International Journal of Industrial Engineering & Production Research March 2022 Vol. 33, No. 1: 1-10
DOI: 10.22068/ijiepr.33.1.12

RESEARCH PAPER

Features of Environmentalization of Agricultural Land Use

Iryna Koshkalda[1], Olena Panukhnyk[2] Kateryna Sheludko[3*], Dmytro Hoptsii[4] & Liudmyla Makieieva[5]

Received 21 November 2021; Revised 6 December 2021; Accepted 25 December 2021;

ABSTRACT

The article analyzes the ecological condition of the soil and identifies the main problems of the environmentalization of land use in Ukraine in the case of the Kharkiv region. Deterioration of the ecological condition of agricultural land, weakening of their erosion resistance, violation of the optimal structure of land, reduction of the content of humus and basic nutrients lead to a decrease in land productivity. In general, the current state of environmental safety of land is quite unsatisfactory, so it significantly reduces the quality and volume of agricultural production. The analysis of the situation and the forecast of the efficiency of soil fertility show that due to the sharp decrease in the application of organic and mineral fertilizers, insufficient implementation of forest reclamation, and anti-erosion measures, degradation processes have intensified in all areas. The problem with the balance of nutrients has become more acute, the acidity of the soil solution is increasing, the humus content is reducing, and the intensity of erosion processes has significantly increased. Thus, to ensure the formation of environmentally friendly agricultural land use, an important condition is the creation of a scientifically sound structure and optimization of the ratio of productive (arable land) and environmentally friendly (hayfields, pastures, wooded areas) land use.

KEYWORDS: *Agricultural land use; Greening; Efficiency; Erosion; Soil fertility.*

1. Introduction

Ukraine, the second-largest country in Europe, is known as the region's breadbasket due to its black soil – a type of soil that is extremely fertile and rich in organic matter called humus [1]. The black soil, which occupies more than half of the entire territory of Ukraine, creates exceptional agronomic conditions for growing a wide range of crops. Ukraine's proximity to major neighboring markets – the European Union - and access to deep-water ports on the Black Sea provide direct access to world markets and, above all, to major grain importers in the Middle East and North Africa. Despite favorable agricultural conditions, Ukraine's serious problem is the constant degradation of soil due to irrational land use and the erosion caused by it. Thus, every year, more than 500 million tons of arable land suffer from erosion, which has already led to a decrease in soil fertility in an area of more than 32.5 million hectares of land. Erosion causes a loss of a third of every dollar from value-added created in agriculture, and 10 tons of eroded soil account for every ton of produced grain. It is also worth noting that the state of degradation and desertification of agricultural land is directly affected by the rate of climate change with a sharp increase in average annual temperatures and the frequency of force majeure weather phenomena [2]. The current state of crisis in Ukraine's land resources, declining soil fertility, and the widespread degradation processes determine the need for significant changes in human economic activity and nature management. In this regard, it is extremely important to apply a systematic approach to

* **Corresponding author:** ***Kateryna Sheludko***
office@khnau.ua

1. *Head of the Department of Land Administration and Cadastre, Kharkiv National Agrarian University named after Dokuchaiev, Kharkiv, Ukraine.*
2. *Head of the Department of Economics and Finance, Ternopil Ivan Puluj National Technical University, Ternopil, Ukraine.*
3. *Department of Land Administration and Cadastre, Kharkiv National Agrarian University named after Dokuchaiev, Kharkiv, Ukraine.*
4. *Department of Land Administration and Cadastre, Kharkiv National Agrarian University named after Dokuchaiev, Kharkiv, Ukraine.*
5. *Department of Land-Use Planning, Kharkiv National Agrarian University named after Dokuchaiev, Kharkiv, Ukraine.*

assessing the current environmental and economic condition of agricultural land and providing scientifically sound recommendations for rational environmentally friendly agricultural land use [3, 4].

To ensure the conditions for the formation of sustainable agricultural land use, an important condition should be the creation of a scientifically sound spatial structure and optimization of the ratio of productive and environmentally friendly land by reorganizing the agricultural area. The main environmentally friendly elements of this structure are agro-ameliorative and forest reclamation measures that form the ecological framework of agro-landscapes and are the basis for providing favorable agro-environmental parameters for field crops, hayfields, pastures, etc. [4-6].

