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STUDIES OF THE SIRKO RAVINE IN ORDER TO PREVENT THE DEVELOPMENT OF LANDSLIDE-HAZARDOUS PROCESSES

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ДОСЛІДЖЕННЯ БАЛКИ СІРКО ЗАДЛЯ ПОПЕРЕДЖЕННЯ РОЗВИТКУ ЗСУВОНЕБЕЗПЕЧНИХ ПРОЦЕСІВ

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ИССЛЕДОВАНИЯ БАЛКИ СИРКО С ЦЕЛЬЮ ПРЕДУПРЕЖДЕНИЯ РАЗВИТИЯ ОПОЛЗНЕОПАСНЫХ ПРОЦЕССОВ

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Abstract. The purpose of research is to study the Sirko ravine, including the analysis of the deformation of buildings and structures, observations by the method of the Earth's natural pulse electromagnetic field to determine the possibility of the development of landslide processes on its slopes.

The study of the Sirko ravine and the adjacent territory was carried out by means of reconnaissance observations, during which the sides of the ravine were described, an analysis of its development, the presence of drainage, water supply systems and the absence of a drainage system, as well as the prospects for its further use. The factors causing the development of landslide processes are the phenomena of soaking due to precipitation and leaks from the water supply system and the absence of storm drainage and sewerage systems.

The main deformations of buildings and structures on the sides of the ravine are considered - the development of cracks on the walls of buildings, fences of asphalt and concrete pavements. Photo documentation is presented, confirming their development. The comparison of the Sirko ravine with the disturbances of the Serednoprydniprovskyi megablock is carried out. It is shown that the strike azimuth of the Sirko ravine coincides with the strike azimuth of the deep fault of the Serednoprydniprovskyi megablock.

To assess the degree of landslide hazard of its slopes, the express method of observation of ENPEMF was chosen. The observations were carried out at the top of the ravine in the area of Gagarin Ave, as well as in the area of the widest part of its thalweg.

The results of observations carried out by the method of the Earth's natural pulse electromagnetic field along two profiles traversed across the strike of the ravine thalweg, which indicate the possible development of landslide deformations of its slopes. These research will help prevent possible deformations of buildings and the development of landslide processes arising from the soaking of its slopes during the development of the slopes of the Sirko ravine.

Keywords: landslide-hazardous processes, deformations of buildings, slopes, natural pulse electromagnetic field.

Introduction. Within the right-bank part of the city of Dnipro, there are about 30 gullies and ravines, with an area of about five thousand hectares, which is more than 25% of the entire right-bank part of the city. The problem of integrating gullies and ravines into the infrastructure of the city is relevant today, especially in the context of the intensification of construction.

Landslides occur annually on their slopes, as a result of which lands valuable for the city are lost, while the most landslide-prone and rapidly growing gullies are located in the central parts of the city, where the cost of land is highest from - 8,000-12,000 USD per one hundred square meters. Examples of such ravines are: Dovha, Sirko, Rybalska, Tunelna, Aptekarska and others.

The ravine-gully system, as a rule, develops along the main directions of deep faults of the Serednoprydniprovskyi megablock: 0° (360°), 12°, 17° and 290°, 25°, 30° and 300°, 35° and 305°, 40°-45° and 310°-315°, 50° and 320°, 85°, 90° (270°), 330°-335°, 340°, 350°.

The geological section of the upper part of the Upper Quaternary deposits of the right-bank part of Dnipro city is composed of deposits of loess and loess-like loams. At the same time, the process of deformation of loess deposits develops more intensively if, simultaneously with the watering of loess rocks on the earth's surface, they are moistened from below, with an increase in the level of groundwater. In such cases, loess deposits lose their bearing capacity and the phenomena of subsidence landslides are formed - displacement of rocks on steep sections of natural slopes, first in the vertical direction, and then in the direction of the slope.

The problems of landslide hazard and studies of ravines were studied by V.N. Salomatin [1], N.N. Shatalov [2], A.S. Kovrov [3] and others.

Thus, in the works of V.N. Salomatin was the first to show the possibility of studying landslide-hazardous processes using the method of observing the Earth's natural pulse electromagnetic field (ENPEMF).

