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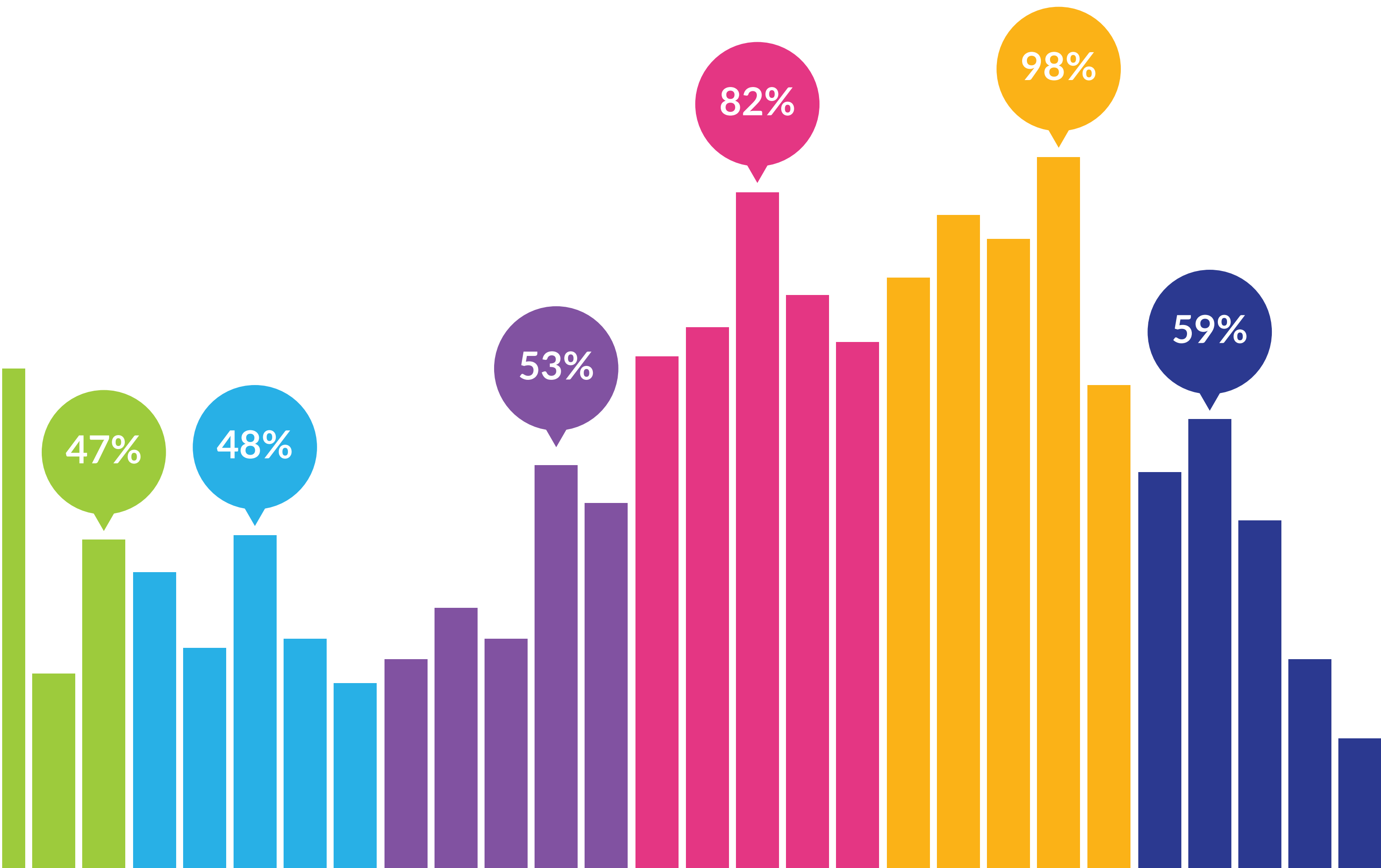
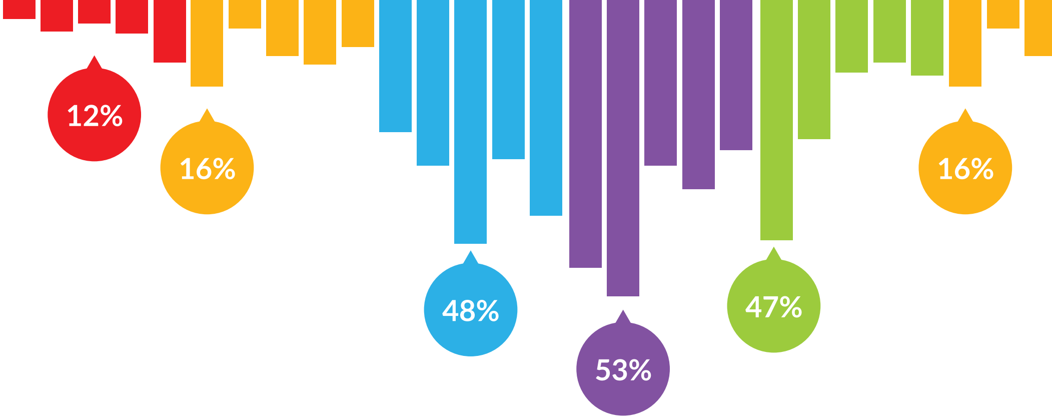
Analyzing the Economic **Costs** and **Benefits** of Climate Change Adaptation Options

