

Nat. Hazards Earth Syst. Sci. Discuss., referee comment RC1  
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## **Comment on nhess-2022-27**

Anonymous Referee #1

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Referee comment on "Comparison of estimated flood exposure and consequences generated by different event-based inland flood inundation maps" by Joseph L. Gutenson et al., Nat. Hazards Earth Syst. Sci. Discuss.,  
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The authors have produced good work in comparing inundation models and some discrepancies between them in representing flood inundation on maps for compound coastal flooding. Some revision should occur before publication to improve the manuscript's clarity and organization. Generally, I agree that Event Maps should be vetted, particularly in cases of compound flooding or the broader case of many inundation mapmakers producing flood estimates with differing data sources for a flood event; however, the three models appearing in this paper have very different purposes that users of the inundation estimates would likely know about—so the paper is more a demonstration that the models produce different flood footprints. Why not use three coastal flood models and include Adcirc or RIFT, among other models designed for the hydrodynamics of compound coastal flooding? If these models are not available for use in this study, please state so. The point is well taken that any one map could be wrong because it omits variables or flood sources, but the authors do not show how the vetting framework proposed would apply to official products, like, for example, the NHC hurricane storm surge inundation graphic. In forecasting, NHC uses numerous models and real-time parameterization decisions in the production of the hurricane storm surge inundation graphic, so it seems there is something to highlight or learn from NHC's model review and communication processes. I've provided some more detailed comments below and would be happy to assist the authors for further review to get this paper ready for publication. Again, it's good work, but some clarifications are needed.

Line 45: assumes that sources are authoritative and/or unknown, whereas event maps are typically sourced according to authority as in lines 39-43

Lines 71-76 present a conclusion/appears out of order

Line 88: passive tense

Figure 2: graphic introduces use of different DEMs and resolutions, introduces hindcast, introduces multiple unexplained acronyms and data sources (are these public?), national water model uses a land surface (NOAA) whereas auto route uses DEM—are these post processes? Do these inconsistencies in land models relate to the differences in inundation maps and/or accuracies?

Line 126: inconsistent units (meter vs arc second in figure 2)

Lines 120-149: streamflow data appears to be a consistent variable across the frameworks whereas elevation, roughness coefficients, and bathymetry appear differently—the fathom framework appears well cited/situated in literature but auto route and HEC RAS approaches are less clear

Lines 150-160: comparison with HWM, here and more broadly, could be problematic given different elevation sources and other spatial/vertical corrections

Lines 169-172: Recommend clarifying that the NSI includes population estimates from Census/ACS—it was not clear that population is included in NSI

Line 178-180: awkward phrasing/qualifier to damage estimates; insurance uptake is a separate but interesting issue—does lower uptake relate to poorer damage estimation? Would you have a better estimate of flood damage bounding if uptake rates increased to 100%?

Figure 3: kernel typo; why is depreciation mentioned (seems more a benefit-cost assessment than a damage assessment)? What is the resolution of the kernel density analysis? Does that represent up/downscaling?

Lines 190-200: are there HWM from Harris County Flood Control District that might supplement the analysis? I understand HCFCD to have collected this data, though it may not be publicly available. The qualitative descriptors for USGS HWM typically refer to whether the HWM itself is recognizable and is not necessarily a description of elevation differences or potential height uncertainty. Further, sources of flooding leaving the HWM is typically noted in USGS data, so it would be appropriate to describe flood sources (are all the HWM coastal, riverine, or compound? Any ponding or other disconnected flooding? Similar comments for Section 3.2).

Line 198: intersecting rather than capturing (word choice)

Lines 199-200: from where was this assumption previously stated? Please state hypotheses in the introduction or methods sections.

Lines 210-226: predicting accurate WSE in HEC RAS is traditionally the model's aim, so this is also an important finding—and begs questions about why the model cannot be differentiated into producing accurate inundation extents and depths

Line 218: what is MASL? Please make sure units and datums are presented consistently or explain the choices for one datum instead of another.

Line 225: again, where was this previously stated? There appears to be a set of assumptions that was not explained in the introduction or established as testable hypotheses

Line 249: where was this expectation stated previously?

Line 259: where was this expectation stated previously?

Section 3.2: What is the source of flooding denoted by the HWM? Is there a distinction between riverine, coastal, or pluvial sources? Or are we to assume that the HWMs reflect

compound flood conditions? Would one model perform better if only one source of flooding was evaluated by each model?

