

REPORTING FORM 2024

Continental Margins Working Group

List authors

1. Ongoing activities, in line with the IMBeR Grand and Innovation Challenges

(Among other uses, information will be used to update the [IMBeR Annual Report to SCOR](#))

1.a. Grand Challenge I

Understanding and quantifying the state and variability of marine ecosystems - with focus on Research Objectives 1 to 3:

Research Objective 1. *Evaluate and predict the cumulative effect of multiple stressors*

Research Objective 2. *Integration of climate change and climate variability*

Research Objective 3. *Impacts on society – preparation for a changed future*

Add text...

Silicon cycle in the Chinese Marginal Seas. Silicon is an essential element in the ocean, and diatoms are the major producers and an important link in exporting carbon to the ocean interior, accounting for 40% of the primary production in the global ocean and up to 75% occurring in the coastal and nutrient-replete waters. A detailed understanding of the silicon cycle is crucial to evaluate the global carbon (C) cycle.

The Coastal and Continental Margin Zones (CCMZs) contribute to 40% of the total burial flux of biogenic silica (bSi) of the world ocean. However, the accurate determination of the bSi content (bSiO₂%) in marine sediments remains a challenge. The alkaline methods commonly used to quantitatively determine bSiO₂% can completely digest the amorphous silica of diatoms but are less effective at digesting radiolarians and sponge spicules. In addition, the lithogenic silica (lSi) found in sediments is partly digested during the alkaline extractions, which can bias the accuracy of the determined bSiO₂%. This is of importance in CCMZs where the lSi:bSi ratio is high. In this study, we examined sediments collected in the CCMZs of East China seas, an environment of peculiar interest given the large amount of lSi deposited by the Yellow River and the Yangtze River. The results show that alkaline digestions using stronger solutions and pretreatment steps resulted in an overestimate of the bSiO₂% due to increased leaching of silica mainly from authigenic silicates and clays, whereas weak digestions underestimated the bSiO₂% owing to incomplete digestion of sponge spicules. We found that the use of the Si/Al method, which corrects for the lSi

fraction in marine sediments, accurately determines the bSiO₂% in the sediments of East China seas CCMZs. To emphasize the influence of these methodological differences, we revised the bSi burial flux in the East China seas and provide a new estimate of 253 (± 286) Gmol-SiO₂ yr⁻¹, which is one third of the previous estimates. We discuss the potential contribution from radiolarian and sponges and we propose a new general protocol for the determination of bSi in sediments that minimizes the methodological bias in bSi determination (Zhu et al., 2023).

The dissolution of silicate minerals on the seafloor releases an important amount of dissolved silicon (dSi), which is necessary for maintaining high diatom production in Coastal and Continental Margin Zones (CCMZs). However, the dissolution of silicate minerals along the continental shelves is variable, which hinders our understanding of the marine Si cycle on both a regional and global scale. To understand the discrepancy of silicon (Si) released in different sediment matrices and its potential controlling factors, we investigated surface sediments of typical CCMZs of the Chinese marginal Seas using a continuous alkaline extraction technique, grain size and chemical (carbon and total nitrogen) analysis as well as a qualitative measurement of clay mineral composition by X-ray diffraction. This study highlights silicate minerals as an important potential marine Si source and emphasizes the need for a better understanding of the roles of silicate minerals in the Si cycle of marginal seas in future studies (Zhu et al., 2024).

The dissolution efficiency of sedimentary biogenic silica (bSiO₂) dramatically affects the regeneration of dissolved silicic acid (dSi) at the sediment-water interface, which is a crucial pathway to maintain Si balance and silicic productivity growth in marine environment. Wet alkaline leach and flow-through experiments were conducted to explore the dissolution behaviors of sedimentary bSiO₂ in the northern South China Sea (NSCS) - one of the largest marginal sea continental shelves. The relatively lower reactivity (1.12 ± 0.3 yr⁻¹) of bSiO₂ in sediments support the NSCS sediments may serve as an important silica sink in the world ocean silica cycle (Ma et al., 2023).

