Risk Assessment of Maritime Navigation across the Greater Caribbean Region (GCR)

Hydrographic Governance and Managing Hydrography in Challenging Environments

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Introduction to the Study

- Shipping is important to the economy of small island developing states within the Greater Caribbean Region (GCR).
- However, the environment, economy and culture of the region are at risk of potential maritime accidents.
- This study involves a risk assessment of maritime navigation across the GCR and tests a cost assessment strategy in relation to the risk.

Structure of the Presentation

1. Introduction to the Study
2. Importance of the Study
3. Strategies to be used in the Study
4. Preliminary Results for a Study done across the Gulf of Paria
5. Conclusion & ongoing research

History of Maritime Accidents across the GCR

Reported accidents across the GCR over the last 16 years :

i. 20 groundings

ii. 8 vessel to vessel collisions

iii. 3 contacts with fixed objects

Introduction to the Study

The results of the study will contribute to the monitoring and management of maritime navigation by allowing the:

i. Prioritization of resources

ii. Reduction of risk

iii. Improved security of the marine environment

iv. Expansion of international trade opportunities

Importance - Expected Increase of Maritime Accidents

Maritime accidents occur due to:

i. Prevailing met-ocean conditions

ii. Failure of vessel equipment

iii. Navigational complexity

iv. Malfunctioning aids to navigation

v. Bathymetry

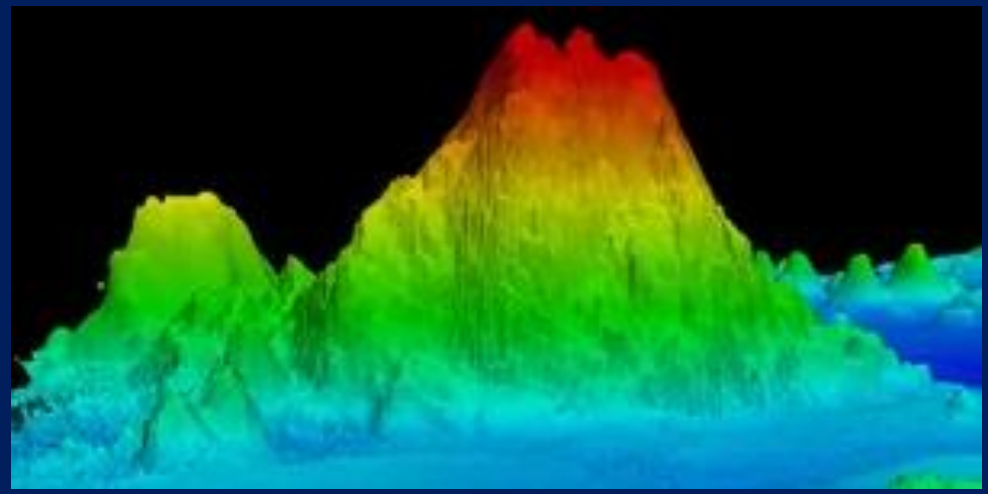
vi. Navigational hazards

Maritime accidents expected to increase due to:

i. Global increase in marine trade

ii. Increase in gross tonnage of vessels

iii. Resurgence of marine tourism



Importance - Consequences of Maritime Accidents

i. Loss of life and injuries to humans

ii. Damage to environmentally sensitive areas

iii. Damage to areas of cultural significance

iv. Decrease of trade, marine traffic, international competitiveness and therefore economic expansion

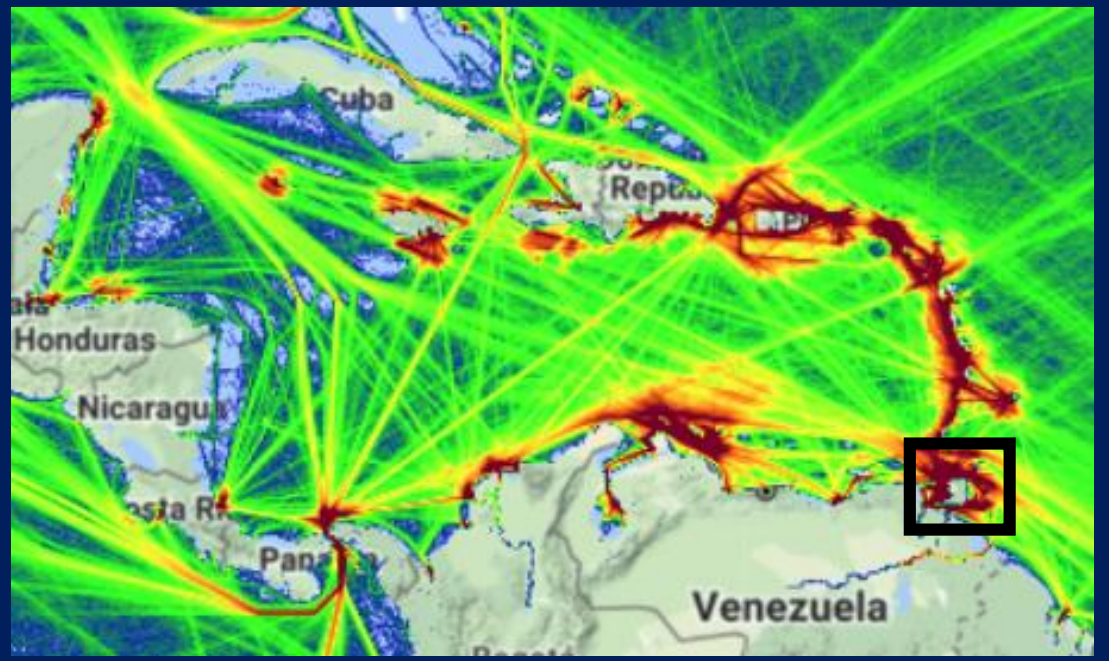
Objectives of the Research Programme

General Objective:

To conduct a risk assessment of maritime navigation across the GCR

Specific Objectives:

1. To map the risk within areas of maritime navigation across the GCR
2. To determine the economic costs associated with risk of accidents



