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Risk assessment for Namukulu and Avatele harbours, Niue

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Pacific Safety of Navigation Project: Risk assessment for Namukulu and Avatele harbours, Niue

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Contents

Executive summary

Although Niue is not a member of the International Maritime Organization (IMO), it is a signatory to the International Convention for the Safety of Life at Sea (SOLAS), of which Chapter V Regulation 13.1 requires contracting governments to provide 'such Aids to Navigation (AtoN) as the volume of traffic justifies and the degree of risk requires.'

Niue is one of the 13 targeted Pacific Island countries and territories of the Pacific Safety of Navigation Project implemented by the Pacific Community (SPC), and funded by the International Foundation for Aids to Navigation (IFAN), whose aim is to improve the safety of navigation in the Pacific region through enhanced AtoN capacity and systems.

During Phase 1 of the project, in 2017, the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) and SPC developed the simplified IALA risk assessment tool (SIRA), a simple qualitative tool to enable smaller states to meet their international obligation of providing AtoN by conducting waterways risk assessments.

During Phase 2 of the project, in February 2019, Niue's Department of Transport identified two priority areas and SPC conducted a risk assessment of the Namukulu and Avatele harbours, using the SIRA tool. This report details the risks identified, the estimated costs in the event of an incident, the risk control options suggested, and their costs for both locations.

Two of the most used boat ramps in Niue are at Namukulu and Avatele harbours, and they are used by local fisherman and tourism operators.

Niue's maritime stakeholders identified different scenarios for both harbours. For Namukulu, three scenarios were identified: 1) grounding on the reef at the channel entrance during the day; 2) grounding on the reef at the channel entrance at night; and foundering within Namukulu's channel. For Avatele, seven scenarios were identified: 1) collision within Avatele harbour; 2) grounding at the entrance to the harbour at night; 3) grounding at night; 4) allision with the boat ramp; 5) allision with a fish aggregation device; 6) foundering in the channel; and 7) a boat running over someone in the water.

For each scenario in each area, the cost of the incident was estimated and a risk score was given, taking into account the probability of the incident happening and its potential impact on the country. Risk control options were then identified. The risk scores for the scenarios under the current situation were then compared with the new risk scores if the risk control options were put in place.

Scenario for Namukulu	Risk score	Risk control option	New risk score
Grounding of a small boat on the reef during the day	4	Provide laminated safety checklists or A5 stickers for all dinghy operators. Further enhance the small boat safety awareness programme, and conduct outboard maintenance and random spot checks by the Fisheries Department.	2
Grounding of a small boat on the reef at night	9	Install AtoN (two channel markers at the entrance and a transit light). Implement a regular maintenance schedule for AtoN.	3
Foundering of a small traditional boat in the channel	12	Engage a coastal engineer to conduct a feasibility study of technical options and costs (i.e. installing wave-breakings and conducting an environmental impact assessment).	12

Scenario for Avatele	Risk score	Risk control option	New risk score
Collision of a small boat and vaka in the harbour, both during the day and at night	8	Make navigation lights on boats and lights on vakas mandatory. Install strobe lights on fish aggregation devices (FADs).	5
Grounding of a small boat and vaka on the reef at night	9	Install AtoN (two channel markers at entrance, two transit lights, floodlights at the rock above the choke point). Implement a regular maintenance schedule of AtoN, and change the direction of the current floodlight.	3
Grounding of a dingy or vaka on wave-breaking blocks at high tide during the day	9	Install markers on wave-breaking blocks and purchase and install lateral markers.	3
Allision with a FAD at night	6	Install strobe lights on FADs.	3
Allision with the boat ramp	6	Install fenders on the boat ramp.	2
Foundering of a vaka in the channel	12	Engage a coastal engineer to conduct a feasibility study of technical options and costs (i.e. installing wave-breaking blocks; and dredging and widening the channel).	12
Boat running over a swimmer, scuba diver or spear fisherman	8	Implement an educational campaign. Make it mandatory for spear fishermen to use a float.	4

The main outcome of the risk assessment process in Namukulu harbour was three recommendations, while seven recommendations were made for Avatele harbour. The recommendations aim to reduce the risks to safety of navigation to an acceptable level for stakeholders. The recommendations and costs of their implementation are outlined below.

Namukulu recommendations

Recommendation 1 To reduce the risk of small boats grounding on the reef, it is recommended that a safety awareness checklist be provided to all fishermen in the area.	
Action	**Cost to implement (NZD)**
Distribute safety awareness checklists and/or stickers	500

Recommendation 2 To reduce the risk of small boats and vakas grounding on the reef at the entrance of Namukulu harbour, it is recommended that: two lit lateral markers be installed at the channel entrance, a transit light be installed on shore, and that a regular AtoN maintenance schedule be drafted and implemented.	
Action	**Cost to implement (NZD)**
Purchase and install lateral markers and transit lights	199,932
Maintenance cost	3160

Recommendation 3 To reduce the risk of vakas foundering in the channel, it is recommended that a coastal engineer be engaged to conduct a feasibility study of technical options and costs (i.e. installing wave-breaking blocks and conducting an environmental impact assessment).	
Action	**Cost to implement (NZD)**
Engage the services of a coastal engineer to carry out a feasibility study	50,000

Avatele recommendations

Recommendation 1 To reduce the risk of collisions between vakas and other boats manoeuvring between the channel and the FAD, it is recommended that all boats and vakas to have navigation lights on them.	
Action	**Cost to implement (NZD)**
Purchase and distribute navigation lights on boats	2400
Purchase and distribute navigation lights on vakas	600
Total	**3000**

Recommendation 2
To reduce the risk of small boats and vakas grounding on the reef at the channel entrance, it is recommended that two lit lateral markers at the channel's entrance and a transit light on shore be installed; that the floodlights at the boat ramp be relocated; and that a regular maintenance schedule for AtoN be drafted and implemented.

Action	**Cost to implement (NZD)**
Purchase and install lateral marks	142,860
Purchase and install transit lights	57,072
Relocate floodlights	500
Total	**200,432**
Maintenance cost	2160

Recommendation 3
To reduce the risk of a small boat grounding on wave-breaking blocks near the boat ramp, it is recommended that two lit channel markers be installed at the entrance of the choke point, and that lit makers be installed on existing wave-breaking blocks.

Action	**Cost to implement (NZD)**
Purchase and install lateral markers	2860
Purchase and install markers for wave-breaking block	10000
Total	13860
maintenance cost	2160

Recommendation 4
To reduce the risk of small boats alliding with the FAD, it is recommended that a strobe light be installed on the FAD.

Action	**Cost to implement (NZD)**
Purchase and install a strobe light on FAD	1000

Recommendation 5
To reduce the risk of boats alliding with the boat ramp while trying to come alongside it, it is recommended that fenders be installed on the leading face of the ramp.

Action	**Cost to implement (NZD)**
Purchase and install fenders on boat ramp	7016

Recommendation 6
To reduce the risk of vakas foundering in the channel at Avatele, it is recommended that a coastal engineer be engaged to conduct a feasibility study of technical options and costs (i.e. installing wave-breaking blocks, and dredging and widening the channel).

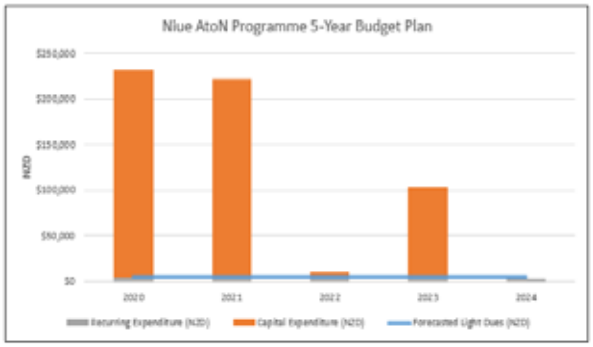
Action	**Cost to implement (NZD)**
Engage a consultant to carry out a feasibility study	50,000

Recommendation 7 To reduce the risk of spear fishermen being run over by boats, it is recommended that floats be used by fisherman while diving, and that a safety and awareness campaign be delivered to stakeholders.	
Action	**Cost to implement (NZD)**
Provide spear fishermen with floats	1000
Deliver a safety awareness programme	1000

As part of the Pacific Safety of Navigation's work on supporting the Ministry of Infrastructure, an AtoN programme five-year budget plan for the delivery of safety of navigation services for the whole of Niue was drawn up to assist in the ministry's budget planning process (Annex E). The budget plan delineates spending according to capital expenditure and recurring expenditure.

Ministry of Infrastructure - Niue Department of Transport **AtoN Programme 5-Year Budget Plan**

	Forecasted Light Dues (NZD)	Capital Expenditure (NZD)	Recurring Expenditure (NZD)
2020	$4,335	$228,634	$3,660
2021	$4,335	$218,179	$3,160
2022	$4,335	$7,016	$3,340
2023	$4,335	$100,000	$3,340
2024	$4,335	$0	$3,340
	$21,673	$553,829	$16,840



* Currently, Niue does not collect light dues from vessels, however, projected potential collection is shown
* Costings of risk control options covered under both the Avatele & Namakulu Safety of Navigation Risk Assessment have been factored in:
  - In 2020, the procurement and distribution of floaters will help mitigate boating accidents vis-à-vis diving in Avatele and in Niue in general
  - In 2020, installation of AtoNs (2 channel markers at entrance, 2 transit lights, flood light at rock above choke point) at Avatele will help mitigate risk of grounding
  - In 2021, installation of AtoNs (2 channel markers at entrance, and 2 transit lights) at Namakulu will help mitigate risk of grounding
  - In 2021, installation of mandatory lights on charter boats, vakas and FADs will help mitigate risk of collisions in Avatele and in Niue in general
  - In 2022, the installation of fenders on Avatele ramp will help mitigate risk of allisions
  - In 2023, it is suggested that a coastal engineer be hired to assess the technical viability of installing wave blockers to mitigate the risk of grounding at Avatele and Namakulu
  - In 2020, 2021, 2022, 2023 and 2024, conduct of educational campaigns to help build awareness on the issue of safety of waterways vis-à-vis diving

1 Background

In early 2016, with support from the International Foundation for Aids to Navigation (IFAN), the Pacific Community (SPC) started the Pacific Safety of Navigation Project in 13 Pacific Island countries and territories (PICTs).[1] The project aims to improve safety of navigation in the Pacific region through enhanced aids to navigation (AtoN) capacity and systems, and hence supports economic development, shipping and trade in the Pacific region through safer maritime routes managed in accordance with international instruments and best practices.

During Phase 1, which ended in July 2018, SPC worked in close collaboration with the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) to conduct technical, legal and economic assessments in the 13 PICTs, to identify needs and gaps in these areas. Another significant output of Phase 1 was the development of a new tool for risk assessment in small island developing states, the simplified IALA risk assessment tool (SIRA). In June 2018, IALA trained personnel in 12 of the 13 PICTs on the use of SIRA to conduct AtoN risk assessments in their countries.

Phase 2 of the project builds on the Phase 1 assessments and tools developed to further assist in building capacity to develop and maintain AtoN in PICTs. Activities include conducting risk assessments (as required by Regulation 13 of the International Convention for the Safety of Life at Sea – SOLAS); developing safety of navigation policy and a legal framework; improving budgetary management; and supporting regional coordination related to safety of navigation in the Pacific.

In February 2019, Niue's Department of Transport, within the Ministry of Infrastructure, invited SPC to assist in conducting a risk assessment of Namukulu and Avatele harbours, where two of the country's most used boat ramps by local fisherman. This report describes the two risk assessments, which were carried out using the SIRA methodology.

