Baltic Earth

Working Group "Marginal Seas – Humans and Environment"

Minutes of the third meeting (hybrid onsite/online)

Sopot, Poland, May 28, 2025, 18:00 - 20:15 CEST

1. Participants:

onsite:

Miroslaw Darecki (MG), Poland; Georgia Desouni (GD), Sweden; Joanna Dudzinska-Nowak (JDN), Poland; Sonja Ehlers (SE), Germany; Jan Harff (JH), Poland (protocol); Kari Hyytiainen (KH), Finland; Janie Jenkis (JJ), Finland; Aarno Kotilainen (AK), Finland; Katarzyna Koziorowska-Makuch (KKM), Poland; Karol Kulinski (KK), Poland; Markus Meier (MM), Germany; Jakub Miluch (JM), Poland; Lew Naumov (LN), Germany; Kevin Parnell (KP), Estonia; Tomasz Tarczyński (TT), Poland; Teresa Radziejewska (TR), Poland; Szymon Uścinowicz (SU), Poland; Jan Marcin Węsławski (JMW), Poland; Wenyan Zhang (WZ), Germany

online (TEAMS):

Cátia Milene Ehlert von Ahn (CvA), Germany; Peter Clift (PC), UK; Junjie Deng (JD), China; Federica Foglini (FF), Italy; Gary Greene (GG), USA; Matthias Gröger (MG), Germany; Pawel Terefenko (PT), Poland; Joanna Waniek (JW), Germany; Ralf Weisse (RW); Jinpeng Zhang (JZ), China,

2. Preface:

The BE Marginal Seas working group met during the Baltic Sea Science Congress (BSSC) 2025 conference at Sopot continuing the discussion of the first and the second working group meetings of 24.10.224 and 29.01.2025 regarding the list of **classification parameters in terms of climate, geosystem, ecosystem, and socioeconomic system**.
A second goal was a global review of marginal seas diversity and - considering representativeness and availability of data - the **selection of key areas** for a study to master the diversity by genrealization.
The third goal of the meeting was the discussion of the **planned publication**.

To facilitate communication with overseas working group members, the meeting was held in a hybrid onsite/online mode. Not only WG members were invited to attend but the meeting was open to the participants of the BSSC 2025.
The minutes here comprise results of presentations and discussions during the meeting but also of further bilateral discussions that the signee had with participants after the meeting, such as PC, FF, JDN, GG, MG, MM, TR, WZ.

3. Agenda

(1) Welcome and introduction: Summary of 1st and 2nd meetings, objectives of 3rd meeting (J. Harff)

(2) Prepared contributions

Classification parameters in terms of climate, geosystem, ecosystem, and socioeconomic system *(continuation of the topic addressed at the 2nd WG meeting on Jan 29, 2025, see minutes)*

Geosystem and climate:
- Data structure exemplified by climate and oceanographic data (M. Gröger)
- Oxygenation of marginal seas' water column (L. Naumov)
- Driving factors for morphological changes of river mouth and coastal systems (J. Deng)
- Ground water discharge to marginal seas (C. v. Ahn)

Ecosystem:
- Marginal seas diversity: FUNCTIONAL DIVERSITY as a potential Integrating concept (T. Radziejewska),
- Marginal seas' sea bed habitats (A. Kotilainen)
- Coastal seas under threats: case studies of anthropogenic fingerprint in marine ecosystems (J. Waniek)

(3) Discussion
Variables to be considered, Key areas for feasibility study, publications

(4) Summary and conclusion (J. Harff)

4. Results

- **Data structure of marginal seas studies**

For a comparison of marginal seas different types of data have to be considered:

(1) Qualitative - semi-quantitative appraisals of systems' status
(2) Quantitative primary data (measured/recorded data)
(3) Quantitative secondary data derived from modeling
(3.1) Paleodata derived from "decoding" of proxy-data or from numerical modeling including climate data reanalysis
(3.2) Future projections derived from forward modeling

Data type (1) refers to a kind of scores assigned to so-called "Urban Seas" considering complex knowledge driven appraisals of experts about parts of ocean margins proposed by Greene and Delaney (2025). For marginal seas studies, this method is to be generalized considering the scope of the study.

MG gave an overview about gridded (numerical) data pools (data types (2), (3.1) and 3.2)) hosting information for marginal seas studies (climate, oceanographic, biogeochemical, atmospheric and remote sensing data). Climate reanalysis data are available from 1993 onward. ESGF-DKRZ provides PalMod data for the Last Glacial Cycle including deglaciation. For future projections an estimation of climate change driven effects, the gradient of oceanographic parameters, such as SST based on IPCC scenarios can be considered.