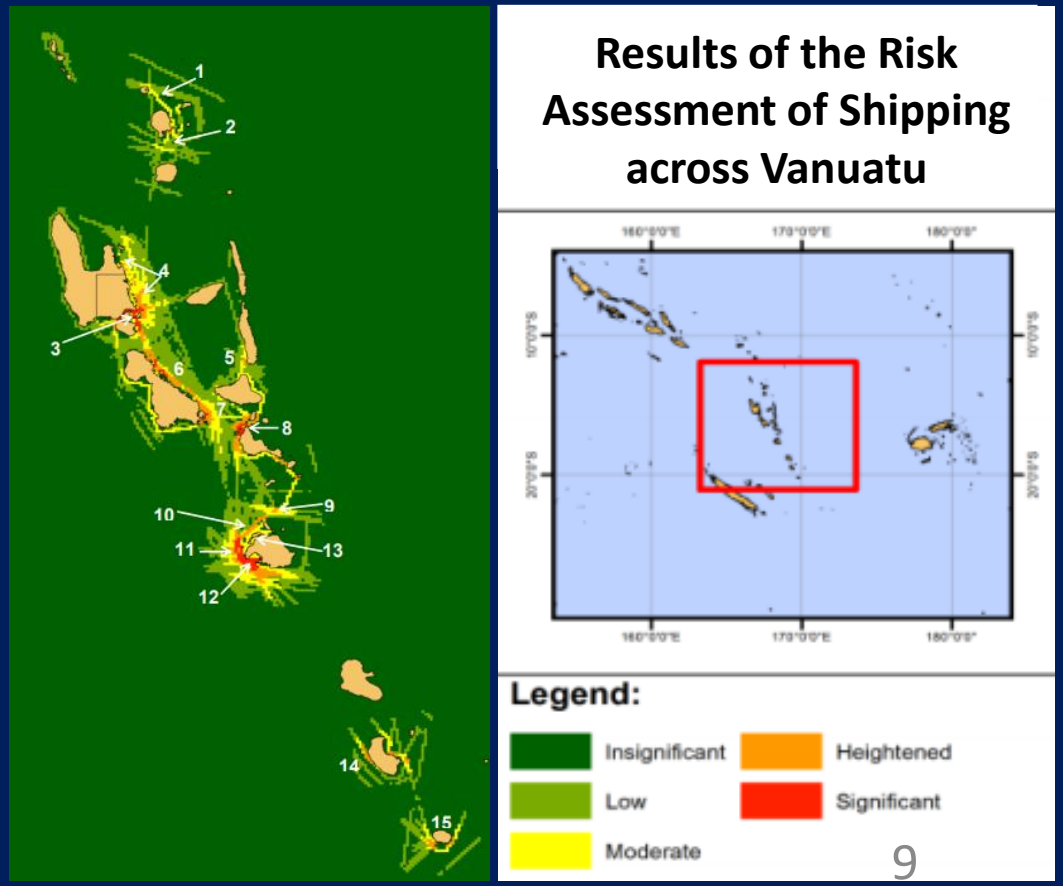
Marine traffic density across the GCR

Global Strategies for Conducting Risk Assessment of Maritime Navigation

Strategies for risk assessment developed by maritime departments including:

1. Land Information New Zealand (LINZ)
2. Canadian Hydrographic Service
3. Arctic Region Hydrographic Commission
4. National Oceanic and Atmospheric Administration
5. Danish Maritime Authority
6. Swedish Maritime Authority
7. Finnish Maritime Authority

Land Information New Zealand (LINZ) Risk Assessment Strategy



Strategies to be used in this Research

1. Adoption of the LINZ risk model
2. Improvements to areas of weakness in the LINZ risk model
3. Development of an accident cost model to estimate the benefit of risk control measures, that reduce accident probability
4. Cost evaluation of implementing risk control measures in selected States

Inferno at sea

1979 tanker collision sparks blaze huge oil spill off Tobago

287,000 tonnes of oil spilled from the Atlantic Empress

38 years later, this is still the **LARGEST ship based oil spill** recorded!

26 lives lost

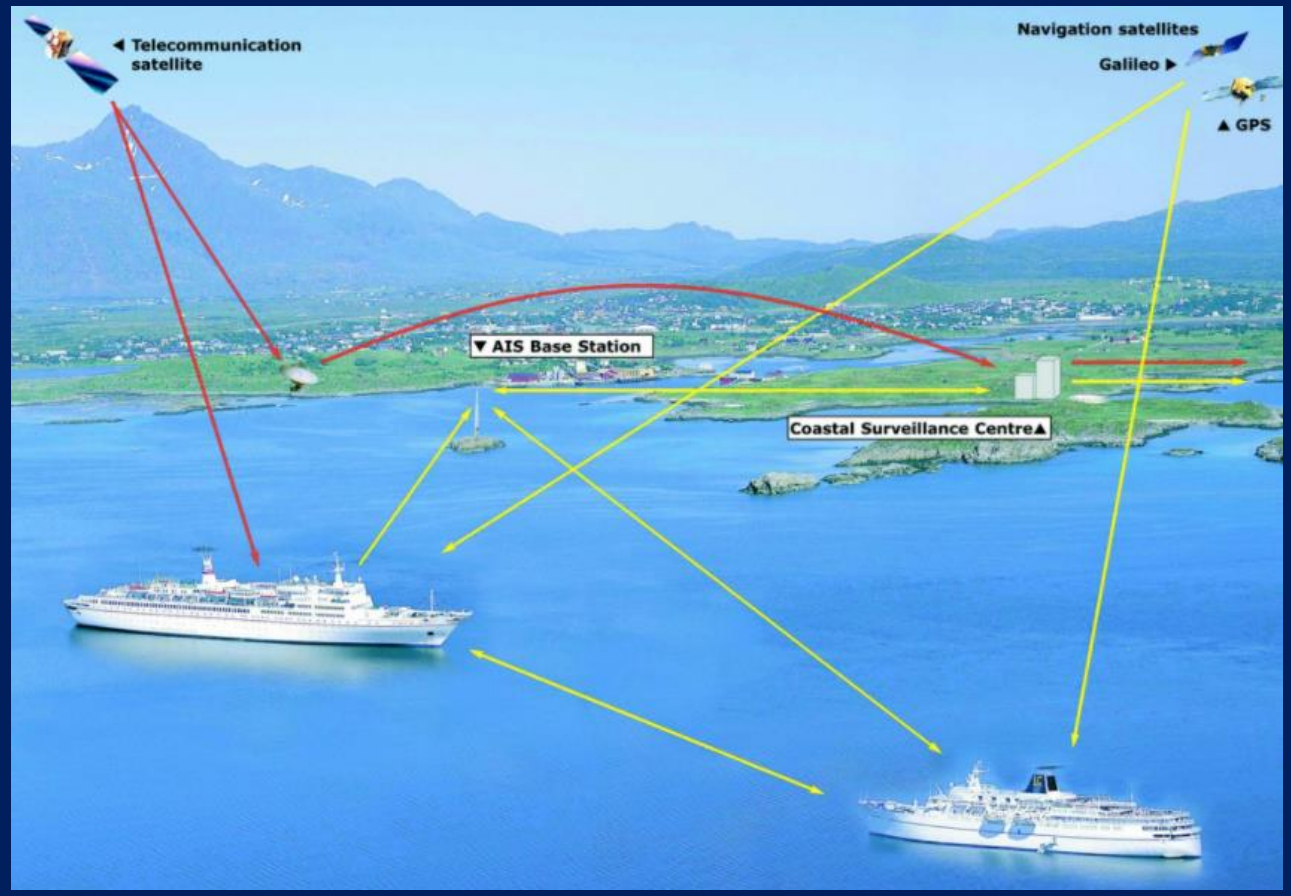
Environmental impact **study** was **NOT** done

Adaptation of LINZ Risk Model within the GCR

The LINZ strategy:

1. Is risk based with a detailed set of criteria
2. Uses satellite and terrestrial vessel position information for identification of shipping routes and for identification of ships
3. Applies weighted overlay method for improved accuracy

Initial research in the Gulf of Paria indicated the need to change the model through the use of probabilities



