Landslides in 3D - Taking stock of landslides, taking a look at the effectiveness of chosen methods.

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Introduction:

Highland regions have a high activity of exogenic processes, which influence their relief directly. The area of the Polish Carpathians is transformed heavily by mass movements, especially by the landslides. The area of 19 600 km² has 50 000 charted landsiles, which give 3 landslides per square kilometer, on average (Rączkowski, 2007). First publications about landslides in the Polish Carpathians were created in the early 20th century (Zuber, Blauth 1907, Sawicki 1917, Schramm 1925).After the 2nd World War began to appear an increasing number of publications on the landslide's subject. The main methods which was used in the studiesin this period were field work, including (mapping of landslides, measuremsnts of surface landslides with geodesy methods) (Dauksza, Kotarba 1973, Ziętara, 1968, 1974, Gil, Kotarba 1977). Furthermore useful in mapping landslides were the analysis of topographic maps and aerial photographs. Current studies landslides in the Polish Carpathians are conducted based on modern research methods. The use of of GIS tools allowed the designation of areas vulnerable to landslides (Dlugosz 2011, Borkowski et al. 2011, 2012), and the increasingly frequent use of point clouds obtained from the Light Detection And Ranging (LIDAR) or Terrestrial laser scanning (TLS) allows precise definition of the boundaries of landslides and microforms within the landslide.

Landslides model from Terrestrial laser scanning (TLS) and Light Detection And Ranging (LIDAR)

The last 15 years developed rapidly modern methods of measurement include TLS and LIDAR. These methods allow obtain many data for very short time, creating a cloud of points. The possibility of new scanners (eg Riegl VZ 4000) allow you to get 220 000 points per second. The main problem in obtaining suitable terrain models of TLS is vegetation, particularly trees. The laser beam is reflected from the trees, not reaching the ground. On the scan are created shadow areas, which affects adversely the later imaging of the surface area. To combat the negative effects of shadows should scan landslide of several positions.This allows for accurate terrain model with very high accuracy, even hundreds of points per square meter. The greatest number of points at the scanner with the distance decreases, the number. Data obtained by scanning the evaluation method of airborne laser scanning are the same for any surface. After entering the appropriate parameters to the device, the scanner will scan the entire surface with the same accuracy. This method is so beneficial that allows you to perform scans of different landslides in the same scale accuracy (number of points per square meter).Landslide terrain models obtained using LIDAR have the same accuracy which allows for their comparison.

