

# Aids to Navigation Risk Assessment in the Pacific; Kiritimati, Kiribati



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## Executive Summary

The Pacific Community (SPC) has started the Safety of Navigation project under the support of International Foundation of Aids to Navigation (IFAN) to improve the level of Aids to Navigation (AtoN) service and enhance AtoN capacity and systems in the Pacific. The project consists of four main areas which are three assessment and support areas (technical, legal, and economic), and the capacity building for the AtoN managers and technicians for the 13 targeted countries.

This study is the risk assessment as part of the technical support for Kiribati which is the pilot country of the project. The risk assessment process is a structured approach to plan, manage and review the AtoN service effectively. Given the low quality and quantity input for the tools for the Pacific region, the IALA simplified version of risk assessment tool was tested to maximize the effect while the other IALA tools couldn't be used, and give a chance to raise the awareness of the safety of navigation.

An AtoN risk assessment workshop for Kiritimati Island was held on 13 Feb, 2017. The workshop was attended by 12 participants, representing the users, authorities, and stakeholders. It was a meaningful event to be aware and discover the potential risks, and to evaluate them by various perspectives.

The theory of the tool was introduced, then the natural, waterway, and navigation environment were discussed, and the worst case scenario were identified to be analysed by technical and economic aspects. The probability and impact of accidents were evaluated by the participants.

For Kiritimati Island, the volume of traffic and degree of risk of the islands justifies that groundings are the most probable risk of the region. The low volume of traffic does not really cause any congestions, but the lack of adequate nautical charts, which are based on sparse and outdated survey information and un-marked shallow waters under the high waves could potentially cause groundings around and/or inside the lagoon.

Various risk control options were discovered for grounding, collision, allusion, foundering, and other issues identified such as current practises of AtoN finance in Kiritimati.

## 1. Introduction

Conscious of the importance of maritime safety in the Pacific region, The Pacific Community (SPC) Economic Development Division (EDD) has started a project under the support of the International Foundation for Aids to Navigation (IFAN) to improve the level of Aids to Navigation (AtoN) services and to enhance AtonN capacity and systems.

For the Pacific Islands region, maritime transport system and infrastructure support all aspects of socio-economic development, ranging from food security, migration and agricultural and value-added trade facilitation, but the importance of maritime safety is yet to be embraced by the island nations. It was identified that the lack of awareness, adequate policies and regulation, limited capacity of staff, and limited budget are the main challenges for the region. AtoN may have not been prioritised in the Government's Strategic Plan yet. Moreover, although there has been recent risk assessment completed with a hydrographic focus, none have been undertaken solely concerned with AtoN.

AtoN risk assessment is a tool for competent authorities to systematically plan, operate, and manage AtoN service rather than relying on in-house knowledge and/or experience of personals for the works. Risk assessment can be used to:

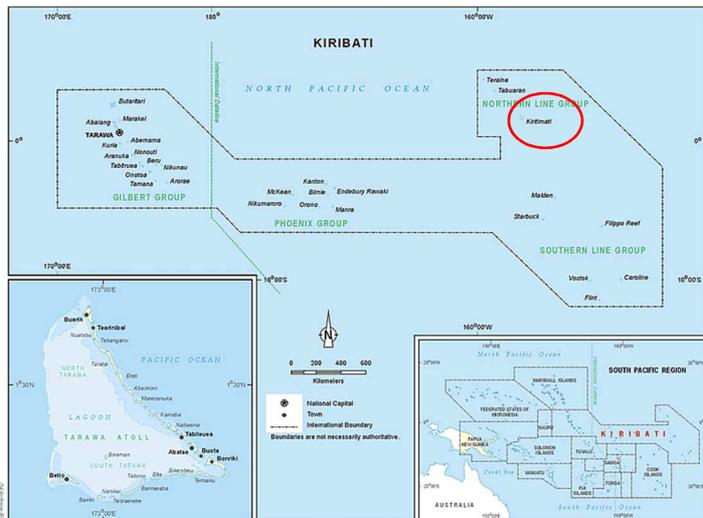
- Develop a Level of Service for AtoN
- Develop and maintain an annual Navigation Plan (NAVPLAN) from which Levels of Service Statement can be generated
- Determine whether existing AtoN is adequate, a VTS should be established, and additional or improved AtoN is required

Among the 13 target countries of the Safety of Navigation project, Republic of Kiribati was chosen and the risk assessment tool has been tried there. One day risk assessment workshop has been conducted on the islands which included various stakeholders.

