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Study on the relationship between improved short-term precipitation forecast and insurance data for risk evaluation in Southern China

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Heavy rainfall is one of the most frequent and severe weather hazards in the world which becomeone of the hugest natural risks. It has been found that during the flood season in South China, high intensive precipitation occurs very frequently due to the impact of east Asian monsoon. An unexpected and unusual extreme precipitation event could lead to millions or billions worth of damage, wash out vehicles and houses, destroy agricultural fields, and threat people's lives. Determining the linkage between heavy rainfall causes, critical meteorological condition, and impacts can make it easier to classify risk level. However, due to the insufficiencies of quantitative heavy rainfall related property damages, and low efficient precipitation forecast, the risk evaluation could not be well determined. Therefore, we employed an improved short-term precipitation forecast based on ensemble deep learning algorithms that can provide more accurate prediction, and apply 25 years of insurance data to aid as proxy for the evaluation of short-term heavy rainfall risks, aiming to trigger in-time precautions and reduce losses.

The improved short-term precipitation forecast is built based on combination of scale-invariant feature transform (SIFT) algorithm and ensemble model including convolutional neural network (CNN), gradient boosting decision tree (GBDT), and neural network. The main dataset used includes radar images and station observed precipitation. The past 1.5 hour radar reflectivity images are measured at 15 times with an interval of 6 minutes, and in 4 different heights from 0.5 km to 3.5 km with an interval of 1 km. The hourly site precipitation is obtained from ground meteorology stations. The SIFT is used to calculate cloud trajectory velocity, and the CNN is implemented with features including pinpoint local radar images, spatial-temporal descriptions of the cloud movement and the global description of the cloud pattern. Weights are assigned to the ensemble model to compute the following 2-3 hours forecasting results. Additionally, the insurance data include more than 50 thousand records provided on a geography coordinate level for the last 25 years.

Result shows that the insurance data have a strong correlation with short-term precipitation. It also indicates that our proposed model of short-term precipitation forecast outperforms only-deep learning-based and traditional optical flow-based methods. The insurance data could provide a good proxy for describing heavy rainfall damage and to aid to explore the causes and impacts. This study would greatly assist policy makers, civil protection agencies, and insurance companies to improve emergency systems and response mechanisms.