A HOW-TO EXAMPLE FROM THE PACIFIC COST-BENEFIT ANALYSIS INITIATIVE



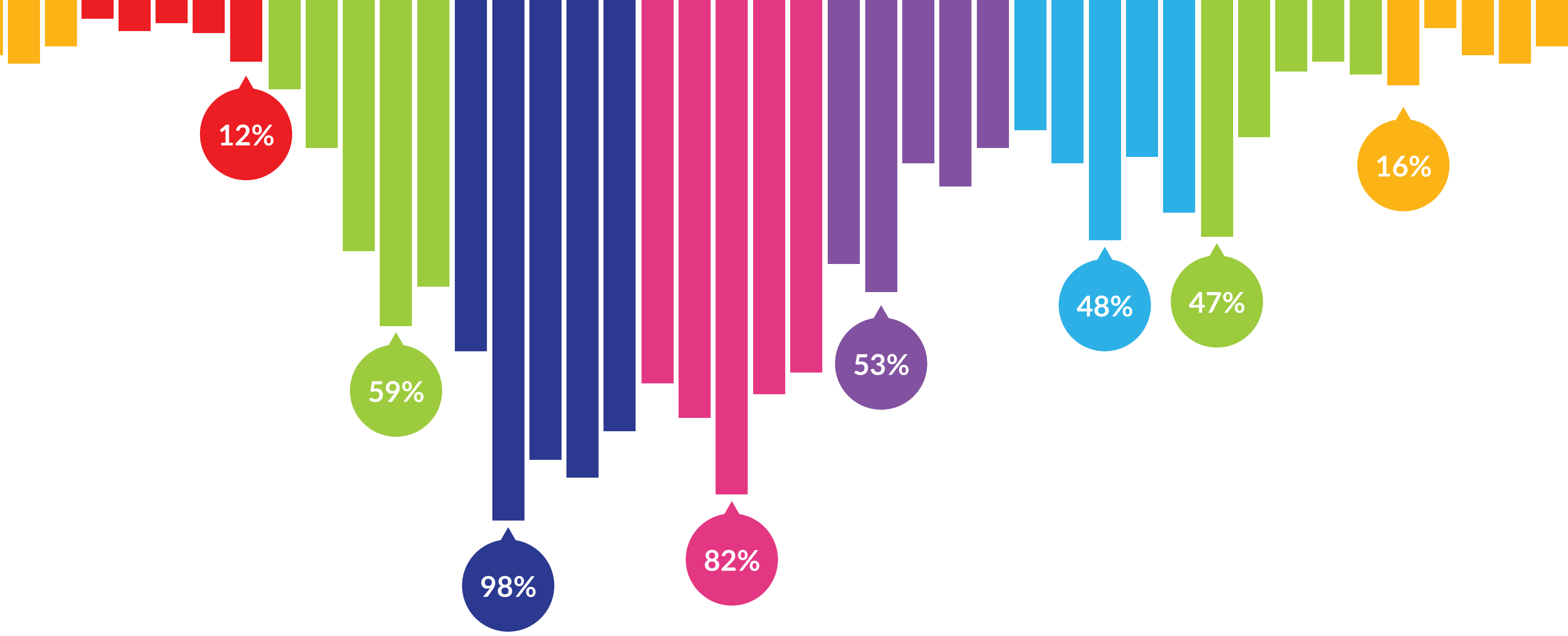


ADAPTATION FINANCE KNOWLEDGE SERIES

Since 2011, the USAID Adapt Asia-Pacific Project has been helping countries develop bankable climate change adaptation projects and improve access to related funding. These experiences, published in this USAID Adapt Asia-Pacific Adaptation Finance Knowledge Series, are based on work with government officials, multilateral institutions, regional organizations, consultants and other experts. The Project acknowledges the contribution of all these institutions and individuals.

For governments to efficiently use the limited resources available for climate change adaptation, they need to have the skills to evaluate the economic costs and benefits of potential investments. As the fourth publication in the USAID Adapt Asia-Pacific Adaptation Finance Knowledge Series, this paper presents the methodology used in the Pacific Cost-Benefit Analysis Initiative (P-CBA) training workshops, along with examples from the trainings of how the methodology has been employed. It is shared as a tool to help countries undertake similar analyses.

USAID Adapt Asia-Pacific intends the brief country case studies employed in this publication to be purely illustrative and in no way pretends to implicitly judge their quality. Further, USAID Adapt Asia-Pacific understands some of the case studies may not be actual projects and many of the CBAs used for training purposes never went ahead. USAID Adapt Asia-Pacific takes responsibility for the content of the publication and any possible confusion caused with the selection of case studies.



ANALYZING THE ECONOMIC COSTS AND BENEFITS OF CLIMATE CHANGE ADAPTATION OPTIONS

Cost-Benefit Analysis (CBA) is a decision-making tool that helps governments design better policies and implement more effective and equitable projects for long-term sustainable results. As the name suggests, CBA provides a systematic approach for quantifying the strengths (benefits) and weaknesses (costs) from the point of view of the society, helping decision-makers determine whether to invest in a particular course of action and leading them to choose those investments that provide the highest returns for society.

CBAs can be used at different stages of decision-making:

- *Before project implementation:* to decide whether a proposed investment is beneficial, or to determine which project options are most economically viable;
- *During project implementation*: to adjust the project design to new challenges or opportunities; and
- *After project completion*: to evaluate whether the project was a benefit to society and to use learnings for future interventions.

In the case of climate change adaptation and climate-resilient development planning, CBA provides a straightforward analytical tool to quantify the impacts of an array of climate change projections in project analysis. Rainfall scenarios, sea level rise, temperature increases, and the frequency of catastrophic weather events can all be worked into the analysis to test whether a proposed investment can withstand the test of time when the climate is changing.

By quantifying the benefits of an adaptation project in monetary terms, CBA can provide the justification for investing in actions whose benefits amount to avoided future climate change-associated costs; benefits that are not often immediately obvious.

A critical element of the project design process, CBA can help project proponents rationalize the project's design and select the most efficient adaptation options to address the problems posed by climate change. When conducted to appropriate standards, a CBA can provide countries with the information required to help get adaptation projects funded (for example, the Green Climate Fund now requires the inclusion of a CBA in every project proposal) and to make the most effective use of any climate change adaptation financing that may be available at national and international levels.

THE PACIFIC COST-BENEFIT ANALYSIS INITIATIVE

Climate change is posing great development challenges to the Pacific region. The impacts of rising sea levels, more frequent and intense storms and increased rainfall are already taking their toll. These are complex issues that government and the private sector are only beginning to grapple with. In this context, good planning and evidence-based policymaking are critical for the Pacific small island countries to successfully adapt to the ever-changing new normal.

