СІЛЬСЬКОГОСПОДАРСЬКІ ДОСЛІДЖЕННЯ

DOI: https://doi.org/10.26565/1992-4224-2025-44-17
UDC (УДК): 911.5+504

S. P. SONKO[1], DSc (Geography), Prof.,
Professor of the Department of Ecology and Life Safety
e-mail: sp.sonko@gmail.com ORCID ID: https://orcid.org/0000-0002-7080-9564

N. O. HNATIUK[1], PhD (Biology),
Associate Professor of the Department of Ecology and Life Safety
e-mail: natgnatiuk@gmail.com ORCID: https://orcid.org/0000-0002-4159-9924

V. O. VOIEVODA[1],
PhD Student of the Department of Ecology and Life Safety
e-mail: voevodavolodimir@gmail.com ORCID: https://orcid.org/0009-0003-2989-276X
[1]*Uman National University,*
1, Instytutska St., Uman, Cherkasy Region, 20305, Ukraine

SPATIAL ORGANIZATION OF AGRICULTURE AS THE BASIS FOR ADMINISTRATIVE AND TERRITORIAL STRUCTURE BASED ON THE PRINCIPLES OF SUSTAINABLE DEVELOPMENT

Purposes. To study the possibility of using data on the dynamics of agroecosystems in the design of administrative-territorial entities (using the example of the Cherkasy region). The main hypothesis of the study is the possibility of scientifically correct "fitting" the production specialization of individual farms into the corresponding agro-landscapes, and subsequently, on this basis, justifying the administrative-territorial structure.

Methods. Cartographic, comparative-geographical, statistical.

Results. Analysis of the distribution of enterprises across the territory of the Cherkasy region confirms their compliance (or non-compliance) with the main natural and economic patterns. Thus, in place of the former 5th forest-steppe and 3rd steppe (2014) along the southern border of the region, the 1st steppe (2024) agricultural region has formed with signs of more pronounced zonal specialization (crops and industries adapted to the arid climate). Over 10 years, the number of farms has increased almost six-fold, which is associated, firstly, with the intensification of land reform implementation and, secondly, with the strengthening of the trend of "integrating" agroecosystems into natural landscapes. Despite the dominance of traditional technologies in the main zonal areas of specialization, a significant number of farms (about 30%) have responded to climate change over the past 10 years (2014-2024) by gradually introducing cover crops into crop rotations to retain moisture in the soil. Thus, most of the farms specializing in grain production are "tied" to the flat plains of the central part of the region. The Dnipro regions of the region are developing specialization with a focus on the consumer (Cherkasy) and significant irrigation resources – open-field vegetables, dairy and beef cattle breeding, and poultry farming. Only in the western regions of the Uman "cluster" is the most comprehensive crop and livestock specialization developing, which is explained by the relative autonomy of this territory. Based on the identification of production types and taking into account landscape diversity, an analysis of agricultural regions in relation to specific landscapes was carried out.

Conclusions. Compared to 2014, the configuration of agricultural areas has changed significantly, which has been fundamentally influenced by climate change. For the Cherkasy region, the main regional centers remain the cores of agroecosystems located in the middle of the four modern administrative districts (Zolotonosha, Cherkasy, Zvenyhorod, and Uman). A more accurate determination of their location, and, most importantly, the periphery of agroecosystems with subsequent refinement of boundaries, will require additional research, both with the use of special statistics and expedition data.

KEYWORDS: *sustainable development, agroecosystem, agricultural, landscape, zoning, cartographic, Cherkasy region*

Як цитувати: Sonko S. P., Hnatiuk N. O., Voievoda V. O. Spatial organization of agriculture as the basis for administrative and territorial structure based on the principles of sustainable development. *Людина та довкілля. Проблеми неоекології.* 2025. Вип. 44. С. 224-239. https://doi.org/10.26565/1992-4224-2025-44-17

In cites: Sonko, S. P., Hnatiuk, N. O., & Voievoda, V. O. (2025). Spatial organization of agriculture as the basis for administrative and territorial structure based on the principles of sustainable development. *Man and Environment. Issues of Neoecology*, (44), 224-239. https://doi.org/10.26565/1992-4224-2025-44-17

Introduction

From the outset, the concept of sustainable development has been based on an ecological imperative, the pursuit of which is enshrined in the sustainable development strategy. Ideally, the essence of following the ecological imperative in agriculture lies in creating and maintaining a material and energy mechanism of human-nature relations that is inherent in the biosphere and its ecosystem structure [1]. The concept of agroecosystems has become a certain compromise on this path [2].

In modern Ukrainian agroecology and geoecology, there are different ideas about the structure and functional features of agroecosystems [3]. According to O.O. Sozinov, "An agroecosystem is a discrete functional component of the agrosphere, the purpose of which is to obtain agricultural products of the required quality with minimal consumption of non-renewable energy, while preserving the environment and natural resources. The energy of agroecosystems is based on photosynthesis and anthropogenic energy. It is characterized by impoverished biodiversity and is unstable. Without human support, it disintegrates and transforms into natural disturbed biocenoses. It is spatially divided into levels: micro: field, garden plot, farm; meso: functioning within individual farms; macro: covering the entire agricultural landscape. An agroecosystem is the result of targeted human action and is largely determined by socio-economic factors.

According to S.P. Sonko, "An agroecosystem is a natural landscape that has been partially or radically transformed by humans (primarily in terms of material and energy exchange), similar in its ecological essence to an artificial ecosystem, in which material and energy flows are deliberately directed towards maximizing the production and subsequent alienation of biomass. In addition to the ecological proposition that “humans have created their own artificial ecosystem” (M. Golubets), a geographical view of the problem of taxonomy primarily involves the spatial component of the ecosystem in the analysis.

However, the only (but fundamental) difference between the human ecosystem (“artificial,” “semi-natural,” “combined,” “anthropogenic,” “technogenic”) from “pure” natural ecosystems lies in the conscious change by humans (as a species of Homo sapiens) in the process of noosphere formation of the spatial essence of the ecotope.

As agriculture has become more intensive, the scientific and practical problem of matching agricultural specialization with agroclimatic resources has ceased to be a priority, the danger of which has been highlighted in many scientific works [4]. Instead, the laws of the market economy have only increased the gap between the specialization of farms and the existing potential of agroecosystems [1].

The modern revival of scientific interest in this issue is primarily due to the scientific fallacy of the “green revolution” concept, the implementation of which over the past thirty years has mainly resulted in a dangerous decline in soil humus content [5].

This is precisely why the conclusions of contemporary scientific research (both domestic and foreign) emphasize the need to shift the focus of agricultural land use from the usual slogan of “increasing productivity” to the slogan of “preserving biological resources for future generations,” which corresponds to the main slogan of the concept of sustainable development [6].

The authors sincerely believe, as expressed in previous publications, that there is no industry closer to biospheric mechanisms than the agrosphere [1]. Therefore, modern research on the spatial organization and typology of agriculture should be the first step towards harmonizing the relationship between nature and society, and at a new methodological level – with the introduction of environmentally friendly technologies for ecological conversion and scientific provisions of modern synergetics on the invariance of relationships in natural ecosystems. In fact, the biosphere independently eliminates anthropogenic impacts on natural ecosystems that occur in the course of agricultural activities [7]. The “integration” of the specialization of individual farms into natural landscapes is intended not only to reduce the negative anthropogenic impact on natural ecosystems, but also to lay a strong foundation for the administrative-territorial structure of any state [8].

The purpose is to study the possibility of using data on the dynamics of agroecosystems in the design of administrative-territorial entities (using the example of the Cherkasy region).

Theory and methods

In terms of the impact on the administrative-territorial structure, in addition to traditional geographical methodological approaches to justifying the specialization of agriculture (E. Kostorvitsky, A. Rakytnikov, I. Mukomel), its methodology should include the main provisions of the theory of the biosphere and the theory of biotic regulation. It is according to them that in natural ecosystems, with the help of self-regulation mechanisms, a state of stable dynamic equilibrium is formed, which is constantly maintained. Accordingly, it is necessary to create environmentally tolerant agro-ecosystems, in which the main material-energy mechanisms are close to natural analogues [9], ecosystem services

Therefore, the basis of modern production typology methods, in addition to traditional ones (spatial organization of society in general and agriculture in particular, cartographic, geoinformation methods), should be landscape planning methods [10, 11], ecological conversion of agriculture [12], ecosystem services [13, 14], adaptation to climate change [15].

The use of these methods will help, in contrast to the predominantly search-theoretical developments inherent in geographical works to date, to translate them into a constructive-practical plane.

