DETAILED ECONOMIC ANALYSIS

A. Introduction

1. Papua New Guinea's (PNG's) economy is dominated by a large, labor-intensive agricultural sector and a capital-intensive mining and petroleum sector (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, on which roughly 85% of the population derives their livelihood, is largely subsistence agriculture. PNG has over 600 islands of which some 150 are inhabited and with altitudes ranging from sea level to 4,500 meters that presents a significant challenge of providing access to markets, commercial opportunity and public services, especially in rural 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 (the 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 and respond to the impacts of climate change. To achieve this outcome, three outputs will be incorporated in the design (i) climate change and vulnerability assessments carried out and adaptation plans developed for target communities, (ii) sustainable fisheries eco-systems 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 cost of each output has been converted into economic terms by applying the general conversion factor (GCF) to financial 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 distortions. Taking into account indirect taxes, the GCF is considered to be 0.9. Labor market statistics are noted to be 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 supplementary 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 indicators - the economic internal rate of return (EIRR), and the Net Present Value (NPV) assessed at a discount rate of 12%.

B. Project Benefits

5. Benefits have been assessed by output for the first three outputs including project management that has been incorporated into Output 3. The consulting services costs for overall project management for items such as procurement and financial management have been excluded from EIRR output estimates but included in the overall project estimate. 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

from the most appropriate source available together with improved sanitation on the islands. Health benefits have been underestimated as only the impact on the working age population has been incorporated. There is a benefit to children that has not been incorporated in the analysis. It also includes potential benefits from the small grants facility that evaluates reduced damage to island assets as a result of physical and biological protection financed by the small grants facility.

6. The second output concerns fisheries ecosystems including reef management, coastal mangrove forest preservation and food security initiatives. The analysis establishes a current value of the reef 'without project' based on its functional uses (raw materials, food (fisheries), and protection from extreme events) based on economic valuations (brought to common 2014 USD terms) of reefs in similar environs drawn from numerous independent studies including those reported in TEEB database).[1] The analysis compares the rates of reef decline for four reef categories (assessed at an average value of $2,079/ha/yr) at 3% without the project to a 1.5% decline introduced progressively over 8 years. The reduced rate of degeneration is due to the enhanced management regime proposed under the project, the difference between the two being the incremental benefit from the project.

7. In the case of mangrove forest rehabilitation, a similar data composition was adopted (food-fisheries, raw materials and coastal protection service values) to estimate the annual value of the coastal mangrove forest ($2,697/ha/yr in constant 2014 terms). The established rate of mangrove forest decline specific to PNG was estimated from GIS mapping work and other 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 country-wide. The comparison of the two rates of decline at the estimated value per unit area of mangrove forest provides an estimate of the incremental benefit accruing from the project.

8. The incremental value from food security initiatives has been estimated based on household garden production with the existing crops produced in the three target provinces (three target islands in East New Britain (Duke of York Islands - Mioko, Utuan and Kerawara Islands), Manus (Andra, Ponam and Ahus Islands) and Milne Bay (Trobriand Islands - Kiriwina, Munuwata and Kaeleuna Islands)). Household crop budgets were developed under the 'with' and 'without project' scenarios. Under assumed adoption patterns, the two scenarios are compared to provide an estimate of the incremental benefit from the adoption of drought tolerant planting material and improved production techniques. Some of the participating islands have limited agricultural resources to entertain 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 project will introduce improved production techniques as a demonstration of improved food security that will be based on the prevailing agricultural system in each location. The household area planted to each plot is representative of the area and is assumed to be averaged for the residents in that location.

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[1] "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 researchers developed a database on monetary values of ecosystem services which now contains over 1,350 data-points from over 300 case studies (http://www.fsd.nl/esp/80763/5/0/50).

9. Benefits from Output 3 result from the assumed reduction (20%) in fatalities reported[2] in the target provinces assessed at the derived value of statistical life (VSL) interpolated from the US per capita value. These benefits accrue from project initiatives on the target 21 islands where emergency response strategies are developed under the project but also a wider application where VHF radio coverage has been extended. [3] The larger beneficiary number has been estimated by GIS capabilities using topographic data sets and population distributions. Inhabitants, fishermen and travelers will be able to access early warning messages from the National Disaster Center and register emergency 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 assessed at the average statistical value of life in the target provinces of VSL of $7,020,000 per individual[4] adjusted by the respective per capita GDP figures where the GDP per capita ratio is 0.05 for PNG to USA. The VSL for PNG used in the analysis is $238,000 per head. Under the 'without' project scenario, the respective numbers of fatalities anticipated by 2021 in the target islands is four individuals while the 'with project' scenario amounts to three persons in year 2021.

1. Approach for Estimating Output 1 Benefits

a. Water and Sanitation Benefit Estimation

10. For Output 1 activities, benefits analyzed include the improved sanitation in target islands as expressed through the reduction in community disease cases of water borne diseases[5] found amongst the working aged population and valued at the number of working days lost as a result of the diseases. Population estimates on the target islands were adjusted by the provincial growth rate reported in the 2011 census.

11. Estimates of the value of the reduced malaria incidence was obtained by applying 7 days incapacitation (as advised by ADB health specialist) when the infected person could not be engaged in income generating activities valued at the current wage rate of K20/day (K16.6/day in economic terms). Community incidence rates were obtained from the DOH Sector Performance Annual Review in 2012 that reported rates of 38%, 17%, 34%, 56% and 20% for the relevant districts in Milne Bay, Morobe, Manus, East New Britain and Bougainville respectively. This formed the 'without project' scenario. Under the 'with project' scenario, the community incidence levels decrease by 30% per annum over two year period after installation of facilities (assumed year 2 and 3), then remaining at that level thereafter (Table SD14.1). For the other diseases, the ratio between discharges from the nearest district hospital and the community incidence for malaria was applied to the hospital discharge rates for other water-borne diseases discharge rates to obtain estimates of community incidence as data on community rates for water borne disease (other than malaria) was not found in DOH reports. The application of the ratio to estimate community incidence of disease is reasonable in the context of PNG island communities. Data on the incidence of diarrhea is only available for children under the age of 5 yet that is not appropriate for use in the analysis (working age

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[2] Disaster records extracted from Centre for Research on the Epidemiology of Disasters (EMDAT), School of Public Health, Université Catholique de Louvain, Clos Chapelle-aux-Champs, Bte B1.30.15, 1200 Brussels, Belgium were analysed for the 25 years 1990-2014 and the relevant figures averaged for the various natural disasters.

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

[4] Figure is the 2013 USA VSL that was obtained from the Tonga Study and adjusted to 2015 PNG terms.

