## Application of Flood Early Warning Using High-Resolution Ensemble Rainfall from Numerical Weather Prediction Model: Case Study of the 2013 Largest Flood Event in Japan

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## 1. Introduction

On mid-September 2013 heavy rainfalls happened over Japan due to the season's 18th typhoon, 'Man-yi', which caused large flooding and enormous landslide disasters over Japan's Kinki region. In Kyoto on September 16, 260,000 people in the city were ordered to evacuate to shelters and were also ordered to evacuate across mainly the west side of Japan. The Japan Meteorological Agency (JMA) issued a "special warning" for three western Japan prefectures of Fukui, Kyoto, and Shiga. Over 70 people were injured and at least one person was killed. Many homes were flooded and about 80,000 were without electricity in western and central Japan.

Flood forecasting is an important technique to reduce damages from flood disasters. As the accuracy of weather forecasts has improved with advances in numerical weather prediction (NWP) techniques with increasing computing power, it is now possible to generate high-resolution rainfall forecasts at the catchment scale and to integrate quantitative precipitation forecasting (QPF) into flood forecasting systems with extended lead time. For this purpose, coupling NWP with flood forecasting has been attempted by advanced flood forecasting centers and hydrologist in the past decade since the predictability of NWP has steadily increased as ensemble forecasting and data assimilation techniques has improved. And several authors have been utilized and investigated the ensemble NWP, and they found that ensembles increase rainfall and flood forecast accuracy and allow for skillful predictions with extended lead time.

## 2. Purpose and Methodology

Given the current issue with application of ensemble NWP to flood forecasting, the aim of this research is to overcome an insufficiency of the deterministic flood forecast using ensemble outputs with 48-hr forecast time and 2km high-resolution and to explore an accuracy improvement of the flood forecasting using ensemble NWP rainfall forecast. Therefore, we assess the latest ensemble NWP outputs with 51 ensemble members, 48-hr forecast time and 2km horizontal resolution whether they can produce suitable rainfall predictions or not during the Typhoon No. 18 'Man-vi' 2013 event, and we also assess the performance of ensemble flood forecasting for application of flood early warning based on the latest ensemble NWP rainfall forecast over the Katsura river basin (Figure 1). In this study, it is important that the ensemble flood forecast with 51 ensemble members, 48-hr forecast time and 2km high-resolution has not been carried out in previous researches for the flood early warning field.



Figure 1. 48-hr ensemble flood forecasting using ensemble NWP rainfall and its application to flood early warning over the Katsura river catchment.