

## ECONOMIC ANALYSIS

### A. Introduction

1. Papua New Guinea's (PNG's) economy is dominated by a large, labor-intensive agriculture sector and capital-intensive mining and petroleum industries (consisting mostly of oil, liquefied natural gas, gold, copper, and silver extraction). The formal sector consists of enclave extractive mining and petroleum industries; cash-crop agriculture production; and a small, import-substituting manufacturing sector. The informal sector, from which roughly 85% of the population derives its livelihood, is largely subsistence agriculture. PNG has more than 600 islands, of which more than 150 are inhabited, and altitudes ranging from sea level to 4,500 meters, presenting a significant challenge in providing access to markets, commercial opportunity, and public services, especially in rural (remote island) areas. Geography and poor transport infrastructure networks isolate large segments of the population from social services, regional markets, and income-earning opportunities. Many of the small island communities are exposed to extreme climate events and lack the capacity to take adaptation measures to minimize the impacts of climate change.

2. The impact of the Building Resilience to Climate Change in Papua New Guinea project is increased resilience to the impacts of climate variability and change. The outcome is improved capacities of communities, government agencies, and civil society to plan for and respond to the impacts of climate change. To achieve this outcome, three outputs will be implemented: (i) climate change and vulnerability assessments carried out and adaptation plans developed for target communities, (ii) sustainable fisheries ecosystems and food security investments piloted in nine vulnerable island and atoll communities, and (iii) an enabling framework for climate-resilient infrastructure established and early warning communication network extended.

3. The economic cost of the project is divided into capital and operating costs. The financial capital costs of each output have been converted into economic terms by applying the general conversion factor (GCF) to estimated costs. This ratio is applied to the constant price financial values in project analysis to derive the corresponding economic values. The GCF removes taxes, subsidies, and other market distortions. Taking into account indirect taxes, the value of the GCF is considered to be 0.9. Labor market statistics are weak; employment statistics were last compiled in 2003. For the purpose of this economic analysis, a shadow wage rate of 0.9 is used to convert domestic financial labor costs into economic costs. The period over which the benefits have been evaluated is 20 years. The residual value of all equipment and infrastructure at the end of the analysis time horizon is assumed to be zero.

4. This document evaluates the potential incremental benefits that accrue from project initiatives for each output and their various activities. The aggregated net benefits present an economic evaluation to assess the contribution of the project to PNG's overall economy using two measures—the economic internal rate of return (EIRR), and the net present value assessed at a discount rate of 12%.<sup>1</sup>

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<sup>1</sup> Supplementary Document 14 of the RRP presents the Detailed Economic Analysis

## B. Project Benefits

5. Identified benefits from output 1 include the improved hygiene status of communities in the 21 vulnerable islands that can be anticipated because of improved techniques for harvesting and storing water and from improved sanitation facilities. Health benefits have been underestimated as the impact on the working-age population. The benefit to children has not been incorporated. Output 1 also assesses the potential benefits from reduced damage to island assets as a result of physical and biological protection financed by the small grant facility.

6. Output 2 concerns fisheries ecosystems and food security initiatives. The analysis establishes a current value of the reef without the project, based on its current functional uses based on economic valuations of similar reefs from numerous independent studies including the TEEB database.<sup>2</sup> The analysis compares the rates of reef decline for four reef categories at 3.0% without the project to a 1.5% decline introduced progressively over 8 years. The reduced deterioration is due to the management regime resulting from the project. Table 1 shows the area in each quality category, derived by applying the two rates of deterioration. The figures reflect the reduced area due to deterioration of the area in that category plus the area that results from the recategorization of higher category coral reef joining the category immediately below. In each case the total equals the target project area of 17,500 hectares.

**Table 1: Base Data for Reef Analysis**

Reef Condition	2014 Area (ha)	Area, Without Project (2021)		Area, With Project (2021)		2014 Unit Value of Category (\$/ha/yr)
		(ha)	(%)	(ha)	(%)	
Depleted		2,317	13.2	1,947	11.1	0
Poor	7,280	6,105	34.9	6,292	36.0	1,736
Fair	5,530	5,289	30.2	5,328	30.4	2,079
Good–excellent	4,690	3,789	21.7	3,932	22.5	2,598
<b>Total</b>	<b>17,500</b>	<b>17,500</b>	<b>100.0</b>	<b>17,500</b>	<b>100.0</b>	

ha = hectare, yr = year.

