Risk Assessment and Mitigation Measures of Maritime Navigation in the Caribbean Sea

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Structure of the Presentation

- Introduction into Maritime Navigation
- Importance of conducting Risk Assessment
- Strategies used to reduced risk to navigation
- Preliminary results
- Conclusion

Study Area- The Caribbean Sea

- The Caribbean is a busy shipping maritime environment representing a wide range of shipping activities.
- The shipping activities become more complex as large-scale offshore operations and maritime activities continue to increase.

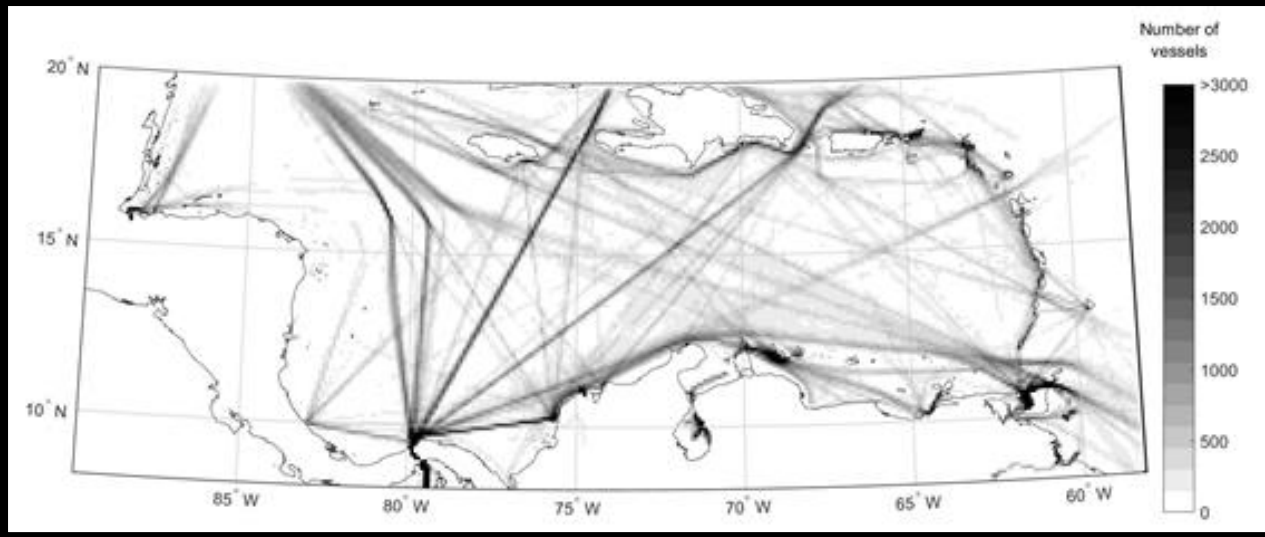
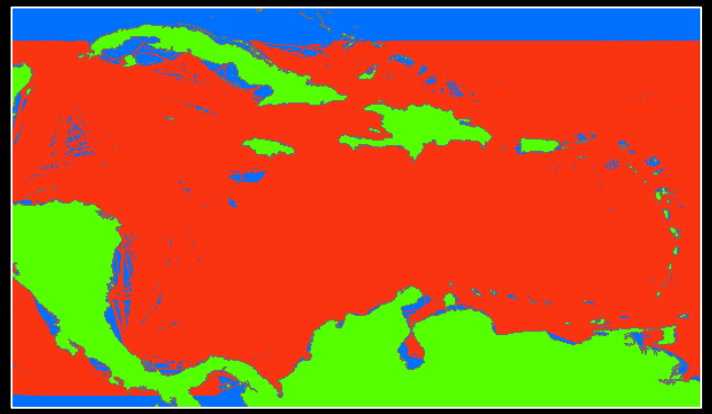
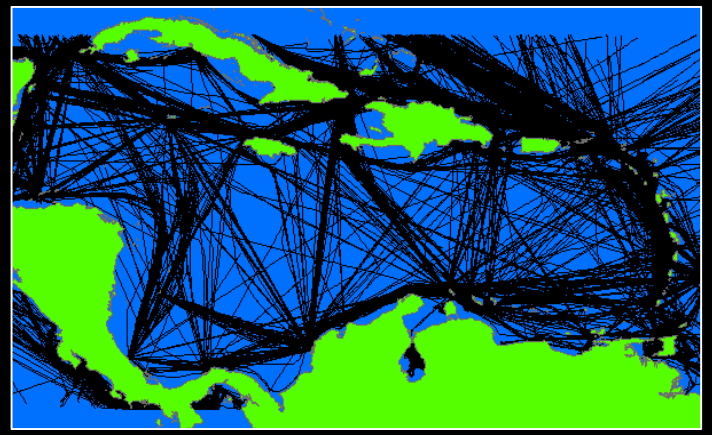


