Dear referee

The following is our response to each of your comments

1. **In Abstract Line 7:** The first statement is repeated in third statement**. First one may be deleted**.

   Response: *Thank you very much for pointing out this error; we will proceed to remove the first statement of the abstract as you suggest.*

2. **Page 10, Line 264:** Since tsunami is long wave and the velocity distribution throughout the depth in vertical direction is almost constant, **the description in parenthesis (averaged vertically) may not be necessary**. However, the authors' choice is welcome.

   Response: *Thank you very much for your comment. We agree that the vertical velocity profile can generally be considered to be approximately uniform in tsunamis. The term "vertically averaged" was originally included to clarify that the velocity given is an average over depth, which is generally obtained from 2DH numerical models. However, we recognize that this clarification is unnecessary in the present context and this had already been mentioned in the previous section. We have therefore removed it from the manuscript, as you suggest.*

3. **Page 10, Line 265:** On the other hand, in the case of a given asset may extend over multiple nodes of the computational grid, the paper recommends that the representative TIM adopted for the vulnerability assessment should correspond to the maximum value identified within the spatial extent of that asset. **Is this maximum value selected from the values at multiple nodes of the computational grid**?

   Response: *Thank you very much for this comment. Yes, this is correct. The maximum value is selected from all computational grid nodes located within the spatial footprint of the asset. Because the proposed TIMs are obtained from a structured-grid numerical model, a single asset may spatially overlap multiple computational nodes. Therefore, for the vulnerability assessment, we adopt the maximum TIM value among all nodes contained within or overlapping the asset footprint. This conservative criterion ensures that the most demanding local tsunami conditions affecting any part of the asset are considered.*

4. **Page 13, Lines 343-349:** The following papers give some other information about the damages at port facilities and coastal structures caused by small size tsunami (1999 Izmit Bay Tsunami). It may be reviewed by the authors and used if relevant.

   - Yuksel; B. Alpar; A. C. Yalciner; E. Cevik; O. Ozguven; Y. Celikoglu, (2003), Effects of the eastern Marmara Earthquake on marine structures and coastal areas, Proceedings of the Institution of Civil Engineers - Water and Maritime Engineering (2003) 156 (2): 147–163. https://doi.org/10.1680/wame.2003.156.2.147

   - Yalciner A. C., Altinok Y., Synolakis C. E., Borrero J., (2000), Tsunami Waves in Izmit Bay, Earthquake Spectra, published by EERI *16*(suppl. A), 55-62. https://www.researchgate.net/publication/290461788_3_Tsunami_Waves_in_Izmit_Bay

Response: *Thank you very much for suggesting these highly relevant references. We have revised both studies and incorporated them into the submitted manuscript. We have added the study of the 1999 İzmit Bay tsunami as an example demonstrating that even a relatively small, locally generated tsunami can cause strong currents, rapid fluctuations in water level, displacement of vessels, failure of moorings and significant disruption to cargo-handling equipment. We have also referred to the documented damage to maritime and port structures following the Kocaeli earthquake. We have clarified that some of the reported structural damage, including that affecting quay walls and cranes, was due to the combined effects of earthquake-induced ground motion and tsunami-related processes, and not solely to the tsunami load. The relevant references have been added to the revised manuscript as follows. (the changes highlighted in yellow)*

> *Historical tsunami events have repeatedly demonstrated the vulnerability of port cargo-handling equipment. For example, the 1946 and 1960 tsunamis caused recurrent damage to port facilities in Hilo, Hawaii, following the events in the Aleutian Islands and Chile, respectively (Lynham et al., 2017). The 1960 Valdivia mega-earthquake and tsunami also affected several ports in Chile and across the Pacific, including the Port of Corral, where cargo-handling equipment and ageing steel cranes suffered significant damage (Lomnitz, 2004). The smaller tsunami generated by the 1999 Kocaeli earthquake also produced notable disturbances within İzmit Bay. Field surveys documented reported strong currents, rapid water-level fluctuations, broken mooring lines, cranes and operational disturbances in ports (Yalciner et al., 2000). Post-event investigations also identified damage to cranes, and other marine structures, although much of this structural damage resulted from the combined effects of earthquake-induced ground motion, and tsunami-related processes (Yuksel et al., 2003). Similarly, the 2004 Indian Ocean tsunami caused extensive damage to port cranes (Synolakis and Kong, 2006), while the 2011 Tohoku tsunami affected cargo-handling equipment in several Japanese ports, including Sendai-Shiogama and Soma.*

New added References

- *Yalciner, A. C., Altinok, Y., Synolakis, C. E., Borrero, J., Imamura, F., Ersoy, S., Kuran, U., Tinti, S., Eskijian, M., Freikman, J., Yuksel, Y., Alpar, B., Watts, P., Kanoglu, U., and Bardet, J. P.: Tsunami Waves in Izmit Bay, Earthquake Spectra, 16, 55–62, https://doi.org/10.1193/1.1586146, 2000.*
- *Yuksel, Y., Alpar, B., Yalciner, A. C., Cevik, E., Ozguven, O., and Celikoglu, Y.: Effects of the eastern Marmara Earthquake on marine structures and coastal areas, Proceedings of the Institution of Civil Engineers - Water and Maritime Engineering, 156, 147–163, https://doi.org/10.1680/WAME.2003.156.2.147, 2003.*

