Clustering of Bridges for Vulnerability Assessment from Combined Debris and Scour

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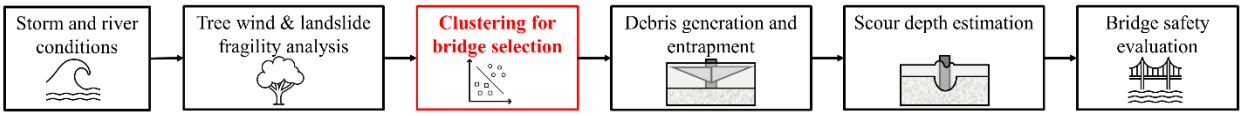
Abstract

During flooding events or extreme storms, bridge safety could be threatened due to hydraulic forces and the erosion of soil around bridge piers in a process known as scour. These risks could be exacerbated by large woody debris generated from failed trees upstream flowing down the river and becoming entrapped at the bridge piers. In addition to the impact forces, the debris can constrict the channel area, leading to increased water speeds and foundation scour. To predict bridge vulnerability, with limited data on debris buildups and bridge failures, a physics-based fragility assessment is proposed. However, to reduce the number and complexity of such models, a few representative bridge structural models are needed as inputs. To select the most representative bridge types while considering the correlations among different parameters, a novel statistical clustering framework is proposed to group bridges based on the similarities of key structural parameters, such as the material type, the bridge structure type, the number of spans, and the average span length. The *K*-prototype clustering algorithm is implemented for its flexibility in handling mixed numerical and categorical data, and the optimal number of clusters is selected using Bayesian Information Criterion (BIC). A case study is conducted for bridges in the state of Vermont. 5 major clusters are noted based primarily on the material and bridge lengths, and the most representative parameters for each bridge type are extracted for use in the structural modeling. The clustering results offer key insights into common characteristics and key differences among the various bridges. The proposed fragility models will be useful for forecasting bridge damages and aiding decision-makers and engineers in deciding which bridges might need to be closed in advance of a storm.



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