## 2. Scope and Methodology

### 2.1. Scope

The work scope of this document covers the Aids to Navigation risk assessment. The Spatial scope of this document is for Kiritimati (Christmas Islands), Republic of Kiribati. The Republic of Kiribati is an island nation in the central Pacific Ocean. It comprises of 32 atolls and reef islands and one raised coral island, Banaba. They have a total land area of 811 km<sup>2</sup> dispersed over 3.5 million km<sup>2</sup> of sea. Kiribati includes three island groups - Gilbert Islands, the central Phoenix Islands and the easterly Line Islands. Most of the land on these islands is less than two metres above sea level. Their spread straddles the equator and the 180 degrees meridian. The permanent population is just over 115,250 (2016), more than half of whom live on the densely populated Tarawa Atoll. Kiribati became dependent from the United Kingdom in 1979. The capital, South Tarawa, consists of a number of islets, connected by a series of causeway. These comprise about half the area of Tarawa Atoll.



Kiritimati (1°55'00N, 157°25'00W) is a Pacific Ocean raised coral atoll in the northern Line Islands. The islands has the greatest land area of any coral atoll in the world, about 388 square kilometres. Its lagoon is roughly the same size. The atoll is about 150 km in perimeter, while the lagoon shoreline extends for over 48km. Kiritimati comprises over 70% of the total land area of Kiribati, a country encompassing 33 Pacific atolls and islands

Irregular shipping affects Kiribati immensely as it has a direct impact on their food security. When an international ship does not provide service on time, it affects food supply on the mainland as well as on the outer islands. Kiribati imports almost 99% of its food – mainly due to lack of arable land or very poor soil quality – and so the country is almost entirely reliant on shipping to sustain itself. Kiribati imports a disproportionately large proportion of its imports, compared to most countries in the world.

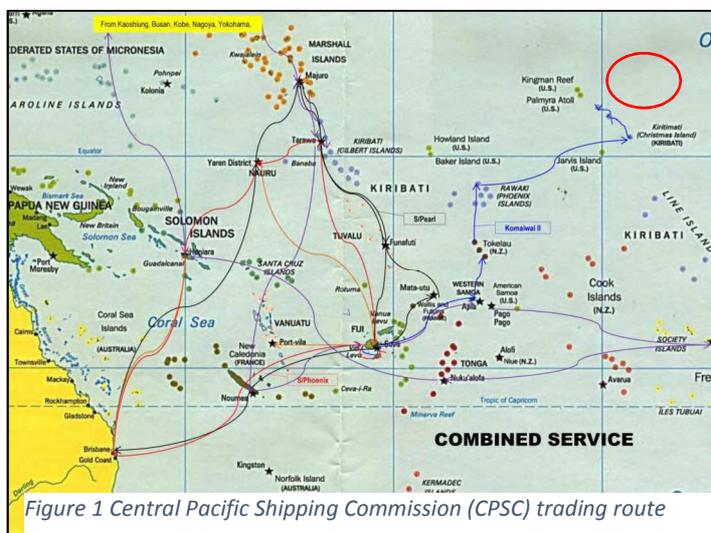


Figure 1 Central Pacific Shipping Commission (CPSC) trading route

## 2.2. Methodology

IALA Waterway Risk Assessment Program (IWRAP) Mk2 tool can be used as a quantitative risk assessment tool, and Port and Waterways Safety Assessment (PAWSA) can be used as a qualitative tool. However, given the fact that in the Pacific region good quality AIS data on which IWRAP depends on is not available, nor are there usually sufficient number of individuals with the necessary level of experience to conduct PAWSA. Accordingly, an IALA developed simplified version of risk assessment tool seems to be the logical tool to try to improve the situation of the region.

IALA Simplified Tool For Assessing Risk (ISTAR) is based on the principles set out in IALA guideline 1018 on risk management. Risk is defined as a combination of two factors – the probability (or likelihood) of an undesirable incident occurring and if it does occur, the severity of its potential long and short-term impact (or consequence). Risk is therefore a measure of the potential for a hazard to lead to an undesirable incident.

A risk management workshop was held on Kiritimati which included 12 stakeholders. The participants discussed the circumstance of the islands and analysed the natural, economic, technical, human, and operational hazards. Then a worst case scenario was discussed for the technical and economic analysis purposes and following consequences and probabilities derived from each participant's expertise were discussed.

### 2.3. Zoning

The Marine Division of the Ministry of Information, Communications, Transport and Tourism Development of Kiribati defined the maritime zones the country in three zones and they are further split into 37 detailed zones. The Kiritimati is the zone of No. 15 C1 KIR. There is no AtoN registered in the national AtoN list, but 1 is in the Admiralty List of Lights and Fog Signals (Volume K).

