International Journal of Engineering & Technology, 7 (4.8) (2018) 850-855

International Journal of Engineering & Technology

Website:www.sciencepubco.com/index.php/IJET

Research paper



Principles of Agricultural Landscapes Durability Formation by the Example of Poltava Region

Tetiana Lytvynenko[1], Tetiana Lvovska[2]*, Roman Mishchenko[3], Valerii Harmash[4]

[1]Poltava National Technical Yuri Kondratyuk University, Ukraine
[2]Poltava National Technical Yuri Kondratyuk University, Ukraine
[3]Poltava National Technical Yuri Kondratyuk University, Ukraine
[4] Head of Limited Liability Enterprise «AHROZEMINFORM», Ukraine
**Corresponding author E-mail: lvovska.tetiana@ukr.net*

Abstract

Land resources usage of Poltava region for their functional use is analyzed. Based on the research data analysis, the principles of agricultural landscapes durability formation are created and formed into 4 groups: territorial differentiation, environmental friendliness, maintenance checkup, law-regulatory and controlling.

Keywords: *agricultural landscape, agriculturally used areas, coefficient of agricultural landscapes stability, landscape durability, plowed field.*

1. Introduction

Ukraine as a state with a sufficiently diverse biota (more than 70 thousand species), the cost of which is estimated at 7.6 trillion dollars is one of the most powerful reserves of European biodiversity recovery, so its preservation as part of Ukrainian natural capital is one of the important factors in its GNP growth [1-3].

European richest land of Ukraine combined with favorable climatic conditions should ensure a high level of agricultural production. However, Ukraine's agro-ecosystems productivity in 2-3 times inferior of the EU, with the trendthere for many years, despite the progress of socio-economic formations, land use structure, scientific support development of agricultural sector, etc [4].

Sustainable development of Ukrainian agricultural sector is impossible without saving and landscape humanity field harmonious development, because it is the basis for spiritual and material population needs, food supply security. Agricultural land is 40-44% according to resource supply, but the current land use in Ukraine does not meet the sustainable development principles. Significant transformation processes during the land reform changed land relations, legal land ownership forms and property violated the land structure and production organization, heightened environmental and economic problems of modern land usage in agriculture, and as a result - reduced the efficiency of agricultural land use. Therefore, highly sustainable agricultural production functionality, especially in a competitive market environment, requires new methodological approaches to its organization based on the principles of sustainable adaptive-landscape agro-ecosystems forming.

2. Defining the problem of agricultural landscapes formation

Under the condition of methodological aspects of environment agricultural landscapes sustainability the land relations transformation was devoted to the work of such scientists as: D. Dobriak, V. Saiko, A. Sohnych, A. Tretiak, A. Barvinsky, V. Tymoshevskyi, T. Kizos, G. Vlahos, L. Schaller and other [1-9]. However, taking into consideration the significant number of new agricultural enterprises, a variety of natural and economic conditions in different soil and climatic zones of the country, it is necessary to ensure the high-performance environmentally sustainable agricultural landscapes models development on the variable basis, considering the relevant features of a particular territory and resources of each entity on earth.

The aim of research is to determine the principles of formation and practical measures development for improving environmental performance and modern agricultural landscapes durability, taking into account soil and climatic conditions of Poltava region.

Agricultural landscapes are a construction at the interface between natural processes and human activities. Land management introduces changes to natural processes on the one side and evokes feedbacks on human activities on the other side.

According to current scientific views, agricultural landscape has been seen as integral natural production heosystem (agricultural heosystem), whereby everything is interconnected and has an impact on agricultural productivity cultures [9, 10]. Modern agriculture covers a large area of agricultural events each year expanding its scope and depth of the impact on natural landscapes. The most important characteristic changes that occur are maximizing agricultural productivity cultures.

Agricultural landscapes are usually defined as the visual result of land uses and management systems in an area. Although, such productive definitions are adequate for the analysis of agriculture and animal husbandry in an area, they lack a

