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Editorial: Nuclear power cooling-water system disaster-causing organisms: outbreak and aggregation mechanisms, early-warning monitoring, prevention and control

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Editorial on the Research Topic
Nuclear power cooling-water system disaster-causing organisms: outbreak and aggregation mechanisms, early-warning monitoring, prevention and control

The outbreaks of aquatic organisms have become more frequent due to the changing global climate and human activities, resulting in negative impacts on the sustainability of marine ecosystems and causing economic losses in local communities (Gobler, 2020; Prakash, 2021). Generally, these outbreaks are indicative of serious environmental disturbances and potential regime shifts in marine ecosystems (Wollrab et al., 2021; Chust et al., 2022). Meanwhile, they are particularly prevalent in waters adjacent to nuclear power plants (NPP), where they may be related to thermal discharge from the plants' cooling water (Lucas et al., 2014; Wu et al., 2023). Besides their ecological and economic impacts, these outbreaks can lead to costly shutdowns, equipment damage, and safety hazards of NPP.

Nevertheless, the processes, mechanisms, potential impact, and prevention and control strategies of disaster-causing organisms (DCO) remain unclear. Furthermore, with the increasing demand for renewable energy to combat climate change, the construction of new NPP is expected to rise (Khttab, 2021). To achieve the dual goals of healthier aquatic ecosystems and operation safety of NPP, urgent research is needed to investigate this issue comprehensively. This specific Research Topic includes twelve original research articles, a brief research article, and an article on methods, which cover organisms such as bacteria, phytoplankton, zooplankton, benthos, and fish.

The thermal discharge from NPP can increase the temperature of the surrounding water, causing changes in the local ecosystem and potentially harming marine organisms. Plankton are highly sensitive to changes in temperature, and even small increases in water temperature caused by thermal discharge can result in significant shifts in their abundance and community structure (Beninca et al., 2011). Liu et al. found that the metabolism of plankton community was enhanced in moderately warm regions, with higher gross primary production and community respiration than in regions with high and extremely high temperatures; meanwhile, the metabolism was evidently inhibited in warmer regions, showing exhibiting heterotrophic metabolism state. Hu et al. detected a rapid photosynthetic and physiological response of phytoplankton to the elevated temperature and a shift in the size-fractioned structure in the thermal discharge area, consequently, the high-temperature inhibition might stimulate the stress response of the common phytoplankton and promote high frequency of harmful algal blooms. However, a sudden drop in temperature caused by the shutdown of power plants may also affect the health and behavior of organisms. The impact of the upper and lower incipient lethal temperatures decreased during fish development, from yolk-sac larvae to juveniles, especially in response to cold shocks, indicating that later developmental stages are more tolerant of temperature fluctuations (Tian et al.). Because of their limited migration ability, relatively long lifespan, and sensitivity to environmental changes, benthos are usually considered to be an effective indicators for assessing ecosystem health (Borja et al., 2016). A test of the adaptability and vulnerability of gastropods under controlled temperature suggested that constant increases in water temperature can be fatal to the slow-moving gastropods, with cellular atrophy and necrosis (Shaikh et al.).

Marine organisms can affect the operations and safety of NPP, therefore, understanding the spatial and temporal patterns of marine organisms can help identify areas of high risk for cooling water blockage, enable the implementation of preventative and control strategies, and inform the design of mitigation measures to minimize the impacts on marine ecosystems. According to a survey conducted in Daya Bay, there was a noticeable seasonal shift in abundance and taxonomic composition of zooplankton communities. Because of their large body size and massive abundance in spring, certain kollaplankton could potentially cause severe damage to the NPP cooling system. In addition, the blooms of *Centropages tenuiremis* during spring and *Penilia avirostris* during summer could potentially lure in groups of larval or adult pelagic fish, thereby posing a threat to the security of the cooling system (Wu et al.). In extreme weather conditions like the typhoon, the threat posed by benthic organisms to the cooling-water system of NPP cannot be ignored. Cai et al. depicted the spatial and seasonal distributions of ten benthic macrofauna species which have the potential to blockage the cooling-water system of Daya NPP, and examined the environmental conditions for these species. Biofouling is a key factor affecting the safety of the water intake of the cooling-water system of coastal NPP. Lin et al. conducted a 1-year simulated concrete panel test in Xinghua Bay (China) from 2020 to 2021 and observed that fouling organisms had the highest attachment period between June and October. The study recommends implementing targeted prevention and control measures during this period, considering the larval attachment period of different dominant groups of fouling organisms.