Adapted LINZ Hydrographic Risk Assessment

Likelihood Overlay Method

3 Criteria:

i. Vessel Traffic – potential for loss of life & potential for pollution

ii. Likelihood – probability of a maritime accident per vessel (**causal** factors)

iii. Consequence – potential effect of a maritime accident

Risk to Maritime Navigation = Traffic * Likelihood * Consequence

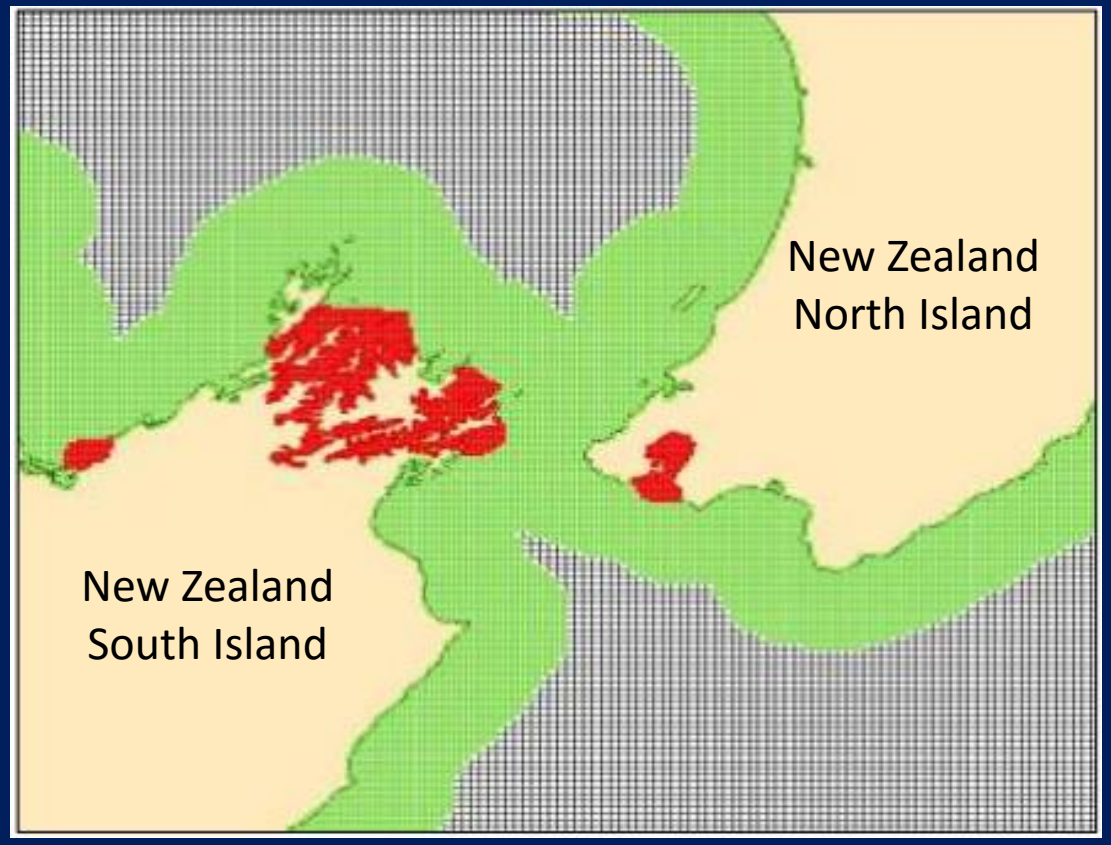
If the probability is accidents per year & the consequence is the cost of an accident, then the risk is measured in cost per year.

Likelihood Overlay

Likelihood and consequences of potential accidents vary spatially.

1. The study area is divided into grid cells. The cell size determined by the granularity of the data.

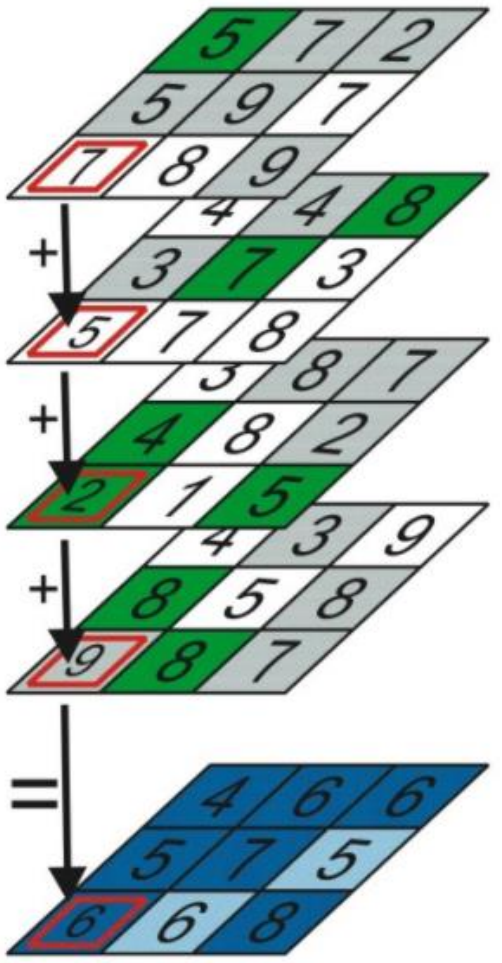
Beyond 12nm – 2km
Inside 12 nm – 1km
Harbor limits – 500m



Overlay

2. The cell value for each input is multiplied by the input's probability.
3. The resulting cell values are calculated for each criteria (vessel traffic, likelihood and consequence).
4. Risk to Maritime Navigation = Traffic * Likelihood * Consequence

A number of risk factors are combined each expressed as a probability



Preliminary Results of the Study
Adoption of the LINZ Risk Model to the Gulf of Paria

Weights – determined by expert guidance.
Consequence – dependent upon type of vessel (nature of cargo, number of personnel) and nature of the environment

