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How can hydrology help improving scour depth estimation around bridge piers?

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This study aims at analyzing this well-known bridge scour issue, traditionally approached through deterministic methods, by means of a statistical approach that is still a relatively new and unexplored technique. Because a significant part of the uncertainty inherent to bridge scour analysis is due to the randomness of the flow series, a probabilistic approach, such as the one here presented, can provide a valuable framework to assess the likelihood that certain scour conditions will be exceeded during the lifetime of the bridge.
In order to support them in their decision making, the scientific literature has provided engineers a myriad of empirical formulations for estimating scour depth at bridge crossings. However, these formulations, derived in the laboratories, interpret the scour process under several assumptions that might limit their application: a realistic scour depth assessment should not be based on assuming steady state flow conditions, that typically do not last for a long time in real world situations, but instead referring to a real hydrograph covering a sufficiently extended time span, that should be as long as the lifetime of the bridge.
However, such a method may require long record of river flow observations at the bridge site, which are seldom available. To overcome the difficulty of finding long historical river flow series, techniques of hydrological simulation can be used to generate synthetic sequences of the observed stream flows that span the expected lifetime of the bridge .
To accomplish this goal, a stochastic model is used to generate many replicates of synthetic river flow sequences of the same length as the expected lifetime of the bridge, having the same statistical properties as the available record of streamflow observations. These series can then be coupled with empirical scour models that predict the local scour around a bridge pier. Through a Monte Carlo procedure, a large sample of scour depth values are generated and treated as random variables that are then used to determine the scour depth probability distribution. This framework aims at estimating the probability that a given scour depth is reached in the course of the lifetime of the bridge.