

Geomorphological comparison of Japan and Taiwan

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Both Japan and Taiwan are located in tectonically active island arcs subject to frequent heavy storms. Therefore, they are characterized by rapid uplift and erosion, and have steep mountain ranges such as the Japanese Alps and the Taiwan Central Range. Abundant sediment supply from steep hillslopes due mainly to landslides has led to the formation of many alluvial fans in piedmont areas. It has often been thought that landforms in Japan and Taiwan are analogous. However, detailed geomorphological comparisons between the two countries have rarely been conducted. We have addressed this issue using digital elevation models (DEMs) and GIS.

In steep mountains in both countries, V-shaped valleys with slope angles about 35 degrees are widespread except their lower parts. Despite this striking similarity, the frequency distribution of slope angles in Taiwan is closer to the normal distribution than in Japan, indicating a state close to equilibrium. In Taiwan, rivers debouches from the main divide of the Taiwan Central range tend to have large watersheds whose dominant slope angles are ca. 35 degrees. In Japan, large watersheds including steep mountains in the upper reaches include less steep low mountains and hilly lands in the middle and lower reaches. Therefore, slope angles of ca. 20 to 25 degrees are more dominant.

The lower slope angles and the larger deviation from the normal distribution of the slope angle in Japan may be related to late Quaternary climatic change at least to some extent. Although the highest areas in both countries were glaciated in the Last Glacial period, periglacial processes in the adjacent areas were much more dominant in Japan because of not only lower temperature at higher latitudes but also significantly reduced processes of running water. The effects of two major causes of heavy rainfall in contemporary Japan, typhoons and the Baiu (Meiyu) front, were much more weakened in the Last Glacial period because of the southward shift of the frontal zones. Such reduction in heavy rainfall was less distinct in Taiwan, judging from the estimated location of the Last Glacial frontal zones. In Japan, abrupt increase in rainfall during the Pleistocene-Holocene transition led to hillslope incision due to both failure of regolith and channelization into consolidated bedrock. This post-glacial hillslope incision is still actively ongoing in most watersheds, and the front of channelization is a place of rapid erosion due to landsliding. Relaxation times involved in hillslope responses to the increased rainfall have played an important role. Sediment yields due to landslides and gulying tend to be higher during the relaxation periods with rapid hillslope incision whereas they decrease when hillslopes are nearly adjusted to Holocene climatic conditions. Even a recent large earthquake-induced landslide in central Japan is related to the progress of post-glacial hillslope incision. Such prolonged impacts of climatic change have been much more limited in mountainous watersheds in Taiwan.

In both countries the characteristics of alluvial fans differ according to the size of source basins. Basins smaller than 80 to 200 km² are characterized by large variations in both alluvial-fan slope and basin slope, whereas larger basins and associated alluvial fans are characterized by more constant slopes. Despite this similarity, the large Japanese fans and basins are characterized by

gentler slopes than the Taiwanese systems.

To conclude, both distinct similarities and differences can be indicated between the landforms in Japan and Taiwan. They deserve more detailed investigations for better geomorphological understanding.

Keywords: DEM, slope, alluvial fan, mountains, Japan, Taiwan