学 位 論 文 内 容 の 要 旨/Dissertation Abstract

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学 位 論 文 題 名/Title of Dissertation

Morphological responses in drainage basins affected by coseismic landslides triggered by the 2018 Eastern Iburi Earthquake, Hokkaido, Japan

（2018年北海道胆振東部地震による地震性斜面崩壊に影響された流域における地形的応答）

Magnitude 6.7 earthquake happened in Eastern Iburi Prefecture, Hokkaido on 6th September, 2018 whose epicenter with focus depth of 37 km was located at 42.690°N and 142.007°E within the Ishikari Teichi Touen Fault Zone. Numerous coseismic landslides (n = 7837) covered over 700 km^2. Tarumae-d tephra layer with fine-grained texture and high-water infiltration capacity was considered as the inherent factor of the coseismic landslides. Gradual post-seismic changes in catchments, including geomorphology, development of fluvial channels, drainage pattern, and continuous slope processing are expected. This study aims to identify the morphological responses of drainage basins affected by coseismic landslide with drainage network development, elevation changes and sediment connectivity, which are assessed by mapping stream networks, quantifying drainage basin hydro-geomorphometric parameters and sediment mobility, following the 2018 Hokkaido Eastern Iburi Earthquake with exploration of fluvial and slope processes affecting those responses across 4 adjacent watersheds with varying shapes, which correspond with multi and inter-related aspects of rainfall intensity, characteristics of soil minerals, varying forms of drainage basins, lack of root reinforcement with limited vegetation recovery and freeze-thaw action on bare slopes.

The study sites are 4 catchments along the Atsuma River with less artificial modifications after the earthquake, which are located on the left side of Apporo Reservoir with coseismic landslides and sedimentation of collapsed materials caused by the earthquake. Digital Elevation Models by Airborne laser scanning of October 2012 and September 2018 from Hokkaido Prefecture, as well as those and orthorectified images by Unmanned Aerial Vehicle based Structure-from-Motion Multi-View Stereo photogrammetry in April 2020 to August 2021 and Light Detection and Ranging of October 2021 taken by field surveys were used. Visual inspections and Geographical Information System analysis were performed for analyzing drainage basin morphology, channel network extraction, stream profile analysis, and morphological change

detection between multiple DEMs. Extraction of stream network and stream head location were conducted by using the threshold area assisted with threshold of flow accumulation and flow direction. By the observed continuous gully erosion channel development on slid slopes and results of quantitative analysis in the multi-temporal DEMs and orthophotos, progressive drainage network development and changes in drainage basin hydro-geomorphometric parameters have been confirmed

Potentially higher surface runoff with fluvial erosion and stream channel development on bare slopes with further slope deformations were expected. This study will contribute to identify and develop an inventory about the effects of the 2018 Hokkaido Eastern Iburi Earthquake on the morphological responses of drainage basin . The results of progressive drainage network development and changes in drainage basin fluvial-geomorphological parameters by multi and inter-related aspects analysis, might be valuable for long-term effects investigation, continuous monitoring for landslide with risk reduction and comprehensive understanding on progressive fluvial landscape evolutionary studies, such as the role of landslides on slope-fluvial channel initiation and drainage headward erosion, which would be beneficial for the investigation of sediment connectivity in catchments affected by earthquake.

The scientific analysis, by using multi-perspectives and multi-functions orientated approach of the present study, for identifying and developing an inventory of the various post-seismic morphological responses in 4 drainage basins affected by coseismic landslides including several perspectives such as Post-seismic: Elevation changes, Sediment connectivity and Drainage network developments supported by mapping of stream networks and quantitative analysis of 35 inter-related hydro-geomorphometric parameters, associated with the analysis of various corresponding factors, which are inter-active and inter-related, indicating those various co-existing post-seismic phenomenon have complicated and inter-reacted relationship with each other, which are relatively more reliable and convincible aspects and be able to eliminate the under-estimation on the influence of other correspondent factors. The present study highlights the importance of multi-aspects inter-related/functional analysis (which are always under-estimated in scientific study) in explanation of various co-existed natural phenomenon is one of the objectives and functions.

The analytical method in this study for extracting stream network and stream head location by using the threshold areas of watershed with flow accumulation and flow direction with field verification may be applicable on fluvial system analysis of large-scale watersheds.