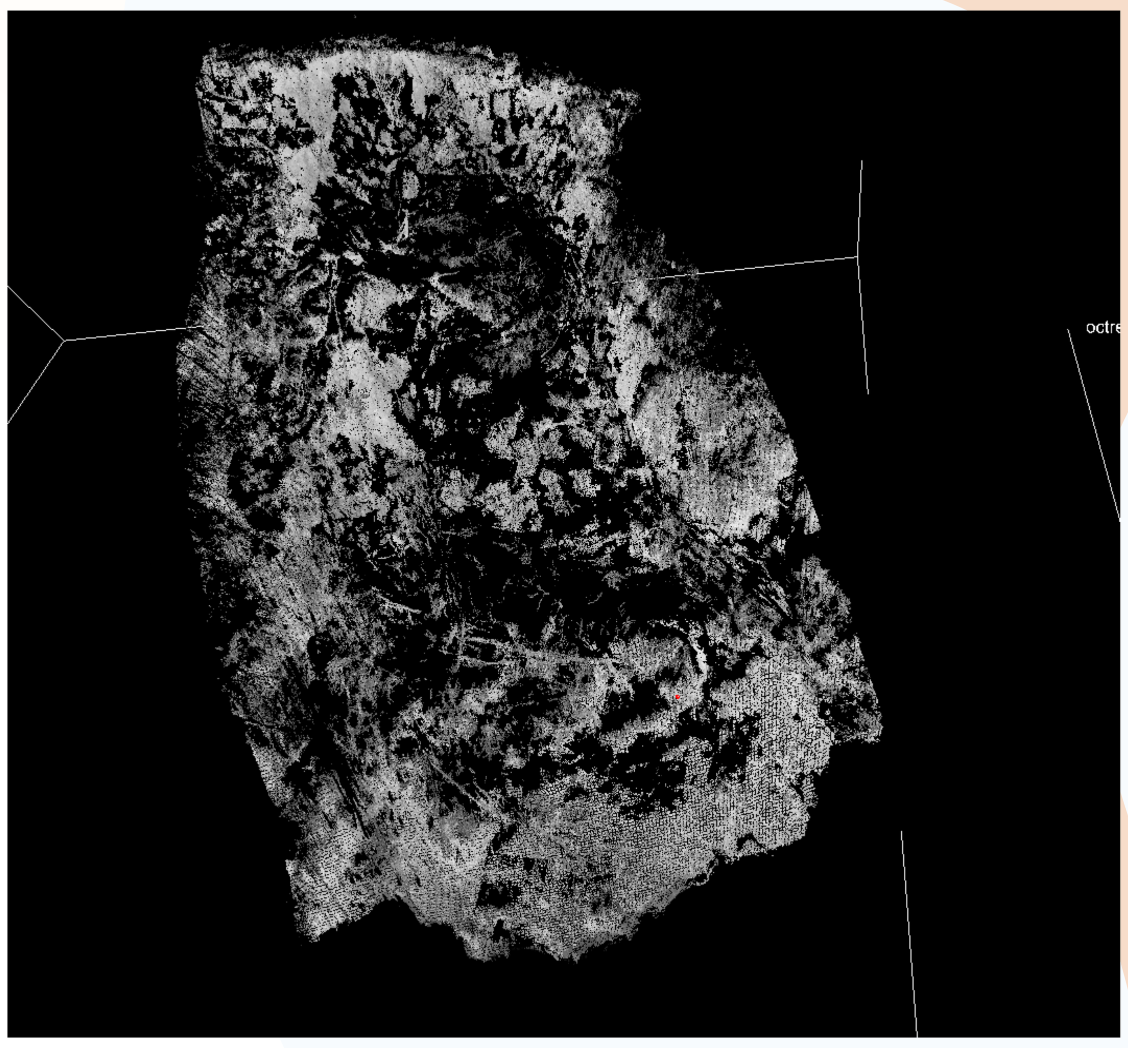

Fig. 2. Point cloud of landslides from TLS without vegetation
source: Jarosław Cebulski

