Climate Change Impacts on Cargo Capacity of Inland Navigation in the Northern Arc Rivers: A Neural Network Approach

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Abstract

In the Amazon, inland waterways are particularly vulnerable to climate change, as river navigation is highly dependent on water levels. Climate change impacts, notably those affecting the hydrological cycle, especially precipitation, lead to alterations in the seasonal configuration of water depths, thereby influencing the cargo capacity of rivers comprising the Northern Arc logistics corridor. This seasonal variability of river flows acts as a limiting factor for navigation, directly affecting vessel loading conditions and, consequently, the logistics of grain transportation in the region. To address this challenge, the present study developed a predictive model for water depths and operational drafts using Artificial Neural Networks, specifically, a Multilayer Perceptron and a Recurrent Neural Network, integrating in situ and satellite-derived data to overcome the scarcity and low quality of conventional hydrological records. The methodology was validated in the Amazon Basin, with a focus on critical navigation stretches, and demonstrated satisfactory predictive performance, achieving an individual R^2 of 0.954 and an RMSE of 0.095. The results allowed the estimation of cargo-carrying capacities of typical convoys operating in the Northern Arc corridor and highlighted the impacts of both flood and drought conditions on waterborne transport. This approach provides a robust computational tool to anticipate seasonal draft losses and navigation bottlenecks, contributing to safer and more efficient inland waterway transport under climate change scenarios.

Keywords

Northern Arc, Grain Transportation, Inland Navigation, Tapajós River, Artificial Neural Networks.