CASE STUDY ON THE APPLICATION OF GIS TO MARINE GEOLOGY

Research Title: Comparison of mass wasting processes on the slopes of the Rockall Trough, Northeast Atlantic

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Scope of the Research:
This study mapped and compared the dimensions and distribution of submarine landslides from the margins of the Rockall Trough, a deep-water basin (up to 3000m water depth) offshore Western Ireland. The aim of the analysis was to determine parameters of the landslides that may have controlled sliding and the amount of sediment remobilized on both slopes of the Rockall Trough and then compare the two slopes. Comparisons like that help identify causes and triggers of slope failures and examine the significance of allogenic (external to the system) vs autogenic (internal to the system) forcing. This study forms part of a larger project that seeks to assess the potential present day geohazard posed by submarine landslides for the Irish offshore. Such an event in the present day would have a socio-economic impact as submarine landslides are able to destroy marine infrastructure such as telecommunication cables and oil platforms but can also generate tsunamis. GIS was necessary to generate a statistically significant dataset (783 scarps) for analysis. The results have been published in the 37th volume of the Springer series in Advances in Natural and Technological Hazards Research entitled Submarine Mass Movements and their Consequences (6th Symposium) (Georgiopoulou et al., 2014).

Overview
A high-resolution bathymetric dataset acquired through the Irish National Seabed Survey, a joined programme between the Geological Survey of Ireland and the Marine Institute completed in 2003, was used in this study (Fig. 1). The dataset was imported in ArcGIS and the Spatial Analyst Tools were used to generate slope and hillshade maps that allowed us to identify slope scarps (Fig. 2). Those were manually mapped (red lines in Fig. 1), creating a shape file which was then used to extract slope gradient and water depth at scarp location as well as scarp length.

Findings
The two slopes resent very different styles of mass wasting. The eastern margin is dominated by numerous, high spatial density, short scarps, whereas the western margin is dominated by long, high but more spatially spread scarps (Fig. 1). This means that sediments on the eastern margin were progressively being evacuated while on the western margin larger volumes collapsed in more abrupt episodes. None of the two areas demonstrates a relationship between scarp location and slope gradient or scarp location and water depth (Fig. 3).

Highlights
The type of landsliding on each slope indicates that there is a larger tsunami threat from the western margin as larger volumes of sediment are more likely to generate tsunamis. On the other hand regular small landslides are more significant terms of seabed infrastructure and so the eastern margin appears to be more prone to those. The lack of relationship between scarp location and
slope gradient or water depth is counter-intuitive as one would expect at least slope gradient to be important. In fact in both cases landslides seem to be more affected by the mode of sedimentation and therefore the rate of sediment buildup in the respected slopes. GIS use in conjunction with high-resolution bathymetric data make the findings statistically significant considering that a total of more than 780 scarps were mapped.

Figure 1 Shaded relief bathymetric map of the study area. Marked with red lines are the mapped scarps based on hillshade and gradient maps generated in ArcGIS. The yellow dashed line represents the maximum extent of the British Irish Ice Sheet (After Benetti et al. 2010). The white lines show 2D seismic profiles of the DGER survey (Petroleum Affairs Division). Bathymetric contours are shown at 500 m intervals. Box defines location of figure 2. RBSC: Rockall Bank Slide Complex; DBF: Donegal-Barra Fan. Modified from Georgiopoulou et al. 2014

Figure 2 Slope gradient image of a part of the Eastern Rockall Bank (see fig. 1). The orange-red colours indicate locations of steep and abrupt slope gradient interpreted to be landslide scarps.
Figure 3 (a) – (c) Scatter plots of scarp parameters expressed in log-log; (d) Table of correlation coefficients (Spearman Rank coefficient, rho for the examined parameters.


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