5. **Page 14, Line 363:** According to UNESCO International Tsunami Survey Team (ITST) Post-Tsunami Survey Field Guide, 2014, https://unesdoc.unesco.org/ark:/48223/pf0000229456, and in Tsunami Glossary UNESCO (2019) Technical Series 85, https://unesdoc.unesco.org/ark:/48223/pf0000188226, the term “**inundation depth**” used in this manuscript refers to the flow depth (**the vertical distance from the ground level to the water surface at the inundation area**). In order to be compatible with the

international terminology, I suggest to use flow depth instead of inundation depth as used in UNESCO documents. Otherwise, a note should be added to the manuscript to describe the inundation depth and flow depth.

Response: *Thank you very much for this very important comment. We agree that the terminology used in the manuscript should be consistent with the international terminology established by UNESCO. Consequently, we have added an explicit clarification in Section 3, 'Tsunami Risk Assessment', specifying that the term* ***"inundation depth"****, as used throughout this study, refers to* ***the vertical distance from the ground level to the water surface at the inundation area****, and It is equivalent to the term "flow depth" as defined in the ITST Field Guide for Post-Tsunami Studies and in the UNESCO Tsunami Glossary. To maintain consistency with the terminology used for numerical model results and throughout the manuscript, We have established this equivalence as follows within the document (highlighted in yellow).*

> *In this study, the term "inundation depth" refers to* ***the vertical distance from the ground level to the water surface at the inundation area****, and is equivalent to "flow depth", term adopted in the UNESCO International Tsunami Survey Team Post-Tsunami Survey Field Guide and the UNESCO Tsunami Glossary (UNESCO, 2019). It should not be confused with inundation height, which is measured relative to a specified vertical reference datum, or with inundation distance, which describes the horizontal inland extent of flooding.*

New added Reference

- *UNESCO: Tsunami glossary, 2019, Paris, https://unesdoc.unesco.org/ark:/48223/pf0000188226 (last access: 7 September 2026), 2019.*

6. The methodological framework focused on tsunami damage and exclude earthquake damage (if exists at the port when near field tsunami occurs). This condition should be discussed in the manuscript.

Response: *Thank you very much for this important comment. We agree that the interaction between earthquake-induced damage and subsequent tsunami impacts deserves explicit consideration, particularly for ports exposed to near-field tsunamigenic sources. The proposed framework is hazard-specific and focuses on the direct physical damage caused by tsunami inundation, assuming that port land works area and assets remain their pre-earthquake condition. It does not currently quantify damage caused by ground shaking, permanent ground deformation, liquefaction, lateral spreading, or other coseismic processes.*
Post-event studies carried out following the 2011 Tohoku earthquake and tsunami at Japanese ports show that these processes may damage or deform quay walls, foundations, crane rails, utility networks, and other port components before tsunami arrival. Consequently, they may reduce the residual resistance of exposed assets and modify the topographic conditions controlling tsunami inundation. However, field observations also demonstrate that separating the respective contributions of seismic and tsunami loading is often difficult (Percher et al., 2013)
Following your recommendation, we have added a specific analysis of this limitation and its implications for the application of the framework to the discussion. The revised

manuscript clarifies that, in the case of near-field sources, the results should be interpreted as estimates of tsunami-specific impact. It also recommends that future applications incorporate assessments of the residual capacity of assets following an earthquake, within a sequential multi-risk framework. The following changes will be made to the discussion section (changes highlighted in yellow)

> *An additional limitation concerns the exclusion of earthquake-induced damage preceding tsunami arrival. The framework assesses direct tsunami damage by assuming that port assets and land-side remain in their pre-earthquake condition. Although this assumption is generally appropriate for far-field tsunamis, it may not hold for near-field events. Strong ground motion, liquefaction, lateral spreading, settlement, coseismic deformation, and foundation or quay-wall displacement may damage port structures, assets and utility networks before the tsunami arrives. This pre-existing damage can reduce the residual resistance of the affected assets and consequently increase their fragility to subsequent hydrodynamic loading. Moreover, earthquake-induced changes in ground elevation, or nearshore bathymetry may modify the resulting inundation patterns and TIMs (Percher et al., 2013; Yuksel et al., 2003). Therefore, for ports exposed to near-field sources, the results should be interpreted as tsunami-specific risk estimates conditional on the assumed pre-tsunami state of the assets.*
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> *Future research should focus on developing asset-specific vulnerability functions, jointly incorporating flow depth and velocity, and integrating more advanced probabilistic approaches to reduce uncertainty in the interaction between different elements (debris). For near-field applications, the methodology should be extended through a sequential multi-hazard approach in which earthquake hazard is first assessed. Another challenge for future research is the need to extend the analysis beyond direct physical damage. A comprehensive risk assessment in ports must consider indirect damage and the spread of consequences throughout the supply chain, with business continuity models and network analytics (like Chua et al., 2024), allowing the quantification of how the failure in a component of the landside operational area propagates, affecting the overall operation of the port.*