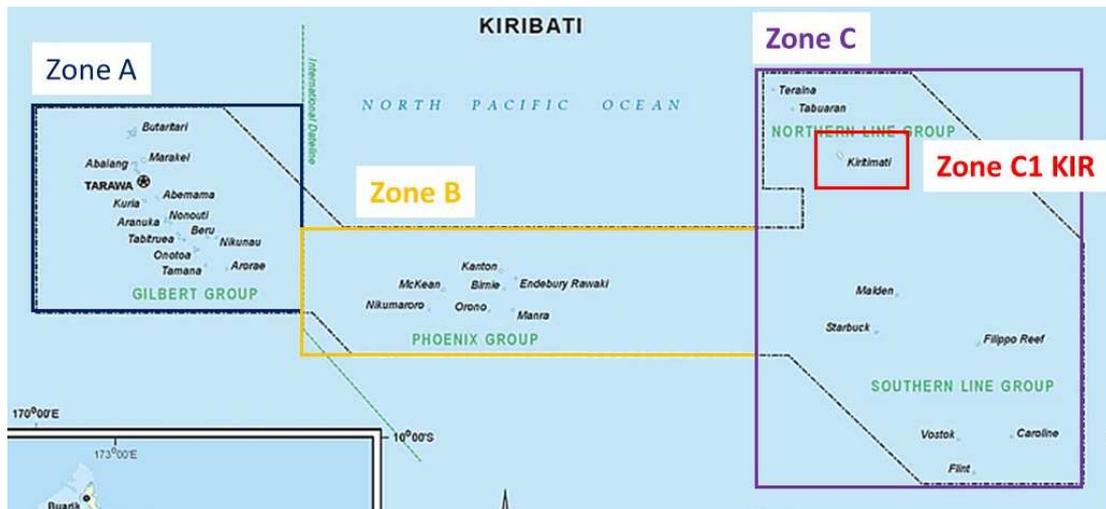


Figure 2 Zones of Kiribati

## 3. Environment

### 3.1. Natural environment

Kiritimati is the principal islands of the Line Group, with a total area of 388 km<sup>2</sup>, from East to West 50 km in diameter. It has been declared a Government Wildlife Sanctuary, and permission from the wildlife warden is required to land on Cook Islet, Motu Upou and Motu Tuba, 4.8 km NNE and ENE of Cook islet respectively.

In 2015 the population of the islands was 6456. The main settlement is London on the N side of the entrance to the lagoon. Paris, a former settlement on the South side of the entrance, is in ruins. London is the seat of administration for the Line Islands Group and the District Officer resides there. It is also a port of entry for Kiribati.

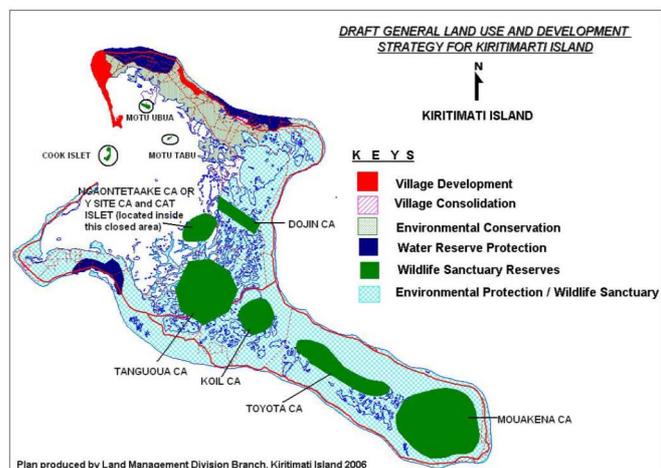


Figure 3 Development Strategy (source: Kiribati CBD)

Exports of the island is mainly copra from the coconuts, which cover a big area of the atoll. In addition, goods like aquarium fish and seaweed are exported. And, there is tourism mainly associated with anglers from the world interested in lagoon fishing and offshore fishing. And, ecotourism is available. In recent years, suffers have discovered this islands and visit throughout the year.

### 3.2. Marine environment

Kiritimati is an atoll and a submerged reef on the North West side. The island is partially covered with groves of coconut palms and dense undergrowth. The atoll may be approached by any direction, however the lagoon can only be entered on the North West side.

The lagoon is generally very shallow and navigation is difficult even for boats. Currents may attain rates of 4 to 5 kn. Tidal level for the islands, mean spring range about 0.7m; mean neap range about 0.4m. Normally light East winds up to 49 kn, A strong West current exists East of the atoll; it divides off the South East extremity one part setting North and the other West.

Kiritimati Atoll lies in the North part of the South Equatorial Current and the great majority of sets in its vicinity are between NW and SW. A large proportion of the W-going currents exceed a rate of 1 kn and rates of 2.5 kn have been experienced. Sets to the East appear to be infrequent from June to November, but they do occur at other times, particularly from March to May. Along the N coast of the islands the current sets NW with considerable strength, forming overfalls N of North West Point. It sets very strongly from the E onto South East Point at the E end of the island.

The low East end of the island is dangerous to approach at night; by day the haze of breakers is often seen before the land.

