

## Reviewer Comments

The manuscript reviews compound flooding in Cork Harbor and its catchment, bringing together studies on flood drivers, modeling approaches, risk management, and climate adaptation. Linking these aspects within a single coastal-estuarine system could provide a useful contribution. However, the review methodology needs to be reported more clearly, and the discussion should provide a more critical comparison of the included studies. Several quantitative interpretations and claims about the wider applicability of the findings also require stronger support. I therefore recommend major revision. My comments are provided below.

**Comment #1:** The Introduction and Discussion sections provide a broad overview of compound flooding, but the comparison with studies outside Cork could be further developed, particularly regarding model coupling approaches, statistical dependence among flood drivers, spatial prioritization of compound flood assessments, and coastal exposure to sea-level rise. These topics are relevant because the manuscript discusses integrated modeling, flood risk management, cultural heritage protection, and the broader applicability of the Cork Harbor findings. The authors should strengthen the literature review and discussion by comparing the approaches, findings, and limitations of studies addressing these aspects, while distinguishing sea-level-rise exposure assessments from compound flood analyses. The following studies are provided as relevant examples and may be considered by the authors where appropriate as they are not intended as a restrictive reference list:

- Santiago-Collazo, F. L., Bilskie, M. V., & Hagen, S. C. (2019). A comprehensive review of compound inundation models in low-gradient coastal watersheds. *Environmental Modelling & Software*, 119, 166–181. <https://doi.org/10.1016/j.envsoft.2019.06.002>
- Couasnon, A., Eilander, D., Muis, S., Veldkamp, T. I. E., Haigh, I. D., Wahl, T., Winsemius, H. C., & Ward, P. J. (2020). Measuring compound flood potential from river discharge and storm surge extremes at the global scale. *Natural Hazards and Earth System Sciences*, 20, 489–504. <https://doi.org/10.5194/nhess-20-489-2020>
- Zengin, E. (2023). A Combined Assessment of Sea Level Rise (SLR) Effect on Antalya Gulf (Türkiye) and Future Predictions on Land Loss. *Journal of the Indian Society of Remote Sensing*, 51, 1121–1133. <https://doi.org/10.1007/s12524-023-01694-0>
- Zengin, E. (2023). Inundation risk assessment of Eastern Mediterranean Coastal archaeological and historical sites of Türkiye and Greece. *Environmental Monitoring and Assessment*, 195, 968. <https://doi.org/10.1007/s10661-023-11549-3>
- Del-Rosal-Salido, J., Bermúdez, M., Ortega-Sánchez, M., Sanuy, M., Silva-Santana, M., & Jiménez, J. A. (2025). A composite index framework for compound flood risk assessment. *Communications Earth & Environment*, 6, 342. <https://doi.org/10.1038/s43247-025-02331-z>

**Comment #2:** The literature search described in Section 2.3.1 is not sufficiently detailed to allow the review to be reproduced. Although the databases and several keywords are listed, the complete search strings, search dates, and search fields are not reported. The authors should provide the exact search strategy used for each database, preferably in a supplementary table. For Google Scholar and grey

literature searches, the authors should clarify how the reported records were selected from the search results, including any screening limits and stopping criteria.

**Comment #3:** The number of included studies is inconsistent between the text and the PRISMA flow diagram. The Abstract and Section 2.2 report 87 sources, comprising 59 peer-reviewed articles and 28 technical or policy reports, whereas Figure 3 shows 88 sources, comprising 59 articles and 29 policy documents. The authors should reconcile these numbers throughout the manuscript. In addition, the diagram groups 182 excluded records under the general explanation “not relevant to objectives,” without clearly distinguishing title and abstract screening from full-text eligibility assessment. These stages should be reported separately, with reasons and corresponding counts for full-text exclusions. A supplementary list identifying the final included sources would also improve transparency.

**Comment #4:** The eligibility criteria and scope of the review need clarification. Section 2.3.2 states that studies were included when they met “one or more” criteria in Table 1, although some criteria concern only publication type, language, or full-text availability and cannot independently establish relevance. The authors should distinguish mandatory eligibility requirements from thematic inclusion criteria and explain how these were applied together. The stated publication period of 1991–2025 should also be reconciled with the use of 2026 publications in the Results. Furthermore, evidence specific to Cork Harbour should be clearly distinguished from findings drawn from other Irish catchments or national assessments. This distinction would clarify which sources form the systematic review dataset and which provide contextual information.