The Pacific Cost-Benefit Initiative (P-CBA) is a multi-agency initiative assisting Pacific Island Country and Territory (PICT) governments to better prioritize, design and implement climate-resilient projects and policies for development. Partners include:

- German International Cooperation (GIZ),
- Secretariat of the Pacific Regional Environmental Programme (SPREP),
- Secretariat of the Pacific Community (SPC),
- Pacific Island Forum Secretariat (PIFS),
- United Nations Development Programme (UNDP),
- USAID Adapt Asia-Pacific,
- Asian Development Bank (ADB), and
- University of the South Pacific (USP).

The initiative is a direct response to national demands for practical support in building the skills to undertake analysis of the costs and benefits of climate-sensitive development projects, targeting government officials from central planning and finance ministries. P-CBA builds on existing experiences, including the UNDP Pacific Adaptation to Climate Change (PACC) CBA work program, the related trainings carried out by SPC and SPREP, and the Economics of Climate Change Adaptation program that UNDP and USAID Adapt Asia-Pacific are implementing for Asian countries.

P-CBA practices a learning-by-doing approach: theoretical trainings are followed by the mentoring of government officials to conduct cost-benefit analysis on specific project proposal(s) or ongoing initiatives. The results of these analyses serve as concrete support to government activities, providing guidance on project formulation and implementation.

In the medium to long term, the P-CBA initiative aims to achieve long-lasting sustainable results by integrating the ongoing climate-sensitive CBA training into other curriculum and national public service trainings in the region.

In the P-CBA training workshops carried out to date, a series of tailored lectures cover the main aspects of a CBA and the entry points for analyzing the impacts of climate change and adaptation. Lectures are followed by practical, hands-on spreadsheet exercises and a work planning session during which participants apply the newly learned skills to real case studies of adaptation-related projects that have been pre-identified by their ministry.

By the end of the workshop, participants have before them a work plan outlining the main steps of the analysis to be undertaken. The participants can take this work plan and use it to develop a full CBA with mentoring support from the P-CBA team of economists.

THE P-CBA APPROACH: A PRACTICAL EXAMPLE

Much information has been written on the economics of climate change adaptation, and even more on the economic analysis of costs and benefits. This publication adds to the existing literature by sharing one practical approach to tackling the seemingly daunting task of quantifying the costs and benefits of particular climate change adaptation actions.

Following the P-CBA methodology, which breaks the analysis down into more manageable tasks, the publication is divided into seven sections outlining the seven steps that make up the CBA work plan developed during the training.

The following pages describe each one of these steps in two sections. The first section, ***IN BRIEF***, introduces each step and provides a short description of the important aspects of the step, highlighting the entry points for climate change.

The second section, ***IN PRACTICE***, provides an example of how one team of P-CBA participants undertook each step of the work plan during a training in Fiji in August of 2014, working on a real case study of a Flood Disaster Risk Reduction Measures CBA. Where relevant, the section provides further examples of the steps from CBA work plans developed in P-CBA trainings around the region.

This short explanation and experience sharing on how to set up a CBA for climate change adaptation will guide the reader in setting up their own CBA work plan.

FLOOD RISK IN FIJI

Climate change is projected to increase the already high levels of flood risk in Fiji. The P-CBA participants decided to measure the relative costs and benefits of investing in different flood risk reduction measures.

Image by Faiyaz Khan, via BlogSpot

1 DETERMINE CBA OBJECTIVES

The first step in any cost-benefit analysis (CBA) is to establish the objective framework, which impacts how all subsequent steps will take place. This is perhaps the most important step because it establishes how climate change will be addressed in the CBA.

IN BRIEF

The first step in a cost-benefit analysis (CBA) for climate change adaptation or any other objective is the same: identify the ***problem*** to be addressed by the project, as well as its ***causes and drivers***. For climate-resilient or adaptation projects, climate change projections and an assessment of vulnerability (identifying potential climate change impacts and society's existing capacity to adapt) should be included in this analysis.

Once the problem and its drivers have been identified, ***adaptation options*** are selected in consultation with technical experts in that field. These options will focus on either reducing the potential impacts (by reducing either exposure or sensitivity to the climate change-induced problem) or increasing society's adaptive capacity. Defining adaptation options involves describing the proposed activity, the primary stakeholders and the potential lifespan.

The primary objective of any CBA is to determine whether the benefits of a particular project option outweigh its costs and by how much relative to alternative project options. The purpose is as follows:

- To determine whether the proposed project option is (or was) a sound investment (ex-ante feasibility assessment or ex-post justification); and/or
- To compare among project alternatives (ex-ante rank and prioritize).

CBAs can be undertaken ex-ante to inform decisions about what project or project options to undertake, during the project to inform implementation and ex-post as an evaluation of the intervention.

The ***objectives of the CBA*** should be clearly and correctly specified at the outset, and should be agreed upon by all involved parties. Parties directly involved in a CBA usually include the institution commissioning the analysis (i.e. a government agency) and the person who is in charge of developing it (i.e. a government official or external consultant). Groups affected by the intervention and other stakeholders should be involved in this process, even if they are not directly involved in the development of the CBA. A sound set of objectives for the CBA will provide a solid framework to undertake the analysis.

IN PRACTICE

Participants in the Pacific Cost-Benefit Analysis Initiative (P-CBA) from Fiji's Ministry of Finance identified the impacts of natural disasters such as cyclones and floods as the ***problem*** to be addressed. Cyclones and floods often damage key areas of the Central, Western and Northern Divisions of the main island of Viti Levu.

The participants perceived that ever more frequent floods and cyclones have damaged agriculture (vegetables and livestock), housing, commercial properties and infrastructure (roads and bridges) in the Rewa, Nadi, Ba, Sigatoka and Labasa areas. The Government, farmers and individual and commercial property owners have incurred losses as a result of flood and cyclone-related damage.

Climate change is perceived to be a ***main cause of the problem***, with initial impacts already being felt throughout the Pacific and projected to further affect rainfall patterns and increase tropical cyclone intensity. ***Other causes*** that increase the sensitivity of the population to increased rainfall and cyclone intensity include large sediment deposits in the area's rivers, an inadequate drainage system and agriculture-related deforestation along the river banks.

