

Responses to Review Anonymous Referee 3

Dear Reviewer anonymous referee 3,

Thank you for your observations regarding our preprint. Your suggestions helped to improve our manuscript. See below our responses marked in blue for each of your main concerns (marked in black).

1. I have read the paper entitled "Modelling tides and storm surge using intertidal bathymetry derived from the waterline method applied to multispectral satellite images" by Costa et al. The study aims to determine whether satellite imagery can be used to extract accurate intertidal bathymetric data; and assess the use of the SDB for hydrodynamic modelling of estuaries. The paper is interesting, and one can see that quite a lot of effort, based on the complex methodology, was put into it. However, the manuscript is quite confusing making it difficult to understand. Part of the problem I had was regarding the use of the term SDB to represent extracted shorelines when the term is coined to deriving bathymetry. The study seems to have its merits but needs a complete re-structure. I found results difficult to understand.

We are pleased that the reviewer finds our manuscript interesting. We are aware (based on your review and others) that the structure of the paper is not ideal, and the structure makes the paper confusing to read. We intend to re-structure the paper according to the reviewers' comments. Regarding the methods implemented, there is a misunderstanding. The identification of the waterline position is done as part of the waterline method for estimating bathymetric data in the intertidal zone. We will make this more clear.

2. Because it presents lots of technical concepts, I'd divide this paper in two manuscripts and focus on convincing the reader that waterline extraction can be useful to derive intertidal DEM in NZ and leave the SDB and modelling approach for another opportunity. A short discussion is also presented in this submitted version for such complex topic. Therefore, a major revision or complete new submission is recommended

We understand that the novelty of our work is the part that discusses the assessment of hydrodynamic modelling. Thus, removing this part from our manuscript would affect the paper's novelty. The SDB techniques shown here

are well discussed in the literature and our paper is not aiming to improve any of them in a significant way.

3. It is not clear to me why one would embark on a shoreline extraction method to create an intertidal model, when one could use SDB (Stumpf and others) to obtain bathymetry, especially where white water/waves are absent.

The Stumpf method has the disadvantage of not properly working in deep areas or when the turbidity of the water is great. The waterline technique has been proven to be efficient in intertidal zones, performing better than the Stumpf method in several studies, when compared. Also the Stumpf method requires in situ depth measurements, but the waterline method does not.

4. I found the introduction a quite confusing as it mixed two different uses of satellite. One to derive bathymetry and the other to derive shoreline positions. This is carried out from the Abstract to Introduction to the other parts of the text, and therefore I suggest a complete rewrite of these sections.

Shoreline positions are used as part of the method for estimating bathymetric data through satellite images. We will make this more clear, as we can see that readers do not expect it to be used in this way.

Some specific points below:

5. L9 - I'd suggest to modify text to make better use of the acronym – Satellite-derived bathymetry (SDB) which obviously differ from “use of satellite images to estimate bathymetry”

We changed “use of satellite images to estimate bathymetry” to “satellite-derived bathymetry”.

6. L11 four instead of 4. Same in L16

Done.

7. L18 The use of the satellite derived bathymetry in hydrodynamic models does not result in significant differences in terms of water levels, when

compared with the scenario modelled using surveyed bathymetry. This seems a big claim to me considering that the method was only used in microtidal settings and NDWI performance in macrotidal places can be more complicated due to the larger wet areas. Sea grass bed areas appear also to be an issue.

We agree. We will modify the text to "In our case, The use of the satellite-derived bathymetry in hydrodynamic models does not result in significant differences in terms of water levels."

8. LN23- what about meteorological tides? They seem quite important for predicting floods

We agree that these are important. However, we decided to focus on the astronomical tides as many places around the world have extreme astronomical tides (spring and equinoctial tides) as the main driver for coastal flooding. In addition, storm surges in New Zealand are quite low (average of 0.5 m). We will add a paragraph in section 1 or in section 2, to better describe the physical processes involved in the flooding events and the particularities of New Zealand locations.

9. LN24 no hyphen in sea level

Ok, it will be corrected.

10. LN25- to my knowledge atmospheric pressure is the one driving storm surges along the coast, fluvial discharge definitely adds to it, but it is the difference in pressure that elevates the water level

We agree and have changed the sentence.

11. Ln34 the references following this sentence should focus on SDB and not shoreline "To overcome these issues, efforts have centred on using spaceborn remote sensing (RS) techniques (Bishop-Taylor et al., 2019; Bué et al., 2020; Caballero and Stumpf, 2019)," should be replaced

We have not made ourselves clear. These references are focused on SDB. The Waterline extraction is only part of the method, as described in paragraph 4, lines 53 to 64; and also in section 2.2. We will rewrite this section to make it more clear.

12. LN41 Again I don't think the Bishop et al. ref is appropriate here, as their article addresses shoreline and not bathymetry

Our mapping method uses the shoreline, and so we do think that the reference is relevant, but we will change the introduction to make it much more clear why the shoreline literature is relevant.

13. LN 42 rewrite "use a radiometric approach, which uses the property that different wavelengths are attenuated to varying degrees in the water column".

We will re-write this as "use a radiometric approach, which is based on the property that light attenuation occurs in the water column in different degrees according to the wavelengths of the visible spectrum".

