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ASSESSMENT OF FLOOD RISKS IN THE CONTEXT OF AGRICULTURAL LAND MANAGEMENT OF TERRITORIAL COMMUNITIES

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Abstract. *The implementation of the land reform and the introduction of the land market encourages the use of highly effective approaches to agricultural land management in the face of climate change. Agriculture is vulnerable to the effects of climate change due to the occurrence of extreme weather events, which lead to increased land degradation processes, such as water erosion and flood. In such circumstances the application of approaches to assessing the risk of flooding in the context of agricultural land management of the united territorial communities is relevant.*

Using the example of Slavske ATC and Skole ATC the flood risk assessment of the Opir River and the Stryi River (at the confluence of the Opir River) was carried out. The research was performed on the normative provisions of the national legislation of Ukraine, as well as Directive 2007/60 / EC and its guiding documents. The flood zones of the territories within Slavske ATC and Skole ATC the flood areas and the amounts of potential losses for agricultural lands under different flood scenarios have been established.

It is proposed to develop and implement a number of measures to minimize the negative effects and losses associated with flood. Prospects for the

application of the results of the development of land management documentation are considered.

Key words: *flood risk assessment, probability of exceedance, agricultural lands, Opir river, Slavske ATC, Skole ATC.*

Problem statement and its urgency. Land reform in Ukraine has conceptually changed the legislation of Ukraine in the field of land relations. The system of land relations management has changed, the legislation on land use planning has been transformed, the mechanism of transfer of agricultural land to territorial communities (TC) has been introduced, the unified methodology of normative monetary valuation of land plots has been approved and the most important that the land market in Ukraine was created.

Such circumstances in the context of decentralization reform in Ukraine open new perspectives for agricultural land use and TC land management. At the same time, new challenges are emerging in these areas, in particular in the areas of land protection, risk assessment of losses and damages due to land degradation. Agriculture is vulnerable to the effects of climate change due to the occurrence of extreme weather events [20], which exacerbate degradation processes.

According to reports from the World Meteorological Organization from 1850-1900, the average air temperature on the planet has risen by 1.2 ± 0.1 ° C (according to 2020). Depending on the volume of global greenhouse gas emissions in the coming years, further growth in average global air temperature is projected in the range of 1.5-4.3 ° C from pre-industrial levels by the end of the 21st century. In particular, it is expected that by 2040 climate change will lead to an increase in the average annual air temperature in Ukraine in the range of 0.8-1.1 ° C [20, 30]. However, according to the latest IPCC estimates, 1.0 ° C warming increases the amount of heavy rainfall (both daily and seasonal), which increases the serious risk of floods with a high probability. More intense

precipitation leads to redistribution of water between surface and groundwater in watersheds, as surface runoff increases, water supply in the soil decreases [25, 28]. Its leads to increased flooding and soil erosion, increased water stress for plants and reduced water safety. From the point of view of agriculture, this means increased dependence on irrigation and the need for water accumulation in reservoirs and ponds [25, 29].

Since there is a positive correlation between global warming and the risk of floods, in the future they will have a negative effect on soil cover, especially near rivers and floodplains [24, 25, 31]. According to estimates [20], in Ukraine in the near future we should expect redistribution of water runoff over time. We are talking about reducing the flow of spring water, which is the main part of the annual volume of river runoff, while increasing the frequency of rain floods, which cause catastrophic flooding of large areas and large economic losses. Accordingly, the need for an urgent solution to the problem of land degradation is urgent [6]. According to current estimates, about 69% of the land in Ukraine is degraded due to water. Almost 12% of Ukraine's lands are flooded, and about 57% of the territory is covered by erosion (water and wind), while water erosion affects 23.7% of agricultural land [1, 8, 13, 19]. With the total plowing of the territories of Ukraine as of 01.01.2020 - 54.27% (32757.3 thousand hectares) [23], and the degradation of 69% of the lands of Ukraine due to the harmful effects of water, there are gradual annual losses of humus in the arable layer, which are about 0.65 tons per hectare [1, 8]. According to estimates [5], "every year 11 million tons of humus, 500 thousand tons of nitrogen and 500 thousand tons of phosphorus and almost 7 million tons of potassium enter the reservoirs as a result of erosion."

In such circumstances, the field of agricultural land management should focus on approaches and methods of assessing and managing the risks of flooding, using modern survey methods [7]. In particular, such measures are provided by the National Action Plan to Combat Land Degradation and

Desertification [18], they were introduced in Ukraine by law [6], at the level of the Water Code of Ukraine (Article 1071) [2], after Ukraine signed the Association Agreement and implemented according to [10-12, 15, 16].

Analysis of recent research and publications. In Ukraine, the introduced approaches to flood risk assessment and management are fully transposed from the internal legal field of the European Union, namely from Directive 2007/60 / EU and its guiding documents [26, 27].

Given that the introduction of approaches to assessing and managing flood risks in Ukraine took place relatively recently, in 2016 [6], and the entire methodological framework was reduced to national legislation in 2018 [10-12, 16], important applied scientific There are not many works devoted to this topic in Ukraine.The greatest achievement in Ukraine in this area is the work of the Ukrainian SES of Ukraine and the National Academy of Sciences of Ukraine [21, 22], which have not yet been published for the general public and prepared in the form of scientific reports. Some aspects of UkrHMI's scientific research in the field of flood risk assessment and management, in particular the results of the preliminary flood risk assessment of Ukraine, are presented on the page of the SES of Ukraine [3], which implements state policy [2, 16, 17].

The vast majority of Ukrainian scientific literature contains publications that cover theoretical and practical aspects of testing the Directive 2007/60 / EU, analytical generalizations of its content and principles. There are also works conceptually related to the risks of flooding and devoted to flood risk and flood protection. Among others, we can highlight the constellation of works by O.M. Kozytsky, S.A. Shevchuk, I.A. Shevchenko, M.V. Yatsyuk, O.I. Kharlamov,

V.P. Kovalchuk, V.I. Petrochenko and other scientists IWPR NAAS of Ukraine, which have many years of experience in this field. And also works of scientists of Taras Shevchenko National University O.B. Obodovsky, V.V. Onyschuk, OI Lukyanets, scientists of ODEK V.A. Ovcharuk, researchers of

UkrHMI SES of Ukraine and NAS of Ukraine M.M. Susidko, L. O. Gorbacheva, Y.B. Nabyvanets, as well as scientists of IPMMS of NAS of Ukraine M. Y. Zheleznyak, S.L. Kivva. Regarding foreign authors, it is worth noting the important and interesting works of M. Z. Bálint, G. Blöschl, K. Breinl, C. Neuhold, D. Niehoff, C. Wobus, Z.W. Kundzewicz, and many others.

Taking into account the issues of agricultural land management, in particular in the context of land degradation, research in this area in Ukraine is presented in many ways in the scientific literature. Of course, it is worth noting the scientific work of the team of scientists of NULES L.A. Gunko, O.S. Dorosh, J.M. Dorosh, T.O. Evsyukova, I.L. Kupriyanchik, I.P. Kovalchuk, A.G. Martin, R.V. Tykhenko, R.A. Kharitonenko, and others, scientists of BNAU A.M. Tretyak, I.D. Prymak, I.P. Gamaliya, researchers of LNUP N.E. Stoyko, O.V. Stadnytska, and other specialists in land issues. Among foreign experts are the works of H. Posthumus, P. F. Quinn, J. Morris, C. J. M. Hewett, Z. Li, H. Fang, D. Favis-Mortlock, D. Mullen.

