frontiers | Frontiers in Marine Science

TYPE Editorial
PUBLISHED 24 October 2023
DOI 10.3389/fmars.2023.1316092

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RECEIVED 10 October 2023
ACCEPTED 16 October 2023
PUBLISHED 24 October 2023

CITATION
Fu W and Ono T (2023) Editorial: Oxygen decline in coastal waters: its cause, present situation and future projection.
Front. Mar. Sci. 10:1316092.
doi: 10.3389/fmars.2023.1316092

Editorial: Oxygen decline in coastal waters: its cause, present situation and future projection

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KEYWORDS

coastal waters, oxygen decline, biodiversity, coastal dynamics, impact on fishery

Editorial on the Research Topic
Oxygen decline in coastal waters: its cause, present situation and future projection

Introduction

The decline of oxygen levels in coastal waters has emerged as a significant and pressing concern, carrying extensive ecological and environmental ramifications. Coastal areas, the interface between land and sea, represent intricate and dynamic ecosystems that hold paramount importance for global biodiversity and sustain a multitude of human activities. Nevertheless, these coastal regions are confronted with mounting stressors originating from both human-induced factors such as nutrient pollution (Dai et al., 2023), natural forces like coastal modifications (Newton et al., 2016), and climate change forced by anthropogenic CO_2 emission (Bindoff et al., 2019; IPCC, 2021). Moreover, coastal zones exhibit intricate dynamics, posing a formidable challenge in comprehending the underlying causes, evaluating the current state, and projecting future oxygen decline trends within these environments. This thematic research area comprehensively explores several pivotal facets of oxygen decline in coastal waters, contributing valuable insights into this urgent Research Topic and furnishing essential information to inform decision-making processes, support sustainable management practices, and bolster conservation initiatives.

Summary of the studies in this Research Topic

Ocean hypoxia is delicately balanced by the changes in circulation, marine production and respiration dynamics, and water temperature, as underscored by (Fu et al., 2018; Pitcher et al., 2021). This intricate balance poses substantial challenges for models, particularly in capturing long-term variability, notably within coastal waters, as noted in previous studies (Isensee et al., 2016; Breitburg et al., 2018; Meier et al., 2021). Therefore, a comprehensive assessment of the influential factors shaping ocean hypoxia becomes imperative as a prerequisite for any future projections.

The impact of elevated temperatures on the rates of organic matter (OM) degradation introduces the potential for significant alterations in dissolved oxygen (DO) levels, as evidenced by findings in the Waccamaw River watershed (Szewczyk et al.,). Notably, wetland sites exhibited considerably higher Q10 values in contrast to values observed in the river and stormwater ponds. Consequently, future models seeking to elucidate DO utilization must incorporate considerations of OM heterogeneity and the temperature sensitivity response governing OM degradation across diverse sources and regions. Such inclusion is essential for enhancing predictions pertaining to the impact of climate change on oxygen impairment within aquatic ecosystems.

On a millennial timescale, Börgel et al. shed light on the critical role played by temperature-dependent mineralization rates in driving hypoxia within coastal Baltic Sea ecosystems, particularly during the Medieval Climate Anomaly (MCA). This significant research challenges previous assertions implicating increased cyanobacteria blooms as the primary driver of hypoxia during this period. Additionally, a novel modeling approach, pioneered by Bernardo et al., was introduced to assess the combined consequences of ocean acidification and deoxygenation on calcifying organisms along the Japanese coast. Although present-day simulations yielded alignments with observed parameters, they unveiled discrepancies attributable to unaccounted factors. Furthermore, future projections conducted under high emission scenarios (RCP 8.5) accentuated the crucial importance of integrating regional and local influences into models addressing acidification and deoxygenation dynamics.

Marine hypoxia has significant ramifications for fish populations and broader marine ecosystems. The study conducted by Duskey delved into the repercussions of marine hypoxia on global fish species, emphasizing the criticality of comprehending population responses as hypoxic regions expand. This research introduced the novel concept of metabolic prioritization, elucidating its pivotal role in shaping individual and community reactions to hypoxic conditions. Furthermore, the investigation extended to the impact of hypoxia on Calanoida copepod eggs, a study conducted off the southern coast of Korea (Choi et al., 2021), where hypoxia is becoming increasingly prevalent because of global warming. Detailed analysis of sediment samples unveiled noteworthy variations in the distribution of these copepod eggs and a heightened occurrence of abnormal egg development. These findings underscore the deleterious consequences of hypoxia on Calanoida copepod eggs, thereby highlighting potential repercussions for the dynamics of marine ecosystems.

Lastly, an investigation by Kvitt et al. delved into the molecular reaction of Stylophora pistillata corals when exposed to prolonged hypoxia. This study revealed that although deoxygenation did not yield significant impacts on factors such as tissue loss or calcification rates, it did induce a noteworthy transcriptional response, particularly during the nighttime. Notably, this research uncovered an acute initial response, which subsequently led to acclimation over a two-week period. This acclimation phase was characterized by an increase in mitochondrial DNA copy numbers and discernible alterations in gene expression patterns related to processes such as symbiosis and predation capabilities. These findings collectively underscore the potential of S. pistillata corals to adapt to deoxygenation through a combination of conserved and coral-specific response mechanisms. This study also underlines the crucial role of endosymbionts and underscores how environmental disturbances can impact the resilience of corals in the face of declining oxygen levels in the ocean.

Conclusion and perspective

Our overarching objective in this Research Topic is to provide a comprehensive perspective on this pressing concern by thoroughly investigating its causative factors, appraising the existing state and impact, and projecting future trends. The Research Topic of declining oxygen levels in coastal waters presents a multifaceted and intricate challenge that necessitates collaborative interdisciplinary research endeavors, enhanced data acquisition and amalgamation techniques, innovative modeling capabilities, and well-informed policy formulation. While the precise outcomes in the future are inherently challenging to predict due to regional differences and inherent uncertainties, addressing the fundamental origins of this predicament and advancing our comprehension of coastal ecosystems stand as indispensable measures in its mitigation. These actions not only serve to protect the invaluable marine ecosystems and coastal communities but also contribute to the realization of a sustainable future for these regions and our planet.

Author contributions

WF: Writing – original draft, Writing – review & editing. TO: Writing – review & editing.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Acknowledgments

We extend our great gratitude to the researchers, scientists, and experts who have contributed their invaluable insights to this Research Topic. Your dedication to understanding and addressing oxygen decline in coastal waters is pivotal to our shared mission.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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