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Risk Management of Liangshuijing Landslide based on Practical Experience and Numerical Simulation

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Landslides that run out into rivers can impact not only the people and buildings within its footprint, but also boats and wharfs, people and buildings on or near the river if they trigger a secondary wave or dam the river. In some cases, the exposure to primary landslide hazard is relatively low and in these cases risk management could help to identify that the key issue is to reduce the risk of potential secondary wave of landslide to those elements navigating along the channel. In this paper, Liangshuijing landslide carried out risk management over a period of six years is used as a case study. The landslide is situated in the middle part of Three Gorges Reservoir in China, its elevation ranges from 100 to 320m, and the volume is about $407\times10^4 m^3$. Landslide displacement is strongly controlled by reservoir water level, which fluctuates annually between 145m to 175m. The landslide underwent visible deformation in 2008 and in 2009 there was a fast movement emergency, which endangered the local population within the landslide body to the extent that they were relocated away from the landslide. As a result, there were now almost no elements at risk on the landslide body. However, there are three simple wharfs located 3.3 km and 3.8 km upstream and 4.3 km downstream from the landslide. Firstly, we estimated landslide initiation probability using the Morgenstern-Price method within and Monte-Carlo framework; and secondary wave height and influence range using Tsunami Squares. Secondly, we constructed a history of risk management activity associated with the landslide and identified a number of discrete activities: field survey, emergency handling, risk assessment, decision making, determination of risk control plan, monitoring and feedback. Our modelling results suggest that the main risk associated with the landslide derives from the secondary wave. Re-calculating the risks associated Liangshuijing landslide under different risk control plan shows that the plan considering secondary wave risk reduction is a better choice. Our case history analysis demonstrates the necessity to conduct risk management for this kind of landslides and the importance of long-term continuous monitoring and feedback.