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THE GLOBAL CLIMATE CHANGE ALLIANCE PLUS INITIATIVE

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SCALING UP PACIFIC ADAPTATION (SUPA)

SNAPSHOT 2021:

Coastal Protection Measures, Tonga

ASSESSING IMPACT AT INTERVENTION LEVEL

Funded by
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THE UNIVERSITY OF THE SOUTH PACIFIC

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Our vision:

A resilient Pacific environment sustaining our livelihoods and natural heritage in harmony with our cultures.

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COUNTRY	TONGA
Capital	Nukualofa
Population	100,651 (2016 census)
Inhabited islands	Tongatapu, Vava'u, Ha'apai, and 'Eua
Land area	748 km2
Max. height above sea-level	80 meters Tongatapu / 131 meters at Mt Talau, Vava'u. / 329 meters 'Eua
Physiography	Tongatapu group, islands are flat with very fertile soil. Ha'apai group, mix of barrier reefs, shallow lagoons, coral shoals and active volcanoes. Vava'u group, northern remote white sandy beaches, tropical rainforests, caves and limestone cliffs.
Location	Latitude -21. 178986 Longitude 175.198242
EEZ	700,000 km2
Climate	Wet season, November - April. Dry season, May - October
Rainfall	About 2,300mm/year during the wet season. Little rain between June-September.
Mean temperature	Between 23-280C. Temperature can drop down to 22-250C at daytime and down to 16-180C at evening from June to September.
Economy	Narrow export base in agriculture – mainly squash, watermelons, vanilla, and yams. Fish make up 2/3 of total exports.
GDP per capita	0.51 billion US dollar in 2020
Currency	Tongan Pa'anga (TOP)
Exchange rate	1.00TOP= 0.50 USD
Languages	Tongan and English
Government	Kingdom and member of the Commonwealth
National focal point	Director of Climate Change, MEIDECC OG Sanft Building Taufa'ahau Road, Nuku'alofa, TONGA. Telephone: (676) 28170/28349

Figure 1. Country profile for Tonga.

In Context:

Determining the impacts of climate change adaptation measures requires a comprehensive approach. The sounder the information about the impacts of adaptation measures, the better it is for planning future adaptation activities that focus on efforts which have the desired, measurable impact. In the context of climate change and climate variability, data and indicators reflecting impact are location-specific and time-sensitive.

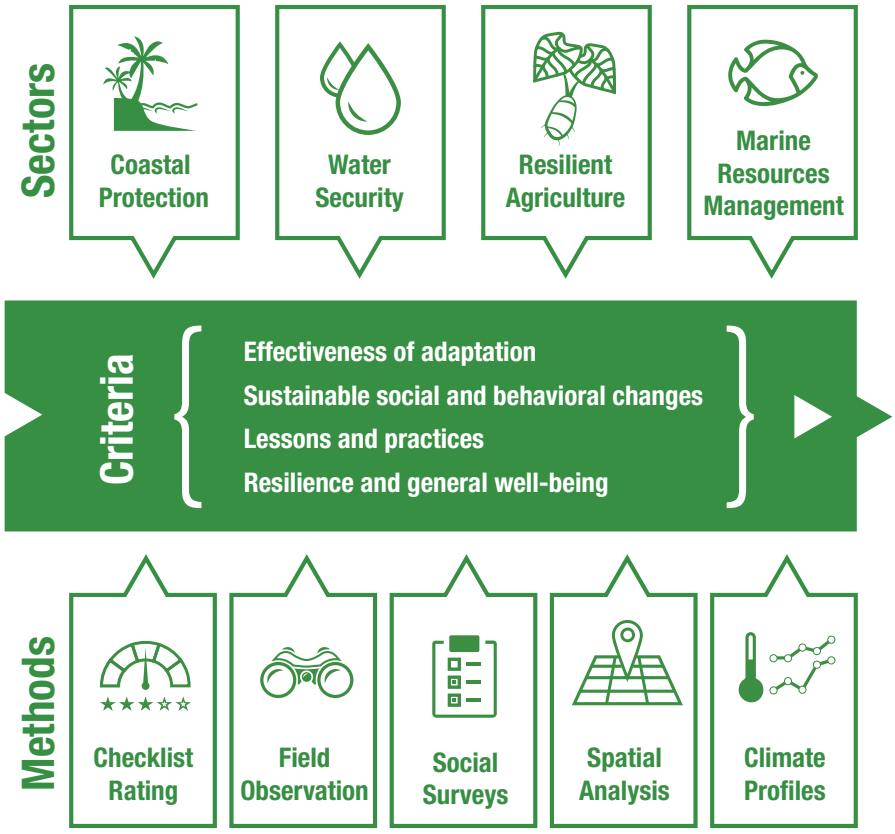


Figure 2. Pathway for Adaptation Impacts Analysis Methodology.

