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Towards a global estimate of compounded risk for dams from earthquakes: historical losses and learning from past studies

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Dams are extremely important components of public and private infrastructure for flood prevention as well as water storage and often energy production for governments and their citizens globally. A failure of a dam or potential failure of a dam can cause major evacuations downstream as well as has the possibility of many deaths and major economic losses.
Earthquakes provide a large risk for dams as a result of damaging ground motions causing cyclic loading of the dam structure as well as associated components to cause progressive damage. As many dams are built on faults, the fault movement and fault rupture also must be explored.
Global dam databases such as ICOLD and GRaND provide a view into the location of dams globally and many can be shown to be in locations of high risk. In addition, the age of many dams calls into question the methods used to determine the design earthquake loads and construction methodologies used.
Using the CATDAT Damaging Earthquakes Database and other research studies, a database of historical dam losses has been developed globally as a result of earthquake shaking and secondary effects such as landslides and liquefaction, and shows the compound effects of earthquake loading. This includes dam collapse events such as the Fujinuma Dam in Tohoku 2011 and the 1925 Santa Barbara earthquake. Events in which earthquake damage was recorded such as 1957 Montana, 1962 Guangdong, 1967 India, 1971 San Fernando, 1983 Japan, 1990 Manjil-Rudbar, 2001 Gujarat etc., have been collected and documented with various parameters such as socioeconomic damage, settlement, damage level etc. Over 100+ historic dam damage reports have been collected, not including tailings dams.
In addition, a database of concurrent earthquake and rainfall events are examined to also check the relationship of previous damage to dams, with potentially influenced effects from earthquakes even if not the main cause of failure, and the importance of dam break studies for downstream elements of infrastructure.
This work hopes to provide a first-order view into the compounding effects of damaging earthquake events on dams and a first-step to providing vulnerability functions for the assessment of global risk to dams.