Results: Characteristics of the Gulf of Paria

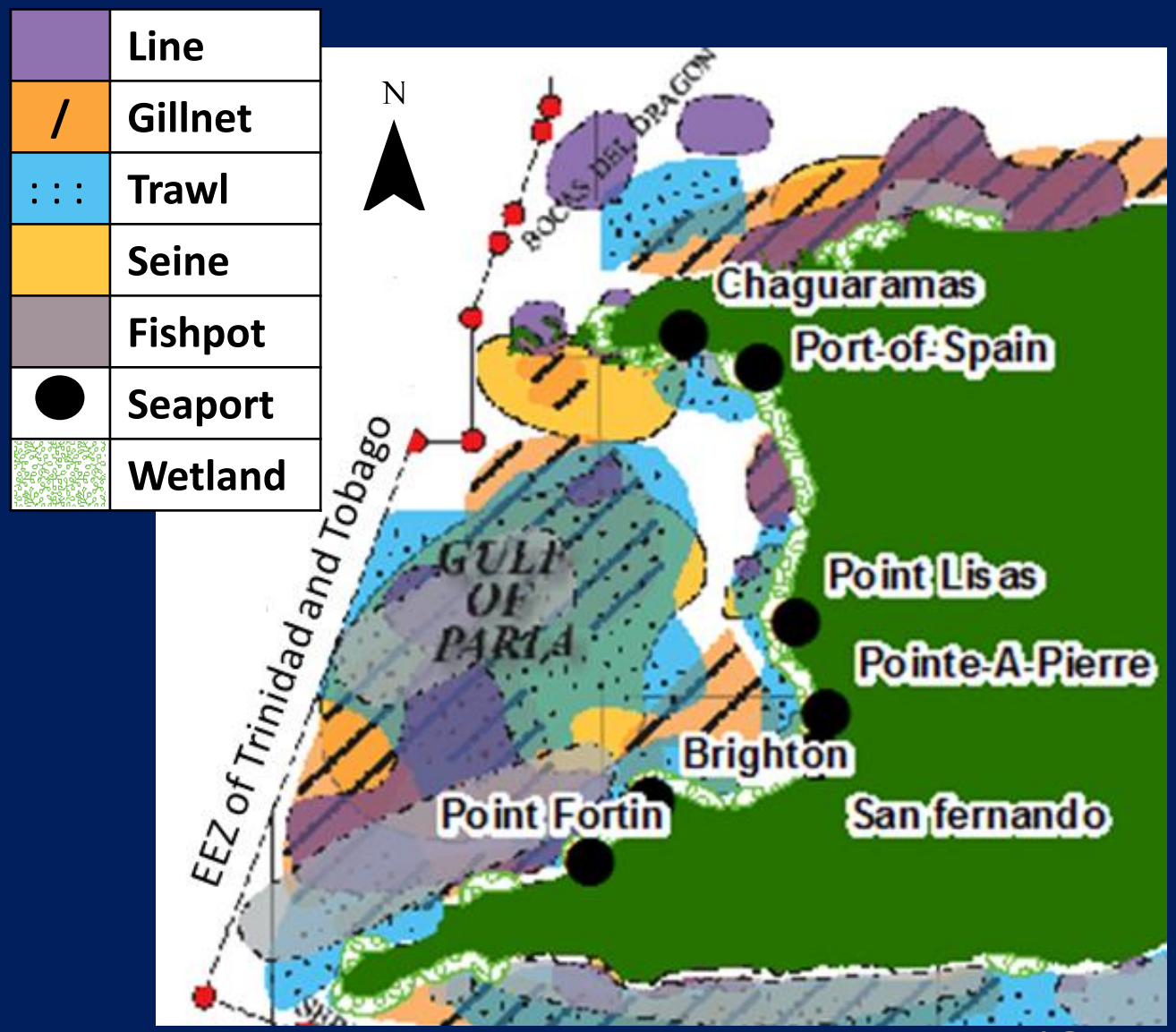
The Gulf of Paria to the west of Trinidad, is of economic, cultural, and environmental importance because:

i. Trade - seven sea ports

ii. Resources - marine tourism

iii. Fishing - 8 fish landing sites

iv. Wetlands - Caroni Swamp protected under the Ramsar Convention



Categories of Data Used in the Weighted Overlay Risk Model

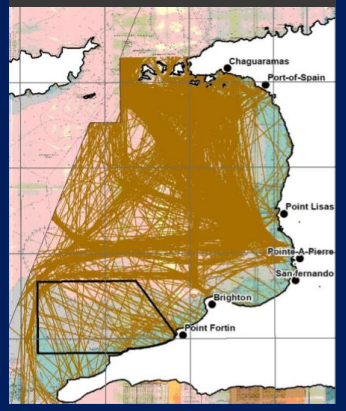
Vessel Traffic Criteria	Likelihood Criteria	Consequence Criteria
Terrestrial automatic identification system (T-AIS) for August 2016 – January 2017	• Met-ocean conditions • Navigational complexity • Aids to navigation • Bathymetry • Navigational hazards	• Environmentally sensitive areas • Culturally sensitive areas • Economically sensitive areas

Description of Vessel Traffic

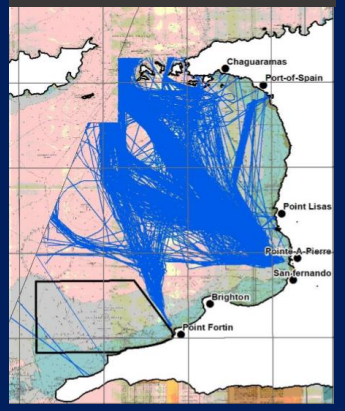
Vessel Type	Number of Transits
Cargo	3,367
Tanker	2,690
High Speed Craft	2,033
Passenger	1,268
Restricted Maneuverability	610
Recreational	207

