Susceptible Slopes of Rainfall-induced Landslides in Aso Caldera, Southwest Japan

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INTRODUCTION

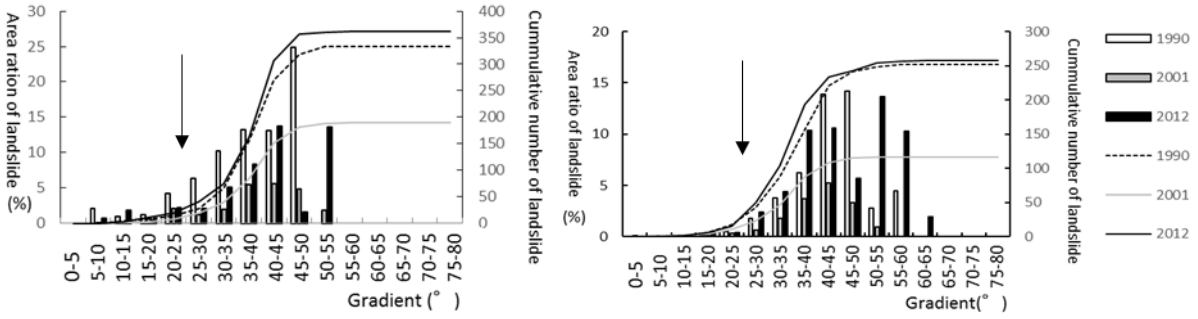
Shallow landslides in tephra layers have often induced serious sediment disasters in the cases of either heavy rainfall or earthquakes in Japan. This study aims to extract landslide-susceptible slopes by rainfall from the geomorphological analysis on the distribution of shallow landslides which repeatedly occurred on the slopes of Aso Caldera, Southwest Japan.

METHOD AND DISCUSSION

Based on the distribution mapping of shallow landslide occurrence areas in 1990, 2001 and 2012 from the aerial photo interpretation, geomorphological factors are analyzed employing GIS in two study areas namely the Takadake area and the Saishigahana area which are located in the caldera cliff slopes and the flank slopes of central cone of Aso Volcano respectively. Since shallow landslides are topographically caused by partial slope steepness and their downslope movement by slope height, slope gradient and relative height are extracted in 10m mesh and 50m mesh respectively. Though both areas are different in topographical setting, distribution of the area ratio of landslide occurrences at each slope gradient rank and that of relative height indicate same lower limit threshold values in landslide occurrences for each study area. They are larger than 25° and 20m respectively (**Figs.1, 2**). These values may indicate shear strength of slip plane during heavy rainfall and development rate of incising erosion on the slopes of Aso Volcano.

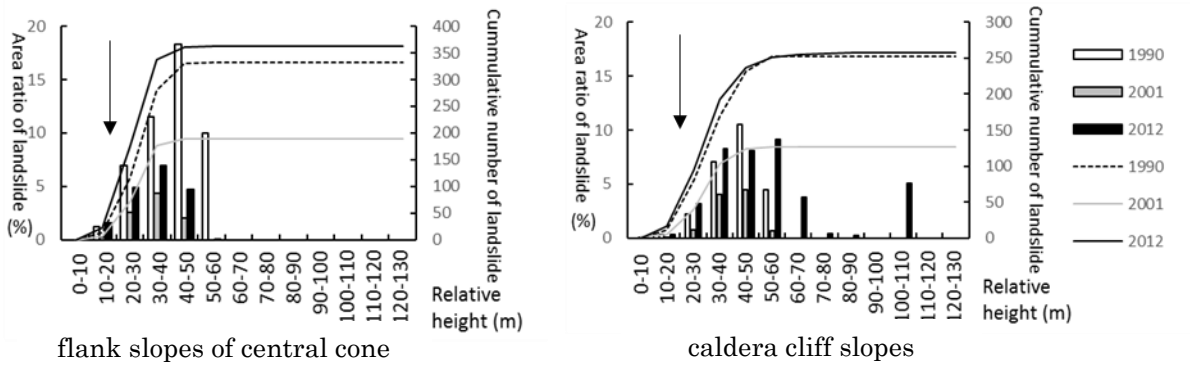
Micro-topographical interpretation has been executed in both study areas by using 1m DEM-based stereoscopic maps produced from the LiDAR data taken in 2009 and 2012. Remnant slopes of past shallow landslide are densely distributed in both areas, characterized by a circular-shape scarplet and often accompanied with deposition areas of collapsed materials from the landslide. This indicates shallow landslides have occurred frequently on tephra-covered slopes in the study area. Hence, spatial relationship between a landslide occurrence area in 2012 and micro-topography of the surrounding slopes such as remnant of past landslides (abbreviated as RPL hereafter) and slope breaks are classified into seven cases. They are 1) in contact behind RPL, 2) in contact with side of RPL, 3) inside of RPL without collapsed material deposition, 4) below RPL, 5) in and around collapsed material deposition area of RPL, 6) valley side slope below slope break, 7) independent. Around 85% of the area rate of landslides belongs to the cases 1), 5), and 6) in both areas (**Fig.3**). The slopes of case 1) are under unstable condition behind the scarplet. The case 6) is caused by steepness of the slope.

