

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



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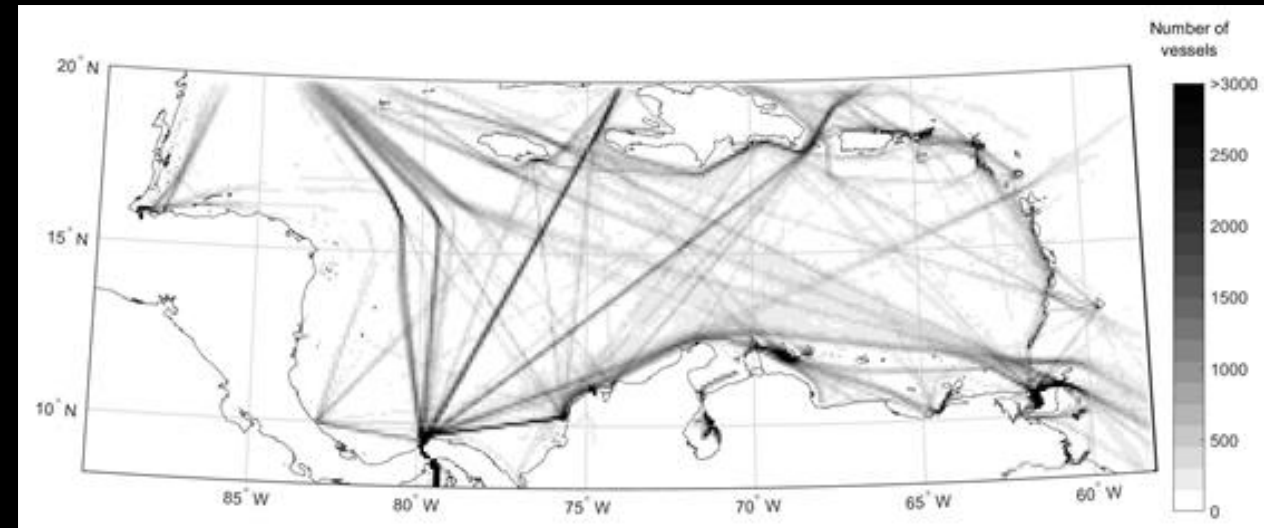
# Structure of the Presentation

- ✚ Recap of Previous Findings
- ✚ Development of Probability Model
- ✚ Implementation of Mitigation Strategies
- ✚ Benefits of Risk Assessment
- ✚ Conclusion



# Study Area: The Caribbean Sea

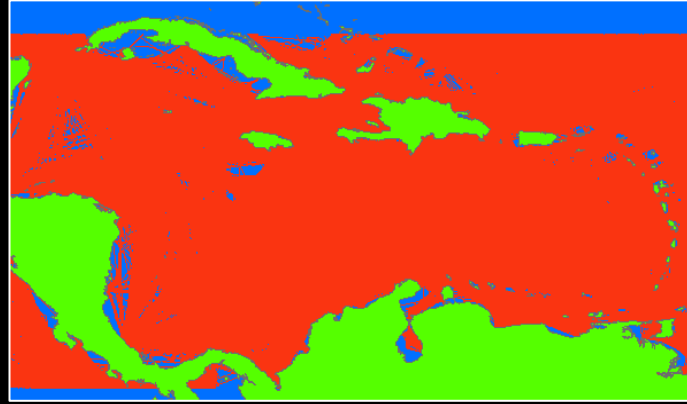
- ❖ The Caribbean is a busy shipping maritime environment representing a wide range of shipping activities.
- ❖ The shipping activities become more complex as large-scale offshore operations and maritime activities continue to increase.



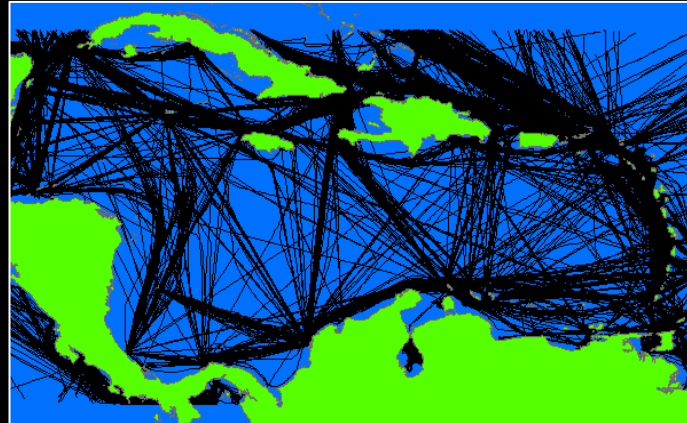
**Figure 1 : Marine Traffic across the Caribbean Sea**



