Clim. Past Discuss.,
https://doi.org/10.5194/cp-2019-36-AC1, 2019

Climate of the Past Discussions

Interactive comment on "Reconstruction of track and simulation of storm surge associated with the calamitous typhoon affecting the Pearl River Estuary in September 1874" *by* Hing Yim Mok et al.

Hing Yim Mok et al.

hymok@hko.gov.hk

Received and published: 10 June 2019

I would like to respond to the Referee Comments of Anonymous Referee #1 posted on 5 June 2019 as follows:

1. Given that change of topography and bathymetry will have effects to the storm surges, the effects could be overestimated or underestimated, depending on how the topography and bathymetry have changed. Hence, the use of the topography and bathymetry in the 1990's for running SLOSH could overestimate or underestimate the estimated storm surges for the typhoon in 1874. I agree that it would be highly desirable to run SLOSH using topography and bathymetry in the 1880's. However, while

locating maps of Hong Kong and Macao in the 1880's might not be that difficult, digitized bathymetry data with spatial resolution of about 1 km in Hong Kong and Macao waters and about 7 km in the open sea to the south of the Pearl River Estuary in the 1880's would very likely be not available for running SLOSH.

2. We have qualitatively discussed the possible sources (including the change in topography and bathymetry) of uncertainty of the estimated storm surges at Hong Kong and Macao for the typhoon in 'Results and Discussion' (Line 475 to Line 494) and stated that care has to be taken when comparing the storm surges and tides estimated in this study with those in other historical typhoons (Line 495 to Line 497). We have conducted a comparison of the SLOSH results using topography and bathymetry data in the 1990's and 2010's (not shown in the paper), during which quite a number of coastal development had occurred such as reclamations and building of new airports. The results show that the maximum storm surges at North Point, Tai Po Kau and Macao using topography and bathymetry data in the 1990's (2010's) are 2.83 m (2.71 m), 2.83 m (2.77 m) and 2.80 m (2.68 m) respectively. Perhaps this can give a brief quantitative idea on the sensitivity of SLOSH results on changes in topography and bathymetry.

3. Bearing the uncertainty of the estimated storm surges and tides, the reconstructed track (positions, intensities and radii of maximum winds) of the typhoon itself can be used as a possible scenario for assessment of storm surge risk in the Pearl River Estuary nowadays.

4. Comparison of the SLOSH results with descriptions in historical documents are described in the paragraph from Line 407 to Line 424. Regarding your comments on the inconsistency on 'the numbers of height are way too higher than the descriptions in the historical documents and the time series pattern are also inconsistent', I would like to elaborate further below:

(a) In Line 417, the historical document quotes 'By three, the water had risen to from five to six feet above its high water' meaning that the storm tide was 1.52 m (five feet)

to 1.83 m (six feet) above the astronomical high tide in Hong Kong. This is a bit higher than what is stated in Line 412 to Line 413 that 'the difference between the storm tide of 3.69 m at 3 a.m. and the astronomical high tide of 2.28 m at around 6:30 a.m.' - which is 1.41 m. Given the observation in the historical document is taken by human eyes at night time and not at the location of the tide station, such a small difference (1.52 m to 1.83 m against 1.41 m) is considered not inconsistent.

(b) In Line 422, the historical document quotes 'storm surge which caused severe flooding of up to 7 feet above high tide level' meaning that the maximum storm tide was up to 2.13 m (7 feet) above the high astronomical tide in Macao. This is smaller than what is stated in Line 418 to Line 419 that 'the difference between the maximum storm tide of 5.37 m at 4 a.m. and the astronomical high tide of 2.77 m at around 6 a.m.' – which is 2.60 m. Again, given the observation in the historical document is taken by human eyes at night time and not at the location of the tide station, such a difference (2.13 m against 2.60 m) is considered not inconsistent.

5. Response to minor comments:

(a) Figure 6 shows the prevailing wind directions in Hong Kong (for strong winds or above) with respect to tropical cyclone positions. The arrow shows a tropical cyclone track moving from east to west along the coast of south China to skirt the south of Hong Kong. The expected sequential change of the prevailing direction in Hong Kong will be NW, N, N to NE, E to NE, E, E to SE. This figure helps to support a westerly track of the typhoon in 1874 as discussed in Line 239 to Line 256.

(b) Figure 3 can be removed.

(c) The purpose of Figure 2 and 3 is to give the readers an idea on the locations in Hong Kong and Macao mentioned in the paper. These figures can be removed.

(d) The red line is the time series of storm surges simulated by SLOSH and the green line is the time series of storm tides (sum of storm surge and astronomical tide at the

same time). Sudden drop after peak and rise again after the down point is not uncommon for storm surges as storm surges at a particular location can change rapidly with changes in the distance of the tropical cyclone from the location, intensity of the tropical cyclone, storm size (in terms of radius of maximum winds) of the tropical cyclone and the prevailing wind direction. For typhoon 1874, the rapid drop after peak would be due to the fast departure (the typhoon was moving at a speed of about 38 km/hour (Line 327 to Line 329) and rapid weakening of the typhoon after making landfall (from 945 hPa at 4 a.m. to 980 hPa at 10 a.m. as shown in Table 5). The small rise again after the down point might be due to the change of the storm size (in terms of radius of maximum winds) from 25 km at 4 a.m. to 45 km at 10 a.m. as shown in Table 5 also. These discussions can be incorporated into the paper.

(e) The statement 'all times mentioned in thyis paper refer to the local mean time, which was on average 7 hours 36 minutes and 41 seconds ahead of UTC in Hong Kong before 1 November 1904' is a note to the readers that there was a change in the Hong Kong Time on 1 Nov 1904. Before 1 Nov 1904, Hong Kong Time was based on local solar time (i.e. sun's transit occurs at local solar noon), which according to the longitude of Hong Kong was on average Greenwich Mean Time (GMT) plus 7 hours 36 minutes and 41 seconds. After 1 Nov 1904, it was changed to GMT + 8 hours. It is just a note and will have no effect to the study results.

Interactive comment on Clim. Past Discuss., https://doi.org/10.5194/cp-2019-36, 2019.