



## Hidden Wrecks and Black Reefs: Harnessing AI to Unveil Maritime Mysteries and Environmental Risks

**Alexandra Karamitrou**<sup>1</sup>, Frase Sturt<sup>1</sup>, and Petros Bogiatzis<sup>2</sup>

<sup>1</sup>University of Southampton, Department of Archaeology, United Kingdom

<sup>2</sup>University of Oxford, Department of Earth Sciences, United Kingdom

Shipwrecks have long fascinated people with their stories of mysteries and hidden treasures. UNESCO estimates that more than three million shipwrecks lie undiscovered in the world's oceans and lakes, yet less than 10% of these have been precisely located. Beyond their historical and archaeological significance, shipwrecks can pose significant environmental threats. Instead of treasures, they often conceal harmful substances like fuels and corroded heavy metals, which, if released, can harm surrounding ecosystems and nearby communities.

This study introduces an innovative artificial intelligence (AI) approach, leveraging convolutional neural networks (CNNs) and open-access remote sensing data, to detect and map shipwrecks in remote coral reefs. The method is designed to identify wrecks based on the environmental footprint they leave, referred to as "Black Reefs", even in cases where the shipwreck itself has completely degraded.

One of the primary challenges was the limited availability of known black reef locations, which restricted the training dataset. To address this, a supervised fully convolutional neural network architecture, called SimpleNet, was employed. This architecture is specifically suited for scenarios with small labelled datasets. From a shortlist of eight suitable reefs (e.g., Kenn, Nikumaroro, Kingman, Kanton, and Rose), five were used for generating training and evaluation data, while the remaining were excluded due to low-resolution imagery or cloud interference.

Image tiles of 256 x 256 x 3 bands were extracted from the training reefs, resulting in approximately 1,600 labelled images. For evaluation, small sections of Kenn and Rose reefs were used to train the model, while other portions served as test datasets. Training was conducted using the IRIDIS supercomputer at the University of Southampton, utilizing 12 CPUs, one node with 264 GB of memory, and MATLAB 9.6 (2019b). The training process took approximately two hours.

The results demonstrate that even with limited training data, the SimpleNet architecture, featuring just eight fully convolutional layers, can efficiently identify and classify black reefs, indicating the presence of shipwrecks. Moreover, the algorithm provides a tool for monitoring reef discoloration and assessing ecological impacts over time through time-series imagery.

This study underscores the potential of AI-driven methods to enhance shipwreck detection and environmental monitoring, offering an efficient, cost-effective solution for tackling the challenges posed by limited ground data and inaccessible regions.