CRITERIA	INCREASED COASTAL PROTECTION
Effectiveness	Trialled measures. Detection of coastal change.
Social-behavioural change	Beach condition and signs of community action to protect adjacent beachfront, people' sense of safety.
Lessons and practices	Vulnerable groups: persons with disabilities, the elderly, women, children access the beachfront for recreation/fishing.
Sustainability	If structural measure is still intact, the extent to which it has/not been maintained, and whether natural assets were enhanced or damaged.

Figure 3. Criteria for measuring impact of adaptation interventions.

With support given to the national consultant working with the adaptation focal point of contact, Losana Latu, Department of Climate Change at the Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Climate Change and Communications (MEIDECC), field trial of the drafted Impacts methodology took about 6 months.

This snapshot describes the field experience in-country with results from tested tools. It is relevant to note that not all elements of the criteria (in Figures 2 & 3) be captured because of data limitations, scientific uncertainty, or a lack of robust monitoring program in place since completion of these adaptation interventions.

Selection of interventions to be assessed were based on relevance and available data from archived record of projects that implemented these adaptation actions.

Since 2013, coastal protection has been a predominant adaptation action along the Tongatapu coastline. Tonga has four types of structural interventions built along the east and western coastlines of Tongatapu: 20 permeable groynes along villages of Talafo'ou, Makaunga Nukuleka, Navutoka and Kolonga; 10 detached breakwaters east of Manuka village, rock revetment at Navutoka village and rock barrier at Ahau village.

From the profiling of archived projects (Figure 4) 10% of island population lived adjacent to coastal protection measures implemented over a 6-to-10-year history of adaptation. At that time 736 families benefited from an array of adaptation actions, awareness raising, capacity building and community outreach. This accounted for 11.6% of coastline was protected with structural and non-structural measures.

Selection of sites

Factors considered in the selection of benefited areas from a history of adaptation interventions were based initially on the availability of relevant information and data archived from past projects, in-country consultation with key people directly involved in those actions who may be able to shed institutional memory. The national consultant with focal point of contact in the climate change office, MEIDECC mapped recently completed, project-funded interventions and profiled for ease of tracking measured results then during the life of the project.

Adaptation measure	Title of project	Funding agency	Year completed
COASTAL PROTECTION MEASURES			
Ahau, Hihifo: Construction of a revetment at the lagoon entrance.	Pacific Adaptation to Climate Change Plus (PACC+)	Global Environment Facility and the Australian Government	2015
Ahau, Hihifo: Reinforcing an existing revetment and mangrove planting.	EU GIZ Adapting to climate change & sustainable energy (ACSE)	European Union	2020
Talafo'ou and Makaunga, Hahake: Construction of semi-permeable groynes together with sand recharge and coastal planting.	The Global Climate Change Alliance: Pacific Small Island States (GCCA: PSIS) Project	European Union	2015

Figure 4. Sample of past interventions treated with the impact assessment methodology.

Impact Indicators

CRITERIA	INDICATOR CODE	INDICATOR DESCRIPTION	METHODOLOGY
Effectiveness	C1	Structural design built to protect the coast from frequent storm surge, flooding, sea level rise. Degree of physical condition of the structure.	• Observations & use impact Checklist that include physical attributes of local environment.
	C2	Area of beach recharged with sand and beach condition over time pre and after structures were built. Healthy/ eroding signs with the shape of the beach surface, coastal vegetation cover, recruitment of small trees, regrowth and signs of local influence-rubbish, footprints, sand extraction & other users.	• Observations & use of impact Checklist. • Spatial mapping of change detection along the focal coastline.
Social-behavioural change	C3	Ascertain level of community management actions taken to protect the coastline. Scoring on clean surrounding area, beach control access, evidence of beach protection and its vegetation, community coastal replanting and brush protection to help with sand build up, management actions to promote beach accretion and control set up signs to access beach.	• Observations & use of impact Checklist. • Meta data from the social surveys of household and focus group be treated for comparative analysis.
	C4	Ascertain level of awareness and community sense of safety with protection of property and land. Expressed as number of people or vulnerable groups whose livelihoods have improved/disrupted as a result, of the adaptation action. Nature of services and type of facilities set up at the reclaimed coast area (if any).	• Observations & use of impact Checklist. • Meta data from the social surveys of household and focus group be treated for comparative analysis.
Lessons and practices Sustainability	C5	Number of assets and asset value of coastal protection measures, including nature-based solutions; derived co-benefits.	Liaise for with national CC focal point for cost details on fiscal budget of built structures.