Niue is a maritime nation, with a large percentage of its citizens working in or closely with the maritime industry. Shipping is critical to the economic and social welfare of the people of Niue, and safe navigation is vital to secure this welfare and to protect the environment.

Niue is a self-governing state in free association with New Zealand, and while not a member of the United Nations directly, is recognised as a freely-associated state with independence for the purposes of law. Niue is a signatory to a number of conventions and protocols of the International Maritime Organization (IMO), including: the International Convention for the Safety of Life at Sea (SOLAS); the International Regulations for Preventing Collisions at Sea (COLREGS); the International Convention on Standards for Training, Certification and Watchkeeping (STCW); the International Convention for the Prevention of Pollution from Ships (MARPOL); the Convention for the Suppression of Unlawful Acts (SUA) against the Safety of Maritime Navigation; and the Nairobi International Convention on the Removal of Wrecks .

Regulation 13 of Chapter V of the 1974 SOLAS Convention (as amended) states that 'each Contracting Government undertakes to provide, as it deems practical and necessary either individually or in co-operation with other Contracting Governments, such aids to navigation as the volume of traffic justifies and the degree of risk requires.'

The SIRA risk control process comprises five steps that follow a standardised management or systems analysis approach:

[1] Cook Islands, Federated States of Micronesia, Kiribati, Marshall Islands, Nauru, Niue, Palau, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu and Vanuatu.

1. identify hazards
2. assess risks
3. specify risk control options
4. make a decision
5. take action.

SIRA is intended as a basic tool to identify risk control options for potential undesirable incidents that Niue should address as part of its obligation under SOLAS Chapter V Regulations 12 and 13. The assessment and management of risk is fundamental to the provision of effective AtoN services.

The assessment involved a stakeholder meeting, as a first step, to gather the views on hazards and risks in Namukulu and Avatele harbours from those directly involved with or affected by AtoN service provision. Information provided by this step was then used by Niue AtoN and SIRA-certified officer Ms Lynsey Talagi and SPC to complete two full risk assessment matrixes based on ten identified possible scenarios: three for Namukulu harbour and seven for Avatele harbour

2 Description of the waterway

2.1 Namukulu

Namukulu is one of two local harbours in Niue and was, therefore, identified by the Department of Transport as a priority for the risk assessment. Namukulu's harbour consists of one domestic boat ramp. There is currently no AtoN in or around the harbour, but there is one floodlight at the boat ramp that illuminates the ramp area at night.

Namukulu's boat ramp is mainly used by the local community to launch small boats such as vakas and small private fishing boats. The maximum draft of vessels that access this ramp is 0.5 m.

The boat channel is 18 metres (m) wide at the entrance, and ranges in depth from 2 m at the entrance to less than 1 m at the front part of the channel. The channel has a safe minimum depth of 1.6 m.

Visibility can be reduced to 0.05 nautical miles in bad weather, which normally occurs between November and April. A maximum predicted swell of 1 m is expected around the channel. There are several hazards present at Namukulu's harbour such as a narrow and winding channel, strong winds, currents, waves, and shallow depths that can pose problems for maritime traffic.

Chart NZ 845 shows Niue at a scale of 1:150,000 (Fig. 1). There is no small-scale coverage of Namukulu harbour on this chart.

2.2 Avatele

Avatele harbour is another major local harbour in Niue and was, therefore, identified by the Department of Transport as a priority for a risk assessment. Avatele harbour consists of one domestic boat ramp. There is currently no AtoN in or around the harbour, but there are two floodlights at the boat ramp that illuminate the ramp area at night.

The Avatele boat ramp is mainly used by the local community to launch small boats such as the vakas and private fishing boats. The ramp is also used by local tour operators during the whale watching season from July to September, and by kayakers.

The ramp is occasionally used to launch the search and rescue boat when conditions are unfavourable for launching at the Alofi wharf.

The depth of the boat channel into Avatele ranges from 1.4 m at the choke point to more than 2.0 m at the entrance. The channel can accommodate vessels with a maximum draft of 1.2 m.

Visibility can be reduced to 0.1 nautical miles in bad weather, which normally occurs between November and April. There are several hazards in Avatele harbour such as a narrow and winding channel, bollards that are underwater at high tide, strong winds, currents, waves, and shallow depths that can pose problems for maritime traffic.

Chart NZ 845 shows Niue at a scale of 1:150,000 (Fig. 1). There is no small-scale coverage of Avatele harbour on the chart.

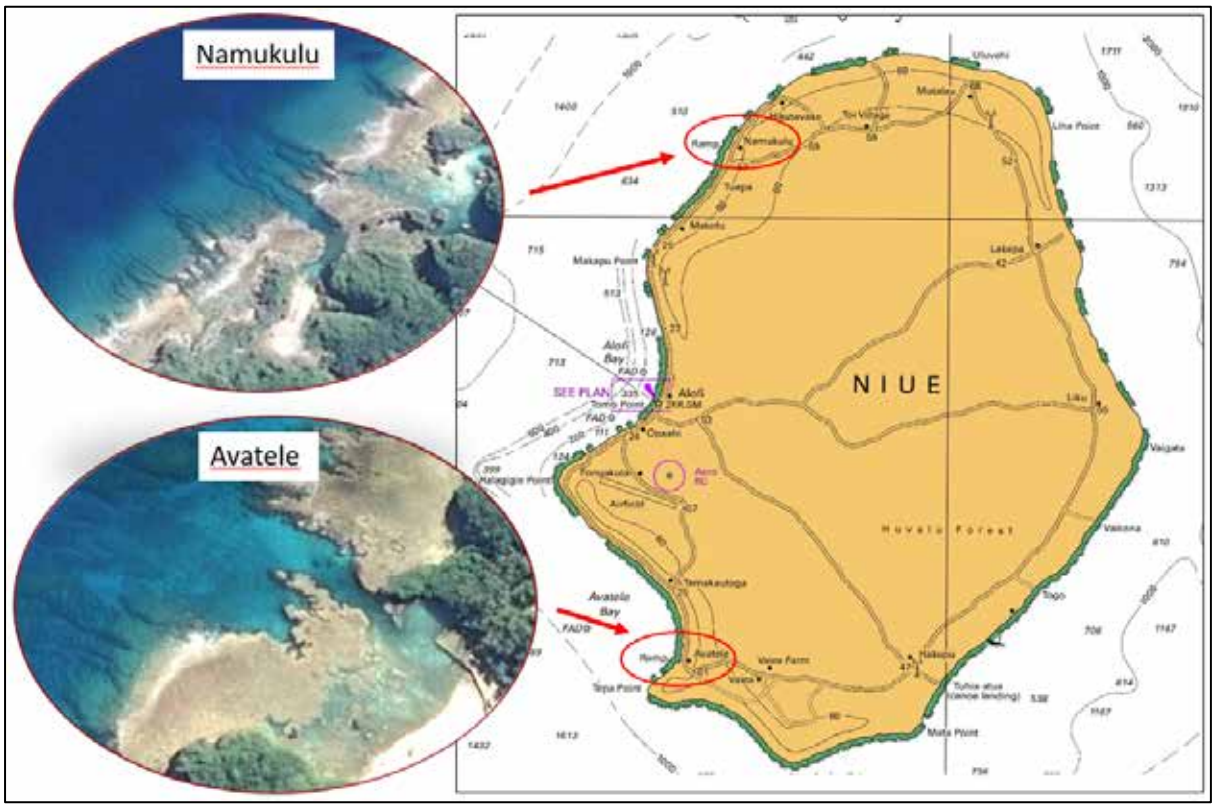


Figure 1. Chart of Niue at a scale of 1:150,000, and Google Earth images of Namukulu and Avatele harbours.

3 Stakeholder meeting

As the first step of the SIRA process, a stakeholder meeting was organised in Niue on 18 February 2019, which aimed to gather the points of view of individuals, groups and organisations involved with or affected by AtoN service provision in Namukulu and Avatele harbours. Stakeholders included the Avatele Village Council, police, Niue Fisheries Department , national hydrographic office, Port of Alofi, Avatele canoe fisherman, Namukulu boat fisherman, Niue Island Fishing Association, Chamber of Commerce, Vaka Fisherman's Association, and others (Annex A). During the meeting, participants were divided into two groups according to their experience and background in one of the two areas identified. They then helped identify potential hazards and possible scenarios in both Namukulu and Avatele harbours using the latest chart of Niue, and other tools such as Google Earth screen shots of Namukulu and Avatele harbours, and their experience.

4 Hazards and risks

A hazard is something that may cause an undesirable incident. Risk is the chance of injury or loss as defined as a measure of 'probability or likelihood' and 'severity or impact'. Examples of injury or loss include an adverse effect on health, property, the environment or other areas of value.

The purpose of the stakeholder meeting was to generate a prioritised list of hazards specific to Namukulu and Avatele harbours. For the risk assessment, SPC and Niue's Maritime Manager and SIRA-trained Ms Lynsey Talagi, worked together to discuss the risks associated with the identified hazards, and identified risk control options and recommendations.

The list of hazards identified for Namukulu and Avatele harbours is given in Annex B.

4.1 Types of hazards

Eighteen hazards were identified for Avatele and Namukulu combined, and were grouped into the following six categories:

- natural hazards, such as storms, earthquakes, safe minimum depth, proximity to danger, minimum visibility, low sun angle, and other natural phenomena;
- economic hazards such as insufficient AtoN funding;
- technical hazards such as system or equipment failure, quality and validity of charted information, substandard ships, and failure of communications systems;
- human factors such as crew competency, safety culture, influence of alcohol and/or drugs, and linguistic challenges;
- operational hazards such as seasonal activities, poor promulgation of marine safety information, poor response to marking new dangers and ramp launching area; and
- maritime space hazards, such as the existence of restricted marine protected areas.

The above six types of hazard have the capability to generate seven different types of losses:

- health losses, including death and injury;
- property losses, including real and intellectual property;
- economic losses, leading to increased costs or reduction of revenues;
- liability losses, resulting when an organisation is sued for an alleged breach of legal duty (such cases must be defended even if no blame is assigned, and liability losses are capable of destroying or crippling an organisation);
- personnel loss when services of a key employee are lost;
- environmental losses (negative impact on land, air, water, flora or fauna); and
- loss of reputation or status.

4.2 Risk factors

Any risk analysis needs to consider the range of factors that contribute to the overall risk exposure. Table 1 lists some of the factors that could be taken into consideration when identifying hazards for waterways and ports.

Table 1. Risk factors relating to maritime navigation.

Ship traffic	Traffic volume	Navigational conditions	Waterway configuration	Short-term consequence	Long-term consequence
Quality of boats	Deep draught	Night/day operations	Depth/draft/under-keel clearance	Injuries to people	Health and safety impacts
Crew competency	Shallow draught	Sea state	Channel width	Oil spill	Lifestyle disruptions
Traffic mix	Commercial fishing boats	Wind conditions	Visibility obstructions	Hazardous material release	Fisheries impacts
Traffic density	Recreational boats	Currents (river, tidal, ocean)	Waterway complexity	Property damage	Impacts on endangered species
Nature of cargo	High speed craft	Visibility restrictions	Bottom type	Denial of use of waterway	Shoreline damage
Participation rate in routing	Passenger ships		Stability (siltation)		Reef damage

systems, such as vessel traffic system (VTS)					
		Background lighting	AtoN mix and configuration		Economic impacts
		Debris	Quality of hydrographical data		

Risk is evaluated to allow attention to be focused on high-risk areas, and to identify and evaluate factors that influence the level of risk. Once all of the risks have been assessed, they are then evaluated in terms of the documented needs, issues and concerns of the stakeholders, and the benefits and costs of the activity, to determine the acceptability of the risk.