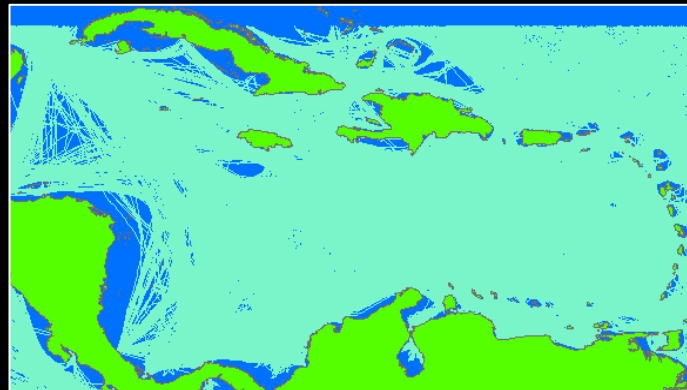
# Types of Vessel Traffic: Caribbean Region



Cargo Transits



Passenger Transits



Tanker Transits



# Importance of Study: Consequences of Maritime Accidents

- ❖ Economic loss - Overall decrease in transshipment 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 9<sup>th</sup>, 2014

# Objectives of the Study

**AIM:** To reduce the risk of maritime navigation by developing a risk assessment strategy that considers the likelihood of a vessel incident occurring across the Caribbean Region.

## **OBJECTIVES:**

- ✿ Assessment of shipping accidents globally to identify key causation factors that influences a maritime accident.
- ✿ Development of probability model based upon additional conditions that influence vessel's behavior.
- ✿ Apply mitigation measures such as improved charting for traffic management to re-assess the risk due to maritime navigation.
- ✿ Evaluation of risk reduction strategies along with associated benefits of implementation to long term reduction in pollution events and loss of life.

