

How sure is sure? Are we absolutely certain when and where floods occur?

Providing probabilistic flood forecasts using an ensemble precipitation forecasting technique

Dr. Edward Norton Lorenz, an American mathematician and meteorologist, realized that small differences in the atmosphere or an atmosphere model can lead to unsuspected results. He stated that “When a butterfly flutters its wings in one part of the world, it can eventually cause a hurricane in another.” The statement later became a world-renowned concept called the “butterfly effect”. Because considerable uncertainty exists in the atmosphere, it is difficult to make accurate weather forecasts. Considering the difficulty of accurate weather forecasting, how can we develop a method of predicting future scenarios? National Taiwan University, National Central University, National Taiwan Normal University, Chinese Culture University, the Central Weather Bureau, the National Center for High-Performance Computing, the Taiwan Typhoon and Flood Research Institute, and the National Science and Technology Center for Disaster Reduction conducted an ensemble precipitation forecasting experiment called the Taiwan cooperative precipitation ensemble forecasting experiment (TAPEX). TAPEX includes various physical model schemes and data assimilation techniques, as well as initial and boundary conditions. Such models provide a wide range of potential future states of the atmosphere. Given quantitative precipitation forecasting information, the flood risk at the township level can be rapidly evaluated based on a rainfall threshold concept. Professor Gwo-Fong Lin led a research team in developing a statistics-based flood forecasting model that provides probabilistic flood forecasts in Taiwan during a typhoon. The model considers different sources of information, such as the designed capacities of storm sewer systems, a flood inundation potential database, and historical flood observations, to identify the cumulative rainfall thresholds that will trigger floods. Using 24-, 48- and 72-h precipitation forecasts from TAPEX, the model can assess the flooding potential with two levels of risk and a 3-day lead time. The model was first applied to Pingtung County and can now be used in analyses of the entire island of Taiwan. A

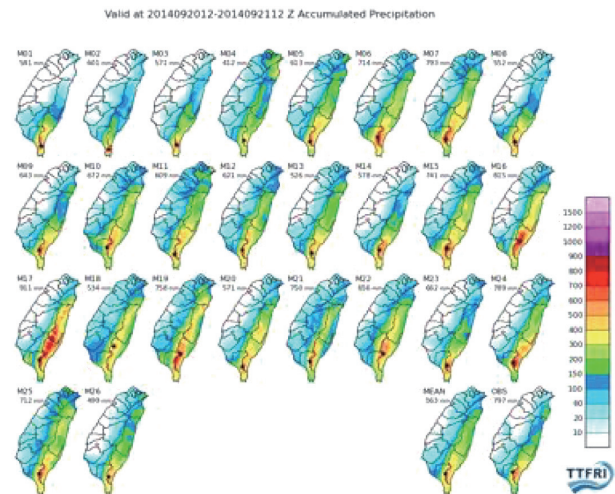


Figure 1. TAPEX rainfall forecasts for a typhoon

dataset of typhoon storms from 2010 to 2015 was used to evaluate the model performance. Although the model cannot predict the exact location and time of flooding, its probability-based results can help decision makers evaluate the reliability of the forecasts and take appropriate measures. Although the model's performance decreases when the lead time increases due to increased uncertainty, the model has considerable potential as a valuable reference for improving emergency responses and alleviating the loss of lives and property due to flooding.

Reference

Tsun-Hua Yang, Sheng-Chi Yang, Jui-Yi Ho, Gwo-Fong Lin, Gong-Do Hwang, and Cheng-Shang Lee. (2015). Flash flood warnings using the ensemble precipitation forecasting technique: A case study on forecasting floods in Taiwan caused by typhoons. *Journal of Hydrology*, 520, 367-378. DOI: 10.1016/j.jhydrol.2014.11.028

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