[5] These include diarrhea, malaria, anemia, skin diseases and typhoid.

people affected). The estimate therefore is an underestimate of the potential benefits from project interventions.

Table SD14.1: Parameters for Estimating Reduced Disease Benefits

Province	Population 2014 [1] (people)	Annual Growth Rate [2] %	Community Disease Incidence Rate (2011) 3		
			Malaria	Diarrhea	Anaemia
Bougainville	2,338	2.60%	28.9%	23.9%	11.7%
East New Britain	3,331	1.90%	56.8%	22.0%	25.2%
Manus	2,858	1.30%	34.3%	45.5%	29.0%
Milne Bay	2,239	2.30%	38.0%	10.0%	13.6%
Morobe	2,605	1.60%	16.6%	21.5%	5.4%
Assumed Reduction			40%	40%	30%

1/ Target Islands only.
2/ Provincial growth rates applied to target islands.
3/ Diarrhea and Anaemia rates derived from local district hospital discharge statistics.

b. Benefits from Small Grants Facility

12. PNG is located in an area that has seen almost 1,000 tropical cyclones over the last 60 years averaging 16 per year.[6] It is the southern part of the country that has been affected since the northern part is close to the equator where tropical cyclones are rarer. Historical major flood events caused by heavy rain and cyclones in PNG[7] is presented in the Table SD14.2. The major recent disaster resulted from Cyclone Guba affecting Oro and Milne Bay Provinces in 2007 with 170 deaths and an estimated $183 million in property damage. In addition, other significant cyclones include Rewa (1993/94), Justin (1996/97), Epi (2003) and Dolphin (2008) affecting PNG and the South Pacific island communities. The extreme tidal surge experienced in 2008 caused extensive damage to the coastal coral reefs that provide natural protection from the prevailing wave action that delivered the full thrust of their aggregated energy directly onto islands without this protection (with consequent erosion and damage to property). The costs from climate related hazards in Milne Bay alone are presented in Table SD14.3.

Table SD14.2: Summary of Extreme Climate Events Reported in PNG

Location	Date & Duration	Deaths	Displaced	Property Damage
Oro Province tropical cyclone	November 2007, 15 days	170	13,000	$183 million
Morobe Province – heavy rain	August 2007, 12 days	2	5,000	No estimate
Southern Highlands Province, heavy rain	April 2006, 4 days	1	300	No estimate
East Sepik Province, heavy rain	April 2006, 7 days	0	400	No estimate

6 National Disaster Center, PNG
7 Dartmouth Flood Database, Dartmouth Flood Observatory

Location	Date & Duration	Deaths	Displaced	Property Damage
Western Highlands Province, heavy rain	February 2006, 7 days	6	5,000	No estimate
Central, Gulf and National Capital, heavy rain	February 2006, 17 days	1	12,000	No estimate
Madang Province, heavy rain	March 2004, 12 days	2	4,000	No estimate
Western Highlands, heavy rain	March 2004, 5 days	0	10,000	No estimate
Morobe Province, heavy rain	November 2003, 5 days	0	30,000	No estimate
East Sepik Province, heavy rain	April - May 2003, 21 days	0	0	No estimate
East Sepik Province, heavy rain	April 1998, 5 days	0	30,000	No estimate
East and West Sepik, heavy rain	May 1992	4	10,000	$12 million
Southeastern PNG, tropical cyclone	January 1994, 5 days	9	No estimate	No estimate
Central Highlands, heavy rain	December 1993, 2 days	14	3,500	No estimate

Source: Dartmouth Flood Database

Table SD14.3: Climate Related Hazards - Milne Bay 2005-10

Hazard	No. of Incidents	No. of Deaths	No. Affected	Damage	Rehabilitation Cost
Sea Mishaps	100	174	616	K92,000	K373,000
Storm Surges	18	3	200	K20,000	K50,000
Drought	8	618	195,000	K5-10million	K2.2million
Cyclone	7	22	81,000	K3.2million	K3.3million
Flooding	20	120	8,000	K242,500	K330,000
Sea Level Rise	2	0	300	K50,000	K40,000

Source: Provincial Disaster Office, Milne Bay Province

13. The benefits from the small grants facility estimates the reduced loss of damage to island assets resulting from climate proofing subprojects financed through the facility. The analysis is based on the population of the 21 vulnerable island communities with the number of residences estimated using an average household size of five people. Whilst the exact number and nature of the subproject investments will be determined during implementation, the criteria for their approval is that they must involve adaptation measure against the impacts of climate change. As a proxy variable to estimate the likely benefit, the analysis assesses the reduced damage to island assets caused by extreme climate events of varying intensities. The values used in the analysis have been assumed based on the existing structural improvements on the islands supported by reports as to the value of damage reported in extreme climate events in the target area.

14. For the purpose of the analysis, the estimated damage from a cyclone depends on the severity with five levels of severity - one in five, one in 10, one in 20 and one in 50 year cyclone with resulting household damage amounting to $300, $1,000, $2,500, and $5,000 respectively. These rates are reduced by an assumed 50% with the adaptation measures introduced under

the project (the example being coastal stabilization structures and biological barriers). Based on the probabilities of each level of severity, an average value of damage per island asset per year has been estimated. The reduced losses compared with the 'without project' scenario estimates the benefit from the small grants facility. It is applied to the number of households (the predominant type of island infrastructure) located on these vulnerable islands. This excludes the benefit that might be obtained to the multiple small scale jetties and wharfs that exist on the remote islands and therefore most likely underestimates the economic benefit assigned.

2. Approach for Estimating Output 2 Benefits

15. The importance and global value of the services that ecosystems provide have been extensively explored and discussed in various literature.[8][9][10][11] However, in spite of the increasing awareness among the community of the need to effectively manage and preserve the integrity of the condition of ecosystems to ensure these services are sustained in the long-term, they continue to be overexploited, threatened, and destroyed by a range of human activities (e.g., unsustainable fisheries, land conversion, urbanization and industrialization, pollution) all of which are further threatened by changes and variability of the climate, with serious environmental and socioeconomic impacts on communities that heavily rely on these ecosystems.