However, despite such an extensive list of publications devoted to this area, the issue of flooding, especially in the context of agricultural land management, is not given enough attention. There are almost no publications on flooded areas, on the structure of lands that are flooded, on the mechanisms of such floods and their threats. This problem is especially typical for Ukraine, where in the conditions of land market development there is a lack of information on the flooding of agricultural lands of the corresponding risks and potential losses from floods. Most likely, this is due to the complexity of the methodological apparatus of research on flooding and limited source information.

The aim of the study. Scientific analysis of the principles of flood risk assessment in the context of agricultural land management in the united territorial communities.

The main tasks of the work were:

- to assess the risks of flooding of the territories of Slavska TC and Skolivska TC (Pic. 1) and to develop layers of geospatial data of flood hazard maps (FHM) and flood risk maps (FRM) in accordance with the requirements of Ukrainian legislation;

- to analyze the effects of floods on agricultural lands of Slavska TC and Skolivska TC, to assess potential losses from floods in different scenarios;

- to propose measures to minimize the negative consequences of flooding of the territories of Slavska TC and Skolivska TC;

- consider the prospects of using the results.

Materials and methods of research. From the methodological point of view, the procedure of flood risk assessment, in the context of territorial management, in Ukraine is carried out on the basis of national water and land legislation according to the provisions [2, 10-12, 16], taking into account the requirements [26, 27]. In particular, the regulation of Article 1071 of the Water Code of Ukraine provides for the priority implementation of preliminary flood risk assessment (FRA) [11], development of FRM and FHM [10, 12], and development of Flood Risk Management Plan (FRMP) [16].

The implementation of the FRMP involves identifying areas that have potentially significant flood risks (PSFR). FRM and FHM are developed for PSFR which have high risk of flooding. FRM and FHM are developed according to the following flooding scenarios (HQ) [12]:

- flooding with a low probability of excess (security) - flooding, which can occur no more than once every 500 years (0.2%);

- flooding with an average probability of excess (security) - flooding, which can occur no more than once every 100 years (1%);

- flooding with a high probability of excess (security) - flooding, which can occur no more than once every 10 years (10%).

Flooding scenario (HQ) is a scenario of floods in which the corresponding water levels (H, m BS) and water flow (Q, m3 / s), a given probability of exceeding:

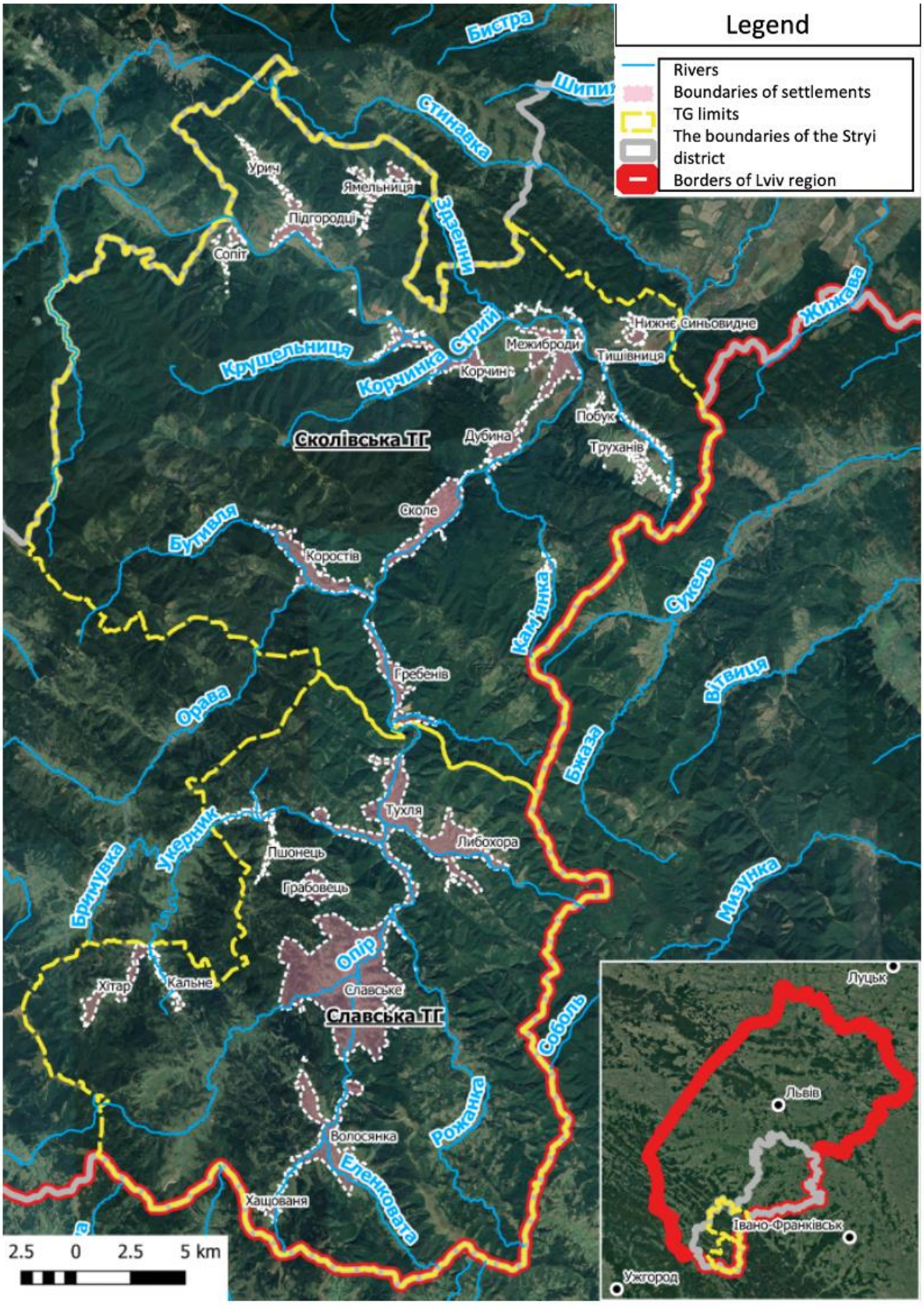
Two types of FRM and FHM are developed for each scenario [12]:

1) FRM (indicating the depth or levels of water; indicating the flow rate or other characteristics of the flow);

2) FHM (threat to people and possible losses from flooding; threat to the environment, cultural heritage and economic activities).

The development of FRM is based on the results of hydrodynamic modeling in accordance with the provisions of [12], according to the recommendations set out in [22]. The content of FHM is developed on the basis of FRM and according to estimates according to [10, 22]. In particular, the amount of potential losses (losses) from possible flooding is determined. Such potential losses are calculated for all nine land categories as a function of flood area [10, 22]. In particular, when agricultural lands are flooded due to heavy rainfall or river waters, there is a risk of delayed sowing, as well as soil compaction and crop loss due to anoxia or root disease [25]. Therefore, according to [10], when flooding agricultural land, the magnitude of potential damage depends only on the area of flooding, without taking into account the depth. Accordingly, the risk of such flooding is determined by the probability of exceeding according to [11]. In general, all categories of land in the flood zone are determined in the relevant scenario. Estimation of land plots of different purpose in flood zones, their number (N) and total area (A, ha) is carried out.

