Generation and analysis of fifth-order mesh inventories earthquake-induced landslides

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The Geospatial Information Authority of Japan (GSI) has been operating the Seismic Ground Hazard Assessment System (SGDAS) since 2019. We are currently conducting research on improving the estimation accuracy of landslides in the system, and needed an inventory that would serve as the correct data for landslides that occurred in various earthquakes. We assume that such a need exists in many other researchers who are examining the predisposition of landslides during earthquakes.
However, there are various standards of data available for landslide distribution maps. In addition, there are various types of data, such as polygons with unclassified contents, polygons classified into landslide type and others, and point data. In recent years, there has been an increase in the use of DEM image processing maps from LiDAR as well as aerial photographs, and the corresponding map scales vary.
On the other hand, the resolution of the estimated seismic intensity distribution map, which is a typical trigger information for seismic landslides, is the Basic Grid Square (3rd-order mesh; about 1 km square) at the present stage, and the seismometer layout is not very dense. Therefore, uniformity of data standards is more important than the level of detail of the inventory. In addition, it would be easier to conduct the verification work if the inventory is prepared separately for shallow landslides with a large contribution from topography and large-scale deep-seated failures and landslides with a large contribution from geology, including geological structures.
Therefore, the authors first classified landslides to deep-sheeted landslides and shallow landslides. In order to aggregate the data, it is necessary to convert polygons, lines, and points into data for aggregation, but the basic idea is to use the data with the least amount of information, i.e., points. For the polygons, the collapsed area was sampled at random points at 50m intervals to unify the standards, and the data was compiled in the 5th order mesh (about 250m) as shown in Fig. 1. The data was stored as a shapefile with attributes such as the number of points for aggregation in the 5th order mesh, whether there were points for aggregation or not, and the number of points per square kilometer.
Using the created data, we tested the comparison with the predisposing information for the 2018 Hokkaido Eastern Iburi Earthquake, the 2016 Kumamoto Earthquake, and other earthquakes. As an example, we compared the layer thickness of the tephra isopach map and the density of landslides in the shallow landslides category within the same terrain type based on DEM's automatic terrain classification, and found that there was a clear relationship between the layer thickness and the density of landslides for the 2018 Hokkaido Eastern Iburi earthquake, as pointed out by Hirose (2020) (Fig. 2). However, in the case of the 2016 Kumamoto Earthquake, there was little relationship between recent tephra layer thickness and the density of shallow landslides, and the tephra contribution itself was statistically absent in the hilly mountainous region where slope failures are generally common, unlike the case of the Hokkaido Eastern Iburi Earthquake. Therefore, in the western Japan, where there are many landslides due to heavy rainfalls, the interpretation of the layer thickness of the isopach map should be changed depending on the type of terrain, because there is a difference in the residual rate of tephra depending on the topography, as known by Kimura et al. (2019).
Other predisposing information such as slope, if rasterized, can be cross-tabulated with the inventory data using GIS, and PR and ROC curves can be created. Those examples will be presented. We are planning to continue creating such a 5th order mesh inventory in the future.

Keywords: Slope failure, Landslide, Inventory, Tephra, Hokkaido Eastern Iburi Earthquake, Kumamoto Earthquake

