A Method to Forecast Extreme River Discharges from Typhoon Hagibis 2019 and Western Japan Floods 2018

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Introduction and Objective

As a result of climate change impact, record breaking disasters are occurring every year with unprecedented amounts of heavy rainfalls, typhoon intensities and associated coastal sea disasters which bring huge amounts of river water and associated nutrients pollution towards river mouths and into coastal sea zones, where they greatly decrease sea water quality and can negatively impact marine environment for several days or weeks. To mitigate negative impact of such disasters, it is important to develop forecasting or nowcasting of extreme river water levels during flood events, but it is still not well developed due to high uncertainty of its occurrence and absence of available historical data for unprecedented rainfall events.

Troselj et al. (2017) quantitatively evaluated the impact of extreme freshwater outflow to the coastal ocean due to typhoon passage by combining river and ocean models using hourly time step data and remote-sensing technology. With the advance of weather forecasting systems and specific availability of forecasting typhoon trajectory and intensity, we aim to be able to apprehend freshwater impacts on the coastal marine environment in advance of typhoon events.

Objective of the study is to show how to utilize methodology developed in the previous study to forecast the most recent extreme flood events occurred in Kanto region of Japan due to passage of Typhoon Hagibis in October 2019 and in Hiroshima region of Japan due to an unprecedented rainfall induced disaster in July 2018.

Methods

We continued the study from Troselj et al. (2017) by testing how river mouth discharges for 9 first class rivers calibrated in the previous study on Typhoons Chataan 2002 and Roke 2011 could have been nowcasted during the passage of Typhoon Hagibis in 2019. We assumed that we had available input meteorologically forecasted data which corresponds to MLIT observed data after the event. Furthermore, the same methodology was applied for heavy rainfall events of 2005 and 2018 for Ota River basin in Hiroshima, Japan, because these events had similar rainfall patterns.

Discussions

We showed that the model used in the study has the capability of simulating extreme discharge events by calibration using previous extreme Typhoon case events with similar trajectory. When using calibrated river basins parameters from Typhoons Chataan and Roke for projection of the Typhoon Hagibis, the

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calculated Nash-Sutcliffe efficiency values (NSE) have mostly been bigger than 0.8 and 0.9, respectively. Exceptions are the most northern rivers Mabechi and Takase which did not show a significant fit due to being located too far away from the trajectory of the Typhoon Hagibis. These results suggest that our models calibrated on Typhoons Roke or Chataan cases can be successfully applied to forecast river runoff values from other similar extreme precipitation events, and furthermore newly calibrated parameters from Typhoon Hagibis can be used as an additional forecasting tool.

Results for cross-calibration and cross-validation of the heavy rainfall events of 2005 and 2018 for Ota River basin in Hiroshima will be finalized and similarly discussed before the JpGU conference, when MLIT releases Ota River discharge data for 2018.

Summary

The extreme discharge events have a lot of uncertainties and differences among their physical processes. However, we emphasize their similarities by calibrating river basin response to particular rainfall and afterwards using the calibrated parameters of the basin to forecast the river discharge from a future event with similar forecasted rainfall pattern.

Reference

Troselj J, Sayama T, Varlamov SM, Sasaki T, Racault M-F, Takara K, Miyazawa Y, Kuroki R, Yamagata T, Yamashiki Y (2017). Modeling of extreme freshwater outflow from the north-eastern Japanese river basins to western Pacific Ocean, Journal of Hydrology, Vol. 555, pp. 956-970, doi:10.1016/j.jhydrol.2017.10.042.

Keywords: extreme river discharge, Typhoon Hagibis 2019, western Japan floods 2018, CDRM hydrological model, SCE-UA optimization method, nowcasting

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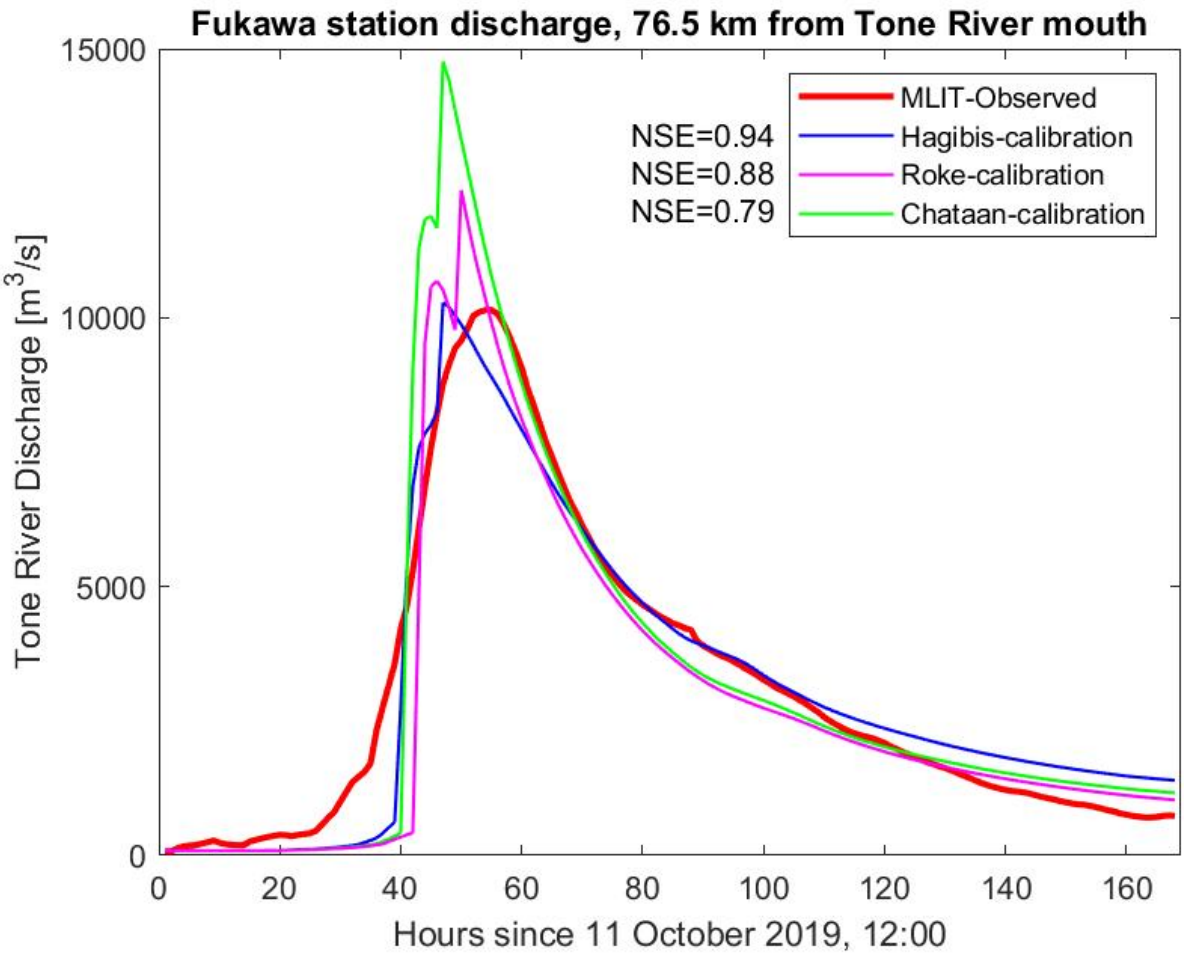

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