Picture 1 - Slavska TC and Skolivska TC



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And at the very end, the PSFR is being developed. It is performed based on the materials of the FRM and the analysis of the FHM. In particular, it develops a program of measures to implement the PSFR in order to reduce the potential

negative impact of flooding on human life, the environment, cultural heritage and economic activities [12], and consequently on agricultural land.

Work to determine the risks of flooding of agricultural lands Slavska TC and Skolivska TC was based on materials of the SES of Ukraine, UkrHMI SES of Ukraine and NAS of Ukraine, UkrHMC (database of automatic workplace monitoring of hydrological phenomena) (State Cadastre data 18.03.2021). The results and developments of the GEF / UNDP / OSCE / UNECE project "Promotion of Transboundary Cooperation and Integrated Water Resources Management in the Dniester River Basin" (field expedition materials, layers of geospatial relief data, etc.) were also used [3, 21, 22]. .

According to the results of surveys and SRS carried out by the SES of Ukraine on the basis of UkrHMI in 2018 [3, 21], 221 PSFR with a total length of 8748 km were identified in Ukraine. Of these, 86 PSFR (38.9% of all PSFR of Ukraine) are concentrated in the Dniester river basin (M5.2), their total length is 2903 km (33.2% of all PSFR of Ukraine). In particular, within the Slavska TC and Skolivska TC there are 9 PSFR of the Dniester river basin district, of which the largest PSFR is the Resistance River with a length of 61 km [3]. In determining the PSFR, the floods of previous years, their probabilities of exceeding, the extent of spread and the extent of damage were analyzed.

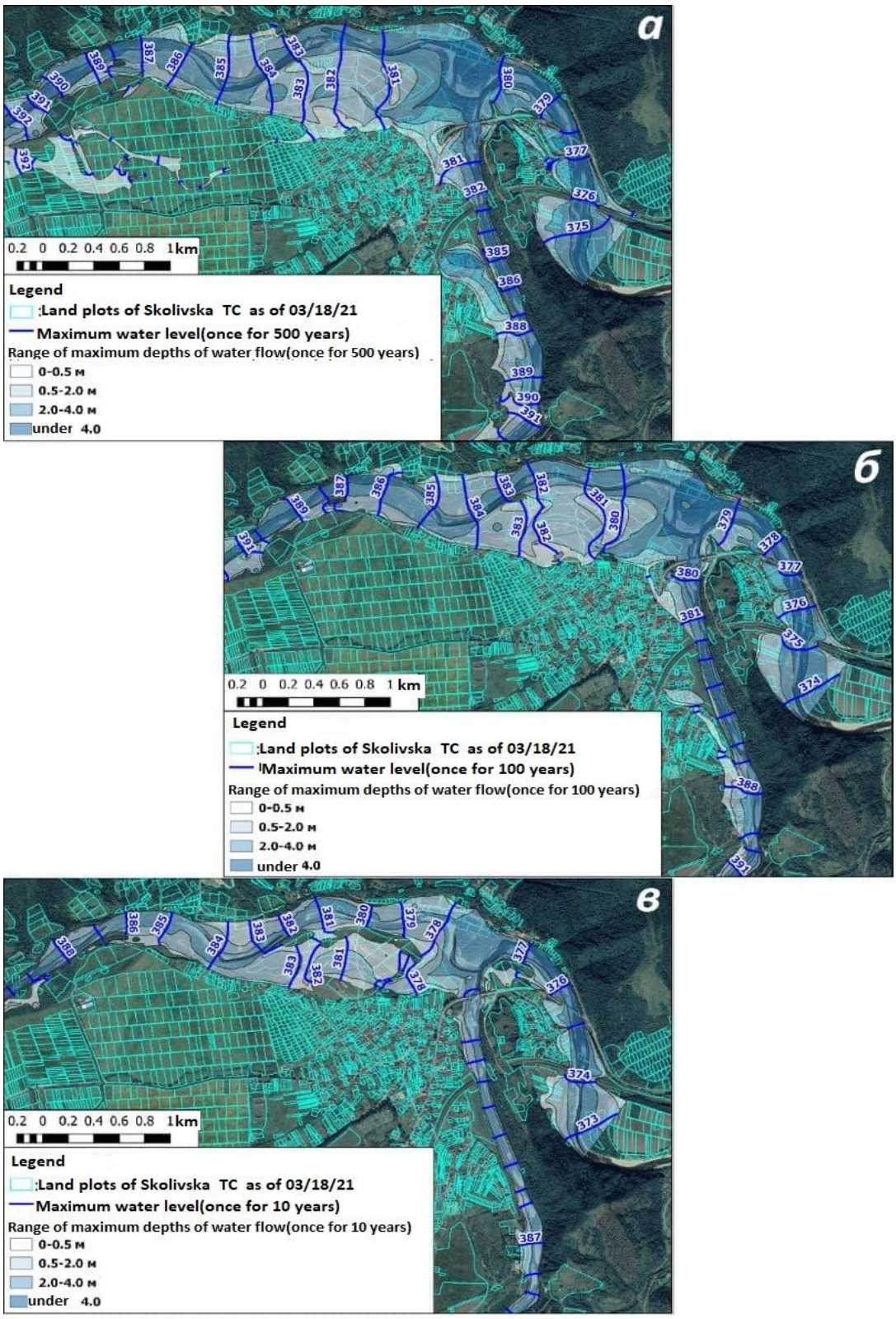
Topographic, geodetic and hydrometric surveys were carried out on 20 calculated representative sites (two of them on the Stryy River) for the development of FRM and FHM for PSFR. The results of the research are presented in [22] and were the basis of the digital terrain model (DTM), which was developed on the basis of topographic maps at a scale of 1: 10000 for the territory of Slavska TC and Skoliv TC. During the development of the DTM, digitization of characteristic significant relief elements (lowering and raising), as well as horizontal heights of terrain, hydraulic structures, bridges, railways and highways were performed. According to modern satellite images using

materials of topographic, geodetic and hydrometric surveys, vectorization of the relief of the coastal strip and the central axis of the channel was carried out, indicating the approximate absolute marks along the line. The developed DTM was the basis of the hydrodynamic model of river runoff, which was developed on the basis of the modeling complex HEC-RAS 6.1.0. Hydrodynamic modeling of floods for different scenarios was performed according to the calculated hydrographs of the maximum runoff of rain floods of 0.2%, 1.0% and 10.0% probability of exceeding.

Research results and their discussion. According to the results of hydrodynamic modeling, the HEC-RAS 6.1.0 modeling complex obtained layers of geospatial data (raster floors, vector geodata) on the distribution of flood zones, maximum depths of water flow due to flooding (m), maximum water flow velocities (m / s). and maximum water levels (m BS), for the resistance scenarios of the Opir HQ 0.2% (once every 500 years), 1.0% (once every 100 years) and 10.0% (once every 10 years) , the probability of exceeding**.**

According to the obtained layers of geospatial data on the distribution of flood zones in different scenarios, a spatial analysis of the state land cadastre (as of March 18, 2021) on land plots of different purposes Skolivska TC and Slavska TC was performed.

