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Deep learning for planform predictions of braided rivers

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Braided rivers are the most dynamic type of rivers, with a rapid and intricate morphological evolution. A limited understanding and inadequate algorithm implementation of specific morphological processes limits the prediction capabilities of physics-based models. The design of structures, infrastructure, and other interventions is consequently hampered. In recent years artificial intelligence (AI) techniques rapidly gained popularity across different contexts. Additionally, the availability of satellite images increased. This research sets a novel attempt to predict the planform evolution of braided rivers by means of deep learning and satellite images. The Brahmaputra-Jamuna River, in India and Bangladesh, was selected as case study. A convolutional neural network (CNN) with U-Net architecture was developed. The model was trained with the Global Surface Water Dataset (GSWD). The goal of the model was to classify each pixel as either "Non-water" or "Water". Four images, representative of the same month over four consecutive years, were used as input. The fifth-year image represented the target. The model demonstrated good skills in predicting the planform development. Processes like the migration of meanders, the abandonment of channels, and the evolution of confluences and bifurcations were often well captured. However, a lack of temporal patterns was noticed. More complex phenomena, like the formation and shifting of channels, were never predicted. The total areas of erosion and deposition were constantly underpredicted. Metrics such as precision, recall, F1-score, and critical success index (CSI) were tracked. Overall, our model achieved a 5-6% total improvement of these metrics compared to the benchmark method for which no morphological change is assumed to occur. Our model could be useful as a preliminary tool for water management authorities in India and Bangladesh. It can support the prioritisation of bank protection measures in areas subject to erosion or land reclamation projects in areas subject to deposition and assist inland navigation. Given the inherent tendency of the model to underpredict erosion, caution is always advised. More research is required to improve the current model. Despite this, deep-learning modelling could become a potentially valuable field of research. Testing alternative model architectures, increasing the datasets size, and incorporating additional data, such as water levels or river discharge, are some of the proposed strategies to improve the model performance.