AIS is a requirement for vessels over a particular size

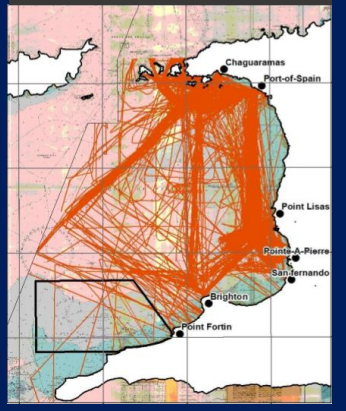
Transit of Cargo Vessels



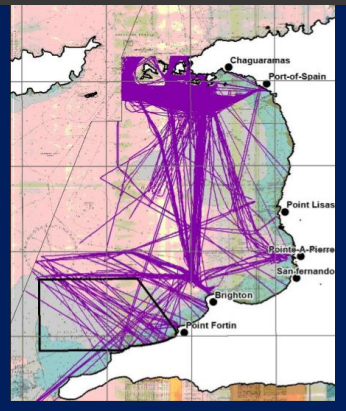
Transit of Tanker Vessels



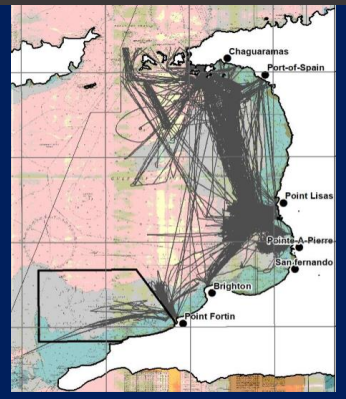
Transit of High Speed Crafts



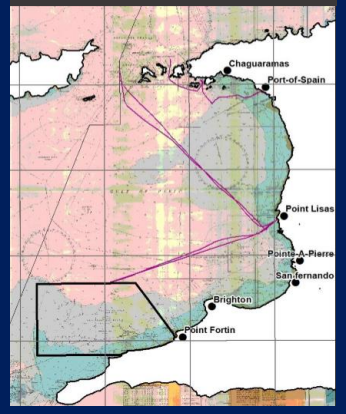
Transit of Passenger Vessels



Transit of Vessels with Restricted Maneuverability



Transit of Recreational Vessels

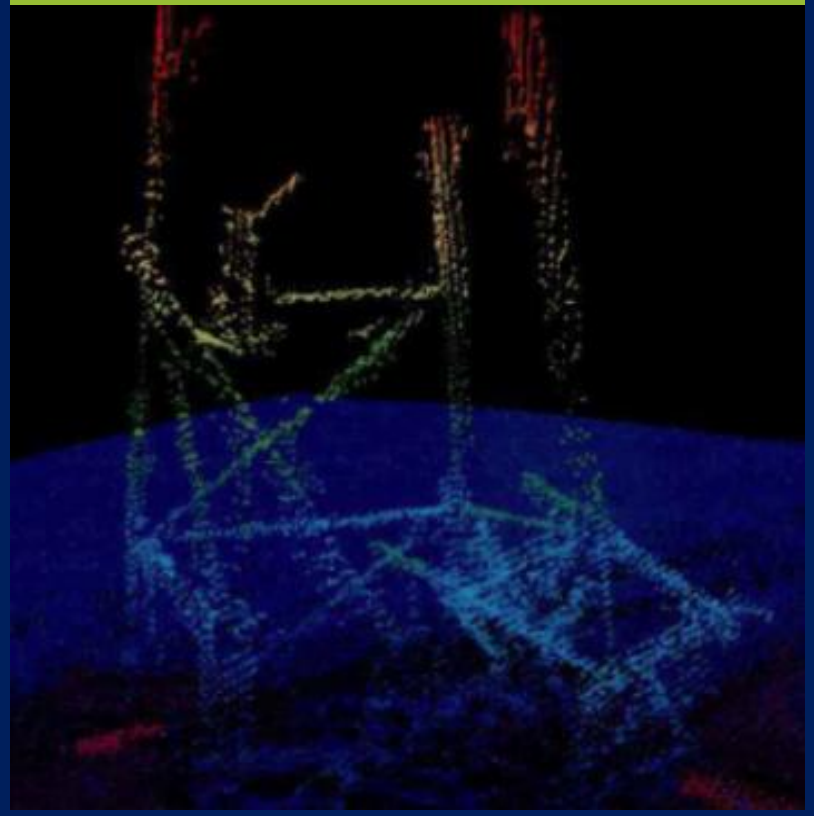


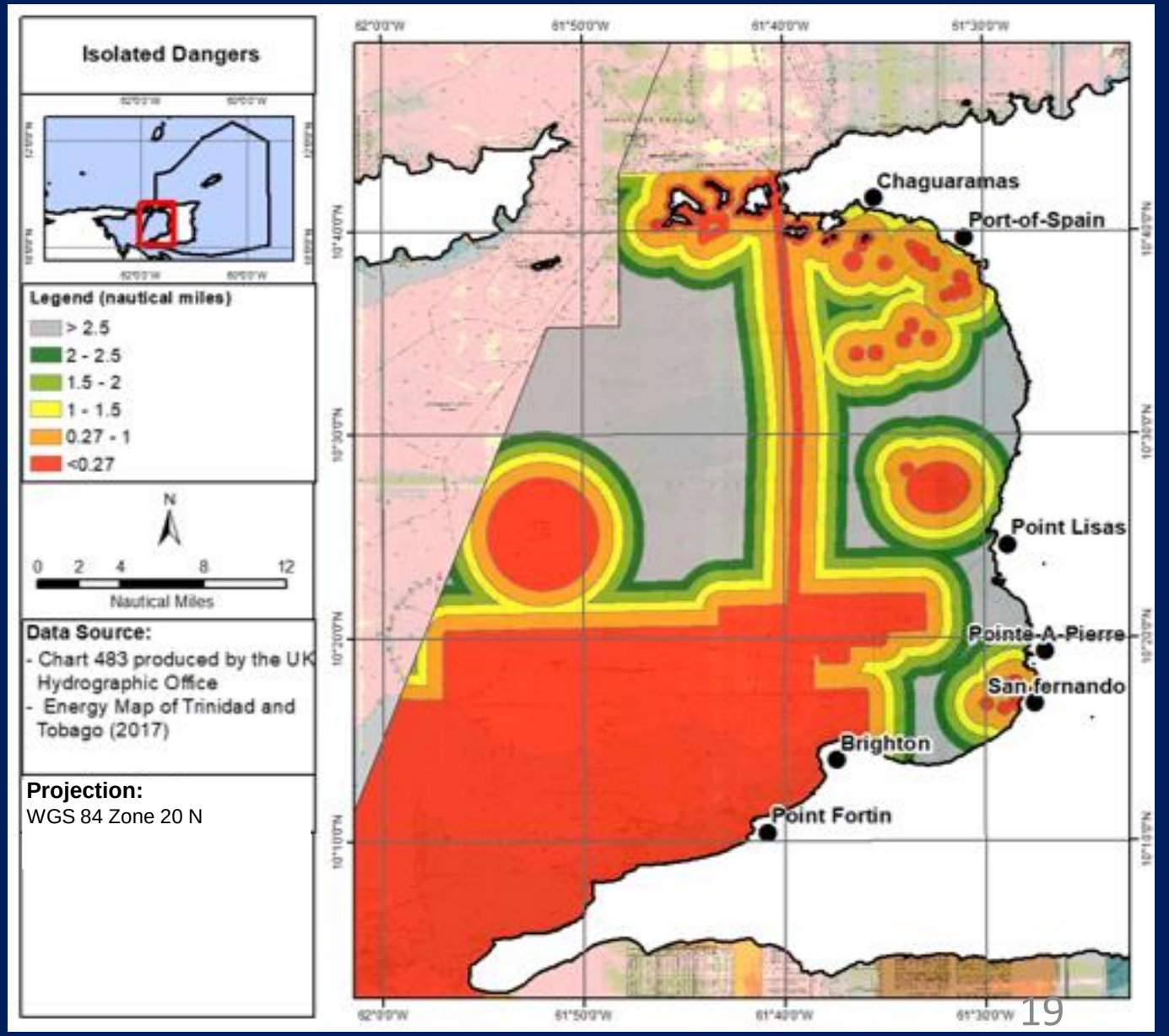
There are a lot of fishing vessels however they do not use AIS so as to maintain the privacy of their fishing locations

Example of Likelihood Criteria

Levels of risk to maritime navigation due to the proximity of vessel traffic to isolated dangers.