Figure 1 : Marine Traffic across the Caribbean Sea

Types of Vessel Traffic: Wider Caribbean Region



Cargo Transits



Passenger Transits

Tanker Transits

Causes of Maritime Accidents

Generic causes of Maritime Accidents:

Meteorological Conditions
Mechanical and Technical Issues
Human Errors
Malfunctioning aids to navigation
Inadequate charting (Bathymetry & Navigational Hazards)
Navigational Complexity

Figure 2: Oil spill vessel accident, Tobago 1979.

Importance of Study- Consequences of Maritime Accidents

- Economic loss - Overall decrease in transhipment of goods and services
- Loss of life
- Environmental Damage to sensitive areas
- Damage to or Loss of property

Gertz 2014

Figure 3: Oil coated the mangroves, as a result of a tanker colliding with another vessel in Bangladesh, on December 9th, 2014

Objectives of the Study

AIM: To develop a strategy that considers likelihood of an incident in relation to **vessel traffic flow** and **navigation information** available to the mariner.

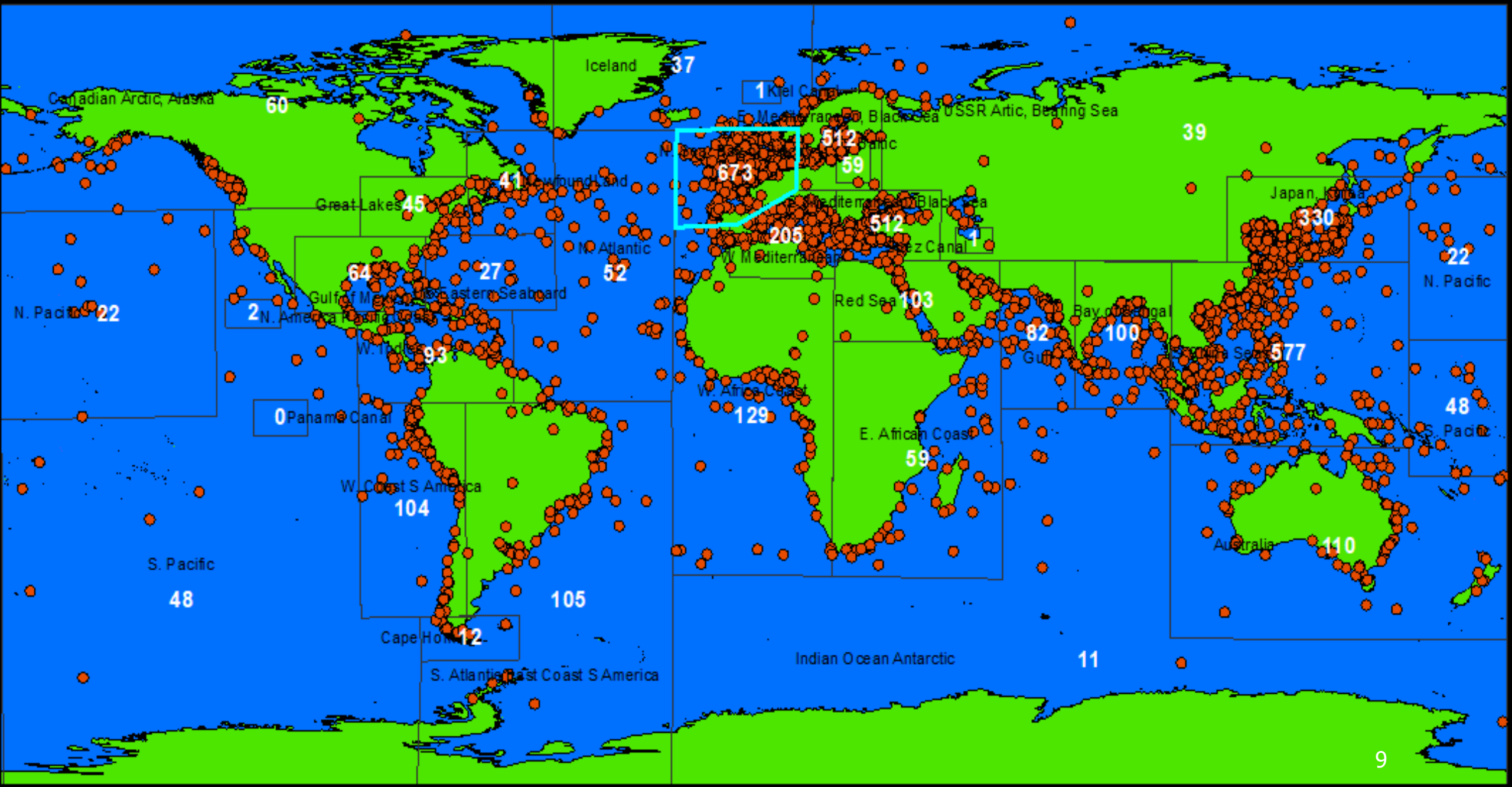
OBJECTIVES:

