Economics of Climate Proofing at the Project Level

Two Pacific Case Studies

The broad-ranging impacts of climate change—on infrastructure, facilities, and livelihoods; resources for food production; and risks to settlements and human health—create significant development challenges for the Pacific region. As such, the assessment of climate change impacts and economic analysis of climate change response have become crucial in rationalizing investments in adaptation and mitigation measures. This study evaluated the economic viability of investments in climate proofing development projects and determined whether or not to invest, when to invest, and how much to invest in climate proofing.

The Pacific developing member countries (DMCs) of the Asian Development Bank (ADB) are a diverse array of countries generally characterized by their small physical size, geographic remoteness, fragile biodiversity, and a limited natural resource base. Most, if not all, Pacific island countries are also confronted with extraordinary circumstances with respect to climate change. As a major development partner, ADB is committed to ensuring the continued economic growth of its Pacific DMCs amid the growing challenges posed by climate change. In the Pacific, adaptation, rather than mitigation, is the more relevant element in addressing climate change impacts.

Adaptation and Climate Proofing

Increasing adaptive capacity through climate proofing means increasing resilience to, and reducing risks posed by, climate change—for example, through improving the ability of coastal infrastructure to withstand floods and cyclones, or relocating physical facilities to higher elevations. To climate proof a development project means to (i) identify risks to the project (or any other specified natural or human asset) resulting from climate variability and extremes; and (ii) ensure that those risks are reduced to acceptable levels through long-lasting, environmentally sound, economically viable, and socially acceptable changes implemented at one or more stages of the project.[1]

[1] ADB. 2005. Climate Proofing: A Risk-based Approach to Adaptation. *Pacific Studies Series*. Manila.

ADB Asian Development Bank

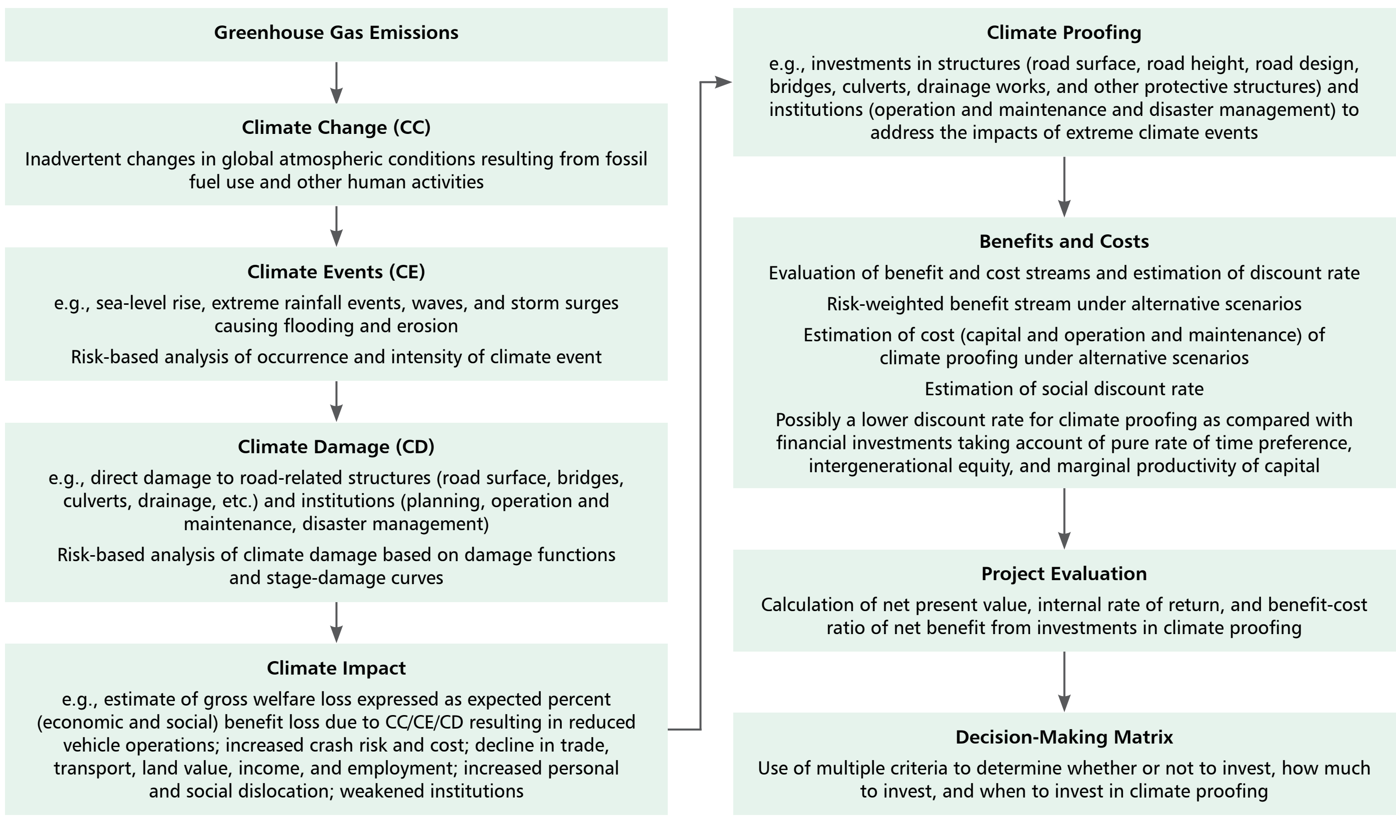
The cost of climate proofing development projects at the design stage will normally be much less than the cost of repairing infrastructure or other assets over their lifetimes, if they were not climate proofed. It is good practice, therefore, to consider climate and disaster-related risks in designing future projects.[2]

