

## Complex geological and geophysical approach to the landslide hazard assessment: Case study from Rzhyshchiv site (Kyiv region)

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### SUMMARY

The consideration is given to the main features of the formation and activation of landslide processes within the site of the Rzhyshchiv village (Geriatric Center), Kagarlytskyi district, Kyiv region. The main factors influencing the mechanism and conditions for the activation of landslide processes in this site are demonstrated. These landslide investigations using geological, geoinformation and geophysical methods to monitor the occurrence of hazardous geological processes have been carried out. The impact of landslide hazards on the infrastructure has been analyzed. The data obtained by Electrical Resistivity Tomography has been applied in order to investigate the lithostratigraphic sequences, the geometry of landslide body and potential mass movement. This method allows to allocate the fracture zones and places with a high water saturation. It has been confirmed the potential new displacement within this site.

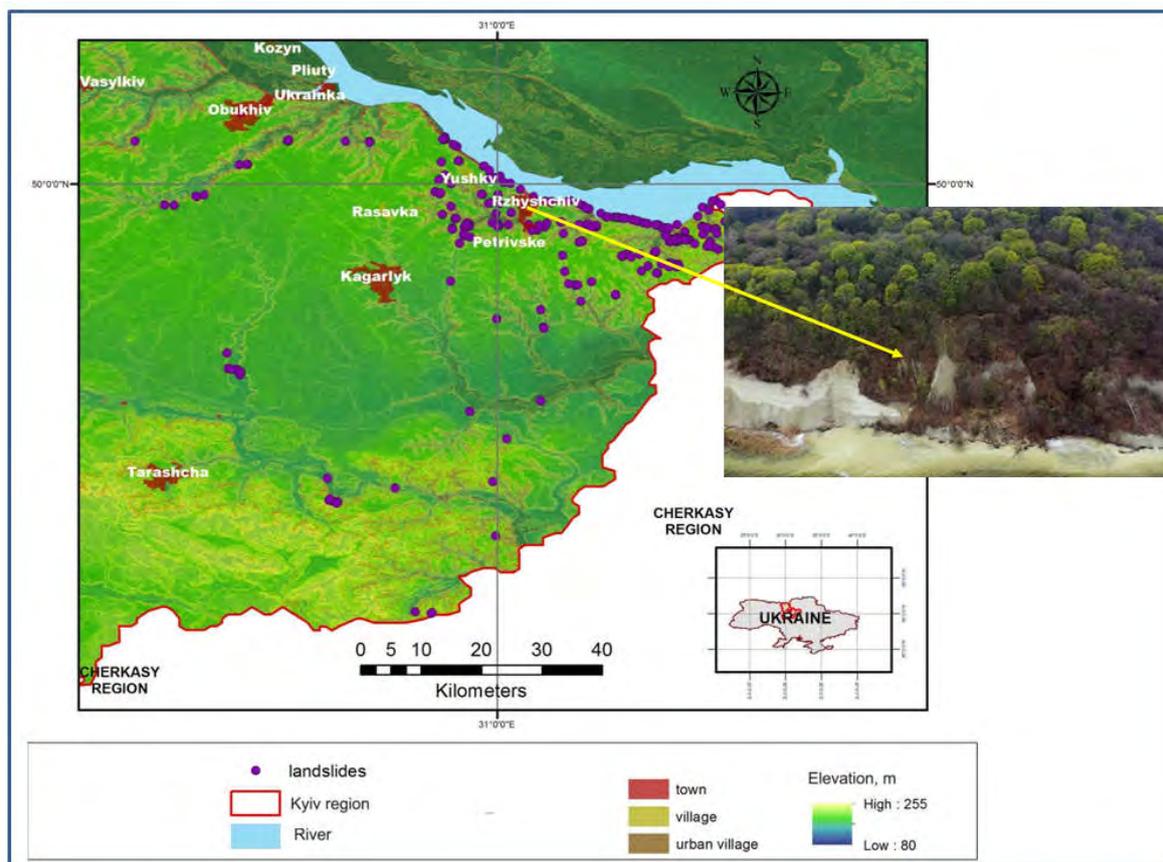


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## Introduction

Recently the predicting of the impact of geological hazards on the infrastructure for prevention of emergency situations and risk mitigation requires comprehensive monitoring research. (Ivanik *et al.*, 2017; Kaliukh *et al.*, 2018a, 2018b, 2020). Within the Kyiv region landslide processes are widely occur. They are temporarily activated and characterized by structural cascade type. The main causes of these processes are the geological structure, tectonic regime, ravine and river erosion, as well as suffusion processes in the Paleogene sands (Bespalova, 2004). One example of the landslides spread is the Rzhyschiv village, where the potential intensification of landslides poses a hazard to the local communities and infrastructure facilities in the village.