Figure 5. Indicator description and tools, for coastal protection(C) measures in Tonga.

Impacts at glance

There were two cyclones recorded in direct effect to Tonga at the time in which the coastal protection measures were in place. Cyclone Zena in 2016 reported only heavy rainfall affecting the country. On February 3, 2018, Cyclone Gita caused extensive damages destroying 171 homes, schools and $152million worth of damage hit agricultural land; the worst to hit Tonga in recorded history .

In efforts to increase resilience of communities, different coastal protection measures were built along a stretch of low-lying coast in Tongatapu.

Preliminary data collected using a survey of 109 households in October 2021 and focus groups with 28 individuals in November 2021 provides a good baseline for future surveys to evaluate impacts.

The stated objectives of the Tonga household survey and focus group exercise were to:

1. Gauge the level of awareness of preparedness for and quality of life in, managing unavoidable risks to climatic change.
2. Determine whether the adaptation measures introduced in the community remain adequate in the changing conditions.

Social survey results show a high level of awareness of climate change. The results show a willingness to undertake actions to prepare for climate risks but does not supply information on actions people may have already undertaken. The focus group results provide qualitative information about the perceived impacts of the adaptations but does not make the link with quality-of-life indicators. For example, several focus group participants said the revetment affected where they can fish, but it is not known whether or to what extent this affects their wellbeing.

The survey results show that people still feel the risk to their community is medium or high. However, respondents also feel very prepared overall, which implies the adaptations are adequate in terms of preparedness. The focus group revealed a desire to make the structures stronger, more durable, or improve maintenance. Most participants considered that the groynes/revetment infrastructure have been helpful in protecting their coastline. Now that the survey has provided a baseline, it would be useful to ask about risk and preparedness again in future to test for changes over time.

In refining the survey tools, it would be useful to collect information about actions households have already taken and probe the extent to which the perceived adaptation impacts affect life satisfaction or other measures of wellbeing.

