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Interactive comment on "Are tidal predictions a good guide to future extremes? – a critique of the Witness King Tides Project" *by* John Hunter

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I thank Ivan Haigh for his thoughtful review in which he makes a number of good suggestions for improving the manuscript.

1. "..... you could mention that the largest semidiurnal tidal range occurs in March and September during the equinoxes, while the largest diurnal tidal range occurs in June and December during the solstices. The day of largest tide varies with phasing of the spring and neap tidal cycle and influence of moons distance to earth (e.g., perigee)."

Good idea - this will be included - see point (7), below.

2. "I wondered whether it would be interesting, for one year or a couple of years, to plot the actual date when the maximum tide occurs, as this will vary quite a bit around the

world depending on whether the site has semi-diurnal, diurnal or mixed tides."

I tend to think that the manuscript already has quite enough plots and complexity, and that this information would not really help anyone to assess the feasibility of performing Witness King Tides (WKT) at a given site. As noted in the Conclusions, such preliminary information can be obtained from Figs 2 to 10 of the manuscript and "it is suggested that, prior to initiating a WKT project, local tide-gauge records that are longer than 20 years are analysed in ways similar to those described here ..... to provide a more detailed assessment of the viability of WKT".

3. "Nowhere do you mention the 4.4 and 18.6 tidal cycles - these can be important in influencing both the timing and height of the annual maximum predicted tide from year to year, but also in a given year. I assume these are accounted for in the tidal analysis."

Firstly, I will add an Appendix note describing briefly the lineage of the tidal analysis program. It is based on astronomical arguments and tidal frequencies generated by software provided by the (then) Proudman Oceanographic Laboratory (now the National Oceanography Centre, Liverpool), the techniques described by Cartwright (1985;Tidal Prediction and Modern Time Scales, International Hydrographic Review, Vol. 62, No. 1, 127-138) and singular value decomposition for the linear regression solution.

Secondly, yes - the 4.4 and 18.6 tidal cycles are accounted for, in two ways: (a) tidal modulations are accounted for by "nodal" corrections, calculated by the routines to be discussed in the Appendix (see above), and (b) the tidal analysis (for 102 constituents) is performed on a two-year time series centred on the middle of the year being analysed. This therefore represents a "running" analysis, which would give a reasonable representation of the tidal modulations, even if "nodal" corrections (a) weren't applied. A "running" analysis is used in order to remove interannual variability and to minimise the effects of unidentified vertical datum shifts in the records.

4. "In the paper there is no mention of storm-surges induced by tropical cyclones. These can be very large. I was just wondering how such events might influence/bias

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the results around the tropics."

There has been no attempt to separate surges induced by tropical cyclones from other surges (e.g. those induced by mid-latitude synoptic systems). The main problem with surges from tropical cyclones is that there are relatively infrequent and probably under-sampled in some of the records (all of which contained at least 20 valid years). This could possibly contribute to the uncertainty in the results at some locations, but further analysis of this effect is beyond the scope of the manuscript, which is to provide preliminary guidance as to the feasibility of a WKT project.

5. "I don't feel too strongly about this, but I wonder whether a short paragraph, or few sentences could be added to briefly highlight the papers that have looked at sunny day or nuisance flooding, as this has some relevance here."

I don't like the term "sunny day flooding" as it infers that "nuisance flooding" only relates to periods when the storm surge is small compared with the tide (i.e. that it occurs on "sunny days", rather than during storms). However, the term "nuisance flooding" describes the effect (flooding which is of low level, and which only causes minor rather than major disruption or property damage), rather than the cause; therefore it can exist in surge-dominated environments as well as tidally-dominated ones. I have dealt with this issue in the next item (6).

6. "Page 1, Line 11 - you could add that this has become known as "Sunny day flooding" or "nuisance flooding".

Agreed (but I will not use the term "sunny day flooding" for the reason given above): I will add, at the end of the sentence "WKT is a citizen-science project designed to collect photos of the shoreline at the time of annual highest astronomical tide, with the aim of indicating the flooding that may occur routinely with sea-level rise" (page 1, lines 9-11), the reference "(e.g. Moftakhari et al., 2015)", after which I'll insert the sentence:

"Such flooding, if it is of low level and only causes minor rather than major disruption

or property damage, is generally referred to as "nuisance flooding" (Moftakhari et al., 2018)."

The two references are:

Moftakhari, H. R., AghaKouchak, A., Sanders, B. F., Allaire, M., & Matthew, R. A. What is nuisance flooding? Defining and monitoring an emerging challenge, Water Resources Research, 54, 4218-4227, https://doi.org/10.1029/2018WR022828, 2018.

Moftakhari, H. R., A. AghaKouchak, B. F. Sanders, D. L. Feldman, W. Sweet, R. A. Matthew, and A. Luke, Increased nuisance flooding along the coasts of the United States due to sea level rise: Past and future, Geophysical Research Letters, 42, 9846-9852, https://doi.org/10.1002/2015GL066072, 2015.

7. "Page 1, line 6 - maybe add a sentence or two to describe why there might be more than one astronomical tides of similar magnitude to the maximum. For example, larger than average tides occur twice per year around either the equinoxes or solstices depending on whether you have semi-diurnal or diurnal tides."

I'll add, on page 2, line 6, after the sentence ending "of similar to the maximum", the sentence: "If the tides are predominantly semidiurnal, the largest maxima occur near the equinoxes (March and September) and, if the tides are predominantly diurnal, the largest maxima occur near the solstices (June and December); for example, see Ray and Merrifield (2019).". The reference is:

Ray, R. D. and Merrifield, M. A. The semiannual and 4.4-year modulations of extreme high tides, Journal of Geophysical Research: Oceans, 124, 5907-5922, https://doi.org/10.1029/2019JC015061, 2019.

8. "Page 2, line 3 - I would replace 'and (in) tidal observations' with 'and (in) sea level observations' as you are considering both tide and surge."

Thank you - of course, I meant "sea-level observations" - I will change it.

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9. "Page 2, line 14 - some justification is need for the first selection. How much data was ignored based on this selection."

After "observed heights that departed by more than 10 standard deviations from the average were rejected" I will insert "(this is a simple check to remove extreme outliers; in the entire GESLA-2 data set of over 300 million data points, only 190 values were rejected in this way)".

10. Page 2, line 15 - I am not sure what you mean by "binned" - do you mean averaged or interpolated.

I mean averaged into bins (e.g. see en.wikipedia.org/wiki/Data_binning). I will change "binned" to "averaged into bins".

11. Page 3, line 5 - which tidal analysis software was used?

See item (3), above.

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