Spatial analysis found that due to different scenarios of flooding of the Opir River, within Skolivska TC and Slavska TC there are threats and risks of flooding of land plots of 31 types of purpose according to [11].



Picture 2 - Flood threat maps (maximum depths (m) and water levels (m BS)), under different scenarios (0.2% (a); 1.0% (b) and 10.0% (c) security)

In the table. 1 presents generalized results of spatial analysis of flood zones of Slavska TC and Skolivska TC by river waters of the Opir River, as well as the

number and total area of all land plots of different types of purpose within the zone according to each flood scenario.

Table 1 - Characteristics of flooding of territories and land plots of Slavska TC and Skolivska TC by river waters of the Opir river under different flood scenarios

The area of flooding by Opir river	HQ, %	The area of flood , h	Land in the flood zone	
			N	A, h
1	2	3	4	5
Slavska TC	0,2	331,1800	763	81,7984
	1,0	290,0498	667	66,2493
	10,0	211,6777	467	35,5123
Skolivska TC	0,2	926,2259	1179	257,6884
	1,0	774,6938	819	179,0464
	10,0	586,3226	481	111,1172
Total	**0,2**	**1257,4059**	**1942**	**339,4868**
	1,0	**1064,7437**	**1486**	**245,2957**
	10,0	**798,0002**	**948**	**146,6295**

In the table. 2 presents statistical data on flooding of land plots of different types of purpose under different flooding scenarios within the territory of Slavska TC and Skolivska TC. And summarized statistical data on flooding of land plots under different flooding scenarios by category of land according to [9] within the territory of Slavska TC and Skolivska TC are presented in table. 3. Total absolute and relative statistical indicators on flooding of land plots of different types of purpose by river waters of the Opir river under different flooding scenarios are set out in table. 4, and by land categories in accordance with [9] in table. 5.

According to the data (Table 2-5), in different scenarios of floods due to flooding of the Opir River within the territory of Slavska TC and Skolivska TC, lands of almost all categories, except for historical and cultural purposes (G), fall.

The most affected by floods within the territory of Slavska TC and Skolivska TC in all flood scenarios are agricultural lands. They make up almost

half of all lands flooded by the Opir River in all water scenarios in terms of quantity and total area (Tables 3, 5). It should be noted that agricultural lands within the territorial communities under study are slightly more than 25% (Table 6).

In particular, among agricultural lands, according to the data (Tables 2, 4), the affected areas under different flood scenarios within the territory of Slavska TC and Skolivska TC include lands with special purpose:

01.01 - For conducting commodity agricultural production;

01.02 - For farming;

01.03 - For personal farming;

01.05 - For individual gardening.

Among them, the largest number of land plots of agricultural land are land plots formed for personal farming (01.03). Their share in the total structure of lands flooded within Slavska TC and Skoliv TC exceeds 30%, both in number and area (Table 4).

These are the estimates of the spatial analysis of potential land floods within the Skolivska TC and Slavska TC under different scenarios of flooding of the Opir River.

But, among other things, this spatial analysis does not reveal the content of all threats of such floods, does not provide an understanding of the mechanisms of flooding and the extent of damage. This requires generalized data on the distribution of maximum depths of water flow (m) and maximum water flow velocities (m / s), within Skolivska TC and Slavska TC during flooding of rivers by river waters of the Opir River and the Stryy River at the confluence of the river. Opir), in different scenarios, which are presented in table. 7.

Table 2 - Statistical data on flooding of agricultural land and in total together with other types of purpose under different flood scenarios within the territory of Slavska TC and Skolivska TC

C/P code	Characteristics of land plots in flood zones											
	Flooding 0.2% PE (flooding once every 500 years)				Flooding of 1.0% of the SP (flooding once every 100 years)				Flooding 10.0% of the SP (flooding once every 10 years)			
	Slavska TC		Skolivska TC		Slavska TC		Skolivska TC		Slavska TC		Skolivska TC	
	N	A, ha	N	A, ha	N	A, ha	N	A, ha	N	A, ha	N	A, ha
1	2	3	4	5	6	7	8	9	10	11	12	13
01.01	0	0	**137**	**37,9335**	0	0	**24**	**5,5892**	0	0	**11**	**1,5832**
01.02	0	0	**1**	**0,0707**	0	0	**1**	**0,0622**	0	0	0	0
01.03	**313**	**28,6001**	**291**	**93,9974**	**269**	**23,1813**	**228**	**77,0376**	**205**	**13,1488**	**145**	**50,5029**
01.05	**64**	**5,4879**	**125**	**8,7456**	**63**	**5,3007**	**113**	**7,5317**	**43**	**3,0514**	**86**	**5,0596**
Total	**763**	**81,7984**	**1179**	**257,6884**	**667**	**66,2493**	**819**	**179,0464**	**467**	**35,5123**	**481**	**111,1172**

Table 3 - Statistics on flooding of land plots by land category [9] under different flood scenarios within the territory of Slavska TC and Skolivska TC

Land category (section)	Characteristics of land plots in flood zones											
	Flooding 0.2% PE (flooding once every 500 years)				Flooding of 1.0% of the SP (flooding once every 100 years)				Flooding 10.0% of the SP (flooding once every 10 years)			
	Slavska TC		Skolivska TC		Slavska TC		Skolivska TC		Slavska TC		Skolivska TC	
	N	A, ha	N	A, ha	N	A, ha	N	A, ha	N	A, ha	N	A, ha
1*	2	3	4	5	6	7	8	9	10	11	12	13
A	377	34,0880	554	140,7472	332	28,4820	366	90,2206	248	16,2001	242	57,1456
B	296	27,7651	517	41,6162	248	20,5926	364	26,2600	148	7,5113	172	11,5699
C	1	0,4789	6	38,5155	1	0,4336	6	34,9422	1	0,3379	6	26,5786
D	0	0	2	0,5405	0	0	2	0,4560	0	0	1	0,0557
E	44	6,3161	9	3,1739	43	6,0782	8	2,1767	30	4,3223	7	1,8298
G	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
H	4	0,5169	2	0,6204	4	0,4575	1	0,2796	4	0,3664	1	0,0001
I	2	0,6919	1	2,8990	2	0,5324	1	2,3220	2	0,4428	1	0,3111
J	35	10,9730	47	13,8677	33	9,1272	37	9,6074	31	6,1216	26	4,6758
K	4	0,9687	41	15,7079	4	0,5459	34	12,7821	3	0,2099	25	8,9506
Total	**763**	**81,7984**	**1179**	**257,6884**	**667**	**66,2493**	**819**	**179,0464**	**467**	**35,5123**	**481**	**111,1172**

According to the data analysis (Tables 2-5, 7), the threat of flooding of the Opir River and the Stryi River (at the confluence of the Opir River) was assessed under different flood scenarios within Slavska TC and Skolivska TC..

