is an additional 0.1% improvement in agricultural production assumed, so that by year 25 of the subproject, agricultural production has increased by 2%. This modest improvement throughout the watershed is expressed as a benefit per hectare restored (although some of the benefit will in practice also be coming from improved forest protection).

The calculation for improvements in agricultural production is calculated as follows:

Improvement in value of agricultural production = (Average value of agriculture for a household x Nb. of households in the watershed x proportion of households farming x (0.1% x Nb. of years beyond year 5 up to a maximum of 20))/ Nb. of hectares restored

Default values used for the agricultural production calculations are given in Table 11 below.

Table 11. Parameters and default values for estimating improvements in agricultural production

Parameter	Default values	Source/notes
Number of households in the watershed	15,000	User defined
Value of agricultural production	$6,000	User defined default value - note this is estimated value of a household's annual agricultural production at year 5
Agriculture production increase with project	0.10%	Assumed annual improvement with protection and restoration activities applies from year 6 and increases by the same amount until year 25
Proportion of households farming	80%	User defined. This is probably low for most relevant situations since, for example, in Comoros and Madagascar, approximately 95% of rural households are engaged in agriculture.

Water Provision

As for agricultural production, some benefits are assumed at the household level in terms of water provision for direct use because the subproject activities are expected to improve both the quantity and quality of available water. As with the agricultural production benefits above, these benefits only start to accrue from year 6 after the start of the subproject and continue to grow until year 25, when they plateau off as the restored areas mature and continue at the same level. As with agricultural production, the improvement is assumed to be 0.1% annually, increasing up to a maximum of a 2% improvement by year 25.

The value of water provision improvements due to the subproject is given by:

Value of improvement per year = (Value of water per household x Improvement in water provision per year (from year 6 and increasing by the same amount each year until year 25) x Nb of households in the watershed) / Area of restored forest

Results

Table 12 shows the costs and benefits of the illustrative subproject to protect 10,000 hectares of forest and restore 50 hectares of forest as riparian buffers. We assumed that these actions would result in relatively modest improvements in water provision and agricultural production over a 20-year period such that after 25 years the value of water provision and improvements in agriculture due to water availability would have improved by 2% each. We also assumed that flood damage to homes would be decreased once the trees in the riparian buffers had become more mature and the degraded forest of the watershed had regenerated. These flood protection benefits started to be observed from year 10 after the start of the subproject as can be seen from the reduced costs for flooding damage in years 11 and 12 of the extract of the model that is presented in Table 12.

Most of the costs for the subproject were incurred in the first 4 years of the subproject, but there are important ongoing costs for enforcement of protecting the 10,000 hectare forest. To invest in such a subproject as part of the Programme there will need to be a strong emphasis on the financial sustainability of the subproject and how these long term costs would be covered, either through novel financial mechanisms or by being absorbed into existing public agency budgets or the operating costs of other organizations, such as is possible for some of the larger NGOs in the region that gain revenues from activities such as ecotourism.

In this CBA, benefits from the subproject were not realised until after several years of the subproject. Indeed, the cumulative NPV of the incremental benefits of the subproject (i.e. by comparison to the "without subproject" baseline case) only became positive at year 9 after the subproject start (when applying a 12% discount rate). Similarly, the internal rate of return up until year 10 was just 7%. Hence, in the early years of the subproject the costs outweighed the benefits. In the longer term, however, the subproject is cost effective and generates significant benefits. Over a 25-year horizon, the financial NPV of the incremental benefits of the subproject is USD 39,810 per hectare, or USD 1,990,500 in total. The IRR for the subproject over 25 years is 28%.

Table 12. Costs and benefits of the forest protection and restoration for the first 12 years since the start of the subproject

Year	1	2	3	4	5	6	7	8	9	10	11	12
Costs												
Flooding damage to homes after storms	$637	$637	$637	$637	$637	$637	$637	$637	$637	$637	$70	$70
Forest restoration planning an preparation	$194	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Initial forest planting	$1,219	$484	$19	$19	$0	$0	$0	$0	$0	$0	$0	$0
Maintenance/replacement of non-surviving plantings	$194	$145	$19	$19	$0	$0	$0	$0	$0	$0	$0	$0
Travel costs	$31	$31	$31	$31	$0	$0	$0	$0	$0	$0	$0	$0
Enforcement of protected forests	$886	$886	$886	$886	$886	$886	$886	$886	$886	$886	$886	$886
Total Costs	$3,160	$2,183	$1,593	$1,593	$1,523	$1,523	$1,523	$1,523	$1,523	$1,523	$956	$956
Benefits (by comparison to the baseline, year zero, situation)												
Agriculture production	$0	$0	$0	$0	$0	$1,440	$2,880	$4,320	$5,760	$7,200	$8,640	$10,080
Water provision	$0	$0	$0	$0	$0	$110	$219	$329	$438	$548	$657	$767
Total benefits	$0	$0	$0	$0	$0	$1,550	$3,099	$4,649	$6,198	$7,748	$9,302	$10,856
Net benefits	-$3,160	-$2,183	-$1,593	-$1,593	-$1,523	$27	$1,576	$3,126	$4,675	$6,225	$8,345	$9,899
Net incremental benefits (with forest protection and restoration - without) and no carbon price benefits	-$2,340	-$1,363	-$773	-$773	-$703	$846	$2,396	$3,945	$5,495	$7,044	$9,165	$10,719

The lack of observable benefits in the early years of the subprojects could be mitigated to a large extent by considering other ecosystem benefits in the model (such as fuelwood provision) and/or adding in shorter term activities such as livelihood improvements (agricultural adaptation, revenue generating activities such as apiculture etc. depending on the needs and context). Also, we have probably been too conservative in our assumptions about the benefits from protecting the forest, which are likely to start earlier than the ten-year point that we've included them in the model and are also likely to be more significant than the modest values we've assigned to them.