Given the country's vulnerability to flooding, the participants from Fiji identified the ***objectives of this project*** as follows: to reduce the threat of flooding and related damage to agriculture, private homes, commercial properties and infrastructure; to promote sustainable development in the various sectors; and to remove the threat of a flood-induced disease outbreak.

After discussion and an assessment of the causes of the problem previously described, the ***adaptation options*** identified to address the causes of the problem were:

1. River dredging;
2. Re-design and installation of a new drainage system; and
3. Afforestation along the river bank.

The participants from Fiji determined that the ***objectives of this CBA*** will be to identify which of these adaptation options delivers the best results. In other words, the CBA aims to understand which of the options provides the highest return to society in terms of achieving the project objectives outlined above, for each $1 faced in costs. This is a clear example of ex-ante analysis where the outcomes of the assessment will inform a policy decision about how the country can invest in projects to best achieve its desired aims.

In other cases, to evaluate the benefits of projects that have already been implemented requires an ex-post analysis that will inform policy decisions based on the efficacy of past investments. One such case in Vanuatu was set up to evaluate a big capital project that connected the country to fast internet access in Fiji through submarine cables. Better access to more reliable communication is widely considered to increase the overall resilience of a country. This example from Vanuatu might be relevant for other nations in the Pacific that aim to build similar infrastructure.

LAYING CABLES IN VANUATU

The analysis of costs and benefits from laying fiber optic cables in Vanuatu could be useful for other countries interested in similar infrastructure.

Image by GeoTel Communications, via GeoTel

2 IDENTIFYING COSTS AND BENEFITS

To begin quantifying the costs and benefits of specific adaptation options, start by listing out the expected inputs, outputs and impacts (both intended and unintended) of the various options. Be sure to consider the projected changes in climate in the project area.

IN BRIEF

The next step in the CBA is a brainstorming exercise to list the generic categories of costs and benefits associated with each of the adaptation options identified in the first step. It is important to also brainstorm the "without project" scenario and to list out the impacts society will experience if none of the adaptation options are implemented. Later, this will provide a baseline against which to compare the adaptation options.

The information gathered through this brainstorming exercise, known as a ***with and without analysis***, can be summarized in a table, with each option presented in a column and the costs and benefits listed out in separate rows.

The far left column in this table is the baseline, or the "without project" scenario representing the status quo or business as usual. This column describes the inputs, outputs, and impacts on society if none of the project adaptation options are implemented. When thinking about the costs and benefits, it is important to consider projected changes in climate and how those might impact the project area.

P-CBA TRAINING WORKSHOP, FIJI

Participants from Fiji's Ministry of Finance work to set up the work plan for the Flood Disaster Risk Reduction Measures CBA in August 2014.

Image by Marco Arena, via P-CBA Initiative

The remaining columns describe the costs and benefits associated with the proposed adaptation options. For each option, the same inputs, outputs and impacts listed in the far left column are assessed under that adaptation option. The critical question is: what changes are expected as a result of implementing this option as compared to business as usual?

Each column also lists additional inputs (up-front capital and operational costs) required to implement the adaptation options and includes any other potential impacts, particularly those that are not the intended focus of the project or those experienced by third-party groups. These impacts can be either positive (benefits) or negative (costs).

IN PRACTICE

Table 1 describes the generic categories of costs and benefits identified by participants in Fiji for the baseline scenario and the three project adaptation options identified in the first step.

As the table shows, not all costs and benefits involve a monetary transaction. CBA is a powerful and important tool because it allows policymakers to account for environmental, health and social values, which is not possible in a simple financial analysis.

In a P-CBA training in Samoa in November 2014, participants from the Ministry of Environment and Natural Resources suggested that the noise and pollution that would affect a nearby school during construction should be considered as costs in the CBA of a riverbank strengthening project in the capital city, Apia. Such an analytical approach to policymaking can ensure that the interests of all stakeholders are taken into account when decisions are made

Table 1 | WITH AND WITHOUT ANALYSIS: FLOOD DISASTER RISK REDUCTION OPTIONS IN FIJI

(a) Baseline	*(b) Dredging*	*(c) Improvements to Drainage System*	*(d) Afforestation*
Impacts	*Costs*		
• Heavy rainfall would cause flooding, incurring vast damage to various sectors. • Post-disaster rehabilitation works. • Outbreak of diseases (sicknesses, medical costs, loss of labor hours, etc.). • Anxiety and tension caused to people when floods occur. • Savings of financial costs linked to undertaking projects. • No potential harm to fresh water organisms and their habitats. • Saving of time spent on planning for projects.	• Contractors: labor, equipment and other related capital costs. • Administration: legal fees, tendering process, pre-consultations with all related parties, traveling expenses. • Environment: potential harm to wildlife such as fish, flora and their habitats. • Recurring cost of future dredging.	• Contractors: labor, equipment, land compensation and other related capital costs. • Expert consultations to assist in the reform of the drainage system in towns. • Administration: legal fees, tendering process, pre-consultations with all related parties, traveling expenses. • Recurring costs of future maintenance. • Traffic congestion during construction.	• Raw materials: seeds, plants and fertilizer. • Labor.
	Benefits		
	• River will be deeper; can hold larger volumes of water during heavy rainfall. • Reduced damage to land, houses, infrastructure and commercial buildings. • Reduced income loss and cleanup costs. • The sand and gravel extracted from riverbed could be sold, providing further income and business opportunities.	• Improved drainage systems with capacity to support larger volumes of water during heavy rainfall; risk of flooding reduced. • Reduced damage to land, houses, infrastructures, and commercial buildings. • Reduced income loss and cleanup costs.	• Less soil erosion and reduced risk of flooding. • Reduced damage to land, houses, infrastructure and commercial buildings. • Reduced income loss and cleanup costs. • Promote a greener and healthier environment.

3 MEASURING AND VALUING COSTS AND BENEFITS

Once costs and benefits have been identified, the next step is to determine how they will be quantified and what information will be necessary to do so.