For more than 50 years of development of the concept of production types of agriculture and agricultural zoning, the main procedural problem remains to this day the reduction of subjectivity in the allocation of production types and agricultural areas. According to M.D. Pistun, we are talking about the delineation of the boundaries of agricultural areas, which are very often carried out at the sensitive level of the researcher without sufficient scientific argumentation [16].

In a market economy, when a farmer has much more property rights than a collective farmer or even the head of a collective farm, information on each farm can be of significant commercial interest to competitors, and the technologies used can be the subject of intellectual property. In fact, this is precisely what causes the significant impoverishment of agricultural statistics used by the authors. Moreover, the mandatory list of statistical indicators is decreasing every year.

Thus, in 2014, when the resource [17] was operational, it was possible to obtain data on yield, gross harvest and sown area of each farm. In 2024, these indicators could no longer be used. That is why the authors admit that the element of subjectivity in drawing the boundaries of agricultural regions in 2024 increased compared to 2014 and significantly increased compared to the methodology used before 1991. It is because of this that the spatial "binding" of farms of certain production types to the corresponding natural landscapes was carried out only according to the 2014 data, because carrying out a similar procedure for the 2024 data would not add objectivity to such zoning.

Nevertheless, in addition to involving the main indicator in agricultural zoning - the level of agricultural intensity - traditional economic and geographical methodological approaches of center-periphery, consumer orientation, and transport accessibility were used [18]. In addition, in order to reduce the element of subjectivity in substantiating this particular configuration of agricultural areas, the authors performed a spatial "binding" of farms of certain production types to the corresponding natural landscapes.

In fact, this approach also does not completely solve the problem of correctly "fitting" the type of agriculture into the type of natural environment. However, it is identical to the well-known developments in natural-agricultural zoning. Data from natural-agricultural zoning give the most general idea of a certain territory and do not provide for the "fitting" of a small-sized farm territory into local landscapes/ecosystems [19].

We deliberately did not use these data, since according to the authors, the entire territory of Cherkasy region is classified as a forest-steppe zone, although in fact, under the influence of climate change, the border between the steppe and the forest-steppe has shifted north by more than 100 km [20].

However, given the certain inertia (time lag) of the development of such inert components of the landscape as geological structure, soils and hydrographic network (compared to climate), their characteristics will be relevant for a long time.

Therefore, as the main working hypothesis of research on the spatial organization of agriculture, it is advisable to consider the assumption of the possibility of scientifically correct "inclusion" of the production specialization of individual farms in the corresponding agricultural landscapes, and further, on this basis, to substantiate the administrative-territorial structure. Approaching the ecological imperative, embedded in the concept of sustainable development, will be possible through achieving maximum ecological compliance of cultivated crops and animals with certain agro-climatic resources, which will contribute to a high level of ecological tolerance.

Research methods: cartographic, comparative-geographic, statistical

Results

According to previous studies [1], the specialization of the main mass of farms in the forest-steppe zone of the Cherkasy region (over 85% of the total number) is approaching monoculture (production of grain and oil crops). This is a consequence of the fact that over the past 20 years, the market economy has objectively "washed out" livestock farming, which traditionally (through the use of organic fertilizers) ensured a certain ecological stability of agroecosystems, from the list of specialized industries. At the same time, modern research on the energy of agroecosystems confirms the possibility of greening agricultural production precisely through the diversification of its specialization [21]. The objective conditions for such diversification are created by nature itself, which "embeds" the appropriate agroclimatic potential in each natural landscape [22], which is the objective basis for the development of the corresponding, strictly determined specialization.

An analysis of the distribution of enterprises across the Cherkasy region confirms their compliance (or non-compliance) with the main natural and economic patterns. Thus, most of the farms specializing in grain production are "tied" to the flat plains of the central part of the region. The Dnipro regions of the region are developing specialization with a focus on the consumer (Cherkasy) and significant irrigation resources – open-ground vegetables, dairy and beef cattle breeding, and poultry farming. Only in the western regions of the Uman "cluster" is the most comprehensive crop and livestock specialization developing, which is explained by the relative autonomy of this territory.

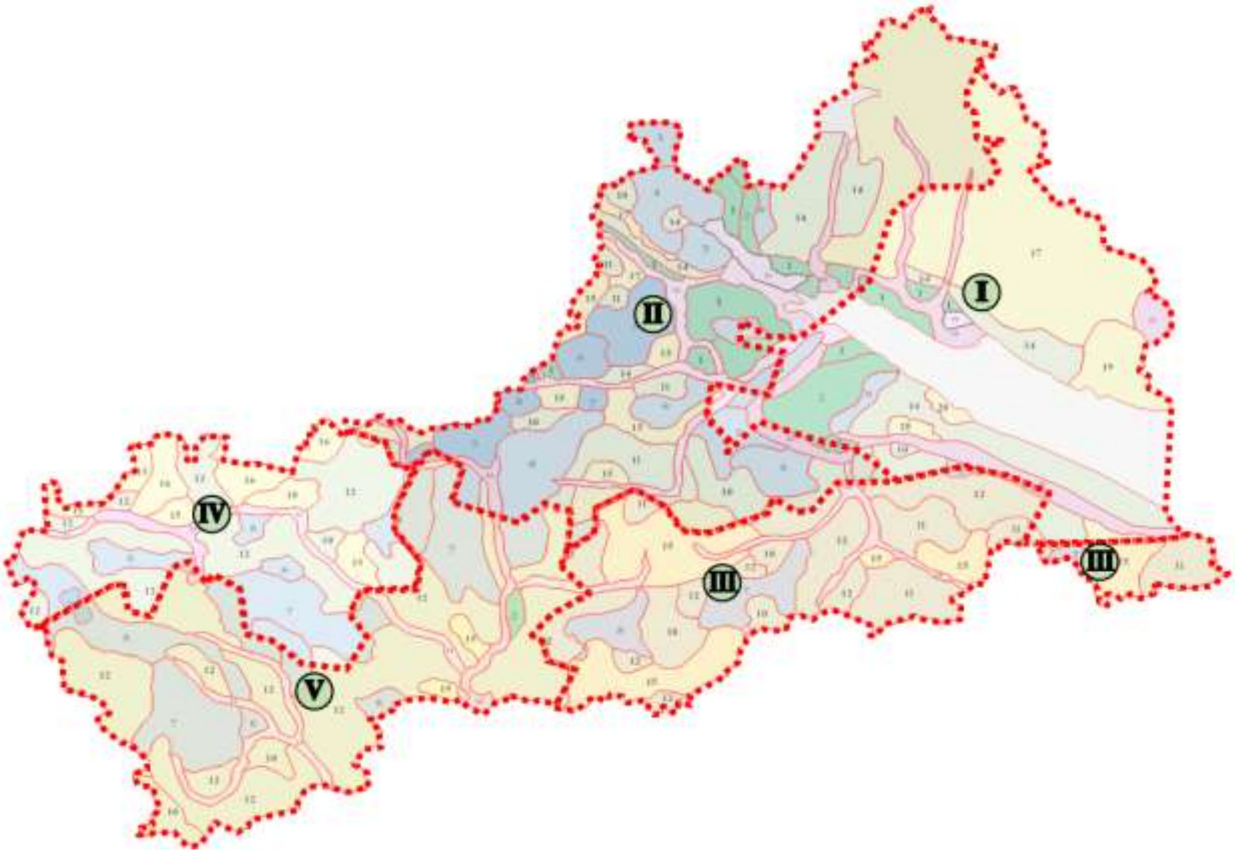
Based on the identification of production types, as well as taking into account landscape diversity [23] [using the "overlay" of the map-mask created by the author (Fig. 1)], an analysis of agricultural regions in their "link" to specific landscapes was carried out.

When conducting the typology and zoning of agriculture in the region based on data from 2024, in addition to the intensity criteria defined above, we used data on climate change, since it was these changes that contributed to the "drift" of the border between the Steppe and Forest-Steppe zones northward by more than 100 km with a corresponding change in specialization.