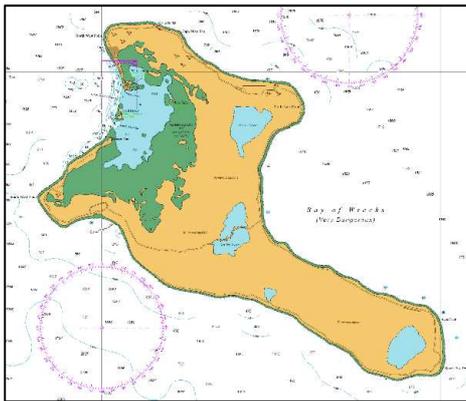


Figure 4 Kiritimati Island overview

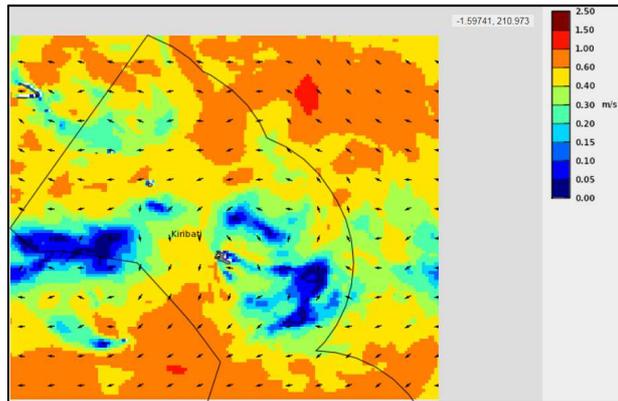


Figure 5 Current speed and direction (source: COSPPac Australia)

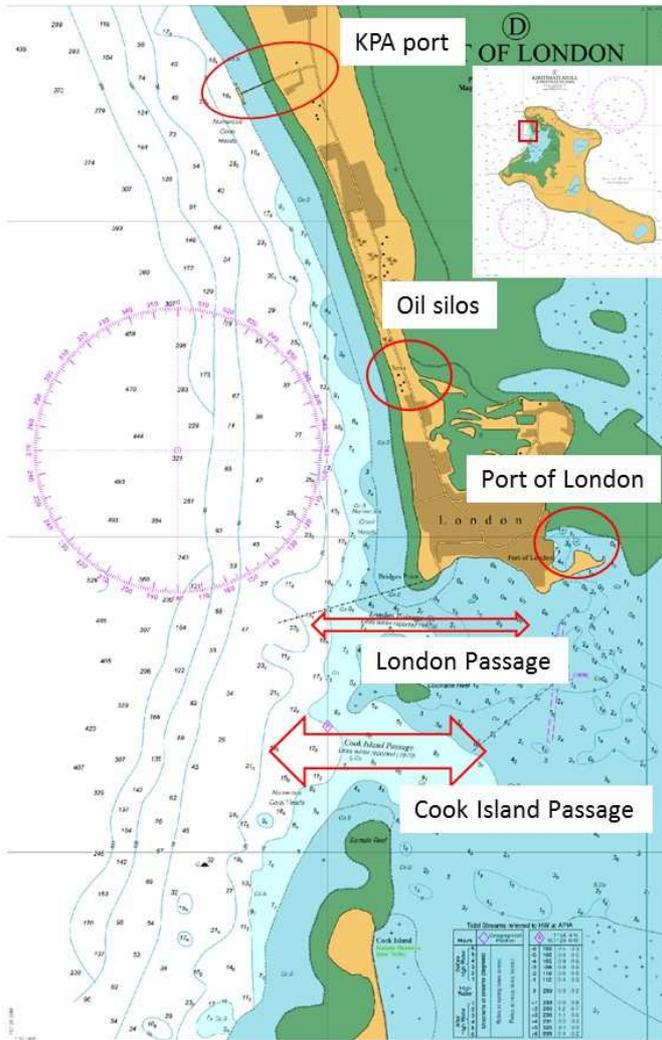
### 3.3. Maritime traffic environment

According to the maritime traffic data in 2013, container ships called the port 8 times throughout the year and 2 times by tanker ships. Import freights are mainly consumer and constructions goods and major exports are small amount of copra (dried coconut pulp). Due to the isolated location and low volume of cargo freight rates are likely to be high.

Table 1 Number of Port calls in Kiribati in 2013

Months	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Cargo Ships	0	0	0	1	1	1	0	2	1	0	0	2	8
TEU	0	0	0	0	19	0	0	26	0	0	0	32	77
Tonnage (tonnes)	0	0	0	187	359	89	0	799	62	0	0	686	2,182
Tanker Ship	0	0	0	1	0	0	0	0	1	0	0	0	2

### 3.4. Navigation condition



Kiritimati’s roughly 320km<sup>2</sup> lagoon opens to the sea in the North West; the only entrance, Burtle Channel is divided into the Northern London Passage, Cook Island Passage and the Southern South Passage. These passages are exposed to the open sea, high and rough waves and swells make the navigation dangerous.

The Kiribati Port Authority (KPA) jetty is placed outer island on the 10m contour depth line. Container vessels (typical capacity 519 TEU) visit the port every 2-3 months.

Oil tanker visit the KOIL every 6-8 months by anchoring in front of the oil silos. There are 2 un-identified wrecks around the anchorage area.

A small passenger vessel (less than 10m long, capacity for about 10 passengers) navigate from one part to another part of the island, navigation 1-2 times a day.