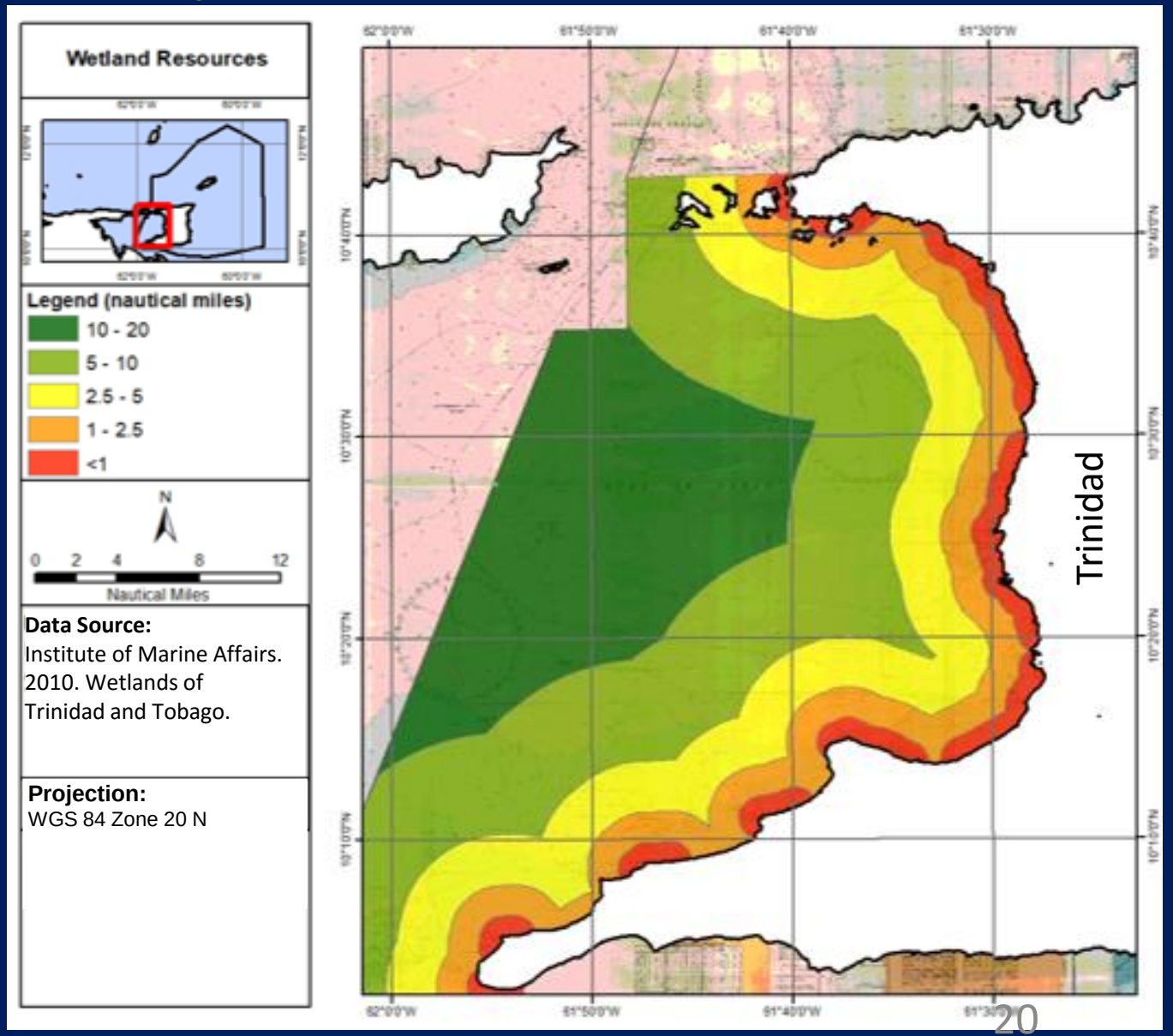
Debris in the Gulf of Paria





Example of Consequence Criteria

Levels of risk to wetlands due to the proximity of maritime navigation.

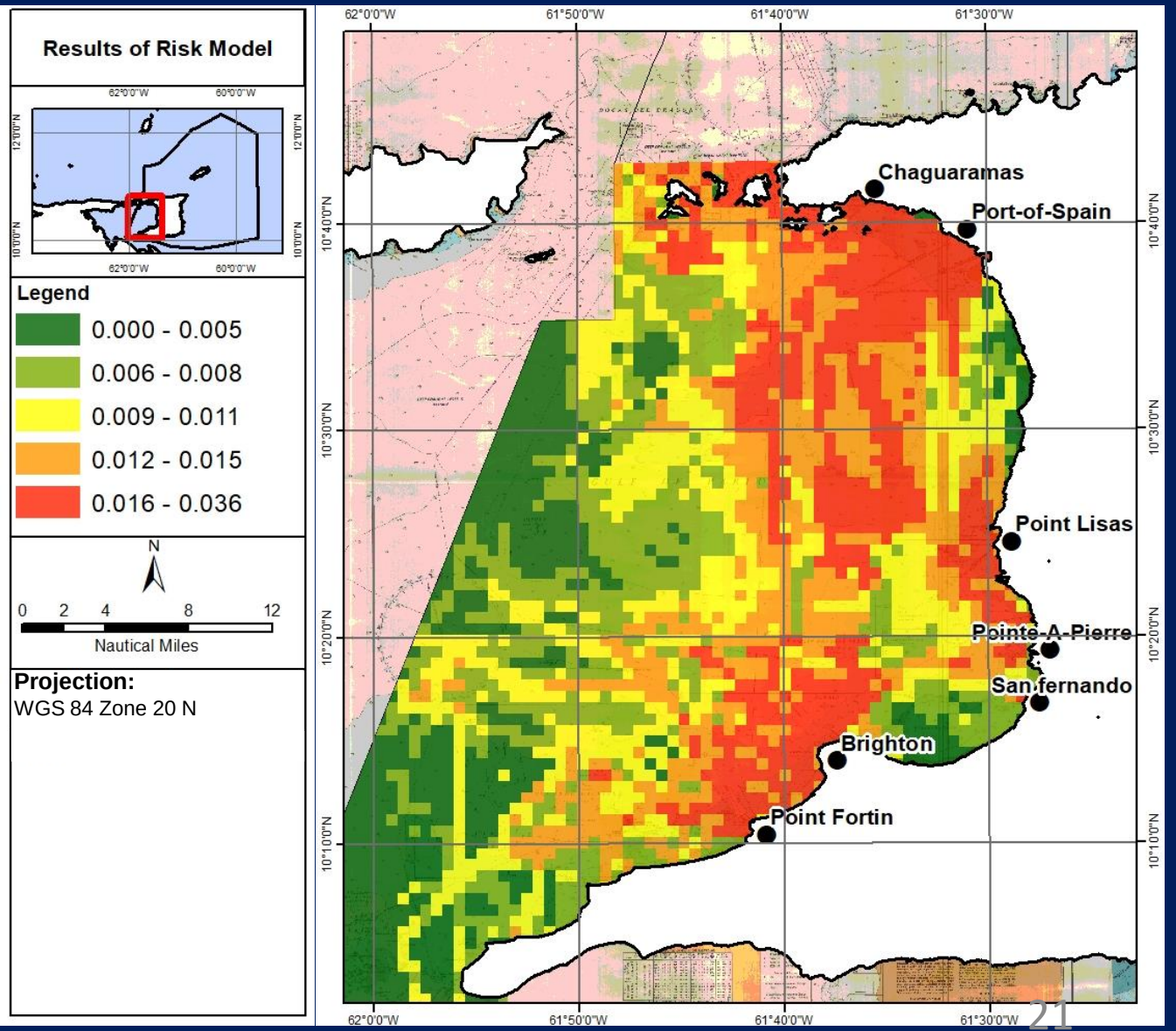


Results of Weighted Overlay Risk Model

There is a risk to maritime navigation in the Gulf of Paria

Levels of Risk to Maritime Navigation	
	Significant
	High
	Moderate
	Low
	Insignificant

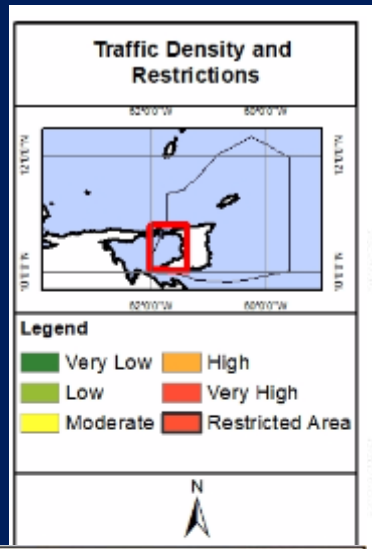
Under the LINZ strategy, no units are associated with risk.

