

17657

Exogenic Processes' Remote Monitoring of Kanivske Reservoir's Right Bank

***O. A. Mykolaenko** (*Taras Shevchenko National University of Kyiv*), **P. V. Zhyrnov** (*State Enterprise "Scientific Research and Design Urban Development Institute"*), **O. V. Tomchenko** (*State institution "Scientific center for aerospace researches of the Earth of IGS NAS of Ukraine"*), **I. O. Pidlisetska** (*Taras Shevchenko National University of Kyiv*)

SUMMARY

The changes' monitoring results of the exogenic geological processes' development are presented in this article on the territory of Kanivske Reservoir's Right Bank, (Trypillya – Rzhyschiv area) which was made on the ERS basis and topographic survey's material, cartographic and statistical reports of various geological and hydrological organizations. Gully erosion and landslides have become widely dissemination in the limits of Kanivske Reservoir's right bank and waterlogging, eutrophication have intensive manifestation within the bounds of low and flat relief of the left bank. Erosion played a major role among exogenic processes before Kanivske reservoirs' creation and landslides were in its final stages and had an insignificant spreading areal. Reservoir's construction triggered the groundwater overpressure's changes and slope abrasive processing that caused the old stabilized landslides' activation and the formation of new ones. There is a clearly pattern of abrasive, erosion and landslide processes' activation of the Kanivske reservoir's coastal territories with the oscillation amplitude of the maximum and minimum soil surface temperature and soil's freezing depth. It was established that the years with the rainfall patterns during summer and autumn period coincide with the years of the greatest landslides' activation within the investigation territory.

Introduction

The construction of the Dnieper reservoirs' cascade had a radically influence on the relief and exogenous processes' course, territories' hydrological and hydrogeological conditions, Dnieper's natural hydrological regime (the river type has been changed to lake type), natural systems' sustainability of the river and dry land. Economic development of the territory affected the adjacent area's climatic characteristics because the average annual air temperature increased a few degrees, wind speeds increased by 40%, average annual rainfall's indexes increased by 20 % (Zhynov, 2011). All these factors have had an influence on the exogenous processes' course. The total area affected by various exogenous processes has grown by 1,5-2 times compared to a condition at the beginning of the 1970s years. Number of adverse exogenous processes' cases has grown by 3-5 times from 1960 to 1996 years according to the geological environment monitoring data conducted by Ukrainian State Service of Geology and Subsoil. Kyivske and Kanivske reservoir's right bank is the region of the most active gravitational processes' manifestation throughout the whole Dnieper valley, that's why researches of exogenous processes' development belongs to the most relevant studies.

Method and/or Theory

Urgent meteorological researches' reports have been analyzed on weather stations "Kyiv" and "Kaniv" from 1999 to 2009 years for the characteristic of natural conditions and factors of current exogenous processes' development. Stock materials of different geological and hydrological organizations (SE "Ukrainian Geological Company", Ukrainian Hydrogeological and Ameliorative Institute, Institute of Geophysics NAS of Ukraine, JSC "Kyiv Scientific Design Institute "Energoprojekt", Scientific and Research Enterprise "Geoprom", Middle Dnieper Basin Water Resources Department) were used for the exogenous processes development's characteristic. Topographic survey's materials of researched territory in the scale 1:25 000 and 1:10 000 and high resolutions spaceimages were used for morphometric, hypsometric, geodynamic relief's characteristic (Kondratyuk, 2006). All present geological and hydrological report's stock materials were converted into a single coordinate system, digitalized and put into the vector themed layers by ArcGIS ArcMap 10.0 software programme for monitoring and identification changes in the exogenous processes' and landslides' development, in particular. Furthermore, the analysis of spaceimages has been made, allowing to enrich the content and improve the accuracy of geomorphological maps, avoid the randomness and unevenness of their special strength, which is common to visual ground observations alone. ERS methods provided an opportunity to identify the dangerous geological processes' development by timeliness spaceimages. Also ERS methods have made it possible to undertake detailed geoeological monitoring, to determine the human pressure's index and environment degradation's level. The exogenous processes' extension map of Kanivske Reservoir's right bank was created during current scientific-research work (Figure 1).