IN BRIEF

The third step in the CBA is to determine the method and data or information needed to estimate the value of each cost and benefit identified in the ***with and without analysis*** undertaken in the previous step.

Methods for valuing costs and benefits vary in terms of complexity and length. Valuing goods and services that are sold on markets, for example, is relatively simple because their value is indicated by their price. When valuing costs and benefits for which a market does not exist, the valuation exercise can become much more complex and, in some cases, costly and time consuming. Valuation is not required for all costs and benefits identified, however. It is up to the CBA analyst and policymakers to decide if certain values are critical to decision-making and how much time and effort to put into valuing the costs and benefits.

Some examples of valuation methods used include ***contingent valuation***, which consists of directly asking people how much they value or would be willing to pay for something. This method is often used to value passive benefits like cultural values, wildlife and environmental quality. Another common method is ***choice modelling***, or asking people how they rank different bundles of services to deduce their preferences and estimate their valuation of the services. These valuation methods, however, have proved resource intensive and technically complex, and thus are not commonly used in the Pacific.

Valuation methods more commonly used in the Pacific include the ***production function approach,*** which estimates the value of a market good or service by looking at its production cost. In the same way, the production function approach can be used to estimate the value of a non-market good or service by estimating its hypothetical production cost. This method is often used in water projects in the Pacific to estimate the benefits of additional water availability in areas where water is free to the public. In these cases, the cost of water production by the water authority can be a good proxy for the benefits. Another common method, the ***avoided costs approach***, is often used in the Pacific to estimate the value of health benefits. For example, in the case of agricultural projects aiming to provide healthier food, the health benefits are estimated as the value of avoided hospital and medicine costs that arise from a decreased incidence of those diseases strictly related to harmful diets, such as diabetes and gout.

IN PRACTICE

Table 2 presents examples of potential valuation methods, associated data required and data sources identified during the CBA training for the river dredging adaptation option identified by Fiji's Flood Disaster Risk Reduction CBA team. While the table below is shown here as an illustration of the task at hand, the Fiji team undertook this exercise for each project adaptation option identified in Step 1 and detailed in Steps 2 and 3.

For a coastal protection project in Kiribati, the government wanted alternatives to beach aggregate mining because it would cause coastal erosion problems. One option identified was to dredge from the lagoon of the atoll instead. The CBA analysis identified both the value of sand and gravel sold as a benefit as well as the impact on existing local sand and gravel extractors as a cost. The CBA team chose to estimate these values given the importance of gravel extraction to project success and its impact on the livelihoods of beach aggregate miners.

Table 2 | VALUATION METHODS AND REQUIRED DATA FOR THE COSTS AND BENEFITS OF RIVER DREDGING

Cost/Benefit	Valuation Method	Data Required	Source of Data
Cost 1 Labor and capital	• Use quotations from contractors to estimate the contract amount, including capital and labor costs.	• Contract amount for project period.	• Contract amount for project period.
Cost 2 Administration	• Use current market price data or figures from previous projects.	• Legal fees. • Use current market price data or figures from previous projects.	• Record of administrative expenses from previous projects or an estimation based on market prices.
Cost 3 Environment: harm to wildlife, such as fish and flora, and their habitats	• Use the market price of fish and other freshwater organisms sold by vendors to estimate unit value. • Use a specific environmental impact assessment (EIA), or expert consultation, to estimate the reduction in wildlife catch. This could also come from previous studies. • Use a contingent valuation survey or the travel cost method to estimate the aesthetic value of pristine rivers.	• Short market survey to estimate the value of river catches. • Estimates of potential losses in river catch.	• Information provided by market vendors. • Information provided by EIA, expert judgment or similar studies.
Benefit 1 River would be deeper, could hold larger volumes of water and the risk of flooding during heavy rainfall would be lower	• Estimate expected average value of losses by multiplying (historical disaster loss assessment data) × (future frequency of flash foods as estimated by climate predictions). • Decrease in losses due to the new dredging system can be estimated by engineers.	• Dollar value of losses incurred by various sectors during previous floods. • Number of floods. • Climate predictions for likelihood of floods. • Dollar value of decreased damage.	• Disaster loss assessment report of relevant government agencies (i.e. Rural and Maritime Development and National Disaster Management). • Climate predictions held by Ministry of Foreign Affairs and Climate Change.
Benefit 2 The extraction of sand and gravel could provide jobs/income	• Calculate as: (market price of gravel and/ or sand) × (expected tons of extraction).	• Market price of gravel/ sand. • Estimated quantity of sand/ gravel to be extracted.	• Existing companies that extract and sell gravel/sand in the area of the project.
Benefit 3 Induce economic activity such as creation of employment opportunities	• Compute the cost of labor for the entire contract work. • Estimate the income activities that can be generated and derived from the project.	• Cost of labor from dredging companies. • Quoted charge for dredging works by companies.	• Quotations. • Information provided by dredging companies.

4 AGGREGATING COSTS AND BENEFITS

Estimating the present value of the costs and benefits is necessary to be able to compare various adaptation options. Setting the rate at which future costs and benefits will be discounted in order to estimate their value today is a critical step in any CBA. Analysts and policymakers should give careful thought to this step as there is no one size fits all solution.

IN BRIEF

The fourth step involves determining how the costs and benefits of the project that arise in the future will be discounted to calculate their value in the present and then combined with any present costs or benefits in order to determine whether the project's overall benefits outweigh the overall costs.

Discounting is the process of determining the ***Present Value*** of a payment or a stream of benefits and costs that occur over time. Discounting needs to be done because of the ***time value of money***. People typically place more weight on those costs and benefits that accrue earlier in the life of a project than those that occur later. As a result, a dollar received today tends to be viewed as more valuable than a dollar received in the future.

The ***Present Value*** can be determined with this simple formula:

$$\textit{Present Value} = \textit{Future Value} \div (1+i)^t$$

where ***Future Value*** is the sum of the costs and benefits arising in a particular year in the future, i is the discount rate and t is the year in which the costs and benefits will occur.