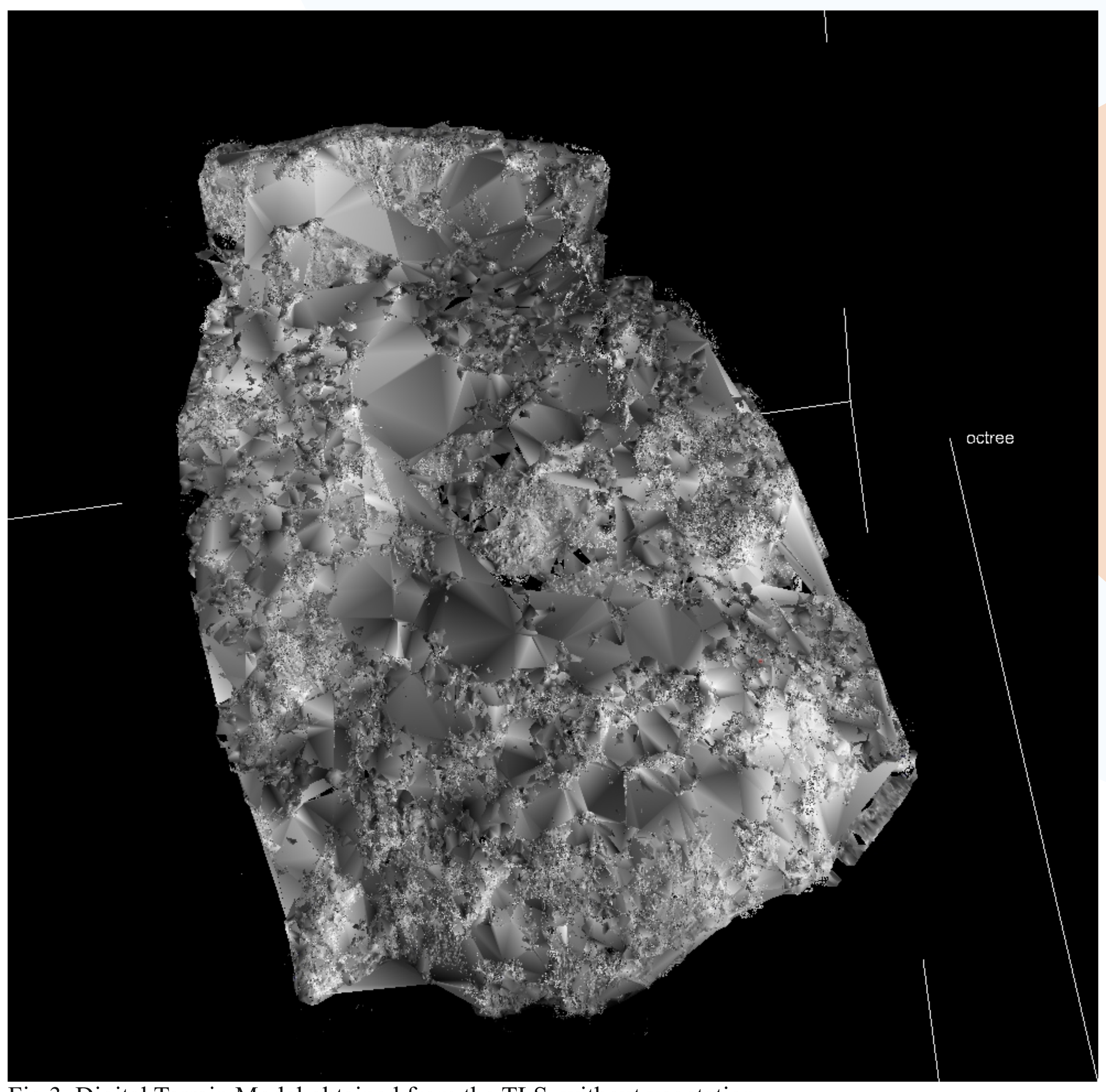

Fig.3. Digital Terrain Model obtained from the TLS without vegetation
source: Jarosław Cebulski