Copyright © 2018 Authors. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

broader perception of landscape level analysis. Such the analysis should include an ecological dimension, since landscapes are habitats of organisms and species and changes in farming practices reflect immediately on biodiversity and a symbolic dimension, as a landscape is a medium of representing, structuring and symbolizing environments for users who live in, visit, consume, imagine it, etc. and agricultural landscapes represent symbols and ideologies. Agricultural landscapes are characterized by significant restructuring of the whole natural complex. Major changes in phytosphere with unproductive wild plants are replaced by high-performance cultures, new forms and varieties are selected, but the vegetation becomes monotonous. The agricultural landscapes impact on land resources is significant and diverse. Lands condition thus depends on the nature, form, business activities directions. Agriculturally used areas meet with such impact kinds as plowing, drainage, irrigation, agricultural work technology, grazing, fertilizers, pesticides, chalking use, etc. An important feature of agricultural landscapes – cultivated soils whose formation is not only a process of influence aimed to improve their fruitfulness, but also as a natural phenomenon that causes adverse changes because of agricultural imperfections practices. Therefore, in agricultural landscapes, along with cultivated soils, which differ from the primary high content of humus and mobile nutrients, improved water-physical properties and morphological characteristics, and ultimately increased productivity, there are exhausted soils, which are characterized by primary characteristics deterioration [11]. In agricultural landscapes microclimate parameters change significantly, especially in the case of large, entirely deserted territories. The dynamic stability of agricultural landscapes, unlike naturally self-regulated landscapes, is substantially weakened due to the partial anthropogenic change in biota, water and thermal regimes violation, soil formation processes, and biochemical cycling. This causes destructive phenomena in the farming lands: erosion, soil resalting, alcalination, disturbance of soil, dredging, waterlogging and contamination of soils and waters, etc. This requires definition of their durability tasks forming in order to ensure sustainable development of the agricultural economy sector [12]. Agricultural landscapes, due to differences in the economic land use, divided on the following main types, such as: field, garden, mixed field-garden and meadow-pasture. For soils plowing are typical field type which changes their properties. With a low culture of agrotechnics the humus content is reduced, a solid fine-grained structure of black soil is lost, and vice versa, high agricultural machinery increases or maintains the soil fertility at the required level. The garden type is characterized by low level of self-regulation and the need for high agricultural machinery for high yields. Anthropogenic field-garden landscapes are a planting of fruit trees, between which there are berry bushes, vegetables, flowers growing. Meadow and grazing type of the landscape complex is characterized by meadows and pasture, among which there are excessive cattle grazing. For Ukraine and for Poltava region, each of these agricultural landscapes types is common [3, 4]. It is determined that one of the main land resources productivity reducing factors are the degradation due to the continuous insufficient ecological farming systems use, the violation of optimal structural and functional territory organization, the balance of the main stabilizing components, which reduces the anti-erosion agricultural landscapes stability, their ecological deterioration condition. The components of modern agricultural landscapes determine their stability or instability. Anthropogenic activity in agroecosystems, as a rule, enhances the risks of environment deterioration [9].

Analysis of agricultural landscapes stability is presented in the form of structural-logical scheme (Fig. 1).

Intensive anthropopression on natural resources has caused a violation of the ecological landscapes stability, including agrarian ones. One of the reasons for ecological situation destabilization in agrarian landscapes is a significant plowing. It adversely affects the reduction of agroecosystem stability, leads to ecological imbalance in the ratio of arable land areas, meadows, forests, reservoirs and impoverishment of biological diversity. This leads to a sharp decline in the agricultural landscapes productivity.

The plowing of Ukraine territory averages 55.2%, and in the steppe regions, this indicator reaches 90%, which goes far beyond the permissible norms of high farming agriculture culture. Due to the intensive erosion processes prevailing on the cultivated lands, there is a need to reduce the arable areas in order to improve agricultural landscapes ecological stability.

Plowed field, to a greater extent than other agricultural landscapes components, causes ecosystem disruption. In the process of plowing, natural vegetation is destroyed, species biodiversity is reduced. When the natural vegetation is destroyed, the process of soil destruction is due to a sharp increase in direct absorption of solar radiation, which leads to "burning" humus, deterioration of its aggregative ability. Open soil in the summer on a sunny day on the surface can warm up to 80°C and even higher. This means not only increased moisture loss due to evaporation, but also a threatening increase in the air temperature, which prevents the "dew point" and the corresponding rain formation. That is, the problem of excessive landscapes vegetation is not only purely local, but also causes the deterioration of microclimatic characteristics in general. There are grounds for believing that rising droughts and aridity in Ukraine and other countries are the cause of this reason.

The problems of finding the best options for agricultural landscapes improvement with the help of ecologically balanced and economically feasible ratio achieving between different types of agricultural land are devoted to the works of many Ukrainian scientists, namely S. Bulihin, V. Burakov, L. Novakovskii, O. Tarariko, Yu. Tarariko, A. Tretiak and others [1, 5, 10].

Agricultural landscapes structure formation is strongly associated with relief that determines the ability of land for agricultural goods growing. The most scientific-based ground for the environmentally sustainable agricultural landscapes formation was conservation cropping system implementation with contour-reclamation territory planning.