Zero risk is not often realised, unless the activity generating the risk is abandoned. Rather than striving to reduce the risk to zero, authorities should reduce the risk to 'as low as reasonably practicable' (ALARP; Fig. 2).

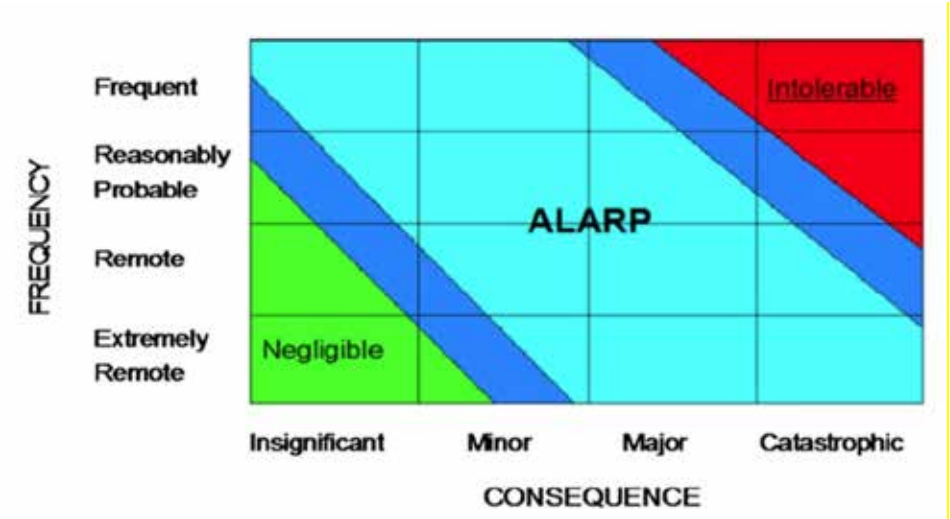


Figure 2. Graphical representation of the levels of risk. The risk level boundaries (negligible/ALARP/intolerable) are purely illustrative.

It is important to remember that when communicating with stakeholders about risk, perception is usually different from reality. People make judgements about the acceptability of a risk based on their perceptions, rather than on scientific factors such as probability. The public's perception of a risk may be influenced by many things, including their age, gender, level of education and previous exposure to information about the hazard. Public perceptions of risk may, therefore, differ from those of technical experts.

5 Scenarios

During stakeholder meetings and discussions with the Niue Maritime Manager, 18 hazards were identified for Namukulu and Avatele harbours combined that could lead to a number of different incidents or scenarios. Each hazard was considered carefully and the scenarios it could cause were identified and recorded. The scenarios for Namukulu were classified into two categories: groundings and founderings; while the scenarios for Avatele were classified into five categories: collisions, groundings, allisions, founderings, and one other scenario.

Annex C lists the identified scenarios.

5.1 Namukulu

5.1.1 Grounding

Grounding is defined as a boat being aground after hitting or touching the shore, sea bottom or an underwater object (e.g. a wreck). Two grounding scenarios were identified for Namukulu harbour, one during the day and one at night. The narrow and winding passage at the entrance to the harbour, combined with strong winds, waves and current increases the risk of a grounding on the hard bottom, and is a concern for small boats and vakas accessing this passage during the day. The lack of any AtoN is a major concern for mariners accessing the ramp at night and during bad weather. Another factor that potentially contributes towards this scenario is the lack of proper regular maintenance and checks on outboard motors.

There is a floodlight at the ramp that illuminates the ramp and acts as an AtoN for fishermen. During power cuts, however, this light does not work, which can potentially contribute to a grounding scenario.

5.1.2 Foundering

Foundering is defined as a boat sinking but not as a result of a collision; for example, a boat might founder if its cargo shifts during bad weather. Foundering at Namukulu harbour could occur during bad weather, especially if the person operating the small boat or the vaka lacks seamanship experience. Vakas foundering in the channel is a concern due to wind and wave direction, currents and tide in the channel.

5.2 Avatele

5.2.1 Collision

Collision is defined as striking or being struck by another ship, regardless of whether either vessel is underway, anchored or moored. The probability of a collision depends on navigational conditions, waterway configuration, and type and volume of maritime traffic. The basic types of collisions are head-on, overtaking, bend, merging and crossing collisions. An analysis of the navigation route and its geometry, combined with the volume and mix of traffic for Avatele harbour, resulted in one probable collision scenario: a head-on collision, where a small recreational fishing boat collides with vakas or other boat in the channel while approaching the FADs at night. This is attributed to the lack of navigational lights on boats and vakas and a lack of AtoN in the harbour and on the FADs.

5.2.2 Grounding

Grounding is defined as a boat hitting or touching the shore, sea bottom or an underwater object (e.g. a wreck). The probability of a grounding depends on many factors, including the harbour's bathymetry, the draft of boats accessing the harbour, and meteorological conditions such as prevailing wind speed and direction. Two grounding scenarios were identified for Avatele harbour. The narrow and winding passage at the harbour's entrance, combined with strong winds, waves and current, increases the risk of grounding on the hard sea bottom and is a concern for local boats accessing this passage. The wave-breaking blocks at the choke point are covered during high tide and so are not visible, and combined with the above-mentioned natural conditions this is a hazard that can potentially contribute to a grounding scenario.

The lack of AtoN in and around the harbour and the intensity and direction of the floodlights at the ramp were reported as being major contributing factors for this scenario.

5.2.3 Allision

The possibility of a boat striking a fixed human-made object such as a wharf, mooring buoy or FAD depends on the position of such structures along the navigation route and the density of maritime traffic. Two different allision scenarios were identified for Avatele harbour: one with the boat ramp, and one with the FAD outside the channel. An allision with the ramp is a concern when boats try to

come alongside the ramp for retrieval, either by the winch or a trailer. An allision with the FAD is a concern at night because it being inconspicuous and unlit.

5.2.4 Foundering

Foundering is defined as a boat sinking but not as a result of a collision; for example, a vessel might founder if its cargo shifts during bad weather. Foundering in Avatele channel can occur due to wind and wave direction, currents and tide, and during bad weather, combined with a lack of experience on the part of the small boat or vaka operator.

5.2.5 Other scenario

One other scenario was discussed during the stakeholder meeting: the possibility of a boat running over a spear fisherman or scuba diver in the harbour because these people are not visible in the water.

6 Probability and impact

SIRA specifies five levels of probability (Table 2) and five levels of impact that each type of scenario would create (Table 3). Each scenario is allocated a score for both probability and impact, and the risk value is calculated from the product of these scores. In this step of the process, the probability and consequences associated with each scenario were estimated and discussed with the AtoN officer.

Table 2. Levels of probability specified for the simplified IALA risk assessment tool (SIRA).

Classification	Score	Probability
Very rare	1	Very rare or unlikely, will occur only in exceptional circumstances and not more than once in 20 years
Rare	2	Rare, may occur every 2–20 years
Occasional	3	Occasional, may occur every 2 months to 2 years
Frequent	4	Frequent, may occur once every weekly to every 2months
Very frequent	5	Very frequent, may occur at least once every week

Table 3. Levels of impact specified for the simplified IALA risk assessment tool (SIRA).

Descrip-tion	Score	Service disruption criteria	Human impact criteria	Financial criteria	Environmental criteria
Insignifi-cant	1	No service disruption apart from some delays or nuisance	No injury to humans; possible significant nuisance	Loss, including third-party losses, of less than USD 1000	No damage
Minor	2	Some non-permanent loss of services such as closure of a port or waterway for up to 4 hours	Minor injury to one or more individuals, may require hospitalisation	Loss, including third-party losses, of USD 1000–50,000	Limited short-term damage to the environment
Severe	3	Sustained disruption to services such as closure of a port or waterway for 4–24 hours	Injuries to several individuals requiring hospitalisation	Loss, including third-party losses, of USD 50,000–5,000,000	Short-term damage to the environment over a small area
Major	4	Sustained disruption to services such as	Severe injuries to many individuals or loss of life	Loss, including third-party losses, of USD	Long-term to irreversible damage to the

		closure of a major port or waterway for 1–30 days or permanent or irreversible loss of services		5,000,000–50,000,000	environment over a limited area
Catastro-phic	5	Sustained disruption to services such as closure of a major port or waterway for months or years	Severe injuries to numerous individuals and/or loss of several lives	Loss, including third-party losses, of over USD 50,000,000	Irreversible damage to the environment over a large area

7 Acceptability of risk

Having determined probability and impact scores by consensus, the risk values are calculated by multiplying these scores, as shown in the matrix in Table 4. To determine whether the risks are acceptable or not, SIRA specifies four colour-banded levels of risk (Table 5). These colours are superimposed on the matrix in Table 4.

Table 4. Risk value matrix.

		PROBABILITY / (LIKELIHOOD)				
		Very Rare (1)	Rare (2)	Occasional (3)	Frequent (4)	Very frequent (5)
CONSEQUENCE (IMPACT)	Catastrophic (5)	5	10	15	20	25
	Major (4)	4	8	12	16	20
	Severe (3)	3	6	9	12	15
	Minor (2)	2	4	6	8	10
	Insignificant (1)	1	2	3	4	5

Table 5. Categories of risk, and the action required.

Risk Value	Risk Category	Action Required
1 – 4	Green	Low risk not requiring additional risk control options unless they can be implemented at low cost in terms of time, money and effort.
5 – 8	Yellow	Moderate risk which must be reduced to the *"as low as reasonably practicable"* (ALARP) level by the implementation of additional control options which are likely to require additional funding.
9-12	Amber	High risk for which substantial and urgent efforts must be made to reduce it to "ALARP" levels within a defined time period. Significant funding is likely to be required and services may need to be suspended or restricted until risk control options have been actioned.
15-25	Red	Very high and unacceptable risk for which substantial and immediate improvements are necessary. Major funding may be required and ports and waterways are likely to be forced to close until the risk has been reduced to an acceptable level.

8 Risk control options

The objective of the risk assessment was to identify risk mitigation options for each undesirable incident that would, if implemented, reduce the risk to a level as low as reasonably practicable (ALARP), and which would be acceptable to stakeholders. Before any risk control decisions were made, they were communicated through the stakeholder consultation process. The risks were evaluated in terms of the overall needs, issues and concerns of the stakeholders. The mitigation options include:

- new or enforcement of existing rules and procedures;
- improved and charted hydrographical, meteorological and general navigation information;
- enhanced AtoN service provision;
- improved radio communications; and
- improved decision support systems.

Tables 6 and 7 show the risk scores for the scenarios under the current situation at Namukulu and Avatele, respectively, and the new risk scores after mitigating the risk. The detailed risk control options for Namukulu and Avatele are shown in the risk control matrix in Annex D.

Table 6. Risk control options for Namukulu harbour, and changes in risk score.

Scenario for Namukulu	Risk score	Risk control option	New risk score
Grounding of a dinghy or canoe on the reef during the day	4	Provide laminated safety checklists or A5 stickers for all small boat operators. Further enhance the small boat safety awareness programme, encourage regular outboard maintenance, and random spot checks should be conducted by the Fisheries Department.	2
Grounding of a dinghy or canoe on the reef at night	9	Install AtoN (two channel markers at the entrance, and a transit light). Implement a regular maintenance schedule.	3
Foundering of a canoe in the channel	12	Engage a coastal engineer to conduct a feasibility study of technical options and costs (i.e. installing wave-breaking blocks and conducting an environmental impact assessment).	12

Table 7. Risk control options for Avatele harbour, and changes in risk score.

