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An Assessment of the Impact of Weather Upon Shipping Patterns using AIS Data and Weather APIs

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Background & Motivation

Shipping forms the backbone of the globalised world economy, sustaining the quality of life for much of the global population. Despite the large technological advancements in shipping and port infrastructure, the shipping network is still impacted by extreme weather. Understanding how shipping activity changes in relation to extreme weather conditions is important for developing the policies and regulations needed to create a more resilient shipping network. The information needed has become more accessible with the increasing availability of Automatic Identification System (AIS) and weather API data. Within this context, this investigation assesses the influence of extreme weather on the spatial distribution and operational behaviour of the North Sea shipping network using AIS and weather API data.

Data & Methods

The AIS dataset is ingested from 24-01-2020 to 30-04-2020. Samples for calm and extreme weather conditions are extracted from the dataset using the weather API data by applying a criterion of gust speed, wave height and precipitation. Records belonging to cargo and tanker vessels are filtered for analysis. The AIS data is explored through three methods: geofencing, traffic density mapping and network analysis. Geofencing uses polygons to group the AIS point data, creating shipping statistics that measure shipping and port activity. Traffic density mapping converts AIS point data into gridded vessel route density maps that plot the spatial distribution of vessel traffic density. Finally, the AIS point data is converted into a spatially representative network graph using complete hierarchical clustering and the Dijkstra's shortest path algorithm so the network size, complexity, and connectivity can be measured using network analysis techniques. The difference between the calm and extreme weather samples are then quantified using an independent t-test for the shipping and network statistics and a local Getis-Ord G* hotspot analysis for the traffic density maps.

Key Findings

Results from the analysis confirm that extreme weather causes an overall decrease in shipping activity within the North Sea. The shipping statistics show that extreme weather causes a general reduction in extra-basin activity, port activity and shipping activity (Figure 1a). The traffic density maps reveal that extreme weather results in a decrease in shipping activity throughout most of the North Sea, with some pockets of increased activity (Figure 1b). The network analysis suggest that extreme weather causes the shipping network to decrease in size, complexity, and connectivity during extreme weather (Figure 1c).

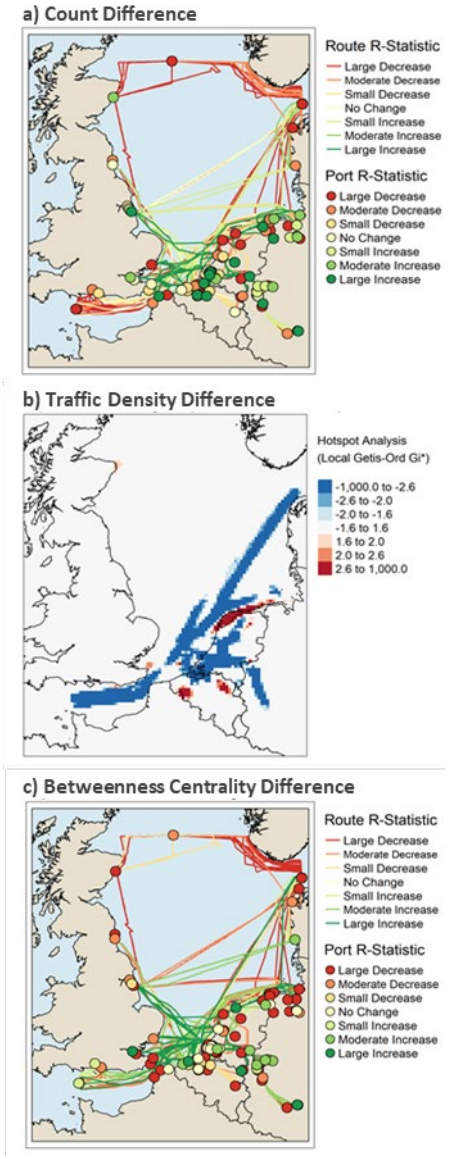

Figure 1: Maps showing the differences in (a) event count, (b) traffic density and (c) betweenness centrality. Interactive maps of the results can be found at: https://jdfj3.shinyapps.io/Dissertation/.

Value of the Research

Overall, the investigation has successfully developed a workflow that converts raw AIS data into useful data products. These products can help map and quantify the impacts of extreme weather on shipping, providing a better understanding of its economic impacts and support hazard mitigation planning. The statistics produced can also act as precursors for further analysis, laying the groundwork for an extensive range of future work that can increase the usefulness of AIS data in maritime planning. It also improves the visualisation of AIS data and aids in its interpretation, potentially increasing its use cases.