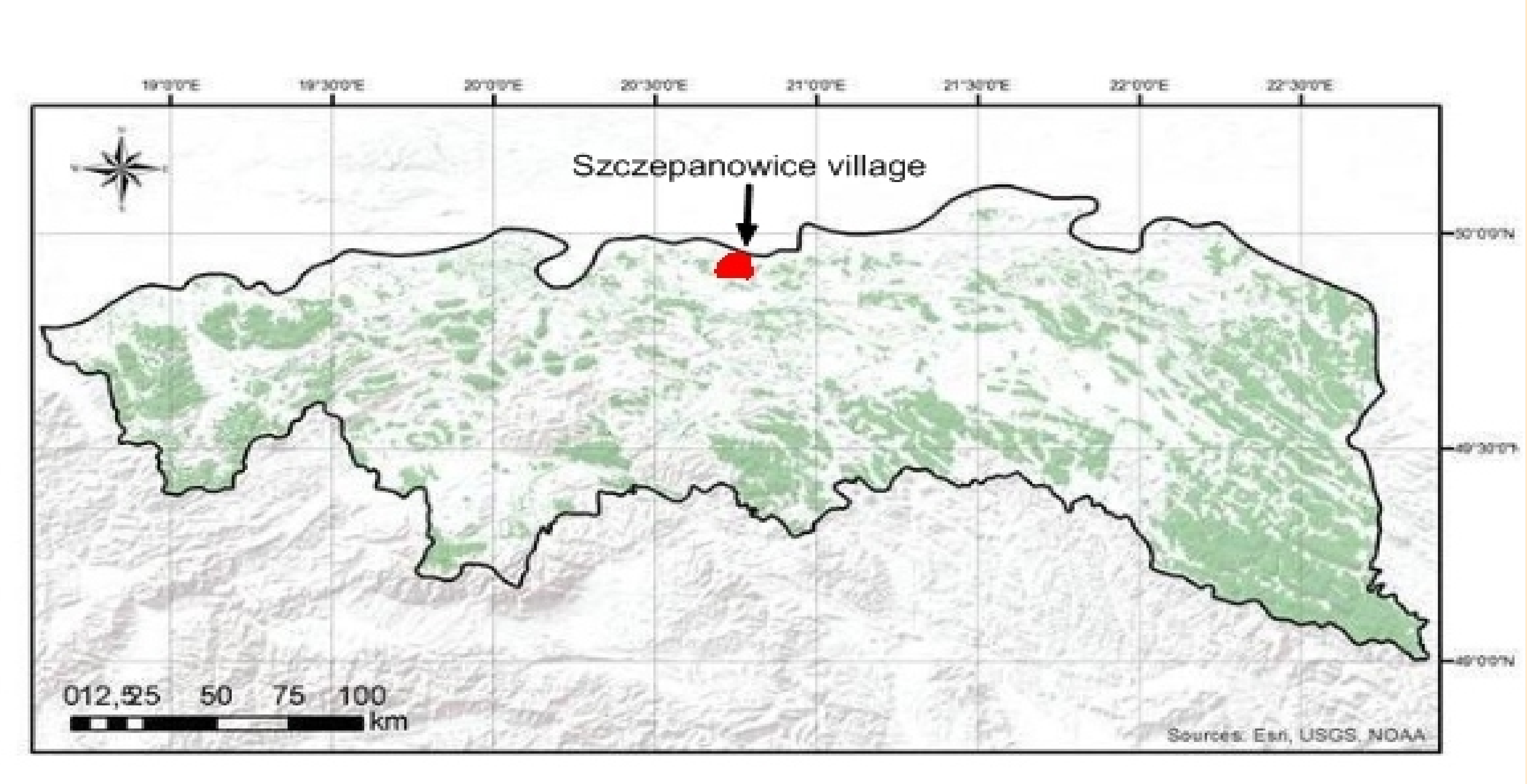

Fig. 4. Study area on the background of Polish Carpathians
source: Anna Świątek