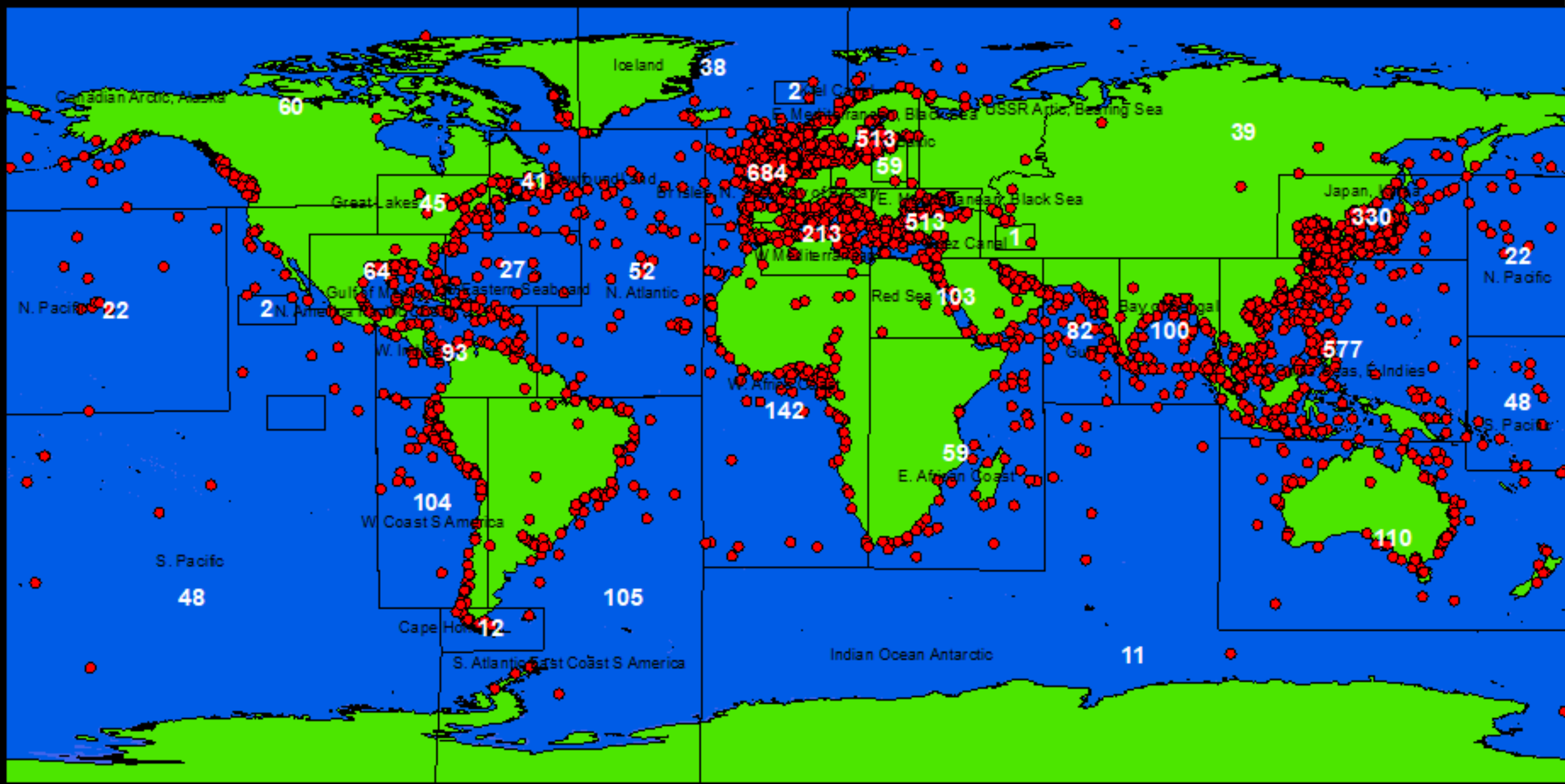


# Preliminary Results

## Quantitative Analysis of Maritime Causalities and Incidents

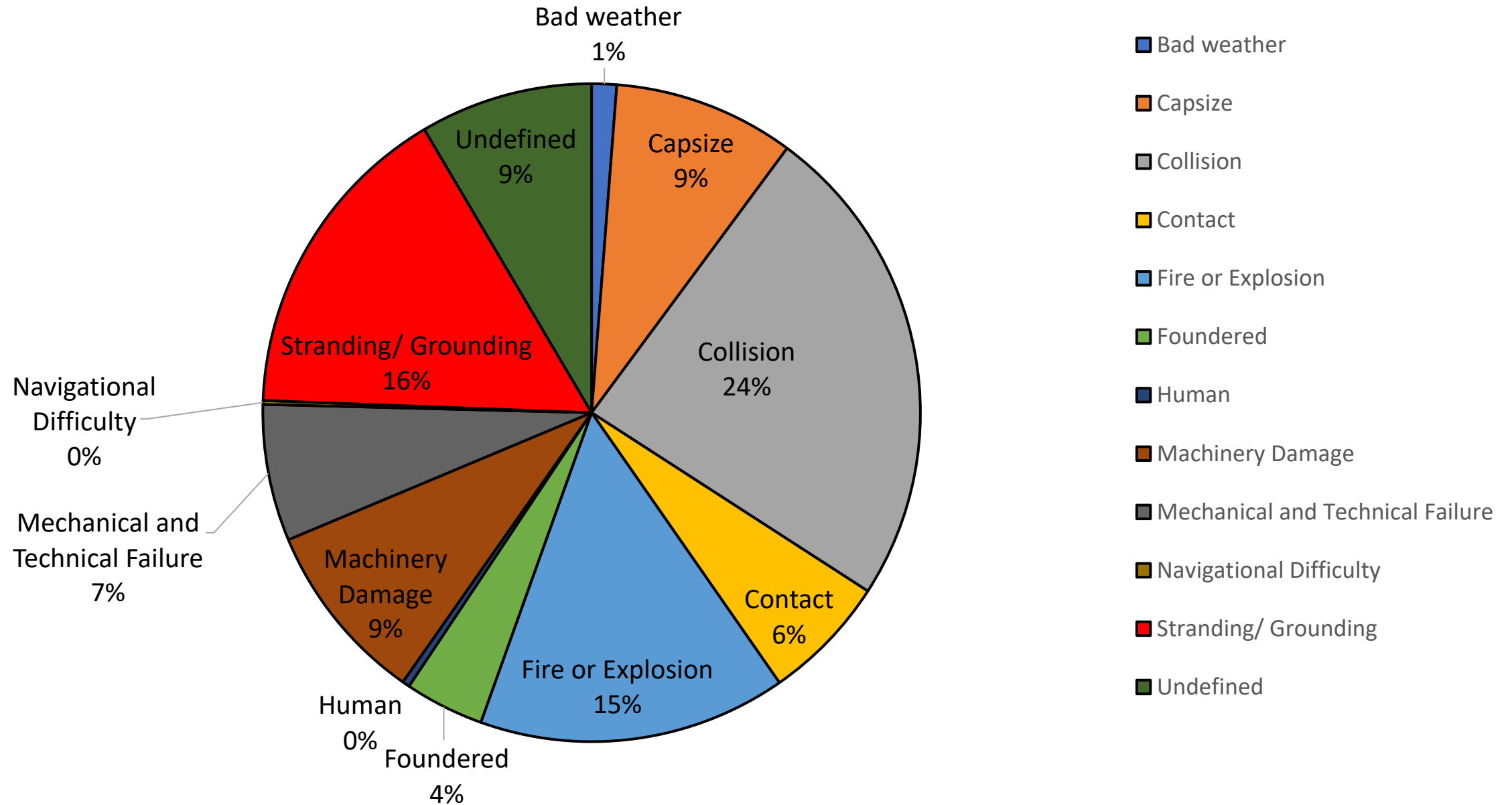


## Location of Maritime Casualties and Incidents





# Percentage Distribution