

Dear Editor,

Dear Referee,

many thanks for these additional comments and suggestions. Even though some recommendations overlap with those provided by two existing reviews, quite many suggestions are definitely useful, and we are happy to amend the manuscript accordingly. Our response is provided using blue italics font.

Sincerely & on behalf of the co-authors

Tarmo Soomere

Review of manuscript egusphere-2024-2640 Tarmo Soomere, Mikolaj Zbigniew Jankowski, Maris Eelsalu, Kevin Ellis Parnell, and Maija Viška: Alongshore sediment transport analysis for a semi-enclosed basin: a case study of the Gulf of Riga, the Baltic Sea

1. General comments

The authors study coastal sediment transport dynamics in the Gulf of Riga, a semi-enclosed bay at the eastern coast of the Baltic Sea using high-resolution wave time series (SWAN wave model) and the Coastal Engineering Research Centre (CERC) equations for the time span 1990-2022. Based on a hierarchical decomposition of the sedimentary near-coast sedimentary system into compartments and cells, the authors are able to specify transport dynamics along the coast. Integrating these local and regional features the authors draw a generalized picture of the wave-driven potential sediment transport dynamics of the study area. In addition to the natural meteorological, oceanographic and sedimentological environment also anthropogenic coastal structures influencing the transport processes are considered.

The work represents a valuable contribution to the model-based description of coastal dynamics of the eastern Baltic Sea. The methodology can be generalized to be applied to microtidal sandy coastal systems for sustainable coastal zone management. A publication is recommended after **moderate revision**.

Thank you for this overall positive evaluation. We are happy adjust the manuscript to meet the comments and recommendations below.

2. Specific comments

A restructuring of the text is suggested:

1. The **introduction** should primarily present the scientific task and the concept of its solution based on current knowledge, and quote to references (including authors' publications).

This recommendation is to some extent opposite to what Referee #2 has suggested. We have make an attempt to meet at least partially all these suggestions by considerably expanding the Introduction in three directions: (i) presenting more detailed overview of the previous work on the subject and its results and limitations, (ii) moving a part of the material in Section 2.1 into Introduction as strongly suggested by Referee #2, (iii) making more clear what is new in our manuscript: the use of considerably increased spatial resolution that allows for the identification of features blocking sediment transport, update of the earlier estimates of wave-driven potential sediment transport rates, their interannual and decadal variations, location of divergence and convergence areas of the sediment flux and associated patterns of sedimentary compartments and cells on the sedimentary shores of the Gulf of Riga, plus understanding why long-term trends in sediment transport in the study area do not match similar trends on the Baltic proper shores.

2. A next section should give an overview of the **study area** which is required especially for readers outside the Baltic region who are not familiar with the regional peculiarities. This concerns a description of the geographical, geological, climatic and oceanographic characteristics of the Baltic Sea before the

Gulf of Riga is described in more detail, whereby the sedimentological peculiarities of the coast should be taken into account. Sediment sources (including inputs from the open Baltic Sea and discharge from rivers) and sinks should be specified.

This recommendation aligns with one of the main suggestions of Referee #2 who specifically recommended to provide a detailed overview of wind and wave climate and some aspects of climate change (e.g., the impact of the loss of sea ice) in the study area. We have done so by considerably expanding Section 2.2. The information about geographical characteristics of the study area is also expanded in Section 2.1 to cover all items that are necessary for adequate interpretation of the results. However, we are reluctant with respect of providing more information about the Baltic Sea as this information is not really needed for following our work and understanding what we have studied and what the meaning of our results is. We therefore hope that a reference to the general Baltic Sea textbooks (Feistel et al., 2005; Leppäranta and Myrberg, 2009) fills this gap. In a similar manner, the particular sedimentological peculiarities of the coast in the study area are not really decisive for our results and their interpretation as we only address potential sediment transport. Thus, here we also hope that a reference to an open access source where this description is given from the specific viewpoint of our studies (Viška and Soomere, 2013b) provides necessary resources. The issue of sediment flux from the Daugava River has been also raised by Referee #2. Additionally to arguments in the response to Referee #2, our apologies for not providing more data about sediment sources and sinks are that (i) our results are invariant with respect to sediment fluxes into and out of the system and (ii) we do not address sediment budget (that is important indeed but far out of the scope of our study).