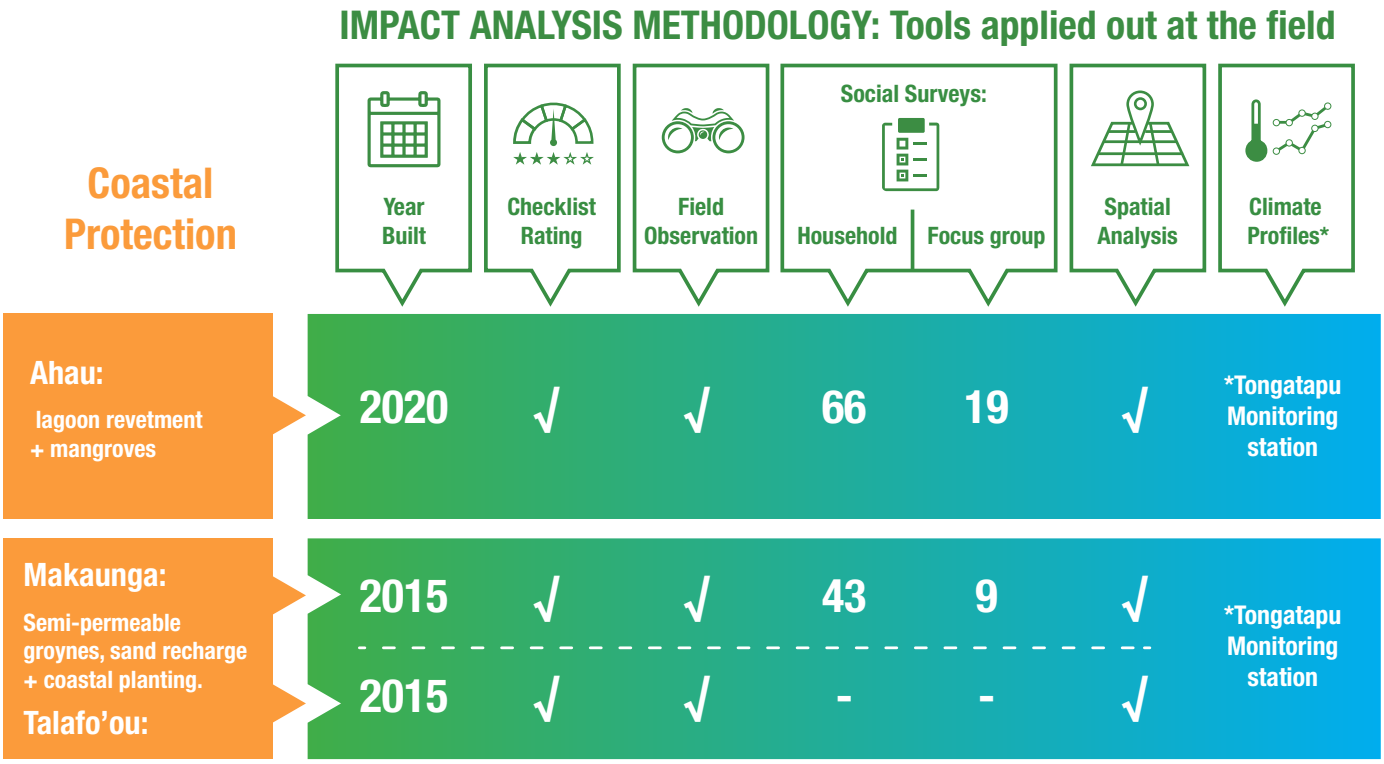


Figure 6. Overview of applied tools: field observation, surveys, interviews, mapping with additional data layer from the nearest climate monitoring station.

Field observations of groynes indicated the good condition of structures with some elements showing general signs of deterioration that require attention. Most of the groynes were placed below the high-water mark by about 1-2metres and obstructs the sand from the up-drift side of the groyne but allows sand to bypass atop of the groynes during high tide.

Figure 7. Photographs (top two) groyne structure showing sand accumulation at 50% permeability. (bottom) photographs show signs of erosion near groynes #11 and #12. Hahake along Makauga-Talafo'ou coastlines. July 2021.

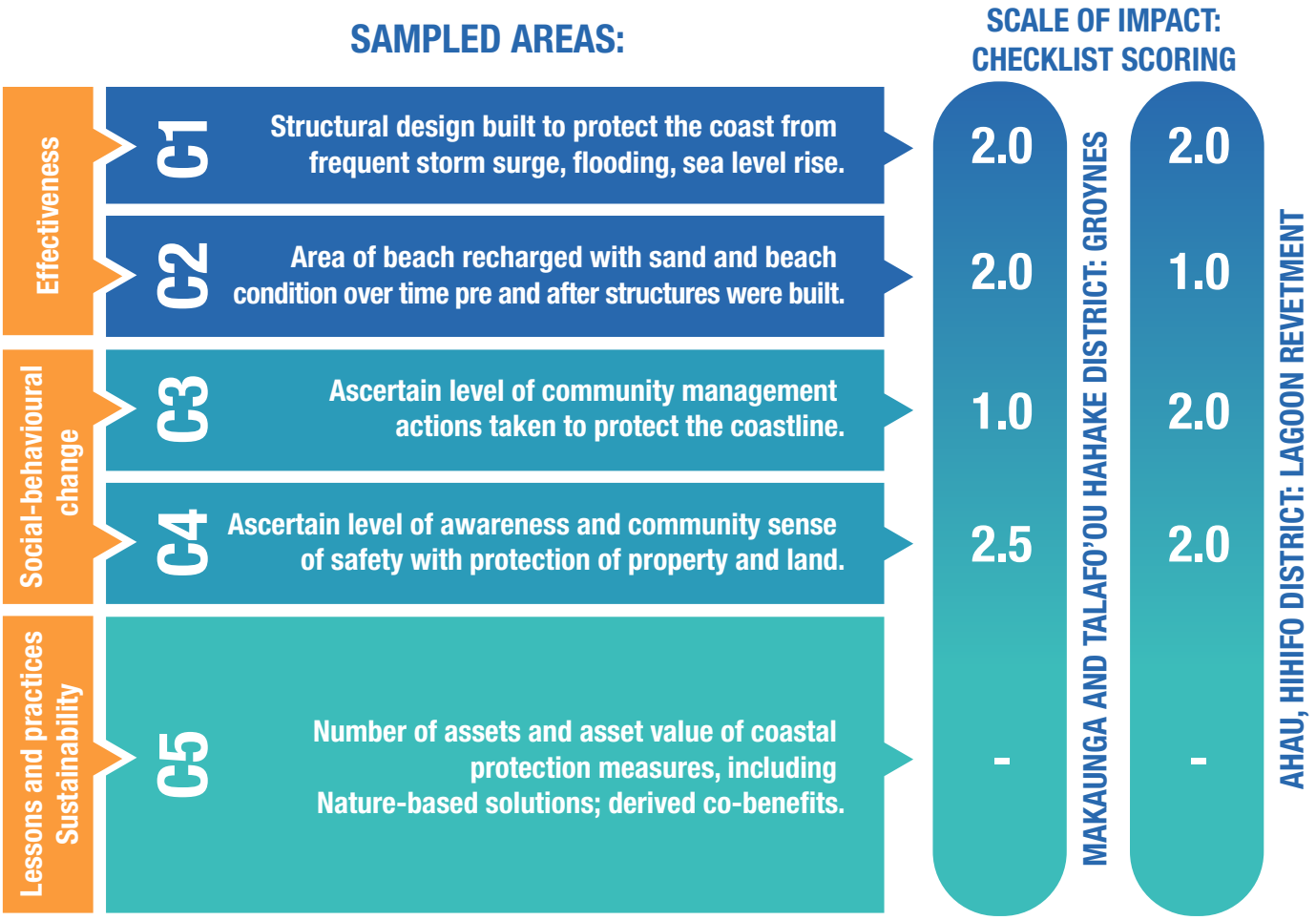
Sourced from: Field report by Talanoa Fuka, national consultant. July 2021.

