

Review of **The Global TanDEM-X High-Resolution Coastline Product** by Warmedinger et al.
submitted for publication at Earth System Science Data. <https://doi.org/10.5194/essd-2026-277>

Reviewer Comments (RC) are presented in black italics.

Author Responses (AR) are presented in blue.

Changes in the Manuscript (CM) are presented in red.

Response to Reviewer 1 (Anonymous Referee):

RC1.1: *Coastlines are dynamic features; so the acquisition period of all input datasets should be clearly stated. Could the authors also provide information on coastline changes that may have occurred during this period and explain whether such changes were considered in the analysis?*

AR1.1: We thank the reviewer for this constructive feedback. We agree that the acquisition period of all input datasets is important considering that coastlines are dynamic features. The acquisition period of the TanDEM-X data ranges from Dec. 2010 to Jan. 2015 and the acquired data was used to create the TanDEM-X DEM and ancillary products as one layer. Because the TanDEM-X coastline is directly dependent on this dataset, any changes of the coastline within the acquisition period cannot be resolved.

The Copernicus DEM and supplementing quality layers were developed from data of the TanDEM-X satellite mission. As such, the acquisition period for the coastline derived from the Copernicus DEM, which is used as input for the coastline extraction, is from 2011 to 2015.

CM1.1a: The Copernicus DEM and supplementing quality layers were created from data of the TanDEM-X satellite mission, which was acquired between 2011 and 2015.

In addition, we introduced a new subsection, Sect. 3.3, discussing the uncertainties and limitations, therein the point of the multi-year acquisition and mosaicking is addressed in detail.

CM1.1b: A source of uncertainty arises from the multi-year acquisition and mosaicking of the TanDEM-X DEM and its ancillary layers, which were collected between 2010 and 2015 and fused at the pixel level via weighted averaging. As a result, the coastline product does not correspond to a specific date or time. In particular, the tidal stage at the time of each individual SAR acquisition is not known or corrected, and its influence on the resulting coastline position is therefore not quantifiable. Across multiple mosaicked acquisitions, this influence is effectively randomized and smoothed rather than removed. Particularly along sandy and tidally influenced coasts and in dependence of the purpose outside of the refinement of the TanDEM-X DEM and HydroSHEDS v2, this unawareness can be considered a limitation.

RC1.2: *Page 4: I recommend adding a figure that illustrates the format of the delivered coastline product, specifically showing that it is provided as polygons outlining landmasses. The figure could also demonstrate the minimum 10 m spacing between consecutive polygon vertices.*

AR1.2: We thank the reviewer for this suggestion. We agree that clearly conveying the format of the delivered product is important. However, we would prefer not to add a dedicated new figure for this, as the chapter on validation already contains several close-up illustrations of the coastline product (Figures 4-7) that show the polygon representation of landmasses in detail. While these figures do not explicitly demonstrate the minimum spacing of 10 m, we state this specification in the text Sect. 2.4 and believe adding a further figure solely to visualize this numerical detail is not warranted given the number of illustrations already present.

Nevertheless, we plan to include a detail of the coastline as a key figure in the manuscript. This additional figure is intended to illustrate the TanDEM-X coastline, but it does not convey details such as scale or vertex spacing. The figure is shown below.



RC1.3: *Page 5: Please provide further justification for using an external coastline as the initial input for coastline generation. In addition, include key specifications of the Copernicus DEMs used in the study, such as its spatial resolution and any other relevant characteristics.*

AR1.3: We thank the reviewer for this question. The external coastline was included for two main reasons. First, due to the tilewise processing, the ocean does not appear as one coherent area within a processed scene. This particularly affects coasts with multiple fjords or islands, where the TanDEM-X input data alone does not allow inland water to be distinguished from ocean. Second, the external coastline is used to separate ocean from inland water at estuaries.

It should be noted, however, that the final TanDEM-X coastline does not strictly follow the coastline delineated from the Copernicus DEM, due to the adjustable margin around the starting line and the manual corrections applied to the preliminary coastline polygon.

Following the reviewer's remark, we now include the key characteristics of the Copernicus DEM in the manuscript Sect. 2.1 for clarification.

CM1.3: In addition to the TanDEM-X data, an external coastline is required as a starting point for the coastline generation. This coastline is extracted from the Copernicus DEM data (DLR e.V. and Airbus Defence and Space GmbH, 2022). The Copernicus DEM and supplementing quality layers were created from data of the TanDEM-X satellite mission, which was acquired between 2010 and 2015. The Copernicus DEM with global coverage at a resolution of 30 m (GLO-30) is provided with several ancillary quality layers, including a Water Body Mask (WBM) that classifies pixels into water-related categories. This WBM was used to extract a coastline as input for the TanDEM-X coastline extraction.

