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A Deep Learning Approach to Downscaling Precipitation and Temperature over Myanmar

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Future climate data are essential for conducting the hydrological assessment. Due to the scarce scale of climate data generated from General Circulation Models (GCMs), the native-scale outputs of climate models could not be directly utilized for basin-scale hydrologic models. Regional Climate Model (RCM) is a dominant technique to dynamical downscaling from the global scale to regional scale with consideration of atmospheric physical processes. However, the computational expense of RCM is costly for developing countries. Therefore, the metamodel of RCM for the specific area is eager to be designed to support decision making. This research introduces novel development and application of Convolutional Neural Network (CNN) to precipitation and temperature downscaling in river basins in Myanmar using real-time satellite data from Global Satellite Mapping of Precipitation (GSMaP) and Himawari8 geostationary weather satellite. GSMaP has the resolution of 10km and Himawari8 has the finer resolution as 1km. The CNN augments conventional neural networks by including two conv layers, two max-pooling layers and final fully connected layer to deliver the outputs of high-resolution 1km hourly precipitation and temperature. The evaluation was based on simulation of CNN under current (1990-2010) climate conditions as training and validation years and future projected (2050-2070) climate conditions as testing years. Comparisons were conducted between CNN and conventional machine learning techniques, such as the artificial neural network (ANN) and support vector machine (SVM). The first CNN downscaling model for Myanmar is proposed. The CNN model can be easily accessed and modified to improve the application for another specific area, not only beneficial to Myanmar-related researchers but global researchers interested in conducting the hydrological assessment using downscaled climate data. The results of CNN for downscaled precipitation and temperature show the similarity to outputs of RCM and reduction of the significant amount of required computational resources. By including the time of training and implementing deep learning model, CNN takes approximately 12% of the time needed for RCM dynamical downscaling. Furthermore, CNN shows nearly 70% smaller spatial weighted root-mean-square-error (S-RMSE) than ANN. The CNN demonstrates the advantages that CNN could show the superiority over the artificial neural network and conventional machine learning downscaling techniques with boost observed and labeled data. With the CNN, researchers related to future climate change impact assessment may be capable of utilizing the metamodel to rapidly and efficiently retrieve the results of future downscaled climate data. The accuracy of the CNN downscaling interestingly decreases during the dry season in Myanmar. Importantly, this study extends deep learning model for downscaling climate data and comparison of deep learning and conventional machine learning techniques is conducted.