2. Literature Review

Today, environmentalization is referred to as the process of gradual and consistent implementation of systems of technological, managerial, and other solutions that increase the efficiency of agricultural land use and the conditions for maintaining land quality. The main tasks of environmentalization of agricultural land are as follows: to reduce environmental losses caused by the use of intensive chemicalization of agricultural land; to implement measures for the application of organic fertilizers that will ensure a deficit-free balance of humus in the soil; to take measures for mechanization, chemicalization, and land reclamation based on the latest methods; to apply anti-erosion measures and new methods of tillage, liming, soil, and minimization of tillage [7].

Many scientists consider the processes of environmentalization of agricultural land use in Ukraine, to mention S.A. Balyuk, O.S. Budziak, V.V. Gorlachuk V.M. Drugak, Yu.O. Lupenko, V.Ya. Mesel-Veselyak, V.Ya. Novakovsky, V. M. Trehobchuk, A.M. Tretyak, M.M. Fedorov, M.A. Khvesyk, O.V. Khodakivska [8-17] and others. Despite the fact that considerable attention has recently been paid to the study of water pollution and climate change [18-19] however, features of land use environmentalization require additional analysis and research. Issues related to the establishment and observance of environmental imperatives of state regulation of land relations in Ukraine and the world remain controversial. In turn, the reform of land relations in Ukraine is at the stage of decentralization of power, which encourages the need to study world experience in this field and prospects for its adaptation to national economic conditions [13-15].

Further search for the ways to solve environmental problems in the field of agricultural land use requires coordination of economic and environmental goals of any economic activity, i.e. the choice of the ratio at which the greatest overall economic and environmental effect is achieved [17].

3. Materials and Methods

The research materials included literature sources, statistical data on Ukraine and the Kharkiv region, as well as some works of contemporary Ukrainian and foreign scientists on the processes of environmentalization of agricultural land use. The use of logical, analytical, comparative, and descriptive methods, which allowed highlighting the relevance and issues of the formation of environmentally friendly land use. The article is based on theoretical and methodological principles of complex research of environmental consequences of functioning of current agricultural land use with the application of modern methods of studying the phenomena and processes. They are: monographic analysis – to consider and generalize theoretical bases of environmentalization and its influence on the formation of agricultural land uses; systematic and comparative analysis – to apply during the ecological and economic assessment of agricultural land; statistical generalization – to determine and compare the efficiency of agricultural land use; analytical method – to study trends in the dynamics of environmental phenomena; calculation and constructive, grouping – to study arable land according to the steepness of the slopes and prospects for the development of their economic activity. Taking into account the above scientific methods, the purpose of our study is to substantiate the most effective ways to improve the ecological condition of soils in the formation of agricultural land use.

The land reserves of the Kharkiv region, according to soil survey data, has more than 150 types of soil. The reason for this diversity is, first, the region's location in two zones – forest-steppe and steppe. The greatest diversity is characteristic of the forest-steppe part of the region, although it is smaller in area than the steppe one. In the northern (forest-steppe) part of the region, deep, gray, dark gray black soil and podzolized soil, as well as podzolized and degraded black soil are widespread. The soil cover of the steppe zone is dominated by ordinary black soil and ordinary

deep black soil. The main types of soil are presented in Table 1.

Tab. 1. The soil of the Kharkiv region and their structure

Types of soil	Rating score	Area total, thous. ha	of the total,%	of them arable lands,%
Ordinary black soil	86	1482,7	47,2	85,5
Typical, regraded black soil	69	964,4	30,7	67,4
Podzolized, dark gray forest, regraded black soil	60	380,1	12,1	78,7
Light gray and gray forest soil	39	81,7	2,6	55,1
Clay-sandy and sandy, sod-slightly podzolized and clay-sandy black soil	25	75,4	2,4	68,3
Solonized and residual solonized black soil	30	66,0	2,1	79,4
Meadow and meadow-black soil	-	91,1	2,9	24,2
Total	-	3141,4	X	X

Source: according to the Kharkiv branch of the state institution "Institute of Soil Protection of Ukraine"

As Table 1 shows, the structure of land in the Kharkiv region is dominated by fertile black soil, which is a national treasure. The soil cover of the region is dominated by ordinary black soil (47.2 %), typical (30.7 %), and podzolized (12.1 %). The most fertile is ordinary and typical black soil. Intensive exploitation and the irrational land-use system have led to severe environmental consequences, namely to such manifestations of land degradation as erosion, which accounts for 52.8 % of the total land area.