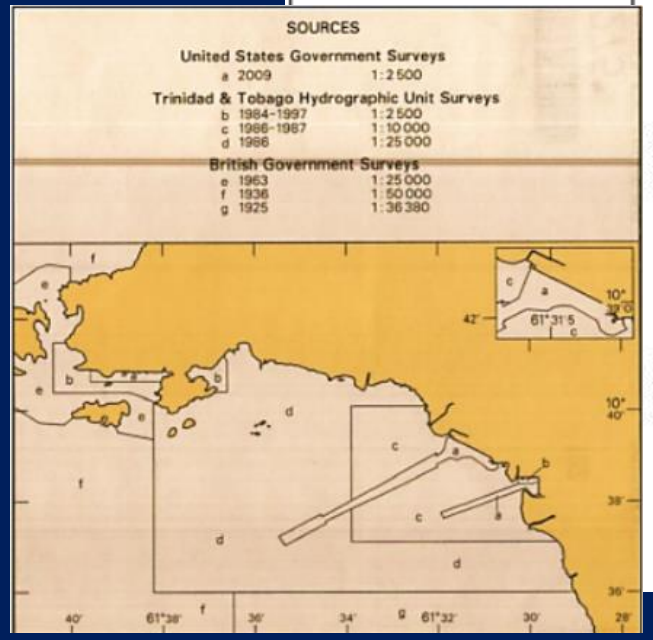


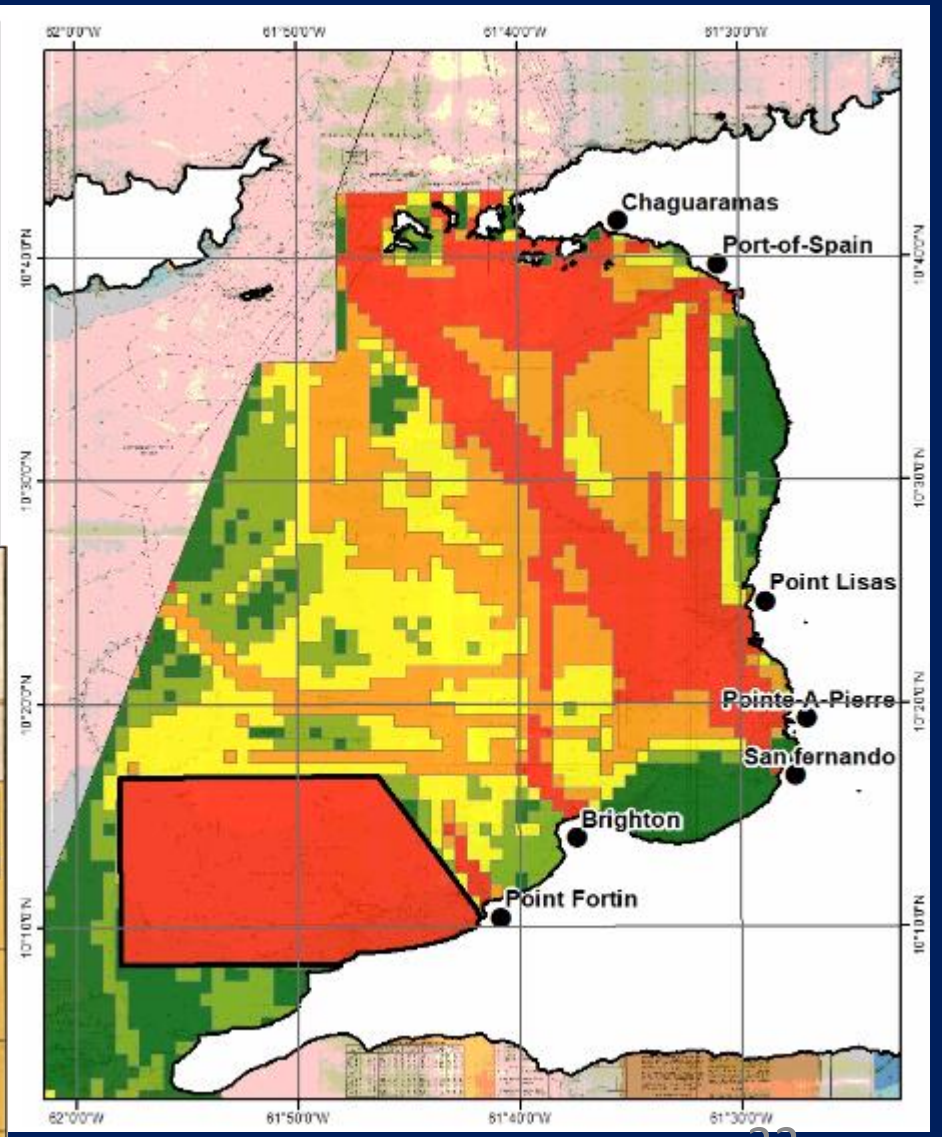
Significant Risk Factors in the Gulf of Paria

Preliminary study based on the LINZ strategy identified primary risk factors of :

i. Traffic density
ii. Gross tonnage of vessels
iii. Non-working aids to navigation
iv. Isolated dangers eg: wrecks
v. Outdated nautical charts
vi. Undefined shipping lanes