16. Coral reefs and mangroves have been recognized as essential life support systems as they are among the world's most biologically diverse and productive ecosystems. These ecosystems are also valuable components of tropical coastal systems on which people depend for their livelihoods. Coral reefs and mangroves provide food for local coastal communities. They are also a source of employment opportunities and revenue (e.g. fishing and ecotourism). Coral reefs and mangroves protect coastlines, serve as habitat for numerous species, and offer unique materials for education and scientific research. In addition to these measurable benefits, coral reefs and mangroves hold an inestimable intrinsic value because of the diversity of life they support and the uniqueness of the biological features they contain.[12]

a. Reef Ecosystem

17. PNG's coral reefs face many pressures, some arising naturally in the environment and some the result of human activities. These threats fall into three categories (i) natural stressors such as cyclones, storms and low-salinity events, (ii) direct human pressure, including sediment and nutrient pollution from land runoff, over-exploitation and fishing practices, and engineering and modification of shorelines, and (iii) global climate change. Global climate change is now considered to be the biggest long-term threat to PNG's coral reefs, with many under threat from increased temperatures and changes in ocean circulation patterns. Increased CO_2 in the atmosphere and oceans is also causing increased ocean acidification. These changes are evident in coral cores taken from large old corals, which contain information about past environmental conditions.[13] Predicted increases in the frequency and intensity of environmental

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[8] White, A.T., Hale, L.Z., Renard, Y. and L. Cortesi, eds. *Collaborative and Community-Based Management of Coral Reefs*, Kumarian Press, 1994.
[9] Moberg, F. and C. Folke, "Ecological Goods and Services of Coral Reefs Ecosystems," *Ecological Economics*, 29: 215-233, 1999.
[10] Cesar, H.S.H., Collected Essays on the Economics of Coral Reefs, Cordio, 2000.
[11] Gustavson, K., Huber, R. and J. Ruitenbeek (2000), *Integrated Coastal Zone Management for Coral Reefs: Decision Support Modelling*, World Bank, Washington, DC.
[12] Wells, S. and N. Hanna (1992), *The Greenpeace Book of Coral Reefs*, New York, Sterling.
[13] http://www.aims.gov.au/docs/research/biodiversity-ecology/corals/corals.html

disturbances (such as cyclones) and biological disturbances (such as outbreaks of disease) associated with climate change also threaten the ability of coral reefs to recover. These disturbances shorten the recovery period available to reefs, and they also destroy neighboring areas of biodiversity that provide an important source of imported larvae to maintain genetic diversity. Currently, only about 26% of Indonesia's coral reefs are considered to be in "good-excellent" condition while about 32% and 42%, respectively, are reported "fair" and "poor".[1415] Indonesia has been cited in view of its geographic proximity and similarity to PNG where equivalent assessment has not been discovered (although PNG lacks the excessive population pressure on its coastal resources with its significantly smaller population).

18. Establishing a reference value for coral reef remains a challenge as this analysis reports the changing rate of degradation under the influence of improved management regimes. The literature reports wide-ranging values using various analytical techniques and utilization values - fisheries, local use, protection from extreme events and biodiversity. Without a similar analyses having been completed in PNG, a comparable geographic and reef status analysis has been adopted as the basis for PNG based on the public database maintained by the "Ecosystems Service Valuation Database"[16] that incorporates information from 1,350 data points on the various biome categories including coral reefs. The commonly used Total Economic Value (TEV) framework divides the value of ecosystem goods and services into use and non-use values. Use values are further broken into direct use, indirect use and option values. Direct use values include consumptive uses—such as timber and food—and non-consumptive uses, such as tourism and recreation. Indirect use values include ecosystem services such as water filtration and shoreline protection. Option values estimate the value of preserving the use of ecosystem goods and services for the future, including "bequest value," where the value is for future generations. Non-use values typically refer to existence value; i.e., the value humans place on the knowledge that a resource exists, even if they never visit or use it. Non-use and option values are frequently the most controversial elements of TEV; they are the most difficult to quantitatively measure, and have the greater associated uncertainty.[17]

19. In view of the lack of PNG source data regarding the value of coral reefs, this evaluation adopts the 'benefit transfer' method applying results obtained in existing studies to different areas (e.g., estimating the value of one beach using the value calculated for a different beach of a similar size and type in a different area). Some benefits transfer approaches may use an economic model developed in one location to estimate the value of a resource in another, new location; characteristics of the new location can then be inserted in the previously developed model, providing a potential advantage over simply transferring the value estimates between locations. Because of the difficulty of accurately assessing the many factors affecting the values of an ecosystem good or service that may vary between sites, this method can only provide an approximation of the real value. Needless to say, most of the valuation techniques adopted in the literature imply considerable under valuation of the asset. Reef values generated were

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[14] Karen Tun, Loke Ming Chou, Annadel Cabanban, Vo Si Tuan, Philreefs, Thamasak Yeemin, Suharsono, Kim Sour, and David Lane, *Status of Coral Reefs, Coral Reef Monitoring and Management in Southeast Asia, 2004,* Australian Institute of Marine Science, http://www.aims.gov.au/pages/research/coral-bleaching/scr2004/pdf/scr2004v1-09.pdf.

[15] Chou LM, Wilkinson CR, Licuanan WRY, Alino P, Cheshire AC, Loo MGK, Tangjaitrong S, Sudara S, Ridzwan AR and Soekarno S (1995) Status of coral reefs in the ASEAN region. pp. 1-10. Wilkinson CR, Chou LM and Sudara S Proceedings, Third ASEAN-Australia Symposium on Living Coastal Resources, Chulalongkorn University, Bangkok, Thailand, 16-20 May 1994. Volume 1. Status Reviews. Australian Institute of Marine Science.

[16] *http://www.fsd.nl/esp/80763/5/0/50*

[17] Value of Coral Reefs and Mangroves in the Caribbean, Economic Valuation Methodology V3.0, World Resources Institute. January 2009.

based on fisheries services, local values (as raw materials) and protection from extreme events as presented in Table SD14.4. Values reported in this table are constant 2014 dollars converted using the World Bank[18] reported GDP deflators and where necessary annual exchange rates as published by the World Bank.[19]

Table SD14.4: Economic Value of Coral Reef Services

		$/ha/yr	Year	2014 Equiv	Source
Coral Reef					
	Fisheries	238.50	2002	307.36	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.
	Coastal Protection	1,500.00	2007	1,689.14	GEF/UNDP/IMO (1999) Total economic valuation: coastal and marine resources in the Straits of Malacca.
	Raw Materials	60.0	1999	82.13	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.
	Total value	**1798.50**		**2,078.6**	

NB: The value for coastal protection was adjusted from the stated figure of $2,800 in view of the replacement cost method used to establish the value.

20. For the purpose of assessment, four categories of reef (reflecting the extent of degradation) are considered, each with different unit values. The reference valuation above is an average value for all categories of coral reef. The unit value for each category has been estimated based on the current areas of each category in neighboring Indonesia highlighted in studies above (footnotes 13 and 14). The rates used in this analysis are presented in Table SD14.5.