Note: Total area of reef in target islands is estimated at 17,500 ha, comprising 9,000 ha in Manus, 4,000 ha in East New Britain, and 4,500 ha in Milne Bay.

Source: reefgis.reefbase.org/default.aspx and Burke, L., E. Selig and M. Spalding. 2002. *Reefs at risk in Southeast Asia*. World Resources Institute, Washington, D.C., ISBN 1-56973-490-9, GEF/UNDP/IMO (1999) Total economic valuation: coastal and marine resources in the Straits of Malacca; and White, A.T., M. Ross and M. Flores. 2000. *Benefits and costs of coral reef and wetland management, Olango Island, Philippines*. In: Cesar, H. (ed), "Collected essays on the economics of coral reefs". Kalmar, Sweden: CORDIO, Kalmar University: 215-227.

7. A similar data composition was adopted to estimate the annual value of coastal mangrove forests. The established rate of mangrove forest decline specific to PNG was estimated from geographic information system mapping and references from the University of PNG Remote Sensing Department. The with-project scenario assumes a reduced rate of mangrove forest deterioration based on historic rates of decline countrywide (Table 2).

<sup>2</sup> Ecosystem Services Valuation Database. Within the context of the TEEB project (2008–2010), the authors of the global overview of the "Estimates of monetary values of ecosystem services", supported by many Ecosystems Service Partnership members, developed a database on monetary values of ecosystem services, which now contains more than 1,350 data points from more than 300 case studies (<http://www.fsd.nl/esp/80763/5/0/50>).

**Table 2: Base Data Used in Assessing Mangrove Benefit**

Location	2014 Area (ha)	Project Area	Without	With Project,	2014 Unit
		2014	Project, 2021	2021	Value
		(ha)	(rate/ha)	(rate/ha)	(\$/ha/yr)
Bougainville	7,959	60	0.54%	0.27%	2,697
East New Britain	2,788	120	0.54%	0.27%	2,697
Manus	7,404	90	0.54%	0.27%	2,697
Milne Bay	44,606	240	0.54%	0.27%	2,697
Morobe	3,590	90	0.54%	0.27%	2,697
<b>Total</b>	<b>66,347</b>	<b>600</b>	<b>565.00</b>	<b>589</b>	

Source: Government of Papua New Guinea. *State of the Forests of PNG, 1992–2002 - Drivers of Change*, Port Moresby.

8. The incremental value from food security initiatives was estimated based on household garden production with existing crops produced in the three locations (Table 3). Household crop budgets were developed under the with- and without-project scenarios. The evaluation is based on household rotations at assumed adoption rates for taro, yams, and sweet potatoes, depending on the location.

**Table 3: Base Data for the Assessment of Food Security Benefits**

Location	District HHs (2014)	Target Island HHs (2014)	% Adoption <sup>a</sup>	Adopting Households		
				Taro	Sweet Pot	Yams
East New Britain	17,566	2,353	19.1	450	450	0
Manus	10,462	3,049	16.4	500	500	0
Milne Bay	8,032	1,928	20.7	400	400	400
<b>Total</b>	<b>36,060</b>	<b>7,330</b>	<b>18.4</b>	<b>1,350</b>	<b>1,350</b>	<b>400</b>

HH = household.

<sup>a</sup> The adoption rate is the anticipated adopting households divided by the target island household number.

Source: 2011 census updated by provincial growth rates to 2014 estimates.

9. Some of the participating islands lack agricultural resources to allow home garden production. In this situation, the food initiatives will be implemented in adjoining mainland communities to support the trade in food items that has long been the practice in coastal island communities. The household area planted to each plot is representative of the area and is assumed to be averaged for the residents in that location.