1.b. Grand Challenge II

Improving scenarios, predictions and projections of future ocean-human systems at multiple scales - with focus on Research Objectives 4 to 6:

Research Objective 4. *Development of integrated data systems and approaches for predictions and projections*

Research Objective 5. Development of predictive models and projections for use at regional scales

Research Objective 6. Development of alternative scenarios to bridge the gap between physical climate sciences and humanities

Add text...

1.c. Grand Challenge III

Improving and achieving sustainable ocean governance - with focus on Research Objectives 7 to 9:

Research Objective 7. Develop knowledge on best practices for multilevel governance approaches to ocean climate adaptation and mitigation

Research Objective 8. Develop understanding on key ingredients for transformation towards more sustainable, equitable and inclusive governance approaches to fisheries and aquaculture

Research Objective 9. Support implementation of post-2020 biodiversity targets for marine spatial planning and marine protected areas

Add text...

Based on long-term series of nutrient datasets for the past two decades, nutrient fluxes to the Bohai Sea from various external nutrient channels controlled by policies issued by the Chinese government have decreased recently and are the major reasons for the decrease in DIN concentrations and DIN/DIP ratios in the Bohai Sea (Liang et al., 2023).

From the long-term observation, it found an alleviation of acidic precipitation of the Yellow Sea under the policy controls of sulfur dioxide (SO₂) and nitrogen oxide (NO_x) emissions. Meanwhile, effective control of sand-dust largely reduced precipitation SiO₃²⁻ concentration. Source also effected precipitation nutrients (Zhang et al., 2024).

1.d. Innovation Challenge 3

To advance understanding of ecological feedbacks in the Earth System

Add text...

Based on long-term series of nutrient datasets for the past two decades, environmental indicators including Chl- α , red tide area and frequency, Shannon-Wiener index of phytoplankton, water color, transparency, macrobenthic species, and fish species have been recovering to varying degrees, positively responding to the decrease in DIN concentrations and DIN/DIP ratios (Liang et al., 2023).

1.e. Innovation Challenge 4

To advance and improve the use of social science data for ocean management, decision making and policy development

Add text...

1.f. Innovation Challenge 5

Interventions to change the course of climate impacts

Add text...

1.g. Innovation Challenge 6

Sustainable management of Blue Carbon ecosystems

Add text...

2. Selected highlights

2.a. Selected scientific highlights since last report (1-5)

Last report was submitted to SSC meeting, April 2023

Add text...

The following highlights are closely related to the task of Chinese Marginal Seas case study.

A. Nutrient changes in the Bohai Sea over the past two decades (Liang et al., 2023)

With the growing problem of eutrophication in the Bohai Sea, actions have been taken to reduce nutrient inputs, but it remains to be seen whether nutrient levels and structure have been ameliorated. In this study, the nutrient trends in the Bohai Sea are re-examined based on observations from 2000 to 2019. The results suggest that dissolved inorganic nitrogen (DIN) concentrations and DIN/DIP (dissolved inorganic phosphate) ratios gradually increased from 2000 to 2013 but dramatically decreased from 2013 to 2019. Both the increase and decrease rates of DIN concentrations decreased with increasing water depth, indicating that DIN concentrations in nearshore waters responded more rapidly to changes in human activities. However, DIP concentrations responded weakly to nutrient inputs, with their trends uncoupled. The DIN/DIP ratios have declined close to and in some seasons even below the canonical Redfield ratio in areas with water depths >20 m recently, implying that relative nutrient limitation in these areas may be shifting from relative phosphorus (P) limitation to absence of relative nutrient limitation or relative nitrogen (N) limitation. Atmospheric deposition, wastewater discharge, and riverine input were responsible for 66%, 21%, and 13% of the variance in the decline of DIN concentration, respectively. Several environmental indicators responded positively to the decrease in DIN concentrations and DIN/DIP ratios, with varying degrees of recovery recently. Our study proves the phased success of various nutrient reduction measures taken by the Chinese government to improve the environment of the Bohai Sea over the past decade.