4. Results and Discussion

Agricultural development of the Kharkiv region reaches 76.8%, plowed agricultural land – 80.2%, of which more than 50 % is eroded. The consequence of unbalanced economic development of land is the progressive degradation of land, erosion, and loss of soil fertility. Low-yielding soil is intensively used and should be decommissioned and reclaimed. The use of arable land with high steep slopes is a potential threat to the development of erosion processes. The area and distribution of arable land on the steepness of the slopes are presented in Table 2.

Tab. 2. Distribution of arable land by steep slopes in the Kharkiv region

Units of measurement	Total arable land	Including the steepness of the slopes (degrees)				
		<1	1-3	3-5	5-7	>7
thous. ha	1942,8	770,0	806,4	218,2	40,9	0,8
%	100	40,1	41,5	11,2	2,1	-

Source: according to the Kharkiv branch of the state institution "Institute of Soil Protection of Ukraine"

About 13.3% of arable land is located on slopes over 3°. Therefore, it is urgent to transform them into hayfields and pastures. Arable land is characterized by a high average annual estimated soil leaching – more than 5 t / ha. The loss of humus reaches 0.5 tons, and nutrients – 0.6 tons/ha on average per year, which is not compensated by the application of fertilizers. Crop yields on eroded land are 20-60% lower than on non-eroded ones.

Today, in Ukraine, the forestry complex is in a state of crisis (15.7% of afforestation in comparison with optimal 22-25%). 57.4% of the total area of the country is eroded land and this figure increases from year to year by 60-80 thousand hectares. Moreover, about 20% of Ukrainian land are in unsatisfactory condition due to the oversaturation of soil with many toxic compounds. However, these are not all the problems affecting the overall environmental condition of agricultural land.

One of the most effective measures of counteracting these negative processes is agroforestry, taking into account natural and climatic zones. Kharkiv region is located in two zones (steppe and forest-steppe), so the following calculations for the planning of forest belts will be considered taking into account the peculiarities of zoning. Forest strips and other protective forest plantations in combination with other agro technical anti-erosion measures increase the yield of grain crops by at least 15-

20%, fodder crops – by 35-40%. These measures stop erosion processes, reduce the need for organic and mineral fertilizers to restore soil fertility lost due to erosion [20].

Proposals to improve the situation with agroforestry were developed by specialists of the Kharkiv branch of the state institution "Institute of Soil Protection of Ukraine" and included in the "Comprehensive program of investment and innovation development of the Kharkiv region by 2030" [21, 22]. The identified potential areas for the creation of field protective forest plantations (field protective and stock-regulating forest strips) were determined for the nearest future (Table 3).

Tab. 3. Calculation of the required area of field protective forest strips following the current standards of protective forest-steppe cover for 2030

Kharkiv region	Protective forest-steppe cover for steeps %		thous. ha		Available forest belts, thous. ha	Available forest cover,%	Necessary to create forest belts, thous. ha		
	≥ 3°	3-7°	≥ 3°	3-7°			≥ 3°	3-7°	total
Northern steppe	3,7	7,8	29,5	11,49	12,9	1,6	16,6	7,03	23,63
Forest-steppe	2,7	7,8	30,51	11,91	13,4	4,84	17,11	7,07	24,18
Region	3,2	7,8	60,01	23,4	26,3	3,94	33,71	14,1	47,81

Source: according to the Department of Ecology and Natural Resources of the Kharkiv region

The creation of protective forest belts is very important as erosion reduces soil fertility and, consequently, crop yields and increases the cost of cultivating eroded land due to increased soil resistance and the formation of shorter runs among the ravines. Thus, in the case of reducing the humus content in the soil from 6 to 2%, the density of its profile increases by about 50%, and the water permeability of the soil and its moisture decreases by 15-20 times. Moreover, the consequence of the use of eroded land is the need to apply to the higher rates of sowing of crops since part of the seeds are washed away, and the rest does not germinate as a result of deteriorating germination conditions.