RC1.4: *Page 5: Please consider referring <https://gee-community-catalog.org/projects/s2coast/> and <https://doi.org/10.1038/s41597-025-05180-9> as part of your reference datasets. These datasets provide global coastline products at spatial resolutions of 10 m and 2 m, respectively.*

AR1.4: We thank the reviewer for this suggestion. Following the comment, we have included the S2Coast-2023 dataset as an additional reference dataset. We did not include the dataset from Mudiyansele et al. (2025), as it is provided as line segments rather than closed polygons, which would require additional pre-processing before it could be used for comparison. Below, we have inserted the description of the S2Coast-2023 product from the manuscript (Sect. 2.5). As a reference coastline, it is included throughout the qualitative and quantitative assessment (Sect. 3.1 and 3.2) of the TanDEM-X coastline product.

CM1.4: S2Coast-2023 is a global 10-m coastline dataset derived from a cloud-free annual composite of Sentinel-2 imagery acquired in 2023 using the Google Earth Engine-based S2Coast framework. The processing includes the delineation of the stable extent of high seawater submergence based on multi-temporal observational information, spectral characteristics and spatial features, as well as the derivation of boundaries through integrated threshold segmentation, and raster-to-vector conversion (Duan et al., 2026). The S2Coast-2023 product includes all continents, most inlands with an area larger than 100 m² but excludes Antarctica and remote polar islands.

RC1.5: *Page 8: ‘The overall quality of the coastline corresponds to that of the TanDEM-X dataset’. This statement could be misleading, as only the spatial resolution of TanDEM-X data is directly inherited by the coastline product, but not necessarily the accuracy of the coastline extraction itself. I recommend revising the wording to more accurately reflect this distinction.*

AR1.4: We agree and have revised the wording to avoid implying that positional accuracy is directly inherited from the source DEM. The statement was intended to convey that the coastline's spatial resolution reflects that of the TanDEM-X DEM, not that the extraction accuracy matches the DEM's accuracy. The statement was entirely removed from the original Sect. 3.3 outlining the coastline extraction process. Instead, we addressed the spatial resolution in Sect. 2.4 on the TanDEM-X Coastline Product.

CM1.4: It is derived from the 10-m-resolution TanDEM-X DEM data. The minimum spacing between two consecutive vertices of the coastline polygon is 10 m and established in the final step of the dataset production. However, no maximum spacing is enforced, so vertex spacing can be considerably larger along straight or gently curved stretches of the coast.

In addition, we have introduced a new subsection, Sect. 3.3, discussing uncertainties and limitations of the coastline product. In this subsection, we address the uncertainties arising from the extraction process in detail.

The positional accuracy of the extracted coastline is influenced by multiple factors along the processing chain. [...] Beyond this underlying geolocation accuracy, the extraction and vectorization workflow introduces additional uncertainty at several stages, including thresholding of the DEM and ancillary layers to delineate the land-water boundary, morphological operations applied to the resulting raster mask, vectorization of the coastline polygon, and subsequent manual editing of the preliminary coastline. As the coastline is derived from a raster dataset and only includes a pixel-based smoothing, its geometry retains a slightly jagged, pixel-based character. This is a limitation along straight coastal stretches such as sandy beaches, whereas it represents irregular coast types such as skerries and cliffs more naturally. A further source of geometric inaccuracy arises from the final post-processing step enforcing a minimum vertex spacing of 10 m, as manually introduced details finer than this spacing were, in some cases, partially lost. We do not provide a separate quantitative estimate for the combined effect of these processing steps on positional accuracy.

[...]

Manual correction of the preliminary coastline was carried out by operators trained in small groups of 2–3. [...] Corrections were additionally based on higher-resolution optical imagery (Google Earth) than the 10 m input DEM and are therefore also subject to the positional accuracy and interpretability limitations of the imagery source. This is closely related to the treatment of human-made structures, as we generally consider permanent anthropogenic structures, such as harbors, to be part of the coastline. Floating or non-permanent structures (e.g., floating piers, boats, bridges), on

the other hand, are intended to be removed during manual correction. In practice, however, it can be difficult to reliably distinguish non-permanent from permanent structures solely based on satellite imagery.