Table 4 - Total absolute and relative statistics on flooding of agricultural land and total together with other types of destination in different flood scenarios

C/P	Characteristics of land plots in flood zones											
	Flooding 0.2% PE (flooding once every 500 years)				Flooding of 1.0% of the SP (flooding once every 100 years)				Flooding 10.0% of the SP (flooding once every 10 years)			
	N	% from N	A, ha	% from A	N	% from N	A, ha	% from A	N	% from N	A, ha	% from A
1	2	3	4	5	6	7	8	9	10	11	12	13
01.01	137	7,05	37,9335	11,17	24	1,62	5,5892	2,28	11	1,16	1,5832	1,08
01.02	1	0,05	0,0707	0,02	1	0,07	0,0622	0,03	0	0	0	0
01.03	604	31,10	122,5975	36,11	497	33,45	100,2188	40,86	350	36,92	63,6516	43,41
01.05	189	9,73	14,2335	4,19	176	11,84	12,8324	5,23	129	13,61	8,1109	5,53
Total	**1942**	**100**	**339,4868**	**100**	**1486**	**100**	**245,2957**	**100**	**948**	**100**	**146,6295**	**100**

Table 5 - Total absolute and relative statistics on flooding of land plots of different land categories [9] by river waters of the Opir River under different flooding scenarios

Land category (секція)	Characteristics of land plots in flood zones											
	Flooding 0.2% PE (flooding once every 500 years)				Flooding of 1.0% of the SP (flooding once every 100 years)				Flooding 10.0% of the SP (flooding once every 10 years			
	N	% from N	A, ha	% from A	N	% from N	A, ha	% from A	N	% from N	A, ha	% from A
1	2	3	4	5	6	7	8	9	10	11	12	13
A	931	47,94	174,8352	51,50	698	46,97	118,7026	48,39	490	51,69	73,3457	50,02
B	813	41,86	69,3813	20,44	612	41,18	46,8526	19,10	320	33,76	19,0812	13,01
C	7	0,36	38,9943	11,49	7	0,47	35,3758	14,42	7	0,74	26,9165	18,36
D	2	0,10	0,5405	0,16	2	0,13	0,4560	0,19	1	0,11	0,0557	0,04
E	53	2,73	9,4900	2,80	51	3,43	8,2549	3,37	37	3,90	6,1521	4,20
G	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
H	6	0,31	1,1373	0,33	5	0,34	0,7370	0,30	5	0,53	0,3665	0,25
I	3	0,15	3,5909	1,06	3	0,20	2,8543	1,16	3	0,32	0,7539	0,51
J	82	4,22	24,8407	7,32	70	4,71	18,7346	7,64	57	6,01	10,7974	7,36
K	45	2,32	16,6765	4,91	38	2,56	13,3279	5,43	28	2,95	9,1605	6,25
Total	**1942**	**100**	**339,4868**	**100**	**1486**	**100**	**245,2957**	**100**	**948**	**100,**	**146,6295**	**100,00**

Table 6 - Structure of lands and agricultural lands of Slavska TC and Skolivska TC of Stryj district of Lviv region (according to data as of 31.12.2015 [14] [determined by the proportional ratio of lands and lands of the former Skoliv district of Lviv region))

Land fund by type of land	**Slavska TC**	**Skolivska TC**	% by all lands	% by all agricultural lands
1	2	3	4	5
Total land area	42993	58117	100,00	
Agricultural lands	10796	14593	25,11	
Agricultural land	10638	14380		100,00
Arable	3771	5098		35,45
Hayfields	3887	5255		36,54
Pastures	2927	3957		27,52
Perennial plantings	52	70		0,49
Non Agricultural lands	158	214		
Forest lands	30651	41433	71,29	
Built-up land	900	1217	2,09	
Wetlands	8	11	0,02	
Open lands without vegetation or with little vegetation	311	420	0,72	
Water fund lands	327	443	0,76	
TOTAL	42993	58117	100,00	100,00

Threats of flooding. According to Table 1, as a result of flooding by river waters of the Opir River, as well as the Stryy River (at the confluence of the Opir River), lands within the Skoliv TC are most affected by flood waters. Within the Slavska TC, there are relatively fewer lands at risk of potential flooding. The disproportion is primarily due to the overall size of territorial communities. The area of Skolivska TC is about 58117 ha, and Slavska TC 42992 ha (Table 6). It is also due to the geomorphological features of the Opir river valley. Skoliv City Territorial Community is located downstream of the Opir River in relation to the territories of the Slavska Village Territorial Community. In the upper reaches, the valley of the Opir River is narrower, 200-500 m wide. The Upper River floodplain. The width of the channel in this area in the border period varies in the range of 3.5-21.5 m, the average depth at this time is from 0.09 m at the top (village Oporets) to 0.5 m at the boundary of the TC, in area with. Lower End (northern part of Slavska TC). In the lower

reaches, the Opir Valley widens significantly, in some places reaching a width of 1500-2000 m. The width of the channel in the range varies in the range of 15-55 m, and the average depth varies in the range of 0.3-0.5 m.

Table 7 - Generalized data on the distribution of maximum depths of water flow (m) and maximum water flow velocities (m / s), within the Slavska TC and Skoliv TC during flooding of rivers with river waters of the Opir River under different flood scenarios

Areas are covered by water flow with different depths and speeds, ha							
Ranges of maximum depths, m	Flooding with different probabilities of exceeding			Maximum speed ranges, m / s	Flooding with different probabilities of exceeding		
	0,2%	1,0%	10,0%		0,2%	1,0%	10,0%
1	2	3	4	5	6	7	8
Slavska TC							
0-0,5	51,1245	52,7398	48,3884	0-0,5	25,6409	22,7313	20,0409
0,5-2,0	131,8873	122,3606	100,7428	0,5-1,0	43,0118	43,8116	37,7635
2,0-4,0	100,8363	84,9414	60,4232	1,0-2,0	110,2190	104,4860	86,5033
понад 4,0	47,3319	30,0080	2,1232	понад 2,0	152,3082	119,0200	67,3699
Total	**331,1800**	**290,0498**	**211,6777**	**Total**	**331,1800**	**290,0489**	**211,6777**
Skolivska TC							
0-0,5	149,4407	103,2819	110,0045	0-0,5	139,9679	79,2216	79,7295
0,5-2,0	270,7894	254,1727	203,7289	0,5-1,0	115,7283	110,5995	101,6522
2,0-4,0	263,8555	248,0639	236,7623	1,0-2,0	254,0737	236,7797	184,8063
понад 4,0	242,1403	169,1753	35,8269	понад 2,0	416,4561	348,0931	220,1346
Total	**926,2259**	**774,6938**	**586,3226**	**Total**	**926,2259**	**774,6939**	**586,3226**
The whole area is flooded by the waters of the Opir River							
0-0,5	200,5652	156,0218	158,3929	0-0,5	165,6088	101,9529	99,7704
0,5-2,0	402,6767	376,5333	304,4718	0,5-1,0	158,7401	154,4111	139,4157
2,0-4,0	364,6918	333,0053	297,1855	1,0-2,0	364,2927	341,2657	271,3096
понад 4,0	289,4721	199,1833	37,9501	понад 2,0	568,7643	467,1131	287,5045
Total	**1257,4059**	**1064,7437**	**798,0002**	**Total**	**1257,4059**	**1064,7428**	**798,0002**

Such hydromorphological circumstances determine the conditions of land use in different ways, as well as the course of the formation and passage of floods and flooding of territories, which they cause within these territorial communities. However, this determines the threat of such floods.