The need to transform degraded arable land to rehabilitate them, i.e. to create conditions for limited use, is emphasized in the new version of the Land Code of Ukraine, which is followed by leading agricultural scientists. A prominent scientist, academician V.F. Sayko proposes to reduce the area of arable land in the country to 24.2 million hectares, i.e. by almost 9 million hectares, and to reduce the level of plowing of agricultural land to 57%.

Academician L.Ya. Novakovsky considers it necessary to prioritize 5.1 million hectares of degraded and unproductive land under natural renaturalization and temporary or permanent conservation [23]. The study of A.S. Danylenko also testifies that in the nearest future, there will be a real opportunity to reduce the area of agricultural land in Ukraine up to 30 million hectares, including arable land – up to 20 - 22 million hectares. That is, there is an urgent state need for the transformation of different types of agricultural land, their renaturalization through phytomeliorative and forest reclamation measures [24].

Appropriate measures need to be implemented in the Kharkiv region, as more than 10 % of agricultural land is degraded and unproductive land in need of conservation (Table 4).

Tab. 4. Conservation of degraded and unproductive land in the Kharkiv region in 2020

Types of land	Total at the beginning of the year		Preservation has been carried out		In need of conservation	
	thous. ha	% to the total area of agricultural land	thous. ha	% to the total area	thous. ha	% to the total area of agricultural land
Degraded	110,2	4,5	-	-	110,2	4,5
Marginal	148,5	6,1	-	-	148,5	6,1
Total	258,7	10,7	-	-	258,7	10,7

Source: according to the Department of Ecology and Natural Resources of the Kharkiv region

Reproduction of soil fertility and stabilization of land use, in general, can also be achieved by reducing arable land, crop culture balanced favor of crop and livestock, as the main task of agribusiness of Ukraine is to ensure food and environmental security.

Contemporary agricultural production of domestic and foreign markets is focused on the transition to world standards of product quality and its profitable export, which determines competitiveness. Production of competitive products is possible when the grain yield reaches 50-60 kg/ha, sugar beet – 400-500, sunflower – 20-25, potatoes – 200-250 kg/ha, cow milk yield – 5-6 thousand kg per year [24].

For example, today, according to agricultural market experts, the average yield of wheat per hectare of Ukrainian black soil barely reaches 3 tons, whereas in Britain, France, and Germany they get an average of more than 7 tons per hectare of non-black soil. One of the reasons for this situation is the low nutrient content of our soil [25-26].

The main agrochemical indicators of soil fertility are the content of humus, mobile phosphorus, and potassium, as well as soil acidity.

One of the most significant diagnostic signs of soil degradation is a decrease in the content of organic matter and its main component – humus. Humus is an organic part of the soil, which is formed as a result of the decomposition of plant and animal remains and products of life of organisms – humification. The decrease in the content of organic matter and the deterioration of the quality of humus can be caused by many reasons [27-28].

Among them, first, the lack of constant compensation for organic fertilizers and plant residues of current costs of organic matter, which occurs mainly due to its mineralization. Second, the change in the correlation between the mineralization of fresh organic matter and the formation and stabilization of new humic substances in the soil.

In general, the growth rate of humus losses in the soils of the region in recent years can be explained by many reasons. The main ones are the intensification of humus decomposition processes due to low rates of organic fertilizers or complete lack of application and changes in the sown area [29].

Analyzing the dynamics of the humus condition of the region's soils for 30 years, the Kharkiv branch of the state institution "Institute of Soil Protection of Ukraine" revealed a steady tendency to reduce the humus content in the region's soils, so in round V (1987-1991) it was 4.5%, and in round IX (2011-2016) – 4.2%.

The rate of humus loss has decreased slightly, and in some areas, its content is close to stabilization.

The analysis of the humus balance by years showed that the balance since 1996 is negative – 0.46 t/ha. The degree of its negative value increases over the years and in 2017 became 0.56 (Table 5).