Scenario for Avatele	Risk score	Risk control option	New risk score
Collision of boats and canoes during the day and at night	8	Make navigational lights on boats and lights on canoes mandatory. Install strobe lights on FADs.	5
Grounding of a dinghy or canoe on the reef at night	9	Install AtoN (two channel markers at the entrance, two transit lights, and a floodlight at the rock above the choke point). Draft and implement a regular maintenance schedule. Reposition the direction of the current flood light.	3
Grounding of a dingy or canoe on wave-breaking blocks at high tide during the day	9	Install markers on wave-breaking blocks and purchase and install lateral markers	3
Allision with FADs at night	6	Install strobe lights on FADs.	3
Allision with the boat ramp	6	Install fenders on the ramp.	2
Foundering of a canoe in the channel	12	Engage a coastal engineer to conduct a feasibility study of technical options and costs (i.e. installing wave- breaking blocks, and dredging and widening the channel).	12
Boat runs over a swimmer, scuba diver or spear fisherman	8	Conduct small boat safety programmes. Make it mandatory for spear fishermen to use a float while in the water.	4

9 Costing the risk control options

The outcomes of the risk assessment are essentially qualitative and subjective, based on the expert opinions of the stakeholders. The next step is to reach consensus on which risk control options to action. The risk control options are prioritised to facilitate the decision-making process.

Costing of the options is part of the decision-making process. Most of the control options identified require funding. Costs must cover capital, labour and other resources needed for planning and implementation, as well as costs of operation and maintenance throughout the life cycle under consideration. Maintenance is important to ensure that AtoN equipment and systems continue to perform at the levels required for mariners to safely navigate the waterways.

The control measures need to be both effective in reducing risk, but also cost-effective. The cost of the measures should not normally exceed the reduction in the expected value of the loss.

The cost of the options should be evaluated over a time frame equivalent to the economic or useful life of the facilities and assets associated with the option.

10 AtoN budgeting and resourcing

For the Niue Department of Transport to provide excellent AtoN services in Niue, it is important that an adequate level of resources be allocated towards AtoN installment, maintenance and management. During the visit, a meeting was held with key stakeholders to determine the allocation of resources and management of AtoN budget. A five-year budget was drawn up with Department of Transport officials to assist in their budget planning (Annex E).

The Department of Transport, under the Ministry of Infrastructure, has no dedicated national budgetary allocation for the installment or maintenance of AtoN, and the Port of Alofi does not collect light dues in any form from any vessel calling into port in Alofi.

To improve the Department of Transport's budgetary planning for AtoN, an AtoN Programme five-year budget plan (2020–2024) was drawn up, in consultation with the Director of Transport, Ms Sonya Talagi, and AtoN Officer, Ms Lynsey Talagi. The budget takes into account new installments, continuous maintenance work, and includes the costed risk control options from the risk assessment above. These have been staggered over the five-year period to ensure that the burden for any one risk option is spread out over the five-year period.

The budget sets out what it would cost Niue's Department of Transport to fund a dedicated AtoN maintenance programme under its work plan, and shows that the programme would mainly consist of maintenance work on all AtoN structures on the island, including hiring machinery, purchasing paint, labour costs, and educational campaigns to build awareness on the use of flags and floaters. This recurring expenditure would cost the government approximately NZD 3660 every year.

Capital expenditure shows the level of investment needed to carry out the recommended risk control option(s) within a given risk assessment. Given the substantial costs involved, the procurement and installation of items is recommended to be staggered over the five-year budget period.

Expenditures include:

- In 2020, the procurement and distribution of floats to help mitigate boating accidents with spear fishermen diving in Avatele, and in Niue in general; and the installation of AtoN (two channel markers at the entrance, two transit lights, and a floodlight at the rock above the choke point) at Avatele to help mitigate the risk of a grounding.
- In 2021, the installation of AtoN (two channel markers at the entrance, and two transit lights) at Namakulu to help mitigate the risk of a grounding; the installation of mandatory lights on charter boats, vakas and FADs to help mitigate the risk of collisions in Avatele, and in Niue in general.
- In 2022, the installation of fenders on Avatele's boat ramp to help mitigate the risk of allisions.
- In 2023, it is suggested that a coastal engineer be hired to assess the technical viability of installing wave-breaking blocks to mitigate the risk of a grounding in both Avatele and Namakulu. The total cost of this risk control option is estimated to be NZD 554,954 over the five-year period.

During consultations with stakeholders, the Ministry of Finance and Planning expressed its interest in exploring the implementation of light dues that could be 'ring-fenced' or dedicated to investing in AtoN maintenance and installation..The budget breaks down how the light dues could be charged. Only three types of vessels call at Alofi: container ships, cruise vessels and recreational vessels (e.g. yachts), and the light dues would have to be structured accordingly. Currently, Matson Shipping, the only shipping line that services the country, is exempt from any further charges under an agreement with the Niuean government. As such, only cruise vessels[2] and recreational vessels can be charged.

[2] Carnival Cruises' MS *Maasdam* has scheduled calls at Alofi twice a year.

The recurring AtoN expenditure total estimated in the budget is then used as the threshold for the amount to collect. At a rate of NZD 0.03 per gross registered tonne, and a flat rate of NZD 10 per recreational vessel, it is calculated that Niue will be able to collect approximately NZD 4300 in light dues, enough to fund a dedicated AtoN maintenance programme. In the future, if the country is able to renegotiate its arrangement with Matson so that it can charge light dues on Matson's container ships, it would effectively make it so that dues would not be levied on yachts that visit the island.

It is suggested that the AtoN Programme five-year budget plan be used to assist the Department of Transport in its own budget planning and discussions for funding in the national budget. A summary and detailed tables with descriptions of the AtoN programme five-year budget plan can be found in Annex E.

11 Recommendations

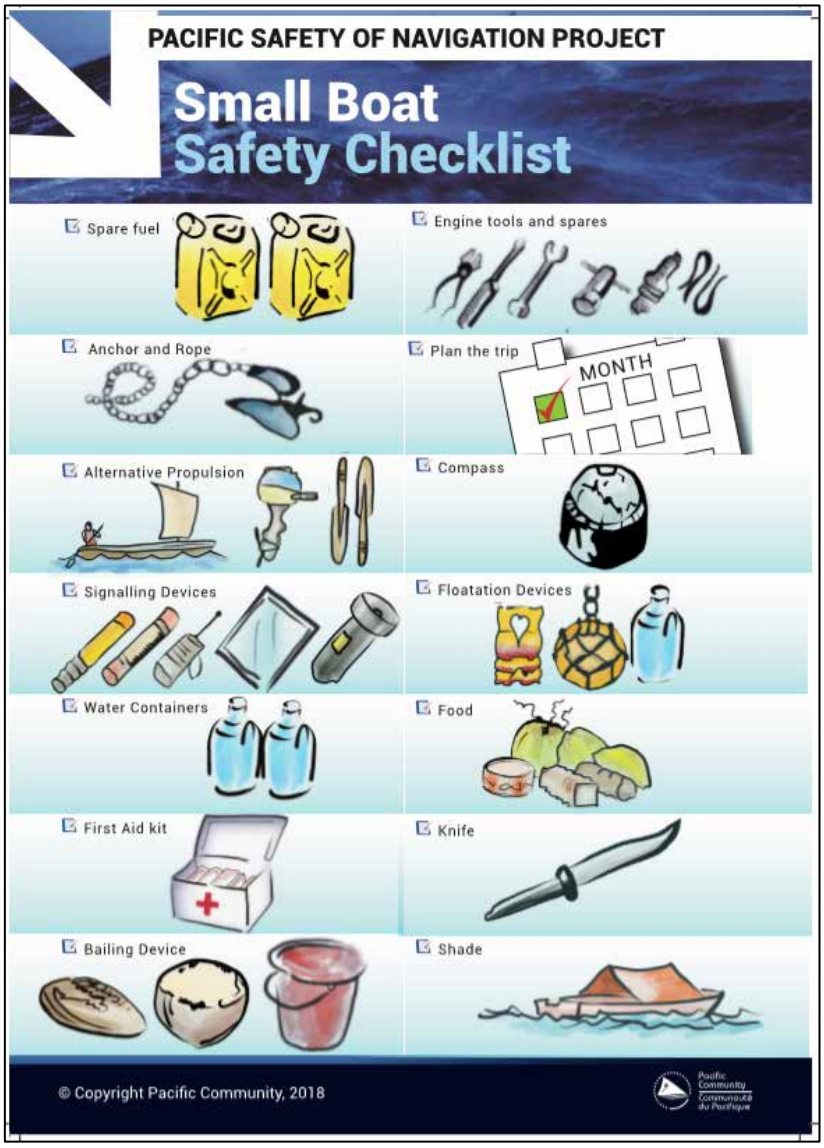
A key outcome of the risk assessment is three recommendations for Namukulu and seven recommendations for Avatele, all of which aim to reduce the risks to safety of navigation to an acceptable level for stakeholders.

11.1 Namukulu

Recommendation 1 (addressing grounding scenario)

This recommendation addresses the potential grounding of a dinghy or vaka on the reef during the day at the channel entrance to Namukulu while returning to shore. A lack of regular vessel maintenance and proper engine checks and safety equipment before trips is a major concern.

It is recommended that laminated safety checklists or stickers (shown below) be provided to all local fishermen in the Namukulu area. It is also recommended that the small boat safety awareness programme be enhanced, and that the Niue Fisheries Department conduct outboard maintenance programmes and random spot checks. The guidance from the checklist and awareness programme should potentially help locals to reduce the risk to as low as reasonably practicable.



Action	Cost to implement (NZD)
Distribute safety checklists and/or stickers	500

Recommendation 2 (addressing grounding scenario)

There is currently no AtoN in or around the Namukulu boat ramp to guide mariners at night. There is only a flood light on the boat ramp that illuminates part of the ramp and also acts as an AtoN.

It is recommended that two lit channel markers (port and starboard) be installed at the channel entrance, and that a transit light be installed to guide mariners through the channel. The following IALA guidelines should be consulted in detail for the implementation of this recommendation: GL #s 1023, 1094, 1134, 1116, 1077, 1073 and 1005.

This should reduce the risk to as low as reasonably practicable.

The cost[3] to implement this recommendation is shown below.