To study the land plots of the Sirko ravine, as well as to assess their landslide hazard and suitability, we also applied the ENPEMF observation method. This method is economical, efficient and easy to use.

The purpose of the work is to identify potentially landslide areas of slopes using the ENPEMF observation method using the example of the Sirko ravine.

Examples of integration into the urban infrastructure are leveled gullies and ravines: the eastern section of Dmytra Yavornytskoho Ave [4], on the street of Ivana Akinfiev - the Rassvet hotel, the blocks of which are located on the sides of the gully; road laid along the thalweg of the gully - Krestyansky descent; swimming pool and stadium "Slavutich" which located in thalweg of gully on the street of 6th Infantry Division and others.

Methods. The study of the Sirko ravine and the adjacent territory was carried out by means of reconnaissance observations, during which the sides of the ravine were described, an analysis of its development, the presence of drainage, water supply systems and the absence of a drainage system, as well as the prospects for its further use. The high degree of wear of the water supply systems also contributes to the intensive soaking of the slopes of the ravine. The factors causing the development of landslide processes are the phenomena of soaking due to precipitation and leaks from the water supply system and the absence of storm drainage and sewerage systems.

To assess the degree of landslide hazard of its slopes, the express method of observation of ENPEMF was chosen. Since it is difficult to apply other geophysical methods in the conditions of urban development and man-made interference. The observations were carried out at the top of the ravine in the area of Gagarin Ave, as well as in the area of the widest part of its thalweg (Fig. 1).

During the study, a radio wave indicator of the stress-strain state of rocks (RVINDS AHI 2.026.001 PS) was used. [5]. The observation data of the ENPEMF

were processed using a personal computer, then the graphs of the flux density of the ENPEMF were plotted.

To reduce the influence of seasonal soil soaking, observations were carried out in the summer.

On the territory available for research, observations were made on two profiles. The observation step was 10 m. The first profile is located at the top of the Sirko ravine - along Gagarin Ave, through a gas station and a garage cooperative. The length of the first profile was 100 m. The second profile is located on the northeastern side of the ravine, (across the strike of the thalweg of the ravine) along Sirko str., the length of the second profile is 90 m (see Fig. 1).

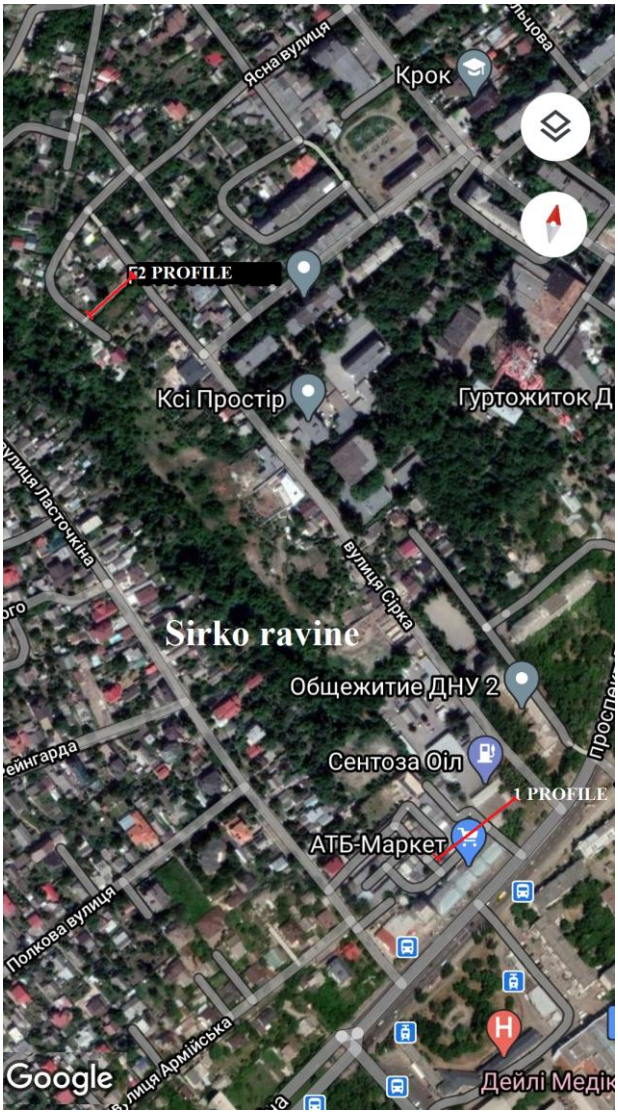

Figure 1 - Position of the Sirko ravine and observation profiles of ENPEMF

The profiles were linked using a topographic map of the city at scale 1: 10,000.