The signs of coastal erosion noted along Makaunga was likely to occur during strong wind and stormy weather in recent past. However, signs of coastal erosion appear to decrease towards the Lighthouse. Field observations suggest that groyne structure is not protecting the Makaunga coastline like it does for the northern part of Talafo'ou where sand is supplied from the Lighthouse end. This maybe due to the interactions between the southerly longshore current and northerly tidal current as observed in the past with local knowledge.

Field observations of revetment at Ahau. Core structure made of fine mud sediment being piled up to about 1.5meter high was now covered with thick coastal vegetation. Rock boulders of different sizes were laid on the seaward side with no impermeable mat laid underneath the rocks. This suggested that with no matting, this made it easier for the seawater to seep through causing various lineal fractures on the rocks' barrier. This was a recently built structure (6-months since it was completed) but showing signs of deterioration however, with overgrown vegetation seem stable.

The structure was constructed with two open ends at the northern and southern ends, allowing sea water to escape to frontline areas during spring tides and stormy weather.

Spatial imagery analysis will be conducted to detect any significant coastal changes, either it be erosion or sand accretion, plant growth areas mapped over time pre and when structures were placed.



STATEMENT OF THE OVERALL MEAN IMPACT OF THE INTERVENTIONS:
MEDIUM IMPACT @ HAHAKE AND HIHIFO

Figure 8. Summary of Indicator Results for trialled coastal protection(C) measures in Tonga.

Impact rating scale: 1 Low impact, 0-25%
2. Medium impact, 26-50%
3 High impact, 51-75%
4 Very High impact, 76-100%

Climate profiles sourced from the Pacific Meteorological Desk (situated at SPREP) demonstrable of available climate data and knowledge adds value in adaptation planning. In this case, the record of cyclone history with its category scale reported the level of damages caused. There had been no recent cyclones to test the strength of the structures except for the onslaught of the naturally occurring coastal processes.

Checklist for a range of characteristics rated during field observation of the groyne structures along Hahake protecting the Makaunga and Talafo'ou coastline sums up scores. Figure 8 details the tally of scores for each indicator aligned to criteria set for measuring the impact of intervention onsite i.e. lagoon revetment along Ahau village in Hihifo and groynes adjacent to Makaunga and Talafo'ou villages. Overall, average impact rating was medium.

In Summary

Figure 9. Impact assessment of coastal protection measures, Tongatapu.

Most of the people from the two communities accept that the two projects are protecting their lives and properties. However, defects from poor engineering needs to be addressed for the Ahau protection. The Makaunga Groyne structure may also need a new design/ structure because sand is not accumulating. Coastal erosion is happening at this coastline.

Lessons learnt:

Rock Barrier - Supervision of project activities for such intervention is required to ensure that proper engineering is adhered to. The slope of the structure needs to be shallower to allow wave energy dissipation. Impermeable carpet should have been used to cover the fine sediment from being washed away by waves. Both ends of the structure need to be closed to protect the frontline families. Heavier rocks should have been used at the top of the structure.