B. Two decades variations of nutrients in precipitation at the Qianliyan island, the western Yellow Sea (Zhang et al., 2023)

Precipitation is of great significance in the transport and removal of atmospheric nutrients. For the sake of the acquaintance of nutrient level, deposition flux and secular trend of marginal sea precipitation, two decades (1997–2019) atmospheric investigations were conducted at the Qianliyan island, the western Yellow Sea. Overall, the annual average wet deposition fluxes of nitrate (NO_3^-), ammonium (NH_4^+), phosphate (PO_4^{3-}), silicate (SiO_3^{2-}), dissolved organic nitrogen (DON) and organic phosphorus (DOP) ranged 9.17–42.80, 13.50–41.44, 0.06–1.88, 0.07–5.56, 14.20–42.14 and 0.09–0.62 $\text{mmol}\cdot\text{m}^{-2}\cdot\text{a}^{-1}$, respectively. The annual average concentrations of NO_3^- in precipitation showed a monotonic rising trend, while that of SiO_3^{2-} showed a monotonic decreasing trend. From the long-term observation, it found an alleviation of acidic precipitation of the Yellow Sea under the policy controls of sulfur dioxide (SO_2) and nitrogen oxide (NO_x) emissions. Meanwhile, effective control of sand-dust largely reduced precipitation SiO_3^{2-} concentration. Source also effected precipitation nutrients. Average concentrations of NO_3^- , NH_4^+ and SiO_3^{2-} in precipitation from the ocean were lower than those from the northern arid area, while average concentrations of PO_4^{3-} , DON and DOP in precipitation from the ocean were higher than those from the northern arid area. Qianliyan precipitation brought rich dissolved inorganic nitrogen (DIN) over PO_4^{3-} to the ocean surface, which might alter the phytoplankton community succession ultimately.

2.b. Publications since last report

Please add all publications since last report to the table below (see notes for details on “Class” and “Activity” fields).

<i>Publication with DOI</i>	<i>Class 1, 2, 3</i>	<i>Activity*</i>
Zhang, Yuhan, Haoming Xu, Guodong Song, Guiling Zhang, Sumei Liu , 2024. Acceleration of reaction by glass magnet stirring shortens the time for the determination of dissolved oxygen in seawater by the Winkler method. Journal of Sea Research 200, 102513. https://doi.org/10.1016/j.seares.2024.102513	3	Improving measurement method of dissolved oxygen
Zhang, Ke, Sumei Liu , Lingyan Wang, 2024. Two decades variations of nutrients in precipitation at the Qianliyan island, the western Yellow Sea. Atmospheric Environment, 321, 120321. https://doi.org/10.1016/j.atmosenv.2023.120321	2	
Liang, Wen, Yan Wang, Jinglong Mu, Nian Wu, Juying Wang, Sumei Liu , 2023. Nutrient changes in the Bohai Sea over the past two decades. Science of the Total Environment, 903, 166696. https://doi.org/10.1016/j.scitotenv.2023.166696	1	Chinese Marginal Seas Case Study 2023 Annual Meeting
Mu, Jinglong, Shuai Ding, Su Mei Liu , Guodong Song, Xiaoyan Ning, Xiaotong Zhang, Wenqi Xu, Hongmei Zhang, 2024. Multiple isotopes decipher the nitrogen cycle in the cascade reservoirs and downstream in the middle and lower Yellow River: Insight for reservoir	2	