10. Benefits from output 3 result from the assumed reduction in fatalities reported<sup>3</sup> in the target provinces assessed at the derived value of statistical life interpolated from the United States per capita value. These benefits accrue from project initiatives on the 21 target islands where emergency response strategies are developed under the project but also a wider application where very-high-frequency (VHF) radio coverage has been extended.<sup>4</sup> The beneficiary number has been estimated by geographic information system capabilities using topographic datasets and population distributions. Inhabitants, fishers, and travelers will be able to access early warning messages from the National Disaster Center and register emergency

<sup>3</sup> Disaster records extracted from Centre for Research on the Epidemiology of Disasters, School of Public Health, Université Catholique de Louvain, Clos Chapelle-aux-Champs, Bte B1.30.15, 1200 Brussels, Belgium were analyzed for the 25 years 1990–2014 and the relevant figures averaged for the various natural disasters.

<sup>4</sup> Natural disasters included volcanic action, earthquakes, tidal waves and tsunamis, and cyclones and typhoons. For the broader network, the influence of earthquakes has been removed as the communications network is unlikely to prevent loss of lives in this instance.

situations to allow a response from others in the area. This benefit has been estimated from reduced fatality rates (15% reduction) within the coverage area. The value of statistical life for PNG used in the analysis is \$238,000 per head. Under the without-project scenario, the number of fatalities anticipated in the target islands in 2021 is 10.0 individuals, while in the with-project scenario it is 9.5 persons.

### **C. Results of the Analysis**

11. Separate output analyses have been undertaken where estimated benefits outlined above have been compared with costs following the cost categories in the main project design. Project management costs have been incorporated under output 3. Project management unit consultant costs (e.g., procurement financial management) were specifically excluded from output EIRR estimates but were included in the overall project assessment. The project EIRR is estimated at 12.6% while the present value of the net benefit stream is estimated at \$0.67 million evaluated at a discount rate of 12%. The estimated EIRR for project output 1 was 11.3%, for output 2 it was 26.0%, and for output 3 12.6%.

12. The relative contribution of the three outputs to the overall benefit stream is noteworthy. The relatively low return for output 1 is a reflection of the high cost of undertaking detailed work in a few island locations where there are few beneficiaries (target island population of 13,000) and the cost of providing services relatively high because of the remoteness. The addition of nongovernment organizations to assist in implementation is considered necessary but adds to the overall cost of output activities.

13. The performance of outputs 2 and 3 are higher. The benefits from the reduced rate of reef deterioration are significant but are not achieved until after 10 years, given the nature of the interventions. Food security benefits are significant because of the application of known technologies among farmers who are currently producing these crops in their own home gardens. The rate used in the analysis (about 20% in each location) is therefore conservative. Also, food security beneficiaries are not confined to the target islands as they are for output 1 activities. For output 3, the relatively low cost of establishing transmitter stations on existing towers combined with the significant potential beneficiary population (over 500,000) suggests that only modest savings in the number of fatalities will generate significant benefits at minimal cost.

### **D. Sensitivity Analysis**

14. Sensitivity analysis was undertaken to determine if results were robust to the assumptions used in the analysis and other risk factors. Sensitivities were conducted for 10% and 20% changes in costs and benefits and from the delay of 12 months in benefit generation, with the costs remaining in their allocated year according to the design (Table 4).

**Table 4: Sensitivity Analysis**

Variation		NPV (\$'000s)	EIRR
Base Case		674.6	12.6%
Project costs increase by	10%	(1,053.3)	11.1%
	20%	(2,781.3)	9.9%
Project benefits decrease by	10%	(1,120.8)	11.0%
	20%	(2,916.2)	9.3%
Costs +10% and Benefits -10%		(2,848.7)	9.6%
Costs +20% and Benefits -20%		(6,372.1)	6.9%
Benefits delayed 12 months		(1,688.2)	10.6%

EIRR = economic internal rate of return, NPV = net present value.

Source: Asian Development Bank estimates.

15. It is concluded that the impact of the project is likely to be positive on the economy of PNG and that benefits are not overly sensitive to either cost increases, reductions in benefits, or delays in generation of project benefits. There are also unquantified benefits relating to the significant capacity building initiatives. The project is therefore a sound investment and is likely to contribute to increasing the awareness of the impacts of climate change on PNG's economy, quite apart from its economic impact.<sup>5</sup>

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<sup>5</sup> The Summary of Economic Internal Rate of Return is detailed in supplementary document 14.