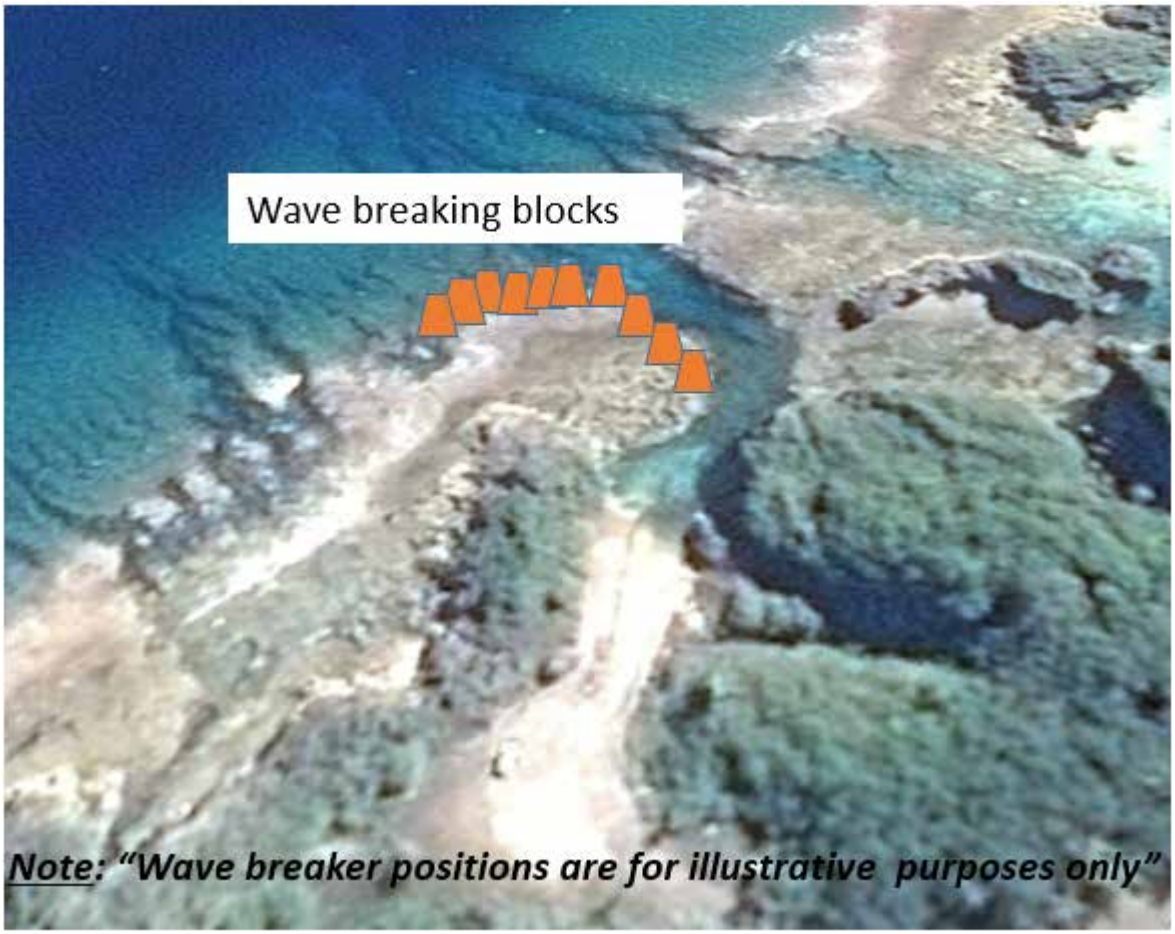
Action	Cost to implement (NZD)
Purchase and install lateral markers and transit lights	199,932.00
Annual maintenance cost	3160

Recommendation 3 (addressing foundering scenario)

On occasion, s when vakas capsize in the channel, and this is caused by strong currents and large waves inside the channel.

It is, therefore, recommended that a coastal engineer be engaged to conduct a feasibility study of the technical options and costs (i.e. installing wave-breaking blocks, and dredging and widening the channel), and that a proper wave inundation model and environment impact assessment be carried out for Namukulu.

[3] These costs come from a quotation from M-NAV solution.



Action	Cost to implement (NZD)
Engage the services of a coastal engineer to carry out a feasibility study	50,000

11.2 Avatele

Recommendation 1 (addressing collision scenario)

This recommendation addresses the potential collision of vakas or other domestic boats with other boats, between the FAD and the channel.

It is recommended that navigation lights be mandatory and installed on boats, and that lights be installed on vakas.

Action	Cost to implement (NZD)
Purchase and distribute navigation lights on boats	2400
Purchase and distribute navigation lights on vakas	600
Total	**3000**

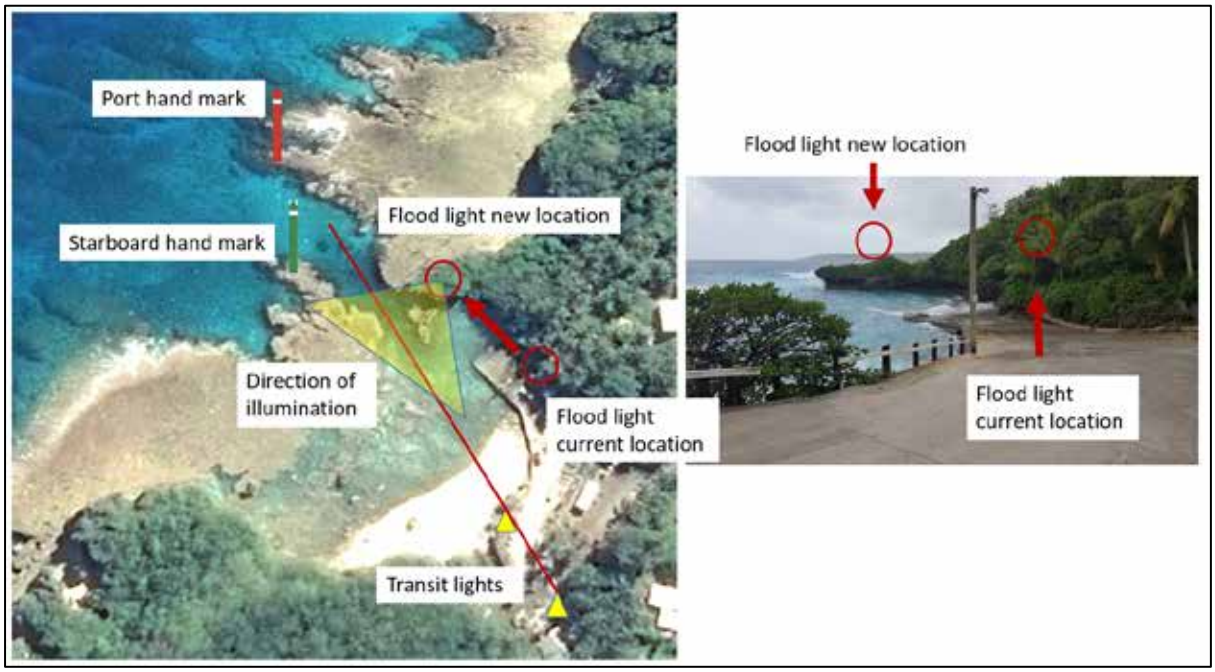
Recommendation 2 (addressing grounding scenario)

This recommendation addresses the potential grounding of a small boats and vakas on the reef at the channel's entrance.

It is recommended that two lit fixed lateral markers (port and starboard channel markers) be installed at the channel entrance, and that transit lights be installed on shore to help guide boats in.

It is also recommended that the position of the current floodlights at the ramp be relocated on the rock above the choke point, and that the direction of illumination point towards the west. In addition, it is recommended that IALA Level-1 AtoN Manager and Level-2 Technician training be provided to relevant staff, and that a regular AtoN maintenance plan be developed to keep the AtoN performing at their optimal levels.

The following IALA guidelines should be consulted in detail for the implementation of this recommendation: GL #s 1023, 1094, 1134, 1116, 1077, 1073 and 1005.



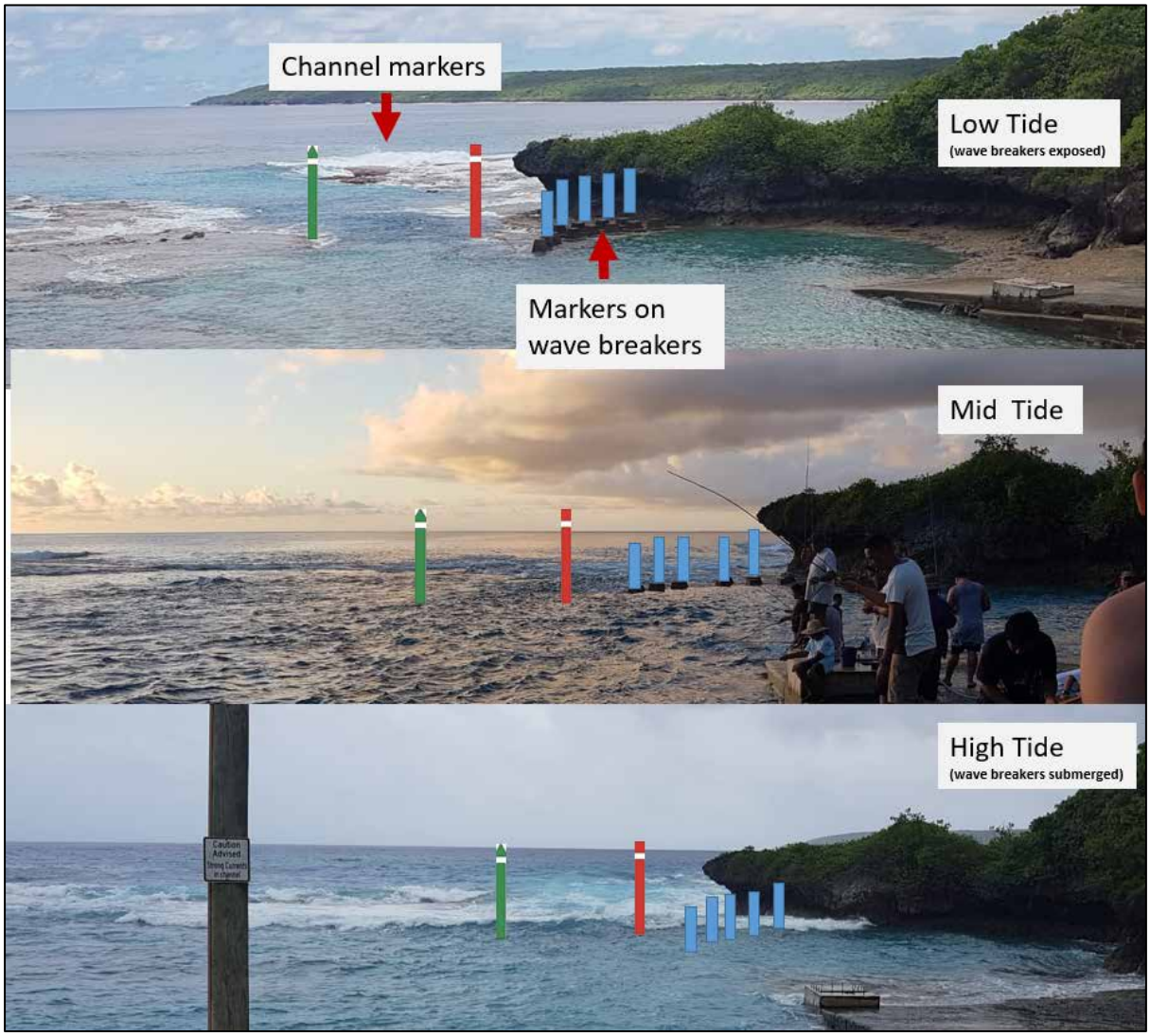
Action	Cost to implement (NZD)
Purchase and install lateral markers	142,860
Purchase and install transit lights	57,072
Relocate floodlights	500
Total	**200,432**
Maintenance cost	2160

Recommendation 3 (addressing grounding scenario)

There are several wave breaking blocks in front of the Avatele boat ramp that are exposed at low tide and are fully submerged during high tide. These blocks are hazardous for boats approaching the ramp at high tide.

It is recommended that two lit channel markers (port and starboard) be installed at the entrance of the choke point, and that lit markers be installed on some of the block so that they are visible to mariners at high tide and at night.

The following IALA guidelines should be consulted in detail for the implementation of this recommendation: GL #s 1023, 1094, 1134, 1116, 077, 1073 and 1005. This will reduce the risk to as low as reasonably practicable.



Proposed placement of markers at channel entrance and on wave-breaking blocks.

