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Regional flood forecasting based on the spatio-temporal variation characteristics using hybrid SOM and dynamic neural networks

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The frequency of extreme hydrological events caused by climate change has increased in recent years. Besides, most of the urban areas in various countries are located on low-lying and flood-prone alluvial plains such that the severity of flooding disasters and the number of affected people increase significantly. Therefore, it is imperative to explore the spatio-temporal variation characteristics of regional floods and apply them to real-time flood forecasting. Flash floods are common and difficult to control in Taiwan due to several geo-hydro-meteorological factors including drastic changes in topography, steep rivers, short concentration time, and heavy rain. In recent decades, the emergence of artificial intelligence (AI) and machine learning techniques have proven to be effective in tackling real-time climate-related disasters. This study combines an unsupervised and competitive neural network, the self-organizing map (SOM), and the dynamic neural networks to make regional flood inundation forecasts. The SOM can be used to cluster high-dimensional historical flooding events and map the events onto a two-dimensional topological feature map. The topological structure displayed in the output space is helpful to explore the characteristics of the spatio-temporal variation of different flood events in the investigative watershed. The dynamic neural networks are suitable for forecasting time-vary systems because its feedback mechanism can keep track the most recent tendency. The results demonstrate that the real-time regional flood inundation forecast model combining SOM and dynamic neural networks can more quickly extract the characteristics of regional flood inundation and more accurately produce multi-step ahead flood inundation forecasts than the traditional methods. The proposed methodology can provide spatio-temporal information of flood inundation to decision makers and residents for taking precautionary measures against flooding.

Keywords: Artificial neural network (ANN); Self-organizing map (SOM); Dynamic neural networks; Regional flood; Spatio-temporal distribution