Deformation processes associated with tectonic faults were identified using a previously developed technique [6].

Results and discussion. The Sirko ravine is a screwdriver for the Dovha ravine. The average width of the ravine is ~ 80 m. The length of the ravine along the

thalweg, taking into account the leveled part, is ~ 1200 m. The area of the ravine is over 10,000 m^2, the average depth to its thalweg is approximately 30 m. The strike azimuth is 315° (Fig. 1).

During a reconnaissance survey of the slopes of the ravine, the most characteristic deformations of buildings located on its sides were revealed - cracks on the walls of buildings and fences, violations of asphalt and concrete pavements, the manifestation of landslide movements due to soil washing out from under the foundations of buildings (Fig. 2-8). The strike azimuth of the reduced deformations of buildings and structures corresponds to the strike azimuth of the Sirko ravine is 315°.

The observation points are shown in Fig. 2. As can be seen from fig. 2, bursting cracks of the fence made of bricks are observed, manifested in the rupture of the masonry both in the cement mortar and in the bricks.

The formation of the reduced cracks on the brick fence indicates the presence of subsidence and ground movements in the direction of the ravine thalweg.

a) b)

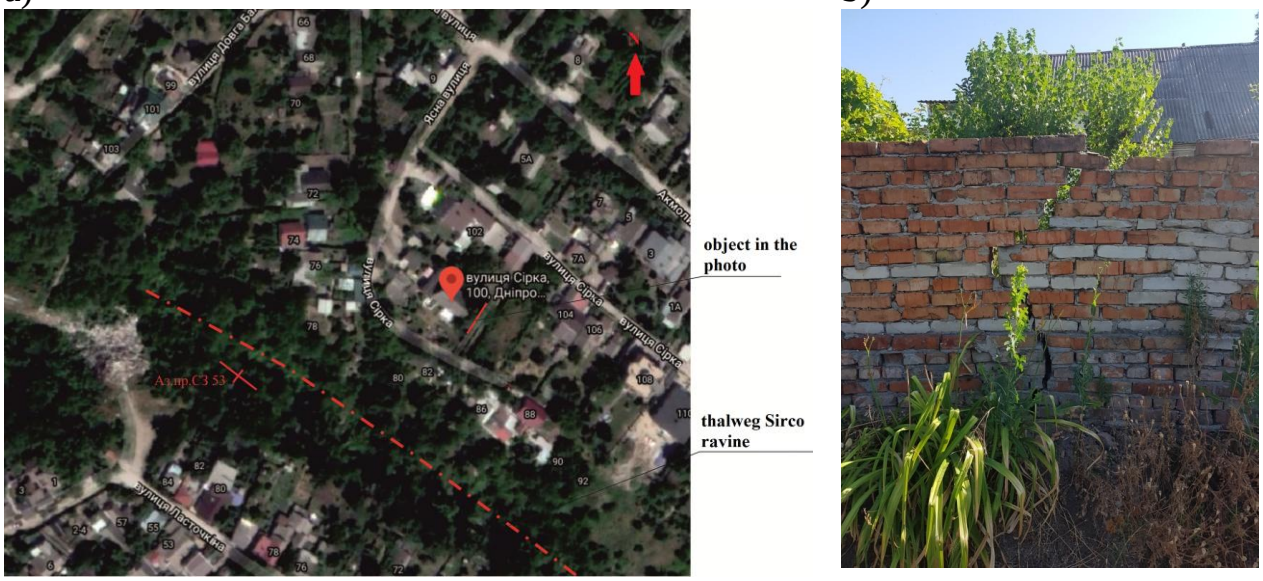

Figure 2 - The position of observation points (a) and examples of deformations of the fence on the Sirko 100 str. (b)

In fig. 3 shows fragments of destroyed garages, in the area of the junction of the Dovha and Sirko ravines.