of Accident Types





**90%** of global trade is carried by international shipping.



**Severe** weather conditions experienced at the Bay of Biscay

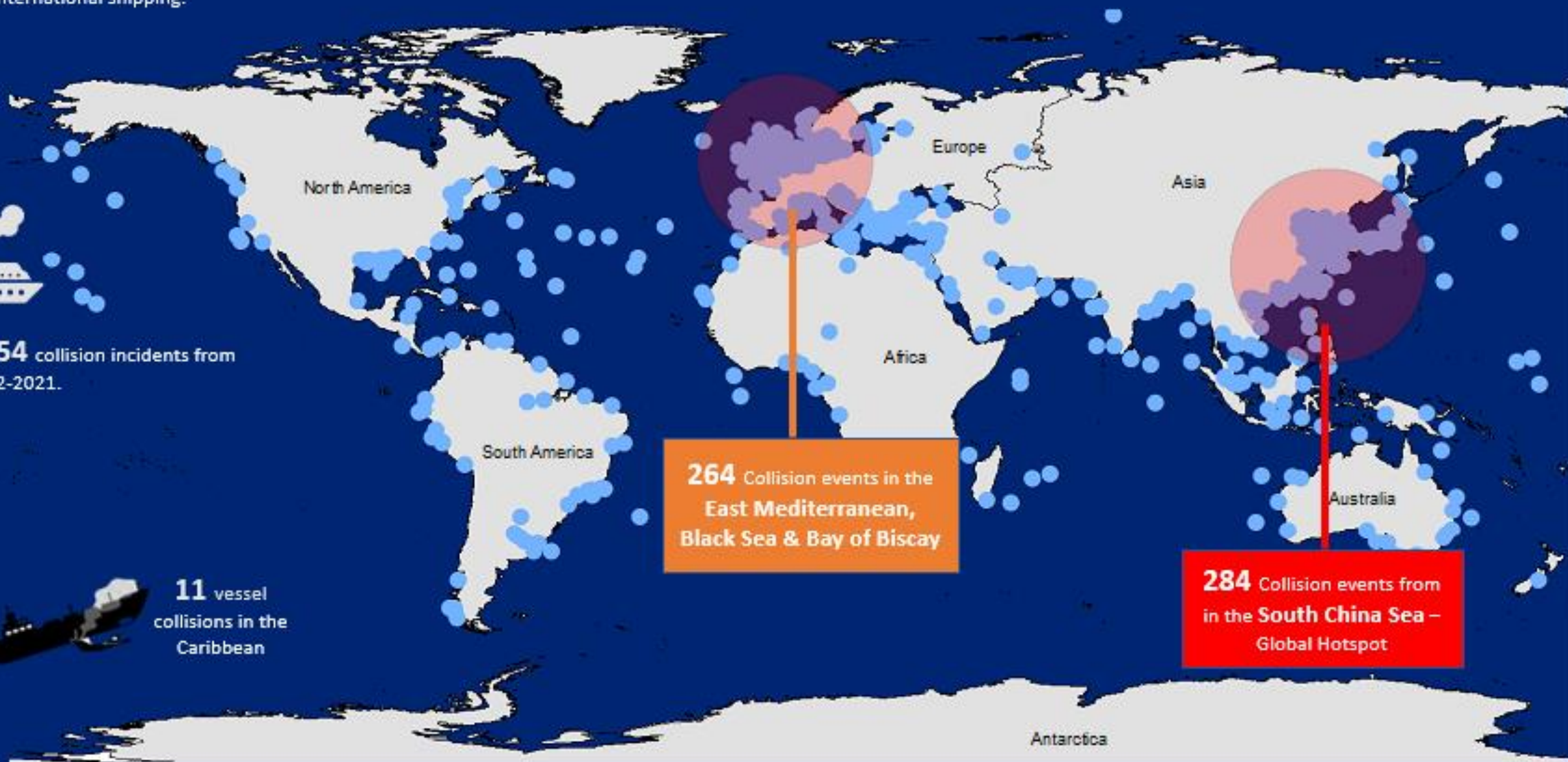
## Location of Collision Incidents (2002-2021)