The tourist fishing vessels depart the port with 4-6 anglers every early morning and travel the flats to drop and pick up during the daytime and back by evening every day.

A lot of surfers are visit the islands throughout the year, and surf around the passages and the main headlands on the West.

Approach to the port of London is very shallow because of the siltation which hasn’t been scientifically measured yet.



Figure 6 Port of London



Figure 7 KPA jetty



Figure 8 Passenger ship



Figure 9 Non-IALA compliant beacon

### 3.5. Current status of Aids to Navigation

The only AtoN charted on the islands is the Kiritimati Atoll (M8536 in ADLL Volume M), but the light has been temporarily discontinued for the moment. Two beacons in front of the London ports are installed but not properly maintained. One buoy is installed to mark the locations of the wrecks.



Number	Location, Name	Position	Character
M8536	Kiritimati Atoll	2°02.29'N157°26.71'W	Aero FR

Elevation	Range	Description, Height	Remarks
39m	18nM	Framework tower	Obstruction

## 4. Risk Assessment Workshop

An AtoN risk assessment workshop for Kiritimati islands was held in the Villages hotel, Kiritimati, Kiribati, on 13 February, 2017. The workshop was attended by 12 participants, representing the users, authorities, and stakeholders, with an interest in the safe and efficient uses of the island from various perspective. Over the workshop, participants discussed and evaluated the risk and hazards inside the lagoon and around the islands, and the probability and consequences based on the worst case scenario.

Participants were firstly familiarized with the theory of risk assessment, outlined the challenges of inadequate AtoN service, and evaluated the conceivable impacts of each cases and probabilities. Most of the participants lacked awareness on the technical approach of risk assessment, but the in-house knowledge and experiences they have were significantly valuable inputs for the process.

Table 2 List of the participants

Name	Job title	Place of Work
Kaititi Tengata	Senior Marine Radio Officer	MICTTD
Kirikori Baoro	Port Superintendent	Kiribati Port Authority
Lavinia Teem	Managing Director KPA Board Director	Dojin Shipping Agency KPA
Ratita Bebe		Wildlife-Environment & Conservation Division

Bobai Tebania	Fisheries Assistant	Fisheries Sub-division Kiritimati Island
Teauoki Nantongo	Branch Manager	Kiribati Seas Company LTD Christmas Branch
Takirua Taabu		Dojin Shipping Agent
Reinte Tiaon	Marine Radio Operator	MICTTD
Tebeia Kaiteie	Branch Manager	Central Pacific Producers LTD
Minsu Jeon	Regional Safety Navigation Adviser	SPC
Francesca Pradelli	Legal Office	SPC
Ville Peltovuori	Economist	SPC

## 5. Worst case scenario

A worst case scenario was discussed to evaluate the impacts and consequences under the current circumstances. The volume of maritime traffic is relatively low compared to other island nations, but it is anticipated that the untouched seas and coastlines are vulnerable to accidents occurring around the area.

### Oil tankers

The worst case accident scenario would be a tanker running aground near the Kiribati Oil Company (KOIL) oil terminal. It could have the following consequences:

- The tanker vessel severely damaged and/or sunk.
- Tanker crew injured or perished.
- The tanker cargo is lost.
- Kiritimati has to wait for a new shipment for several months and left without fuel for a period of two months after running out of existing stocks. This would leave the island without electricity severely restricting economic activities.
- Oil leaks from the tanker wreck through the passage into the lagoon. Cook Island, a protected seabird nesting site is heavily polluted. Large parts of the lagoon are also moderately to heavily polluted.
- Due to oil contamination, Kiritimati is no longer an attractive tourist destination for foreign anglers. It takes 15 years for the environment and reputation to recover.

### Container vessel

The worst case scenario concerning a container vessel would be a vessel hitting Kiribati Port Authority (KPA) container jetty. It could have the following consequences:

- The container vessel is severely damaged and/or sunk. A typical container vessel (Southern Pearl) calling Kiritimati is geared, built in 2003 with a capacity of 519 TEU.
- Vessel crew or port workers are injured or perished.
- The container vessel cargo is lost.
- Some oil leaks from the vessel into the coastal area near the port.
- The container jetty is damaged with repairs taking about 3 months. In the meantime container vessels (carrying also the construction materials for repairs) are unable to come alongside. Containers need to be discharged at open sea instead using a barge. This increases discharge and loading times considerably.

- Repairs need to be carried out on the container jetty.

### Small Vessel

At night a fishing boat is unable to find its way back to Kiritimati with the following consequences:

- The lives of three fishermen are lost.
- The fishing boat is lost.
- Search and rescue efforts to attempt to recover the fishermen have a considerable cost.

## 6. Probability and Impact

### 6.1. Probability (Likelihood)

The probability scores were given on the undesirable incident scenarios for the natural, economic, technical, human, operational, and the marine space hazards. Generally, the risk probabilities is higher for the small vessels.