Tab. 5. Balance of humus in agriculture of Kharkiv region

Year	Applied organic fertilizers, thous. ha	The yield of plant residues, thous. ha	Humus balance, +/-
1991-1995	5,7	4,1	0,27
1996-2000	2,4	2,9	-0,46
2001-2005	1,1	4,0	-0,28
2006-2010	0,47	4,1	-0,51
2011-2016	0,4	4,1	-0,55
2017-2020	0,3	3,9	-0,56

Source: according to the Kharkiv branch of the state institution "Institute of Soil Protection of Ukraine"

This can be explained by the fact that one of the factors of humus formation – the application of organic fertilizers has fallen sharply due to reduced livestock development. This decrease in the formation of humus due to organic fertilizers is explained by the reduction of their application: whereas in the early '90s, an average of 5.7 t / ha was applied, in 2017-2020 it was 0.3 t/ha. The formation of humus due to plant residues during the study period did not change, except for 1996-2000 (Table 6).

Tab. 6. Balance of nutrients in arable land of agricultural enterprises of the Kharkiv region, kg/ha (+,-)

Years	Nitrogen	Phosphorus	Potassium	Total
1991-1995	-3,7	16,34	0,2	12,9
1996-2000	-39,4	-13,68	-43,5	-96,6
2001-2005	-45,5	-16,86	-59,52	-121,9
2006-2010	-45,0	-19,8	-76,0	-140,8
2011-2016	-31,8	-17,2	-66,4	-115,4
2017-2020	-36,1	-17,9	-60,2	-114,2

Source: according to the Kharkiv branch of the state institution "Institute of Soil Protection of Ukraine"

This amount of applied fertilizers cannot ensure a deficit-free balance of humus and nutrients in Ukrainian soil, i.e. the basic law of agriculture is not observed – the removal of nutrients must be compensated by returning them to the soil. As a result, in recent years there has been a negative balance of humus and nutrients in the soil.

Today, new approaches and technological solutions to the problems of chemical land reclamation are needed. Even if modern resource-saving technologies of chemical land reclamation are used, farms cannot do without significant state support [30-32].

The country's environmentalization of land use during the implementation of land reform measures has not taken place. In the study period, an extremely dangerous deformation of agricultural land use was determined as a sharp decline in soil fertility, caused by excessive anthropogenic pressures on agricultural land, and, above all, the collapse of the volume of soil protection due to the economic crisis. The volume of agrochemical and 5-7 times reclamation and other works that preserve and increase the fertility of soils has been reduced 2.5–5 times. The application of organic fertilizers decreased more than 10 times, and mineral fertilizers – 4-5 times.

As a result, there is widespread depletion of soil, except arable land. Restoration of humus content in them reached the maximum allowable minimum level (0.6%). Accumulation of humus in the soil is a prerequisite for reproduction and an increase in soil fertility. To ensure high and sustainable crop yields, the soil must an optimal humus content. According to the research institution "Institute of Soil Science and Agrochemistry named after O. N. Sokolovsky", the optimal level of humus content in the soil of Ukraine should be 4%, though the actual one is 3.1%.

Currently, the nutrient balance in the area is negative. Thus, in 2017-2020 it was minus 114.2 kg/ha, NPK including nitrogen – 36.1 kg/ha, phosphorus – 17.9 kg/ha, potassium – 60.9 kg/ha, which causes the harvest mainly due to the natural fertility of the region's soil. The negative balance of nutrients is caused by the insufficient application of organic and mineral fertilizers (Table 7).

Tab. 7. Application of fertilizers in agriculture of the Kharkiv region

Years	Organic fertilizers, t / ha	Mineral fertilizers, kg / ha			
		total	N	P	K
1986-1990	7,4	150	62	47	41
1991-1995	5,7	105	46	30	29,5
1996-2000	2,3	14	10	2,9	0,6
2001-2005	1,1	16	12	2,8	1,4
2006-2010	0,4	49,8	34,4	8,7	6,8
2011-2016	0,4	59,9	42,5	11,3	6,1
2017-2020	0,3	62,7	45,8	10,9	6,0

Source: according to the Kharkiv branch of the state institution "Institute of Soil Protection of Ukraine"

The analysis of the situation and the forecast of the efficiency of soil fertility prove that due to the sharp decrease in the application of organic and mineral fertilizers, insufficient implementation of forest reclamation, and anti-erosion measures, all areas of degradation processes have intensified. The problem with the balance of nutrients has worsened, the acidity of the soil solution is increasing, the humus content is decreasing, and the intensity of erosion processes has significantly increased.