Uncovering the mechanisms of the outbreak and aggregation of DCO is crucial to developing effective prevention and control strategies. Bacteria communities are essential in the marine ecosystem since they contribute to biochemical reactions and are involved in the chemical transformations of virtually all elements. Shi et al. investigated the community profiles of bacterioplankton, particle-attached bacteria, and colony-attached bacteria during a *Phaeocystis globosa* bloom. The results showed that the diversity of bacterioplankton and particle-attached bacteria communities significantly decreased as the bloom progressed from the exponential to the decline phase. In the decline phase of the bloom, Bacteroidota and Verrucomicrobiota were found to be the dominant and highly abundant bacteria in the bacterioplankton community, while Verrucomicrobiota dominated the particle-attached bacteria community. Large jellyfish constitute the main groups of DCO. The researchers analyzed the aggregation processes and interactions of two scyphozoan jellyfish species, *Nemopilema nomurai* and *Aurelia coerulea*, in the intake area of NPP in Eastern Liaodong Bay (China). They observed a rapid increase in the individual growth and relative biomass (RB) of the jellyfish from late June to July, followed by a rapid decrease thereafter. The RB of *N. nomurai* was found to be positively correlated with sea surface temperature (SST) and negatively correlated with levels of dissolved oxygen (DO) in the region. As SST increased, RB also increased, but it decreased with increasing DO levels. On the other hand, the RB of *A. coerulea* was negatively correlated with that of *N. nomurai*, and the two species showed alternating peaks of biomass over time. This pattern may be due to the fact that the two jellyfish species occupy similar ecological niches.

Early-warning monitoring systems are also essential in preventing and controlling outbreaks of DCO. Several studies have explored different approaches to monitor and predict the abundance and movements of DCO. For instance, Li et al. applied a three-dimensional numerical current–wave-coupled model to simulate the causes of blocking events near the Changjiang NPP, highlighting the windage effect and surface Stokes drift induced by waves as the primary causes. Lou et al. utilized the Lagrangian flow network (LFN) to map the transport pathways and aggregation areas of *Acetes*. Huo et al. developed a deep learning algorithm to predict the biomass of DCO, while Li et al. employed a seafloor *in situ* integrated monitoring system (IMSDCO) equipped with optical microscopic imagers and hydrometric sensors to automate the monitoring process. Fu et al. created a 3-dimensional numerical model (TELEMAC-3D) to determine the impingement probability of DCO under various environmental conditions.

In summary, the proliferation of organisms in nuclear power plant cooling-water systems is a serious issue that poses risks to both the safety of the plants and the health of marine ecosystems. However, by enhancing our understanding of these organisms, developing monitoring systems, and implementing prevention and control measures, we can ensure the safety and reliability of nuclear power while also protecting marine ecosystems. This is crucial not only for environmental conservation, but also for sustaining human life and ensuring long-term sustainability. Looking forward, continued research and innovation in this area will be essential for addressing the challenges posed by DCO in cooling-water systems. Additionally, increasing public awareness of these issues can help encourage greater investment in research and development, as well as the implementation of effective prevention and control measures. Ultimately, by working together to address these challenges, we can ensure the safe and reliable operation of nuclear power plants while also protecting the health and diversity of marine ecosystems for future generations.

Author contributions

HH wrote the manuscript of the Editorial, the other guest editors of the Research Topic reviewed and revised the manuscript. All authors contributed to the article and approved the submitted version.

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References

Beninca, E., Dakos, V., Van Nes, E. H., Huisman, J., Scheffer, M., et al. (2011). Resonance of plankton communities with temperature fluctuations. *Am. Nat.* 178 (4), E85–E95. doi: 10.1086/661902

Borja, A., Elliott, M., Andersen, J. H., Berg, M., Carstensen, J., Halpern, B. S., et al. (2016). Overview of integrative assessment of marine systems: the ecosystem approach in practice. *Front. Mar. Sci.* 20. doi: 10.3389/fmars.2016.00020

Chust, G., González, M., Fontán, A., Revilla, M., Alvarez, P., Santos, M., et al. (2022). Climate regime shifts and biodiversity redistribution in the bay of Biscay. *Sci. Total Environ.* 803, 149622. doi: 10.1016/j.scitotenv.2021.149622

Gobler, C. J. (2020). Climate change and harmful algal blooms: insights and perspective. *Harmful algae* 91, 101731. doi: 10.1016/j.hal.2019.101731

Khttab, K. (2021). Nuclear power reactors in the world. *Atom Dev.* 33 (2), 43–55. https://www.iaea.org/publications/14989/nuclear-power-reactors-in-the-world

Lucas, C. H., Gelcich, S., and Uye, S. I. (2014). Living with Jellyfish: Management and Adaptation Strategies. In: Pitt, K., Lucas, C. (eds) Jellyfish Blooms. (Dordrecht: Springer). doi: 10.1007/978-94-007-7015-7_6

Prakash, S. (2021). Impact of climate change on aquatic ecosystem and its biodiversity: an overview. *Int. J. Biol. Innov.* 3 (2), 312–317. doi: 10.46505/IJBI.2021.3210

Wollrab, S., Izmest'yeva, L., Hampton, S. E., Silow, E. A., Litchman, E., Klausmeier, C. A., et al. (2021). Climate change–driven regime shifts in a planktonic food web. *Am. Nat.* 197 (3), 281–295. doi: 10.1086/712813

Wu, J., Kong, J., Laws, E. A., Liu, X., Wang, C., Chen, J., et al. (2023). The link between marine thermal discharges and nemopilema nomurai blooms around nuclear power plants. *Ecosystem Health Sustainability* 9, 0009. doi: 10.34133/ehs.0009