To create sustainable and balanced agricultural landscapes with high biological productivity, it is necessary to reduce the rate of erosion, which is possible by streamlining the agricultural landscapes structure. Today, numerous research in the landscape area show ecological and agrotechnological systems development, but only a relatively small part of these findings is being implemented in practice. In modern conditions, this is achieved by optimizing the composition and scientifically grounded correlation of lands, forest, meadow, wetland, recreational zones and aquatic ecosystems, and removing from plowed field degraded and low-yielding land.

In modern agricultural sector, the formation of an environmentally sustainable (healthy) and effective agricultural landscape for a long time becomes of special significance. This means that agricultural landscape, along with the highest productivity achievement, should, to the same extent, carry out protective environmental and aesthetic functions. This can be achieved by creating the maximum ecological diversity of an intensively used area. It will be able to counteract the one-sided loads that arise during the economic development of the territory (soil cultivation, fertilization, pesticides, etc.), that is to create conditions for erosion processes preventing, pollution of reservoirs and air basin, in other words, to ensure landscape ecological stability. Such stability, according to Dokuchaev research, it is possible to achieve by regulation of rivers, lagars, beams, as well as water management on all lands used in agricultural production, normalized definition of areas allocated for arable land, forests, pastures, application of soil cultivation practices that most contribute to the correct moisture use. Dokuchaev plan for the Steppe revival is ecological. The system of forest strips protecting the fields from drylands, the system of ponds supporting a groundwater certain level is all non-violent interference with nature, otherwise stated it is restoration of those interconnections that existed in the exuvial steppe [10].

The landscapes of Ukraine were maintained in harmony until the first half of the nineteenth century, i.e, before serfdom liquidation, after which the systematic forests felling in the forest steppe, the drainage of lands in the marshy scrub (Polissya) and plowing in the steppe zones began.

In our time, we can talk about two types of agricultural landscapes that have been formed in Ukraine. The first type is characterized by broad-leaved grasslands, cross-linked field-forest bogs, and 80-90% of the land stock. Monocultures are common here, mineral fertilizers and chemical agents are used in moderate norms. These are our steppes.

The second type is characterized by the mosaic spread of fields among woody vegetation, differentiated cultivation of agricultural crops by intensive application of mineral fertilizers and plant protection products. These are the areas of the forest-steppe and Polissya. Such landscapes are characterized by significantly higher productivity while preserving natural production potential. The first type of agricultural landscapes are rapidly approaching production and biological barriers, the violation of which is threatened by region agriculture crisis.

Consequently, in the agricultural landscape should be a stable self-regulating system, which would exclude negative phenomena. It must implement an integrated approach, that is, the protection of both soil and water, plant and animal life [13].

In order to achieve the ecological balance in the agricultural landscape, the rate of plowed field afforestation in conditions of plain forest-steppe zone terrain should be at least 2.5-4%, and the average - not less than 10-12% (for Poltava region now 9%).

In land-use as a complex, multifactorial system, the natural and anthropogenic components and their properties are so interrelated that a slight change in the influence of only one of them can lead to significant changes in the man's acquisition of agricultural products [7]. Therefore, the problem of transition to sustainable development of the agricultural sector requires an integrated approach to its solution, while taking into account the social, environmental and economic factors.

With this background, sustainable land use development should be considered as a model of agricultural socio-economic development sphere, when the satisfaction of growing material population needs is ensured by the highly efficient land resources use, taking into account environmental constraints on technogenesis. Such model should provide, first of all, a set of measures that ensure the creation of favorable conditions for the sustainable agricultural landscapes formation in various natural and agricultural areas of the country.