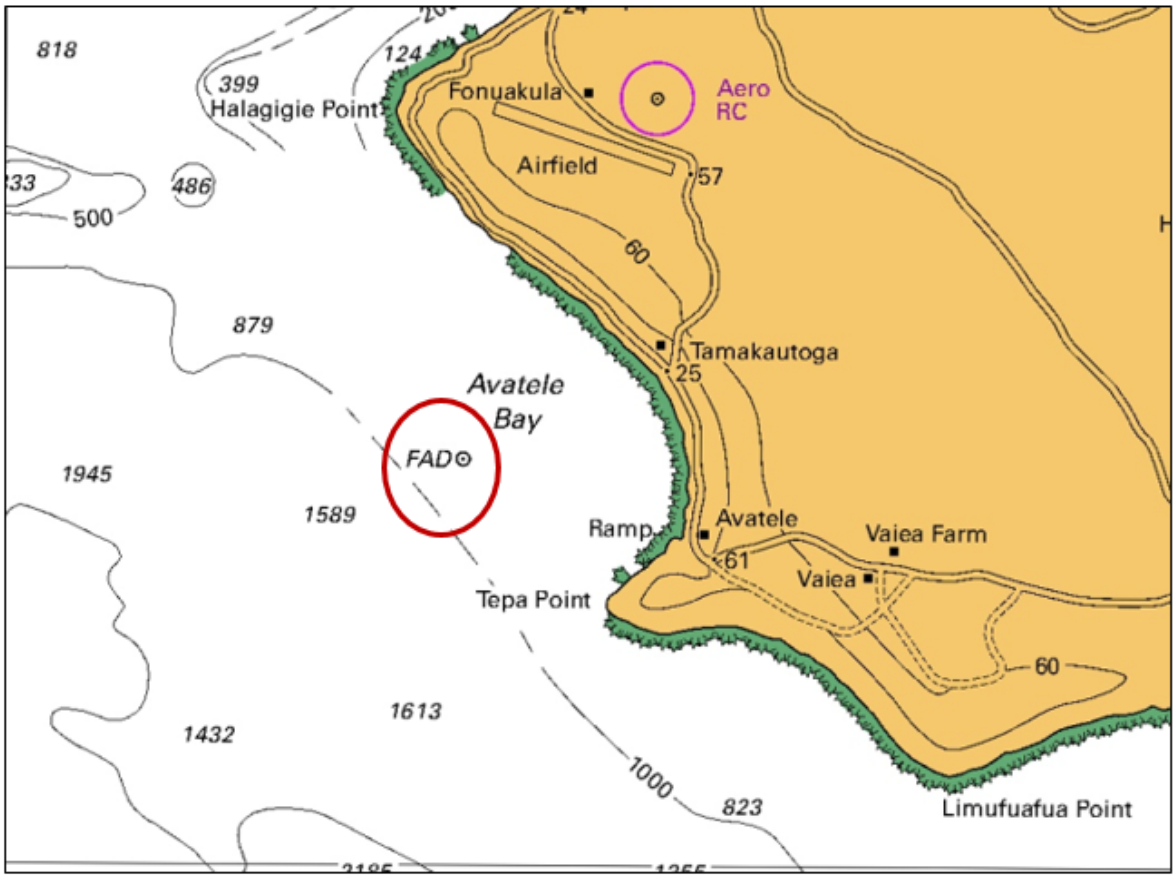
Action	Cost to implement (NZD)
Purchase and install lateral markers	2860
Purchase and install markers for wave-breaking blocks	10,000
Total	**13,860**
Maintenance cost	3660

Recommendation 4 (addressing allision scenario)

A FAD is located in Avatele Bay at the following position: latitude 19° 07.04'S, longitude 169° 56.48'W. Local fishermen access this FAD both day and night. Currently, there is retroreflective tape and floats that are visible only during the day.

This FAD is not conspicuous at night, and thus poses a danger for boats fishing around it at night.

It is recommended that a strobe light be installed on the FAD that will make it visible for mariners at night. The following IALA guidelines should be consulted in detail when implementing this recommendation: GL #s 1073 and 1145.



Action	Cost to implement (NZD)
Purchase and install a strobe light on FAD	1000

Recommendation 5 (addressing allision scenario)

Outside of cyclone season (April to October), a crane is used at the ramp to assist fishermen with launching and recovering their boats. There are currently no fenders alongside the Avatele ramp, and boats on their return typically allide with the ramp.

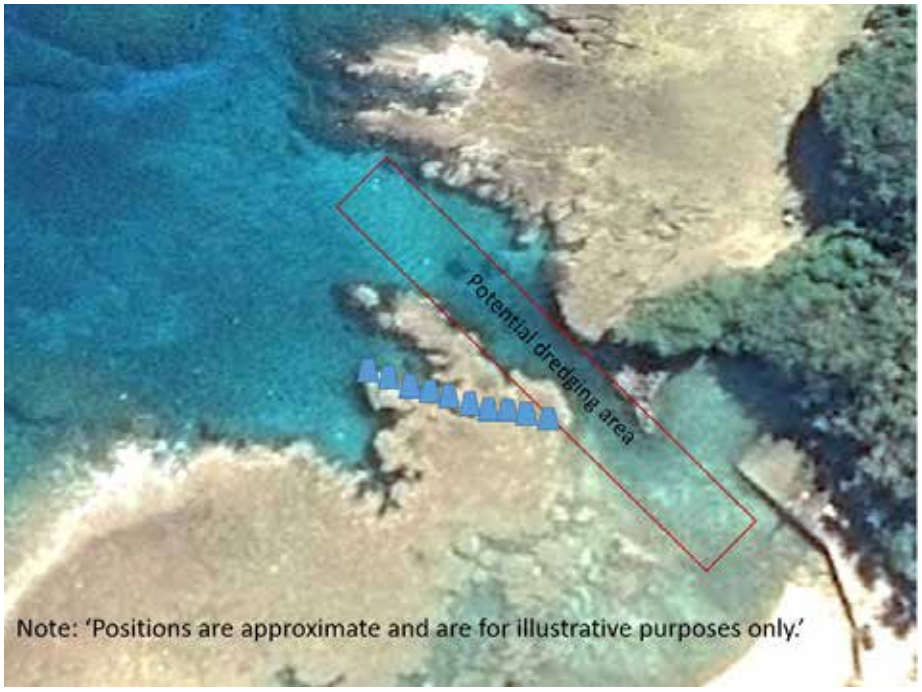
It is recommended that fenders be installed along the ramp face to prevent boats hitting and damaging the ramp and boats. This will enable users to safely come alongside and reduce the risk to as low as practical.

Action	Cost to implement (NZD)
Purchase and install fenders on boat ramp	7016

Recommendation 6 (addressing foundering scenario)

On occasion, canoes capsize in the channel to Avatele harbour as a result of strong currents and big waves.

It is, therefore, recommended that a coastal engineer be engaged to conduct a feasibility study of the technical options and costs (i.e. installing wave-breaking blocks, and dredging and widening the channel), and that a proper wave inundation model and environmental impact assessment be carried out of Avatele harbour.



Action	Cost to implement (NZD)
Engage a consultant to carry out a feasibility study	50,000

Recommendation 7 (addressing 'other' scenario)

There are occasions when spear fishermen and divers can be run over by boats. This scenario is due to the lack of visibility of divers and spear fishermen in the water. Currently, dive operators use flags on their boats, whereas spear fishermen do not use either flags or floats. This is mainly due to the lack of a safety culture on the part of spear fishermen.

It is recommended that spear fishermen use floats while diving so that boat operators are aware of their presence in the water. It is also recommended that more educational campaigns be delivered to stakeholders on safety regulations. This is currently funded under the Pacific Maritime Safety Programme.

Action	Cost to implement (NZD)
Provide spear fishermen with floats	1000
Deliver a safety awareness programme	1000
Total	**2000**

12 Conclusion

This report completes the risk assessment process as required by Regulation 13 of the International Convention for the Safety of Life at Sea. It is also meant to guide Niue's Department of Transport, within the Ministry of Infrastructure, in delivering compliant AtoN services, and should be used in conjunction with the Land Information New Zealand, Pacific Regional Navigation Initiative, and the Niue Hydrographic Risk Assessment Report 2016.

SPC can provide further support in relation to capacity development, AtoN services and management, governance, and budget management to assist Niue in offering safe maritime routes and meeting the country's international obligations.

It is suggested that a consistent and wider approach be taken by Niue to include the delivery of hydrographic, marine meteorology, maritime safety information, and maritime search and rescue services in its governance processes.

Annex A. Stakeholders in the Namukulu and Avatele harbours risk assessment.

Stakeholder List			
Representing	**Name**	**Gender**	**Contact email**
National (Competent) Authority	Andre Siohane	M	Andre.Siohane@mail.gov.nu
Avatele Village Council	Speedo Hetutu	M	Speedo.Hetutu@mail.gov.nu
Niue police	Greg Harding	M	Gregory.Harding@mail.gov.nu
Fisheries Authority Namukulu Canoe Fisherman	Launoa Gataua	M	Launoa.Gataua@mail.gov.nu
National Hydrographic Office	Richard Siataga	M	Richard.Siataga@mail.gov.nu
Port Authority	Sonya Talagi	F	Director.Transport@mail.gov.nu
Port Authority	Lynsey Talagi	F	lynsey.talagi@mail.gov.nu
Avatele Canoe Fisherman	Umuti Makani	M	
Avatele Boat Fisherman	James Douglas	M	jimfairway007@gmail.com
Niue Island Fishing Association	Brendon Pasisi	M	brendon.pasisi@gmail.com
Chamber of Commerce	Rae Finlay	F	bdm@niuechamber.com
Vaka Fishermen's Association	Taumafai Fuhiniu	M	
Ministry of Finance and Planning Namukulu Canoe Fisherman	Poi Kapaga	M	Poi.Kapaga@mail.gov.nu
Niue Meteorological Service	Robert Togiamana	M	Robert.Togiamana@mail.gov.nu
Niue Meteorological Service	Rossy Mitiepo	F	Rossy.Mitiepo@mail.gov.nu
Ministry of Justice, Lands and Survey	Steve Alapaki	M	Steve.Alapaki@mail.gov.nu

Annex B. Hazards identified for Namukulu harbour.

Hazards		Value	Remarks
Natural	Safe minimum depth (m)	1	1 m for dinghies at low tide at the channel bend.
	Proximity of danger (nm)	3–9	Channel width is 18 m at channel entrance but only 6 m at the bend. Boats must stay in the middle of the channel.
	Tide, winds, waves and tidal flow effect	1.1	Most boats need a high tide when they return. Winds are mainly easterly. Waves break around the corner at low tide when the sea is rough. At low tide and with calm seas, waves do not break. Timing is important.
	Minimum visibility (nm)	0.05	Heavy rainfall affects visibility from the FAD (~300 m). Rainfall can also affects visibility at ~100 m from the channel entrance.
	Low sun angle	Y	Early morning low sun angle on the sea makes it difficult to see.
	Earthquake and/or tsunami	Y	Niue has no experience with either; however, earthquakes elsewhere lead to rough sea conditions.
Economic	Insufficient AtoN funding	Y	Issues with maintenance when lights are out. Lack of spare AtoN.
Technical	Quality and validity of chart information	Y	Awaiting updated chart from the Land Information New Zealand office after LiDAR survey.
	Loss of communications	Y	VHF coverage around the island is an issue. Tsunami sirens have not been tested with fishermen on the water.
	AtoN failures	Y	Lack of AToN is a hazard.
Human	Crew competency	4	No issues with boat skippers; safety training is addressed under the Pacific Maritime Safety Programme.
	Safety culture	Y	Install a life ring at the ramp with at least 70 m of line.
	Influence of alcohol and/or drugs	Y	
	Culture or language issues		Fishing techniques (e.g. use of driftnets in the channel)
	Tourists	Y	Those who go out at Limufuafua Point need to be rescued via the channel.
Operational	Seasonal activities	Y	Marine open days, including fishermen from other villages
	Poor promulgation of marine safety information		The channel Ph 101 speaks too fast and hence it's difficult to understand
	Poor response to marking new dangers	Y	FADs and dive buoys have no lights or reflective tape.
	Ramp launch area	Y	Install winch for boats to avoid skidding. Alternative is put mesh on ramp.
Maritime space	The existence of restricted areas	N	Marine safety information is underway for Niue. In the future, various areas will likely become marine protected areas.