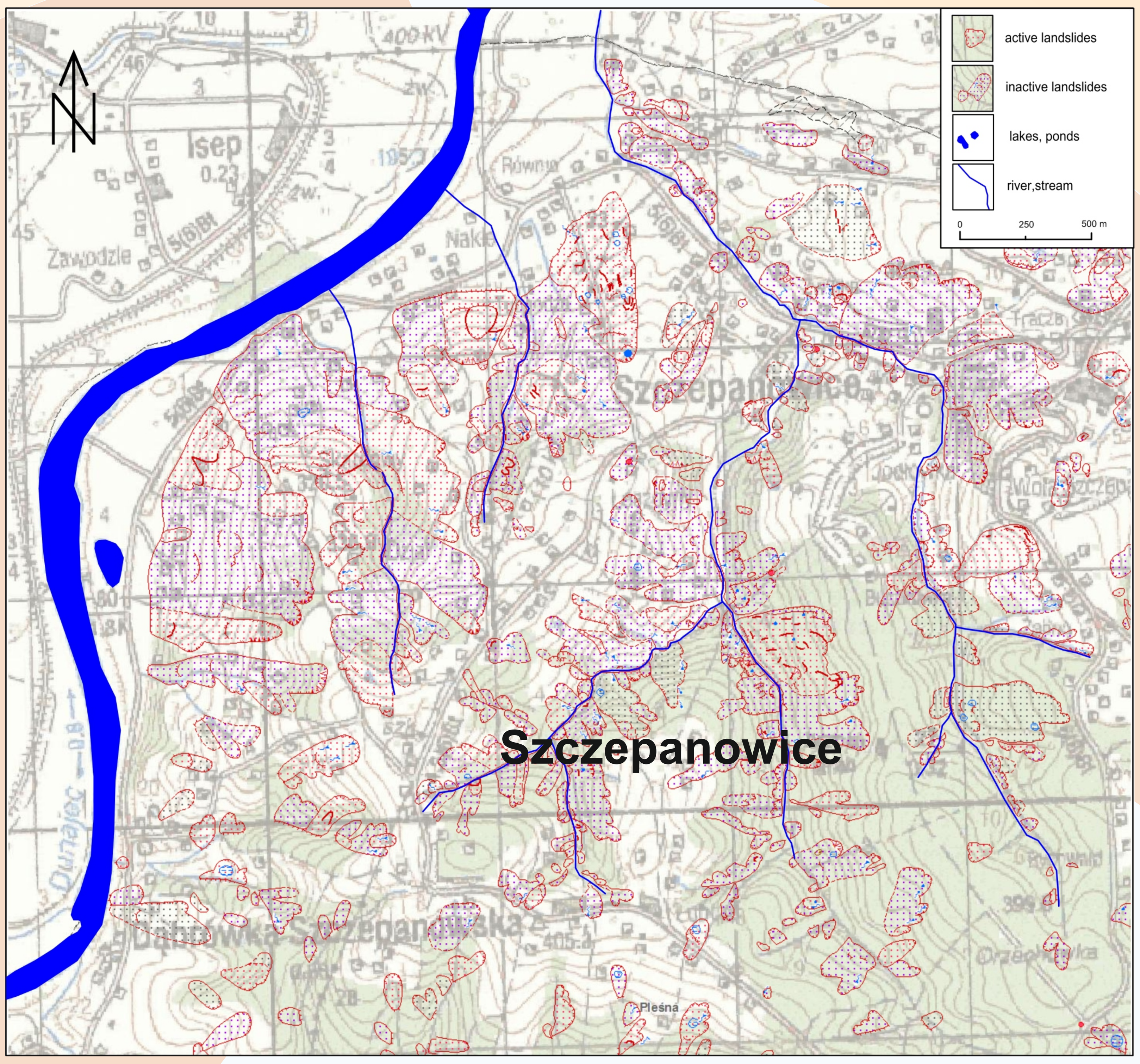

Fig. 5. Topographic map from
source: SOPO (The system shield Anti landslides)

