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Assessment of sediment transport processes along a physical model of a stream with an arched bridge, under climate change scenarios

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Scour is considered to be one of the biggest causes of bridge failure in the United States of America and across the world, having a devastating effect on infrastructure and many times resulting in loss of lives. Under climate change flooding and scouring of infrastructure may intensify in terms of frequency and magnitude. This study aims to investigate sediment transport processes along a physical model of a stream with irregular bed topography and a simulated arched bridge with a scour hole at one of its embankments, under a range of climate change scenarios. To this goal, a set of flume experiments is conducted, to assess the transport of three distinct types of sediment fed at a control location, under a range of maximum flow rates due to three different hydrologic events.
The following conclusions can be obtained from the initial analysis of the experimental results:
• Sediment transport rates for the smallest particles size, nearly doubled when Shields' shear stresses increased by 53%. Representing the flow and particle results on the Shields' diagram, demonstrated that there exists a generally good agreement with Shields' predictive criterion: points above the limit curve correspond to cases of increased likelihood for sediment transport.
• Topographical irregularities on the bed surface resulted in a quite diverse flow field with a sequence of subcritical and supercritical regimes, along which flow velocities can be decreased and increased respectively, affecting the areas where sediment particles can be deposited and transported (regions of "hot" spots of transport correspond to the assessed peaks in the measured flow field).
• For small transport rates, turbulent flow events (Valyrakis, et al. 2010) dominate the transport process, while for higher transport rates, inter-particle collisions become important (Pähtz & Durán, 2017).
• Sediment size is deemed to have a greater effect on particle transport over shape factor for the range of particle parameters measured.

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