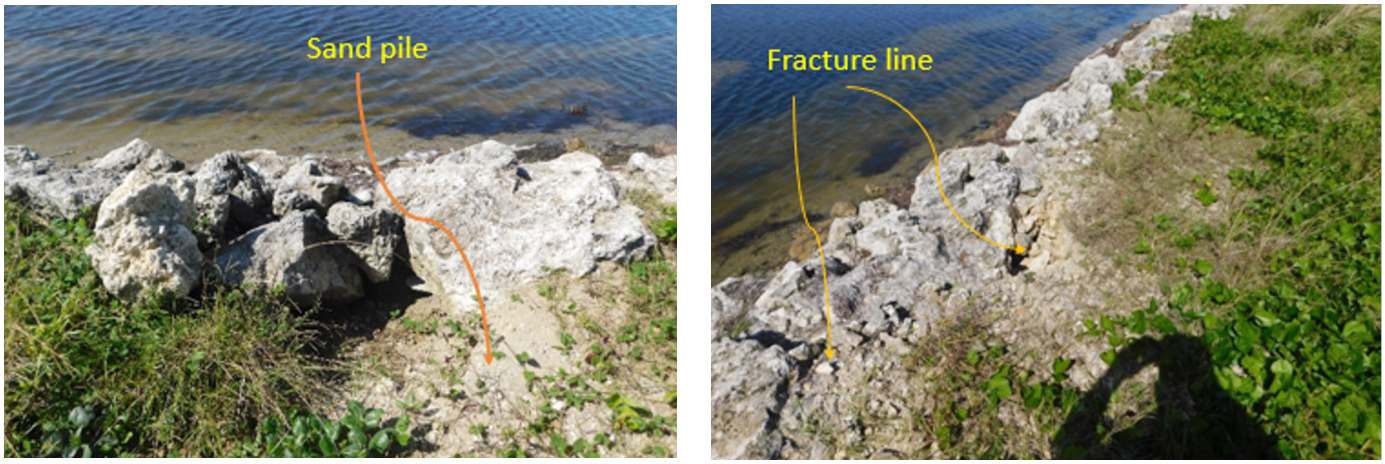


Figure 10. Fracturing along the Barrier structure.

Groyne structure- May need to be replaced with a rick revetment, especially the portion towards Makaunga village. Require adherent to detail of modern engineering and to be well supervised.

Figure 11. Groyne structure at Hahake completely disfigured by the recent Tsunami, 15th January 2022.

There is a need to get the community involved through trainings and consultations. MEIDECC needs to be involved with the target community to provide training and supervision. Considering this, a pathway needs to be incorporated for community involvement as a prerequisite to more projects.

Annex I.
Key Reference Documents for Tonga

1. Tonga Joint National Action Plan 2 on Climate Change and Disaster Risk Management 2018-2028. Monitoring and Evaluation System Guide. Prepared by Department of Climate Change, Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Climate Change and Communications (M.E.I.D.E.C.C) in consultation with the JNAP task force and national stakeholders, Tonga. October, 2019.
2. GCCA: Pacific Small Island States Case study. Best practice coastal protection in Tonga. May 2016.
3. EIA report for the project to upgrade wharf for domestic transport. Ministry of Infrastructure. 2015.
4. Climate Resilience Sector Project. Climate proofing of evacuation roads subproject. Environmental Assessment. March 2017.
5. GCCA: Pacific Small Island States Individual Country Evaluation Report. May 2016
6. Rapid Vulnerability and Adaptation assessments of 6 communities in Tongatapu, Ha'apai and Vava'u, Tonga. September & October 2012.
7. Preparation of a Diagnostic study to inform an integrated coastal management plan for Tongatapu.
8. CTL, 2012a. MEC Consultancy to conduct Coastal Feasibility Studies, Coastal Design and Costing, of Six Communities on the Eastern side of Tongatapu: Report of Coastal Feasibility Studies March 2012 ECoast, 2013
9. Final Design of two coastal erosion options for eastern Tongatapu, Tonga. Report prepared for SPC – GCCA PSIS, June 2013
10. McCue (2014) Report on the Preparation of a diagnostic study to inform an integrated coastal management plan for Tongatapu, Tonga. Report prepared for SPC- GCCA PSIS, 2014
11. Mead, S. T., W. Hiliau and D. J. Phillips, 2013c. Monitoring and Evaluation for Two Coastal Erosion Options for Eastern Tongatapu, Tonga. Report prepared for SPC – GCCA:PSIS, June 2013.
12. PREA , 2016a. Global climate change alliance. Pacific Small island states Individual country evaluation report – Tonga. Report prepared for SPC, 2016.
13. PREA, 2016b. Global Climate change Alliance: Pacific small islands states evaluation report. Report prepared for Pacific Community
14. GCCA PSIS Volume 1: Final report, 2016
15. GCCA PSIS (2013) Information fact sheet
16. GCCA PSIS Concept Note
17. GCCA PSIS- Project design document Trialing coastal protection measures in eastern Tongatapu, Amendment 2
18. GCCA PSIS- Tonga Project Planning workshop, 2016
19. GCCA PSIS Report on Tonga capacity development in proposal preparation using the logical framework approach workshop 17-21 february 2014
20. GCCA PSIS Impact Evaluation of Proposal preparation using the logical framework approach workshop in Tonga, 2016
21. Palau-Tonga Exchange Workshop Report Visit of Palau representatives to Tonga Sharing Experiences on Coastal Management 9-13 February 2015
22. Workshop report Tonga National Lessons Learnt Meeting Global Climate Change Alliance: Pacific Small Island States project
23. Groyne assessment report by the Coastal Resources Section, Natural Resources Division Tonga, 2019
24. GCCA+ SUPA Community based impact assessment in Eastern Tongatapu, Report December 2020
25. GCCA+ SUPA Community based impact assessment in Western Tongatapu, Report November 2020
26. GCCA PSIS Climate change profile, Tonga 2016