In fig. 4 a, b shows examples of the destruction of the fences of the household farmsteads located on the Lastochkina, 48 str. The location of these observation points on the satellite map is shown in fig. 5 b.

In addition to violations of buildings and fences, deformations are observed on the asphalt pavement on the Sirko str. and Lastochkina str., separation cracks, which show the direction towards the Dovha ravine (Fig. 5 a, b).

An example of deformations of buildings, as well as the position of observation points on a satellite map on the Olena Han, 1 str. is shown in Fig. 6 a, b.

Figure 3 - Destroyed garages in the area of Dovha Balka str.

Figure 4 - Deformation of structures on the Lastochkina, 48 str.

a) b)

Figure 5 - Cracked asphalt pavement on the Sirko, 47 str. (a) and the position of observation points on a satellite map (b)

a) b)

Figure 6 - Deformations of the walls of the house (a) and the position of observation points on the satellite map (b)

In the area of the top of the Sirko ravine, deformation processes are also observed.

To establish the patterns of formation and predict the growth of ravines and gullies within the right-bank part of the Dnipro city and, in particular, the Sirko ravine, a tectonic map of the Serednoprydniprovskyi megablock was considered [7]. The dominant strike azimuths of deep-seated faults have been identified: 10 º -12º, 30º and 300º -305º, 40º -45º and 315º, 285º -290º, 325º -330º. Within the city, they find their manifestation in the form of the development of a ravine and gully system.

Further, according to the ENPEMF observational data, the flux density graphs were plotted, shown in Fig. 7 -8. So in fig. 7 shows a graph of the flux density ENPEMF on the first observation profile. The northeastern and southwestern parts of the observation profile (points 1-4, 8-9) are located in the upper parts of the sides of the ravine (the ENPEMF flux density is more than 20 conventional units (cu). The lowest values (less than 10 cu .) are confined to the ravine thalweg (5-7 observation points).

The second profile (Fig. 8) was passed from the northeastern side of the ravine to its thalweg, which is quite long at this point. At the upper point of the ravine side, the ENPEMF flux density is characterized by 18 cu. (observation point 1). In the thalweg area, across the strike of the ravine (observation points 2-9), the ENPEMF flux density sharply decreases to 2 cu - which can be explained by the confinement of the ravine thalweg to the watered part of the fault. As shown earlier, in the obtained copyright certificates, discontinuous faults are characterized by the lowest values of the flux density Fig. 7-8. Plots of flux density EIEMPZ on observation profiles across the strike of the Sirko beam. [8].