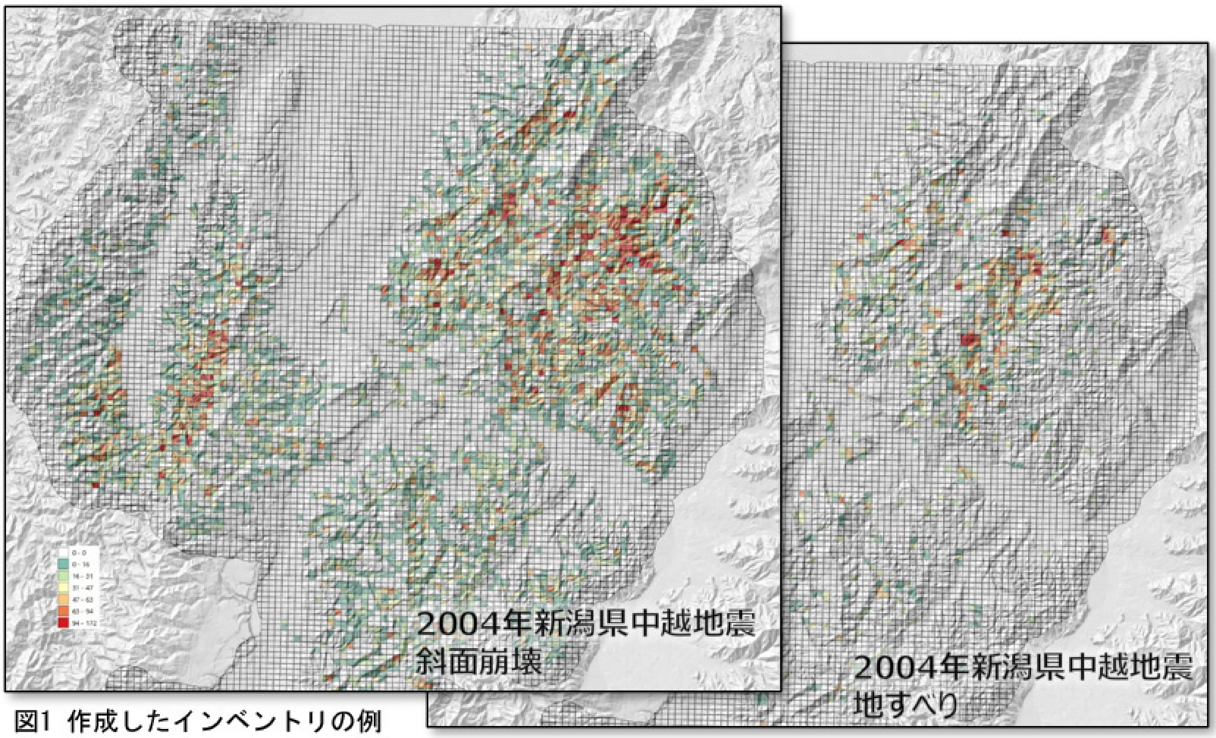

図1 作成したインベントリの例

崩壊発生位置は平成16年新潟県中越地震1:25,000災害状況図（国土地理院）による

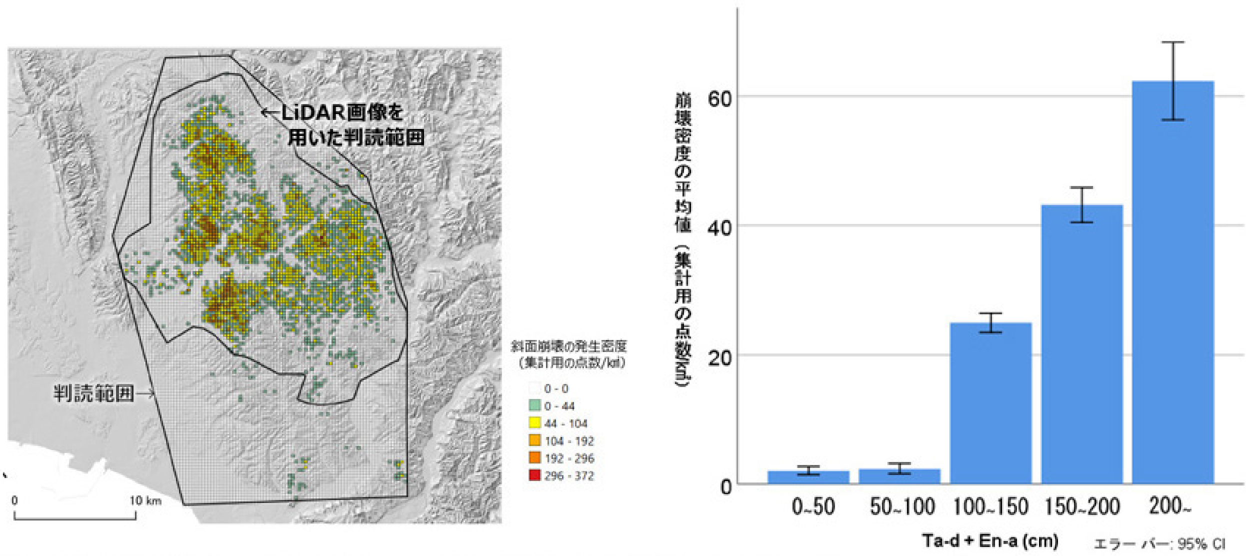

図2 2018年北海道胆振東部地震による斜面崩壊の発生密度（左）および
LiDAR画像を用いた判読範囲におけるIsopach層厚ごとの崩壊密度の平均値（右；谷底等は除く）

崩壊発生位置は故山岸宏光氏により、空中写真（地理院地図）の他、北海道水産林務部による発災後の航空レーザー測量2mDTMを基にした地貌図（CBZ（株）シン技術コンサル変換・作成）の判読により作成（山岸・岩橋、2020）。Isopach層厚は、町田・新井（2020）；古川・中川（2010）を廣瀬亘氏がGIS化したものを使用。