In support of ADB's commitment to develop tools, methodologies, and guidelines for climate adaptation, this study developed basic economic models of benefit and cost analysis for climate proofing investment projects. The study considers the significant impacts that an extreme climate event may have on a project within its lifetime and beyond, and the additional investment in climate proofing required to partially, if not fully, secure the project's benefit stream. The analysis provided indicative guidelines for if, when, and how much, to invest in climate proofing.

Framework and Methodology for Project Economic Analysis

The benefits of climate proofing development projects against the impacts of climate events (e.g., sea-level rise, flooding, coastal erosion) is determined by the estimated loss of project benefits when no investments were made in climate proofing. The study first determines relevant climate events, climate damages, and climate impacts on development projects, then examines climate proofing options and their benefits and costs based on historical and projected data. The climate proofing options are analyzed using project evaluation criteria—net present value (NPV), internal rate of return (IRR), and benefit–cost ratio (BCR)—for three scenarios: (1) without a climate event; (2) with a climate event and no climate proofing; and (3) with a climate event, with climate proofing. Economic analysis for scenario 2 considers the

Framework for Project Analysis under Climate Change



[2] ADB. 2009. Mainstreaming Climate Change in ADB Operations: Climate Change Implementation Plan for the Pacific (2009–2015). *Pacific Studies Series*. Manila.

Estimated Economic Viability Indicators by Project Area and Project Scenario under IPCC Greenhouse Gas Emission Scenario A2 Assuming a 30-Year and 50-Year Project Life

