Assessment of Flood Risk in Hokkaido, northern Japan, Associated with Climate Change

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In August 2016, 4 typhoons sequentially attacked Hokkaido region (Northern part of Japan) within 2 weeks and caused severe flood damage. Because this sequential typhoon attack is the first time in recorded history and remarked maximum rainfall amount on many observatories in Hokkaido region and this heavy rainfall caused various flood disaster (inundation caused by dyke break, damaged to load and farmland), it became one of a trigger that led river administrators (Hokkaido regional development bureau of the Ministry of Land, Infrastructure and Transport (MLIT) and Hokkaido prefectural government) to consider flood risk change associate with climate change. Actually, they organized a committee in order to project future flood risk in Hokkaido. MLIT has also organized a committee since fiscal 2018 in order to consider flood prevention plan associate with climate change. As can be seen these backgrounds, projection of future flood risk became important and urgent issue. This study quantified flood risk under both historical and warmer climate condition by using a large ensemble simulation dataset.

In this study, we analyzed characteristics of annual maximum rainfall over river basins in Hokkaido region under historical and warmer climate conditions in order to evaluate flood risk change. This research used d4PDF (database for Policy Decision making for Future climate change) which consists of large ensemble climate data (historical climate: total 3,000 years, 2K warmer climate: total 3,240 years, 4 K warmer climate: total 5,400 years). This research conducted dynamical downscaling (DS) using a regional climate model for annual maximum rainfall events detected from d4PDF (convert from 20 km to 5 km) in order to take into account topographic effect and shapes of the target river basin more precisely. This research focus on not only rainfall amount but also weather pattern which caused heavy rainfall. We classified weather patterns based on SOM (Self Organizing Map) and evaluated their return period.

The rainfall after DS under historical climate condition and rainfall obtained from observation results have similar frequency in terms of rainfall amount and include many events which exceed maximum recorded rainfall. These results show that DS is effective way to make many possible heavy rainfall patterns. The comparison between historical and future climate showed that rainfall amount significantly increase. Especially, low probability rainfall (e.g. 99 percentile value) become much heavier. Because of the increase of rainfall amount, estimated inundation area become larger and estimated fatalities increase under same occurrence probability. Climate change caused not only increase of rainfall amount but also concentration of heavy rainfall in spatiotemporally. Because heavier and more concentrated rainfall causes increase of peak discharge and change of characteristics of flood damage, the change of rainfall characteristics must be considered for flood disaster prevention plan. Classification of weather pattern shows the factor of heavy rainfall changes in warmer climate.

These results show necessity of flood protection plan considering climate change and large ensemble climate dataset can be greatly helpful for planning. This study became the core of the discussion at the committee related to future flood risk in Hokkaido, Japan which was held in fiscal 2017, future flood control measures are going to be discussed based on these results.

Keywords: Climate change, Flood risk, d4PDF, adaptation