Hazards Identified for Avatele harbour.

Hazards		Value	Remarks
Natural	Safe minimum depth (m)	1.5	Different depths within the channel, and channel width is an issue at the choke point. Choke point of the channel is shallow and narrow and affected by side current from the south. A 2 m safe minimum depth would be good.
	Proximity of danger (nm)	5	Reef edge and wave break on each side. Bollards hidden at high tide. Lit markers for both the channel and bollards are required. Channel profile uneven.
	Tides, winds, waves and tidal flow effect	1.5	Strong sweeping current out of and across the channel, which scours out the beach and sandy area.
	Background lighting		Floodlights need to be redirected so they do not blind mariners when they come through the channel.
	Minimum visibility (nm)	100	Lead lights needed.
Economic	Insufficient AtoN funding	Y	More AtoN needed, especially due to the number of accidents and increased tourism, and the offset demand for wharf access on marine days and emergencies.
	Other	Y	Cultural sensitivity and infrastructure delay (loss of income).
Technical	Quality and validity of chart information	Y	Charts for Avatele need to be updated.
	Loss of communications	Y	VHF, HF and 4G could all be improved.
	Substandard ship	Y	Boat integrity: there is a need for basic boat seaworthiness certification.
	AtoN failures	Y	There used to be lead lights (before Cyclone Heta), and these need to be replaced.
Human	Crew competency	Y	No current requirement/certification for competency; there is a need for basic rules, regulations and/or by laws. A licence is not required for speed boats.
	Safety culture	Y	Fishermen are not fully trained on safety issues. Other projects look after safety training.
Operational	Seasonal activities	Y	During marine open days, outsiders might not know the channel.
	Poor response to marking new dangers	Y	FADs and moorings have no lights or reflective tape.
	Fishing activities	Y	Free divers and spear fishermen in the channel are not visible. There is a need for floats for spear fishermen fishing in the channel. Swimming spearing in fishing areas (traditional).
	Poor promulgation of marine safety information (MSI)	Y	There is no VHF auto update on weather reports. .

	Other	Y	There are no lights around the island.
Maritime space	The existence of restricted areas	N	Marine safety information is underway for Niue. In the future, various areas will likely become marine protected areas.

Annex C. Possible scenarios identified for Namukulu harbour.

Scenario		Hazards causing scenario	Remarks
Groundings	Grounding on reef	Engine failure, natural conditions, timing, lack of AToN, powercut	Lack of a safety culture
Foundering	Capsizing	Natural conditions	Inexperienced crew, swells

Possible scenarios identified for Avatele harbour.

Scenario		Remarks
Collisions	Head-on	A collision is possible at sunrise and at in the channel and when boats approach FADs because most boats and canoes do not have navigational lights, and they are currently not mandatory. Hazards: lack of crew competency and lack of a safety culture.
Groundings	Grounding on reef	A grounding could occur because of natural hazards, bathymetry, and the lack of proper AtoN. Background lighting is a hazard.
Allisions	With FAD	Hazards: lack of crew competency and lack of a safety culture.
	With ramp	Natural hazards
Foundering	Capsizing	Natural hazards
	Structural failure of external features	Boat stuck when power is cut off during launching and taking off (Hazard: infrastructure failure).
Other	Boats running over spear fishermen or scuba divers	Hazards: lack of crew competency and lack of a safety culture.

Annex D. Risk assessment matrix for Namukulu harbour.

	Scenario	Description of incident	Root Cause(s) (Hazards)	Description of Consequences (Short term and long term)	Existing Risk Control Measures	Probability Score	Consequence Score	Risk Score	cost of Incident (NZD)	Further Risk Control Options	New Probability Score	New Consequence Score	New Risk Score	cost of RCO (NZD)	Remarks
1. GROUNDINGS															
1.1	Grounding on Reef - dinghy	A dinghy's engine fails upon return (daytime)	lack of maintenance, proper checks of engine, low fuel	Short term consequences includes damage to dinghy, equipment, environment (minor) and personnel. Long term consequences include loss of income and livelihood	Safety workshops and outboard maintenance workshops under PMSP2. Safety checklist displayed at ramp. Annual safety checks and random spot checks by Fisheries Division	2	2	4	50,000.00	Provide laminated safety checklists or A5 stickers for all dinghy operators. Further enhance small boat safety awareness program, outboard maintenance and random spot checks by the fisheries division	1	2	2	500.00	
1.2	Grounding on Reef - dinghy and vaka	Dinghy grounding at night	No lights (powercut), no AToN	Short term consequences includes damage to dinghy, equipment, environment (minor) and personnel, and loss of vaka. Long term consequences include loss of income and livelihood	None	3	3	9	200,000.00	Install AToN (2 channel markers at entrance, 2 transit lights). Regular maintenance schedule to be in place.	1	3	3	199,932.00	Costs include cost of channel markers, transit lights, and installation costs - which account for commissioing, materials and mobilisation
2. FOUNDERING															
2.1	Vaka Capsizes	Vaka capsizes after entering the channel	Natural conditions and lack of safety culture	Short term consequence include loss of vaka, equipment, life, livelihood. Long term consequence is loss of income and livelihood	Weather bulletins, safety equipment, safety workshops	3	4	12	500000 - 1,000,000	Engage a coastal engineer to conduct a feasibility study of technical options and costs (i.e. installation of wave breakers and environmental impact assessment)	3	4	12	50,000.00	Approximate cost for a consultant to carry out the feasibilty study

Risk assessment matrix for Avatele harbour.

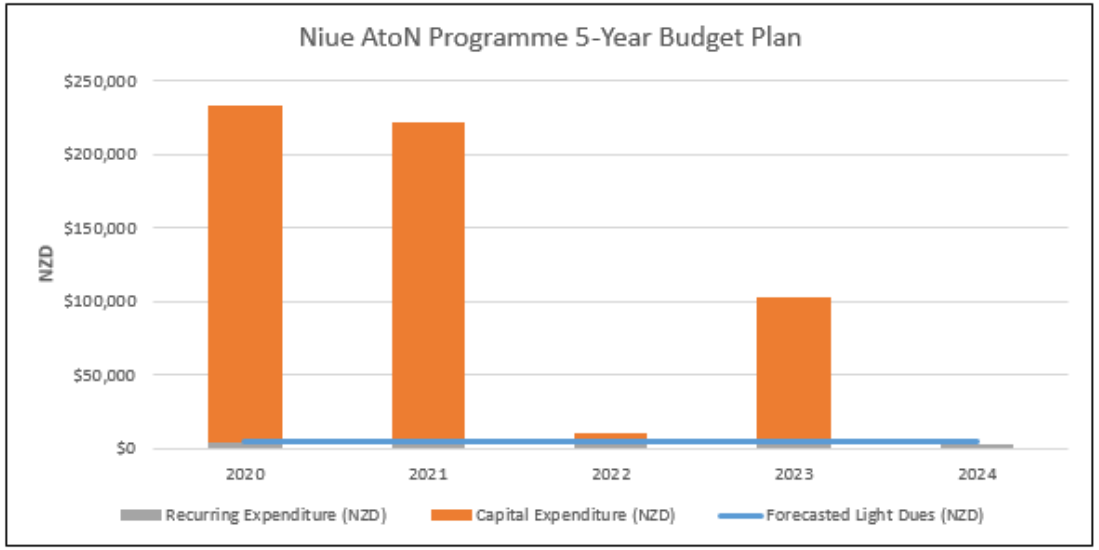
	Scenario	Description of incident	Root Cause(s) (Hazards)	Description of Consequences (Short term and long term)	Existing Risk Control Measures	Probability Score	Consequence Score	Risk Score	Cost of Incident (NZD)	Further Risk Control Options	New Probability Score	New Consequence Score	New Risk Score	Cost of RCO (NZD)	Remarks
1. COLLISIONS															
1.1	Head on collision - boats/vaka	At sunrise and night time a collision occurs in the channel and in the approach of FADs	No navigational lights and AToN. Natural conditions	Consequence is damage to boat/vaka, equipment, environment and personnel, loss of life, loss of income, loss of livelihood	Some boats have navigational lights. Safety training and equipment under PMSP2. Reflective tape on FAD	2	4	8	200000 (not including loss of life) - $1,000,000	Mandatory navigational lights on boats and light on vaka. Strobe lights on FADs	1	4	5	300 (nav lights for one charter boat), 500 (strobe lights for FAD), 50 (light for vaka). TOT 3000	ALARP
2. GROUNDINGS															
2.1	Grounding on Reef - boats/vaka	boats/vaka grounding at night	No lights on ramp due to powercut) and no AtoNs in place.	Short term consequences includes damage to boats/vaka, equipment, environment (minor) and personnel, and loss of vaka. Long term consequences include loss of income and livelihood	None	3	3	9	200,000.00	Install AtoNs (2 channel markers at entrance, 2 transit lights, flood light at rock above choke point). Regular maintenance schedule and change direction of the current flood light	1	3	3	200,432.00	Costs include cost of channel markers, transit lights, flood lights and installation costs - which account for commissioing, materials and mobilisation
2.2	Grounding on Reef - boats/vaka	boats/vaka grounds on wave breaks at high tide during the day	The wave breaker blocks are under water at high tide and the natural conditions, such as wind, waves and current.	Short term consequences includes damage to boats/vaka, equipment, environment (minor) and personnel, and loss of vaka. Long term consequences include loss of income and livelihood	None	3	3	9	200,000.00	Install markers on the wave breaker blocks and purchase and install lateral markers	1	3	3	13,860.00	Costs include the cost of material (5 galvanised pipes at NZD 200 each) and installation costs
3. ALLISIONS															
3.1	Allision with FADs at night	Boat collides with FAD at night	FAD is not visible	Damage to boat, FAD and personnel	Reflective tape on FAD and visible floats. FAD on chart	2	3	6	50,000 - 200,000	Install strobe lights on FADs	1	3	3	1,000.00	Cost includes purchase, installation, maintenance
3.2	Allision with ramp	Boat collides with ramp on return	Natural conditions	Damage to boat and personnel	None	3	2	6	10,000.00	Install fenders on ramp	1	2	2	7,016.00	Cost includes purchase, labour
4. FOUNDERING															
4.1	Vaka Capsizes	Vaka capsizes after entering the channel	Natural conditions	Short term consequence include loss of vaka, equipment, life, livelihood. Long term consequence is loss of income and livelihood	Weather bulletins, safety equipment, safety workshops	3	4	12	500,000 - 1,000,000	Engage a coastal engineer to conduct a feasibility study of technical options and costs (i.e. installation of wave breaker blocks; dredging; widening the channel)	3	4	12	50,000.00	Approximate cost for a consultant to carry out the feasibilty study
5. OTHER															
5.1	Boat runs over swimmers,scuba divers and spear fisherman.	Skipper fails to notice personel in water and runs them over	Skipper is not aware of dive flags. Local swimmers and spear fishermen don't use dive flags	Loss of life	Dive operators use dive flags	2	4	8	1,000,000.00	Educational campaign. Mandatory for spear fishermen to use a float	1	4	4	1,000 (floats), 1,000 (educational campaign)	Educational campaign funded under PMSP3

Annex E. Ministry of Infrastructure – Niue Department of Transport AtoN Programme five-year budget 2020–2024.