Table SD14.5: Value of Coral Reef Services by Category of Reef

Reef Quality	% Area	Derived Unit Value	Contribution to average
Good-excellent	27%	2,598.29	701.54
Fair	32%	2,078.63	665.16
Poor	41%	1,736.43	711.94
Depleted	0%	0.00	0
	100%		**2,078.6**

21. The trend in coral reef degradation is reflected by the volume of fish catch per unit effort (CPUE) estimated over a period of years. There are indications that open water fisheries, particularly in parts of Indonesia and the Philippines, have reached their sustainable limits with coastal fisheries exhibiting declining average annual CPUE.[20] The primary reason for the

18 http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTDECPROSPECTS/0,,contentMDK:20587651~menuPK:5962952~pagePK:64165401~piPK:64165026~theSitePK:476883~isCURL:Y,00.html

19 *http://data.worldbank.org/indicator/PA.NUS.FCRF*

20 White and Cruz-Trinidad, 1998

decline of these near shore and small-scale fisheries is that they are habitat dependent. Fish production in this ecosystem will decline as the condition of coral reef deteriorates. In PNG, fishing pressure is somewhat less than that of the Philippines because of the lower population density found amongst coastal communities. However, the fact that PNG has resorted to unsustainable fishing practices such as the use of dynamite to harvest reef fish is evidence that the CPUE has also declined in PNG.

22. If conservation measures are not established to correct the trend in the degradation of coral reef, the annual rates of decline have been reported at about 3.4% in Brunei Darussalam and Malaysia,[21] 3% in Indonesia,[22] and 7.7% in the Philippines.[23] These rates may even increase as population growth continues to further exert pressure on coral reef resources. As a consequence, fish CPUE will continue to decline significantly with subsequent impact on per capita fish consumption of coastal communities, particularly the poor who are heavily dependent on coral reefs for their food and livelihood. Of greater significance, as these problems remain unabated, they will continue to contribute to the worsening resource degradation and poverty cycle prevalent in the coastal areas. The analysis estimates the areas of coral reef surrounding the target nine selected islands for Output 2 initiatives using GIS maps of the coral reef surrounding these islands.[24] Under the without project scenario, a rate of decline of 3% per annum has been adopted using the derived economic values. Under the 'with project' scenario, a 50% reduction in the rate of decline has been used in the analysis introduced over an 8 year period and applied equally across the three categories of coral reef with value, the depleted category being of zero value.

Table SD14.6: Base Data for Reef Analysis

Reef Condition	**2014 Area** (ha)	**Without Project (2021)**		**With Project (2021)**		**2014 Unit Value of Category**
		Area (ha)	**Area** (%)	**Area** (ha)	**Area** (%)	($/ha/yr)
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
Total	**17,500**	**17,500**	**100.0%**	**17,500**	**100.0%**	

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

23. The analysis then compares the 'with' and 'without' project scenarios based on the reduced degradation of the reef assessed at the derived economic values. The areas of each category has been estimated by applying the two rates of deterioration with and without the

[21] I. C. Stobutzki, G. T. Silvestre, A. Abu Talib, A. Krongprom, M. Supongpan, P. Khemakorn, N. Armada, and L. R. Garces, *Decline of Demersal Coastal Fisheries Resources in Three Developing Asian Countries,* Fisheries Research 78 (2006), 130-142.

[22] The rate adopted in the economic analysis, under "without project" situation, *Final Report for the ADB-funded Integrated Coastal Fisheries Resource Management Project, (PPTA No. 4373 – INO)*, July 2006.

[23] Bureau of Fisheries and Aquatic Resources, Region XI, National Stock Assessment Program.

[24] Estimates were obtained using Reef GIS http://reefgis.reefbase.org/default.aspx?wms=RGWReefGIS&wmsbbox=-30,-90,330,90&bbox=138.275612272727,-14.26482,158.655157727273,0.68018&layers=Countries,Coral%20Reefs%20WCMC,Mask,Land,Borders,Coral%20Reefs,Coastline,Bathymetry,Topography,Place%20Names

project. The derived area for each category each year assumes the deteriorated area is transferred to the next lowest category, reducing the area of that category. The area of the category is increased by the area being transferred from the higher quality category immediately above that is considered to have deteriorated. The figures reported in Table SD14.6 are the net changes from these two influences.

b. Coastal Mangrove Forest

24. In the case of mangrove forest rehabilitation, a similar data composition was adopted (food-fisheries, raw materials and coastal protection service values) to estimate the annual value of the coastal mangrove forest ($2,697/ha/yr in constant 2014 terms). The established rate of mangrove forest decline specific to PNG was estimated from GIS mapping work and other 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 country-wide. The comparison of the two rates of decline at the derived value per unit area of mangrove forest provides an estimate of the incremental benefit accruing from the project. Basic value data used in the mangrove analysis are presented in Table SD14.7.