The traditional organomineral fertilizer system is currently not widespread due to a sharp decline in manure production (the consequences of a sharp

reduction in livestock production) and low-cost recovery in the application of mineral fertilizers (too high prices for fertilizers and understated prices for finished products). In such a situation, the balanced return of nutrients removed with the crop becomes problematic [33-36].

5. Conclusion

Thus, the main tasks of the environmentalization of agricultural land use involve measures for increasing soil fertility by limiting the use of intensive chemicalization of agriculture; measures for the application of the organic fertilizer to ensure a deficit-free balance of humus in the soil; measures for mechanization, chemicalization, land reclamation using the latest methods; anti-erosion measures and the use of new methods of tillage, liming, soil, and minimization of tillage. The main environmentally friendly elements of this structure include agro-ameliorative and forest-ameliorative measures that form the ecological framework of agro-landscapes and are the basis for providing favorable agro-environmental parameters for agricultural land. Considering the complex degradation processes occurring in agricultural soils, the most effective real measures to increase soil fertility and their effective use are as follows:

- to allocate crops within each land use in a rational way;
- to implement scientifically sound plans for mineral fertilizers, which allows a more rational use of very limited fertilizer resources;
- to increase the annual application of organic matter due to manure and the use of crop residues in terms of manure to 8.0 t/ha, which will make up the loss of humus.
- to achieve an optimal amount of mineral fertilizers up to 110 kg of nutrients per hectare and to increase their payback to change the timing and methods of their application.
- to implement the minimization of tillage widely due to the lack of moisture; to increase the sown area of perennial grasses; to optimize the ratio of areas of row crops and continuous sowing.

The proposed recommendations can be used by the departments of agro-industrial development in the formation of programs, projects and plans for the development of land resources at the regional and local levels, which will significantly strengthen the processes of greening not only agricultural land but also the environment.

References

[1] Audrey L. Mayer, Brian Buma, Amélie Davis, Sara A. Gagné, E. Louise Loudermilk *et al.*, "How Landscape Ecology Informs Global Land-Change Science and Policy", *BioScience,* Vol. 66, No. 6, (2016), pp. 458-469.
DOI: 10.1093/biosci/biw035.

[2] Anand Madhur, Andrew Gonzalez, Frédéric Guichard, Jurek Kolasa, Lael Parrott, "Ecological Systems as Complex Systems: Challenges for an Emerging Science" *Diversity,* Published by MDPI, No. 2, (2010), pp. 395-410.
DOI:10.3390/d2030395.

[3] Kirsten M. Parris, "Existing ecological theory applies in urban environments", *Landscape and Ecological Engineering*, No. 14, (2018), pp, 201-208.
DOI: 10.1007/s11355-018-0351-4.

[4] Report from the commission to the European Parliament and the council on the implementation of the ecological focus area obligation under the green direct payment scheme COM/2017/0152 final Sustainable land use (greening), (2017) Available: https://ec.europa.eu.

[5] Craig R. Allen1, David G. Angeler, Graeme S. Cumming, Carl Folke, Dirac Twidwell et. al, "Quantifying spatial resilience", *Journal of Applied Ecology,* № 53, (2016), Published by British Ecological Society, pp. 625-635.
DOI: 10.1111/1365-2664.12634.

[6] Erik Andersson, Stephan Barthel, Sara Borgström, Johan Colding, Thomas Elmqvist, et al. "Reconnecting cities to the biosphere: stewardship of green infrastructure and urban ecosystem services", *AMBIO,* No. 43, 17, (2014), pp. 445-453.
DOI: 10.1007/s13280-014-0506-y.