- Assessment of shipping accidents globally to identify key contributing factors relating to ships and the environment to produce statistical evaluation for use in risk assessment
- Apply mitigation measures such as improved charting and traffic management to re-assess risk
- Strategy for assessment of impact of risk reduction measures through the provision of tools and models that will support port development

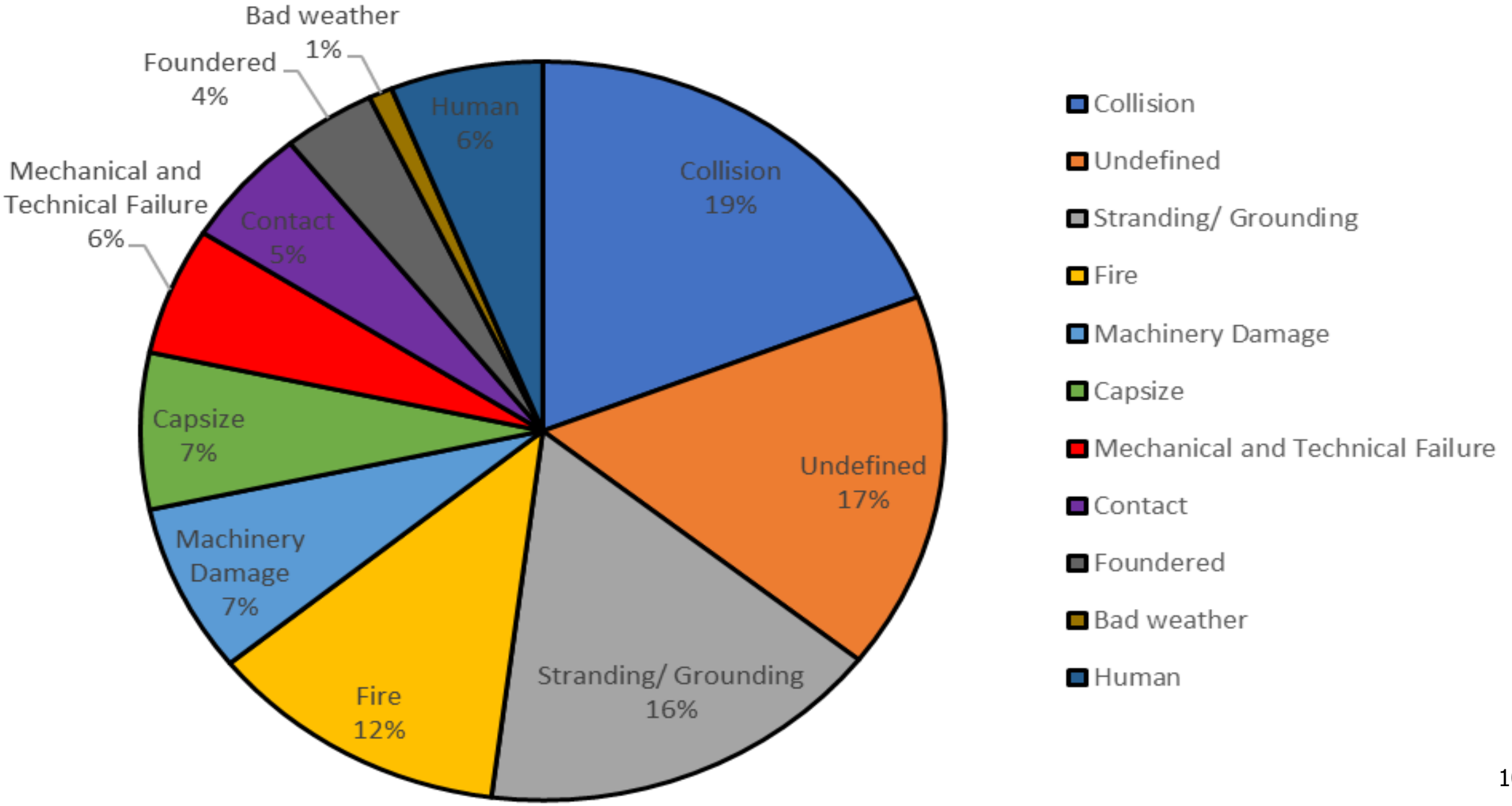
Preliminary Results

Quantitative Analysis of Maritime Causalities and Incidents

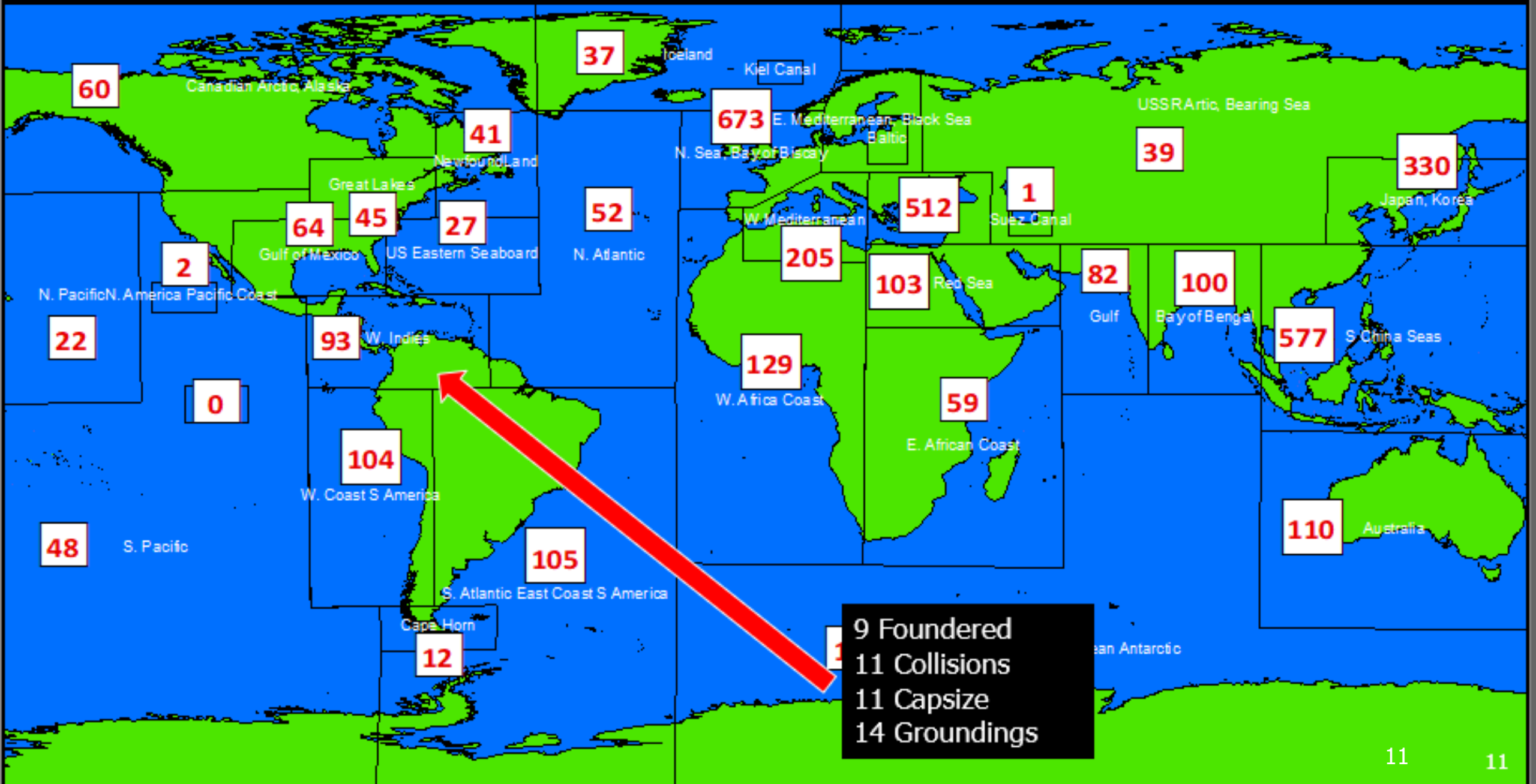
Location of Maritime Causalities and Incidents