**Comment #5:** Section 3.2 mainly describes individual modeling studies, but provides limited comparison of their strengths, limitations, and supporting evidence. Statements about improved accuracy, simulation fidelity, and forecasting performance should be supported by the validation results reported in the original studies. The authors should include a comparative table summarising the flood drivers represented, model coupling approaches, spatial and temporal resolutions, calibration and validation data, performance measures, and treatment of uncertainty. Studies using overlapping datasets or the same historical flood event should also be identified, as their findings may not constitute independent evidence. This comparison would help establish which advances are well supported and which modeling gaps remain unresolved.

**Comment #6:** The interpretation of projected inundation areas in Section 3.1.3 needs reconsideration. The manuscript reports an increase in coastal inundation from 38 to 191 ha and in fluvial inundation from 187 to 242 ha. These values show that future coastal inundation exceeds the present-day fluvial extent, but do not establish that coastal flooding will exceed future fluvial flooding. The claim that the dominant mechanism will shift from fluvial to coastal flooding, also presented in the Abstract and Conclusions, therefore requires clearer justification. The authors should specify the scenarios, return periods, and baseline conditions behind these comparisons and revise the claim accordingly. Furthermore, an increase from 38 to 191 ha represents approximately a 403% increase, or five times the original area, rather than the “fourfold expansion” stated in the text.

**Comment #7:** The manuscript repeatedly describes compound flooding as producing impacts that exceed the sum of those caused by individual drivers. However, the evidence supporting this claim is not clearly distinguished from evidence of simultaneous flooding or increased inundation under combined forcing. The authors should clarify which reviewed studies explicitly demonstrate nonlinear amplification and which identify co-occurrence, statistical dependence, or hydraulic interaction. Where amplification is reported, the comparison metric and reference conditions should be stated. This distinction is particularly important when interpreting changes in inundation extent, as overlapping flooded areas cannot simply be added. The wording should reflect the evidence available for each interaction rather than imply that all combinations necessarily produce greater-than-additive impacts.

**Comment #8:** The discussion of machine learning in Sections 3.2.4 and 4.2 should distinguish demonstrated capabilities from proposed developments. Training a machine-learning model on hydrodynamic simulation outputs does not, by itself, establish that physical constraints are explicitly incorporated into its formulation. The authors should clarify whether the reviewed approaches are surrogate models trained on simulation results or physics-informed models that enforce physical relationships. Claims about operational readiness and applicability in resource-constrained regions should also be supported by evidence from independent validation, forecast lead times, computational requirements, and performance under conditions beyond the training data. Where such evidence is unavailable, these applications should be presented as research opportunities.

**Comment #9:** The assessment of management and adaptation measures should distinguish proposed interventions, implement measures, and demonstrated outcomes. For example, Section 3.3.1 discusses the Lower Lee Flood Relief Scheme as a proposed scheme but subsequently states that it has substantially enhanced Cork City's flood-defense capacity. The implementation status and evidence supporting this statement should be clarified. Similarly, the benefits of nature-based and hybrid measures should be separated into measured flood reduction, modeled benefits, ecological co-benefits, and anticipated outcomes. Evidence of improved habitat or water quality does not alone demonstrate effectiveness against compound flooding. This distinction would strengthen the assessment of existing adaptation measures and the justification for future recommendations.

**Comment #10:** The Source-to-Sea Compound Flood Resilience Framework in Section 4.6 and Figure 5 could provide a useful synthesis, but its practical application and transferability require further explanation. The authors should clarify how the proposed framework extends the integrated flood risk management concepts introduced in Section 2.1 and how its components are informed by the reviewed evidence. A worked conceptual example from Cork could illustrate how a modeling output informs a management decision, which institutions act on that information, and how monitoring results trigger adaptation. Figure 5 should also explicitly show the feedback loops described in the text. Finally, the authors should identify the data, institutional capacity, and environmental conditions required for application elsewhere, and qualify claims of global transferability accordingly.