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Influences of the Three Gorges Project on seismic activities in the reservoir area

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Abstract Reservoir-induced earthquakes related with the construction of the Three Gorges project have attracted great concerns of the public. Since the first water impoundment on May 25, 2003, a number of earthquakes have occurred during the water storage stages, in which the largest was the Badong $M5.1$ earthquake on December 16, 2013. In this paper, the relationships between seismic activities, b value, seismic parameters, and reservoir water level fluctuations have been studied. In addition, based on the digital seismic waveform data obtained since 2000, the focal depth changes and focal mechanism characteristics before and after the water impoundment are studied as well. These provide us important information to understand the earthquake mechanisms. The results show that these earthquakes are typical reservoir-induced earthquakes, which are closely related to water infiltration, pore pressure, and water level fluctuations. The majority of the micro and small earthquakes are caused by karst collapse, mine collapse, bank reformation, superficial unloading, and so on. The larger earthquakes are related to the fault structures to some extent. Due to the persistent effects of water impoundment on the seismic and geological environments around the reservoir and water infiltration into the rocks, the influences on the crustal deformation field, gravity field, seepage field, and fault medium-softening action may vary gradually from a higher strength to a weaker one. Therefore, it is possible that small earthquakes and few medium earthquakes ($M \leq 5.5$) will occur in the reservoir area in the future.

Keywords Three Gorges project, earthquake monitoring network, reservoir-induced earthquake, seismic activity, b value, focal mechanism

1. Introduction

The Three Gorges Reservoir is a world famous large water conservancy and hydropower project. From the demonstration, construction to the completion of the project, it has been paid much attention. One of the focuses is whether the operation of the project will have significant impacts on the ecological, seismic and geological environment of the region. Especially after water impoundment, the problem became more important. It has been over 13 years since the Three Gorges reservoir started to impound. Massive water load and a long-term periodic water level variation from 30 to 40 m each year have affected the gravitational field, crustal deformation field, stress field and so forth in the reservoir and the adjacent regions. Furthermore, these kinds of changes affected the seismic activity and the geohazards in the reservoir [1–3]. The common knowledge is that the induced earthquakes can cause damage and therefore increase the hazard and risk across the region [4–6]. To some extent, it is very essential to systematically summarize the influences and analyze the impacts of the Three Gorges project on the seismic geohazards in this region [7]. It is not only an important scientific issue, but also an inevitable realistic one for protecting the security of the reservoir area.

For the purpose of the study, the influences of the construction and operation of the Three Gorges project on the seismic activities and geological hazards are comprehensively discussed. Multi-source digital observation data monitored by the Three Gorges reservoir induced earthquake monitoring system

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