Quantitative Analysis of Maritime Causalities and Incidents



Number of Maritime Causalities and Incidents



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Quantitative Analysis Findings

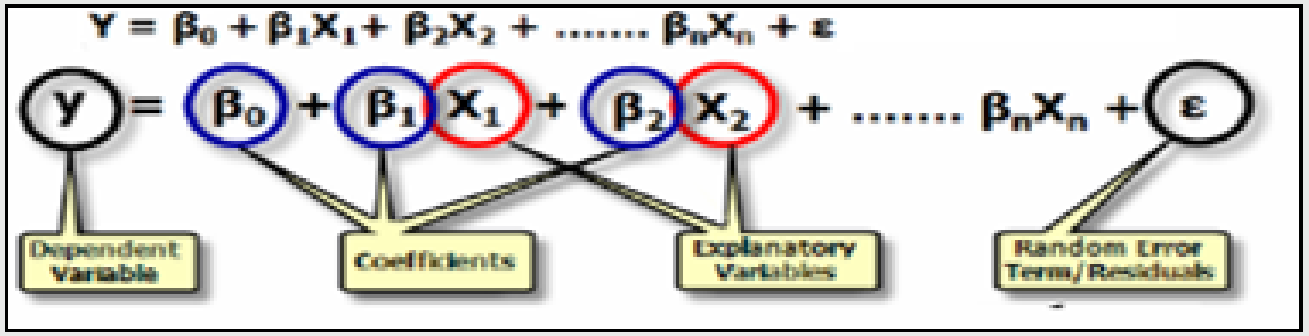
From the analysis, it was determined that :