27. GCCA+ SUPA: Assessment of the impact of the royne structure at Hahake on protecting the Makaunga-Talafo'ou coastlines, Tongatapu, Kingdom of Tonga 2021

28. GCCA+ SUPA: Assessment of the Impact of the Hihifo rock barrier, Kingdom of Tonga 2021

29. eCoast Report prepared for GCCA+ SUPA: Coastal protection along the North coast of Tongatapu, Tonga Report 2, 2021

30. Mangrove replanting plan for Hihifo District , fo'ui Ha'avakatolo, Kolovai and A'hau – November 2017

31. Terminal evaluation of pacific adaptation to climate change projects PACC and PACC+ final report, May 2015.

Annex II. Standardised Rating for Coastal Protection

LEVEL OF IMPACT	RATING SCALE	PERCENTAGE SCALE	STANDARDISED DESCRIPTION
Low Impact	1	0-25%	• Little beach growth and extensive signs of structure damage[1]. • Extensive absence of vegetation with beach eroded back to the edge of buildings or road and little sand. • No community actions in place to protect the beach (No coastal planting, no signs places/ no brush protection). • Low level of community awareness of the coastal protection measure(s)and less than 25% of community group feel safe in their exposure to extreme weather events and risk to flooding, coastal inundation, storms, and cyclones.
Medium Impact	2	26-50%	• Condition of structure is showing signs of damage. • Coastline showing high eroding signs. • Tree canopy uneven with signs of sand extraction and vegetation damage. • Lack of community awareness of the coastal structure(s). • Results from survey show that between 25-50% of the group feel safe because of the built protection. • Focus group interviews report that e.g. frequent coastal inundation affecting property during high tides and stormy conditions. • Affected when there are bad weather/ extreme events all year round.
High Impact	3	51-75%	• Coastal structure(s) remain intact with little signs of wear. • Healthy beach condition[2] with occasional flooding of residential/community area during spring tides, cyclone season. • Community has a moderate level of awareness of the coastal structure(s) and survey shows that 50-75% of the group feel safe because of the built protection. • Some impact observed with broken canopy of trees with some regrowth and seedling recruitment[1]. • Evidence of structural and non-structural measures initiated by the community to protect the beach.
Very high Impact	4	76-100%	• Coastal structure(s) remain intact with little to no sign of wear, healthy beach condition[1]. • Community has a high level of awareness of the coastal structures and over 75% of the group feel safe and satisfied with the coast being fully protected with no reported inundation and flooding since build of structural measures. • Minimal evidence of human impact coupled with a range of support actions from government, NGOs, community) with a monitoring protocol in place.

1. https://borgenproject.org/cyclone-gita-in-tonga/
2. Coastal Ecosystem-based Rehabilitation Guide. SPREP, 2015.

Figure 12. Standardised Rating for Coastal Protection.

Annex III. Sample of Field Checklist

IMPACT CHECKLIST FORM: COASTAL PROTECTION MEASURES					
Coastline (N-S orientation)	Country ID:	Location:	GPS (refer to retrieved map info. available)		
			Waypoint ID:	GPS start:	GPS End:

Island/State/ Municipality:	Structural type:	Distance to nearest population:	Name of nearest community:	Distance of site from nearest river/stream:

Length of coast protected:	Tide at time of inspection:	Condition of Day (rain, clear sky, windy):	River mouth width (circle):	
			<10m 11-50m 51-100m 101-500m	

Year of activity:	Funding source:

Inspection date:	Time start:	Time end:	Survey team members:

ELEMENTS	CHARACTERISTICS TO MEASURE	YES	NO	RATING (1-4)	DESCRIPTION NOTES	COMMENTS
Beach Condition *Source: Coastal Ecosystem-based Rehabilitation Guide. SPREP, 2015.	A healthy beach				**1**. Severe Impact (Very degraded). Extensive absence of vegetation (just isolated trees), no recruitment of trees or shrubs, no vines nor herbs, beach is eroded back to edge of buildings or road & little sand; beach profile concave-up with a cliff/ scarp in the upper to lower beach; high tide mark is at top of the beach. **2** - Some Impact : sign of collapse on the structure, even canopy of coastal vegetation with no gaps; some human impact. **3** - Moderate Impact. Broken canopy of trees, some regrowth & recruitment, vegetation cover have gaps with damage signs of trampling, beach is flat in profile, high tide mark approx.5m in front of beach trees, **4** - No Impact (Good Condition) Coastal vegetation, even canopy with no gaps; no evidence of human impact, beach wide & convex in profile, high tide mark has sizeable dry beach above it below the vegetation.	Healthy indications -convex shape of the beach surface, the vines trapping sand and the health growing tips spreading over loose sand.
	Eroding beach					Eroding signs- concave shape of the beach surface, lack of vines & broken vegetation cover, a small cliff of sand at the back of the beach.
	Sand removal					
	Structures					
	Nearby pig pens				**Yes/No** rating only	
	Nearby use of fertiliser-farming					
	Signs of beach litter				**1** - Low (no rubbish). **2** - moderate (signs of rubbish including disposal of household waste). **3** - High (sign of communcal rubbish dump in the vicinity). **4** - Very High	
	RATINGS AVERAGE					

Condition of shore structures	Condition of structures				**1** - Poor condition. **2** - Fair condition. **3** - Good condition. **4** - Very good condition.	
	Signs of sand accummulation				**1** - No signs of sand accummulation. **2** - Some signs of sand accumulation. **3** - Moderate signs of sand accumulation. **4** - Extensive signs of sand accumulation.	
	Erosion at vicinity of structures				**1** - Very high. **2** - High. **3** - Moderate. **4** - Low.	
	Effectiveness of the structure (Did it serve its purpose)				**1** - Signs of high erosion, community remain impacted. **2** - Affected by coastal process, structure is intact. **3** - Partial effective (condition of structure is intact, coastline remains the same). **4** - Effective (community is protected from coastal inundation, storm waves, erosion & healthy beach condition)	
	RATINGS AVERAGE					
Extent of Ownership	Clean surrounding area				**1** - Not clean. **2** - Fairly clean. **3** - Moderately clean. **4** - Very clean.	
	Beach control access to reduce impact				**1** - No control. **2.** Some actions of control. **3.** Moderate level control. **4.** High level of control.	Place signs in the area to inform the community of the rehabilitation efforts.
	Protection of the beach & vegetation				**1** - No protection. **2** - Low protection. **3** - Moderate protection. **4** - High protection (no access).	
	Coastal replanting by community				**1** - No coastal planting. **2** - At least one coastal planting. **3** - Community activity in routine. **4** - Other support (NGO) for a community replanting program.	
	Set up control signs to access beach				**1** - No signs at all places/ no brush protection. **2** - At least one sign/some form of brush protection. **3** - Two signs visible. **4** - More than 3 signs visible	Build of brush protection on an eroding beach. Local techniques eg.fix a barrier with cut branches & coconut fronts held up by stakes, on the upper beach where erosion is occuring.
	Brush protection to help sand build up					
	Management actions to promote beach accretion				**1** - No management actions in place. **2** - Few management actions. **3** - Moderate signs of management actions in place. **4** - Management actions highly observed and practiced by the community.	
	RATINGS AVERAGE					
Peoples Perspectives (from focus interviews, surveys)	Is your coast protected?				**1** - Low level of community awareness of the coastal protection measure(s)and less than 25% of community group feel safe in their exposure to extreme weather events and risk to flooding, coastal inundation, storms, and cyclones. **2** - Lack of community awareness of the coastal structure(s). Results from survey show that between 25-50% of the group feel safe because of the built protection. **3** - Community has a moderate level of awareness of the coastal structure(s) and survey shows that 50-75% of the group feel safe because of the built protection, **4** - Community has a high level of awareness of the coastal structures and over 75% of the group feel safe and satisfied with the coast being fully protected with no reported inundation and flooding since build of structural measures	
	Community sense of safety					
	Protection of property & other land uses					
	RATINGS AVERAGE					

Geospatial planning					ref. Spatial analysis	
Calculating Level of Impact Score	Calculate Average of the calculated Averages of Ratings for each Element.					
Impact Scoring	Impact Scores				**1: 0-25%** Low impact, **2: 26-50%** Medium impact, **3: 51-75%** High impact, **4: 76-100%** Very high impact	
Note: Secondary assessment - use of spatial mapping & focus group surveys to provide details on • extent of coastal change over time • did the structures reduce exposure & vulnerability of communities living adjacent to the coastline • level of protection of families and their properties etc.						

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