[7] Cumming G.S., Craig A., Natalie B., Duan B., Harry C. Biggs, et al. "Understanding protected area resilience: a multi-scale socioal-ecological approach", Ecological Applications, Ecological Society of America, , Vol. 25, No. (2), (2015), pp. 299-319.
DOI: 10.1890/13-2113.1.

[8] Balyuk S.A., Vorotintseva, L.I. "On the state of the soil cover of Ukraine, its fertility, degradation and protection", Monitoring and indicators of the neutral level of land degradation in Ukraine, Space-M, Lviv, Ukraine, (2018), p. 96.

[9] Balyuk S., Medvedev V., Vorotintseva L., Shimel V. "Modern problems of soil degradation and measures to achieve its neutral level", *Bulletin of Agricultural Science,* Vol. 95, No. (8), (2017), pp. 5-11. DOI:https://doi.org/10.31073/agrovisnyk201708-01.

[10] Budzyak O. and Budzyak V., "Planning of environmental use of land units of Ukraine in conditions of climate change", *Agrosvit,* Vol. 1, (2018), pp. 3-9.

[11] Drugak V.M., Tretyak N.A. "Methodological bases of formation of ecology of land use in the system of public interests", *Ecological sciences,* No. 1, (2013), pp. 61-68.

[12] Drugak V.M., Tretyak N.A. "Ecology of land use of Ukraine in the system of public interests", *Zemleustriy, cadastr i monitoring zemel*, , Nos. 1-2, (2017), pp. 86-95.

[13] Artur Gudmanian, Liubov Drotianko, Oksana Shostak, Hanna Kleshnia and Serhii Ordenov "Transformation of ecological consciousness in the process of solving global ecological problems", E3S Web Conf. XIII International Scientific and Practical Conference "State and Prospects for the Development of Agribusiness – INTERAGROMASH 2020", Vol. 175, (2020), p. 10, DOI: 10.1051/e3sconf/202017514017.

[14] Hrusha V.V., Horozhankina N.A., Boiko Z.V. "Analysis of geoecological problems of Dnipropetrovsk region (in multidimensional sign space)", *Journal of Geology, Geography and Geoecology,* Print ISSN 2617-2909, Online ISSN 2617-2119, Vol. 28, No. 1, (2019), pp. 68-78. DOI: 10.15421/111909.

[15] Interactive map of soils of Ukraine. Main site of agronomists. Available: https://superagronom.com/karty/karta-gruntiv-ukrainy#win19.

[16] Khvesyk M., Bystryakov I. "Paradigmatic view on the concept of sustainable development of Ukraine", *Economyca Ukrainy,* No. 6, (2012), pp. 4-12.

[17] Khodakivska O.V., Fedorov M.M., Mesel-Veselyak, V.Ya. "Theoretical principles of development of land relations in agriculture", Kiyv: NNz "IAE", (2018), p. 236.

[18] Korchemlyuk M, Arkhypova L, Kravchynskyi R and Mykhailyuk J. "Anthropogenic influence from point and diffuse sources of pollution in the Upper Prut River basin", *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu*, Vol. 1, No. 169, (2019), pp 125-131. DOI: 10.29202/nvngu/2019-1/12.

[19] Hryniuk V.I., Arkhypova L.M. "Regularity of effects of climatic changes on quality indicators of surface water of the Dniester basin", *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu*, Vol. 3, No. 165, (2018), pp. 125-133. DOI: 10.29202.

[20] Maffesoli M. "From society to tribal communities", *The Sociological Review,* Vol. 64, No. 4, (2017), pp. 739-747. DOI: 10.1111/1467-954X.

[21] Project of the Cabinet of Ministers of Ukraine "On approval of the Concept of the State target program for the development of land relations and national infrastructure of geospatial data in Ukraine for the period up to 2030", (2020). Available: https://land.gov.ua/info/proekt.

[22] Review of the state of implementation of the National Action Plan to combat land degradation and desertification, (2018), Available: https://menr.gov.ua/news/32333.html.

[23] Novakovsky L., Novakovskaya I. "Formation of land use of united territorial

communities in the second stage of decentralization of power", *Visnyk agrarnoyi nauky,* No. 2, (2019), pp. 5-12.

[24] Public report of the state agency of forest resources. Available: http://.menr.gov.ua › files › images› news_(2020).