The **methods and data** section should include information on all primary (measured) or model-derived secondary data used, as well as a description of the models and their handling (such as the decomposition of the coastal space into cells and compartments and the model grid design). Regarding the models, it concerns the SWAN wave model and the ERA5 model for generating forcing data, the CERC equations and their parameterization.

We fully agree that detailed description of the decomposition of the coastal space into cells and compartments and the model grid design is a vital part of the study and should be described in great detail. We have pretty much done so already in the original version, and have amended this description in Section 2.2 and made it more coherent also following recommendations of Referee #2.

We, however, are reluctant with respect of providing in this manuscript more detailed information about the wave model SWAN and its forcing ERA5. Both these items and their implementation has been described in numerous papers, including two our own papers about wave simulations in the study area (Giudici et al., 2023; Najafzadeh et al., 2024). Also, the ERA5 model and dataset are today a sort of standard and extremely well-described in the international literature data set. Thus, to our understanding, there is no need to include any more details about ERA5 into this particular manuscript additionally to the source (Hersbach et al., 2020).

We admit the some more information about how the simulations work (e.g., one-way nested system, the use of independent high-resolution grids) might be important to follow the line of thoughts, and we have included these aspects. Also, we have included reference to one more comparison of the use of ERA5 forcing near the study area.

The equations associated with the use of the CERC model and its particular implementation are described in detail in Section 2.5. We have expanded the description of how we interpret the outcome of this model in locations where the model may not work properly.

In a separate section, the **results** already described in the present manuscript should be presented in a coherent manner. However, by now there is a discrepancy between the numerical model approaches and the purely qualitative verbal (or graphic) form of the result descriptions. This discrepancy could be

minimized through quantification (increased use of statistically estimated generalizing parameters and parameter functions).

We agree that the original submission did not always separate new results from the pre-existing ones as also mentioned by other referees. We have made every attempt to make the presentation more coherent and highlight very clearly what is new. Additionally, as suggested also by Referee #2, we have added numerical values of the described statistical features (correlation coefficients, measures of statistical significance, slopes of trendlines, etc.) wherever we have reached any kind of conclusion that needed quantitative back-up.

A separate **discussion** section is recommended. In this section, the acceptability of generalized data as model input should be discussed in particular.

Here we are faced with opposing views of Referee #1 (who explicitly recommended to merge Results and Discussion sections) and Referee #3. The best we can do here is to provide the same argument as in the response to Referee #1, with hope that our position makes sense. Namely, we admit that we have, somewhat untraditionally, placed large parts of discussion directly after the relevant results. Our justification is twofold: (1) several results are counter-intuitive and probably needed some comments immediately, (2) properties of transport in different coastal stretches are greatly different, and we decided to help the reader by providing an immediate comparison wherever relevant and necessary.

Other points are the reliability of the results and the limitations of the methods used. It is also important to refer here to the effects of anthropogenic structures in the coastal area on sediment dynamics, which are mentioned in various places in the text but are not yet discussed sufficiently.

Yes, of course. We have considerably expanded Section 2.4 (2.5 in the revised version) towards explaining how we handle our results in locations where man-made structures may strongly distort sediment transport.

In a final **summary and outlook** section, the results are to be concluded and a perspective is to be given. Figure 13 can be used as a basis for a graphic summary. However, the question arises whether the potential net transport could not be quantified by scaling the corresponding arrows.

We have tried to do so but alongshore variations in the magnitude of sediment flux are so massive (many tens of times) that it was simply impossible to scale the arrows correspondingly. Thus, we have chosen to show at least qualitatively how sediment flux varies along the study area.

In order to facilitate the understanding of the spatial and temporal relationships of the local model results, an additional tabular summary of the results is recommended.

We definitely agree that quantitative estimates should be provided and we have done so in many locations following detailed recommendations of Referee #2. However, the number of meaningful/essential quantities is quite limited and we decided to provide them as part of body text in locations where they are relevant. To our eyes, doing so makes the text more transparent and easier to follow (compared to multiple references to various table entries).

In the outlook, the spatial extension of the investigations already indicated in the last sentence of the manuscript, as well as a methodological refinement for sustainable coastal zone management, should be addressed in more detail.

We have expanded this discussion to cover several other potential developments of the model, such as the use of variable locations of nearshore wave model grid cells to better replicate wave properties at the breaker line.