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EDITED AND REVIEWED BY
Eric 'Pieter Achterberg,
Helmholtz Association of German Research Centres (HZ), Germany

*CORRESPONDENCE
Jiapeng Wu
wujiapeng@gzhu.edu.cn

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Editorial: Nutrient biogeochemistry in the land-sea continuum

Jiapeng Wu[1]*, Kai Xiao[2], Yi Liu[3], Carlos Duque[4,5] and Qianqian Wang[2]

[1]Institute of Environmental Research at Greater Bay Area, Key Laboratory for Water Quality and Conservation of the Pearl River Delta, Ministry of Education, Guangzhou University, Guangzhou, China, [2]State Environmental Protection Key Laboratory of Integrated Surface Water-Groundwater Pollution Control, School of Environmental Science and Engineering, Southern University of Science and Technology, Shenzhen, China, [3]Earth, Ocean and Atmospheric Science (EOAS) Thrust, Function Hub, the Hong Kong University of Science and Technology (Guangzhou), Guangzhou, China, [4]Department of Geodynamics, University of Granada, Granada, Spain, [5]Department of Geosciences, University of Oslo, Oslo, Norway

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Editorial on the Research Topic
Nutrient biogeochemistry in the land-sea continuum

Anthropogenic activities over the past decades have greatly increased the level of nutrients and caused severe eco-environmental problems (Galloway et al., 2008), such as eutrophication (Seitzinger and Phillips, 2017), hypoxia expansion (Lam and Kuypers, 2011), acidification (Cai et al., 2011) and acceralated nitrous oxide emissions (Hu et al., 2023; Xiang et al., 2023) in coastal areas. The land-sea continuum (e.g., beach, estuary, bay, and coasts) as the transition zone of terrestrial and marine ecosystems generates "reaction pools" for nutrients (e.g., carbon, nitrogen, and phosphorus; Hong et al., 2019; Wu et al., 2021). It is also a setting in which different disciplines coalesce with land hydrologists, biologists, and oceanographers to solve geochemical processes with strong biological implications (Duque et al., 2020). Still, the investigation on nutrient transport and transformation with coupled influencing mechanisms of land-ocean physical interactions, geochemical reactions, and biological processes is scarce.

Eight articles on this Research Topic employed interdisciplinary approaches, seasonal investigations, and historical data to study (1) the source, transformation, molecular composition, and environmental effects of DOM and POM; (2) the effects of river input, submarine groundwater discharge (SGD) and river plume on nutrient budgets and eutrophication; and (3) biogeochemical processes in the subterranean estuaries. The summaries are listed below.

Lu et al. incorporated isotope and optical analysis to investigate the fate of particulate organic matter (POM) and dissolved organic matter (DOM) in Tieshangang Bay, a weak dynamic bay located in the northern South China Sea (NSCS). At this location, the terrestrial discharge and external organism activity were the main POM and DOM sources in the upper bay, and *in situ* biological activities were the main OM source in the outer bay. The processes responsible for the additions of DOM in the upper and outer bay were different due to the weak hydrodynamics. This study suggests that hydrodynamics is the critical factor regulating the biogeochemistry of OM across Tieshangang Bay.

Cai et al. provided new insights into the transformation of OM in coastal bays. After determining DOM and POM concentrations in seawater samples collected from Qinzhou Bay (northern Beibu Gulf). The distribution of DOM was shaped by hydrological and biological processes, whereas POM originated from terrigenous OM and freshwater phytoplankton. Moreover, temperature and substrate activity were the critical factors enhancing the production of recalcitrant DOM in Qinzhou Bay.

Silva et al. aimed to elucidate the sources and potential transformation pathways of DOM on its underground land-sea transport in a tidal flat at Sahlenburg, Germany. Groundwater springs influenced the physicochemical characteristics of the tidal flat, which resulted in low salinity and dissolved organic carbon (DOC), and high nitrate and oxygen concentrations. According to the abundances and fingerprints of humic-like fluorescent DOM and DOM, salt marsh plants and nearby estuaries were the main input sources of DOM. This study highlights the significant influence of groundwater springs on the geochemical processes of tidal flats.

Ke et al. conducted a studied to examine the impact of river input on the seasonal distribution patterns of total nitrogen (TN) and phosphorus (TP) in the Pearl Rivers and estuary. The study found that a significant amount of riverine TN and TP, approximately 8.61×10^{10} and 1.55×10^{9} mol/year, respectively, were discharged into the Pearl River Estuary (PRE). As a result, there was a decreasing trend of TN and TP from the upper river to NSCS. The average TN/TP ratios from upper river to estuary seawater were higher than the Redfield ratios (16), suggesting the deteriorating of water quality in PRE and calling for strengthened governmental monitoring and management of TN and TP inputs.

Sun et al. investigated the SGD and its effect on the distribution of nutrients and algal bloom in Dongshan Bay. The SGD-derived fluxes of dissolved inorganic nitrogen (DIN) (7.06×10^{5} mmol d^{-1}), soluble reactive phosphorus (SRP) (2.05×10^{4} mmol d^{-1}), and dissolved silicate (DSi) (1.12×10^{6} mmol d^{-1}) contributed over 95% of the total nutrient inputs. A significant positive relationship between SGD and water column nutrients was found suggesting the dominant role of SGD in regulating the seawater nutrients in Dongshan Bay. This study highlights the importance of SGD-associated nutrient fluxes in small bays' nutrient budgets.

Xie et al. explored the effect of river plumes on the biogeochemical structure of the Laptev Sea by analyzing annual biogeochemical data from transects between 2015 and 2020. The study revealed that the diffusion patterns of the river plume, both interannually and seasonally, significantly influence the physical and biogeochemical characteristics of the Laptev Sea. Additionally, multiple factors, including Lena River flow, coastal erosion, OM input, and seasonal cooling, affect the migration and transformation of water masses between September and October.

He et al. identify the driving factors of eutrophication in Zhanjiang Bay by analyzing seasonal nutrients and related environmental parameters from 20 cruises and historical data spanning 30 years. The eutrophication index was higher in the upper bay characterized by higher concentrations of DIN and PO_4^{3-}. Additionally, terrestrial discharge during rainy seasons contributed to the high levels of nitrogen and phosphorus in Zhanjiang Bay, exacerbating eutrophication. Long-term (over the past 30 years) observation revealed that increasing phosphate rather than nitrogen is the primary factor responsible for the aggravation of eutrophication in Zhanjiang Bay.

Massmann et al. developed an interdisciplinary research methodology to investigate the biogeochemical processes in the subterranean estuaries on the northern beach of the island of Spiekeroog (DynaDeep project). Through the introduction of several research hypotheses, a set of relevant processes and parameters were targeted using an innovative infrastructure installed on Spiekeroog Beach. The initial results emphasized that the transition from land to the coast acted as biogeochemical reactors for terrestrial nutrients before discharging into the sea.

Overall, this Research Topic brings progress, datasets, as well as novel methodologies for understanding nutrient biogeochemistry in the land-sea continuum.

Author contributions

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Conflict of interest

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