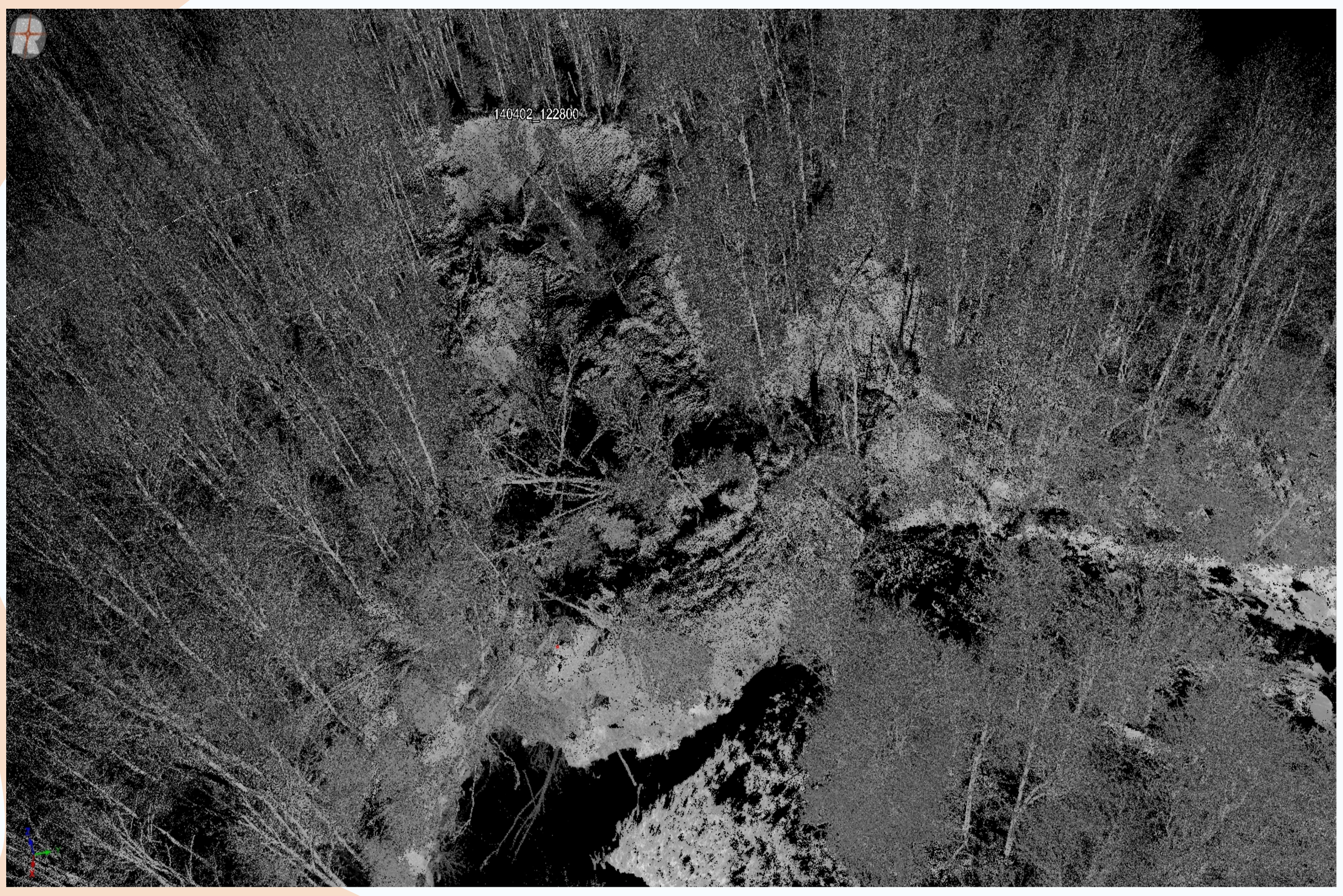

Fig.6. Point cloud of landslidesfrom TLS with vegetation
source: Jarosław Cebulski

Fig. 1. Terrestrial laser scanning position of the landslides
source: Jarosław Cebulski

