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EDITORIAL

Editorial: data science and AI for marine science and the blue economy

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Abstract

This editorial introduces the Special Collection "Data Science and AI for Marine Science and the Blue Economy" published in the International Journal of Data Science and Analytics. The collection explores how data-driven and AI-enabled approaches are advancing marine research, supporting operational monitoring, and enabling evidence-based decision-making across blue economy domains. The guest editors summarize the motivations for this initiative, briefly present the contributions included in the issue, and outline emerging themes and future perspectives in this evolving interdisciplinary field.

Keywords Data science · Artificial intelligence · Marine science · Blue economy

1 Introduction

The ocean plays a fundamental role in sustaining life on Earth and supporting global economic and social development. Yet, marine ecosystems face unprecedented pressures caused by climate change, pollution, overexploitation of resources, and loss of biodiversity. Addressing these complex challenges requires a deeper and more timely understanding of marine environments, coupled with innovative approaches that enable informed and sustainable management of ocean resources.

In recent years, the convergence of data science and artificial intelligence (AI) with marine science has opened new opportunities to monitor, model, and predict ocean processes at scales and resolutions that were previously unattainable. The growing availability of in situ observations, satellite imagery, sensor networks, and autonomous platforms has generated vast volumes of heterogeneous marine data. These data, when combined with advanced analytics, machine learning, innovative services and infrastructures, and open science practices, can lead to actionable insights supporting ecosystem conservation, resource optimization, and the transition toward a sustainable blue economy.

This Special Collection brings together a diverse set of contributions that exemplify how computational and data-driven methods are applied to marine and maritime domains. The aim is to illustrate the state of the art in data-centric marine research, to demonstrate practical implementations that move beyond theoretical exploration, and to highlight cross-disciplinary collaboration among data scientists, oceanographers, ecologists, and engineers.

The papers included in this collection reflect a shared commitment to openness, reproducibility, and operational relevance. They collectively show that data science and AI are not only enhancing scientific discovery but also transforming how ocean data are managed, shared, and used to support sustainable development goals. In what follows, we summarize the contributions presented in this collection and discuss their implications for the evolving landscape of marine data analytics and blue economy innovation.

2 Overview of the contributions

The papers featured in this Special Collection illustrate the diverse ways in which data science and AI are supporting

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marine science and blue economy research. Together, they provide a comprehensive view of the data lifecycle—from data acquisition and management to analysis, prediction, and operational use.

Coro et al. [3] present an open science automatic workflow for multi-model species distribution estimation, which introduces a fully automated and reproducible framework for species distribution modeling. The workflow integrates multiple modeling algorithms and data sources within an open science architecture, enabling scalable and transparent production of biodiversity predictions. This contribution showcases how automation and FAIR data practices can accelerate the delivery of actionable ecological information.

Mishra et al. [7] present a topic modeling approach where unsupervised learning is used to analyze publication trends in computational economics. By revealing the evolution of research themes over time, this study contributes to understanding how data science techniques can illuminate socio-economic dimensions of the blue economy and inform future research priorities.

Wijaya and Nakamura [9] apply data mining techniques to Automatic Identification System vessel data to derive indicators of port efficiency. Their approach combines trajectory segmentation and classification to quantify port performance metrics, offering a data-driven method for monitoring maritime logistics and sustainability objectives.

Boldrini et al. [1] details the design and implementation of the Blue-Cloud Data Discovery and Access Broker, a federated system that integrates heterogeneous marine data resources into a unified open science environment. This paper demonstrates how interoperable data infrastructures can support collaborative and reproducible research across the marine and blue economy domains.

Canelas et al. [2] contribute a paper demonstrating the use of deep learning to detect marine mammals in aerial imagery. By combining convolutional neural networks with high-resolution drone data, the authors achieve accurate and efficient detection of cetaceans. This work offers a scalable and non-invasive tool for wildlife monitoring and marine biodiversity protection.

Li et al. [6] propose a paper addressing one of the most persistent challenges in marine observation: ensuring reliable data at scale. Their method employs active learning to optimize expert validation efforts, reducing the annotation workload while maintaining high data quality. This study exemplifies how human-in-the-loop AI approaches can enhance the efficiency and consistency of ocean data curation.

Giuffrida et al. [4] discuss the adoption of FAIR data principles to foster circularity in aquaculture. The paper identifies key barriers and enablers to effective data governance, proposing a roadmap that aligns technical, organizational, and policy perspectives. It highlights how robust data management frameworks underpin innovation and sustainability within the blue economy.

Kim et al. [5] propose an hybrid model integrating classical decomposition methods with deep learning to forecast dissolved oxygen levels accurately and in real time. The work demonstrates how AI-enhanced predictive modeling can optimize aquaculture operations and support environmentally sustainable production.

Veylit et al. [8] propose a digital toolbox for marine restoration that, by leveraging digital infrastructures, aims at democratizing knowledge by going beyond mere data sharing by aggregating and openly disseminating best practices, methodological approaches, and digital tools to a broad audience of practitioners and non-academic users.

3 Conclusion

This Special Collection successfully captured the dynamic and transformative power of AI-enabled approaches across the marine domain.

The assembled works collectively demonstrate that the convergence of Data Science with Marine Science is not merely academic, but foundational to solving complex real-world challenges. Contributions showcased in this issue span a wide range, from developing automated workflows for biodiversity modeling and effective deep learning models for marine mammal detection, to generating data-driven port efficiency metrics and implementing hybrid models for real-time aquaculture risk prediction. These are all methodologies designed for tangible, operational impact.

Crucially, a significant theme emerging across the collection is the indispensable role of open science principles and robust data infrastructures in the future of the blue economy. Several papers highlighted the technical and policy work needed to make marine data Findable, Accessible, Interoperable, and Reusable (FAIR). This includes work detailing the necessary infrastructure for metadata harmonization and platforms that provide scalable pathways for experts to ensure the high quality and reliability of ocean observation data. Furthermore, the commitment to open and reusable practices extends to knowledge democratization, with contributions showcasing the development of Digital Toolboxes designed to put science-based best practices for marine restoration directly into the hands of practitioners.

In closing, the contributions in this collection affirm that the next wave of advancement in marine science and the blue economy will be inherently data centric and driven by a systemic embrace of open science. The papers not only offer innovative solutions but also define the strategic imperative for continued investment in the shared digital infrastructures and collaborative frameworks that will allow these AI and data science tools to achieve their full, scalable impact in support of global sustainability goals.

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