Threats of flooding of high probability. In particular, during floods with a high probability (10.0% probability of exceeding), which occur once every 10 years by the waters of the Opir River and the waters of the Stryi River, about 798,0002 ha of land are flooded at the confluence of them (Table 1). In

particular, up to 586.3226 ha are flooded within Skolivska TC, and up to 211.6777 ha within Slavska TC.

During the flooding of the Opir River, most of the land is flooded with a depth range of 0.5 to 2.0 m, about 304.4718 hectares. Within the Slavska settlement territorial community, up to 100.7428 ha are flooded with such depths, which is almost half of the flooding area within the community. But within the Skole TC most of the territory is threatened by flooding with a layer of water from 2.0 to 4.0 m, namely 236.7623 hectares.

It should also be noted that in most areas of flooding of the Opir River due to high probability flooding, maximum flow velocities above 2 m / s will be observed. The total area of the site with such maximum speeds will be 287.5045 ha, in particular within Skolivska TC 220.1346 ha. In this case, the maximum flow velocities above 6 m / s will be recorded on the dynamic flow axis. They will be observed in places of narrowing of the channel corridor, mainly in the areas of bridge crossings. Within the Slavska TC, the largest area will be covered by water flow with speeds in the range from 1.0 to 2.0 m / s, namely 86.5033 ha (Table 7).

Due to the flooding of 798,0002 hectares of land, under the scenario of high probability, 948 land plots of various purposes fall into the affected area (as of March 18, 2021). Of these, 460 (51.69%) are agricultural land plots. Almost the same number of land plots within Slavska TC and Skolivska TC is at risk of flooding, 467 (248 agricultural land) and 481 (242 agricultural land) land plots, respectively (Tables 1, 3). The total area of land under threat of flooding during the flood 10.0% probability of exceeding is 146.6295 hectares. At the same time, the largest total area is occupied by land plots of Skolivska TC, up to 111.1172 ha of lands of formed land plots are flooded there, and 35.5123 ha are flooded within Slavska TC (Table 1).

Among agricultural land plots, the largest in the flood zone is the land with the purpose of 01.03 - for personal farming, namely, 350 land plots (36.92% of

the total). The total area of flooding of land plots for personal farming is 63.6516 ha (43.41% of the total area) as a result of flooding by river waters of the Opir River. At the same time within the Slavska TC in the zone of high probability flooding there are 205 land plots for personal farming, with a total area of 13.1488 ha, and within the Skoliv TC 145 land plots of similar purpose, with a total area of 50.5029 ha (Table. 2).

Threats of flooding of medium probability. During the floods of medium probability (1.0% probability of exceeding), which occur once every 100 years, the river waters of the Opir River flood about 1064.7437 hectares of land. Of these, most of the areas at risk of flooding are within the Skoliv TC - 774.6938 ha, and within the Slav TC 290.0498 ha (Table 1).

Under this scenario, flooding of the territory with the waters of the Opir River, the largest land area, namely 376.5333 hectares, will be covered by a layer of water in the range of 0.5 to 2.0 m. 3606 ha, and within the Skole TC 254.1727 ha.

In turn, the maximum water flow velocities, in particular, more than 2 m / s, will be observed on the area of 467.1131 ha (Table 7). For the most part, such a strong flow will prevail in most areas in the zone of average probability of flooding within Skolivska TC - 348.0931 ha, and within Slavska TC - 119.02200 ha. At the sections of bridge crossings, the maximum flow velocities will be over 7 m / s.

Among 1,064.7437 hectares of potential flooded areas in the scenario of flooding by river waters of the Opir of average probability, 1486 land plots of various purposes fall into the flood zone (as of March 18, 2021). Their total area is 245.2957 hectares. In this context, 667 land plots (66.2493 ha) and 819 land plots (179.0464 ha) fall within the 1.0% probability of flooding within the Slavska TC.

The vast majority of land plots at risk of flooding of medium probability are agricultural plots, 698 land plots (46.97% of the total). The area of flooding

of land plots of agricultural lands will be 118.7026 ha or 48.39% of the area of all land plots in this flood zone. In particular, in Slavska TC the Opir River during floods with a 1.0% probability exceeds the risk of flooding 332 land plots with a total area of 28.4820 ha, and in Skolivska TC 366 land plots with a total area of 90.2206 ha (Tables 3, 5).

Detailing the flooding of agricultural lands by the river waters of the Opir River in the scenario of medium probability, it should be noted that the vast majority at risk of flooding - land with a purpose 01.03: for personal farming. Their number among the total structure of lands within the zone of 1.0% probability of exceeding is 497 land plots (33.45%), and the total area is 100.2188 ha (40.86%). At the same time, the largest number of land plots allocated for personal farming is located in the zone of flooding of average probability within the Slavska TC - 269 land plots with a total area of 23.1813 hectares. In Skolivska TC 228 land plots with such a purpose are threatened with flooding, although their total area is more than twice, and is 77.0376 ha.

Threats of flooding of low probability areas. As a result of flooding in the low probability scenario (0.2% probability of exceeding), which occurs once every 500 years, the river waters of the Opir River flood about 1257.4059 hectares of land. According to this flood scenario, the largest area of areas at risk of flooding is within the Skoliv TC - 926.2259 ha, and within the Slav TC 331.1800 ha (Table 1).

During a flood with a 0.2% probability of exceeding the resistance in the floodplains of the Opir River, the predominant maximum depths will be in the range from 0.5 to 2.0 m. The area of land covered by the water layer in this range will be 402.6767 ha. In particular, within the territory of Slavska TC the area of flooding by a layer of water in the range from 0.5 to 2.0 m will be about 131.8873 ha, and in Skolivska TC 270.7894 ha (Table 7).

The speed regime of water flow in the scenario of flooding of territories by Opir river waters e of low probability will be marked by the predominance of

areas with speeds over 2 m / s, their total area will be 568.7643 ha. The area of land that will be marked by flooding with a maximum water flow velocity of more than 2 m / s within the Slavska TC in the low probability scenario will be 152.3082 ha, and within the Skoliv TC - 416.4561 ha. In general, the maximum water flow velocities of the Opir River in the scenario of flooding of low-probability areas in some areas will be more than 8 m / s. Under such hydraulic conditions, the vast majority of flood protection infrastructure is likely to be destroyed. Accordingly, land flood areas and flood depths will differ significantly.

In the general zone of flooding of the river waters by the river Opir, according to the flood scenario, 0.2% of the probability of exceeding, which will be about 1257.4059 ha, falls 1942 land plots of various purposes (as of 18.03.2021). Their total area will be 339.4868 hectares. Directly within the Slavska TC, under the low probability scenario, there is a threat of flooding of 763 land plots with a total area of 81.7984 ha. In Skolivska TC, respectively, 1179 land plots of various purposes are under the threat of low probability of flooding, their total area in the flood zone is 257.6884 ha.

Most of the land plots in the low probability flood zone belong to the categories of agricultural lands, namely 931 land plots (47.94% of the total). Their total area will be about 174.8352 hectares (51.50% of the total land area in the flood zone). In particular, during a flood of 0.2% probability of exceeding within the Slavska TC there is a threat of flooding by river waters of the Opir River 377 land plots of agricultural land with a total area of 34.0880 hectares. In turn, within the Skolivska TC 554 plots with a total area of 140.7472 ha fall into the zone of low probability of flooding..