Simply put, the discount rate marks the speed at which values (benefits and/or costs) change over time. High discount rates tend to favor projects with an immediate pay off, since benefits that flow further into the future will be discounted more.

The process of deciding on the discount rate is delicate and there is no consensus as to how to establish it. Generally, higher discount rates favor immediate benefits, while lower discount rates favor long-term benefits, such as those arising from adaptation options targeting a reduction in the negative impacts of future climate change.

The Asian Development Bank suggests using a 12% discount rate for projects in the Pacific. It should be noted, however, that this rate tends to favor those projects that have immediate benefits or costs that accrue a long way into the future, and would not generally be advantageous for projects with benefits that come to fruition in the long term. Projects with benefits such as decreased loss and damage, likely to occur many years down the line as a result of some adaptation options, are at a disadvantage with this kind of discount rate.

Once the discount rate has been chosen, and the present value of all future costs and benefits has been estimated, the ***Net Present Value***, or the difference between total discounted benefits and total discounted costs, can be determined for each option being considered.

if *Net Present Value > 0*
Based on quantified values only, the project is beneficial *(total discounted benefits outweigh total discounted costs).*

if *Net Present Value < 0*
Based on quantified values only, the project ***is not*** beneficial *(total discounted benefits* ***do not*** *outweigh total discounted costs).*

AN ILLUSTRATION

To demonstrate how this might work, imagine two possible adaptation options, each with an upfront cost of $50 to implement. For the sake of this example, suppose both will have a $100 benefit, but the first option's benefit will accrue 5 years down the road, while Option 2 won't come to fruition until 10 years into the future. The difference in net benefits, or ***Net Present Value***, between the two options becomes clear when they are evaluated under a 12% discount rate.

In order to calculate the present value of each one of these costs and benefits we will use the present value formula listed above three times for this example, each time filling in the appropriate values ***Future Value*** ($50 for costs and $100 for benefits), ***i*** (0.12, based on the 12% discount rate), and ***t*** (0 years for costs, 5 years for Option 1 benefits and 10 years for Option 2 benefits).

Because the costs are up front (taking place at the start of the project, in year zero), they will not be discounted. The present value of the cost is the full value of the cost, since it will be spent in the present and not in the future.

Total present value of costs for Option 1 and 2:
$\$50.00 \div (1 + 0.12)^{0} = \mathbf{\$50.00}$

A future $100 benefit that will accrue at year five is worth about $57 in the present when using a 12% discount rate, while that same benefit at year ten has a present value of only about $32. Note that the further in the future the benefit occurs, the less it is worth in the present.

Total present value of benefits for Option 1:
$\$100 \div (1 + 0.12)^{5} = \mathbf{\$56.74}$

Total present value of benefits for Option 2:
$\$100 \div (1 + 0.12)^{10} = \mathbf{\$32.20}$

The overall or net present value of each of the options is equal to the present value of all benefits minus the present value of all costs.

Net Present Value of Option 1:
$56.74 - $50.00 = $6.74 ▶ beneficial

Net Present Value of Option 2:
$32.20 - $50.00 = - $17.80 ▶ not beneficial

For Option 2, the present value of the benefits, $32.20, which will not accrue until ten years after the project begins, does not outweigh the present value of the costs, $50.00. For Option 1, however, the benefits of $56.74 do outweigh the costs of $50.00. In this case, only Option 1 is a beneficial option for society, even though at the start, it seemed that the total benefits ($100) would outweigh the total costs ($50) by a ratio of two to one for both options.

IN PRACTICE

For Fiji's Flood Disaster Risk Reduction CBA, the team chose to set up their work plan for Step 4 using a discount rate of 12% to estimate the value of the costs and benefits over time. They chose this specific discount rate because it has been used by Fiji's Ministry of Agriculture for CBAs on previous projects. To make for a fair comparison, all projects will be compared based on the lifespan of the adaptation option projected to last the longest, which was estimated at approximately 40 years. Once all the data identified in the previous step are gathered and the costs and benefits are valued, then the present value of the costs and benefits can be estimated and aggregated. The ***Net Present Value,*** or the difference between benefits and costs, will be used to select the best project option.

At a P-CBA training held in Kosrae, Federated States of Micronesia, in November 2014, the government team proposed to study relocating a road to promote inland resettlement of households to escape the impacts of sea level rise and increased storm surge. Most of the benefits of this project will accrue in the long term, after households have been relocated. In this context, a discount rate lower than 12% would be more likely to yield a fair assessment of the project's benefits. The government is in careful discussion about which discount rate should be used.

5 SENSITIVITY ANALYSIS

Sensitivity analysis aims to determine whether an analysis yields consistent results, even when there is uncertainty about some of the parameters. It is a practical tool that can be used to mainstream the potential impacts of climate change into the CBA and to assess whether adaptation project options continue to be beneficial under the full range of climate scenarios. Essentially, a robust net present value even after a sensitivity analysis indicates that the adaptation project would be a "no regrets" investment for society.

IN BRIEF

In calculating an activity's benefits and costs, there may be uncertainty about their nature or scale. For example, the effect of a water harvesting project on water supply may be unclear in the face of climate change, as rainfall may be expected to change over time. To check if the findings of a cost-benefit analysis are reliable and provide a sound basis for decision-making, a sensitivity analysis should be conducted for those parameters which are uncertain. As an example, start by listing those parameters used to quantify the costs and benefits (Steps 3 and 4) that entail a significant amount of uncertainty. This list will include those items from Table 2 whose correct value either cannot be absolutely known or has the potential to greatly fluctuate in the future (e.g. the likelihood of an extreme climate event, the intrinsic value of an endangered species, and the fluctuating price of oil).

Once this brainstorming exercise is complete, the ***Net Present Value*** calculations can be tested to check whether the results of the CBA are sensitive to the uncertainty of the parameters.