Project Area	Economic Viability Indicator	Scenario 1 30 Years	Scenario 1 50 Years	Scenario 2 30 Years	Scenario 2 50 Years	Scenario 3 30 Years	Scenario 3 50 Years	Increment due to Climate Proofing 30 Years	Increment due to Climate Proofing 50 Years
Second Solomon Islands Road Improvement Project (SIRIP II)									
Northwest Guadalcanal Road Project (29 km)	NPV ($ million)	8.45	13.38	(3.18)	(2.40)	0.99	3.78	4.23	6.13
	IRR (%)	20	20	<0	1	7	9	>100	>100
	BCR	2.09	2.73	0.53	0.67	1.12	1.43	4.23	4.96
Makira Island Coastal Road Project (72.5 km)	NPV ($ million)	34.56	34.56	(7.82)	(5.00)	13.40	13.40	18.74	14.75
	IRR (%)	22	22	<0	2	10	10	36	36
	BCR	2.94	2.94	0.59	0.75	1.71	1.71	9.59	7.76
North Malaita Road Project (31.5 km)	NPV ($ million)	9.27	14.45	(1.31)	0.12	2.33	5.44	3.25	4.72
	IRR (%)	22	22	<1	5	9	10	32	32
	BCR	2.26	2.94	0.81	1.02	1.33	1.72	7.50	9.66
Timor-Leste Road Network Sector Development Project (RNSDP)									
Ermera–Maliana Road Project (61.2 km)	NPV ($ million)	35.05	58.66	(9.80)	(7.55)	2.38	17.86	10.35	63.76
	IRR (%)	16	16	1	<1	6	8	13	141
	BCR	1.68	2.16	0.78	0	1.05	1.34	2.61	9.82
Dili–Mota Ain Road Project (78.8 km)	NPV ($ million)	62.36	96.79	(9.98)	(1.29)	15.43	36.17	20.36	29.77
	IRR (%)	25	25	0	5	10	11	27	25
	BCR	2.14	2.68	0.82	0.98	1.27	1.58	4.39	`5.36

BCR = benefit–cost ratio, IRR = internal rate of return, km = kilometer, NPV = net present value, ( ) = negative value.
Source: ADB.
Notes: Intergovernmental Panel on Climate Change (IPCC) greenhouse gas emission scenario A2: Continuous population increase (2100 world population at 1.5 billion); slow economic growth; slow technological progress.
Scenario 1: Based on project appraisal, assuming a 30-year project life and a 50-year project life; status quo.
Scenario 2: With climate change, no adaptation (climate proofing). Appraised project benefits reduced by percent benefit–loss due to climate change. Appraised project costs increased by higher operation and maintenance (O&M) costs due to climate change.
Scenario 3: With climate change, with climate proofing. Appraised project benefits reduced by the portion of percent benefit–loss due to climate change that is not recovered by climate proofing. Appraised project costs increased by higher required capital and O&M costs due to climate proofing.
Increment due to climate proofing: Appraised incremental benefit of climate proofing reduced by the portion of percent benefit–loss due to climate change not recovered. Appraised increase in capital and O&M costs due to climate proofing.
For all of the case study road projects analyzed under the present study, relevant climate events were assumed to include heavy rain, flooding, and coastal erosion. Road construction was assumed to commence in year 0, and project benefits were assumed to being accruing in year 1. Similarly, climate proofing investments were assumed to begin in year 0, and the benefits associated with climate proofing were assumed to begin accruing in year 1. Social discount rate was assumed at 5.27%, based on rate of pure time preference; social opportunity cost of capital; and utility, elasticity, and growth rate of consumption.

truncated project life, lower benefits, and unchanged or higher operation and maintenance (O&M) costs. Scenario 3 considers higher initial investment cost, unchanged or higher benefits, and lower O&M costs. The study's framework of analysis is summarized in the figure on previous page.

An economic model was used to evaluate the economic viability of climate proofing development projects in the context of the low (A1), median (B1), and high (A2) greenhouse gas emission scenarios of the Intergovernmental Panel on Climate Change (IPCC).

Application: Two Case Studies in the Pacific[3]

Two road development projects were selected as case studies for application of the framework: (i) the Second Solomon Islands Road Improvement Project (SIRIP II) in Guadalcanal, Makira, and Malaita provinces; and (ii) the Road Network Sector Development Program (RNSDP) in Timor-Leste, covering the Dili–Mota Ain road (a coastal road with mountainous stretches) and the Ermera–Maliana road (a forest road). The high likelihood of future intense flooding, rainfall, and coastal erosion can lower the projects' expected benefits due to direct damage to land and coastal infrastructure. Without climate proofing, an expected project life of 30 years and 50 years would be truncated to 20 years and 30 years, respectively.