**1254** collision incidents from 2002-2021.



**11** vessel collisions in the Caribbean





## Location of Grounding Incidents (2002- 2021)

832 total losses over  
past 20 years



Bay of Biscay

Black Sea

South China Sea

487 Cargoes

71 Containers

114 Tankers

Antarctica

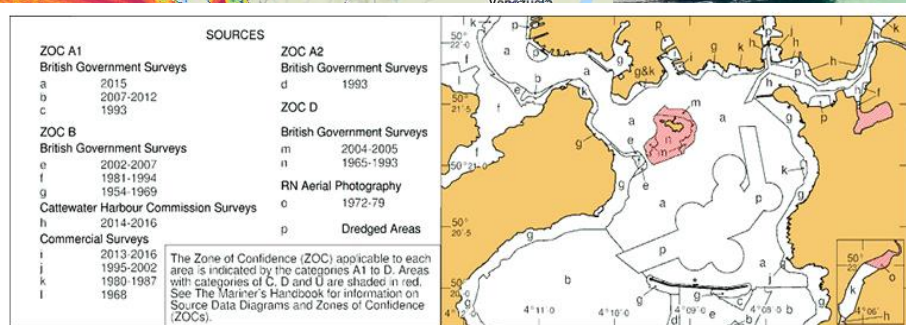
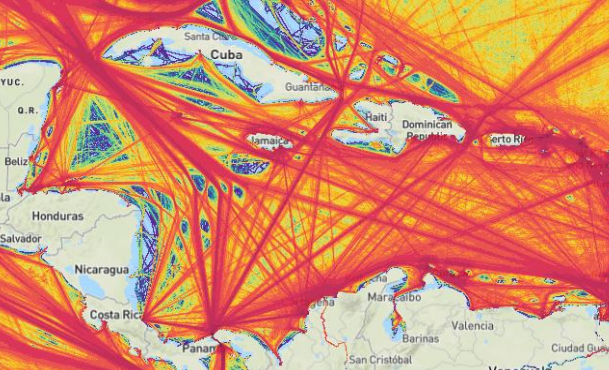


# Findings of Quantitative Analysis of Maritime Causalities and Incidents

The probability of a shipping accident will occur when all the following factors act together:

1. Key hotspot locations (S.E. Asia, the E. Med/ Black Sea, N, Sea/ British Isles);
2. A majority of poorly performing flag States.
3. Vessel type
4. Size of vessel
5. Time of Incident; and
6. Age of vessel