Line 265: Why is Gesch et al 2014 cited for Fathom? Should this be a Wing citation? Or is the citation for some reference to NSSDA?

Lines 265-267: if HEC RAS is considered better accuracy, why does the derived inundation map not correlate with HWM intersections and/or depths? Are there other limitations to the model beyond parameterizations or lack of data?

Line 269: Can Fathom run at 1-meter resolution to be commensurate with HEC RAS analysis? Comparing model resolutions is important to explain.

Line 277: "the user must understand the assumptions made by the modeler." A better way to state this: "the user should understand the parameterizations made by the modeler." Choosing to omit or include certain parameterizations is the key message here and relates to the discussion in Section 3.3 at line 326—the user, and reader for that matter, needs the parameterizations. A user can make assumptions that one model is "better" than another based on same reported aspect of accuracy; however, the modeler's role is to express what is and what is not accounted for in an analysis—like, as lines 342-343 reflect, *\*not intending to represent flood inundation\** because data is insufficient, erroneous, or non-existent. The modeler chose to not parameterize inundation for Armand Bayou in the HEC RAS analysis; therefore, the HEC RAS analysis should not be compared to the other models because it is incomplete, reflected in the statement at lines 343-344.

Lines 278-280: this appears to be explaining conditions very specific to HEC RAS, whereas

the comment is directed to users of Event Maps—what other explanations of very specific modeling parameters or assumptions can be made more generally to apply to each of the models?

Line 283-284: Why was AutoRoute chosen to model this explicitly compound flood event? Why not use a combination of other models to consider coastal vs riverine vs pluvial vs compound events?

Lines 300-315: This section is unclear, particularly lines 311-312 which appears to set out the overall differences in dollar/damage exposure: greater water depths should have greater expected losses, per the damage functions used in the study; however, little attention is given to water depths across the three modeled flood inundations. There is also no comparison of modeled depths to HWM depths. Line 313 suggests a bias in the AutoRoute model whereas greater depths may simply be a feature of the model or given its configuration for this analysis (e.g., it doesn't do coastal, so WSE will be higher given upstream/inland ground elevations and thus a potential for greater depths or depth errors from DEM).

Section 3.3: recommend not using the term "impact(s)" without discussing or getting into vulnerability assessment; recommend sticking to "exposure" to reduce confusion about the assessment

Line 356: what is the "quantitative pattern" referenced here? Spatial pattern? Depths? Differences in elevations?

Line 360: Please clarify—is this the correct use of "deterministic" in this statement? It

seems that the implication or operative term is single event, not single source. Merwade et al 2008 presents a method to display a single, deterministic (i.e. static) inundation map with possible spatial errors—that is, a flood inundation map that includes visualization of quantifiable uncertainties affecting the spatial extent of estimated flooding. Applying Merwade et al 2008 here infers that the maps produced by the 3 evaluated models each do not account for uncertainties that may include sources of flooding, different DEM resolutions and vertical errors, different roughness coefficients, etc. The follow-on reference to the national hurricane center interactions with stakeholders (NOAA 2013) does not refer to stakeholders favoring probabilistic storm surge maps and appears to conflate the approach offered in Merwade et al 2008 (that is, cartographic representation of uncertainty versus numerical or forecast uncertainties). The report states that stakeholders found the map colors and water depth classifications useful and easy to understand; however, the report details hazard-specific probabilistic maps (wind, storm location uncertainty, arrival timing of wind speeds—standard NHC advisory products) but not probabilistic storm surge inundation maps.

Lines 369-374: Comparison of NFIP claims to NSI valuation is problematic and likely underestimates damages.

Section 3.3 offers an interesting solution to a complex problem in producing and applying flood inundation maps in emergency management situations. It would be interesting to delve further into the reasons that inundation mapping is not a primary function of the federal agencies partnered in IWRSS or that any one entity does not produce an authoritative map, like NHC does for hurricane storm surges. (Are the authors implying that the NHC storm surge map should also be refereed?) However, this seems somewhat beyond the scope or intent of this paper unfortunately—but one can't help but wonder what the reasons are for NWS or USGS or USACE not producing real-time, publicly-accessible inundation maps beyond technical limitations. Is there a statutory reason for not producing inundation maps in real-time? Budgetary or staffing shortages? Clearly these data and maps can be made, and many in near-real-time, so is adjudication the right solution over, say, accounting for mapping uncertainties cartographically and explaining the use cases for the maps and data?