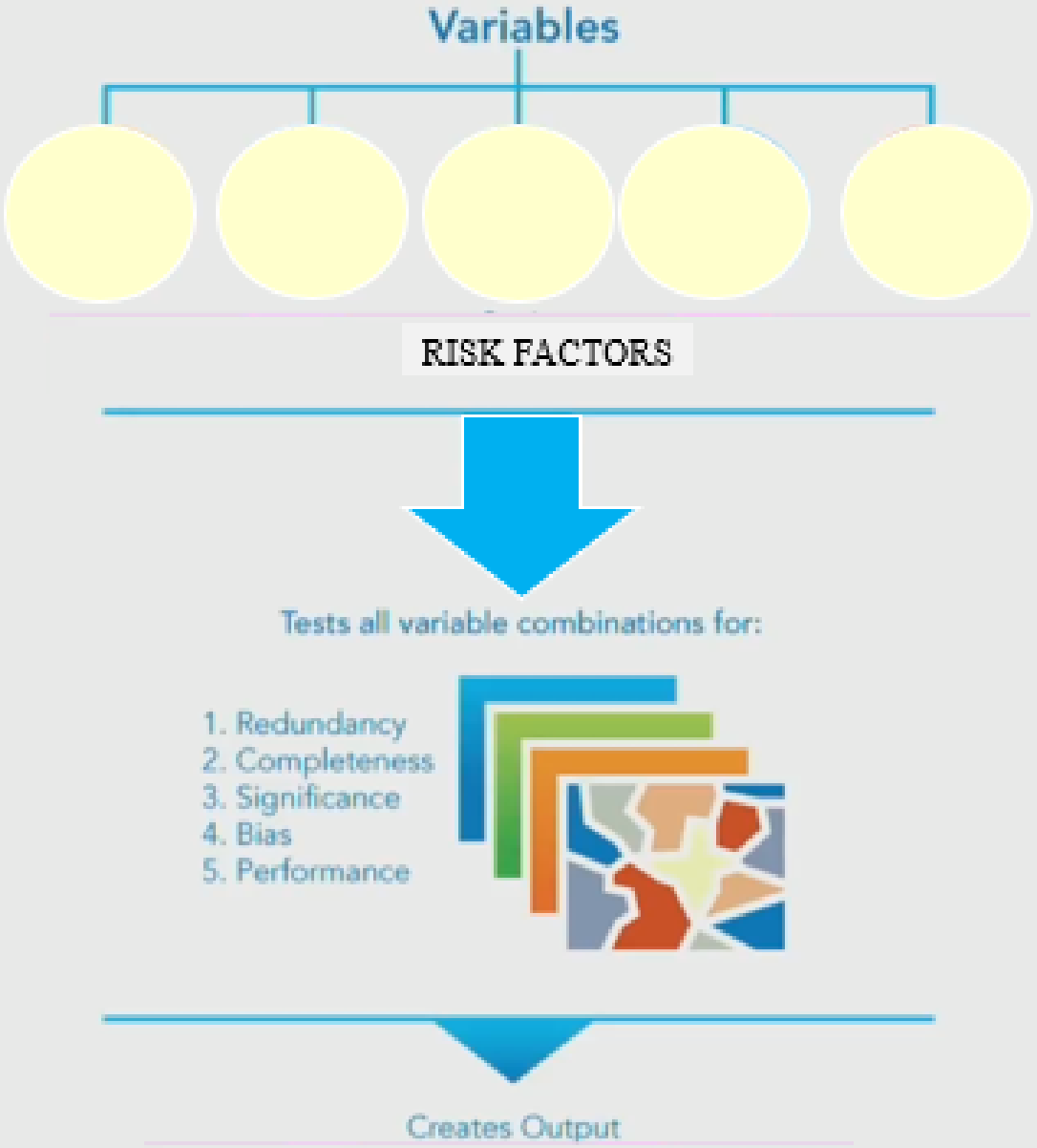
- The cause of majority of these incidents resulted from Collision.
- The major type of vessels that were involved in all accidents were cargo vessels, followed by fishing and tanker vessels.
- Most incidents occur in the South China Sea, Bay of Biscay and the Black Sea.

Using Geographical Weighted Regression (GWR) to explore spatial variations in the relationship between the location of maritime accidents with the factors that presents a risk to Maritime Navigation

