Effect of monsoon surges on tides in Peninsular Malaysia

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Abstract

It has been established through several studies in this field, that climate change will not only increase the intensity, but also the frequency of such flash floods, with the island-nation of Singapore being hit by three episodes within a span of three months between October to Decemeber. From existing literature, we have seen that the combined effect of climate variabilities, monsoon surge events and the impact of astronomical alignment on tides can cause sea level anomalies, along with severe coastal floods (such as the ones seen on 23rd December 1999). The primary motivation of this study is to investigate the effect of MS events, in conjunction with the internal climate variability phenomena that affects the sea levels and rainfall of the region (such as the El-Niño Southern Oscillation (ENSO)). Hourly tide gauge (research quality) data from the University of Hawaii Sea Level Centre between $1990-2013$ has been used to study the impact of monsoon surge (MS) events during the northeast (NE) monsoon in Peninsular Malaysia, focussing on the gauges along the eastern Malaysian coast and the Singapore Strait (SS). Further cleaning and analysis of the data has not only allowed to specify a definition for 'high tides', find overlaps with recorded monsoon surge days, the previously defined 'high tides' and astronomical alignment, but also develop a model to predict the daily maximum tide across these gauges, using sea-level anomalies, and the associated wind speed and pressure level anomalies as variables, given the presence of an abnormally high tide. The development of this model aims to improve predictability for surge-induced flash floods, with implications for disaster preparedness in South-East Asia, thus aiding government agencies in risk mitigation for vulnerable areas and early warning systems. (283 words)

Points to be included in the abstract according to SPS guidelines:

- Introduction and background literature review
  - For this: can use the literature review already provided by Xin Rong
- Short brief as to why this question is important to solve: explain the research gap
- Short brief into the methodology and techniques used
- How does it fit into the 'bigger scheme of things?'

Sample abstract 1

Pham et. al (2019)

With sea levels projected to rise as a result of climate change, it is imperative to understand not only long-term average trends, but also the spatial and temporal patterns of extreme sea level. In this study, we use a comprehensive set of 30 tide gauges spanning 1954–2014 to characterize the spatial and temporal variations of extreme sea level around the low-lying and densely populated margins of the South China Sea. We also explore the long-term evo- lution of extreme sea level by applying a dynamic linear model for the generalized extreme value distribution (DLM-GEV), which can be used for assessing the changes in extreme sea levels with time. Our results show that the sea-level maxima distributions range from 90 to 400 cm and occur seasonally across the South China Sea. In general, the sea-level maxima at northern tide gauges are approximately $25-30\%$ higher than those in the south and are highest in summer as tropical cyclone-induced surges dominate the northern sig- nal. In contrast, the smaller signal in the south is dominated by monsoonal winds in the winter. The trends of extreme high percentiles of sea-level values are broadly consistent with the changes in mean sea level. The DLM-GEV model characterizes the interannual variability of extreme sea level, and hence, the 50-year return levels at most tide gauges. We find small but statistically signifcant correlations between extreme sea level and both the Pacifc Decadal Oscillation and El Niño/Southern Oscillation. Our study provides new insight into the dynamic relationships between extreme sea level, mean sea level and the tidal cycle in the South China Sea, which can contribute to preparing for coastal risks at multi-decadal timescales.

Sample Abstract 2

Tkalich et. al(2013)

Among the semi-enclosed basins of the world ocean, the South China Sea (SCS) is unique in its configuration as it lies under the main southwest-northeast pathway of the seasonal monsoons. The northeast (NE) monsoon (November-February) and southwest monsoon (June-August) dominate the large scale sea level dynamics of the SCS. Sunda Shelf at the southwest part of SCS tends to amplify Sea Level Anomalies (SLAs) generated by winds over the sea. The entire region, bounded by Gulf of Thailand on the north, Karimata Strait on the south, east cost of Peninsular Malaysia on the west, and break of Sunda Shelf on the east, could experience positive or negative SLAs depending on the wind direction and speed. Strong sea level surges during NE monsoon, if coincide with spring tide, usually lead to coastal floods in the region. To understand the phenomena, we analyzed the wind-driven sea level anomalies focusing on Singapore Strait (SS), laying at the most southwest point of the region. An analysis of Tanjong Pagar (TG) tide gauge data in the SS, as well as satellite altimetry and reanalyzed wind in the region, reveal that the wind over central part of SCS is arguably the most important factor determining the observed variability of

SLAs at hourly to monthly scales. Climatological SLAs in SS are found to be positive, and of the order of 30 cm during NE monsoon, but negative, and of the order of 20 cm during SW monsoon. The largest anomalies are associated with intensified winds during NE monsoon, with historical highs exceeding 50 cm. At the hourly and daily timescales, SLA magnitude is correlated with the NE wind speed over central part of SCS with an average time lag of 36 to 42 hours. An exact solution is derived by approximating the elongated SCS shape with onedimensional two-step channel. The solution is utilized to fit empirical function connecting SLAs in SS with the wind speeds over central part of SCS. Due to delay of sea level anomaly in SS with respect to the remote source at SCS, the simplified solutions could be used for storm surge forecast, with a lead time exceeding one day.