# Causation Factors

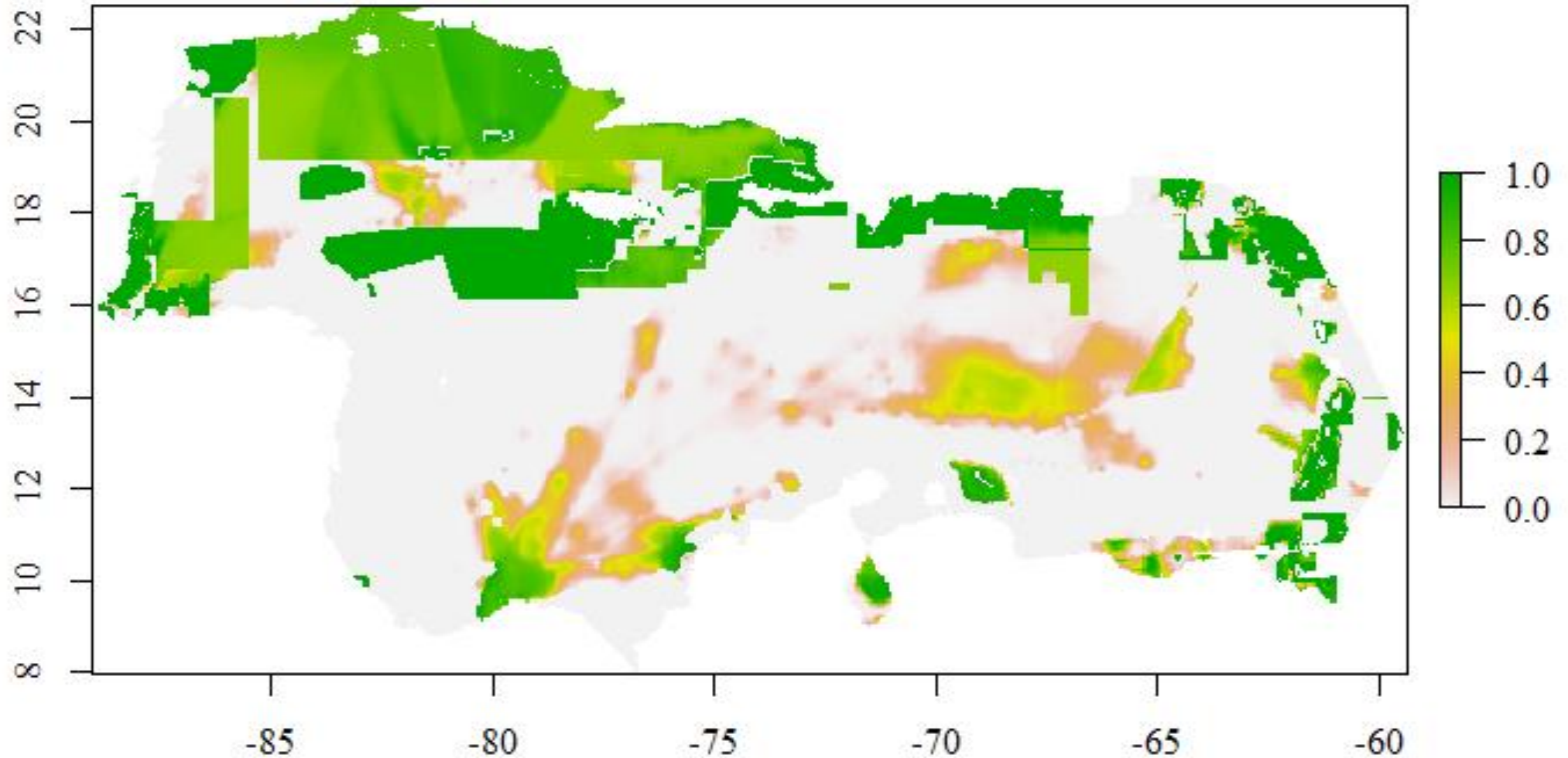
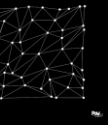