The vast majority of land plots of agricultural land in the zone of low probability of flooding for the intended purpose 01.03 - for personal farming. Their total number is 604 (31.10% of the total), and the area of land for personal farming in the zone of threat of flooding 0.2% probability of exceeding is

122.5975 hectares. Of these, 313 land plots (28.6001 ha), with the purpose of 01.03 - for personal farming, is located within the Slavska TC. Within the Skoliv TC, 291 land plots (93.9974 ha) fall into the flood flood zone with a 0.2% probability of excess, with the purpose of 01.03 - for personal farming.

Risks of flooding. Determining the risks of flooding of agricultural lands within Skolivska TC and Slavska TC was performed based on the results of flood threat analysis of the Opir River and Stryj rivers (at the confluence of the Opir River), under different flood scenarios. According to the provisions of [10, 12], taking into account the indicators of regulatory monetary valuation (RMV), agricultural land (Table 8), determined the size of potential losses from flooding of agricultural land for different purposes in different flood scenarios (Table 9-11). Based on the obtained results, created layers of geospatial data for FHM with the established levels of risks of flooding of land plots of agricultural lands of different purposes (Fig. 3).

Table 8 - Indicators of RVMs of agricultural lands in Lviv region as of 01.01.2020 (UAH per hectare) [4]

Land	Arable land, fallows	Perennial plantings	Perennial plantations	Pastures
1	2	3	4	5
RVM	21492,00	27091,21	5797,63	4089,95

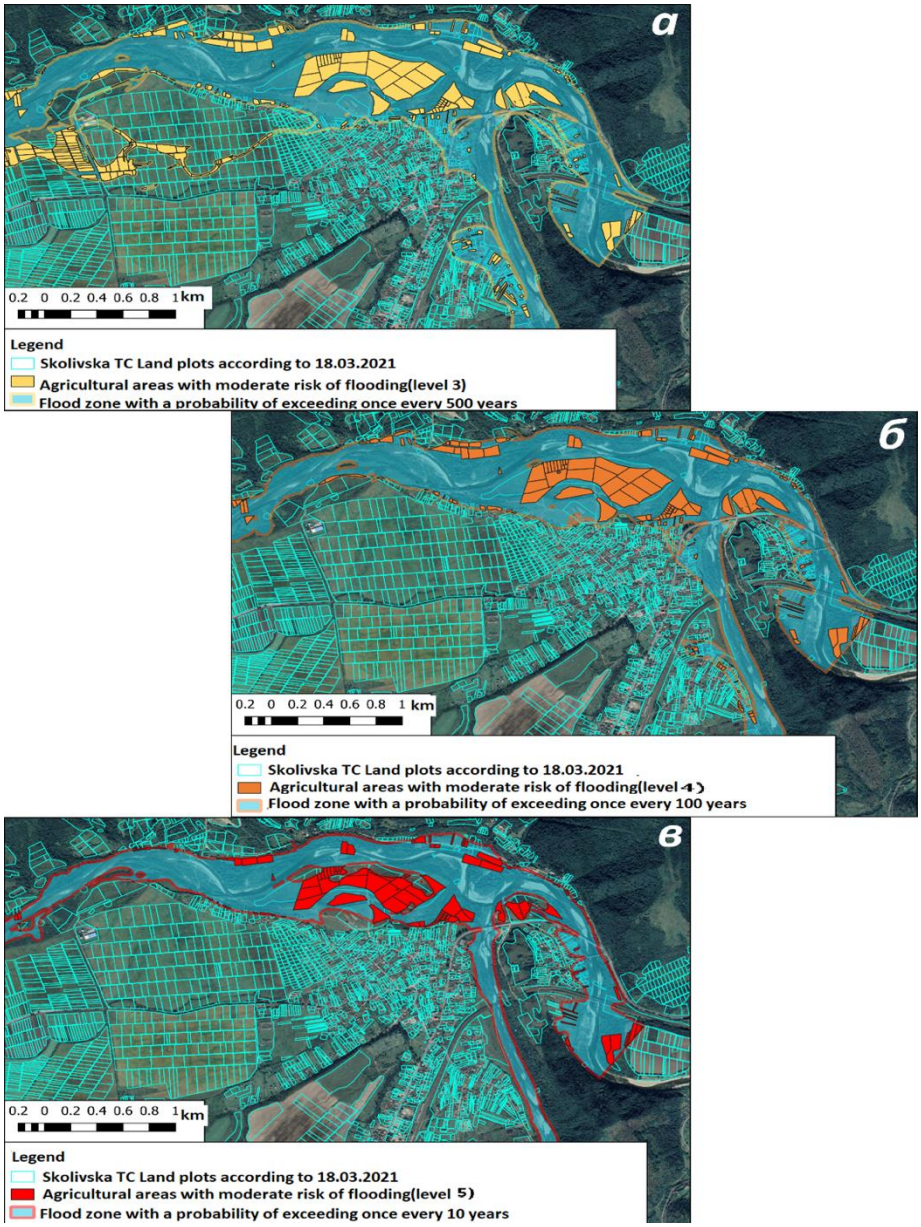
When calculating the amount of potential losses from flooding of agricultural land for different purposes in different flood scenarios, the indicators of RVM for the following types of agricultural land in relation to the purpose were taken into account:

- Arable land, fallows (01.01; 01.02; 01.03) [9];

- Perennial plantings (01.05) [9].

According to the data (Table 9), there is a very high risk of flooding of land plots of agricultural land for various purposes, which are flooded in the scenario of high probability. The amount of potential losses from flooding of land plots with very high risk is UAH 1.621 (Table 9, 10).

Land plots have a high risk of flooding, which is likely to exceed 1.0% of the probability of flooding during a flood, acccording to the medium probability scenario. The amount of potential losses from flooding of land plots at high risk of flooding within Slavska TC and Skolivska TC totals UAH 2.6230 million (Tables 9, 10).



Picture 3 - Flood risk maps (agricultural land plots), in different scenarios (0.2% (a); 1.0% (b) and 10.0% (c) security)

Table 9 - Potential losses from flooding of land plots of agricultural lands of different purpose according to the codes of DPAC[9] under different scenarios of flooding by river waters of the Opir River

HQ, %	Risk level	**D PAC code** [9]	Area of zones flooding, ha	Land in the flood zone		Land plots (s / d), agricultural purposes in the flood zone and potential losses		
				N	A, ha	N	A, га	Potential losses from flooding, UAH million
1	2	3	4	5			6	7
0,2%	moderate (3)	01.01	**1257,4059**	**1942**	**339,4868**	137	37,9335	0,8153
		01.02				1	0,0707	0,0015
		01.03				604	122,5975	2,6349
		01.05				189	14,2335	0,3856
		Total				**931**	**174,8352**	**3,8372**
1,0%	high (4)	01.01	**1064,7437**	**1486**	**245,2957**	24	5,5892	0,1201
		01.02				1	0,0622	0,0013
		01.03				497	100,2188	2,1539
		01.05				176	12,8324	0,3476
		Total				**698**	**118,7026**	**2,6230**
10,0 %	extreme (5)	01.01	**798,0002**	**948**	**146,6295**	11	1,5832	0,034
		01.02				0	0	0
		01.03				350	63,6516	1,368
		01.05				129	8,1109	0,2198
		Total				**490**	**73,3457**	**1,6218**