Scenario 1: Status Quo. When climate change is not considered in project formulation, SIRIP II and Timor-Leste RNSDP (each with assumed economic lives of 30 years and 50 years) are viable, with positive NPVs, IRRs, and BCRs. The NPV values in the 50-year analysis range from about $13.38 million (for Guadalcanal) to $96.79 million (for Dili–Mota Ain). The IRR values range from 16% (for Maliana) to 25% (for Dili–Mota Ain). Maliana's BCR

[3] This section presents only the results of project analysis against the IPCC A2 high greenhouse gas emission scenario (the worst-case scenario); the other analyses are presented and discussed in more detail in the study's final report (publication underway).

value of 2.16 is the lowest estimate, yet is still acceptable. The Makira and Malaita road projects showed the highest BCR estimate of 2.94. The 30-year analyses came up with NPV and BCR values slightly lower than those from the 50-year analysis; the two periods of analysis posted equal IRRs (see table).

Scenario 2: With Climate Change, No Adaptation (Climate Proofing). In this scenario, the Scenario 1 benefit is reduced by the estimated expected percent benefit–loss, which was assumed to be constant year after year. To account for possible future variation, the value of expected percent benefit–loss used in the study is the weighted average of percent benefit–loss across different levels of climate event intensity, weighted by the probability of occurrence at a particular intensity of the climate event.[4]

The higher cost assumed in this scenario does not restore the Scenario 1 expected benefit stream because higher O&M and periodic maintenance costs are incurred due to the damage caused by climate change; with no climate proofing, a greater physical damage to projects can be expected.

Under the 30-year analysis, all the case projects posted negative NPVs and became economically infeasible. Compared with Scenario 1, the IRRs were significantly reduced and the BCRs fell to less than 1. Only the Malaita project posted a positive NPV and a BCR greater than 1 in the 50-year analysis.

Scenario 3: With Climate Change, with Adaptation. Analysis shows that for road projects assumed to last 30 years and 50 years, climate proofing decreases the project's vulnerability to damage due to extreme climate events. Under the 30-year analysis, instead of the project incurring a net loss of $3.18 million (in present value terms), climate proofing the Guadalcanal road project generates an NPV of almost $1.0 million, with an IRR of 7%, and a BCR of 1.12. Similarly, the 50-year analysis showed positive NPVs, IRRs above the social discount rate, and BCRs more than unity.

Increment Due to Climate Proofing. Under the IPCC worst-case scenario, climate proofing may recover about 22% of expected net benefits for a project life of 30 years, and 34% for a project life of 50 years, and improve the project's NPV, IRR, and BCR. The full report shows that, regardless of emission scenario, climate proofing is economically viable in the project case studies in Solomon Islands and Timor-Leste; standard sensitivity analysis confirmed the results.

[4] Although annual estimates of the expected percent benefit–loss were not used, the possible annual variability in expected percent benefit–loss can still be captured by the weighted average.

Investing in Climate Proofing

Traditional project viability indicators are only one element in making decisions regarding investments in climate proofing. Other elements are time preference (the priority placed on present over future well-being); population life cycle (young or old); manner of decision making (democratic or otherwise); level of concern for future generations; IPCC carbon dioxide emission scenario; probability of extreme climate-related events occurring; intensity of anticipated (structural, economic, and social) impacts of such event at the country and project levels; discount rate employed (both nominal and social); the project's NPV and IRR with or without a climate-related event; long-term rate of return on capital; marginal cost of reducing future risks; the country's climate proofing development plan or budget; and prospects for long-term concessional or grant funding.

As such, investing in climate proofing at project onset would be indicated by a combination of a high rate of time preference, a young population, democratic decision making, a high degree of concern for future generations, and high probability of an intense climate-related event. On the other hand, the same combination of elements plus a moderate probability of an intense climate-related event would indicate the need for future programmed investments. For Solomon Islands and Timor-Leste projects analyzed in this study, investment appears to be required at both project onset and in the future. This means that climate proofing investments should be planned on a longer-term basis and need not made simultaneously.

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