

Dear Sir/Madam,

Thank you for your valuable comments. We tried to do our best for all the suggestions. All changes were in the manuscript were highlighted (yellow color). According to reviewer's comments, you can find the point-to-point replies below.

Best regards,

İsmail Akçay

Review of the manuscript Impacts of recent eutrophication and deoxygenation on the sediment biogeochemistry in the Sea of Marmara , by Akçay et al, submitted to Biogeosciences (egosphere-2025-1255).

### **Manuscript overview**

The manuscript presents a quite detailed overview of the chemical state of surface waters and sediments (pore water and solid state) with respect to eutrophication in the Marmara Sea. It lists new observational results and puts them into perspective using previously published work and own analysis. As three areas are considered in more detail, each with their own distinct eutrophication status, the manuscript draws both local and regional conclusions, which together form a good overview of the Sea of Marmara and its eutrophication issues. It is determined that in very eutrophied parts the sediment biochemistry is enhancing the problems through feedback of nutrients from the sediments in hypoxic or anoxic conditions.

### **Review overview**

The manuscript is generally well written and very comprehensive, both in the inclusion of relevant prior work and previous observational evidence. The described mechanisms for eutrophication enhancement are not new in themselves but have not been shown before to play a role in this area. As such, the manuscript provides a good overview of the area and its eutrophication status, some of its local governing mechanisms and thus allows for more detailed management of the area with respect to related water quality issues. In this respect I do miss some discussion on natural occurring eutrophication (given the local topography I would expect some in the deep basins), the physical controls of the area in terms of nutrient mixing and the expected future changes in eutrophication due to these factors and the sedimentary processes. For me, this would put the presented results more in context, which can help prioritise possible management actions. Although I fully acknowledge that the presented work is a detailed scientific study that does not aim to provide a basis for marine policy. Detailed comments are provided below.

### **Recommendation**

Moderate revision, some graphs could be adjusted and text should added but no new figures or analysis are needed.

## Detailed Comments

1. Line 47: a reference to figure 1 would be helpful here.

R: We added Fig.1 for reference.

2. Line 51: “The Marmara Sea ecosystem”

R: We corrected.

3. Line 59: with a permanent pycnocline at 15-20 m I would like to know what the effect of shipping is in the region, as the whole area is a busy thoroughfare (as far as I know) and ship wakes can reach to these depths (e.g. Nylund et al, 2020). Does the traffic volume affect the pycnocline and vertical mixing?

R: We added some information according to result of Nylund et al (2020).

4. Line 60: “Thus a major oxygen source”

R: We corrected it.

5. Section 2.1: can the authors say anything about how representative the year 2019 was for the area? And I miss a description of the sediments themselves here: are they sandy or muddy, is the medium grain size known, are there differences between the three areas in terms of seabed composition?

R: We include about some physical properties of the obtained sediment core samples.

6. Line 97: “CTD probe that was coupled to”

R: We checked and corrected.

7. Line 131: “indication a significant fraction of the TN pool”

R: We corrected this sentence.

8. Lines 232-236: please rephrase, too long and grammatically incorrect.

R: Grammar was checked and the sentence was rewritten.

9. Line 237: “In all sites ”

R: It was corrected.

10. Line 239/241: “Porewater diffusive PO<sub>4</sub>, NH<sub>4</sub> and Si fluxes” is repetitive, please rephrase

R: We rephrased

11. Line 244: are the increases in the diffusive fluxes of reactive iron and manganese derived from figure 7 or from unpublished results?

R: This sentence was rewritten.

12. Line 246: “mixing across the basin, intensifying during winter”

R: We corrected it.

13. Line 248: “The correlation between”, I see no correlation parameters provided anywhere for this statement.

R: We wrote relationship instead of correlation for this sentence.

14. Figure 5: please provide a 0 line for the NO<sub>x</sub> plots

R: We revised this graph based on your comments.

15. Line 269: if these results are not shown please state so clearly, otherwise indicate the relevant table or figure.

R: We have rewritten this sentence.

16. Line 274: “core samples and decreased”

R: We corrected the expression.

17. Line 280: “İzmit Bay”, and they had higher TOC levels compared to what? Previous studies, or the third region under study?

R: We changed this sentence. Our study and other studies mentioned in the manuscript showed higher concentrations of TOC in the Sea of Marmara.

18. Line 285: “results further show”

R: We corrected it.

19. Lines 285-287: I don't quite see the evidence for this statement as the manuscript does not contain accumulation rates or previous results for İzmit Bay.

R: This sentence was rewritten.

20. Line 287: “results also report”

R: Corrected.