In 2024, 11 main types of agriculture with 75 subtypes were formed (Fig. 2). The following subtypes of agriculture were added to those identified in 2014: Grain farming (cereals, legumes, and corn) combined with industrial oilseeds and fodder crops; Grain farming combined with industrial oilseeds, fodder crops, and vegetable growing; Cultivation of industrial and fodder crops; Grain farming, industrial crops, fodder crops, and horticulture; Grain farming, industrial crops, fodder crops, and vegetable growing; Horticulture and berry growing; Grain farming, industrial crops, fodder crops, horticulture, and vegetable growing; Vegetable growing; Mushroom growing; Grain farming, industrial crops, fodder crops, and vegetable growing; Fruit growing and berry growing; Grain farming, industrial crops, fodder crops, fruit growing, and vegetable growing; Vegetable growing; Mushroom growing; Grain farming combined with industrial crops, vegetable growing, and animal husbandry; Grain farming, cultivation of industrial and fodder crops, vegetable growing, diversified animal husbandry; Vegetable growing, fruit growing, animal husbandry, dairy and beef cattle breeding, and pig breeding; Pig breeding; Fish farming; Cattle breeding; Rabbit breeding; Grain farming, industrial crops, fodder crops, and integrated plant protection; Grain farming, industrial crops, fodder crops, freight transportation;

Grain farming, technical, feed, scientific services; Pig farming and processing of its products. Horticulture and nursery; Seed production of field crops; Forest nursery; Grain farming, cultivation of industrial and fodder crops with dairy and beef cattle breeding and horse breeding; Grain farming, cultivation of industrial and fodder crops with dairy and beef cattle breeding; Grain farming, cultivation of industrial and fodder crops with dairy and beef cattle breeding, pig farming, and horse breeding; Grain farming, cultivation of industrial and fodder crops, horticulture, and animal husbandry; Grain farming combined with industrial oilseeds, fodder crops, and beekeeping; Grain farming combined with industrial oilseeds, fodder crops, and fish farming; Grain farming combined with industrial oilseeds, fodder crops, and pig farming; Grain farming combined with industrial crops, fodder crops, and animal husbandry; Grain farming combined with industrial crops, vegetable growing, horticulture, and animal husbandry.

We compared the production types of farms in the Cherkasy region in 2014 and 2024 using 12 indicators (an example of one of the districts is given in Table 1).



I, II, III and IV indicate the numbers of agricultural districts as of 2014.

Fig. 1 – Landscape map-mask of the Cherkasy region. (Prepared by the authors based on [7])

Table 1

Key indicators of agricultural production types in the Drabiv district

№	Comparable indicator	Value
1	Increase in the number of farms in 2024 compared to 2014 (%)	455
2	Farms with a predominant production type (as a % of the total number in 2024)	85,3
3	Number of farms that added new industries in 2024 (among those operating since 2014) (units)	2
4	Number of farms where old industries disappeared in 2024 (among those operating since 2014) (units)	5
5	Number of farms where drought-resistant industries (or crops) increased in 2024/2014 (units)	3
6	Number of farms where the number of cover crops increased in 2024/2014	8
7	Number of farms where crops and industries that promote greening are represented (units)	4
8	Average area of ecosystem services provided by one farm in 2014 (sq. km)	43,0
9	Average area of ecosystem services provided by one farm in 2024 (sq. km)	9,4
10	Percentage of farms specializing in livestock production in 2014 (%)	48,1
11	Percentage of farms specializing in livestock production in 2024 (%)	13,8
12	Number of farms with highly specialized commodity sectors added in 2024 (units)	9

I, II, III and IV indicate the numbers of agricultural districts as of 2024.

Fig. 2 – Production types and agricultural regions forming in the Cherkasy region in 2024

The main trends from the comparative analysis of production types are as follows:

- The largest number of farms added in 2024 is in the 1st South-Central agricultural region. It is important to note that this same territory covers the area to which the steppe zone has expanded under the influence of climate change [1]. In other words, the main mass of farms (1,274 out of 1,808) is located in a zone of risky agriculture that is affected by climate change. It is likely that, over time, this group of farms will respond to these changes.

- The decrease in the share of crop and livestock farms in the total number of farms in 2024 compared to 2014 did not affect their total number. The largest decrease in the share of such farms occurred in Zolotonosha (by 45%), Uman (by 45%), and Kamyanska (by 52%). However, despite the low percentage (10-18%) of such farms in these districts, in absolute terms there are at least 20 of them. This is on average 3-5 farms more than in 2014. These indicators show generally proportional changes in the ratio of crop and crop-livestock farms over 10 years.

- The smallest changes (both in terms of quantity and specific weight) occurred in the northern forest-steppe zonal types of farms (Kaniv, Zhashkiv, and Korsun-Shevchenkivskyi districts). To a certain extent, this may indicate that the forest-steppe zone farms are more resilient to climate change (compared to the zonal steppe types).

An analysis of fluctuations in individual indicators in agricultural regions revealed the following:

1. "The number of farms increased in 2024 compared to 2014 (%)". The average regional values of this indicator were exceeded in nine districts: Zvenyhorod, Kamianka, Kaniv, Katerynopil, Korsun-Shevchenkivskyi, Lysianka, Mankivka, Monastyryshche, and Smila. At the same time, the values of this indicator exceed the regional average by two times or more in the Kamyansky, Mankivsky, and Smilyansky districts. This excess may indicate the extremely high activity of land share owners, who, after the land market became more active starting in 2020, returned their land shares and registered new farms. Thus, in the Kamyansky district, instead of 9, 114 new farms were established during 2020-2024. At the same time, all newly formed farms have decided on their specialization, the predominant type of which is grain farming (cereals, legumes, and corn) in combination with

technical crops (soybeans, sunflowers, rapeseed). Crop and livestock farms are almost absent among the new ones.

2. “Farms with a predominant production type (as a percentage of the total number in 2024)”. To a certain extent, this indicator reflects the level of monocultural specialization of farms, since the number of such farms in 2024 increased by approximately two to three times compared to 2014. According to this indicator, the regional averages are slightly exceeded in the Zvenyhorod, Kamyanske, Mankivske, Monastyryshchenske, Uman, and Shpola districts. Therefore, to a certain extent, it can be assumed that there is a tendency toward monocultural specialization in these districts.

3. “Number of farms that added new industries in 2024 (among those operating since 2014), (units)”. This indicator shows that farms operating since 2014 are trying to diversify their production, both under the influence of market factors and by adapting to changing natural conditions (including under the influence of climate change). Of all districts, the values of this indicator exceed the regional average in the Zhashkiv, Zvenyhorod, Zolotonosha, Talne, Uman, Khristynivka, Cherkasy, and Chornobaiv districts. At the same time, this indicator is almost twice as high as the regional average in the Zolotonosha and Khristynivka districts.

4. “Number of farms where old industries disappeared in 2024 (among those operating since 2014) (units)”. This indicator to some extent reflects the impact of market factors, which may have reduced the profitability of these industries, which in turn led to a decision not to develop them further. Of all districts, the values of this indicator exceed the regional average in the Gorodishche, Drabiv, Zhashkiv, Mankiv, Talne, Uman, Chornobaiv, and Shpola districts. At the same time, the values in the Zhashkiv, Mankiv, and Uman districts are almost twice the regional average.

5. “Number of farms where drought-resistant industries (or crops) increased in 2024/2014 (units)”. This indicator may indicate a certain response of farms to climate change. Among such crops, we include millet and sorghum, and among livestock, sheep farming. Of all regions, the values of this indicator that exceed the regional average are in the following: Zvenyhorodsky, Katerynopilsky, Talnivsky, and Shpola. It is important to note that despite the relatively small number of farms in which these industries are represented, all these farms are located within the “new” steppe zone (I agricultural region, Fig. 3).

6. “Number of farms where the number of cover crops increased in 2024/2014 (units)”. This indicator, like the previous one, may indicate the response of farms to climate change, since one of the important functions of cover crops is to retain moisture in the soil [24]. There are about 20 cover crop mixtures. In addition to the traditional lupine, clover, phacelia, mustard, and sudan grass, any grain, radish, and even sunflower can be used [25]. Therefore, without specific data on mixtures, we relied on the data provided by farms, understanding that the use of cover crops/green manure may be one-time – one mixture this year, another next year, and from purchased seed material. Of all regions, the values of this indicator exceeding the regional average are in the following: Drabiv, Zolotonosha, Uman, Khristinivka, Cherkasy, and Shpola. It is important to note that on the analytical map, all of the listed farms are divided into four gradations (by the number of cover crops) and marked with corresponding symbols (Fig. 3).

7. “Number of farms representing crops and industries that promote greening (units)”. This indicator shows the potential of a particular farm in terms of greening agriculture, i.e., minimizing or eliminating the use of mineral fertilizers. In particular, crops that leave nitrogen in the soil, such as peas, chickpeas, vetch, and mung beans, or cattle and rabbit breeding as a source of manure—an effective natural fertilizer that does not require large investments to prepare (composting)—were taken into account. We deliberately did not consider pig manure as a fertilizer, as it requires special, costly, and, as a rule, lengthy preparation before application [26, 28]. In addition, the use of pig manure is largely limited for ecological and aesthetic reasons (foul odor). We also did not consider beekeeping as a source of natural plant pollination, firstly, due to the relatively small number of farms where this industry is developed, and secondly, due to the use by the vast majority of farms of hybrid seeds of most field crops [27].

