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Ad-hoc estimation of landslide-generated impulse waves – from the lab to the field

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Landslide tsunamis generated by extremely rapid subaerial mass wasting are also referred to as impulse waves and may occur both along coastal areas and in inland waters including engineered reservoirs. The hydraulic process chain comprising wave generation, propagation, and run-up needs to be comprehensively assessed to predict whether these waves represent a threat to the shore and adjacent infrastructure. Hazard assessment studies based on site-specific hydraulic laboratory models and numerical simulations may generally yield quite accurate predictions of the expected wave and run-up heights. While the former involves the availability of specialized lab infrastructure and instrumentation, the latter requires in-depth knowledge of suitable numerical methods as well as experience in their application to scenarios at prototype-scale. Therefore, both approaches are time-consuming, involve high costs, and pose substantial entry thresholds for practitioners. Especially in emergency situations, when first-order estimations need to be quickly at hand, the ad-hoc applicability of these approaches may therefore be limited.

Motivated by an imminent landslide hazard at Carmena reservoir, Switzerland, in 2002, the national supervisory authority for dam safety, the Swiss Federal Office of Energy, commissioned the development of a fast and readily applicable computational procedure. As a result, the first edition of the so-called 'impulse wave manual' was published in 2009 and provides an extensive literature review of generally applicable equations derived from lab experiments. It combines selected equations into a coherent computational framework covering all stages of an impulse wave event's hydraulic process chain. Based on the estimation of e.g. wave and run-up heights, this manual allows to rapidly implement mitigation measures including reservoir drawdown or precautionary evacuation. In addition to an improved emergency planning, the manual proved to be an inexpensive tool to obtain an estimation of an impulse wave event's magnitude during the preliminary design phase of new reservoirs. Back in 2009, the manual's literature analysis already identified specific research gaps, leading to the initiation of further experimental investigations. Following these research efforts over the past ten years, a second edition of the manual was published in 2019 featuring an updated computational procedure.

This contribution provides a brief introduction to the updated computational procedure and applies it to prototype events with available survey data, e.g. Chehalis Lake, Canada, in 2007. The comparison to prototype data allows to highlight the procedure's capabilities as well as its

limitations for future ad-hoc estimations of landslide-generated impulse waves.