Table 10 - Potential losses from flooding of agricultural lands of different purpose according to the codes of the DPAC [9] within the Slavska TC and Skoliv TC under different scenarios of flooding by river waters of the Opir River

HQ, %	**DPAC code** [9]	**Slavska TC**				**Skoliv TC**			
		Area of zones flooding, ha	N	A, ha	Potential losses from flooding, UAH million	Area of zones flooding, ha	N	A, ha	Potential losses from flooding, UAH million
1	2		3	4	5		6	7	8
0,2%	01.01	331,1800	0	0	0	926,2259	137	37,9335	0,8153
	01.02		0	0	0		1	0,0707	0,0015
	01.03		313	28,6001	0,6147		291	93,9974	2,0202
	01.05		64	5,4879	0,1487		125	8,7456	0,2369
	Total		**377**	**34,0880**	**0,7633**		**554**	**140,7472**	**3,0739**
1,0%	01.01	290,0498	0	0	0	774,6938	24	5,5892	0,1201
	01.02		0	0	0		1	0,0622	0,0013
	01.03		269	23,1813	0,4982		228	77,0376	1,6557
	01.05		63	5,3007	0,1436		113	7,5317	0,2040
	Total		**332**	**28,4820**	**0,6418**		**366**	**90,2206**	**1,9812**
10,0 %	01.01	211,6777	0	0	0	586,3226	11	1,58316	0,0340
	01.02		0	0	0		0	0	0
	01.03		205	13,1488	0,2826		145	50,5029	1,0854
	01.05		43	3,0514	0,0827		86	5,0596	0,1371
	Total		**248**	**16,2001**	**0,3653**		**242**	**57,1456**	**1,2565**

Moderate flood risk is characterized by land flooding in the low probability scenario. The amount of potential losses from flooding of land plots at high risk of flooding within Slavska TC and Skolivska TC totals UAH 3.8372 million (Tables 9, 10).

The largest losses in different scenarios of flooding by the Opir River and the Stryi River (at the confluence of the Opir River) within the Slavska TC and Skolivska TC were marked by land plots intended for 01.03 - for personal farming. This is due to their significant distribution within flood zones in different scenarios.

In particular, the size of potential losses from flooding of river lands of agricultural lands within the Slavska TC is:

- UAH 0.7633 million in the low probability flooding scenario;
- UAH 0.6418 million in the scenario of medium probability flooding;
- UAH 0.3653 million under the high probability flooding scenario.

Within the Skole TV, the amount of potential losses from flooding of agricultural lands by river waters is:

- UAH 3.0739 million under the low probability flooding scenario;
- UAH 1.9812 million in the scenario of medium probability flooding;
- UAH 1.2565 million under the high probability flooding scenario.

Given the results of the analysis, the location of agricultural land within the flood zones of different scenarios of threats and risks of flooding, it is worth proposing a number of measures to minimize the negative effects of harmful effects of water on them. In particular, such measures may be:

- development and implementation of working land management projects for the construction of anti-erosion hydraulic structures, taking into account maps of threats and risks of flooding;

- development of working land management projects for the creation of protective forest plantations, taking into account maps of threats and risks of flooding.

Also, information on possible flood zones in different scenarios can be used to develop such land management documentation as comprehensive spatial development plans of territorial communities, in particular, Slavska TC and Skoliv TC. In addition, operating a list of all land plots within the flood zones of the Opir River and the Stryi River (at the confluence of the Opir River), different scenarios for clarifying RMV.

Conclusions and prospects. The urgency of the application of flood risk assessment in the context of agricultural land management of the united territorial communities is due to both socio-economic and natural challenges of today. The implementation of land reform and the introduction of the land market encourages the introduction of highly effective approaches to agricultural land management in the context of climate change. Agriculture is vulnerable to the effects of climate change due to the occurrence of extreme weather events, which lead to increased land degradation.

On the example of Slavska TC and Skolivska TC, the risk of flooding of the Opir River and Stryj rivers (at the confluence of the Opir River) was assessed, based on the regulations of the national legislation of Ukraine, as well as Directive 2007/60 / EU and guidelines to her. The zones of flooding of the territories within Slavska TC and Skolivska TC and the areas of the respective floods under different scenarios have been established. In particular, the river waters of the Opir River, as well as the Stryi River (at the confluence of the Opir River) floods about 1257.4059 ha of land in the low probability scenario. Under the medium probability scenario, about 1,064.7437 ha are flooded, and under the high probability scenario, 798,0002 ha. Within the flood zone, 931 plots of agricultural land with a total area of 174.8352 ha and the amount of potential losses from flooding of UAH 3.8372 million are under moderate risk.

698 plots of agricultural land with a total area of 118.7026 and a potential flood loss of UAH 2.6230 million are at high risk of flooding. Very high risk of flooding by the Opir River and the Stryi River (at the confluence of the Opir River) within the Slavska TC and Skolivska TC is characterized by 490 plots of agricultural land with a total area of 73.3457 ha and the amount of potential flood losses 1, UAH 6,218 million.

Taking into account the results of the analysis of the location of agricultural land within the flood zones of different scenarios, the threats and risks of flooding, the development and implementation of land management projects for the construction of anti-erosion hydraulic structures, the creation of protective plantations based on flood and hazard maps. The prospect of applying the results of work for the development of comprehensive plans for spatial development of Slavska and Skoliv territorial communities or in the revision of RMV was also considered. The obtained results can be used and implemented in the development and implementation of the Flood Risk Management Plan of the Dniester River Basin District.

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ОЦІНКА РИЗИКІВ ЗАТОПЛЕННЯ ТЕРИТОРІЙ В КОНТЕКСТІ УПРАВЛІННЯ СІЛЬСЬКОГОСПОДАРСЬКИМИ ЗЕМЛЯМИ ТЕРИТОРІАЛЬНИХ ГРОМАД

Реалізація земельної реформи та запровадження ринку землі спонукає до використання високоефективних підходів управління сільськогосподарськими землями в умовах кліматичних змін. Сільське господарство є вразливим до впливів зміни клімату через виникнення екстремальних погодних явищ, які спричиняють посилення процесів деградації земель, таких як водна ерозія та підтоплення. За таких обставин актуалізується застосування підходів оцінки ризиків затоплення територій в контексті управління сільськогосподарськими землями територіальних громад.

На прикладі Славської ТГ та Сколівської ТГ реалізовано виконання оцінки ризиків затоплення територій водами річки Опір, а також річки Стрий (на ділянці впадіння р. Опір). Дослідження виконано на нормативних положеннях національного законодавства України, а також Директиви 2007/60/ЄС та керівних документів до неї. Встановлено зони

затоплення територій в межах Славської ТГ та Сколівської ТГ, площі відповідних затоплень та розміри потенційних втрат для земель сільськогосподарського призначення за різних сценаріїв затоплень.

Запропоновано розробку та реалізацію низки заходів з метою мінімізації негативних наслідків та втрат, пов'язаних із затопленням земель. Розглянуто перспективи застосування результатів при розробці документації з землеустрою.

Ключові слова: *оцінка ризиків затоплення, ймовірність перевищення, сільськогосподарські землі, річка Опір, Славська ТГ, Сколівська ТГ.*