Of all districts, the values of this indicator exceeding the regional average are in the following: Zhashkiv, Zvenyhorod, Zolotonosha, Mankivka, Talne, Uman, Khristynivka, Cherkasy, and Chornobaivka. At the same time, the highest excess values are in the Uman, Talne, and Chornobaivka districts.

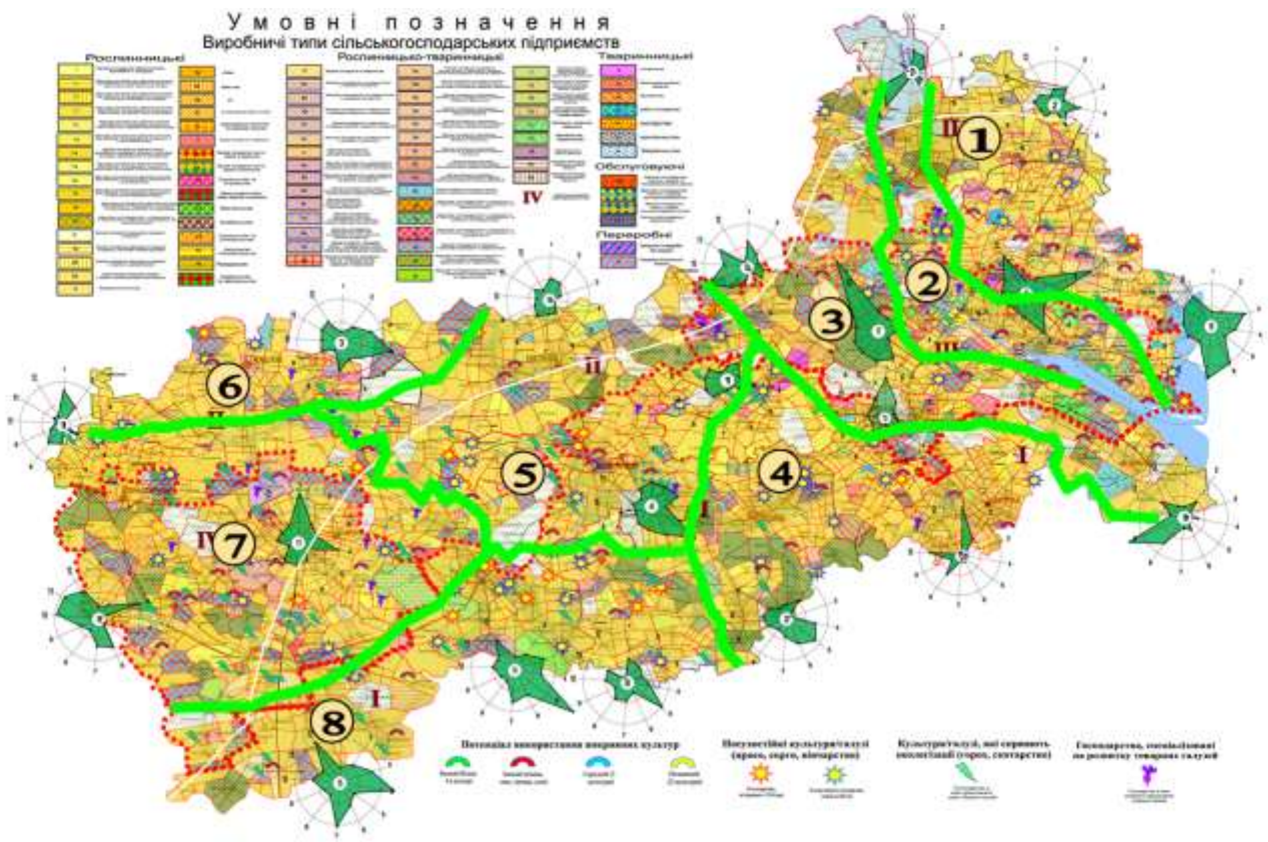


Fig. 3 – Analytical map for comparative analysis of agricultural production typology in 2014 and 2024. (Petal diagrams show fluctuations in key indicators; the white line shows the current boundary between the steppe and forest-steppe zones [32]

8. "Average area of ecosystem services provided by one farm in 2014 (sq km)". Given that agroecosystems are modified ecosystems, we used this indicator to assess their role in providing ecosystem services for a specific area (the area of an administrative district). This indicator is compared with the next one, calculated for 2024. Of all districts, the values of this indicator that exceed the regional average are in the following: Kamyansky, Kanivsky, Korsun-Shevchenkivsky, Mankivsky, Monastyryshchensky, Cherkasy, and Chygyrynsky. The average area provided with ecosystem services by one farm in 2014 by district is distributed as follows: Kaniv (128.3); Chyhyryn (86.9); Cherkasy (84.6); Korsun-Shevchenkivskyi (81.4); Kamyanskyi (80.5); Monastyryshchenskyi (72.0); Mankivskyi (69.5).

The rest of the districts have indicators that fluctuate slightly and are on average lower than the seven districts listed above: Zvenyhorodsky (63.1); Chornobaivsky (59.7); Horodyshchenskyi (58.8); Smilianskyi (58.3); Lysyanskyi (57.3); Katerynopilsky (56.0); Zolotonosha (55.3); Drabiv (43.0); Uman (42.3); Shpola (36.8); Talne (35.2); Khristynivka (35.1); Zhashkiv (30.1).

9. "Average area of ecosystem services provided by one farm in 2024 (sq. km)". Given that the number of farms will increase almost sixfold in 2024, this indicator is expected to decrease, as each farm will account for a smaller area on which ecosystem services are provided. Of all districts, the values of this indicator that exceed the regional average are in the following: Zolotonosha, Kaniv, Korsun-Shevchenkivskyi, Cherkasy, Chyhyryn, and Chornobaivka. The average area covered by ecosystem services provided by one farm in 2024 is distributed among districts as follows: Chornobaivskyi (15.8); Zolotonosha (16.2); Kaniv (19.4); Cherkasy (19.9); Korsun-Shevchenkivskyi (24.8), Chyhyryn (34.7).

The rest of the districts have indicators that fluctuate slightly and are on average lower than the six districts listed above: Gorodishche (13.5); Drabiv (9.4); Zhashkiv (12.5); Zvenyhorodsky (9.5); Kamyansky (5.4); Katerynopilsky (8.2); Lysyansky (9.5); Mankivsky (5.3); Monastyryshchensky (7.1); Smilyansky

(8.8); Talnivsky (9.1); Uman (10.4); Khristinivsky (11.4); Shpola (11.7).

However, given the internal ecological content of this indicator (the area provided with ecological services by one farm), it should be noted that the load per farm in 2024 decreased precisely because of the increase in the number of farms from 375 to 1,808. That is why it is more appropriate to rank administrative districts in order of priority from smaller to larger values: Mankivsky (5.3); Kamyansky (5.4); Monastyryshchensky (7.1); Katerynopilsky (8.2); Smilyansky (8.8); Talnivsky (9.1); Drabivsky (9.4); Zvenyhorodsky (9.5); Lysyansky (9.5); Uman (10.4); Khristinivsky (11.4); Shpola (11.7); Zhashkivsky (12.5); Horodyshche (13.5); Chornobaivka (15.8); Zolotonosha (16.2); Kaniv (19.4); Cherkasy (19.9); Korsun-Shevchenkivskyi (24.8), Chyhyryn (34.7). A comparison of this indicator with 2014 showed the following (Table 2).

Based on the analysis of the data in the table, we can see that the largest decrease in the area providing ecosystem services occurred in

Table 2

Comparison of the area covered by ecosystem services provided by one farm in 2014 and 2024 (km^2)

№	Name of the district	2014	2024	Difference (%)
1.	Mankivsky	69,5	5,3	1311
2.	Kamensky	80,5	5,4	1490
3.	Monastyryshchensky	72,0	7,1	1014
4.	Katerynopilsky	56,0	8,2	683
5.	Smilyansky	58,3	8,8	663
6.	Talnivsky	35,2	9,1	387
7.	Drabivsky	43,0	9,4	457
8.	Zvenigorodsky	63,1	9,5	664
9.	Lysyansky	57,3	9,5	603
10.	Uman	42,3	10,4	407
11.	Khristinivskyi	35,1	11,4	308
12.	Shpolianskyi	36,8	11,7	315
13.	Zhashkivskyi	30,1	12,5	241
14.	Horodyshchenskyi	58,8	13,5	436
15.	Chornobaivskyi	59,7	15,8	378
16.	Zolotonoskyi	55,3	16,2	341
17.	Kanivskyi	128,3	19,4	661
18.	Cherkasy	84,6	19,9	425
19.	Korsun-Shevchenkivskyi	81,4	24,8	328
20.	Chyhyrynskyi	86,9	34,7	250

three administrative districts: Kamyanske (1490%), Mankivske (1311%), and Monastyryshchenske (1014%). Looking at the maps (landscapes, physical, soils (Fig. 1), agroclimatic), it is difficult to attribute this distribution to natural factors. However, comparing these values with the first indicator (Table 1), we find a certain similarity.