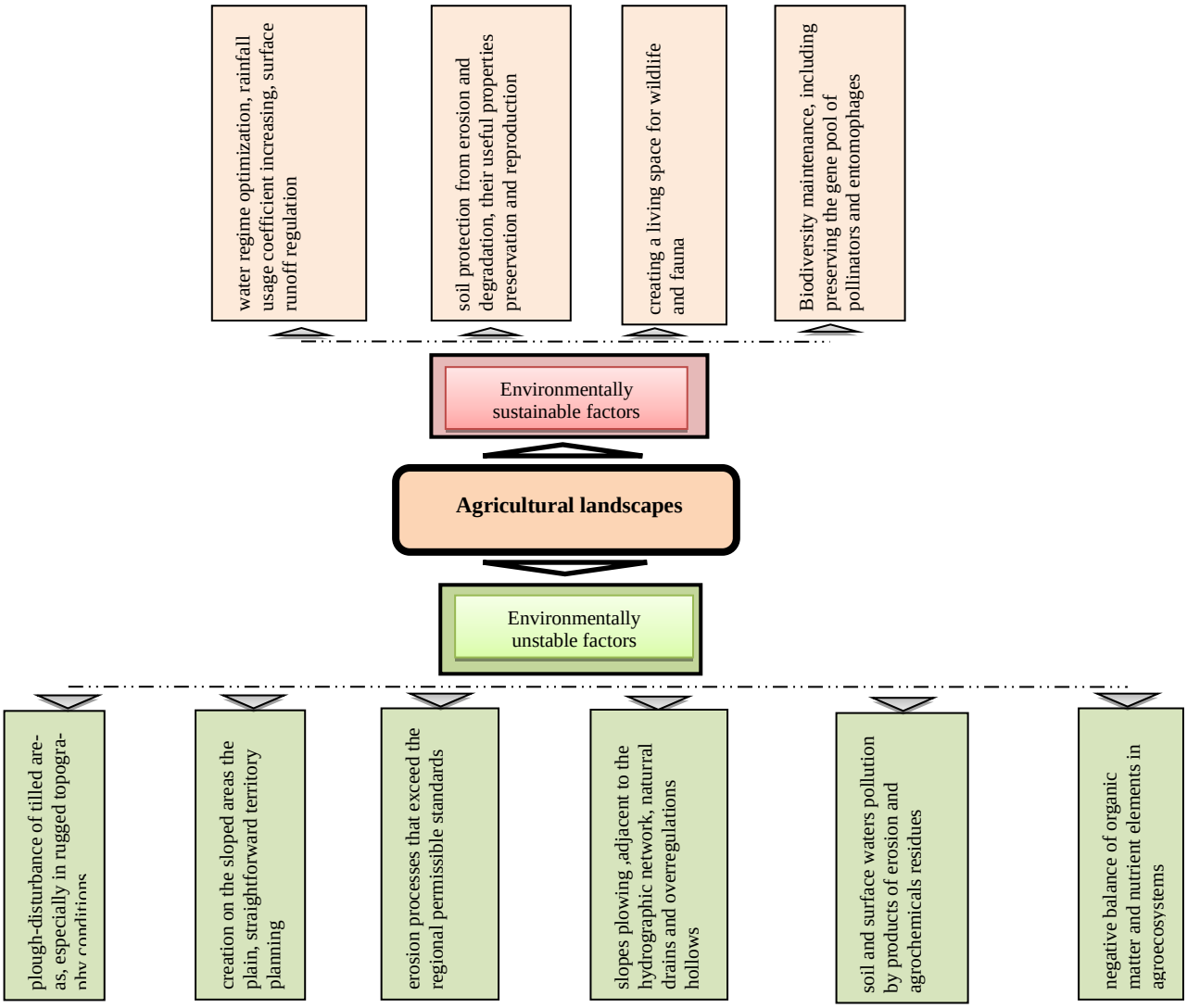


Fig. 1: The landscape durability analysis

Poltava region is characterized by very high intensity of land resources exploitation. At the same time, the region territory has quite a variety of natural conditions. Therefore, the research of land resources condition in the region and advanced ways establishment of their rational use are very urgent.

For functional use, the region land fund is divided into:

Agriculturally used areas	2223197 ha (77%)
forested area	286033 ha (10%)
built-up land	119382 ha (4%)
opened marshy land	85099 ha (3%)
opened land without plant cover	12923 ha (0,45%)
below water	148431 ha (5%)

In the territory of agricultural lands, farming acreage occupy 2165381 ha or 75% of which:

plowed field	1774686 ha (62%)
grassland	2478 ha (0,08%)
perennial plantings	28686 ha (1,0%)
hay meadow	160334 ha (0,06%)
grazing land	199195 ha (7%)

The analysis shows that current agriculturally used areas structure in Poltava region for its functional use does not correspond to the sustainable development principles (the ratio of plowed field and ecologically stabilizing lands in the region is 1.02, and in agricultural landscapes – 3.02), since it determines the excessive anthropogenic impact on land resources. Poltava region agriculturally used areas structure is calculated and presented in Tab. 1.