Table SD14.7: Economic Value of a Mangrove Forest - 2014 Constant US Dollars

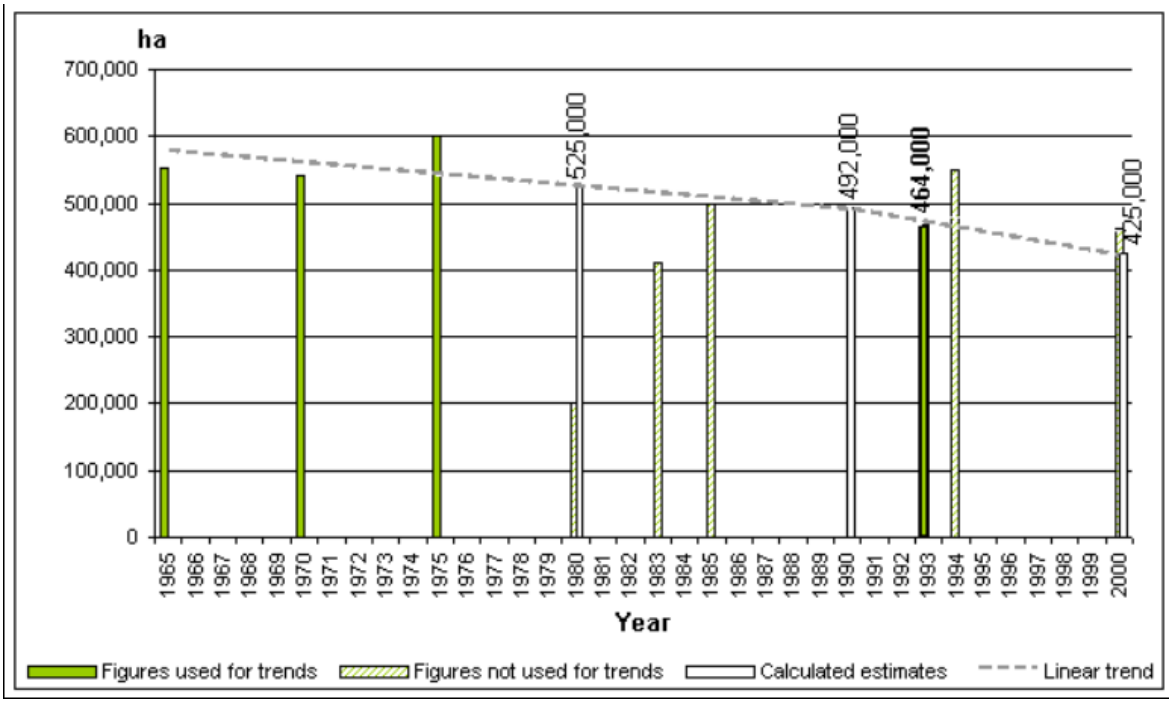
Mangroves		$/ha/yr	Year	2014 Equiv	Source
	Fisheries	600.00	1997	842.11	C. Bann. 1997. The Economic Value of Mangroves: A Manual for Researchers. Ottawa: International Development Center
	Coastal Protection	672.00	1998	933.04	Samonte-Tan, G.P.B., A. T. White, M. A. Tercero, J. Diviva, E. Tabara and C. Caballes (2007) Economic Valuation of Coastal and Marine Resources: Bohol Marine Triangle, Philippines. Costal Management 35(2): 319-338.
	Raw Materials	818.70	2007	921.93	Nickerson, D.J. (1999) Trade-offs of mangrove area development in the Philippines. Ecological Economics 28 (2): 279-298.
	Total Value	**2090.70**		**2,697.1**	

25. The rate of decline of the mangrove forest is based on national figures from a number of independent studies published by the Food and Agricultural Organization.[25] The annual rate of decline adopted in this study is 0.54% per annum without the project while the 'with project' scenario assumes a reduction of 50% of this rate. Comparison of the 'with' and 'without project' scenarios generates the area saved due to the project which is valued at the 2014 economic value derived for mangrove forests.

26. The areas of mangrove forest located in the near proximity to the target islands has been estimated using the shoreline distance along the main land mass nearest the islands and the depth of the forest is assumed to average 30 meters. In this way, target island mangrove forest areas have been obtained to which the decline rates and values have been applied. Base details are included in Table SD14.8.

[25] FAO Publication referenced at http://www.fao.org/docrep/007/j1533e/J1533E79.htm#P5658_257507

Figure SD14.1: Mangrove Decline in Papua New Guinea
(ha)



Source: FAO Corporate Document Repository - Status and Trends in Mangrove Area Extent Worldwide.

Table SD14.8: Base Data used in Assessing Mangrove Benefit

Location	**2014 Provincial Area** (ha) [1]	**Project Area 2014** (ha)	**Without Project 2021** (rate) **/** (ha)	**With Project 2021** (rate) / (ha)	**Value used in Estimation** ($/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
Total	**66,347**	**600**	**565**	**589**	

Source: State of the Forests of PNG, 1992-2002 - Drivers of Change
1/ Collectively, these provinces account for 12.7% of PNG's 2002 mangrove forest area.

c. Food Security

27. Benefits from project initiatives in the food security sub-output have been estimated using household garden models based on traditional cropping patterns. Incremental benefits have been estimated from the adoption of drought-tolerant varieties and improved production techniques associated with water management and conservation techniques introduced that have resulted in increased yields. Yield estimates for the 'with project' scenario are based on

trial work undertaken by NARI[26] where the yields from the climate resilient varieties achieved are about double those of traditional varieties and production techniques. It is recognized that drought tolerant varieties can outperform traditional varieties by as much as 100% (i.e. yields are doubled) in drought years. Often, under a normal year, potential yields of drought tolerant tubers are more likely to be less than this figure. For this reason, productivity increases assumed in the analysis is only 25% higher than from traditional varieties of sweet potato and taro and 50% higher for yams.

28. The evaluation is based on a household rotations of three crops, taro, yams and sweet potatoes, depending on the location (as confirmed by NARI). Under the without project scenario, inputs (other than family and exchanged labor) are limited to the planting material. The labor operations (person days) is based on NARI estimates in each of the target island communities.

Table SD14.9: Sweet Potato Gross Margin to Estimate Food Security Benefits

Economic Crop Model - 30 x 20 Sweet Potato Plot - 'without Project'									
				Manus		Trobriands		Duke of York	
Material Inputs	**Units**	**Number**	**Unit Cost**	**Total**	**Unit Cost**	**Total**	**Unit Cost**	**Total**
Planting material	cuttings	2400	0.18	432	0.18	432	0.18	432
Labour Inputs - 30 x 20 Sweet Potato plot								
Land preparation	p-days	3	16.6	49.8	12.45	37.35	16.6	49.8
Mounding & Planting	p-days	4	16.6	66.4	12.45	49.8	16.6	66.4
Weeding	p-days	3	16.6	49.8	12.45	37.35	16.6	49.8
Harvesting	p-days	1	16.6	16.6	12.45	12.45	16.6	16.6
Transporting	p-days	1	16.6	16.6	12.45	12.45	16.6	16.6
		12		199.2		149.4		199.2
Production								
		Yield	**Price**	**Total**	**Price**	**Total**	**Price**	**Total**
Gross Income	tubers/plot	4800	0.18	864	0.18	864	0.18	864
Direct Expenses	K/plot			631.2		581.4		631.2
Gross Margin	K/plot			232.8		282.6		232.8

Economic Crop Model - 30 x 20 Sweet Potato Plot - 'with Project'									
				Manus		Trobriands		Duke of York	
Material Inputs	**Units**	**Number**	**Unit Cost**	**Total**	**Unit Cost**	**Total**	**Unit Cost**	**Total**
Planting material	cuttings	2400	0.18	432	0.18	432	0.18	432
Labour Inputs - 30 x 20 Sweet Potato plot								
Land preparation	p-days	3	16.6	49.8	12.45	37.35	16.6	49.8
Mounding & Planting	p-days	4	16.6	66.4	12.45	49.8	16.6	66.4
Weeding	p-days	4	16.6	66.4	12.45	49.8	16.6	66.4
Harvesting	p-days	5	16.6	83	12.45	62.25	16.6	83
Transporting	p-days	5	16.6	83	12.45	62.25	16.6	83
		21		348.6		261.45		348.6
Production								
		Yield	**Price**	**Total**	**Price**	**Total**	**Price**	**Total**
Gross Income	tubers/plot	6000	0.30	1800	0.45	2700	0.45	2700
Direct Expenses	K/plot			780.6		693.45		780.6
Gross Margin	K/plot			1019.4		2006.55		1919.4

NB Similar crop gross margins have been prepared for yams and taro.