10. “Percentage of farms specializing in livestock production in 2014 (%)”. Given the higher intensity of livestock farming, this indicator should reflect the intensity of agriculture in 2014, since preliminary estimates show that the percentage of farms specializing in crop and livestock production reached 30-40% that year. Comparing this indicator with the values in 2024 will help to draw conclusions about the growth (or decline) of the overall level of agricultural intensity within individual production types. Of all regions, the values of this indicator that exceed the regional average are in the following: Zolotonosha, Kamyansky, Korsun-Shevchenkivsky, Uman, Khristinivsky, and Chornobaivsky.

Analyzing the table (Table 3), we can see that the Kamyanskyi district has lost the most livestock farming over the past 10 years (-72.6% /-3). During this time, cattle and pig farming have almost completely disappeared, which is most likely explained by the low profitability of these sectors at the beginning of farming activities. After all, the Kamyanskyi district is among the leaders in terms of (1) the increase in farms (1266%).

Table 3.

Comparison of the specific weight and absolute number of enterprises that developed livestock specialization in 2014 and 2024

№	Name of the district	%			Quantity (units)		
		2014	2024	Δ	2014	2024	Δ
1	Mankivsky	46,5	14,4	-32,1	5	10	+5
2	Kamensky	77,0	4,4	-72,6	8	5	-3
3	Monastyryshchensky	10,0	10,1	+0,1	1	10	+9
4	Katerynopilsky	50	17,2	-32,8	6	14	+8
5	Smilyansky	43,8	13,2	-30,6	7	14	+7
6	Talnivsky	50,0	14,8	-35,2	13	15	+2
7	Drabivsky	48,1	13,8	-34,3	13	17	+4
8	Zvenigorodsky	43,7	6,6	-37,1	7	7	0
9	Lysyansky	32,2	14,1	-18,1	4	11	+7
10	Uman	66,6	16,4	-50,2	20	21	+1
11	Khristinivskyi	94,4	30,9	-63,5	9	18	+9
12	Shpolianskyi	56,6	14,8	-41,8	16	14	-2
13	Zhashkivskyi	40,6	16,8	-23,8	13	13	0
14	Horodyshchenskyi	46,6	15,3	-31,3	7	11	+4
15	Chornobaivskyi	69,2	25,5	-43,7	18	24	+6
16	Zolotonoskyi	59,2	21,7	-37,5	17	19	+2
17	Kanivskyi	5	10,4	+5,4	2	7	+5
18	Cherkasy	52,6	24,7	-27,9	10	24	+14
19	Korsun-Shevchenkivskyi	54,5	25,0	-29,5	6	9	+3
20	Chyhyrynskyi	28,5	20,0	-8,5	4	7	+3

11. Almost nothing has changed in the Monastyryshche district over the past 10 years – the percentage (10.0%/10.1%) has remained virtually unchanged, although the number of livestock sectors increased by 9 in 2024. In the Khristinivskyi district, there was a fairly high loss of livestock sectors (-63.5%) with an increase in the number of farms with livestock sectors (+9). In the Shpola district, the absolute number of farms with livestock sectors decreased (16/14) with a significant decrease in the percentage of these sectors (56.6/14.8). In two districts, Zvenyhorod and Zhashkiv, the absolute number of farms has not changed over 10 years, 7/7 and 13/13, respectively.

The remaining regions share a common trend of a decrease in the share of livestock sectors in 2024 (by an average of 30-50%) with a simultaneous increase in the absolute number of these sectors (by an average of 3-9).

12. “The number of farms with highly specialized commodity sectors in 2024 (units).” This indicator may demonstrate the priority of market factors in the formation of the specialization of individual farms. Since the phrase “highly specialized commodity sectors” only roughly defines the list of such sectors, because any crop can be a “commodity,” we limited ourselves to plotting beet growing on the analytical map (Fig. 3). Of all regions, the values of this indicator that exceed the regional average are in the following: Zhashkiv, Zolotonosha, Talne, Uman, Khristynivka, Cherkasy, and Chornobaivka. At the same time, in Zolotonosha, Uman, and Cherkasy, these values exceed the regional average by more than half.

The use of data from agricultural typology in the design of the administrative-territorial structure was made possible thanks to the experience accumulated by Prof. S. Sonko in identifying the boundaries of agroecosystems in the Kharkiv region [28]. In particular, we attempted to identify them in the Cherkasy region. A comparison of the results of these studies deserves a separate, more detailed presentation, which we have provided in [1].

Certainly, the identification of “entropy stress zones” in the Cherkasy region as evidence of the noospheric nature of agroecosystems requires further research. However, we were unable to fully utilize the geoecological approach to the identification and further analysis of agroecosystems for several reasons. The first is the lack of data (as mentioned above), which did not allow us to correctly define the natural boundaries of agroecosystems (types of agricultural land organization). The second is the peculiarities of the configuration of the Kharkiv (closer to a circle) and Cherkasy (closer to a line) regions. The latitudinal elongation of the Cherkasy region confirms traditional ideas about the boundaries of natural zones (and corresponding landscapes). However, in recent years, the drift of the boundaries of the steppe and forest-steppe natural zones to the north (Fig. 3) has "included" almost the entire territory of the region in the Steppe [29].

In addition, the distribution of natural landscapes across the Cherkasy region attests to their significant discreteness. Even within the old boundaries of natural zones (before 2019), separate areas (in the form of "patches") of coniferous-broadleaf forests, broadleaf forests, and especially forest-steppe forests are very often interspersed with steppe landscapes. Therefore, we were unable to identify landscape areas that would have significant continuity with a predominant landscape type over most of the Cherkasy region due to the danger of "mechanistic" (and, therefore, subjective) nature of this procedure.

The only exception is the territory of the 1st agricultural region (2014, eastern part), a significant part of which (almost half) is occupied by a homogeneous landscape of continuous extension (17 - meadow-steppe, slightly dissected with depressions and a beam-hollow system, with typical light and medium loamy chernozems on lowland, accumulative, loess terrace plains (Fig. 1).

As for the economic boundaries of agroecosystems (boundaries of agricultural regions), their configuration in 2014, with a certain degree of convention, allows us to distinguish them by the number of agricultural regions (5). However, the lack of data on the types of agricultural land use allows us to speak only about the spatial identification of agroecosystem cores, which (based on the experience of agricultural zoning in the Kharkiv region [28]) hardly change their spatial location over time (Fig. 4). These are:

I. Prydniprovsko-Cherkasy region (comprising the territories of Cherkasy, Zolotonosha, Chornobaivka, Drabiv, the eastern part of Horodyshche, the northern part of Smila, and the eastern part of Chyhyryn administrative districts).

II. Central Forest-Steppe (comprising the territories of Kaniv, Korsun-Shevchenkivskyi, Zvenyhorodka, Lysyansk, the northern part of Horodyshche, and the northern part of Shpola administrative districts).

III. Southern Forest-Steppe (comprising the southern and western parts of Chyhyryn, the whole of Kamyansky, the southern part of Smilyansky, the central and southern parts of Shpola, and the whole of Katerynopil administrative districts).

IV. North-Western Forest-Steppe (comprising the territories of Zhashkiv, Monastyryshche, and Mankiv administrative districts).

V. South-Western Forest-Steppe (comprising the territories of Talne, Uman, and Khristyniv administrative districts).

As we can see, the number of districts designated in 2014 is close to the number of administrative districts "assigned" in the new administrative reform. According to the reform, there are only four of them: Zolotonosha, Cherkasy, Zvenyhorod, and Uman. We consider this conditional coincidence to be an objective prerequisite for building a new administrative system based on ecosystem principles, which has been discussed in separate works [30].

The above data may refer to the meso level of agroecosystems [30]. However, the results of previous studies allow us to compare the micro level of agroecosystemology, where the primary unit of study is a farm. With regard to the hierarchy of agroecosystems, in the near future, the lowest micro-level, which spatially corresponds to a peasant farm, is "visible" and, from the point of view of ecosystemology, seems to us to be the most important, since it covers the lowest taxa of landscape classification closest to the natural organization – facies, formations, and tracts. As for the composition of the listed agricultural regions, they are also similar, but to natural-agricultural zoning [19].

The dynamics of changes in the production typology of agriculture over 10 years (2014-2024) shows that in most cases, the production types identified in 2014 were joined in 2024 by those that are more narrowly specialized in fruit growing, vegetable growing, certain areas of animal husbandry (fish farming, rabbit breeding, horse breeding), product processing, and services (fertilizers, seed production, seedling production, repair of agricultural machinery) [31].

