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Rapid Evolving Environment and Exposure and Their Implication of New Risks in Mountainous Regions after Major Earthquake

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The Ms 8.0 Wenchuan Earthquake occurred in mountainous Sichuan Province triggered widespread coseismic landslides and heavy human casualties in the year 2008. Much attention has been focused on instantaneous hazards of seismicity and coseismic landslides, while few attentions are paid on the effects of the changed mountain environments caused by great earthquakes of this magnitude. Five years following the devastating Ms 8.0 Wenchuan Earthquake, new landslides, debris flow and flash floods are frequently reported and observed in the severely earthquake stricken regions. This indicates that the geological hazards after the major earthquake in a mountainous environment can be a long-term evolving threat.

In this work, we combine image interpretation and extensive field reconnaissances to uncover the mechanism of the constant post-quake disasters that repeatedly destroyed rebuilt houses in Wenchuan Region. Based on high resolution image interpretations and field reconnaissance, coseismic landslides in 2008, post-quake landslide in 2011 and rural house footprints in 2002 and 2011 are interpreted manually in Shikan River Watershed of the heavily affected Pingwu County. Spatial analysis reveals that the spatial distributions of coseismic landslides mainly concentrated in steeper and high altitude slopes, while the post quake landslides evolves to gentle and lower slopes. Compared with pre-quake houses, more relocated houses are also concentrated on limited flat regions near riversides. The evolution of landslide debris and changing distribution of rebuilt houses after the Wenchuan Earthquake has shown quite similar moving trends to lower elevations and gentle slopes, and more post-disaster houses were relocated closer to expanded riverbed after the earthquake. Field reconnaissance also confirmed the downward movement of post-quake mass wasting, which fills up riverbed with debris, expanding river width and results in a catastrophic flash flood event in August 2013. Here we show that the evolving mountain environment, including both the changed geographic distribution of new landslides and the continuously uplifting riverbed, raises emerging risks of existing and rebuilt houses.

With the spatial analysis of the landslide debris and the houses based on the interpretation of high resolution images and field reconnaissance in the study area, we found that both the new landslides and the rebuilt houses after the Wenchuan Earthquake have a similar trend of moving to lower elevations, gentler slopes, and closer to rivers. This study confirms that the persistent downward movement of landslide debris filled up riverbeds rapidly in the past five years. The elevated riverbeds make the study area extremely susceptible to flash floods, which further bring risks to the newly rebuilt houses that moved closer to the river. This research also highlights the often neglected dynamic process that involves changes in both natural environment and man-made constructions and their interaction. This dynamic process requires the long-term monitoring and adaptive management of mountainous regions after major earthquake which can fully consider the sophisticate evolving risks caused by changing environment, exposure and vulnerability in the region.