PhD Program in Maritime Science and Technology

Curriculum in Engineering for Marine and Coastal Environments

The research projects submitted for the admission to the PhD program must be prepared in accordance with one of the projects listed in this file, which are organized by general thematic.

Project: Geo-Hazard of Turbidity Currents on Underwater Infrastructures in a Changing Climate

Keywords: turbidity currents, sediment transport, submarine geohazard, underwater infrastructures, numerical modelling

Description: The aim of this PhD fellowship is analysing the impact of turbidity currents on underwater infrastructures. Turbidity currents are sediment gravity flows that, once initiated, can traverse considerable distances, spanning hundreds to thousands of kilometres into the deep ocean, and reach velocities as high as 20 m/s (Piper et al., 1999). The potential consequences for infrastructure along their path are severe, as demonstrated by the impact on the submarine cable sector dating back to the installation of the first transatlantic cables, notably during the 1929 Grand Banks earthquake and other subsequent events. Recent cable displacements and ruptures in Taiwan's Gaoping Canyon and in the Congo Canyon serve as a stark reminder of this ongoing risk faced by offshore facilities (Carter et al., 2012; Talling et al., 2022). Amid the rapid expansion of submarine telecommunication and power cables, offshore oil & gas projects, scientific monitoring experiments, deep-sea mining, and renewable energy initiatives since the 1990s, the exposure of seafloor infrastructures to storm-induced turbidity currents becomes an increasingly significant geo-hazard that demands effective management strategies. Coupled with the increased exposure associated with the growth of offshore infrastructure installations trends in climate change indicate that a warming ocean could lead to the development of larger and stronger cyclonic storms (Emanuel, 2003). Understanding the effect of stronger storms, on coastal climate on the frequency and magnitude of turbidity currents is a topic that remains largely unknown.

In response to these challenges, this PhD research project involves a comprehensive and systematic investigation of the complex interactions between storms, triggering and development of deep-sea sediment gravity flows. The project's multi-faceted approach starts with the analysis of synthetic tropical cyclone databases, enabling controlled studies even in regions with limited historical data, such as those at the edges of cyclone basins. This approach combines the benefits of using global climate models and synthetic modelling to generate future climate synthetic tropical typhoons spanning hundreds of years (Bloemendaal et al., 2022). Parametric relations for cyclonic wind and pressure fields will be employed to extract site-specific data from these databases, while refined parametric formulas for cyclone-induced waves and storm surges will provide crucial information on wave and water level conditions across selected study sites. The analytical wind field formulation will be calibrated through the results of high-resolution simulations of typhoons performed in selected areas of interest.

The outcome of this research project will aid in developing targeted mitigation strategies, enhancing the resilience of energy and telecommunication networks, discriminating between natural and anthropogenic risks for underwater infrastructures, and supporting sustainable coastal and offshore development in storm-prone areas, paving the way for sustainable development and climate adaptation in the face of increasing cyclonic activities and sea level rise.

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Relevant links: www.weatherwatersand.com