drainage period. Science of the Total Environment 918, 170625.		
Mu, Jinglong, Hongmei Zhang, Su Mei Liu , Nian Wu, Guodong Song, Shuai Ding, Xiaotong Zhang, 2024. Nutrient dynamics in the Yellow River -a case study of different reservoir regulation operations. Journal of Hydrology, 629, 130563. https://doi.org/10.1016/j.jhydrol.2023.130563	2	
Zhu, Dongdong, Su Mei Liu , Aude Leynaert, Paul Tréguer, Jingling Ren, Jonas Schoelynck, Yuwei Ma, Jill N. Sutton, 2024. Muddy sediments are an important potential source of silicon in coastal and continental margin zones. Marine Chemistry, 258, 104350. https://doi.org/10.1016/j.marchem.2024.104350	3	
Ma Y, B Yang, N Zhou, J Huang, SM Liu , D Zhu and W Liang, 2023. Distribution and dissolution kinetics of biogenic silica in sediments of the northern South China Sea. Front. Mar. Sci. 10:1083233. doi: 10.3389/fmars.2023.1083233	3	
Zhu D, JN Sutton, A Leynaert, PJ Tréguer, J Schoelynck, M Gallinari, Y Ma and SM Liu , 2023. Revisiting the biogenic silica burial flux determinations: A case study for the East China seas. Front. Mar. Sci. 9:1058730. doi: 10.3389/fmars.2022.1058730	3	

**If appropriate, please list the IMBeR activity through / by / from / during which the publication arose*

******Notes on publications******

Publications are logged in the IMBeR Zotero library which is publicly accessible online –

[Publications since 2016](#) | [Publications prior to 2016](#)

Publications are categorised by “Class” and linked to “Activities”:

Class 1 publications are specifically generated through/by/from/during **IMBeR activities** - for example, arising from IMBIZOs and IMBeR conferences such as the IMBeR open science meeting and the IMBeR West Pacific symposia and from the activities of the working groups, regional programmes and the SPIS scoping teams.

Class 2 publications are on topics relevant to the IMBeR Science Plan that benefitted from some interaction with IMBeR or **IMBeR activities**, for example by IMBeR symposium attendees, past and present SSC members, working group, regional programme and endorsed project members, or national contacts.

Class 3 publications are on topics relevant to the IMBeR Science Plan but for which there is no direct link to or benefit from an IMBeR activity. These might include publications by SSC members, working

group, regional programme or endorsed project members or members of the IMBeR international community that were written as part of the normal scientific activity of the authors and would have occurred irrespective of IMBeR's existence. You can report Class 3 publications, but they will no longer be logged in the IMBeR database.

[See "[What is an IMBeR publication?](#)" for further information]

Why list 'Class' and 'Activity'? This helps us to declare authentically which publications IMBeR has helped to generate, and it makes it easier for us to demonstrate the value of the Regional Programmes, the Working Groups, and IMBeR in general, and it helps us to justify support for IMBeR activities when we can list tangible outputs.

2.c. Events, Meetings, and Workshops

List all international and national events, meetings and workshops. Describe the level of participation: e.g. chairing session/workshop, organising meeting. Include Endorsed Projects committee meetings and workshops.

Format: Title of event. Date. Location. Description of participation. Any other pertinent details.

Add text...

Joint IMBeR/Future Earth Coasts Continental Margins Working Group (CMWG) – Chinese Marginal Seas Case Study 2023 Annual Meeting 23-24 November 2023, Qingdao, China & Online: The CMWG Chinese Marginal Seas Case Study 2023 Annual Meeting was a hybrid meeting with offline venue in Qingdao on 23-24 November 2023 (around 20 participants on-site). The annual meeting had two parts with part I (WEBINAR - Tour of the Asian Marginal Seas) having four invited presentations on the Chinese marginal seas, the Seto Inland Sea, the Persian Gulf, and the Gulf of Thailand for the first day, respectively, and part II having 12 presentations on various disciplines of marine science and thoroughly discussion about how to overview the scientific synthesis of the Chinese marginal sea ecosystems during the second day. A draft outline of the overview was discussed, which includes economy and service of the Chinese marginal seas, status and sustainability emergency, challenges and focuses and outlook. Additionally, a draft timeline was discussed.