Sensitivity Analysis

As with the mangrove example, three tools are provided for examining the model's sensitivity on the worksheet "Sensitivity Analysis – watershed". Figure 2 shows that the incremental benefits of the subproject are sensitive to discount rate. As with the mangrove example, the assumed ecosystem service benefits are assumed to peak and then plateau off. In this case this happens at year 25 when it is assumed that the restored forest reaches maturity and there are no incremental increases in the value of the ecosystem services provided. For the higher discount rates, the peak NPV of net incremental benefits is reached earlier than year 25 as the incremental improvement falls below the discount rate. For example, for a discount rate of 12% the highest NPV of incremental benefits is in year 14 since the start of the subproject. This is the point at which added benefits from the ecosystem services are growing most rapidly.

Figure 2. Sensitivity of the annual net incremental benefit of the watershed subproject under different discount rates

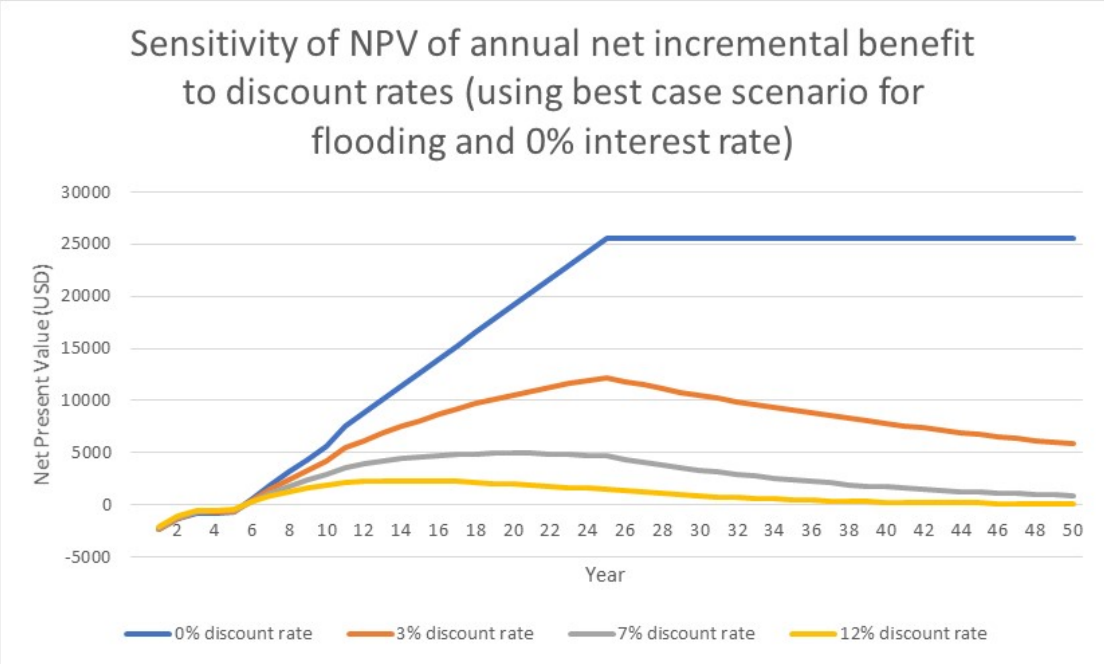

Table 13 shows how the IRR of the subproject varies for a range of different cost and benefits scenarios. To create the table, the overall cost values were varied from -30% and +30% of the default values. The overall benefit values were also modified by -30% and +30%. The analysis shows that even if the cost values are 30% higher and the benefit values are 30% lower than the default figures used, the subproject still has an IRR of 20%. At the other extreme, if costs are 30% lower and benefits are 30% higher then the IRR will be 38%. The analysis shows that the subproject remains a cost-effective investment under a broad range of input costs and assumed benefits.

Table 13. Table showing how the Internal Rate of Return of the subproject over 25 years varies with changes to the values of costs and benefits.

	IRR (over 25 years)							
			Changes to benefit values					
		-30%	-20%	-10%	0%	10%	20%	30%
	30%	20%	22%	23%	25%	26%	27%	28%
Changes	20%	21%	23%	24%	26%	27%	28%	29%
to	10%	22%	24%	25%	27%	28%	29%	31%
cost	0%	23%	25%	27%	28%	30%	31%	32%
values	-10%	25%	27%	28%	30%	31%	32%	34%
	-20%	26%	28%	30%	31%	33%	34%	36%
	-30%	28%	30%	32%	33%	35%	36%	38%

Note: IRR values above 30% are indicated in pale green, values from 20-29.99% are indicated in yellow and values under 20% are indicated in red.