Results

Gully erosion and landslides have become widely dissemination in the limits of Kanivske Reservoir's right bank and waterlogging, eutrophication have intensive manifestation within the bounds of low and flat relief of the left bank. Erosion played a major role among exogenous processes before Kanivske reservoirs' creation and landslides were in its final stages and had an insignificant spreading areal. Reservoir's construction triggered the groundwater overpressure's changes and slope abrasive processing that caused the old stabilized landslides' activation and the formation of new ones (Bagmet, 2006). There are such exogenous processes have become widely spread in the territory of Kanivske Reservoir's Right Bank:

- erosion processes;
- landslides;
- reservoir shores' abrasion;
- suffusion;
- waterlogging;
- eutrophication and salinization (Cherevko, 2003).

Let us dwell on landslides in more detail: landslides are rocks' displacement on slopes due to the gravitational force. There are such exogenous processes have an impact on landslides' formation in the research area:

- exogenous unloading and rock's unsealing which occurs by gully cutting in the Jurassic clays' thickness. The process characterizes by rocks' swelling by a wetting, which occurs to drastically reduce their strength and promotes plastic type landslides' formation. Process activation occurs during intensive gullies growth and rocks' blurring;
- physical, chemical and biological weathering of clay rocks. The process is manifested in the gradual destruction of cement binders of rocks. The process is manifested in the gradual destruction of cement binders of rocks, the structural bonds' weakening of clays and the formation of secondary minerals (Prihodko, 2005);
- erosion-and-accumulation activity of gully network. It is manifested in the soil flushing form developed on easily erodible loess soils, as well as in uncultivated slopes' areas with steepness more than 10°, especially during periods of rain. Deep erosion is manifested in the further gully systems' indentation, sediment gullies' formation, rapid growth of young "coastal" type gullies. The gully network's accumulation activity is investigated in the sand-clay material removal during spring snow-melt, summer showers and in the proluvial fans' formation from gullies;
- erosion processes play a major role in relief's and landslides' formation (Zhyrnov, 2010).

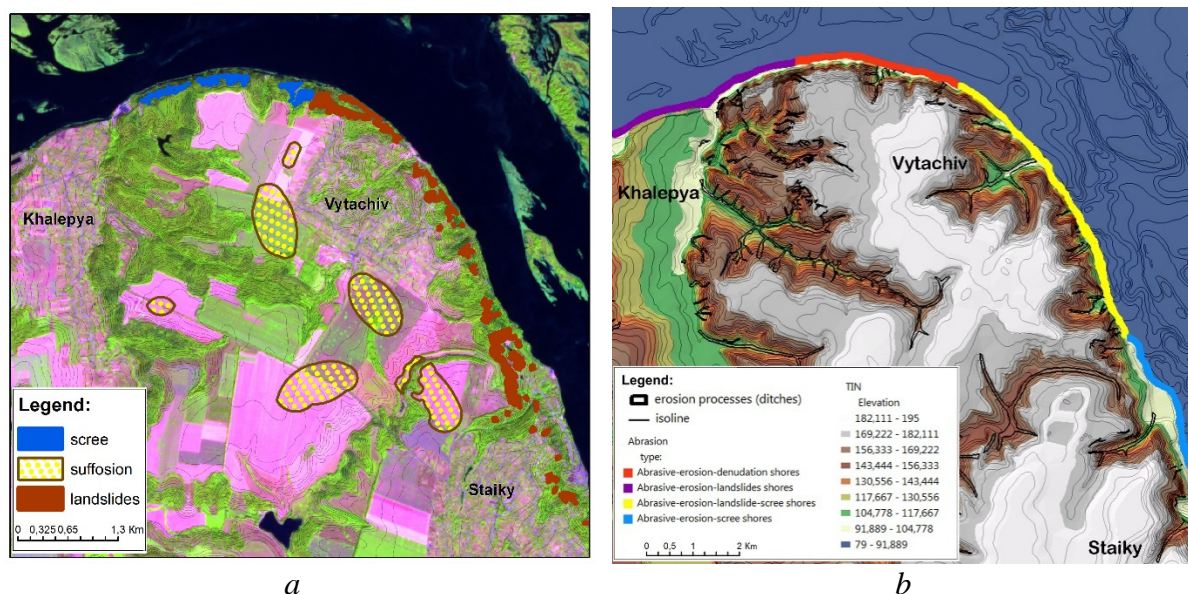


Figure 1 Map fragment of exogenous processes' distribution in the territory of Kanivske Reservoir's Right Bank (area of «Khalepya–Staiky») presented on the basis of satellite images Landsat-8(a) and three-dimensional elevation model (b)