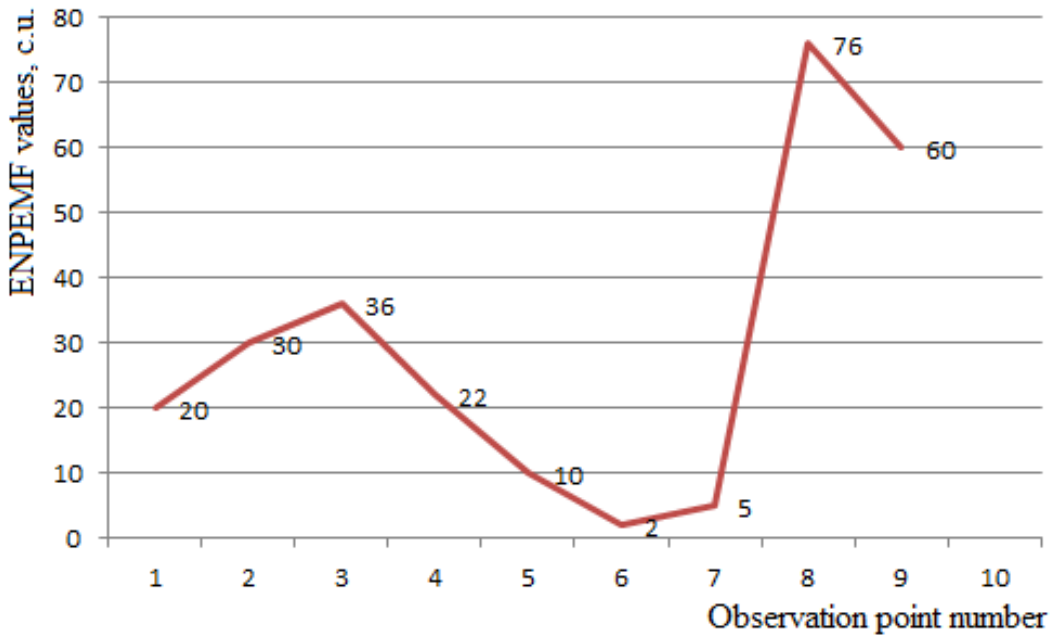

Figure 7 - Plots of flux density ENPEMF on 1 observation profile across the strike of the Sirko ravine

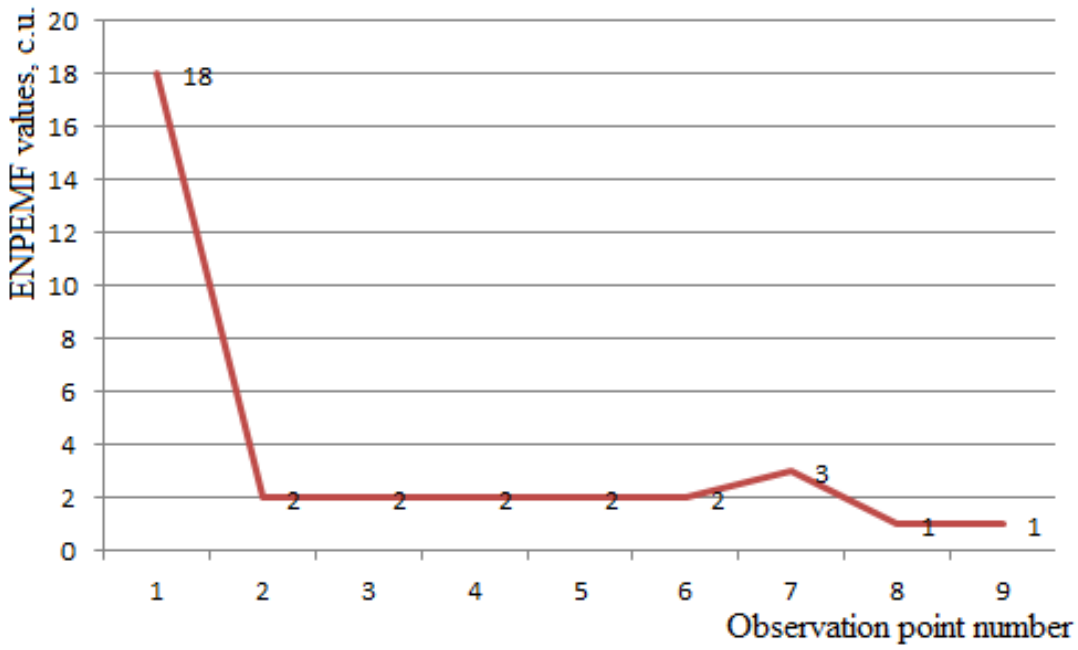

Figure 8 - Plots of flux density ENPEMF on 2 observation profile across the strike of the Sirko ravine

The data presented indicate that the Sirko ravine is confined to a deep fault, and its northeastern side is characterized by significantly higher values of the flux density ENPEMF. Taking into account the geological structure and active water cut and soaking of its slopes during maintenance, it is possible to predict the development of landslide phenomena in the territory of the observed areas.

Conclusion.

1. According to the observation results, a sharp decrease in the values of the flux density of the ENPEMF allows us to conclude that the slopes of the ravine are characterized by a high degree of landslide hazard.

2. To preserve the maintenance suitability of the north-eastern slope of the Sirko ravine, it is recommended to take measures to reduce its soaking capacity by organizing a centralized drainage system - sewer and storm water systems, as well as conducting an audit and, if necessary, repairing the water supply system.

3. With the future development of the Sirko ravine, it is recommended to carry out engineering and geological studies, including observations by the ENPEMF method to predict the development of further landslide processes.