[25] Fabian Thomas, Estelle Midler, Marianne Lefebvre, Stefanie Engel "Greening the common agricultural policy: a behavioral perspective and lab-in-the-field experiment in Germany", *European Review of Agricultural Economics,* Oxford University Press (OUP), Vol. 46, No. 3, (2019), pp. 367-392.
DOI: 10.1093/erae/jbz014.

[26] Swinnen J., Ciaian P., d'Artis Kancs, Van Herck K., Vranken L. "Possible effects on land markets of new cap direct payments. Study", Brussels, (2016), p. 103.

[27] Rolando Rodrı´guez, Pamela Encina, Miguel Espinosa, Norio Tanaka "Field research of planted forest structures and their role in protecting communities from tsunamis: experiences along the coast of Biobio, Chile", *Landscape and Ecological Engineering*, Vol. 12, No. 1, (2015).
DOI:10.1007/s11355-015-0271-5.

[28] Katie K Arkema, Robert Griffin, Sergio Maldonado, Jessica Silver, Jenny Suckale et al., "Integrating the social, environmental and physical sciences to promote the natural protection of coastal communities", (2017), pp. 5-26.
DOI: 10.1111/nyas.13322.

[29] Tetyana Yereskova, Oleg Mazuryk, Halyna Tymofieieva, Tetiana Opryshko "Social Activity of Contemporary Ukrainian Society: Threat to Internal Stability or Possibility of Social Dialogue", *Postmodern Openings*, Vol. 11, No. 4, (2020).
DOI: https://doi.org/10.18662/po/11.4/227, pp. 144-173.

[30] Hadi Susilo Arifin & Nobukazu Nakagoshi "Landscape ecology and urban biodiversity in tropical Indonesian cities", *Landscape and Ecological Engineering*, 22 January, Vol. 7, (2011).
DOI: https://doi.org/10.1007/s11355-010-0145-9.

[31] Khilchevskyi V.K., Kurylo S.M., Sherstyuk N.P., "Chemical composition of different types of natural waters in Ukraine", *Journal of Geology, Geography and Geoecology*, Vol. 27, No. 1, (2018), pp. 68-78.
DOI: https://doi.org/10.15421/111832.

[32] Erik Andersson "Functional landscapes in cities: a systems approach", *Landscape and Ecological Engineering,* 02-07-2018, Vol. 2, (2018),
DOI: https://doi.org/10.1007/s11355-017-0346-6.

[33] Koshkalda I., Sheludko K. "Greening as a prerequisite for state regulation of the formation of sustainable agricultural land use", *Ukrainian Journal of Applied Economics.* Vol. 5, No. 2, (2020), pp. 88-94.
DOI:https://doi.org/10.36887/2415-8453-2020-2-10.

[34] Popadynets N., Bondarenko V., Dovba I. & Fedurtsia V. "Assessment of Efficiency of the Use of Natural Resources Capacity by Territorial Communities in Conditions of Administrative -Territorial Reform in Ukraine". *International Journal of Industrial Engineering & Production,* December, Vol. 31, No. 4, (2020), pp. 499 -510.
DOI: 10.22068/ijiepr.31.4.499.

[35] Aleskerova Y., Titenko Z., Skrypnyk H. & Grytsyna O. "Modeling The Level Of Investment Attractiveness Of The Agrarian Economy Sector". *International Journal of Industrial Engineering & Production*, December, Vol. 31, No. 4, (2020), pp. 647-653.
DOI: 10.22068/ijiepr.31.4.647.

[36] Kaminskyi A., Nehrey M., Komar M. "Complex Risk Analysis of Investing in Agriculture ETFs". *International Journal of Industrial Engineering & Production*, December, Vol. 31, No. 4, (2020), pp. 579 -586.
DOI: 10.22068/ijiepr.31.4.579.

Follow This Article at The Following Site:

Sheludko K, Koshkalda I, Panukhnyk O, Hoptsii D, Makieieva L. Features of Environmentalization of Agricultural Land Use. IJIEPR. 2022; 33 (1) :1-10
URL: http://ijiepr.iust.ac.ir/article-1-1371-en.html