**Figure 1** Distribution of landslides within Kyiv region

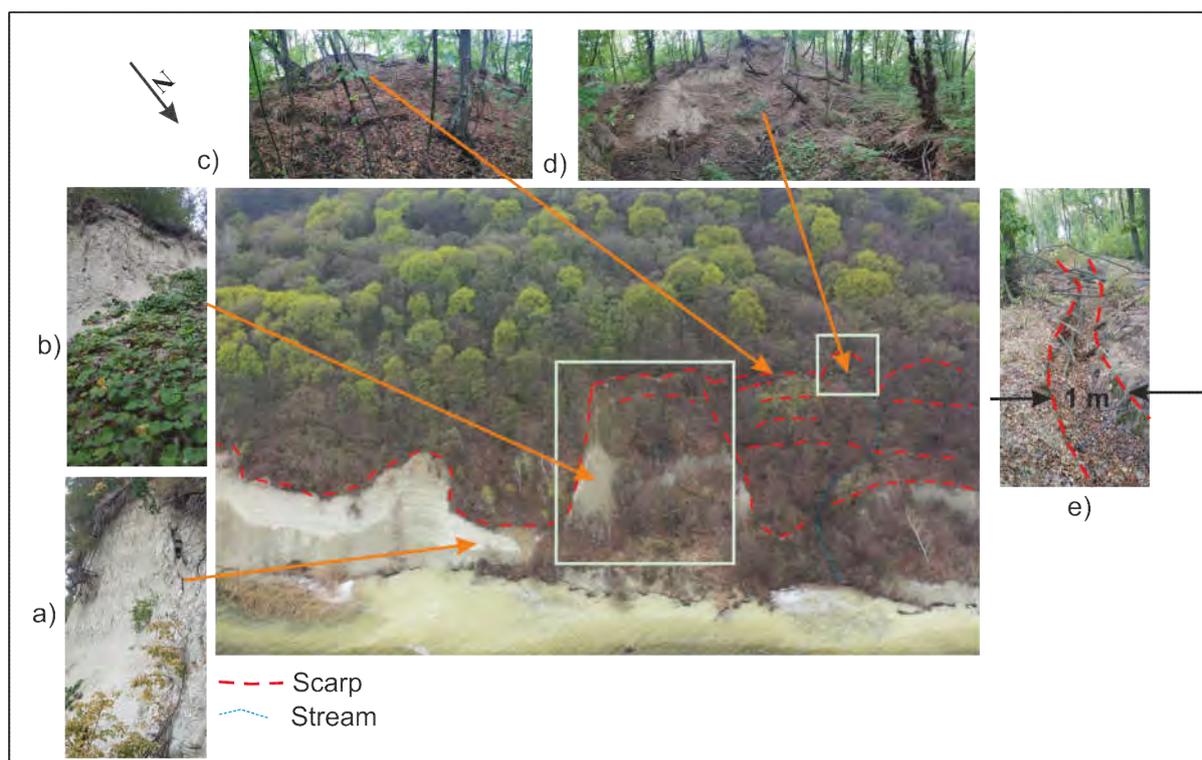
## Case study

Neotectonic movements (weak uplifts periodically replaced by short-term downlifts of the territory) had an important role in the formation of Kyiv Dnieper landforms, which was proved by structural-morphometric studies (Ivanik *et al.*, 2020). This made it possible to assess the impact of tectonic factors on landslides formation and activation.

**Rzhyschiv site.** The study area is represented by horizontal layers of Paleogene, Neogene and Quaternary deposits (State Geological Map., 2001). Lithological, stratigraphic, geomorphological and hydrogeological conditions in combination with hydrometeorological factors determine the potential occurrence of landslides. The case study within *Rzhyschiv geriatric boarding house* is considered here. This site is different from lithological and geomorphological points of view.



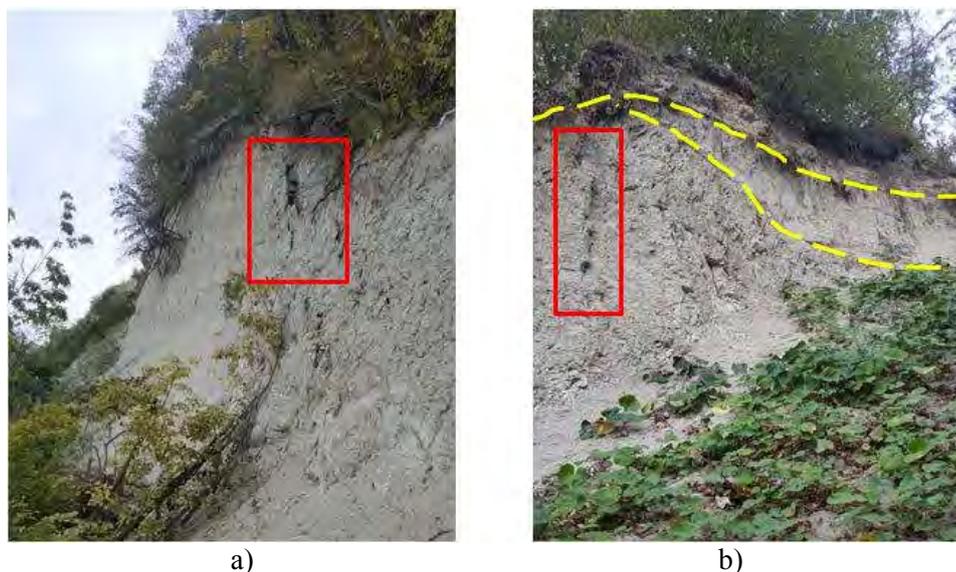
The Rzhyshchiv site is located in rural areas, near Kaniv reservoir and characterized by the specific lithological and geomorphological features. The *Rzhyshchiv site* belongs to the third zone of plastic landslides. In Rzhyshchiv area the sequence of sediments is disturbed due to the loss of brown and variegated clays from the section, as a result of which the deposits of the loess series are on the *Berekska* ( $P_3br$ ) and *Mezhyhirska* ( $P_3mž$ ) Suites (*Bespalova, 2004*). They, in turn, also fall out of the section in some areas. As a result the loess layers are on the marls of the Kyivska Suite. The marls are the basis for the activation of structural landslides in the lower part of the slope within the Middle Dnieper area. Due to temperature fluctuations, marls are strongly exposed to weathering processes, which caused the formation of numerous cracks, This leads to a decrease of the slope stability (Fig. 2a, 2b, Fig. 3).