Upper slope's loess thickness erosion leads to the gully formation and first aquifer's draining after its watered fluvioglacial deposits' achieving to be found in the loess thickness' bottom. Groundwater interaction with brown and motley clay's roof causes surface structural type's landslide. In relief, this process is expressed by the collapse of blocks of rocks of loess thickness on all its power. Morphologically landslides displacements are cirque-like depressions separated by interlaced capes. Interlaced capes are formed due to the uneven indentation of the loess plateau's edges, which are expressed in relief by ridge-shaped elevations that are extended 50-100 m to the Kanivske Reservoir compared to the steep walls of the plateau.

The slope and height of the existing landslides were changed by creation of the Kyivske and Kanivske reservoirs. The Kyivske reservoir's height was increased from 19.0 to 80.0 m and Kanivske reservoir's –from 35.0 m to 75-100.0 m. This situation provoked the development of new landslides and the activation of old ones. The landslides of the Kanivske reservoir can be divided into the following types from the engineering-geological point of view. (Bespalova, 2004):

- structural type - the morphological body of these displacements is represented by a purely block structure, a pronounced wall of breakdown, a cirque or frontal shape in plan;

- structural-plastic type - characterized by a clearly expressed wall of failure, the body of displacement has the appearance of blocks at the top and the form of flow at the bottom;
- the plastic type is characterized by a clearly pronounced wall of failure, with a height of not more than 1 - 3 m, the surface of the sheared masses has a finely humped structure with numerous outflow forms, the length of the core exceeds the width.

Four reference landslide sections allocated on the territory of the research by depending on the geological structure and morphology of the slopes and slope areas, the intensity of the impact of the wave abrasion of the reservoir.

The main slope landslide sections of the right bank of the Kanivske reservoir are:

- detachment and collapse of loess loam on the edges of the plateau and its slopes;
- moving previously displaced rocks in the form of earth currents from the cirque depressions on the 1st terrace sliding to the foot of the slope or on the 2nd terrace;
- the destruction of landslide capes, which results in the merger of cirque type depression;
- gravitational and other displacements confined to the frontal ledges of the displacement capes, which are amenable to abrasive processing (Zhyrnov, 2012).

Three are examples of displacements on the supporting sections below (Figure 2-3).

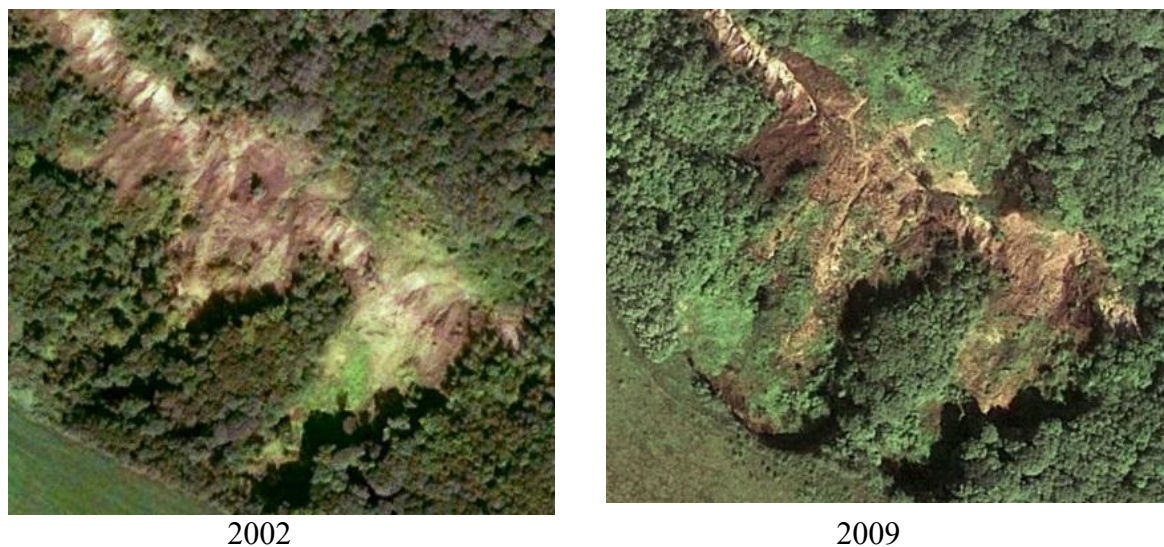


Figure 2 Activation of landslides on suburban areas between the villages of Staiky and Grebeni ($50^{\circ} 2'24.87''N$ $30^{\circ}57'12.68''E$)



