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Dynamic prediction model for landslide susceptibility based on deep learning methods

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Landslide is a common natural hazard that causes extensive damage and losses worldwide every year, especially during the rainy season. To minimize these losses and reduce landslide risks, modeling and predicting the occurrence of landslide dynamically are meaningful and supportive for managing regional landslide risks. In addition, although landslide susceptibility is generally considered to be a specific phenomenon of a particular location, there are indications that the history of landslides collectively determines the susceptibility of future landslides and landslide susceptibility process is dynamic rather than time-invariant. In recent years, the Convolutional Neural Network (CNN) and the Long Short-Term Memory neural network (LSTM) have become an important state-of-the-art deep learning algorithm, and its implementation has enriched many fields. CNN has excellent spatial feature extraction ability and LSTM is proposed for processing time series data, which has great advantages in processing dynamically changing data. Therefore, we proposed a dynamic prediction model for landslide susceptibility based on combining CNN with LSTM. First, multi-temporal landslide inventory was prepared using multi-source remote sensing images and field investigation data. Eleven geo-environmental variables were mapped using Geographic Information System. Second, the architecture of the CNN-LSTM model was designed and hyperparameters were optimized. Finally, the landslide susceptibility assessments in nine phases were carried out by using the deep dynamic models, and the global performance of the CNN-LSTM model was evaluated by using the receiver operating characteristic curve and the area under the curve (AUC). The results confirm the higher accuracy of the proposed CNN-LSTM model compared to shallow machine learning methods. The CNN-LSTM is more suitable for the dynamic prediction of landslide susceptibility.