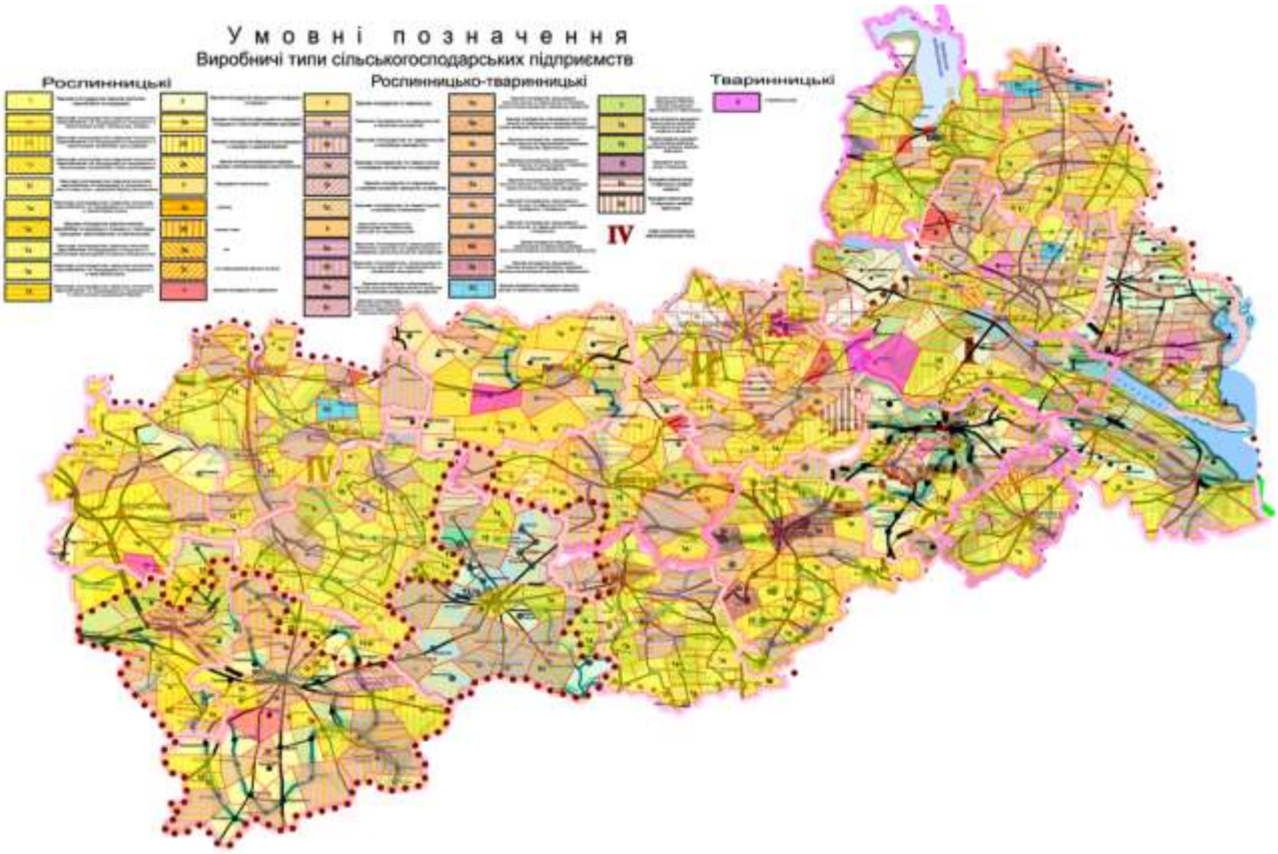


Fig. 4 – Agricultural regions and production types of farms in Cherkasy region (2014)

Conclusions

Compared to 2014, the configuration of agricultural areas has changed significantly, which has been fundamentally influenced by climate change. Thus, in place of the former 5th forest-steppe and 3rd steppe (2014) along the southern border of the region, the 1st steppe (2024) agricultural region has formed with signs of more pronounced zonal specialization (crops and industries adapted to the arid climate). However, over the past 10 years, most farms have deliberately abandoned certain more labor-intensive livestock sectors (cattle breeding, pig breeding, poultry farming), which to a certain extent may indicate a decrease in the environmental friendliness of production due to the lack of manure. Over the past 10 years, the number of farms has increased almost sixfold, which is associated, firstly, with the intensification of land reform and, secondly, with the strengthening of the trend towards "integrating" agroecosystems into natural landscapes, as mentioned above.

Compared to 2014, the number of agricultural entities has increased almost fivefold. In total, there were 375 farms operating in the Cherkasy region in 2014, and 1,808 in 2024. In 2014, nine main types of agriculture with 39 subtypes were identified. In 2024, 11 main types of agriculture with 75 subtypes were formed. This situation is explained primarily by the activation of the land market, when shareholders, having returned their shares, began to form independent farms. From an environmental point of view, the increase in the number of farms may indicate a reduction in the environmental load per farm and, to a certain extent, confirms the need to reduce the area of a single farm, as emphasized by the classics of agricultural science as early as the 19th and 20th centuries. Despite the dominance of traditional technologies in the main zonal areas of specialization, a significant number of farms (about 30%) responded to climate change over a 10-year period (2014-2024) by gradually introducing cover crops into crop rotations to retain moisture in the soil.

Thus, in "constructing" agroecosystems, on the basis of which it will be possible to improve the administrative-territorial structure on the principles of sustainable development, in addition to the level of the agricultural region (2024), it is advisable to "approach” from two distinct “poles” of understanding of the agroecosystem – agroecological (according to O.O. Sozinov) and natural-agricultural zoning. However, for more effective implementation of any management actions from the level of the highest state authorities down to the level of rural communities, the most suitable level is that of agroecosystems, which are formed by types of agricultural enterprises.

For the Cherkasy region, the main regional centers remain the cores of agroecosystems located in the middle of the four modern administrative districts (Zolotonosha, Cherkasy, Zvenyhorod, and Uman). A more accurate determination of their location, and, most importantly, the periphery of agroecosystems with subsequent clarification of boundaries, will require additional research, both with the use of special statistics and expedition data.

Conflict of interest

The authors declare no conflict of interest regarding the publication of this manuscript. Furthermore, the authors have fully adhered to ethical norms, including avoiding plagiarism, data falsification, and duplicate publication.

***Authors Contribution*:** all authors have contributed equally to this work.

The work does not use artificial intelligence resources.

References

1. Sonko, S. P., & Zozulia, I. O. (2024). Ecologically balanced agroecosystems – a guarantee of sustainable development. *Man and Environment. Issues of neoecology*. (41), 57–69. https://doi.org/10.26565/1992-4224-2024-41-04 (in Ukrainian)
2. Khvesyk, M., & Bystriakov, I. (2012). A paradigmatic view of the concept of sustainable development of Ukraine. *Economy of Ukraine*, (6), 4–12. (in Ukrainian)
3. Sozinov, O. O., Sonko, S. P. (2006). Agroecosystem. In A. V. Tolstokhov (Ed.). Ecological Encyclopedia (Vol. 1, p. 14). Kyiv: Center for Environmental Education and Information LLC. (in Ukrainian)
4. Prymak I. D. and Hamaliy I. P. (Eds.) (2024). Agroclimatology. Vinnytsia: TVORY LLC. (in Ukrainian)
5. Berezhnyak, E. M., Naumovska, O. I., & Berezhnyak, M. F. (2022). Degradation processes in Ukrainian soils and their negative impact on the environment. *Biological Systems: Theory and Innovation*, *13*(3–4), 96–109. (in Ukrainian)
6. Lanovenko, O. G., Ostapishina, O. O. (2013). Stable (sustainable) development. Dictionary-reference book on ecology. Kherson: PP Vyshemirsky V. S. Retrieved from https://web.archive.org/web/20180619190047/http:/ekhsuir.kspu.edu/bitstream/123456789/1563/1/%D0%A1%D0%9B%D0%9E%D0%92%D0%9D%D0%98%D0%9A%20%E2%80%93%20%D0%94%D0%9E%D0%92%D0%86%D0%94%D0%9D%D0%98%D0%9A.pdf (in Ukrainian)
7. Gorshkov, V., & Makarieva, A. (2018). Time in life, technology and physics. https://doi.org/10.13140/RG.2.2.35964.59528
8. Makarov, G. (2022). The ethnic factor in reforming the administrative-territorial structure: the experience of European democratic states. *Aspects of Public Administration*, *10*(5), 54–61. https://doi.org/10.15421/152235 (in Ukrainian)
9. Sonko, S. P., Maksymenko, N. V., Vasylenko, O. V., Hurskyi, I. M., Shyian, D. V., & Zozulia, I. O. (2022). The concept of agroecosystems as a theoretical basis for environmentally tolerant nature management. *Man and Environment. Issues of Neoecology*. (37), 71–81. https://doi.org/10.26565/1992-4224-2022-37-07 (in Ukrainian)
10. Maksymenko, N. V. (2017). Landscape and ecological planning: theory and practice: monograph. Kharkiv. (in Ukrainian)
11. Golubtsov, O. G. (2021). Landscape planning: basic provisions and experience of implementation in Ukraine. *Ukrainian Geographical Journal*, *1*(113), 63–72. https://doi.org/10.15407/ugz2021.01.063 (in Ukrainian)
12. Demianuk, O. S., Gumenyuk, I. I., Levishko, A. S., Vakulenko, S. O., & Poltava, O. P. (2022). Ecological aspects of forming sustainable food systems. *Balanced nature management*, (4). 119–128. https://doi.org/10.33730/2310-4678.4.2022 (in Ukrainian)
13. Soloviy, I., & Kuleshnyk, T. (2021). Comprehensive evaluation of ecosystem services in forest-agricultural landscape. *Proceedings of the Forestry Academy of Sciences of Ukraine*, (22), 209-216. https://doi.org/https://doi.org/10.15421/412119 (in Ukrainian)
14. Shvorak, A., & Filiuk,D. (2021). The impact of ecosystem services on the intensification of agricultural production. *Economic journal of Lesya Ukrainka Volyn National University*. *1*(25), 37–51. https://doi.org/10.29038/2786-4618-2021-01-37-51 (in Ukrainian)
15. Snizhko, S., Ryabchenko, O., & Tripolska, G. (2021). Technology needs assessment for climate change adaptation preparing a technology action plan. Retrieved from https://unfccc.int/ttclear/TNA/UKR-TAP-TAP_Adaptation_2021.pdf