29. Some of the participating islands have limited agricultural resources to entertain home garden production. In this situation, the food initiatives will be implemented in adjoining

[26] NARI. Farming Systems Survey for Ware, Nuakata and Kiriwina Islands, 2013.

mainland communities to support the trade in food items that has long been the practice in coastal island communities. The project will introduce improved production techniques as a demonstration of improved food security that will be based on the prevailing agricultural production system in each location. For the purposes of this evaluation, three crops have been modeled. The household areas planted to each plot is representative of the area and is assumed to be averaged for the residents in that location. The number of households involved in the project has been estimated on the household numbers in the target location as detailed in Table SD14.10.

Table SD14.10: Base Data for the Assessment of Food Security Benefits

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

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

30. Against these numbers, the crop models were used to estimate incremental benefits using the assumed adoption rates. These rates are considered conservative given the nature of the interventions proposed and the visible impact they will have to others farming in the same region.

3. Approach for Output 3 Benefit Estimation

31. Assessed benefits from Output 3 initiatives relate only to the extension of the radio network throughout the island communities. The approach adopted derives benefits from two sources - those directly benefiting from the radio systems established on the 21 vulnerable islands where the project will establish communication centers and link these to the broader communications network associated with the development of emergency responses within each of the communities to disasters; and secondly, those who can benefit directly from the extended VHF radio coverage providing emergency services to report distressed situations as people go about their daily livelihood pursuits - e.g. fishing, transport etc. The radio communications network will allow those in distressed situations to register their circumstances and facilitate others within the area to provide support/rescue.

32. The method used to assess these benefits are similar in that they use the value of statistical life (VSL) in PNG to value the reduced numbers of fatalities from weather and natural disaster related cases. Benefits from Output 3 result from the assumed reduction in fatalities reported[27] in the target provinces assessed at the derived VSL interpolated from the US per capita value. These benefits accrue from project initiatives on the target 21 islands where emergency response strategies are developed under the project but also a wider application where VHF radio coverage has been extended. The beneficiary number (in excess of 500,000

[27] Disaster records extracted from Centre for Research on the Epidemiology of Disasters (EMDAT), School of Public Health, Université Catholique de Louvain, Clos Chapelle-aux-Champs, Bte B1.30.15, 1200 Brussels, Belgium were analysed for the 25 years 1990-2014 and the relevant figures averaged for the various natural disasters.

people) has been estimated by GIS capabilities using topographic data sets and population distributions. Inhabitants, fishermen and travelers will be able to access early warning messages from the National Disaster Center and register emergency 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 assessed at the average VSL in the target provinces of $7,020,000 per individual[28] adjusted by the respective per capita GDP figures where the GDP per capita ratio is 0.05 for PNG to USA. The VSL for PNG used in the analysis is $238,000 per head. Under the 'without' project scenario, the respective numbers of fatalities anticipated in the target islands is 10 individuals while the 'with project' scenario amounts to 9.5 persons in year 2021.

Table SD14.11: Incidence of Natural Disasters PNG 1990-2014

1990 - 2014	Incidents	People			25 yr Average	
		Deaths	Affected	Injured	Deaths	Injured
Drought	1	60	500,000	0	2.40	0.00
Earthquake	8	2,243	23,599	939	89.72	37.56
Flood	10	9	427,193	0	0.36	0.00
Storm	5	219	199,486	40	8.76	1.60
Transport Accident	8	370	0	4	14.80	0.16
Volcanic Activity	10	9	150,079	31	0.36	1.24

Reference: http://www.emdat.be/advanced_search/index.html

[28] Figure obtained from Tonga Climate Resilience Project 2013.

Table SD14.12: Projected Mortality Rates from Natural Disasters - Target Islands

Event	Year	National Figures	Selected Island Fatalities	Selected islands
From climate events	1990-2014	11.52	0.004	Manus
	Average		0.005	E. New Britain
			0.004	Bougainville
			0.004	Morobe
			0.003	Milne Bay
From earthquake and volcan	1990-2014	90.80	0.035	Manus
	Average		0.040	E. New Britain
			0.028	Bougainville
			0.032	Morobe
			0.027	Milne Bay
From transport related incide	1990-2014	14.80	0.006	Manus
	Average		0.007	E. New Britain
			0.005	Bougainville
			0.005	Morobe
			0.004	Milne Bay
From all sources		117	0.046	Manus
			0.052	E. New Britain
			0.036	Bougainville
			0.041	Morobe
			0.035	Milne Bay

33. The mortality rate has been adjusted downward by 50% to remove the influence of earthquakes for which an early warning system will most likely provide little benefit.

C. Results of the Analysis

34. Separate component 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 included in output EIRR estimates except for those consulting services costs associated with overall project management such as procurement, financial management and social and environmental safeguards. For the sake of sustainability, operational and maintenance costs on infrastructure and equipment have been included that do not form part of the overall project cost but are included in the estimate of EIRR. Costs are converted to economic terms using the SCF of 0.9 assessed in 2014 USD. Future income streams less costs are discounted at 12% to derive Net Present Value estimates for the respective outputs and overall project.

35. The project EIRR is estimated at 12.6% while the PV of net benefit stream is estimated at $0.67 million evaluated at a discount rate of 12%. Estimated EIRRs for project Outputs 1, 2 and 3 were 11.3%, 26.0% and 12.6% respectively.

36. 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 the beneficiaries are few in number (target island population just over 13,000) and the cost of providing services relatively high due to their remoteness and high transport costs. The addition of NGOs to assist in implementation is considered necessary but adds to the overall cost of output activities.

37. The performance of Outputs 2 and 3 are positive. 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 amongst farmers who are currently producing these crops in their own home gardens. The significant yield responses coupled with the increased availability of climate adapted planting material on local multiplication farms will allow for significant adoption. The rate used in the analysis (about 20% in each location) is therefore conservative and can be expected to be exceeded during implementation. The other explanation for the significant net benefit from food security initiatives is project beneficiaries are not confined to the target islands alone as they are for Output 1 activities. For Output 3, the relatively low cost of establishing relay 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

38. Sensitivity analysis was undertaken to determine if results were robust to the suspected assumptions used in the analysis and other risk factors. It is customary to review changes to overall project benefits and costs as well as a delay in the generation of project inputs caused by delays in implementation. Sensitivities were conduction 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. Results of the analysis are presented in Table SD14.13.