Geographically Weighted Regression

Exploring spatial variation





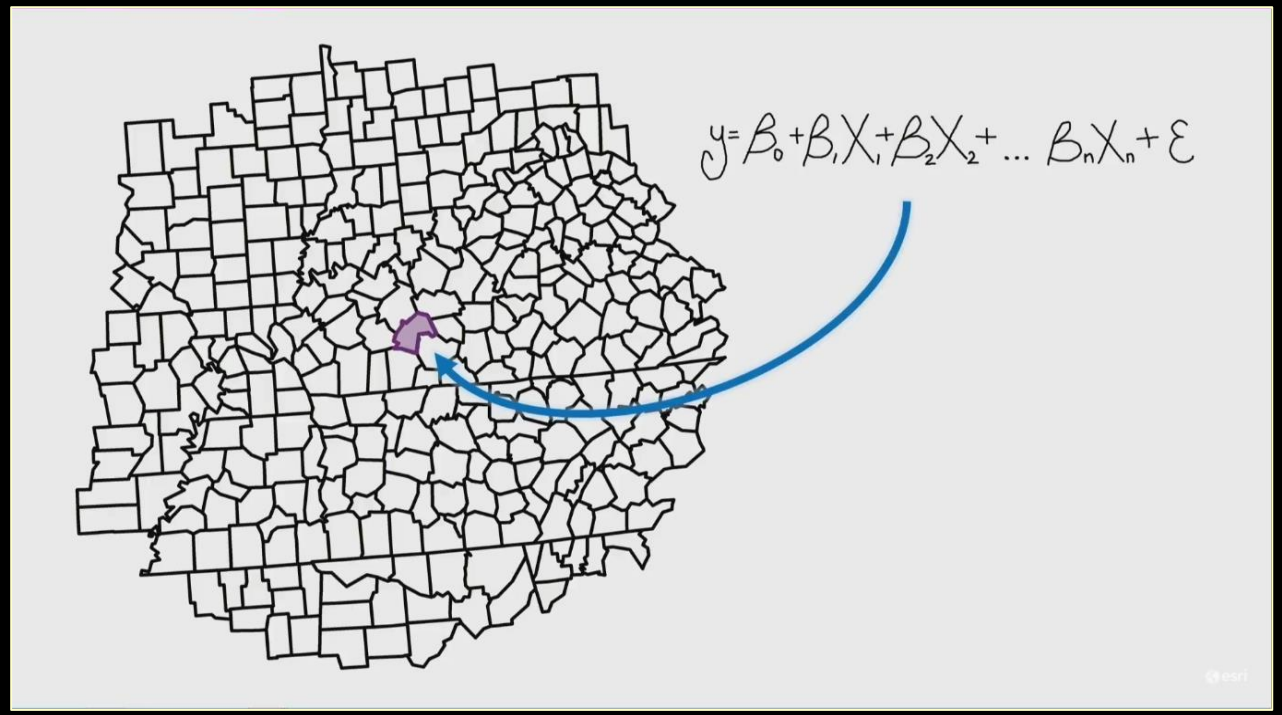
Data Needed for the Research

Risk Factors	Aspatial Information
Traffic Density	Number of vessel transits per cell
Navigational Hazards	Number of Navigational Hazards per cell
ChartZOC	Quality of Charts
Bathymetry	Depth of Water
AtoNs	Number of AtoNs per cell
Maritime Incidents	Number of Maritime Accidents per cell
Current Velocity	Average speed of the Current per cell
Flag	-----
Age of Vessel	-----