16. Pistun, M. D., Gutsal, V. O., Provotar N. I. (1997). Geography of agro-industrial complexes. Kyiv: Lybid, (in Ukrainian)
17. *AnyFoodAnyFeed* Retrieved from http://www.anyfoodanyfeed.com
18. Piotrowska, I. (2025). Geography as a Compass for Understanding the World. In: Piróg, D., Świętek, A. (eds) Future-Ready Geography. Key Challenges in Geography. Springer, Cham. https://doi.org/10.1007/978-3-031-81268-2_1
19. Martyn, A. G., Osypchuk, S. O., & Chumachenko, O. M. (2015). Natural and agricultural zoning of Ukraine: monograph. Kyiv: CP "Komprint". (in Ukrainian)
20. Zozulia, I. (2024). Geographical features of agriculture in the Cherkasy region in the context of climate change. *Problems of continuous geographical education and cartography*, (40). 68–79. https://doi.org/10.26565/2075-1893-2024-40-08 (in Ukrainian)
21. Polyovyi, A. M. (2017). Formation and functioning of the agroecosystem. Odesa. (in Ukrainian)
22. Chimi, P. M., Fobane J.L... & Mala, A.W. (2025). A bibliometric analysis of agroecological practices: trends, impacts, and future directions. *Environmental Systems Research.* Preprint. https://doi.org/10.21203/rs.3.rs-4861038/v1
23. Report on the development of a regional eco-network scheme for the Cherkasy region. (2014). Department of Ecology and Natural Resources of the Cherkasy Regional State Administration. Cherkasy. (in Ukrainian)
24. Orlov, O. (2023). Cover crops: advantages and features of effective use. Proposal. Retrieved from https://propozitsiya.com/ua/pokryvni-kultury-perevagy-ta-osoblyvosti-efektyvnogo-vykorystannya (in Ukrainian)
25. Filatov, V. (2024). Siderates as a way of survival. *Farming systems "ROOT VS. IRON"*. Retrieved from https://www.youtube.com/watch?v=gBGZ8yS8DWw (in Ukrainian)
26. Karatyeeva, O. I., Koval, O. A., & Groza, V. I. (2018). Technology for processing household and agricultural waste. Mykolaiv: MNAU. (in Ukrainian)
27. What is the difference between varieties and hybrids? (2025). *Lucky Seed*. Retrieved from https://luckyseed.ua/ua/articles/chem-otlichayutsya-sorta-ot-gibridov (in Ukrainian)
28. Sonko, S. P. (2018). Agricultural zoning of the Kharkiv region: geographical problem – ecological consequences. *Journal of Geology, Geography and Geoecology*, *26*(1), 165-175. https//doi.org/10.15421/111818 (in Ukrainian)
29. Adamenko, T. (2019). Climate change and agriculture in Ukraine: what farmers need to know. German-Ukrainian Agricultural Policy Dialogue. Retrieved from https://www.apd-ukraine.de/fileadmin/user_upload/Hanbuecher/Zmina_klimatu_v_Ukrajini_web3.pdf (in Ukrainian)
30. Hnatiuk, O. M., & Melnychuk, A. L. (2020). Territorial patterns of changes in the administrative structure of Ukraine. *Ukrainian Geographical Journal*, (3.), 46 – 55. https://doi.org/10.15407/ugz2020.03.046 (in Ukrainian)
31. Zozulia, I. O. (2024). Changes in the specialization of agriculture in the Cherkasy region over 10 years. *Man and Environment. Issues of Neoecology*, (42). 147–160. https://doi.org/10.26565/1992-4224-2024-42-10 (in Ukrainian)

Submission received: 10.09.2025 / Revised: 14.11.2025 / Accepted: 20.11. 2025 / Published: 30.12. 2025

С. П. СОНЬКО[1], д-р географ. наук, проф.,
професор кафедри екології та безпеки життєдіяльності
e-mail: sp.sonko@gmail.com ORCID ID: https://orcid.org/0000-0002-7080-9564

Н. О. ГНАТЮК[1], канд. біол. наук, доц.,
доцент кафедри екології та безпеки життєдіяльності
e-mail: natgnatiuk@gmail.com ORCID ID: https://orcid.org/0000-0002-4159-9924

В. О. ВОЄВОДА[1],
аспірант кафедри екології та безпеки життєдіяльності
e-mail: voevodavolodimir@gmail.com ORCID ID: https://orcid.org/0009-0003-2989-276X

[1]*Уманський національний університет,*
вул. Інститутська, 1, м. Умань, Черкаська обл., 20305, Україна

ПРОСТОРОВА ОРГАНІЗАЦІЯ СІЛЬСЬКОГО ГОСПОДАРСТВА ЯК ОСНОВА АДМІНІСТРАТИВНО-ТЕРИТОРІАЛЬНОГО УСТРОЮ НА ЗАСАДАХ СТАЛОГО РОЗВИТКУ

Мета. Можливість використання даних з динаміки агроекосистем при конструюванні адміністративно-територіальних утворень (на прикладі Черкаської області), можливість науково коректного «вписання» виробничої спеціалізації окремих господарств у відповідні агроландшафти, а надалі, на цій основі обґрунтування адміністративно-територіального устрою.

Методи. Картографічний, порівняльно-географічний, статистичний.

Результати. Аналіз розподілу підприємств по території Черкаської області підтверджує відповідність (або невідповідність) головним природним та господарським закономірностям. На місці колишніх 5-го лісостепового і 3-го степового (2014) вздовж південного кордону області сформувався 1-й степовий (2024) сільськогосподарський район з ознаками більш яскравої зональної спеціалізації (культури та галузі, адаптовані до посушливого клімату). За 10 років кількість фермерських господарств зросла майже вшестеро, що пов'язане, по-перше, з активізацією впровадження земельної реформи і, по-друге, з посиленням тенденції «вписання» агроекосистем у природні ландшафти. Незважаючи на панування традиційних технологій в головних зональних галузях спеціалізації, помітна кількість фермерських господарств (близько 30%) за 10 років (2014-2024 р.р.) відреагувала на зміни клімату поступовим введенням у сівозміни покривних культур, які зберігають вологу у ґрунті. Так, більша частина господарств з зерновою спеціалізацією «прив'язана» до плакорних пласких місцевостей центральної частини області. Придніпровські райони області розвивають спеціалізацію з орієнтацією на споживача (м. Черкаси) і на значні ресурси зрошення – овочі відкритого ґрунту, молочно-м'ясне скотарство, птахівництво. Лише в західних районах Уманського «куща» розвивається найбільш комплексна рослинницько-тваринницька спеціалізація, що пояснюється певною автономністю цієї території. На підставі виділення виробничих типів, а також з урахуванням ландшафтного різноманіття здійснений аналіз сільськогосподарських районів в їх «прив'язці» до конкретних ландшафтів.

