

## **Landslide disaster mitigation in the Three Gorges Reservoir, China**

Author: Petley, David N.

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## Landslide disaster mitigation in the Three Gorges Reservoir, China

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The Three Gorges dam and reservoir project is, without doubt, one of the most extraordinary engineering projects of the last 50 years. The statistics of the project are impressive—the dam is 185 m high, 2.3 km long, and contains over 27 million tons of concrete and over 460,000 tons of steel; the reservoir will contain almost 40 km<sup>3</sup> of water with a surface area of 1045 km<sup>2</sup>; the banks of the reservoir stretch over a total distance of 1300 km; and 1.3 million people have been displaced by the project. The aims of the dam are varied, but they include flood control on the lower reaches of the Yangtze River, the generation of hydroelectric power, and the creation of a navigable waterway into the heart of China.

However, such aims come at considerable environmental and social cost, in addition to the huge financial burden. From the outset of the project, many geologists expressed severe reservations about just one of the many issues: the potential for the generation of extensive landslides along the banks of the reservoir. Worries about landslides and reservoirs are well founded. In 1963, controlled filling of the Vaiont Reservoir in the Dolomites of northern Italy triggered a catastrophic rockslide with a volume of over 200 million m<sup>3</sup>, which sent a wave over 200 m high over the top of the dam and into the valley below, killing more than 2000 people. Avoiding a repeat of such a disaster is inevitably a central concern in all large dam development projects, and it is a testament to the depth of understanding of the problem that such

occurrences are so rare. However, the Three Gorges Reservoir is on a different scale altogether, requiring new approaches to the identification and management of landslide hazards. The presence of an estimated 75 million people living along the river downstream of the dam renders the consequences of a Vaiont-type landslide event almost unimaginable.

It is therefore unsurprising that a huge amount of effort has gone into the analysis and management of the landslides on the banks of the Three Gorges Reservoir. There is little doubt that these projects have contributed to the growing, and increasingly impressive, strength of landslide research in China. To this end, this weighty volume on the mitigation of landslide hazards associated with the construction of the dam and reservoir is welcome. The book is extensive, detailed, well-presented and highly informative, and generally written in good English. Most of the papers are of journal quality, and many address issues that are rarely developed in mainstream landslide literature, such as landslide prediction and the development of landslide warning systems. The case studies on the management of very large landslides are welcome, as there are few detailed examples in the existing literature.

However, despite its strengths, there are three elements of the book that are frustrating. The first and most important is a lack of a set of overview chapters that would allow the reader to understand the Three Gorges project as a whole. Thus, there is no detailed chapter explaining properly the planning, development, and construction of the dam and associated infrastructure; and there is no chapter describing the geology and geomorphology, although there is an appendix containing a stratigraphic column and a very basic geological map. Two chapters do describe the overall number and distribution of landslides, although at least one of these studies appears to have been started

after 2000, when dam construction was under way. There are some confusing contradictions in the statistics provided; for example, the foreword states that there are 392 landslides with a volume greater than 10,000 m<sup>3</sup>, while chapter 3 indicates that there are 684 landslides with a volume greater than 100,000 m<sup>3</sup>.

Second, the book's title implies that the volume is about landslide *disaster* mitigation, not just landslide mitigation. When teaching undergraduates, we continually reinforce the idea that, by definition, disasters involve people, not just a hazardous process. The book largely omits any detailed consideration of the human dimension to the problems on the banks of the Three Gorges reservoir, instead focusing on the technical and engineering dimensions. Given the magnitude of the problem, this is surprising, although this is undoubtedly in part a political issue that may be difficult to document. While the technical components are, of course, important, the book is somewhat mistitled as a consequence, and it feels like an important opportunity has been missed.

Finally, there is a glaring lack of critical analysis of the successes and failures of the landslide management component of the Three Gorges project. In such a large-scale analysis, it is inevitable that those involved did not get it right all of the time—there is no shame in this. The most valuable paper that this volume could have contained would have been a review of what was expected in terms of landslides at the point at which the filling of the reservoir commenced, and what actually happened. It would be interesting to know where the errors and omissions occurred, and why, as well as a description of the successes. It is likely that we will see a new round of large dam construction over the next few years, both to reduce carbon dioxide emissions and to provide power to burgeoning economies in Asia. There must be many lessons that can be learned from the Three Gorges Reservoir

experience; it is a shame that these are not shared.

These points are brought into sharp relief by the events at the end of 2009, when the final filling of the reservoir was scheduled to occur, bringing the project to completion. However, in November 2009, the China Daily newspaper reported that the final filling phase had been postponed. It was then widely reported in the media in January 2010 that an additional 300,000 people would have to be relocated in the short term due primarily to landslide hazards, along with the likelihood of

many more relocations being needed in due course. This might suggest that the initial studies of the landslide potential along the banks of the reservoir were optimistic, and that the magnitude of the hazard was overlooked. This is not reflected in the text of the book, which appears to present almost every case study as a great success.

These criticisms apart, the papers contained within the volume are valuable and interesting. Indeed, several present interesting new approaches to landslide investigation, analysis, and mitigation, and I am sure

that many of these techniques will find widespread application elsewhere. However, in its current form, this most certainly is not a volume that provides a proper analysis of landslide disaster mitigation at the Three Gorges site, which is a shame.

#### AUTHOR

**David N. Petley**

*d.n.petley@durham.ac.uk*  
Department of Geography, Durham University,  
Durham DH1 3LE, United Kingdom

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