**Figure 2** Distribution of landslides near the Rzhyshchiv geriatric boarding house, Kyiv region

Within the Rzhyshchiv section in the upper part of the slope, the activation of structural landslides is also associated with ravine erosion. Absolute elevations of this zone are 146 - 124 m. Erosion of the loess layer leads to the formation of ravines, and after reaching the erosive ravines of flooded fluvio-glacial sediments lying below the loess stratum, drainage of the first aquifer from the surface begins (Fig. 2b). The foot of the slope is represented by the marls, the visible thickness of which in this area varies from 2 to 4 m. The water saturation of the deposits leads to the fragile destruction of the marls layer (Fig. 3a, 3b), as evidenced by the formation of two systems of intersecting cracks, on which the sliding is happening.

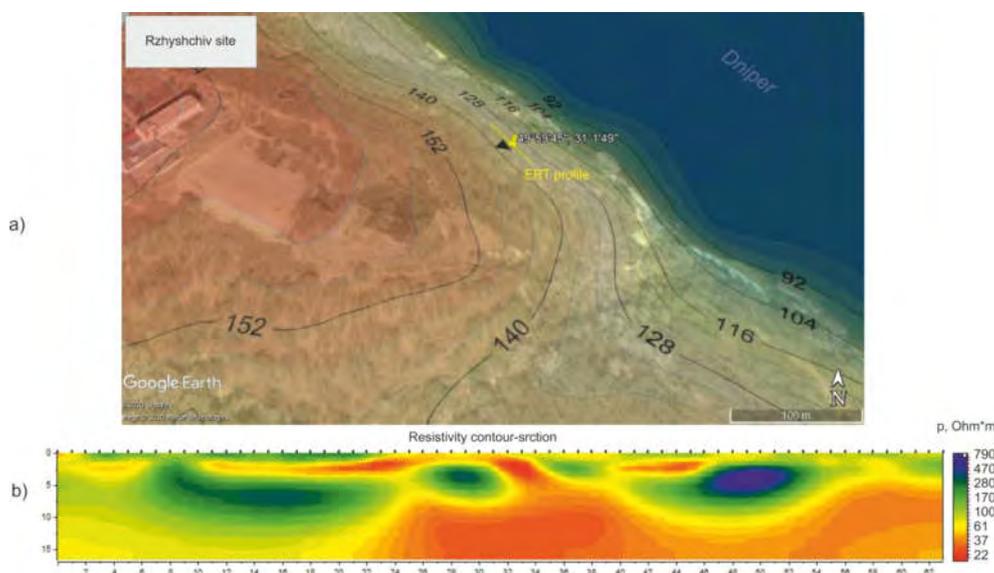




**Figure 3** Fracture zone in the layer of marls of Eocene deposits, Kyivska Suite (P<sub>2</sub>kv)

**Results**

The presented research has shown that the application of ERT method enables a better understanding of the location of fracture zones and areas of high water saturation. This analysis has also confirmed the formation of new displacement zones within the main landslide, which have been flagged up by visual site observation (Figure 4). The obtained data provides a detailed characterization of the weak zones within landslide-prone areas.



**Figure 4** Electrical Resistivity tomogram for the Rzhyschchiv site and its location

**Conclusions**

The landslides in the Rzhyschchiv area are an site object for the prediction of landslide hazard at the large scale. Integration of geological, geophysical methods and GIS analysis are recommended for the landslide monitoring. Zones of landslide processes formation are confined to the specific geological



conditions and physical and mechanical properties of rocks. This causes the formation of landslides of different types. It is important to perform the Electrical Resistivity Tomography (ERT) for the analysis of the fracture zones and areas of high water saturation. It will yield a new knowledge on the principal factors of geological hazards and ensures the design of a corresponding prevention and mitigation strategy.

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