Reliable historical accident data for Kiritimati is not available. In addition the volume of traffic in Kiritimati is so low that using historical accident data to derive accident probabilities would not be statistically robust. Instead reference probabilities from Tianjin Port in China according to Zhang et al. (2016) are used. While collision risk in Tianjin Port is much higher than in Kiritimati due to higher volume of traffic (over 70 per cent of accidents are caused by collision or contact), other factors, such as inadequate aids to navigation, may contribute to higher risk of e.g. grounding in Kiritimati. Zhang et al. also compared accident rates in Tianjin Port to a study in the Baltic Sea with lower traffic volume and found them to be similar. For small vessels ten times higher accident probability compared to container vessels was assumed. The accident probabilities used are shown in table 1 by vessel type.

Table 3. Accident rate by type of vessel. Source: Zhang et al. (2016), and author's estimates

Type of ship	Oil Tanker	Container	Small vessels
Accident rate (per ship call)	$4.85 \times 10^{-4}$	$1.54 \times 10^{-4}$	$1.54 \times 10^{-3}$
Vessel calls per year	2	6	17,520
Accident rate (per year)	$9.70 \times 10^{-4}$	$9.24 \times 10^{-4}$	26.98

### 6.2. Impact (Consequences)

The impact was analysed for the direct and indirect impact. Each factors were ranked from high to low.

It was agreed that the direct impact could be death and/or injuries of the seafarers, and before the towing vessel arrives the oil from the ship will pollute the coast, reef and the wild life sanctuary. Most of the marine life inside the lagoon would die, and tourists would cancel their bookings and businesses would stop functioning as we know it. Fortunately, most of the sea beds are sand which will cushion the impact for the first moment.

For the indirect impact, the public health of the inhabitants would be impacted, and the reputation of it as a fishing island will be tarnished. The restoration process for the coastal zone and protected/endangered species would take a few decades.

## 7. Risk summary

The probability and impact of each risk based on a score of 1 to 3 where 1 = low probability and/or minor impact and 3 = high probability and/or severe impact.

### Grounding

The fishing vessels and passenger ships are exposed to the risk of grounding at the passages and inside the lagoon. Groundings of the small vessels are the most significant risk of the island.

### Collision

The volume of traffic and degree of risk of the islands justifies that groundings are the most probable risk of the region. The low volume of traffic doesn't really cause any congestions, but, the lack of fit for purpose and up to date nautical charts and un-marked shallow waters under the high waves could potentially cause vessels groundings through lack of awareness of dangers to navigation.

### Allision

Pilot is on board, but still the severe high waves and swells make it difficult to come alongside the jetty. The probability and impact are moderate and they could be reduced by proper AtoN.

### Foundering

There is no evidence of hazard around the KOIL discharging anchorage, but the two wrecks infer the risk of foundering around the area.

### Other

The light due is not ring-fenced for the Aids to Navigation installation and maintenance. And the low capacity of the staff on board and ashore is the other risk on the islands.

Table 4 Risk level table for Kiritimati

Undesired Incident Scenario	Probability	Impact	Risk Level
Grounding	3	2	6
Collision	1	1	1
Allision	2	2	4
Foundering	1	1	1
Other (fund,training)	2	1	2

Risk Level	Action
1 or 2	monitor
3 or 4	propose control measure
6	specify urgent action
9	emergency action

Table 5 Risk matrix - Hazards

			Grounding	Collision	Allision	Foundering	Other(Funding, training)
<b>HAZARDS</b>		"Value"	<b>Undesirable Incident Scenarios</b>				
<b>Natural</b>	Safe Minimum Depth (m)	15.05	Low				
	Proximity of danger (NM)	0.12					
	Net tide and wind effect (Kts)	7.0					
	Wave or Swell (m)	11.0			High	Med	
	Minimum visibility (NM)	1					
	Low sun issues	Y					
	Background glare	N					
	Loss of PNT	N					
	Loss of Communications	Y	Med	Low			
<b>Economic</b>	AtoN funding issues	Y					High
	Legal action problems	N					
<b>Technical</b>	Total Navaid failure (large vessels)						Low
	Total Navaid failure (small vessels)						High
<b>Human</b>	Large vessel crew competency	3					Low
	Small vessel crew competency	3	High				
	Quantity of AtoN	3	High	High			
	Quality of Charts	3				High	
	Competency of VTS	3					
	Other AtoN provider competency	3					
	Competency of pilotage	1			Low		
	Piracy/terrorism	N					
Political issues?	N						
<b>Operational</b>	Time to grounding (minutes)	1	Med				
	Maximum no. of large vessels	7					
	Maximum no. of small vessels	102		Low			
	Availability of AtoN service	3	Med				
	Adequacy of routeing	1	Low				
	Adequacy of reporting	3					
<b>Mar Space</b>	Crowded waterway issues	N					
	Complex waterway issues	N					
<b>Probability Scores</b>			3	1	2	1	2

