

Transfer Learning Models for Oil Spills Detection Based on Satellite Data

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Introduction

The HORIZON Europe project iMERMAID is devoted to the development, implementation, and demonstration of innovative strategies for preventing, monitoring, and mitigating toxic and enduring chemical pollution in the Mediterranean Sea. A key focus of this study is oil spill detection based on free satellite data, which aligns with the iMERMAID project's main goals. Literature analysis makes clear that the most informative and accessible source of information is Sentinel-1 SAR data. However, the most significant constraint is the lack of available training data for the pilot territory. This study solves this problem via a transfer learning neural network technique.

Data and Method

A transfer learning approach for an oil spill detection model utilizes ~270 Sentinel-1 fragments, an open dataset from Marine Pollution Surveillance Reports for the Atlantic Ocean from 2018-2020, 2022-2023 for training and 2021 for testing. The model employs the LinkNet semantic segmentation network and its ability to generalize SAR imagery for the pilot region. For the Mediterranean Sea, coordinates with oil spills from CleanSeaNet reports are available, but only the accident year is indicated, without date specification. This 2022 information was used for model testing in the region near Cyprus.

Results

The model achieved an F1-score of 0.721 and IoU of 0.564 on the validation set. The results also indicate applicability of the proposed approach and its effectiveness for the independent Atlantic and Mediterranean regions. The transfer learning strategy demonstrates potential for automated expansion of oil spill monitoring to new areas lacking training data.

Conclusion

With further refinement, similar systems could provide actionable information to stakeholders working to mitigate environmental damage from oil spills. We plan to continue this research by expanding the dataset diversity, exploring model extensions, and conducting tests on larger geographic areas.

Keywords

Oil spill detection, Mediterranean Sea, remote sensing, Satellite imagery, SAR Sentinel-1, Deep learning, Transfer learning.