Mapping the Safety of Navigation in UK Waters

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Background

Accidents involving vessels can result in loss of life, major pollution and economic impacts. Within the UK alone, the Marine Accident Investigation Branch (MAIB) record more than 1,000 incidents each year [1]. Understanding where these incidents are most likely to occur and why, allows coastguards to more effectively both prevent incidents and prepare to respond to their consequences.

Yet, these studies are generally conducted at a local or regional scale and are therefore disjointed and incomparable [2], failing to recognise that shipping is international and cross-border. Furthermore, risk analyses are limited to local jurisdictions such as ports that are an inadequate spatial unit for national policy decisions. There is therefore a need to develop more robust national models of maritime risk, combining big data analytics with spatial statistics.

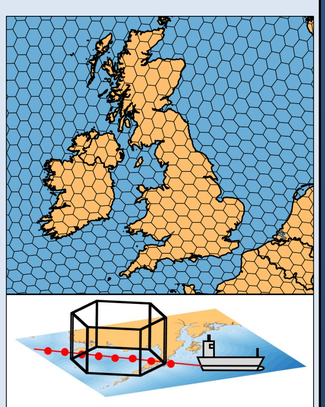
This work aims to analyse the spatial distribution of maritime risk to support decision makers in managing navigation safety.

Methodology

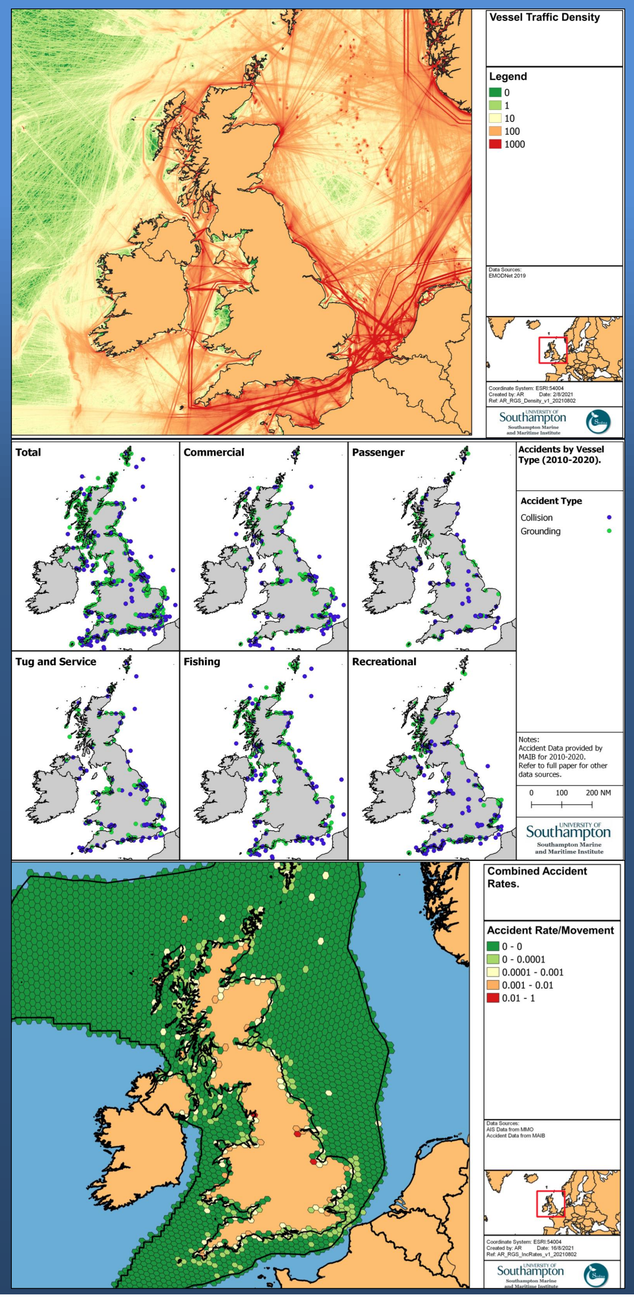
The spatial distribution of maritime accidents and shipping activity are compared using a Geographical Information System (GIS):

- More than 10,000 accidents recorded between 2010 and 2020 by the MAIB are analysed.
- The density of historical transits as collected from the Automatic Identification System (AIS) is calculated. [3]
- Other features such as ports and traffic lanes are mapped.

The data is encoded using a Discrete Global Grid System (DGGS) to fuse the heterogenous datasets into a holistic model [4]. Incident rates are calculated to show relative risk.

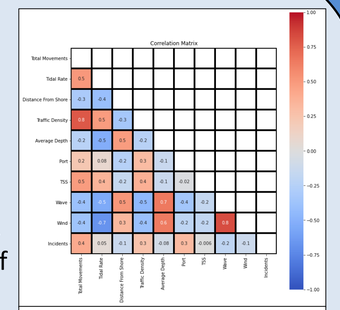


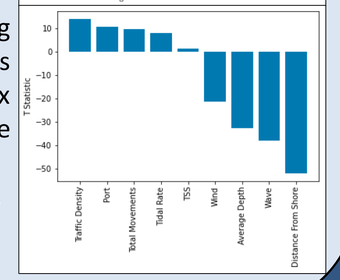
DGGS Encoding of AIS/Incident Data



Results

The mapping clearly identifies areas of high and low relative risk, that might warrant additional action by the coastguard. In particular, the majority of accidents occur adjacent to major UK ports, with much of the UK's EEZ having relatively few accidents. However, when calculated as a rate, many of the busiest waterways have relatively low accident rates, with inland waterways having particularly high rates. Furthermore, analysis of different factors using a correlation matrix and t-test shows that traffic density, distance from shore and presence of ports are strongly correlated with accident frequency. Inclusion of other factors could be used to help guide policy decisions.





Summary and Conclusions

The analysis identifies clear hot-spots of collisions and groundings immediately adjacent to the UK's major ports, with few accidents occurring offshore, even in busy shipping lanes. The results show that different representations of risk can be provided using relative and absolute numbers of accidents. The method also enables statistical analysis of the contributory cause of different incident types.

An expansion of this work could include the inclusion of new features or development of a risk prediction framework using machine learning and big data techniques. From this work, a risk management framework can be developed to optimise the allocation of mitigation, such as Search and Rescue assets, and to provide an evidence base for decision makers for marine spatial planning purposes.

References

[1] MAIB (2021). Annual Report. Available at: https://www.gov.uk/government/publications/maib-annual-report-2020.
[2] EMSA (2018). Joint Workshop on Risk Assessment and Response Planning in Europe. 14 April 2018, London.
[3] MMO (2014). Mapping UK shipping density and routes from AIS (MMO 1066).
[4] Barnes, R. (2016). dggridR: Discrete Global Grid Systems for R. Available at: https://github.com/r-barnes/dggridR.

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