PACIFIC SAFETY OF NAVIGATION PROJECT

Ministry of Infrastructure - Niue Department of Transport AtoN Programme 5-Year Budget Plan

	Forecasted Light Dues (NZD)	Capital Expenditure (NZD)	Recurring Expenditure (NZD)
2020	$4,335	$229,759	$3,660
2021	$4,335	$218,179	$3,160
2022	$4,335	$7,016	$3,340
2023	$4,335	$100,000	$3,340
2024	$4,335	$0	$3,340
	$21,673	$554,954	$16,840



* Currently, Niue does not collect light dues from vessels, however, projected potential collection is shown
* Costings of risk control options covered under both the Avatele & Namakulu Safety of Navigation Risk Assessment have been factored in:
  - In 2020, the procurement and distribution of floaters will help mitigate boating accidents vis-à-vis diving in Avatele and in Niue in general
  - In 2020, installation of AtoNs (2 channel markers at entrance, 2 transit lights, flood light at rock above choke point) at Avatele will help mitigate risk of grounding
  - In 2021, installation of AtoNs (2 channel markers at entrance, and 2 transit lights) at Namakulu will help mitigate risk of grounding
  - In 2021, installation of mandatory lights on charter boats, vakas and FADs will help mitigate risk of collisions in Avatele and in Niue in general
  - In 2022, the installation of fenders on Avatele ramp will help mitigate risk of allisions
  - In 2023, it is suggested that a coastal engineer be hired to assess the technical viability of installing wave blockers to mitigate the risk of grounding at Avatele and Namakulu
  - In 2020, 2021, 2022, 2023 and 2024, conduct of educational campaigns to help build awareness on the issue of safety of waterways vis-à-vis diving

2020

		Estimated Cost (NZD)	Estimated Cost (NZD)	Notes
Capital expenditure				
Procurement				
	Procure: Channel markers x2	$2,860.00		- As part of Avatele SoN risk assessment recommendations, installation of channel markers and its lights will help help mitigate risk of groundings
	Installation costs: Channel markers	$140,000.00		
	Procure: Breaker markers	$2,000.00		- As part of Avatele SoN risk assessment recommendations, installation of markers (stainless steel pipes) on existing wave breakers will help mitigate the risk of groundings
	Installation: Breaker markers	$10,000.00		
	Procure: Transit lights & associated equipment	$7,072.00		- As part of Avatele SoN risk assessment recommendations, installation of transit lights and its lights will help help mitigate risk of groundings
	Installation costs: Transit lights	$50,000.00		- As part of Avatele SoN risk assessment recommendations, installation of channel markers and its lights will help help mitigate risk of groundings - estimated cost of commissioning, equipment, material and mobilisation costs to install transit lights
	Procure: Alofi transit lights spares	$1,904.00		The current leading lights at Alofi port comprise of front and rear marks for the transit leading into Alofi Harbour. The transit is lit, using two Carmanah 650H solar lights. Each light costs about NZD 952 (https://www.allsunsolarproducts.com/cabm64nmbsom.html)
	Procure: Flood light	$500.00		- As part of Avatele SoN risk assessment recommendations, installation of a flood light at the ramp will help mitigate risk of grounding
	Procure: Floaters	$1,000.00		- As part of Avatele SoN risk assessment recommendations, the procurement and distribution of floaters will help build awareness on safety around diving
	Freight	$11,005.68		Estimation of freight based on current Matson TEU rate for AUCKLAND-ALOFI (Approx. $5,502.84). Assuming boxed cargo will take up space on two TEU
	Customs charges	$3,417.00		Estimated Niue Consumption Tax (NCT) and Port Charge (PC) based on estimated weight (30kg): PC: (.075*1,000kg), NCT: (($13,660*.125)+PC)
Total Capital exp			$229,758.68	
Recurring expenditure				
Maintenance				
	Hire of machine - Waterblasting	$200.00		Estimated cost for hire of machinery for waterblasting of transit lights structure in Alofi Port
	Purchase of painting equipment	$700.00		Purchase of painting equipment as part of regular maintenance schedule
	Labour - Beacon maintenance	$1,200.00		Estimated cost of labour to conduct maintenance on Comms tower beacons
	Labour - Transit lights maintenance	$60.00		Estimated cost of labour to conduct maintenance on transit lights in Alofi
Training				
	Safety checklist display	$500.00		- As part of Namakulu SoN risk assessment recommendations, the display of safety checklist at Namakulu ramp will help mitigate risk of groundings
	Educational campaigns	$1,000.00		- As part of Avatele SoN risk assessment recommendations, the conduct of educational campaigns will build awareness on the use of dive flags and floaters
Total Recurring exp			$3,660.00	
Value added tax				
TOTAL BUDGETED			**$233,418.68**	

2021

		Estimated Cost (NZD)	Estimated Cost (NZD)	Notes
Capital expenditure				
Procurement				
	Procure: Channel markers x2	$2,860.00		- As part of Namakulu SoN risk assessment recommendations, installation of channel markers and its lights will help help mitigate risk of groundings
	Installation costs: Channel markers	$140,000.00		- As part of Namakulu SoN risk assessment recommendations, installation of channel markers and its lights will help help mitigate risk of groundings - estimated cost of commissioning, equipment, material and mobilisation costs to install channel markers
	Procure: Transit lights & associated equipment	$7,072.00		- As part of Namakulu SoN risk assessment recommendations, installation of transit lights and its lights will help help mitigate risk of groundings
	Installation costs: Transit lights	$50,000.00		- As part of Namakulu SoN risk assessment recommendations, installation of channel markers and its lights will help help mitigate risk of groundings - estimated cost of commissioning, equipment, material and mobilisation costs to install transit lights
	Procure: Charter boat lights x8	$2,400.00		- As part of Avatele SoN risk assessment recommendations, installation of mandatory lights on charter boats will help mitigate risk of collisions
	Procure: Vaka lights x12	$600.00		- As part of Avatele SoN risk assessment recommendations, installation of mandatory lights on *vaka* will help mitigate risk of collisions
	Procure: FAD strobe lights x2	$1,000.00		- As part of Avatele SoN risk assessment recommendations, installation of mandatory strobe lights on FAD will help mitigate risk of collisions
	Freight	$11,005.68		Estimation of freight based on current Matson TEU rate for AUCKLAND-ALOFI (Approx. $5,502.84). Assuming boxed cargo will take up space on two TEU
	Customs charges	$3,241.50		Estimated Niue Consumption Tax (NCT) and Port Charge (PC) based on estimated weight (1 tonne): PC: (.075*1,000kg), NCT: ((6,316*.125)+PC)
Total Capital exp			$218,179.18	
Recurring expenditure				
Maintenance				
	Hire of machine - Waterblasting	$200.00		Estimated cost for hire of machinery for waterblasting of transit lights structure in Alofi
	Purchase of painting equipment	$700.00		Purchase of painting equipment as part of regular maintenance schedule
	Labour - Beacon maintenance	$1,200.00		Estimated cost of labour to conduct maintenance on Comms tower beacons
	Labour - Transit lights maintenance	$60.00		Estimated cost of labour to conduct maintenance on transit lights in Alofi
Training				
	Educational campaigns	$1,000.00		- As part of Avatele SoN risk assessment recommendations, the conduct of educational campaigns will build awareness on the use of dive flags and floaters
Total Recurring exp			$3,160.00	
Value added tax				
TOTAL BUDGETED			**$221,339.18**	

2022

		Estimated Cost (NZD)	Estimated Cost (NZD)	Notes
Capital expenditure				
Procurement				
	Procure: Fenders	$5,000.00		- As part of Avatele SoN risk assessment recommendations, installation of fenders on Avatele ramp will help mitigate risk of allisions
	Freight	$1,375.71		Estimation of freight based on current Matson TEU rate for AUCKLAND-ALOFI (Approx. $5,502.84). Assuming boxed cargo will take up 25% of space on a single TEU
	Customs charges	$640.00		Estimated Niue Consumption Tax (NCT) and Port Charge (PC) based on estimated weight (30kg): PC: (.075*30kg), NCT: ((1904*.125)+PC)
Total Capital exp			$7,015.71	
Recurring expenditure				
Maintenance				
	Hire of machine - Waterblastin	$200.00		Estimated cost for hire of machinery for waterblasting of transit lights structure in Alofi Port
	Purchase of painting equipmer	$700.00		Purchase of painting equipment as part of regular maintenance schedule
	Labour - Beacon maintanance	$1,200.00		Estimated cost of labour to conduct maintenance on Comms tower beacons
	Labour - Transit lights mainten	$240.00		Estimated cost of labour to conduct maintenance on transit lights in Alofi, Avatele and Namakulu
Training				
	Educational campaigns	$1,000.00		- As part of Avatele SoN risk assessment recommendations, the conduct of educational campaigns will build awareness on the use of dive flags and floaters
Total Recurring exp			$3,340.00	
Value added tax				
TOTAL BUDGETED			**$10,355.71**	

2023

		Estimated Cost (NZD)	Estimated Cost (NZD)	Notes
Capital expenditure				
Procurement	Consultant hire: Coastal engineer	$100,000.00		- As part of both Avatele and Namakulu SoN risk assessment recommendations, it is recommended that a coastal engineer be hired to assess the technical viability and costs of installing a breakerwater and/or dredging. A ball park figure of $50,000 is put up to be the cost of each consultancy
Total Capital exp			$100,000.00	
Recurring expenditure				
Maintenance				
	Hire of machine - Waterblasting	$200.00		Estimated cost for hire of machinery for waterblasting of transit lights structure in Alofi Port
	Purchase of painting equipment	$700.00		Purchase of painting equipment as part of regular maintenance schedule
	Labour - Beacon maintanance	$1,200.00		Estimated cost of labour to conduct maintenance on Comms tower beacons
	Labour - Transit lights maintenance	$240.00		Estimated cost of labour to conduct maintenance on transit lights in Alofi, Avatele and Namakulu
Training				
	Educational campaigns	$1,000.00		- As part of Avatele SoN risk assessment recommendations, the conduct of educational campaigns will build awareness on the use of dive flags and floaters
Total Recurring exp			$3,340.00	
Value added tax				
TOTAL BUDGETED			**$103,340.00**	

2024

		Estimated Cost	Estimated Cost	Notes
Capital expenditure				
Procurement				
Total Capital exp			$0.00	
Recurring expenditure				
Maintenance				
	Hire of machine - Waterblasting	$200.00		Estimated cost for hire of machinery for waterblasting of transit lights structure in Alofi Port
	Purchase of painting equipment	$700.00		Purchase of painting equipment as part of regular maintenance schedule
	Labour - Beacon maintanance	$1,200.00		Estimated cost of labour to conduct maintenance on Comms tower beacons
	Labour - Transit lights maintenance	$240.00		Estimated cost of labour to conduct maintenance on transit lights in Alofi, Avatele and Namakulu
Training				
	Educational campaigns	$1,000.00		- As part of Avatele SoN risk assessment recommendations, the conduct of educational campaigns will build awareness on the use of dive flags and floaters
Total Recurring exp			$3,340.00	
Value added tax				
TOTAL BUDGETED			**$3,340.00**	

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