Table SD14.13: 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%

15. It is concluded that the impact of the project is likely to be positive on the economy of PNG and that benefits are relatively robust from cost increases and reductions in benefits - for whatever reason. The project is intended to have a demonstration impact in that approaches for the implementation of adaptation measures to climate change are being tested and developed. The project is therefore a sound investment and likely to contribute to increasing the awareness of the impacts from climate change in PNG's economy, quite apart from its economic impact (Table SD14.17).

E. Distribution Analysis

39. Rural people living in areas with roads/wharfs and access to markets to buy and sell produce, or with opportunities to work (e.g. on plantations or mines) are relatively well-off. They live within the cash economy and are able to more easily satisfy needs above subsistence level. In areas where services still exist and land quality is satisfactory, subsistence farmers will manage even if they are isolated. But those people who are cut-off and living in minimally serviced villages and outside the cash economy are more likely to live at subsistence level, especially if their land is poor. Poor services leave them vulnerable to disease, deaths during childbirth, illiteracy and of course in the many island communities, climate change. They are the most disadvantaged, but because of their isolation, their plight is largely hidden from view. Moreover, this group is growing larger as the government withdraws from rural areas, leaving these families with few ways of climbing out of poverty, except for migration to towns or rural areas with better land and roads and access to the cash economy, jobs and services.

40. The project will provide direct benefits to people selected for their vulnerability in the target 21 islands. Output 1 initiatives directly develops the capacities of isolated communities to adapt to climate change through improved water, sanitation and by assisting them in developing strategies to respond to natural disasters. All benefits from Output 1 activities will be received by this vulnerable and poor level of community. The capacities of provincial and district government personnel to support these more vulnerable communities will also be strengthened and facilitate the replication of similar initiatives with other vulnerable communities.

41. Similarly, Output 2 initiatives will address the food insecurity of people in vulnerable islands and provide incremental benefits from a more sustained reef environment as well as food security demonstrations. Again, the areas selected for project interventions are the more vulnerable areas where poverty is highest and government services are reduced because of the cost of accessing these communities. It is anticipated that all benefits from this output will be received by the poor through the targeting mechanism engaged under the project.

42. For Output 3, the early warning disaster communication facilities will have a direct impact on the poor through the selection of target vulnerable islands. The radio network expansion will however be enjoyed by a wider section of the community where poverty levels are generally lower. Beneficiaries of the expanded communication networks will include those who are regular travelers between islands and those with resources to operate transport services. While their passengers will be predominantly poor, benefits will also flow to the better of operators of these transport services. Under the Output 3, benefits are more likely to be received by a wider segment (where poverty is not as concentrated) of the rural population.

43. Overall it is concluded that the benefits from the investments under the project will be received mostly by the poor and vulnerable inhabitants of the target island communities. As such, the distribution of benefits falls heavily towards the poor and more vulnerable segments of the population of PNG.

Table SD14.14: Output 1 EIRR Estimation

		USD		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
		Financial	Economic																					
Output Costs																								
	Civil Works (WATSAN)	1,844.7	1,660.3		600	1060.3																		
	SGF (assumed mostly works)	5,000.0	4,500.0			500	1000	1200	1300	500														
	Consulting Services	1,671.4	1,504.3	500	500	504.3																		
	Workshops Seminars and Conferences	371.3	334.2	150	184.2																			
	Operating Costs (of a capital nature)	110.0	99.0			30	30	39																
	- Annual drawdown			650.0	1284.2	2094.6	1030.0	1239.0	1300.0	500.0														
	Operations and Maintenance (1% capex)	68.4	61.6					61.6	61.6	61.6	61.6	61.6	61.6	61.6	61.6	61.6	61.6	61.6	61.6	61.6	61.6	61.6	61.6	61.6
Total Output Costs		8,997.4	8,097.7																					
	Total Output 1 Economic Costs			650.0	1,284.2	2,094.6	1,030.0	1,300.6	1,361.6	561.6	61.6	61.6	61.6	61.6	61.6	61.6	61.6	61.6	61.6	61.6	61.6	61.6	61.6	61.6
	Total Output 1 Economic Benefits			0.0	659.7	732.8	751.0	769.7	788.9	808.6	828.6	849.3	870.3	892.2	914.5	937.2	960.6	984.6	1,009.0	1,034.3	1,060.3	1,086.7	1,113.7	157.6
	Net Benefit Stream (economic)			-650.0	-624.5	-1,361.8	-279.0	-530.9	-572.7	247.0	767.0	787.7	808.7	830.5	852.9	875.6	899.0	923.0	947.4	972.7	998.7	1,025.1	1,052.1	96.0
	Net Present Value (12%)	($ '000s)	($176.30)																					
	Economic IRR		11.3%																					

Table SD14.15: Output 2 EIRR Estimation

	USD		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
	Financial	Economic																					
Output Costs																							
Civil Works	0.0	0.0																					
Vehicles and Equipment	243.0	218.7		150	68.7																		
Consulting Services	2,704.6	2,434.1		800	800	300	300	234.1															
Workshops Seminars and Conferences	3,391.2	3,052.1		1000	1000	500	552.1																
Operating Costs (of a capital nature)	600.0	540.0																					
- Annual drawdown			0.0	1950.0	1868.7	800.0	852.1	234.1															
Operations and Maintenance (10% vehicles)		21.9					21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9
Total Output Costs	6,938.8	6,244.9																					
Total Output 2 Economic Costs		**($ '000s)**	**0.0**	**1,950.0**	**1,868.7**	**800.0**	**874.0**	**256.0**	**21.9**	**21.9**	**21.9**	**21.9**	**21.9**	**21.9**	**21.9**	**21.9**	**21.9**	**21.9**	**21.9**	**21.9**	**21.9**	**21.9**	**21.9**
Output 2 Economic Benefits		**($ '000s)**	**0.0**	**103.7**	**231.9**	**469.9**	**747.2**	**1,049.0**	**1,281.2**	**1,510.9**	**1,774.5**	**1,984.3**	**2,270.8**	**2,546.8**	**2,812.8**	**3,069.3**	**3,316.4**	**3,554.7**	**3,784.5**	**4,006.0**	**4,219.7**	**4,425.8**	**4,624.6**
Reef ecosystems		($ '000s)	0.0	0.0	24.5	95.3	205.6	359.4	551.0	778.4	1,039.6	1,247.0	1,531.1	1,804.8	2,068.4	2,322.3	2,567.0	2,802.8	3,030.0	3,249.1	3,460.2	3,663.7	3,859.8
Mangrove rehabilitation		($ '000s)	0.0	2.2	4.4	6.7	8.9	11.2	13.5	15.8	18.2	20.5	22.9	25.3	27.8	30.2	32.7	35.2	37.7	40.3	42.8	45.4	48.0
Food security		($ '000s)	0.0	101.5	203.1	367.9	532.7	678.5	716.7	716.7	716.7	716.7	716.7	716.7	716.7	716.7	716.7	716.7	716.7	716.7	716.7	716.7	716.7
Net Benefit Stream (economic)			**0.0**	**-1,846.3**	**-1,636.8**	**-330.1**	**-126.7**	**793.1**	**1,259.4**	**1,489.0**	**1,752.6**	**1,962.4**	**2,248.9**	**2,524.9**	**2,791.0**	**3,047.4**	**3,294.5**	**3,532.8**	**3,762.6**	**3,984.2**	**4,197.8**	**4,403.9**	**4,602.7**
Net Present Value (12%)	($ '000s)	$6,090																					
Economic IRR		26.0%																					