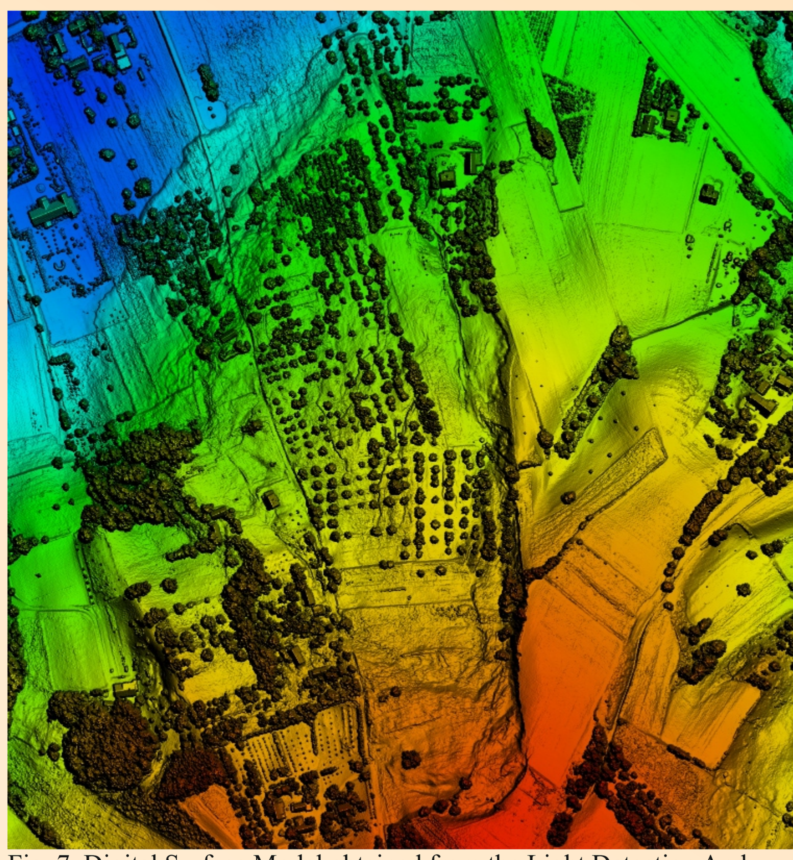

Fig. 7. Digital Surface Model obtained from the Light Detection And Ranging (LIDAR) (model with vegetation)
source: mggp areo

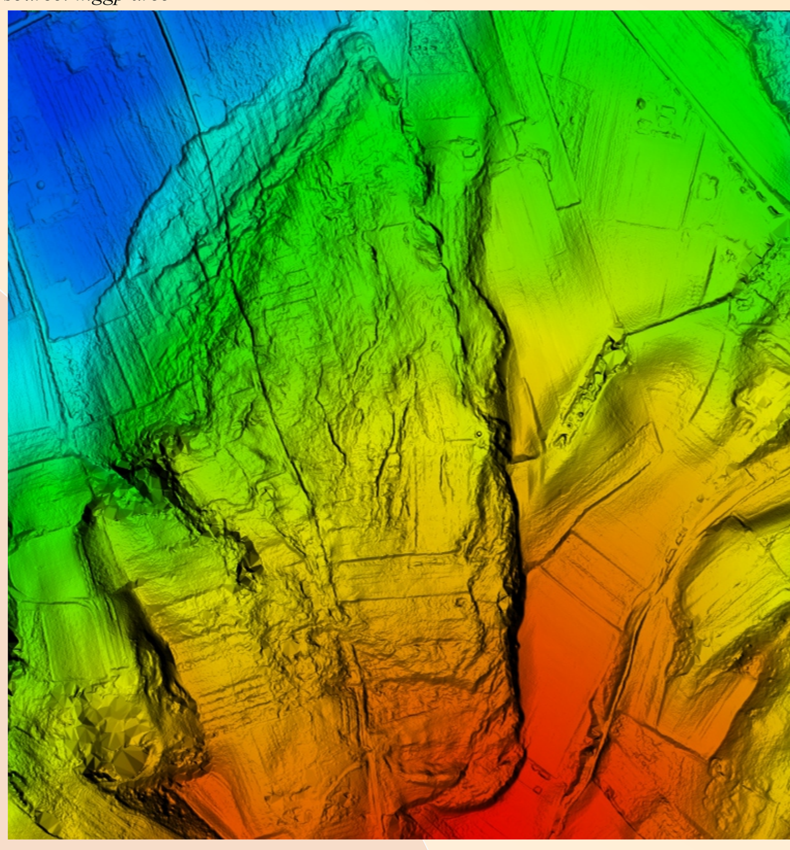

Fig. 8. Digital Terrain Model obtained from the Light Detection And Ranging (LIDAR) (model without vegetation)
source: mggp areo

Fig. 9. Orthophotomap landslides Tubendza before 2010
source: mggp areo

Fig. 10. Orthophotomap landslides Tubendza after 2010
source: mggp areo

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