21. Line 294: “results altogether show” and it seems only stations IZ-30 and IZ-2 have elevated levels. Of TOC and TN, not the other stations in the same bay. Also please provide a reference for the Baltic statement.

R: This sentence was revised and we added a reference for the Baltic Sea.

22. Line 300: I see no difference in figure 6 between the TOC and TN levels of southern Marmara and Çınarcık Basin.

R: For some stations high concentrations of TOC/TN were recorded in the Çınarcık Basin.

23. Line 304: “caused accumulation of excess amounts of”

R: Corrected.

24. Figure 7: the markers for stations IZ-2 and 8 are practically identical

R: The graph was revised.

25. Line 336: “nitrogen (NO<sub>3</sub>) through denitrification”

R: Corrected.

26. Line 343: what is N.A.F.?

R: We added the long version – ‘North Anatolian Fault’.

27. Line 355: “core samples in this study were taken by”

R: Corrected.

28. Line 377: the figure 7 results for Mg seem the same everywhere?

R: This sentence was rewritten.

29. Line 390: as there are no observational data for primary production anywhere in this manuscript (only Chla) I suggest the authors rephrase this statement

R: This sentence was revised.

30. Line 393/396: the manuscript has not introduced actual sedimentation rates before, so this information should be presented in the discussion. No new evidence should be included in the conclusions.

R: This sentence was removed from conclusion and added to results and discussion section of the manuscript.

31. Line 396-400: overly long sentence making it unclear what the “respectively” actually refers to. I suspect it refers to the areas (Çınarcık Basin/İzmit Bay vs southern Marmara Sea) but on initial reading it seems linked to sink and source.

R: This sentence was rewritten.

32. Line 411: as this refers to primary production I would assume that the process of higher nutrient fluxes to the deep water is gravity driven, not gradient (diffusive) driven

R: We revised this sentence.

33. Lines 428-431: as states way above I would like to see some perspective for this, in the discussion section. How important is this process compared to for instance climate change impacts on nutrient inputs, increased stratification, etc.? And is there any natural (background) eutrophication occurring in this region? It doesn't have to be long or extensive, but as marine management is touched on here I think it is relevant.

R: Thank you for your suggestions. We added new text about the climate change and possible effects on marine eutrophication and on the benthic nutrient dynamics.

### **Added References**

Albayrak, S., Balkis, H., Zenetos, A., Kurun, A., and Kubanç, C.: Ecological quality status of coastal benthic ecosystems in the Sea of Marmara. *Marine Pollution Bulletin*, 52(7), 790-799, <https://doi.org/10.1016/j.marpolbul.2005.11.022>, 2006.

Nylund, A.T., Arneborg, L., Tengberg, A., Mallast, U., Hasselov, " I.M.: In situ observations of turbulent ship wakes and their spatiotemporal extent. *Ocean Sci.* 17(5), 1285–1302. <https://doi.org/10.5194/os-17-1285-2021>, 2021.

van Helmond, N.A., Robertson, E.K., Conley, D.J., Hermans, M., Humborg, C., Kubeneck, L.J., Lenstra, W.K., and Slomp, C.P.: Removal of phosphorus and nitrogen in sediments of the eutrophic Stockholm archipelago, Baltic Sea, *Biogeosciences*, 17(10), 2745-2766, <https://doi.org/10.5194/bg-17-2745-2020>, 2020.

**Review overview**

This work is good and scientifically sound. The work is addressed to effects of eutrophication on the Sea of Marmara, and specifically on redox conditions in marine sediments. The authors have done a good job analyzing spatial variations in biogeochemical properties of marine sediments. They have shown a clear relations between the level of primary production, its spatial variations, ventilation of different layers of the sea and spatial variations in redox conditions and the distribution of redox sensitive biogeochemical substances. I support publication of this manuscript, but after correction of the text. Many of my corrections and suggestions are in the attached file. Yet, some of them must be mentioned here. Firstly, English needs to be improved. Secondly, information in some tables and figures is very the same. Thirdly, data on and discussion of major redox none-sensitive irons are not related to the subject of this work and should be eliminated. All other comments are in the attached file.

**Response**

Dear Sir/Madam,

We would like to express our gratitude to Sergey Konovalov (reviewer 1). Thank you for his valuable comments. We tried to do our best for all the suggestions. All changes were in the manuscript were highlighted (green color). Most notably, the language of the manuscript was improved. We preferred to keep Table 2 since it represents the data of physical and biochemical parameters in the deep water. Figure 4 represents the vertical profiles of nutrients for the sediment core samples. Finally, as requested by the reviewer, data and discussion of major non-redox-sensitive elements were eliminated for a better focus on the main message on eutrophication impact on sediments.

Best regards,

İsmail Akçay