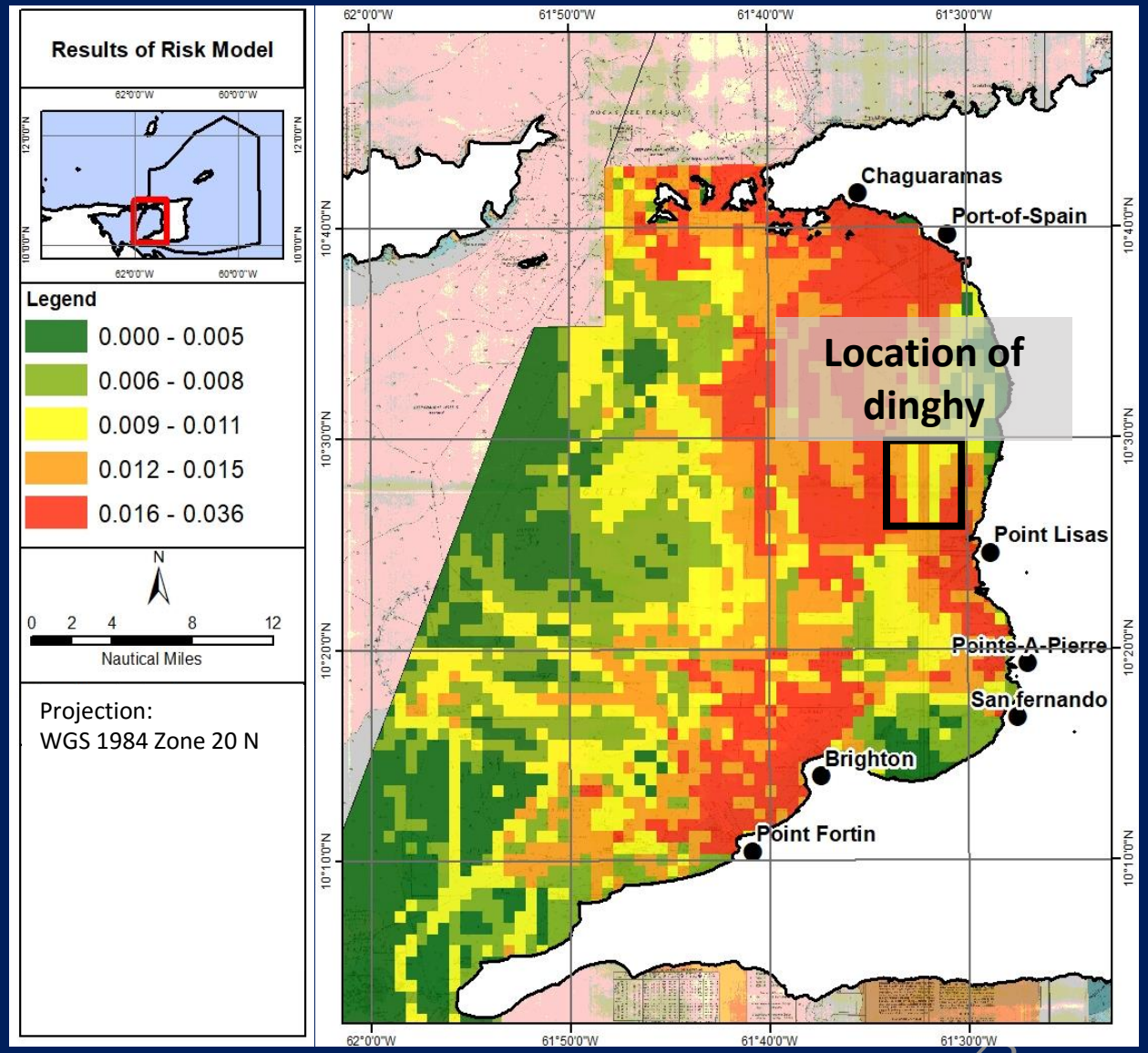






Party Boat Sinks in the Gulf of Paria

- On November 4th, 2017 the party boat struck an unknown object in the Gulf of Paria
- The vessel is now completely submerged.
- The location of the wreck is marked by a dinghy



Weakness of the LINZ Risk Model

Despite the results generated in the previous map, the are weaknesses in the model:

i. The LINZ strategy is based on subjective weights

ii. The final risk score does not have a unit of measurement

iii. The traffic density does not accurately reflect traffic flow.

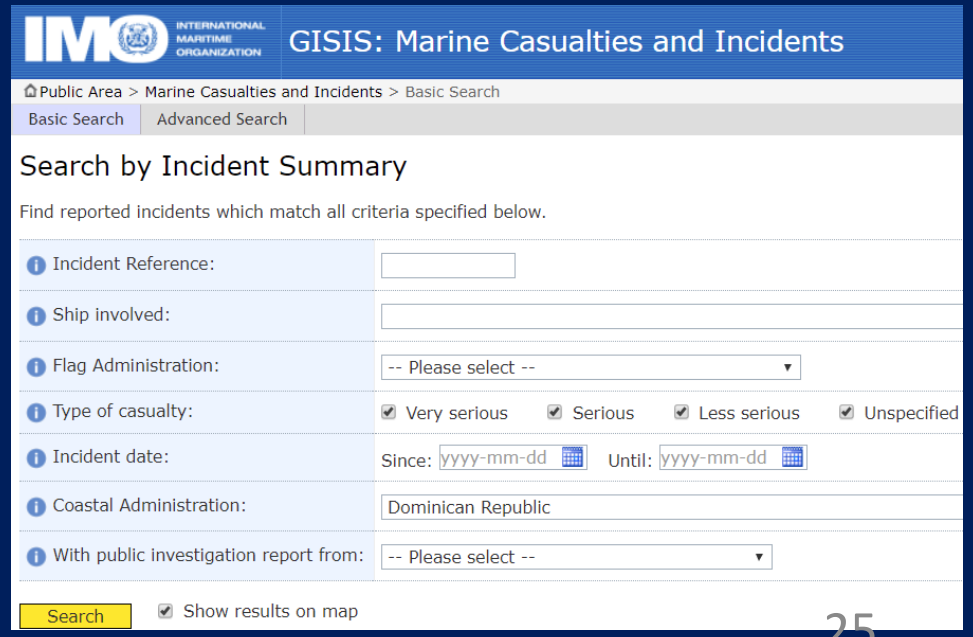
iv. Consequence is dependent not only on the immediate environment, but also on type of vessel involved, which is also not adequately defined.

The Way Forward

Given the weaknesses in the LINZ strategy, the risk model would be redefined by:

1. Applying probability of accidents occurring, derived using event trees and global maritime accident databases.
2. Enhancing cause and consequence criteria specific to individual operational zones within the **GCR**.
3. Better defining costs for consequences.

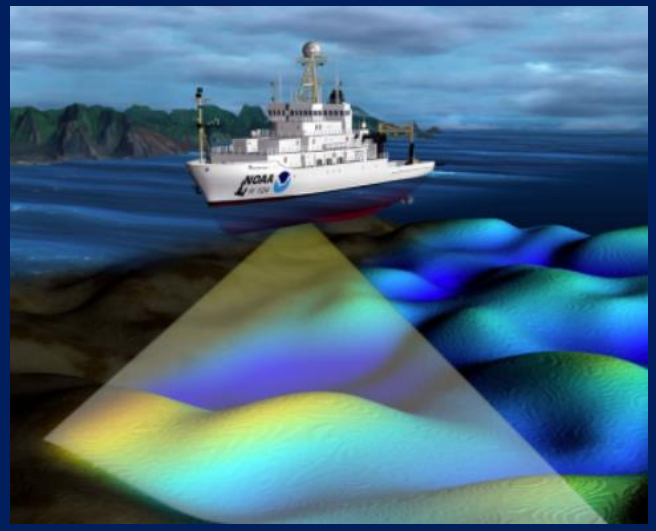
Hence results offer cost on an annual basis and this can be compared with the cost of mitigation measures.



Conclusion

The risk assessment of maritime navigation across the GCR is necessary and with the use of AIS data such studies are now viable:

1. There exists substantial risk to maritime navigation across the Gulf of Paria, as shown in the results of the risk model.
2. Risks to maritime navigation are increasing.
3. There is therefore an urgent need to monitor and manage risks to maritime navigation to ensure improved security of the marine environment.



Ongoing Immediate Objectives

There are two components that need a lot more consideration:

1. Spatial modelling of the probabilities of incidences.
2. Cost associated with incidences in terms of damage to the economy, environment, loss of life and injuries.

Ship Accident Loss (£ per ship year)					
Accident Type	Ship accident cost	Environmental damage and clean up	Risk to life	Risk of injuries and ill health	Total cost
	£	£/tonne x number of tonnes	Fatalities x £ X m	DALY x £ Y	£
Collision Contact Foundered Fire/explosion Hull damage Machinery damage War loss Grounding Other ship accidents Other oil spills Personal accidents					
TOTAL					

DALY = Disabled Adjourned Life Years
(The World Health Report 2000; www.who.int)

IMO Accident Loss Matrix

Ongoing immediate objective:

Major Accident Costs Identified by Global Maritime Departments

Accident costs to:

1. People due to loss of life and injury
2. Property due to reparation, docking fees and cargo damages
3. Environment due to oil spill response, damages to coastal resources which are sensitive to oil
4. Economy due to decreases in marine tourism freight income and customers, delayed supplies due to blocked navigation channels, deployment of authoritative services, accident investigations, fines for spills under MARPOL and legal expenses