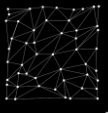
# Predicting Maritime Events with ANN



# Preliminary Findings of Probability Model



Maritime Accident Predictions of the Caribbean Sea





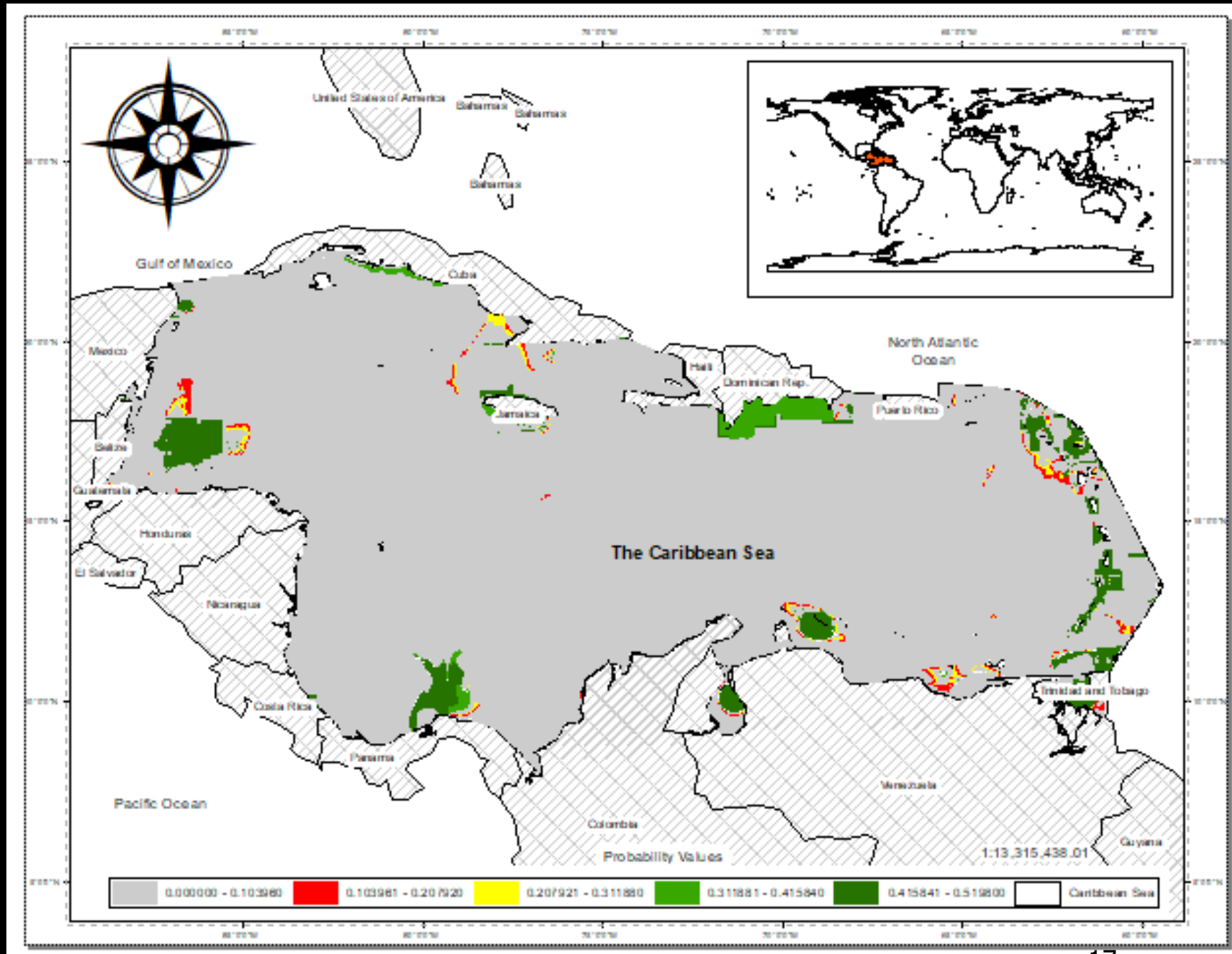
# Risk Reduction Approach

Predictors	Improvements
CATZOC	More recently surveyed areas
Survey Age	Recent Surveys
Navigational Hazards	Less Navigational Hazards
Flag State of Vessel	Less number of incidents associated with each flag
Aids to Navigation	More AtoNs
Age of Vessel	More newly constructed vessels