14. LN55 detecting the land-water boundary has nothing to do with deriving bathymetry with satellites. The shoreline is the interface not the morphology of the seafloor. Bishop et al., didn't derive bathymetry. They derived intertidal DEM, linking terrestrial and bathy datasets

We clearly have made this very confusing. We are using the changing shoreline over the intertidal region to map the morphology of the region, and use this to create an intertidal DEM, which we then refer to as bathymetric data. We will make sure that our terminology is clearly and consistently defined at the beginning of the paper.

15. LN57-59 only here I start to get a feeling of why you are talking about SDB, but even after that I think that you are creating a DEM of a few mts- depending on the local amplitude- instead of lets say shallow water bathymetry

We agree, and we will make sure the next version is clear.

16. LN71 bathymetry. You are talking about creating a DEM based on shoreline positions. Some of these positions will be above tide datum. Does that make bathymetry or topography?

Interesting. We are considering it as bathymetry because is below the maximum possible tide/water level. But this is something we should clarify in

the manuscript or adopt the term Intertidal topography instead of intertidal bathymetry.

17. LN77 2 main steps (Fig. 1).

Ok. It will be done.

18. LN78 two instead of 2

Ok. It will be done.

19. LN88 the intertidal zone is easily distinguished by the colour of sand accentuating reflectance in the near infrared band – This sentence seems out of context or needs some further clarification as Fig 2 is not a false colour image.

Ok. It will be re-written.

20. LN89 Associated with tidal flats, mangrove forest can be observed in all the studied estuaries. Where can I observe mangrove and seagrass banks?
Modify text

Ok. We will give indications (e.g., southern part of the estuary with mangrove and the northern part with seagrass).

21. Ln92 I get confused here.” For the implementation of SDB techniques, only tidal levels and imagery are needed. We used additional in situ bathymetric data to validate the SDB.” Do you need bathy or not for implementing SDB?

You need additional bathymetry to validate the method, as explained in section 2.3. We will make this more clear.

22. LN114 t seems to me that some of the derived shoreline elevations cannot be considered bathymetry and this is part why I don't like the use of the term for this shoreline extractions. Some of the elevations will be above MSL. Can you still call it bathymetry? Shouldn't be topography then?

That is a good question. We will do some research on terminology and make sure we are consistent; in any case, we will make it clear that we are estimating the elevations in the intertidal zone to avoid misunderstanding.

23. LN140 you are using NDWI to define the intertidal area. Please explain know the 9 images for Tauranga or the 7 for Ohiwa are capturing the full extent of the intertidal area. Where they acquired during the lowest-highest tidal range?

You can see the full extension of the range captured by looking at Figure 7 for Tauranga harbour and in the supplementary material for the other locations. Indeed, the number of images limits the method, this aspect is discussed in section 4. A greater number of images would make for smaller errors.

24. LN156 Again- colloquialism

We will remove this.

25. LN157 (Fig. 4)

Change will be made.

26. LN158 once the waterline for a given image is identified, a height value is assigned to it accordingly to the corresponding tide level observed at the closest tide gauge (Omokoroa for the Tauranga Harbour case study, Fig. 2D). I see 4 gauges in the estuary. What's the rationale for choosing Omokoa? Oraumatua seems way closer to let's say Rangataua Bay! How do you account for the tidal lag? The level at the entrance is different than at the head.

We choose to use just Omokoroa tide observations to show the difference that could occur when the tidal lag is not accounted for, particularly when the tide gauge is situated a long way from the region of interest. In section 2.4 and 3.3 the use of what we called "dynamical correction" is applied to correct the effects of tide lag (where a local tide is used).

27. Ln202 hyphen mean-sea level

Change will be made.

28. LN259 Tauranga Harbour's waterline-derived SDB (primary SDB)- Sometimes I get really lost- What's primary SDB and how it differs from the other SDBs. Please explain

Primary SDB is the SDB without the statistical or dynamical corrections (explained in section 2.4). We will go through the entire paper and make sure that our explanations and definitions are much more clear.

29. Fig 8 font size too small

Change will be made.

30. Fig 9 Why are the coordinates in this map in NZGD? This figure needs to be improved. The colour scheme does not allow differentiation btw gauges and lines. It has 2 contradicting legends showing water lines as points and lines. Where are the LiDAR and the dynamic waterlines? Are they only shown in profile? I bit confusing to understand

The figures coordinates will be homogenized through all manuscript. The colour scheme will be changed. The points and triangles are the waterline position in profile for primary SDB and the dynamical SDB, respectively. The continuous and dashed lines represent the water level in the local tide gauge and in the dynamic model output. Lidar data are represented in black, only in profile. We will make sure everything is more clearly defined.

31. LN323 The simulation scenarios showed that it is possible to obtain similar, or even enhanced water level predictions, by using the SDB rather than the surveyed bathymetry – I'm a bit lost here. My understanding is that we need bathymetry to do SDB! At least I had to use a few lines in the past.

We meant that by using the estimates from SDB, as the bathymetry in numerical modelling, we can obtain reasonable predictions of water-level/tide. We will make this more clear.

32. LN 383 Bathymetric data are fundamental for solving the hydrodynamic equations in shallow water – This seems obvious, isn't?

Indeed. But is it too obvious for someone that is not familiar with numerical models? In any case, we can remove this sentence and the paragraph will start with "Hydrodynamic models and flooding risk assessments in coasts and estuaries are highly sensitive to depth values...".

33. LN6that it? A 1.5 pg long discussion, for such a complex paper?

We will expand the discussion. (This was also noted by the other reviewers)