Figure 3 Activation of landslides Rzhishchiv town ($49^{\circ}59'13.73'' N$ $31^{\circ} 2'42.68'' E$)

The statistics of landslide dynamics are obtained on the basis of the analysis of information yearbooks about activation of dangerous exogenous geological processes in the territory of Ukraine according to the EGP monitoring data from 2010 to 2018 (Table 1).

Table 1 The dynamics of the affected area of the Kiev region landslides (selected years)

Year	number of landslides, pcs	Landslides area, km ²	affection of territory, %	number of active landslides, pcs	active landslide area, km ²	number of landslides in the built-up area, pcs	number of economic objects in the landslides zone, pcs
2010	814	23,75	0,08	13	0,2	111	-
2012	814	23,75	0,08	14	0,47	67	-
2014	814	23,75	0,08	32	0,47	67	9
2016	815	23,75	0,08	32	0,2	67	9
2018	815	23,75	0,08	33	0,22	108	12

Conclusions

The regular pattern of activation of abrasive, erosion and landslide processes of the coastal territories of the Kanivske reservoir with the amplitude of oscillations of the maximum and minimum soil surface temperature and depth of soil freezing is traced. It is established that the years characterized by the rainfall patterns of precipitation during the summer and autumn period coincide with the years of the greatest activation of landslides within the research area. The regularity of the processes of flooding, waterlogging and hydrodynamic scour of the landslides of the Kanivske reservoir through intensive construction of the territories of the settlements of Koncha-Zaspa and Kozyn and the imposition of artificial soils have been established.

References

- Bagmet O. B. [2006] Spatio-temporal patterns of development of landslide and abrasion processes on the eastern slope of the Kyiv plateau: natural-geographical studies. *Ukrainian Geographical Journal* ISSN 1561-4980, No1, pp. 22–27 (in Ukrainian).
- Bespalova E.N. [2004] Dynamics of landslide process of the Middle Dnieper on the example of the Tripillya - Kaniv section. Extended abstract of Doctor's thesis. 04.00.07 Engineering geology, permafrost and soil science. Taras Shevchenko National University of Kyiv Institute of Geology (in Ukrainian).
- Zhyrnov P. [2010] Engineering-geomorphological studies of landslide sections of the right-bank part of the Kaniv reservoir within the Kiev region. *Scientific journal Physical Geography and Geomorphology* ISSN: 0868-6939. No 61, pp. 189 - 195.
- Zhyrnov P. [2011] Interrelation of activation of negative geomorphological processes with meteorological and hydrogeological conditions of the bank of the Kanivske reservoir on the example of the Kyiv - Rzhyschiv section. *Scientific Journal Physical Geography and Geomorphology* ISSN: 0868-6939. No 62, pp. 137 - 146.
- Zhyrnov P. [2012] Engineering geomorphological analysis of the right bank of the Kanivske Reservoir (on the example of the key section of Kyiv-Rzhyschiv). Extended abstract of Candidate's thesis 11.00.04. *Geomorphology and paleogeography*, p. 212. (in Ukrainian).
- Kondratyuk S.V. [2006] Engineering-geological survey of the territory of Kyiv, Chernihiv, Zhytomyr and Transcarpathian regions to geologically justify landslides and geological support VIAS NA. *Geological report*, 223 p. (in Ukrainian).
- Prikhodko V.V., Rudko G.I., Nikitash O.P. [2005] Development of dangerous landslide geological processes in the territory of Kyiv region. *Scientific and technical journal*. ISSN 1726-5428. No 6, pp. 52-61.
- Cherevko I.G., Sushkin N.G., Bulava L.M. [2003] Modern exogenous gravity processes in Ukraine. *Magazine Geography and fundamentals of economics at school*. No 6, pp. 39-41.