# Slope failure - debris flow events in rhyolitic and granitic areas in Hiroshima triggered by 2018 torrential rainfall and its implications for disaster risk reduction –a quantitative approach by photogrammetry and field survey

*Toshihiko Sugai[1], Kunnga Mergen[1], Natsuki Sasaki[1], Sako Hasegawa[1], Shoichiro Uchiyama[2]

1. Department of Natural Environmental Studies, Institute of Environmental Studies, Graduate School of Frontier Science, The University of Tokyo, 2. National Research Institute for Earth Science and Disaster Resilience

Introduction
2018 torrential rainfall hit western Japan and large areas were covered in debris and mud. This study focused on several slope failure –debris flow depositional events occurred in both rhyolitic and granitic mountainous areas in Hiroshima Prefecture and estimated geomorphological changes quantitatively through the events by field survey coupled with photogrammetry. Furthermore, geomorphological land classification and river segmentation based on reach type classification was carried out to discuss the relationships between 2018 geomorphic changes and the surrounding geomorphic development history.

Case study in rhyolite mountain area
Two contrasting slope failure events named as case E and case W occurred on rhyolitic mountain slopes were picked up in the Kurose, Higashihiroshima city. In the case of E, the failure sediments became debris flow and went down through dissected river valley, destroying several Sabo dams alternately from side to side. At the mountain foot, the debris flow slightly denuded peaty silt at the bottom and eroded previous debris flow sediment laterally, and then deposited with the thickness of around 2 m, accompanying gigantic gravels including huge blocks of the destroyed Sabo dam on the depositional surface with upward coarsening structure. Lots of driftwood jammed behind the gigantic gravels with its long axis perpendicular to the flow direction. The debris lastly broadened the depositional area up to 100m.
In the case of W, failure sediments went down along the shallow unclear valley slightly denuding the surface soils keeping the width of the fluid area about 50 m. Reddish colored strongly weathered crust can be observed below the debris and the transportation area gradually changed into deposition area. The debris of the case W was much finer and slightly thinner than that of case E, with lots of driftwoods whose long axis parallel the flow direction.
To summarize in rhyolitic mountains partly covered with reddish weathering crust, even slightly dissected slopes (case W) may failure triggered by unprecedented heavy rainfall, while already dissected slopes (case E) may failure much more frequently to produce debris flows with huge gravels and continue to develop the dissected valleys progressively.

Case study in granitic mountain area
Concerning granitic mountain slopes, Kawasumi (KWS) in Kumano town, Yanohigashi (YNH) in Hiroshima city, and Koyaura (KYU) and Sakahigashi (SKH) in Saka town were picked up. KWS and YNH locate on artificially modified debris flow fan surfaces and/or mountain foot erosional gentle slopes, where plural small steep valleys met before the housing development. The distance between the present outlet of the valleys and valley heads are rather short, about 500m with steep slopes, and the $2^{nd}$ is the stream order of the valley defined as the Strahler system of stream ordering. Debris with huge core stones deposited below the outlet of the valley.
KYU and SKH locate on small alluvial lowlands produced by fluvial depositional processes by $5^{th}$ order

 

streams whose drainage basins have a dozen of slope failures occurred by the 2018 heavy rainfall. The river course can be divided into 3 segments of 1, 2a and 2b, based on the reach types consisting the segment. Segment 1 locates upstream of the fan apex characterized by marked lateral erosion by braided channel reaches. Segment 2a locates the upstream part of the alluvial lowland with the longitudinal slope of about 6 percent characterized as debris flow fan where braided channel potentially migrates laterally without artificial channel fixing. Segment 2b locates the downstream part of the lowland characterized by straight artificial channel on fan delta with the slope of less than 6 percent.
Because the drainage basins behind KYU and SKH may produce debris flows by valley-head failures frequently, the river side narrow plains in Segment 1 are not suitable for land use. Outside areas of the curved channels in Segment 2a are the same because debris flows directly hit the areas. Actuary crevasse spley was formed at the area by the 2018 event. Along Segment 2b sand and mud tend to flow over the bank and cover the lowland widely.

In conclusion, it is critical for mitigating flooding and debris flow disasters to evaluate the diversity of local geomorphic conditions quantitatively based on the regional geomorphological development history which has produced the conditions through time. Thus, nationwide-geomorphological classification mapping based on the local landform development history is crucial, and to do this we need to learn much more from the floods and landslides triggered by torrential rain in western Japan 2018.

Keywords: slope failure, crevasse spley, nationwide high-resolution landform classification map, river segment, photogrammertry

 