Participating Plenary Session of Marine Ecology and Blue Carbon Sink during Global Ocean Summit 2023 in Qingdao, China (experts from over 30 countries and nearly 150 marine research institutes and universities worldwide) and presented a talk on the changing marine biosphere – selected IMBeR's research highlights represented by Su Mei LIU for IMBeR: The Chinese Marginal Seas Case Study as a working group documents the ecosystem and physicochemical environment change in the last 60 years. This presentation shed light on the intricate web of biogeochemistry-ecosystem-social interactions within the ever-changing marine biosphere. Eutrophication and Ocean Color-based Plant species identification and Carbon flux in the Indo-Pacific oceans study groups have been fostered, and made noteworthy progress. Furthermore, IMBeR has forged a dynamic partnership with the UNESCO Integrated Ocean Carbon Research, with collaborative effort on reevaluation of its 2021 vision document to establish a new Ocean Decade Community of Practice on ocean carbon. As we approach the culmination of IMBeR 2016-2025, IMBeR is actively exploring options for synthesis of its achievements and preparing ways to develop a timely new

international project that will advance scientific knowledge to decipher the changing marine biosphere.

3. International collaboration and links

Add text...

Giving a talk about IMBeR during Circulation Research in East Asian Marginal Seas (CREAMS)/PICES Program in East Asian marginal Seas (AP-CREAMS) inter-sessional meeting, June 20-21, 2023, on-line meeting

4. Input to management, policy and SOCIETY* over the last year

Add anything that is not covered under "1.c. Grand Challenge III"

**As previous reporting forms requested 'input to management and policy' only, please add any 'input to society' not captured in previous reports*

Add text...

5. Education, outreach and Capacity Development

Add text...

The part I (WEBINAR - Tour of the Asian Marginal Seas) during the Joint IMBeR/Future Earth Coasts Continental Margins Working Group (CMWG) – Chinese Marginal Seas Case Study 2023 Annual Meeting 23-24 November 2023, Qingdao, China & Online having four invited presentations on the Chinese marginal seas, the Seto Inland Sea, the Persian Gulf, and the Gulf of Thailand. These presentations and discussion play an important role for the young scientists and students to understand the status and interactions between the ecosystem and societies of the continental marginal seas globally.

6. Planned activities

6.a. Activities and Outreach and how they link to the Challenges (including, but not limited to convening sessions, meetings, summer schools, workshops, etc)

Add text...

As a core case study of the Continental Margins Working Group, the objective of the Chinese marginal seas case study is to understand the impacts of the major social service needs on the eco-environment of Chinese marginal seas and their further consequences for human well-being, to establish the scientific basis for actions needed to enhance the sustainable use of ecosystems and their contributions to human well-being, to meet the Grand Challenges in the earth system for global sustainability. The major focus in the future will include revise the outline of overview interactions among ecosystem and societal demands.

6.b. Upcoming papers (Community-Position-Review-etc)

Add text...

7. Funding

7.a. Funding from external sources

7.b. Funding proposals in progress or planned

7.c. Funding requested from IMBeR for 2024-2025

Include a brief budget and justify requests

We ask the IMBeR to grant us USD 5,000 that needed to support the CMWG activity, which mainly cover the 2025 annual meeting of the Chinese Marginal Seas Case Study Group of the IMBeR-FEC Joint Continental Margin Working Group and the overview activities of Chinese marginal seas case study. The budget mainly covers tea breaks, meals, and local transportation/airport transfers.

8. Changes to Organisational Structure (e.g. SSC) of Regional Programme

Add text...

9. Images / Figures

*****It is always good to have some recent photos / figures / infographics to create more exposure for the Regional Programmes, Working Groups, etc. These can range from those suitable for a very scientific audience, to those that would engage the general public. IMBeR would use these, on the website (e.g. <http://www.imber.info/> and <http://www.imber.info/en/news>), in tweets (@imber_ipo), in presentations, etc. In addition, Future Earth (one of our sponsors) regularly asks us to provide high quality images for their glossy reports. These can highlight the activities of IMBeR and their other Global Research Projects (see pdfs of past Future Earth reports here <https://futureearth.org/publications/annual-reports/>)*

*So, please provide any images that you might think are useful. These can be pasted in this document or emailed as an attachment to imber@ecnu.edu.cn.*****

10. Anything not covered above

Add text...

11. How to improve this form

Please give suggestions on how to improve this form and make it better next time.

Add text...

12. Appendices

Add appropriate meeting / workshop reports and include URLs (this helps to track where online content is missing)

Add text...