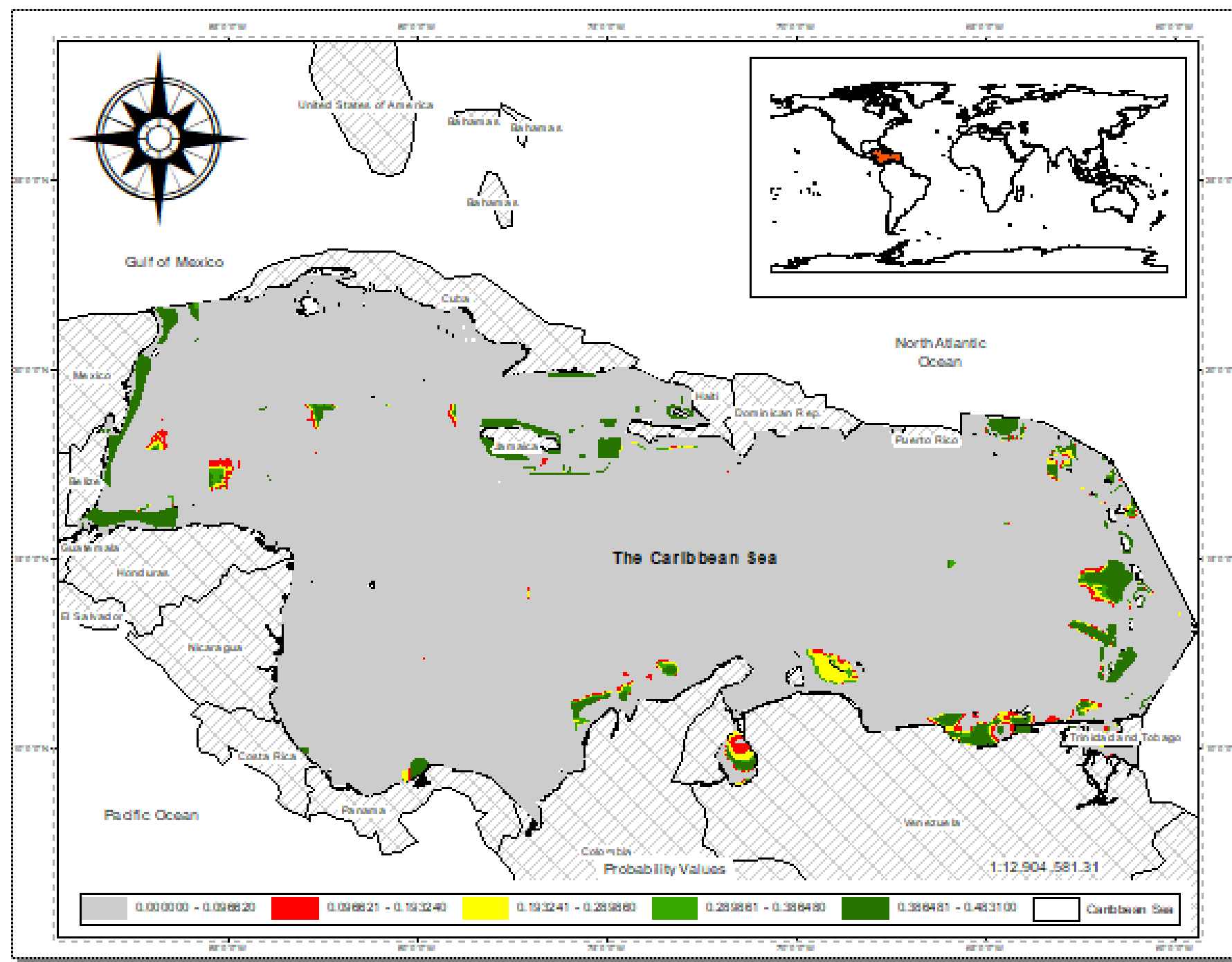
# Improvements to CATZOC

- ❖ The CATZOC surrounding the port approaches along the Southern coastline of the Dominican Republic were improved from ZOC C to ZOC B. Due to the improvements, the probability markedly reduced to 0.3.
- ❖ The open sea areas were also reduced substantially within the North of Honduras and East of Belize.
- ❖ In addition, the risk due to maritime navigation was also reduced along the port approaches within the Southern coastline of Cuba.



# Improvements to Hazards

- ❖ In the open sea areas, west of the Lesser Antilles, the high-risk area was notably decreased with probabilities ranging between 0.1 - 0.3.
- ❖ The regions that are mainly affected by the changes of the navigational hazards are areas surrounding the port approaches of the Lesser Antilles, port approaches of Jamaica, the entrances of the Panama Canal, Northern coastal areas of Honduras and North-East of Venezuela.



# Summary of Findings

- The presentation presents application of the ANN modeling with GIS technology to predict the potential incident location of maritime events based on several combination of selected risk factors.
- The results indicate that the neural network based-GIS modeling can be powerful alternative approach toward automated spatial decision making.





# Novelty of this Research

- ✿ Global Quantitative Analysis of Maritime Casualties and Incidents for the past 20 years.
- ✿ Regional Assessment of Maritime Accident Hotspots across the Caribbean Region.
- ✿ The development of a predictive model using Artificial Neural Networks
- ✿ Adoption of Mitigation Strategies across the Caribbean Sea