Table 6 Risk Matrix - Impact and consequences

		Grounding	Collision	Allision	Foundering	Other(Funding, training, etc)
Direct Impact		Undesirable Incident Scenarios				
	Injury to persons ashore			Low		
	Injury to mariners afloat	High	High	High	High	Med
	oil spill	High	High	High	High	Low
	hazardous cargo release	Low	Low	Low	Low	Med
	damage to other vessels	Low	Low			
	damage to property/infrastructure			Low	Low	Low
Indirect Impact	Public health damage	Low	Low	Low	Low	Low
	Lifestyle disruption	High	High	High	High	
	Impact on tourism	High	Low	Low	High	
	Reputation	Low	Low	Low	Low	
	Land based businesses and livelihoods					
	Food security					
	pollution of fisheries	Med	Med	Med	High	Low
	damage to PSSAs	Med	High	High	High	Low
	protected/endangered species	Med	High	High	High	Low
coastal zone damage	Low	Med	High	Med	Low	
Other	other					
	other					
	<b>Impact Scores</b>	2	1	2	1	1

## 8. Needs for new Aids to Navigation

The needs for new Aids to Navigation was discussed during the workshop and distinguished by the priorities. This will be an input for cost benefit analysis and deciding the level of service.

At this moment, 2 beacons inside the lagoon are the only AtoNs in Kiritimati water. It was represented by a number of stakeholders, including Members of Parliament, that improved AtoN were necessary, to permit safe passage through the reefs surrounding the outer islands.

### 1<sup>st</sup> Priority

It was also presented that due to the low-lying terrain and lack of shore lights on the islands, local fishermen lost sight of land at night if they were more than 2 NM offshore. Landfall lights were considered necessary in at least two locations. One could be on the top of the telecommunication tower in London, and the other one on another tower in the south.

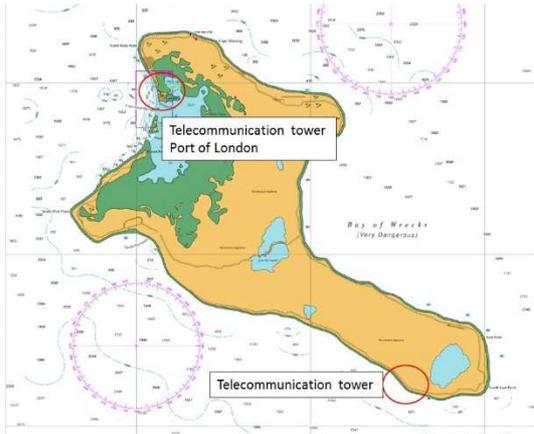


Figure 10 Telecommunication tower



Figure 11 Landfall lights potential locations

## 2<sup>nd</sup> Priority

The anglers move to many flats to fish and the vessels rely on their local knowledge, the numerous flats should be marked with simple type of beacons. At least, 10 locations were identified from the anglers map.

## 3<sup>rd</sup> Priority

The main entrance to the London port was marked with six buoys, which were lost in bad weather about 10 years ago. There is a need to re-mark the locations for the yacht and small vessels. And, it was agreed that the wave breaking point on the south end of the north passage should be marked with a beacon. And, the KPA jetty could be marked with a beacon for the cargo and container ships approaching to the facility.

Moreover, AIS Base station could help the Marine Division and KPA to get the necessary information to compile the situation. It is suggested that this could be improved significantly by the installation of VHF AIS Base Stations.

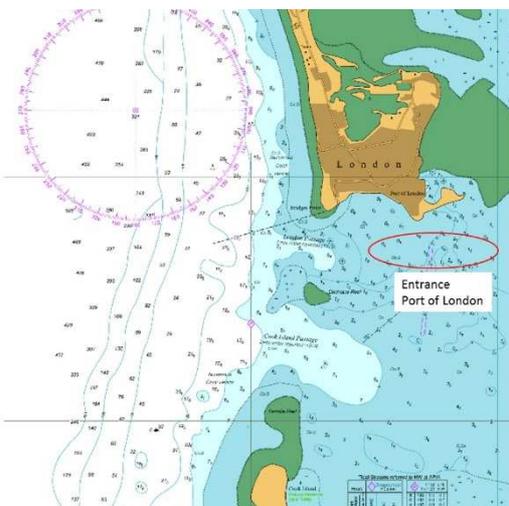


Figure 12 Entrance to the port London



Figure 13 Locations of the flats

## Total

The total number of AtoNs are summarized in a table below.

	Lighthouse	Beacons	Buoys	AIS BS	Remark
1 <sup>st</sup> priority	2				Lanterns
2 <sup>nd</sup> priority		10			
3 <sup>rd</sup> priority		1	6	1	

## 9. Risk Control Options

### Grounding

There is no official statistics about the maritime accidents records, but, it has been known that most of groundings are happening in the lagoon. To decrease the possibility of these accidents new AtoNs should be installed on the main routes inside the lagoon. At this moment, there is no IALA compliant AtoN installed in the Kiritimati zone, proper AtoN service and improvements in the nautical charting could help make the movement of vessels expeditious and safe.