Several options exist to check the sensitivity of the CBA results to changes in parameters. At a simple level, this test could involve inserting the upper and lower bounds – the highest and lowest possible values – for each uncertain parameter into the present value equation from Step 4. Since predictions of future climate change are uncertain, the sensitivity analysis can test the results of the CBA by considering the upper and lower bound of the predictions provided by climate models. In doing so, the results will fluctuate. The size of that fluctuation will indicate how sensitive the CBA results are to uncertainty of a particular parameter.

If by testing different parameters the ***Net Present Value*** does not change from positive to negative ***and*** does not fluctuate greatly…	…then **the results of the CBA are robust** because they do not change regardless of different assumptions.
If by testing different parameters the ***Net Present Value*** does change from positive to negative ***or*** remains positive but fluctuates greatly…	…then **the results of the CBA are uncertain** because they change if we change assumptions.

For example, a CBA of an investment in a wind power plant should consider the estimated cost savings arising from reduced dependence on fossil fuels. Given that the price of fossil fuels is an uncertain parameter and is subject to market fluctuations, the CBA will include a sensitivity analysis that assesses whether the project would still be beneficial even when the lowest and highest prices from the last 20 years are applied.

IN PRACTICE

The participants working on Fiji's Flood Disaster Risk Reduction CBA identified the following uncertain parameters from the river dredging adaptation option to be tested in the sensitivity analysis:

- Number of floods estimated to occur (the extent to which rainfall and cyclone intensity are impacted by climate change may cause the frequency of flood occurrence to vary significantly over the life span of the project).
- Useful life of dredging works and their impact on flooding.
- Volume of sand/gravel extracted from the river and available for sale.

The team will consult sources of data/information for each parameter to determine the highest and lowest possible values to complete the analysis.

In a CBA conducted in Tuvalu in 2012, for example, different rainfall scenarios were taken into consideration in the analysis of a new water catchment in Funafuti. In this case, the upper and lower rainfall values were analyzed to account for their effects on the project's Net Present Value and to ascertain whether the project was beneficial for society under different scenarios. The results of the CBA were robust regardless of the change in assumptions for rainfall, indicating the project was indeed beneficial.

SENSITIVITY ANALYSIS

Given the inherent uncertainty in climate change projections, sensitivty analysis is particularly important for identifying "no-regrets" adaptation solutions. By testing the upper and lower bounds of climate projections, we can determine whether the benefits of an adaptation option outweigh its costs under all climate scenarios.

Image by Marco Arena, via P-CBA Initiative

6 EQUITY AND DISTRIBUTIONAL IMPLICATIONS

Before the CBA is complete, the analyst must make sure that the value of any adaptation project option is distributed equitably across society and does not create inequalities where benefits are restricted to only a select few, while costs are incurred disproportionately by other groups.

IN BRIEF

While ***Net Present Value*** provides a useful measure of a project's value, it does not show the distributional impacts of the proposed project. Some project options may be beneficial overall, but disproportionately favor one group over another. Other projects may be specifically designed so that the majority of benefits are received by only one group (e.g. the poorest) and therefore the positive value of the project would be restricted to only a select few. In this case, an analysis of the equity implications aims to understand whether the benefits for a particular group are coming at a high cost to another group, so that these distributional inequalities can be mitigated.

As a result, analysts may be interested in assessing the distribution of a project's impacts as a means of informing project design or learning lessons from past investments. For this purpose, a sixth step in a CBA can be to examine the level of social equity in the distribution of costs and benefits.

To evaluate the social equity of the project, first list all the stakeholder groups, including third parties, that may not be directly involved in the project but that are in some way related to or affected by it. Then, for each of the major benefit and cost categories, identify which stakeholder groups incur costs and which accrue benefits. This information can be organized into a table like the one shown below (Table 3).

Based on the outcomes of this analysis, the analyst can recommend measures to mitigate persisting inequalities. A well-designed equity and distributional analysis in the CBA can provide policymakers with important suggestions to make development investments more equitable.

IN PRACTICE

Fiji's Flood Disaster Risk Reduction CBA team undertook an analysis of which stakeholder groups are burdened or benefitted by the major costs and benefits of the river dredging option. Their observations are summarized in Table 3.

This analysis shows that while the reduced flood risk benefits all groups, the environmental costs of dredging the river will be faced mainly by local communities and the tourism sector, while the benefits from the sale of gravel will accrue primarily to industry.

With this information, it is possible to design strategies to alleviate distributional inequality. Initial options to mitigate this inequity include requiring the industry contractor that implements the project to take precautionary measures to avoid environmental damage that would affect the tourism sector in the area. Another option is to require the contractor to employ mostly local laborers to provide income opportunities to the affected population as a form of compensation for the environmental costs that they incur.

The CBA from Kiribati introduced in Step 3, ***Measuring and valuing costs and benefits***, is a clear example of distributional issues in the costs and benefits of a coastal protection project. By banning beach aggregate mining and promoting dredging in the lagoon, the Government could reduce the scope for private aggregate vendors to earn incomes, while shifting those benefits to a single entity. After becoming aware of this inequality in the CBA of the project, the project was redesigned to involve affected stakeholders in the new dredging system.

Table 3 | SOCIAL EQUITY AND DISTRIBUTION OF COSTS AND BENEFITS OF OPTION 1: RIVER DREDGING FOR FIJI'S FLOOD DISASTER RISK REDUCTION CBA

Cost/Benefit	***Stakeholder***			
	Government	Individuals/ households in the area	Private sector (Industry)	Private sector (Tourism)
Cost 3 Environmental costs: harm to wildlife such as fish and flora and their habitats		•		•
Benefit 1 Reduced risk of flooding during heavy rainfall	•	•	•	•
Benefit 2 The extraction of sand and gravel could provide jobs/ income			•	

7 NEXT STEPS: FINALIZE THE CBA

CBA helps policymakers be climate-smart in their decision-making, as it provides a practical tool for taking the inherent uncertainty of climate change into account. By quantifying the costs and benefits of adaptation options and comparing them both to each other and to a scenario without adaptation, policymakers are better equipped to make sustainable decisions regarding the investment of finite development resources.

