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Editorial: Interaction between climate change and anthropogenic pressures in the eutrophication process - volume II

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Editorial on the Research Topic
Interaction between climate change and anthropogenic pressures in the eutrophication process - volume II

Eutrophication is considered among the greatest threats to the health of estuarine and coastal ecosystems worldwide. It is a global phenomenon, with significant effects on food webs, water quality, and aquatic chemistry. Eutrophication is the result of a supply of nutrients into estuarine and coastal regions beyond the ecological capabilities of the ecosystem (Nixon, 2009; Rabalais et al., 2009). The nutrient loadings may also cause a change in nutrient ratios, which may produce an 'undesirable disturbance' in the marine ecosystems. In this end, the extent to which good environmental status (GES) can been achieved for the coastal areas, is critical. The drivers causing coastal eutrophication are set within a larger framework of multiple human-induced stressors and the impacts of eutrophication (e.g. losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters) seem to be exacerbated by synergies with other pressures, including over fishing, coastal development and climate-driven increases in sea surface temperature, ocean acidification and coastal discharge. In fact, climate change will affect nutrient inputs and behaviour and will probably exacerbate eutrophication and its associated negative impacts (Statham, 2012; Malone and Newton, 2020; Rozemeijer et al., 2021). However, the link between climate change and eutrophication is complex and is mainly related to modifications to temperature, wind patterns, the hydrological cycle, and sea level rise, resulting to inundation of freshwater systems, changes in stratification, flushing times and phytoplankton productivity, increased coastal storm activity, changes in species and ecosystem function (Statham, 2012).

The importance of eutrophication on the health of aquatic environments and its link with multiple pressures has led to compile the current Research Topic entitled: "Int*eraction between climate change and anthropogenic pressures in the eutrophication process, Volume II*".

Major themes include:

- Tools and models for eutrophication assessment, including changes over time.
- Biogeochemical consequences of nutrient enrichment and interactions between eutrophication and biological communities.
- Trends in anthropogenic pressures enhancing/reducing eutrophication.
- Interactive effects of climate variability and nutrient enrichment.
- Ecosystem comparisons across the global gradient of nutrient enrichment.
- Eutrophication effects on ecosystem services.
- Challenges and successes at managing eutrophication.

The current volume comprises 6 papers (5 original research papers and 1 review) contributed by 82 scientists working in: Australia, China, Germany, Italy, India, Maldives, Seychelles, Sri Lanka, United Kingdom, USA and Turkey. The collection of works compiled in this Research Topic contributes to better understanding the effects of different factors on marine ecosystems.

Phytoplankton in coastal marine ecosystems are affected by anthropogenic activities such as aquacultures and climate change. Yuan et al. study the relationship between climatic and anthropogenic disturbances and long-term phytoplankton changes. They used Artificial Neural Network (ANN) model coupled with paleoecological datasets (e.g. biomarker proxies in sediment cores) to reconstruct the records of Sea Surface Temperature (SST), rainfall, and the diatom and dinoflagellate biomasses. Anthropogenic activities (oyster farming) plays a dominant role in changes in phytoplankton species (diatoms and dinoflagellates), while climatic factors exert different influences between diatoms and dinoflagellates determined by their ecophysiological traits. Temperature plays a second important role, whereas, rainfall is the least important factor affecting phytoplankton. In addition, long-term warming due to climate change can increase metabolic rates, which can accelerate phytoplankton growth as well as bacterial oxygen consumption. Moreover, it can strengthen stratification and affect the seawater oxygen saturation. Codiga et al. examine the effect of managed N load decrease on marine ecosystem in relation to climate factors. According to their findings, the reduction of phytoplankton biomass and hypoxia, due to the managed load decline, is less than it otherwise would have been without warming, and warming is expected to continue to exacerbate hypoxia in the decades to come.

Understanding how fish stocks may respond to climate change is a critical first step towards anticipating alterations in marine ecosystem structure and function. McClure et al. apply the NOAA Fisheries Climate Vulnerability Assessment method to 64 federally managed species in the California Current Large Marine Ecosystem to assess their vulnerability to climate change. They find that most of the species examined have moderate or greater vulnerability to climate change.

The ecosystem of coral reefs is driven by the combination of the global stressors of increased ocean temperature and ocean acidification, coupled with more localized anthropogenic stressors. Coral bleaching immediately impacts the reef benthos and probably affects fish communities. Painter et al. review the effect of eutrophication on coral ecosystems in South Asia, in relation to climate-induced factors. It seems that there is currently limited evidence of widespread impacts of eutrophication on coral reefs, compared to the interactions with other stressors such as seawater warming, thus more extensive study is needed. Koester et al. study changes in fish abundance, biomass and community composition before and after the 2015/2016 coral bleaching event at Seychelles, considering that these changes are often delayed and confounded by anthropogenic interactions. They find that the extended surveys recorded changes in fish abundance and biomass related to coral bleaching, which would otherwise have gone undetected, highlighting the importance of survey methods that include the full suite of species to detect ecological responses to environmental drivers.

The response of the marine environments to climate-change driven changes in the intensity of extreme precipitation events in relation to human-induced eutrophication and pollution is studied by Basdurak, in the Sea of Marmara. Cumulative stressors (warming, nutrient over-enrichment, pollutants) pose a threat of triggering extreme events and eutrophication in the Sea of Marmara with multiregional impact.

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AP: Writing – original draft, Writing – review & editing. MG: Writing – review & editing. EY: Writing – review & editing.

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.

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