A similar analysis on NPV of the net incremental benefit of the subproject is provided in Table 14. As with the analysis above, this shows that despite applying a relatively high discount rate of 12%, the subproject continues to have positive net incremental benefit even if costs are actually 30% higher and benefits are 30% lower than assumed in our default analysis. Even in this scenario, the NPV of net incremental benefits 25 years after the start of the subproject would be USD 1254 per hectare, or USD 62,700 for the subproject as a whole.

Table 14. NPV of incremental net benefit at year 25 (USD per hectare restored) for the watershed subproject and using a discount rate of 12%

	NPV of net incremental benefit at year 25; discount rate 12% (USD/Ha)							
		Changes to benefit values						
		-30%	-20%	-10%	0%	10%	20%	30%
	30%	$1,254	$1,437	$1,619	$1,802	$1,985	$2,167	$2,350
Changes	20%	$1,260	$1,442	$1,625	$1,808	$1,990	$2,173	$2,356
to	10%	$1,265	$1,448	$1,631	$1,813	$1,996	$2,179	$2,361
cost	0%	$1,271	$1,454	$1,636	$1,819	$2,002	$2,184	$2,367
values	-10%	$1,276	$1,459	$1,642	$1,825	$2,007	$2,190	$2,373
	-20%	$1,282	$1,465	$1,647	$1,830	$2,013	$2,196	$2,378
	-30%	$1,288	$1,470	$1,653	$1,836	$2,018	$2,201	$2,384

Conclusions

The two CBAs were conducted on illustrative subprojects similar to those for which CEPF expects to receive funding requests from CSOs. The CBAs only considered a limited number of benefits from the subproject activities but these nevertheless demonstrated that the subprojects would have positive financial net present values over the mid and long term. In both cases, the subprojects were sensitive to discount rates because the benefits to ecosystem services were assumed to level off after several years, once restored ecosystems had achieved maturity. Also, in both cases the subprojects were resilient to changes in costs and benefit values within a range of -30% to +30% suggesting that such subprojects can have a wide margin of error and be relatively low risk, cost effective investments. Nevertheless, the CBAs also illustrated the importance of clearly articulating and quantifying the expected benefits of proposed EbA subprojects. In practice, more benefits than we considered would be likely to occur as co-benefits to proposed subprojects which would likely further strengthen the case for EbA subprojects in many instances.

The CBA compared two scenarios to illustrate the value of a small mangrove restoration activity to reduce flooding for a coastal community prone to flooding linked to sea level rise. The mangrove restoration subproject showed significant net benefits over the “without subproject” baseline case. These benefits were robust to the application of a relatively high discount rate for such projects (12%) and when sensitivity analysis was conducted on the costs and benefits. The subproject would remain highly cost effective even if the default values for costs that we have used were to be increased by 30% and if the benefits of the subproject were actually 30% lower than we have estimated. The benefits come from reduced storm damage from coastal flooding and also from co-benefits associated with improved fisheries production. We didn’t consider other ecosystem benefits of the mangroves although some estimations in the literature consider these to have significant value. For example, we did not include the economic value of carbon sequestration despite growing recognition of the role of mangroves for this. Similarly, we didn't consider additional benefits that could be added to a subproject of this type by associating activities to improve livelihoods and increase household resilience to climate change threats.

Overall, the CBA supports the argument that Ecosystem based Adaptation activities such as mangrove restoration on the scale proposed in this example (22 hectares), can be highly cost-effective investments against the impacts of climate change.

In the second subproject example, costs and benefits were considered for an illustrative subproject to protect 10,000 hectares of forest and restore 50 hectares of forest as riparian buffers. As for the mangrove example, the CBA showed positive financial NPV of incremental benefits and an IRR that supported the investment case. Again, the subproject was robust to changes in the cost and assumed benefits.

We assumed that the subproject activities would result in relatively modest improvements in water provision and agricultural production over a 20-year period such that after 25 years the value of water provision and improvements in agriculture due to water availability would have improved by 2% each. Such improvements are modest by comparison to studies that have illustrated strong empirical evidence for the impact of forest cover on clean drinking water. For example, Mapulanga et al. (2019) found that a 1.0% increase in deforestation equated to a 0.93 percentage decrease in the availability of clean drinking water in Malawi. They conclude that the estimated deforestation in Malawi (14%) over the last decade has had the same magnitude of effect on access to clean drinking water as that of a 9% decrease in rainfall.

The need for good quality data on the value of ecosystem services in the local context where the EbA activities is again highlighted by using these CBAs. This was a priority research theme identified during the public consultation activities for the Programme and further highlights the reason for including research activities on EbA as part of the Programme activities.

The two CBAs also serve to illustrate the challenge for EbA activities that they are long-term investments, where the considerable benefits start to accrue once ecosystems start to reach maturity. This was observed in both of the CBAs and will be particularly the case for EbA subprojects that involve ecosystem restoration.

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