IN BRIEF

The final task in a CBA is to draw conclusions from the various levels of analysis and pull all the information together to share with the decision-makers. As demonstrated throughout this document, CBA is a tool that can help policymakers make rational and effective decisions about where to invest limited funds. This has particular relevance in the context of climate change, where uncertainty and long project lifespans can make the task of efficient and effective decision-making all the more challenging.

Taking adaptation into consideration does not have many precedents in policymaking as it is a relatively new line of work in most countries. Additionally, given the necessarily local scale of adaptation, even if precedents did occur, the same adaptation option can have totally different impacts in different locations. The exercise of listing and measuring all the costs and benefits of implementing an adaptation option in a specific location helps government officials to have a clearer understanding of the project and avoid the risk of poor planning and maladaptation.

THE P-CBA INITIATIVE

A training workshop in Fiji in August 2014.

Image by Marco Arena, via P-CBA Initiative

Strengthening the use of Cost Benefit Analysis in the Pacific

PACIFIC COST-BENEFIT ANALYSIS INITIATIVE (P-CBA)

P-CBA is a multi-agency initiative assisting Pacific Island Country and Territory (PICT) governments to better prioritize, design and implement their projects and policies for more effective and efficient climate- and disaster-resilient development. A direct response to national demands for support with Cost-Benefit Analysis, P-CBA targets government officials from central planning or finance ministries, building on existing experiences such as the Pacific Adaptation to Climate Change (PACC) CBA work program and related cost-benefit analysis trainings. Partners include the German International Cooperation (GIZ), the Secretariat of the Pacific Regional Environmental Programme (SPREP), the Secretariat of the Pacific Community (SPC), the Pacific Island Forum Secretariat (PIFS), the United Nations Development Programme (UNDP), USAID Adapt Asia-Pacific, the Asian Development Bank (ADB), and the University of the South Pacific (USP).

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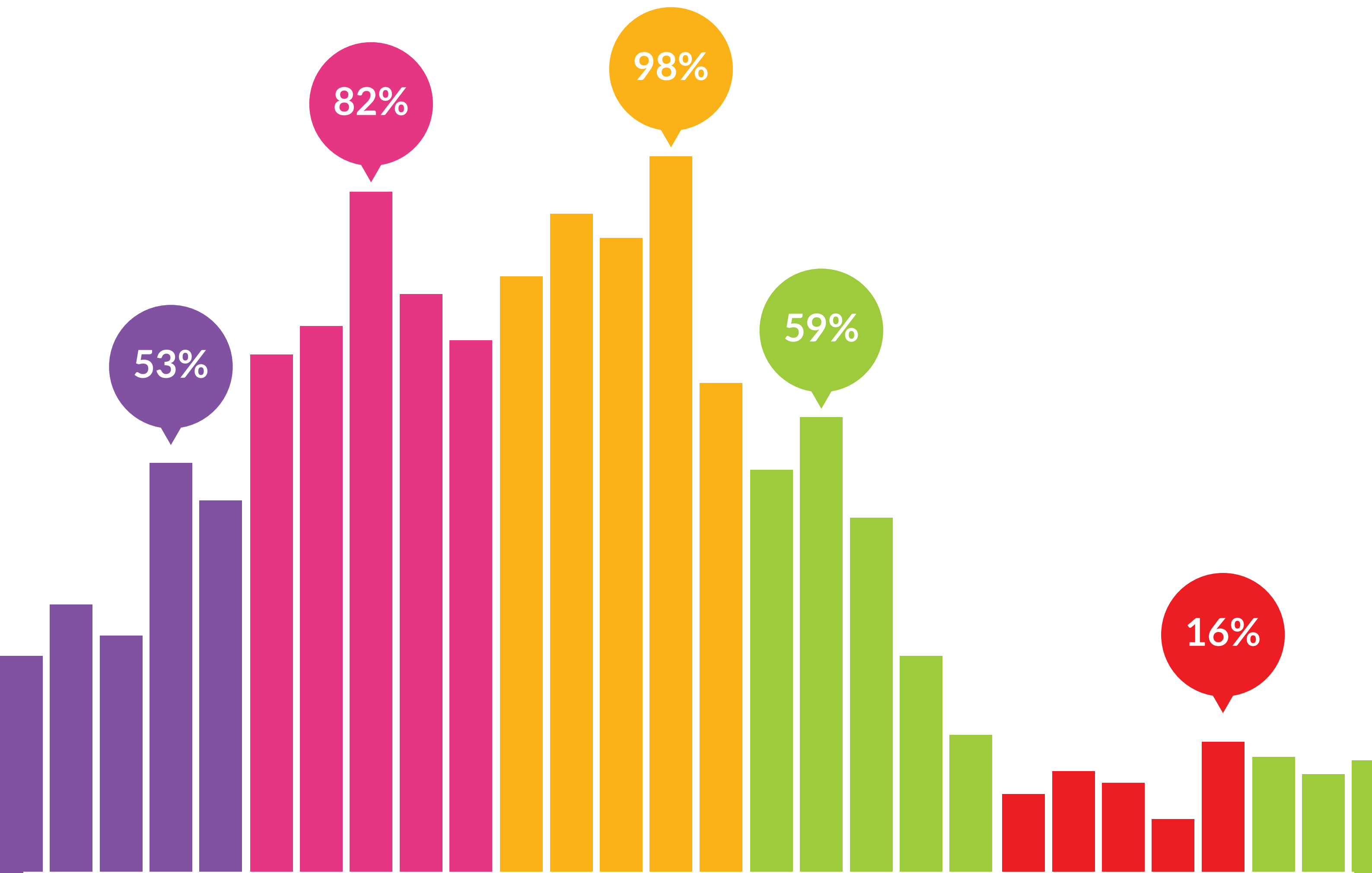

USAID Adapt Asia-Pacific

CLIMATE CHANGE ADAPTATION PROJECT PREPARATION FACILITY FOR ASIA AND THE PACIFIC

The USAID Adapt Asia-Pacific project (2011-2016) is designed to help countries in Asia and the Pacific obtain financing to address climate change impacts, through a combination of technical support in project preparation, providing relevant training and developing specialized materials to build national and regional capacity for accessing finance.

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