Висновки. Порівняно з 2014 роком суттєво змінилась конфігурація сільськогосподарських районів, на яку докорінно вплинула зміна клімату. Для Черкаської області головними районоутворюючими осередками залишаються ядра агроекосистем, які знаходяться в середині сучасних 4-х адміністративних районів (Золотоніського, Черкаського, Звенигородського та Уманського). Більш точне визначення їхньої локації, і, головно, периферії агроекосистем з наступним уточненням кордонів, вимагатиме проведення додаткових досліджень, як з залученням спеціальної статистики, так і експедиційних даних.

КЛЮЧОВІ СЛОВА: *сталий розвиток, агроекосистема, сільське господарство, ландшафт, районування, картографічний, Черкаська область*

Конфлікт інтересів

Автори заявляють, що конфлікту інтересів щодо публікації цього рукопису немає. Крім того, автори повністю дотримувались етичних норм, включаючи плагіат, фальсифікацію даних та подвійну публікацію.

Внесок авторів: всі автори зробили рівний внесок у цю роботу

В роботі не використано ресурс штучного інтелекту.

Список використаної літератури

1. Сонько С. П., Зозуля І.О. Екологічно збалансовані агроекосистеми – запорука сталого розвитку. *Людина та довкілля. Проблеми неоекології.* 2024. Вип. 41. С. 57-69. https://doi.org/10.26565/1992-4224-2024-41-04
2. Хвесик М., Бистряков І. Парадигмальний погляд на концепт сталого розвитку України. *Економіка України.* 2012. № 6. С. 4-12.
3. Созінов О.О., Сонько С.П. Агроекосистема. Редколегія: А.В.Толстоухов (головний редактор) та ін К.:ТОВ «Центр екологічної освіти та інформації», 2006.-Т.1. С.14.
4. Примак І.Д., Гамалій І.П., Мартинюк І.В., Лозінський М.В., Федорук Ю.В., Покотило І.А., Лозінська Т.П., Присяжнюк Н.М., Павліченко А.А., Хахула В.С., Устинова Г.Л., Горчанок А.В., Савенко Н.М. Агрокліматологія : підручник / за ред. І.Д. Примака та І.П. Гамалій. Вінниця : ТОВ «ТВОРИ», 2024. 263 с.
5. Бережняк, Є. М., Наумовська О. І., Бережняк М. Ф.. Деградаційні процеси в ґрунтах України та їх негативні наслідки для довкілля» *Біологічні системи: теорія та інновації* 2022: Т. 13. №3-4. С. 96-109.
6. Лановенко О. Г., Остапішина О. О. Розвиток стабільний (що підтримується). Словник-довідник з екології: Херсон : ПП Вишемирський В. С., 2013. С. 157. URL: https://web.archive.org/web/20180619190047/http:/ekhsuir.kspu.edu/bitstream/123456789/1563/1/%D0%A1%D0%9B%D0%9E%D0%92%D0%9D%D0%98%D0%9A%20%E2%80%93%20%D0%94%D0%9E%D0%92%D0%86%D0%94%D0%9D%D0%98%D0%9A.pdf
7. Gorshkov, V., & Makarieva, A. Time in life, technology and physics. 2018. https://doi.org/10.13140/RG.2.2.35964.59528
8. Макаров, Г. (2022). Етнічний чинник реформування адміністративно-територіального устрою: досвід європейських демократичних держав. *Аспекти публічного управління,* Т. 10. № 5. С. 54-61. https://doi.org/10.15421/152235
9. Сонько С.П., Максименко Н.В., Василенко О.В., Гурський І.М., Шиян Д.В., Зозуля І.О. Концепція агроекосистем як теоретична основа екологічно толерантного природокористування. *Людина та довкілля. Проблеми неоекології.* 2022. Вип. 37. С.71-81. https://doi.org/10.26565/1992-4224-2022-37-07
10. Максименко Н.В. Ландшафтно-екологічне планування: теорія і практика: монографія. Харків, 2017. 216 с

11. Голубцов О. Г.. Ландшафтне планування: основні положення та досвід реалізації в Україні. *Укр. геогр. журн*. 2021. Т.1. №113. С. 63-72. https://doi.org/10.15407/ugz2021.01.063
12. Дем'янюк, О. С., Гуменюк, І. І., Левішко, А. С., Вакуленко, С. О., Полтава, О. П. Екологічні аспекти формування стійких продовольчих систем. *Збалансоване природокористування.* 2022. № 4. С.119-128 https://doi.org/10.33730/2310-4678.4.2022
13. Soloviy, I., & Kuleshnyk, T. Комплексне оцінювання послуг екосистем лісоаграрного ландшафту. *Наукові праці Лісівничої академії наук України*. 2021. № 22. С.209-216. https://doi.org/https://doi.org/10.15421/412119
14. Shvorak, A., Filiuk, D Вплив екосистемних послуг на активізацію розвитку сільськогосподарського виробництва. *Економічний часопис Волинського національного університету імені Лесі Українки*. 2021. Т.1. № 25 С.37–51. https://doi.org/10.29038/2786-4618-2021-01-37-51
15. Snizhko S., Ryabchenko O., Tripolska G. Technology needs assessment for climate change adaptation preparing a technology action plan. URL: https://unfccc.int/ttclear/TNA/UKR-TAP-TAP_Adaptation_2021.pdf
16. Пістун М. Д. Гуцал В.О., Провотар Н. І. Географія агропромислових комплексів. К. : Либідь, 1997.
17. *AnyFoodAnyFeed.* URL: http://www.anyfoodanyfeed.com
18. Piotrowska, I. Geography as a Compass for Understanding the World. In: Piróg, D., Świętek, A. (eds) Future-Ready Geography. Key Challenges in Geography. 2025. Springer, Cham. https://doi.org/10.1007/978-3-031-81268-2_1
19. Мартин А.Г., Осипчук С.О., Чумаченко О.М Природно-сільськогосподарське районування України: монографія. К. : ЦП «Компринт» 2015. 328 с.
20. Зозуля І. Географічні особливості сільського господарства Черкаської області в умовах змін клімату. *Проблеми безперервної географічної освіти і картографії.* 2024. Вип. 40. С. 68–79. https://doi.org/10.26565/2075-1893-2024-40-08
21. Польовий А. М. Формування та функціонування агроекосистеми Одеса:, 2017. 120 с.
22. Chimi, P. M., et al. A bibliometric analysis of agroecological practices: trends, impacts, and future directions. *Environmental Systems Research.* 2025. 14.1 4. https://doi.org/10.21203/rs.3.rs-4861038/v1
23. Звіт з розробки регіональної схеми екомережі Черкаської області. Департамент екології та природних ресурсів Черкаської облдержадміністрації. Черкаси, 2014. 138 с.
24. Орлов О. Покривні культури переваги та особливості ефективного використання. URL: https://propozitsiya.com/ua/pokryvni-kultury-perevagy-ta-osoblyvosti-efektyvnogo-vykorystannya
25. Філатов, В. Сидерати як спосіб виживання. Системи землеробства «КОРІНЬ ПРОТИ ЗАЛІЗА». 2024. URL: https://www.youtube.com/watch?v=gBGZ8yS8DWw
26. Каратєєва О. І., Коваль О. А., Гроза В. І. Технологія переробки побутових відходів та відходів сільського господарства : курс лекцій для здобувачів вищої освіти ступеня «бакалавр» спеціальності 162 «Біотехнології та біоінженерія». Миколаїв: МНАУ, 2018. 190 с.
27. У чому різниця між сортами та гібридами? URL: https://luckyseed.ua/ua/articles/chem-otlichayutsya-sorta-ot-gibridov
28. Сонько С.П. Сільськогосподарське районування Харківської області: географічна проблема – екологічні наслідки. *Журнал з геології, географії та екології.*, 2018. Т. 26. № 1. С.165-175. https://doi.org/https://doi.org/10.15421/111818
29. Адаменко Т. Зміна клімату та сільське господарство в Україні: що варто знати фермерам? Німецько-український агрополітичний діалог. 2019. 36 с. URL: https://www.apd-ukraine.de/fileadmin/user_upload/Hanbuecher/Zmina_klimatu_v_Ukrajini_web3.pdf
30. . Гнатюк О.М., Мельничук А.Л.. Територіальні закономірності змін адміністративного устрою України. Український географічний журнал. 2020 № 3. С. 46-55. https://doi.org/10.15407/ugz2020.03.046
31. Зозуля І. О. Зміни у спеціалізації сільського господарства Черкаської області за 10 років. *Людина та довкілля. Проблеми неоекології.* 2024. Вип. 42. С.147- 160. https://doi.org/10.26565/1992-4224-2024-42-10

Отримано:10.09.2025 / Переглянуто: 14.11.2025 / Прийнято: 20.11. 2025 / Опубліковано: 30.12. 2025