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Про автора

Змієвська Крістина Олегівна, кандидат геологічних наук, науковий співробітник відділу проблем технологій підземної розробки вугільних родовищ, Інститут геотехнічної механіки ім. М.С. Полякова Національної академії наук України (ІГТМ НАН України), Дніпро, Україна, zmievskaja@gmail.com

Анотація. Метою дослідження було вивчення балки Сірко, що включає аналіз деформацій будівель і споруд, проведення спостережень методом природного імпульсного електромагнітного поля Землі для визначення можливості розвитку зсувних процесів на її схилах.

Вивчення балки Сірко та прилеглої до неї території проводилось шляхом рекогносцирувальних спостережень, в ході яких було виконано опис бортів балки, аналіз її забудови, наявність дренажної, водопідводної систем і, відсутність водовідвідної систем, а також перспективність її подальшого використання. Факторами, що зумовлюють розвиток зсувних процесів, є явища замочування за рахунок атмосферних опадів і витоків з системи водоподачі і відсутності лівнестокової і каналізаційної систем.

Розглянуто основні деформації будівель і споруд на бортах балки - розвиток тріщин на стінах будівель, огорож асфальтового і бетонного покриття. Наведено фотодокументацію, що підтверджує їх розвиток. Проведено зіставлення балки Сірко з порушеннями Середньопридніпровського мегаблоку. Показано, що азимут простягання балки Сірко збігається з азимутом простягання тектонічних порушень Середньопридніпровського мегаблоку.

З метою оцінки ступеня зсувонебезпечності її схилів, застосовувався оперативний геофізичний експрес-метод спостереження природного імпульсного електромагнітного поля Землі (ПІЕМПЗ). Спостереження проводились на вершині балки в районі пр. Гагаріна і в районі найбільш широкої частини її тальвегу. Наведено результати виконаних спостережень методом природного імпульсного електромагнітного поля Землі за двома профілями, пройденими вхрест простягання тальвегу балки, які свідчать про можливий розвиток зсувних деформацій її схилів. Результати дослідження дозволять при забудові схилів балки Сірко запобігти можливим деформаціям будівель і розвитку зсувних процесів, що виникають внаслідок замочування схилів балки.

Ключові слова: зсувонебезпечні процеси, деформації будівель, схили, природне імпульсне електромагнітне поле.

Аннотация. Целью исследования было изучение балки Сирко, включающее анализ деформации зданий и сооружений, проведение наблюдений методом естественного импульсного электромагнитного поля Земли для определения возможности развития оползневых процессов на ее склонах.

Изучение балки Сирко и прилегающей к ней территории проводилось путем рекогносцировочных наблюдений, в ходе которых было выполнено описание бортов балки, анализ ее застройки, наличие дренажной, водоподводящей систем и, отсутствие водоотводящей систем, а также перспективность ее дальнейшего использования. Факторами, обуславливающими развитие оползневых процессов, являются явления замачивания за счет атмосферных осадков и утечек из водоподающей системы и отсутствия ливнестоковой и канализационной систем.

Рассмотрены основные деформации зданий и сооружений на бортах балки – развитие трещин на стенах зданий, ограждений асфальтового и бетонного покрытий. Приведена фотодокументация, подтверждающая их развитие. Проведено сопоставление балки Сирко с нарушениями Среднеприднепровского мегаблока. Показано, что азимут простирания балки Сирко совпадает с азимутом простирания тектонических нарушений Среднеприднепровского мегаблока.

С целью оценки степени оползнеопасности ее склонов, применялся оперативный геофизический экспресс-метод наблюдения естественного импульсного электромагнитного поля Земли (ЕИЭМПЗ). Наблюдения проводились на вершине балки в районе пр. Гагарина и в районе наиболее широкой части ее тальвега. Приведены результаты выполненных наблюдений методом естественного импульсного электромагнитного поля Земли по двум профилям, пройденным вкрест простирания тальвега балки, которые свидетельствуют о возможном развитии оползневых деформаций ее склонов. Данные исследования позволят при застройке склонов балки Сирко предотвратить возможные деформации зданий и развития оползневых процессов, возникающих вследствие замачивания склонов балки.

Ключевые слова: оползнеопасные процессы, деформации зданий, склоны, естественное импульсное электромагнитное поле.

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