Total area of landslide occurrences in 2012 at the inside of preceded landslides in 1990 and 2001 is statistically 4.3-8.1 times smaller than that of the cases 3) and 5). Landslide occurrences in 2012 at the inside of recent landslides is remarkably less than those of RPL. It suggests that the landslides with collapsed material deposition (case 5) tend to occur after a certain period of the past landslide occurrences to get sufficient thickness of soil layer by tephra deposition.



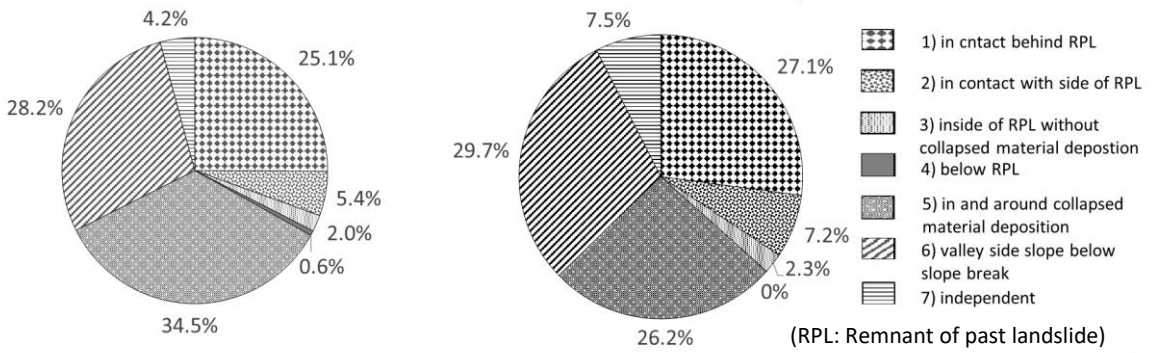
flank slopes of central cone caldera cliff slopes

Fig.1 Area ratio of landslide occurrence by slope gradient (Arrow indicates threshold.)



flank slopes of central cone caldera cliff slopes

Fig.2 Area ratio of landslide occurrence by relative height (Arrow indicates threshold.)



flank slopes of central cone caldera cliff slopes

Fig.3 Area ratio of the 2012 landslides for each locality classification

CONCLUSION

GIS-based study on landslide occurrences on tephra-covered slopes in Aso Volcano reveals that hazard zoning of rainfall-induced landslides can be performed by the extraction of slopes with both 25° in gradient (10m mesh) and 20m in relative height (50m mesh) on a digital elevation model. Both the adjacent backside slopes of the remnant shallow landslides and the deposition areas of collapsed materials from the past landslides are the susceptible slopes from the micro-topographical viewpoint.

Keywords: Susceptible slopes, Shallow landslide, Aso Volcano, Tephra, Micro-topography