Nat. Hazards Earth Syst. Sci. Discuss., author comment AC10
https://doi.org/10.5194/nhess-2021-323-AC10, 2022

Reply on RC3

Pierre Henry et al.

Author comment on "Mass flows, turbidity currents and other hydrodynamic consequences of small and moderate earthquakes in the Sea of Marmara" by Pierre Henry et al., Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2021-323-AC10, 2022

Thank you for your supportive comments and for the new references.

We agree that an important observation that we do not emphasize enough is that the source of mass flows triggered by these earthquakes is in deep water, while a storm may be expected to cause mass flows and resuspend sediment on the shelf or at the shelf edge. Sediment provenance could thus help make a distinction (but an earthquake could also occur near the shelf edge…).

Detailed comments (They are nor all minor...)

L22 sea floor destabilization causes mass-wasting and gravitational flows. Mass-wasting can take the form of a slide, slump and debris flow. Mud flows are also a type of mass-wasting because the event is suspended in mud

Good point, reviewer 1 and 2 also point out that we should clarify what we mean by mud flow vs turbidity current. For the abstract, it will be more appropriate to word a general statement as: "Earthquakes are known to cause mass wasting and turbidity currents on submarine slopes, but the hydrodynamic processes associated with …

L38-39 In Marmara Sea, the historical earthquakes documented as event deposits in the basin floors, by most authors were of M>6.8 most M>7.0. This is an oversimplification of a complex process. The extent of an event will be controlled by the magnitude of the earthquake, the proximity to the rupture, the availability of sediment, frequency of earthquakes along that plate boundary and the accomodation space

This is true, the reported threshold is 6.8. In any case the last 2 sentences of the abstract were misleading and have been removed.

L44 Recent studies of the Sumatra 2004 M9.2 and Tohoku 2011 M9.0 earthquakes documented that the huge tsunamis were related to the fact that the ruptures reached the seafloor.

Yes, without question. The statement here is regarding whether some other earthquake-related-tsunami could be enhanced by mass wasting as has been proposed in the Sea of Marmara. We here refer to models and a discussion following Papua New Guinea earthquake. What would be the best example supporting the hypothesis that mass wasting could enhance earthquake tsunamis?

L50 Sediment input to the Japan Trench is very high 100-450 cm/ky including turbidites. Without turbidites 80->300 cm/ky (Ikehara et al. 2016, 2017). These sedimentation rates are high for a trench setting

Yes, the statement should be sedimentation rate low and/or earthquakes frequent. This comes from the cited reference (Pope et al., 2016).

L54 Both McHugh et al 2014 and Ikehara et al 2016 sampled the deepest parts of terminal basins L57 Storm deposits are not expected in, for example the Japan Trench at 8 km of water depth. There are sampling techniques that are applied to obtain the best record of earthquake triggered event deposits. For example, a transect of cores across the deepest part of a basin or "depocenter" and "fault basins". Both locations are needed for sampling and verifying an earthquake triggered event deposit. In Cascadia, Goldfinger used "synchroneity of events" by identifying the same earthquake over long distances. Synchroneity does't apply in all basins, especially transform basins with short recurrence intervals. Or basins with low sedimentation rates. You stay away from sampling the base of slope or canyon outlets where stroms are likely to affect sedimentation.

Yes, and our study does further suggest to stay away from canyon outlets and unstable slopes.

This part was changed also to account for comments of other reviewers that synchronicity and confluence tests are important criteria and that even those may fail.

L76 There are new and also interesting papers: Porcile et al., 2020, Sequeiros et al., 2019

Yes, we will include these references

L89 These are good observations. Johnson et al., 2017 for Cascadia margin is also a very interesting paper. Along the lines of what is mentioned in this.

Yes, we will include this reference

L116 This seismic profile is a good indicator of where to sample. Away from the base of the slope fan and canyon outlet. Unless you aim to recover a storm record, which would *also be important to understand…*

Good point, we consider including that in the discussion/conclusion

L123 You mean a canyon with tributary heads? Or a canyon branched at the base of slope?

Both are seen in Figure 1, it looks fractal. Perhaps "a complex canyon system with multiple confluence points and tributary heads"

L125 How short is. the canyon? Is it the lenght in km you are writing about?

Length is not the point here. There is perhaps only one canyon in the Sea of Marmara that is fed by a major river, Simav Çayi. This river also fed the famous low-stand deltas in Imrali Basin (Sorlien et al., 2012). This canyon has a very different morphology with meanders, and no confluences. "Canyons… "

L134 Beneath the seafloor? Not clear what beneath means?

Means under

L268 The authors should refer to the Johnson et al., 2017 paper that uses similar techniques to document a very distal earthquake

L531 This is true, but when you evaluate the event deposits the characteristics of the environment need to be taken into consideration (for example, sediment supply and slope). The first turbidite may appear thicker and therefore derived from a stronger earthquake, while the second would not.

This seems logical. However, I recently looked at the correlation between event thickness and time elapsed since the previous event in one of the Sea of Marmara cores and was surprised that the correlation was very poor, almost non-existent.

L534 One big question this study addresses is how to differentiate small magnitude earthquakes from storms given known sedimenation rates and seafloor topography. This ought to be highlighted as an important point. Recent studies have documented turbidity currents triggered by storms. What would be the difference between a low magnitude earthquake deposit and a storm deposit? I think this would advance the field of submarine paleoseismology.

From what we observe, it would be logical to think that a storm deposit will generally remobilize sediments from the shelf or shelf edge, while a moderate earthquake will remobilize sediments depending on where it occurs. So may be provenance is the key.

L545 to the epicenter? larger distances from what?

From the device

L547 Cite previous papers that deal with this topic for example McHugh et al., 2020

Yes

L555 but there is carbonate material (foraminifers) in the Central Basin depocenter so the carbonate source doesn't need to be from a shallow source.

Difficult question, the forams and bival shell fragments in the deep basins are probably in large part reworked, urchins shell fragments can be locally derived. In any case, no sediment was recovered from this site yet.

L565 Yes, that is why the base of slope or canyon outlets are not good sampling locations for obtaining an earthquake record.

Yes. This can be emphasized in the conclusion.

L570 the samples were taken across the basin depocenter for this purpose

Yes

L575 This study and others similar to this one that have sensors along canyon floors and base of slopes are good at characterizing small earthquakes and flood and/or storm deposits. Can we differentiate between each in the sedimentation record? This would be really helpful to be understand aftershocks after a large event, for example. This study also verifies that the sampling techniques presently used to understand large earthquakes are sound

I doubt that we can answer this question with this study. However, we can emphasize in the conclusion that cores taken at the base of slopes or near canyons may record local events, and contain turbidites as well as debris flow deposits. Yielding records that are more difficult to interpret as paleoseismological records.