Characteristics of Slope Failures and Conditions for Formation of Landslide Dam in Kii Peninsula Caused by Typhoon Talas in 2011

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INTRODUCTION

Slope failure as a result of weakened self-retainability of the soil under the influence of rainfall or earthquake forms in many types of disasters, namely shallow landslide, debris flow, deep-seated landslide, landslide dam, slump, etc. Each type of slope failure form has different characteristic and condition for formation.

Specifically on large-scale landslide, collapsed material generally forming three types of hazards, namely (1) collapsed materials change to debris flows and flow down in the streams, (2) collapsed materials deposit in the river course and form landslide dams, and (3) others; collapsed material never change to debris flows and never form landslide dams.

Kii Peninsula was hit by Typhoon No. 12 (Talas) from 2nd to 4th September 2011 with more than 1000 mm precipitation, causing more than 3000 cases of slope failures including debris flow, deep-seated landslides, landslide dams, and shallow landslides in Mie, Nara and Wakayama Prefectures. This disaster also caused numerous casualties and property damage.

Understanding of characteristics of slope failures and conditions for landslide dam formation informs a basis for predicting future disaster, planning for disaster prevention and mitigation, and provides an insight to understand landslide dam formation. Therefore, this research clarifies the characteristic of slope failures caused by Typhoon No. 12 at Kii Peninsula and aims to discover the conditions for landslide dam formation.

METHODOLOGY

Slope failure formation is influenced by several aspects, namely the geology of collapsed material, volume of material, topography, and human activity. In this research, topography features such as slope inclination, distance of collapsed area from valley, angle and direction of confluence of collapsed material and stream, and gradient of stream bed were analysed in order to find out the characteristic of slope failures and conditions for formation of landslide dam.

The topographical features of research area were obtained from DEM (Digital Elevation Model) from Geospatial Information Authority of Japan (GSI) which elaborated to slope aspect, contour, stream flow direction, stream order, watershed area, etc. By interpreting aerial photographs and comparing the photographs before and after the Typhoon Talas, the area of slope failures can be obtained. Using ArcGIS, these areas of slope failures used as clipping feature to cut the topographical features in order to obtain special features on each slope failure area.

RESULT AND DISCUSSION

By comparing aerial photographs of before and after Typhoon Talas, 393 landslides were founded at the research area. About 80% of the

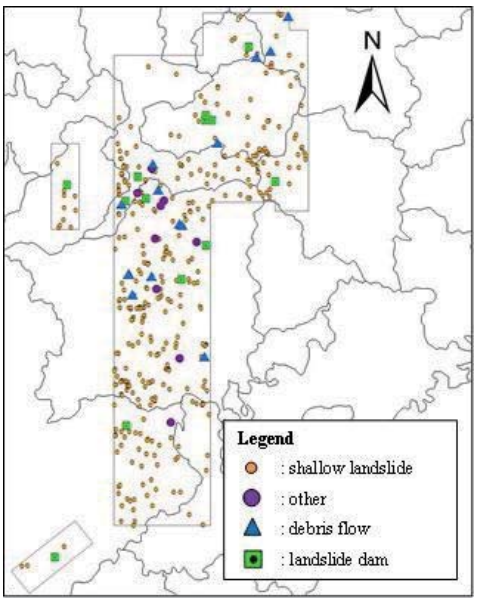

Fig 1. Study area and distribution of landslides at Kii Peninsula

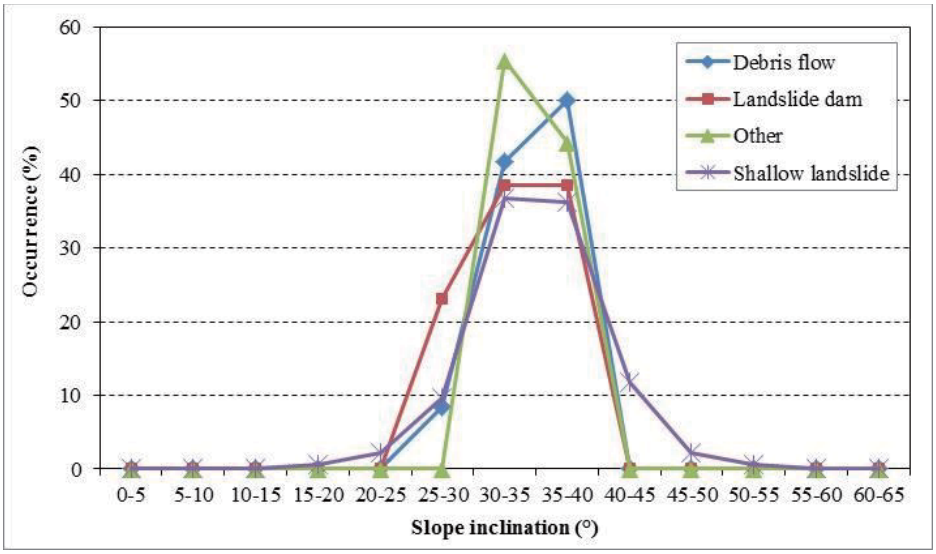

Fig 2. Slope inclination of slope failures

landslides are shallow landslides with mass volume less than 100,000 m^3. The rest are 13 deep-seated landslides that formed to landslide dams, 12 debris flows, and 9 other deep-seated landslides. The distribution of the landslides is shown in Figure 1.

Regarding the distance from valley, most of the slope failures occur at less than 100 m distance from the valley, landslide dams mostly occur at 100-200 m distance while debris flows mostly occur at 100-250 m distance and other deep-seated landslides occur at 100-150 m distance from valley. Most of shallow landslides and debris flows occur at first stream order, which means at the headwaters area of the stream while landslide dams and other deep-seated landslides mostly occur at second or third stream order. Landslide dams and other deep-seated landslides mostly occur at 60-90° of confluence angle of collapsed material to the valley, while debris flows mostly occur at 0-30° of confluence angle.

As showed in Figure 2, most of the slope failures occur on 30-40° slopes, either for debris flow, landslide dam, shallow landslide or other type of deep-seated landslide. Most of debris flows occurred at slope with 30-40° inclination, while landslide dam's slope inclinations are distributed between 25-40°. Other types of deep-seated landslides are mostly occurred in 30-40° of slope inclination. Based on the data, there are no deep-seated landslides recorded on slopes more than 40° inclination thus the vulnerability of more than 40° slope could not be determined. But unstable soil on slopes more than 40° are likely to fall by themselves before they are combined into large soil mass and collapsed into deep-seated landslides.

CONCLUSIONS AND FURTHER RESEARCH

Landslide dams are likely occur on 25-40° of slope inclination, second or third stream order, 100-200 m distance from the valley and confluence angle of collapsed material and stream is about 60-90°. For further research, inclination of the stream bed, collapsed material volume, collapsed material properties and geologic structure will be included. Thus the characteristic of slope failures and conditions for formation of landslide dams will be more accurately understood.

Keywords: landslide dam, slope failure, Kii Peninsula, Typhoon Talas

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