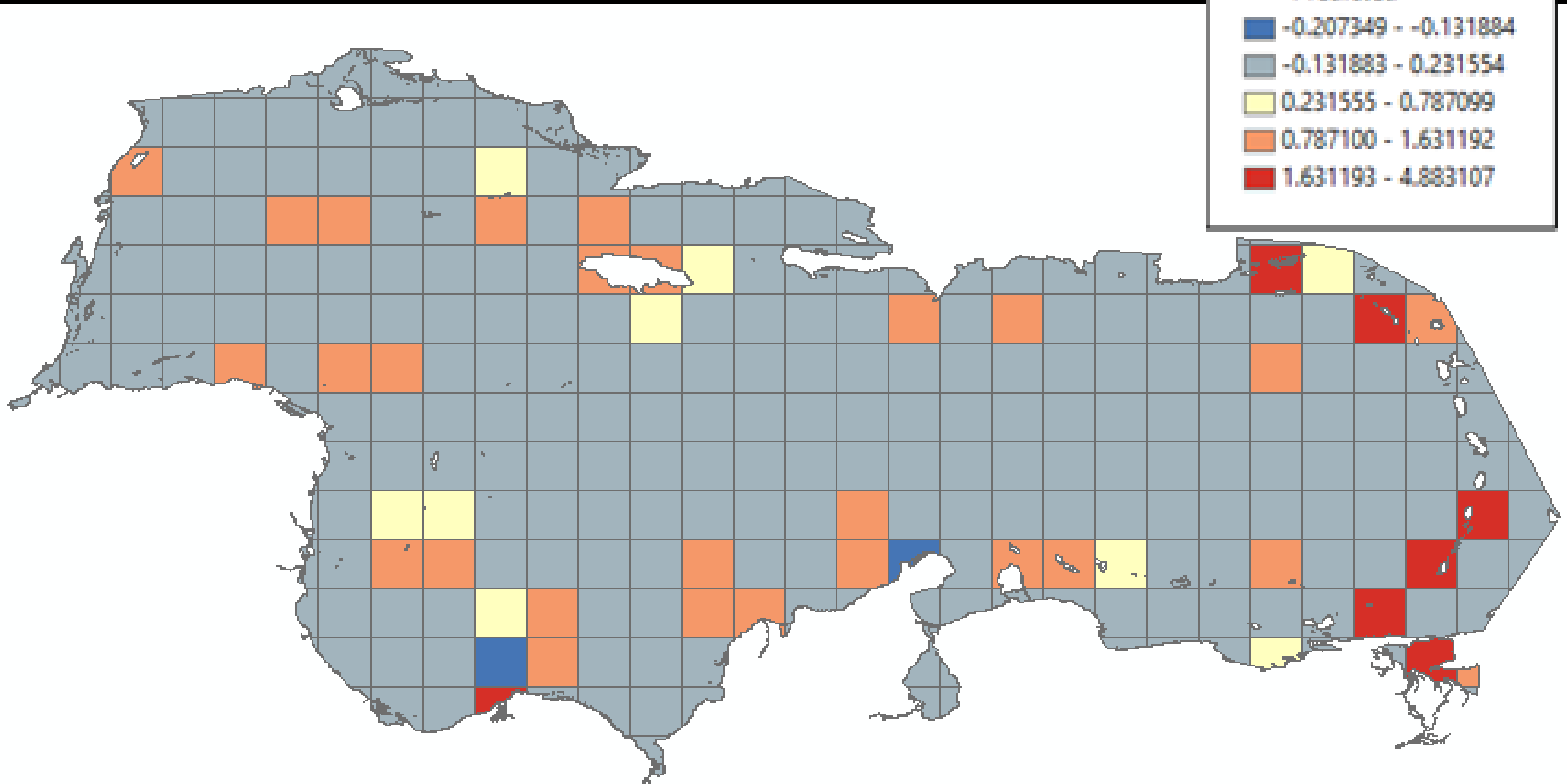
Determination of Coefficients

Training Data used to identify the Coefficients:

1. SAIS Traffic Data
2. Location of Maritime Events
3. Admiralty Charts



Results of GWR



Coefficients_ Atons	Coefficients_ Bathymetry	Coefficients_ Chartzoc	Coefficients_ NavHazards	Coefficients_ TrafficDensity	Location
0.342458	0.000658	-0.120938	0.736532	0.937159	**Panama Canal**
0.114292	-0.000567	0.394616	0.271881	0.724681	**St. Vincent and the Grenadines**
0.125899	-0.000492	0.337018	0.241723	0.709784	**Gulf of Paria**
0.636752	-0.001207	0.82989	0.054757	0.710434	**Virgin Islands**
0.008338	0.136374	-0.000515	0.231462	0.624871	**Venezuela**
0.466177	-0.000482	0.412672	0.204294	0.617423	**St. Kitts and Nevis**
0.12169	-0.000536	0.368507	0.25714	0.5347914	**Grenada**

Findings of GWR

- GWR produces a surface of parameter estimates.
- The spatial changes in the magnitude of the parameter estimates across the surface indicate the locally changing influence of a variable on the dependent variable, in some areas the influence might be much stronger than in other areas.
- This is the essence of spatial heterogeneity – the structure of the model changes from place to place across the study area as the parameter estimates change in relation to each other in the model.

Research Plan

On going research:

- Assessment of reasons for incidents and shipping traffic in the Caribbean

- With the traffic information and likelihood, events will be modelled and the rules of conduct within the waterways will be changed, with the aim of reducing risk.

Figure 4 : VTMS (Magnus 2016)

Benefits of this Research

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

- The Caribbean Sea is a special area and there is need for risk management
- Therefore there is an urgent need to monitor and manage risks to maritime navigation to ensure improved security of the maritime environment.

Novelty of this Research

- Global Quantitative Analysis of Maritime Casualties and Incidents for the past 18 years.
- Regional Assessment of Maritime Accident Hotspots across the Wider Caribbean Region.
- The development of a variety of covariates was demonstrated to be a suitable method to achieve modelling of the location of maritime accidents;