- **Classification parameters in terms of climate, geosystem, ecosystem, and socioeconomic system**

In addition to variables discussed already on Jan 29, 2025 the following ones were highlighted:

Geosystem
MG recommended to consider in particular the **gradient of SST warming** climate change driven parameter of marginal seas. LN discussed the **oxygen supply** to marginal seas water as part of the bio-geochemical cycle as a key-parameter for marginal seas dynamics at different physiographic sites and climate zones.
JD interpreted global **coastal morphodynamics** in particular of large river mouth systems as a function of river discharge, oceanographic dynamics and human activities and referred to global data pools as well to his own studies in the Pearl River Estuary (PRE). **Ground water discharge** as a marginal seas' geo-parameter was discussed by CvA.

Ecosystem
As an essential parameter besides **eutrophication** and other biogeochemical parameters, TR recommended to take into account **functional (bio)diversity(FD)** - a measure of the number of functionally disparate species within a system, performing life functions differently (e.g. different feeding mechanism, different motility, predator vs prey, etc.). To describe the ecosystem of marginal seas as a parameter the **sea bed habitat** should be considered. According to AK corresponding maps are available on the local and regional level. In some marginal seas the ecosystem is highly degraded because of anthropogenic **pollution**. On the global scale, JW referred in this respect in particular to microplastic and chemicals such as estrogens.

5. Conclusion

After the presentations and discussions during the meetings of Oct 24, 2024, Jan 29, 2025, May 28, 2025, and subsequent bilateral discussions between the signee and participants of these meetings, the following conclusions are drawn:

- Marginal seas provide significant resources for human society, but are also among the areas on Earth most threatened by natural and anthropogenic processes. The complexity of this issue requires internationally coordinated management of measures for the protection and use of these seas marking an continent/ocean interface. This requires, first, the identification of key tasks, taking into account the overlapping aspects of the geosystem, ecosystem, climate processes, and socioeconomic demands as a prerequisite for solutions. One approach leads to an approach to **classifying marginal seas**, taking into account

multivariate parameters that adequately describe the aforementioned aspects of the complex interrelationships between climate and geo-, ecological-, and socioeconomic systems.
- **Global numerical data pools are sufficiently available** to compare marginal seas quantitatively, and in an interdisciplinary manner, aiming to specify strategies for improving the environmental status of marginal seas, their use and protection (in line with the UN's Sustainable Development Goals).
- The **necessary expertise** for scientifically investigating the diversity of marginal seas **is ensured** by the composition of the Baltic Earth working group.

A step-by-step approach is proposed for addressing the marginal seas issue by the working group:

The **first phase** (feasibility study) is planned for the **academic year 2025/2026**.

The program will focus on:

- **Selection of marginal seas** for analysis based on representativeness of study areas in terms of expected diversity along climate zones, geological provinces, and ecological status. Precondition is the precise spatial, temporal, and disciplinary definition of the research objects and targets.
- **Data acquisition** for the selected marginal seas using suitable classification parameters based on suggestions by previous working group meetings using qualitative - semi-quantitative appraisals of systems' status (data type (1)). As a fundamentally suitable qualitative/semi-quantitative data model, the proposal by Greene and Delaney (2025) for "Urban Seas" will be generalized for the analysis of marginal seas. The expected result is a spreadsheet spanned by variables and their semi-quantitative values assigned to each of the individual marginal seas under study.
- Development of a multivariate similarity function to compare marginal seas based on their data collected in spreadsheets and application to the areas under study for the **numerical classification**. A structural relationship of achieved classes assigned to the ruling natural and anthropogenic driving forces will lead to generic interpretation serving as a basis for further work.
- Results shall be published in a **white paper**. The selection of the journal for publication will be based on the significance of the results obtained. Initially, the journal Earth System Dynamics (https://www.earth-system-dynamics.net/) is intended for publication.

The detailed work program will be drafted by JH in co-operation with members of the WG to be finalized and submitted before 1.10. 2025 to the BE Steering Committee for evaluation.

In **phase II further study is recommended to be carried out in the academic year 2026 / 2027** based on phase I results. In this second phase hypotheses formulated in phase I should be tested first by extension of the number of marginal seas to be included and quantification of the studies using globally available data pools (data type (2)). To assist the complex data management master students should be invited to join the team.

The journal for publication of phase II results will be selected based on the significance of the results to be published.

A **phase III** can be targeted for the period 2027-2030, assuming successful research in the first two work phases. In particular, data types (3) should be intended to focus at, i.e., modeling results for future scenarios, which also enable feasibility analyses of management strategies. This ambitious research cannot be accomplished without research funding, which requires prior successful application to potential funding institutions. The project should also be integrated into international research programs.

protocol: J. Harff / 07.07. 2025

Reference

Greene, H. G., Delaney, J.R., 2025. Urban Sea Systems and why they are important: A preliminary characterization. Estuarine, Coastal and Shelf Science. Volume 322, 15 September 2025, 109274, https://doi.org/10.1016/j.ecss.2025.109274.