Table SD14.16: Output 3 EIRR Estimation

		USD		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
		Financial	Economic																					
Output Costs																								
	Civil Works	10.6	9.5		9.5																			
	Vehicles and Equipment	1,538.9	1,385.0		500.0	885.0																		
	Consulting Services	0.0	0.0		0.0	0.0	0.0	0.0																
	Workshops Seminars and Conferences	75.1	67.6			33.8	33.8																	
	Operating Costs (of a capital nature)	1,803.0	1,622.7		270.4	270.4	270.4	270.4	270.4	270.4														
	- Annual drawdown			0.0	780.0	1189.2	304.2	270.4	270.4	270.4														
	Operations and Maintenance (3% equip)		41.6					41.6	41.6	41.6	41.6	41.6	41.6	41.6	41.6	41.6	41.6	41.6	41.6	41.6	41.6	41.6	41.6	41.6
Total Output Costs		3,427.6	3,084.8																					
	Total Output 3 Economic Costs		**($ '000s)**	**0.0**	**780.0**	**1,189.2**	**304.2**	**312.0**	**312.0**	**312.0**	**41.6**	**41.6**	**41.6**	**41.6**	**41.6**	**41.6**	**41.6**	**41.6**	**41.6**	**41.6**	**41.6**	**41.6**	**41.6**	**41.6**
	Output 3 Economic Benefits		**($ '000s)**	**0.0**	**0.0**	**191.3**	**335.2**	**394.1**	**401.5**	**409.1**	**416.8**	**424.6**	**432.6**	**440.8**	**449.1**	**457.6**	**466.3**	**475.1**	**484.1**	**493.2**	**502.6**	**512.1**	**521.8**	**531.7**
	Net Benefit Stream (economic)		**($ '000s)**	**0.0**	**-780.0**	**-997.9**	**31.0**	**82.1**	**89.5**	**97.1**	**375.2**	**383.1**	**391.1**	**399.3**	**407.6**	**416.1**	**424.7**	**433.5**	**442.5**	**451.7**	**461.0**	**470.5**	**480.2**	**490.1**
	Net Present Value (12%)	($ '000s)	$67.6																					
	Economic IRR		12.6%																					

Table SD14.17: Summary of EIRR Estimation

	USD		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
	Financial	Economic [1]																					
Output Costs																							
Civil Works	2,393.6	2,154.2	10	900	900	249.2	80	15															
Vehicles and Equipment	2,049.1	1,844.2	75	800	800	69.2	50	50															
Consulting Services	7,338.7	6,604.8	630	2400	2000	800	550	224.8															
Workshops Seminars and Conferences	5,043.3	4,539.0	25	270	1700	1850	620	74															
Small Grants Facility	6,000.0	5,400.0			1000	1500	1500	1400															
Operating Costs (of a capital nature)	4,462.7	4,016.4	320	700	820	850	860	466.4															
- Annual drawdown			1060.0	5070.0	7220.0	5318.4	3660.0	2230.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operations and Maintenance		125.0	0.0	0.0	0.0	0.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0
Total Output Costs	27,287.4	24,558.7																					
Project Economic Costs		**($ '000s)**	**1,060.0**	**5,070.0**	**7,220.0**	**5,318.4**	**3,785.0**	**2,355.2**	**125.0**	**125.0**	**125.0**	**125.0**	**125.0**	**125.0**	**125.0**	**125.0**	**125.0**	**125.0**	**125.0**	**125.0**	**125.0**	**125.0**	**125.0**
Estimated Project Economic Benefit	**($ '000s)**	**($ '000s)**	**0.0**	**763.4**	**1,156.1**	**1,556.1**	**1,911.0**	**2,239.4**	**2,498.9**	**2,756.3**	**3,048.4**	**3,287.2**	**3,603.7**	**3,910.4**	**4,207.6**	**4,496.1**	**4,776.1**	**5,047.8**	**5,312.0**	**5,568.9**	**5,818.5**	**6,061.3**	**5,313.8**
Output 1 Benefits		($ '000s)	0.0	659.7	732.8	751.0	769.7	788.9	808.6	828.6	849.3	870.3	892.2	914.5	937.2	960.6	984.6	1,009.0	1,034.3	1,060.3	1,086.7	1,113.7	157.6
Output 2 Benefits		($ '000s)	0.0	103.7	231.9	469.9	747.2	1,049.0	1,281.2	1,510.9	1,774.5	1,984.3	2,270.8	2,546.8	2,812.8	3,069.3	3,316.4	3,554.7	3,784.5	4,006.0	4,219.7	4,425.8	4,624.6
Output 3 Benefits		($ '000s)	0.0	0.0	191.3	335.2	394.1	401.5	409.1	416.8	424.6	432.6	440.8	449.1	457.6	466.3	475.1	484.1	493.2	502.6	512.1	521.8	531.7
Net Benefit (economic)		**($ '000s)**	**-1,060.0**	**-4,306.6**	**-6,063.9**	**-3,762.3**	**-1,874.0**	**-115.8**	**2,373.8**	**2,631.2**	**2,923.4**	**3,162.2**	**3,478.7**	**3,785.4**	**4,082.6**	**4,371.1**	**4,651.1**	**4,922.8**	**5,187.0**	**5,443.9**	**5,693.4**	**5,936.3**	**5,188.8**
Net Present Value (12%)	($ '000s)	$674.6																					
Economic IRR		12.6%																					

Converted from financial to economic values using the GCF of 0.9.