### Collision

Given the volume of traffic for the islands, the possibility for collision seems very low. However, other factors such as absence of communication could affect to the collision case.

In addition, considering the power deficiency of the islands, power back up system could be installed. And the officers of Marine Division and Port Authority could join proper capacity building programmes to help to raise the level of safety of navigation.

### Allision

The definition of Allision is striking of a vessel against a fixed man-made object. The main jetty of KPA is placed on the outer island and exposed to swell and big waves from the ocean. Under this geographical circumstance, its structure itself present a continuous hazard for the vessels navigating across and approaching. In 2000, there was an unreported about 10m high swell incurred onto the jetty, and it swept away the upper structure and containers on the top of the jetty.

This kind of natural disaster cannot be prepared for before the structure is moved into the lagoon, but at least, beacons to mark the end of object could be installed to be recognized at night time.

### Foundering

One research vessel and cargo vessel had sunk between the KOIL anchorage and the north passage due to unknown reason. Nevertheless, the two wrecks which are not marked on the chart in front of the KOIL silos suggest the presence of latent hazards.

### Other

A matter of the highest priority for the safety of navigation is the lack of human resource and capacity building of the officers. Because of its remote location and low population, Kiritimati is not a focus for human and financial resources from Tarawa.

## 10. Finance

Although Marine Division has a maintenance budget for aids to navigation in Kiribati, currently there is no budget for marine aids to navigation in Kiritimati. Expenditure has also not been incurred. Some financial indicators at the national level in Kiribati are shown in **Error! Reference source not found.**

Table 7. Kiribati financial aids to navigation indicators at the national level.

Indicator	2014	2015	2016	Source
Light dues collected, foreign cargo vessels (AUD)	\$56,678	\$97,024	\$62,446	Marine Division, MCTTD
Light dues collected, foreign fishing vessels (AUD)	\$9,728	\$3,930	\$62,446	Marine Division, MCTTD
Light dues collected, foreign cruise liners (AUD)	\$0	\$954	\$0	Marine Division, MCTTD
Light dues collected, domestic vessels (AUD)	\$2,873	\$2,868	\$2,939	Marine Division, MCTTD
Light dues collected, total (AUD)	\$69,279	\$104,776	\$127,831	Calculated
Aids to navigation expenses	\$36,669	\$42,164	\$25,659	Marine Division, MCTTD
Light dues collected per number of AtoN (AUD)			\$976	Calculated
Aids to navigation expenses per AtoN (AUD)			\$196	Calculated
Aids to navigation expenses (% of light dues collected)			20.1%	Calculated
Number of AtoN			131	Marine Division, MCTTD. List of Aids to Navigation in Kiribati

## 11. Discussion and Conclusions

The aim of risk assessment for the Pacific is to raise the awareness and contribute to safer and effective maritime traffic. It was recognized that the risk assessment workshop itself was valuable to gather the stakeholders and give them a chance to talk about the risks together.

The concept of risk management was quite a new thing for the participants including the marine division, Port Authority, shipping lines, Environment department, and departments concerned, but it was a fruitful workshop to get together and discuss about the risk, likelihood, and the consequences of the island.

It was a challenge to gather the formal input to the risk assessment tool which require information from various areas. Many of them had to be assumed based on verbal inputs from the stakeholders as the documented information were limited. Nonetheless, most of the contributions were critical for the assessment.

For the Kiritimati Island, it was identified that groundings are the most probable risk. The low volume of traffic doesn't really cause any congestions, but, the lack of adequate nautical charts and un-marked

shallow waters under the high waves could potentially cause groundings around and/or inside the lagoon.

Based on the low volume of traffic and accident rates elsewhere in the world, accidents involving oil tankers or container vessels are very unlikely. However, such accidents could have severe consequences to Kiritimati. Any AtoN expenditure on Kitimati needs to balance the low likelihood with high impact. On the other hand, movements of small vessels, such as small fishing boats, are frequent with a much higher chance of accidents in any given year, but with obviously limited impact. It may be that AtoN's to help these vessels navigate is at least as important as for tankers and container vessels. In any case, since there is currently no AtoN expenditure in Kiritimati it is safe to say that the expenditure level is too low in relation to the risks.

This paper could be used as an input to determine whether existing AtoNs are adequate, and additional or improved AtoNs are required. Furthermore, the AtoN level of service and related plans could be developed based on this report.

## Notes and references

IALA guideline 1018 on Risk Management

IALA recommendation O-134 on the IALA Risk Management Tool for Ports and Restricted Waterways

IALA World Wide Academy Technical Needs Assessment Mission to Kiribati, Nov 2016, IALA

PAWSA workshop guide, July 2005, USCG

The central pacific shipping commission: History, successes and lessons learnt, July 2014, SPC