Table 1: Poltava region agriculturally used areas structure

Total land area, ths. ha	Agriculturally used areas function-type, ths. ha					
	agricultural landscaping			environment stabilizing		
	total	plowed field	lands under perennial plantings	total	forests and forested area	waters and opened marshy land
I. Administrative-territorial unit lands Agricultural enterprise (total land by right of ownership and use) / Land reserve and lands, not provided to the property and permanent use within the settlements (which are not provided for temporary use)						
2875,0/ 640,5	1075,2/ 295,6	1035,4/ 34,5	2,9/ 6,8	40,2/ 342,9	28,1/ 137,1	12,1/ 205,8
II. Among other – within settlements Agricultural enterprise (total land by right of ownership and use) / Land reserve and lands, not provided to the property and permanent use within the settlements (which are not provided for temporary use)						
426,4/ 137,2	10,1/ 61,9	9,3/ 9,1	0,2/ 1,8	1,7/ 48,4	1,6/ 32,1	0,1/ 16,3

The ecological agricultural landscapes stability directly depends on the area of preserved natural phytocenosis. Ecological situation improvement is seen in the spec. gravity plowed field reducing, accordingly, forage lands increasing, bushy and tree plantation, id est agriculturally used stabilizing areas, functioning on natural analogues with minimized anthropopression [6, 8].

Qualitative assessment of land resources includes land productivity determination, landscape durability, degradation processes that occur under the human economic activity influence. End of purpose is possible unless and until scientific research of many territory parameters and the their manifestation peculiarities under the intensive economy development influence [8, 9].

An integral part of agriculturally used areas characteristics in quality is the environmental stability assessment and territory anthropopression. The basic qualitative data, indicating the ecological agricultural landscape balance, their stability and the degree of transformation under the business activities influence, are the coefficients of anthropopression and environmental sustainability. These indicators provide an opportunity to comprehensively assess, in other words, how rational is the land structure fund. 62% of the territory in Poltava region under the plowed field, but the level of agricultural land cultivation exceeds 79%, which shows the intensive technogenesis influence on the environment. On the territory of Poltava region agricultural enterprises, the share of ecologically stabilizing lands in the structure of agricultural landscapes is only 20% (refer to Table 1). Such agriculturally used areas correlation causes the ecological situation deterioration and clearly needs an improvement. In general, the land use of Poltava region is characterized by an average level of ecological stability (Kes. = 0.35), and agriculturally used areas are environmentally unstable (Kes. = 0.30). The problem of Poltava region economic and natural lands ratio optimizing includes less as each particle determination than as their rational distribution on agricultural enterprises territories.

To solve the problem of agriculturally used areas structure optimizing, scientists suggest different methodological approaches, in particular, regarding the particle of plowed field in agricultural landscapes. It is proved that maximum permissible cultivation territory level should not be flooded above 40%, and agriculturally used areas – 50% [3, 10]. Therefore, in our opinion, the optimal agriculturally used areas structure should be considered, where the agricultural landscape areas type is 57-60%, the environment stabilizing – 32-34% and rural (territory of settlements) – 5-6%. According to expert estimates, in Poltava region, 128 ths. ha of plowed field should be excluded from intensive cultivation, 25% of which belongs to eroded soils, 43% - unproductive land, 18% - land of water protection zones [10]. This will reduce Poltava region plough-disturbance of tilled areas to 38%.

The coefficient of anthropopression ($K_{a.p}$) characterizes how great influence on the environment condition , human activities have, including land resources [11]. This coefficient is calculated by the formula:

$$K_{a.p.} = \sum P \times Б / \sum P, \quad (1)$$

where P – area of land with an appropriate anthropopression, ha; B – a ball of the corresponding area with a certain anthropopression level. According to A.M. Tretiak research [5], the land of industry, transport, settlements has 5 points; plowed field, perennial plantings – 4; natural forage lands, forested beams – 3; forest bands, shrubs, forests, swamps, lands under water – 2; reserved area – 1 point.

According to the determined optimized structure of the territory land fund the coefficient of agricultural landscapes stability (K_{sa}) is calculated, which is an analogue of agriculturally used areas coefficient and represents the ratio of ecologically stable lands amount areas (hay meadow, grazing land, forests, swamps), as well as lands allocated for rehabilitation and regeneration , to the total plowed field and perennial plantings area. According to this indicator, the territory with $K_{sa} > 0.7$ relates to the sufficient stable, $K_{sa} <0.3$ 7 relates to the most pregnable. The coefficient of agricultural landscapes durability allows to check the optimization land conducting work effectiveness [8].

Research results. On 01.01.2016, in Poltava region agricultural development amounted to 77.3% of the total land area, and plowed field – 61.7%. These are average data, which in some Poltava regions reach even greater values. Thus, farms located on the central territory regions brought under cultivation by 82.6% and plowed by 66.0%; the territory of the northern Poltava regions is brought under cultivation by 78.9%. Indicators of development and ploughness in the southern region (73.8% and 61.3% respectively) are lower than the regional average. The same tendency has ploughness of forest-steppe zone (58.6%). Analysis of plowed field composition in Poltava region also indicates the presence of large unproductive and unfit land part (refer to Table 1).

As a result of performed calculations, the total anthropopression coefficient in Poltava region is about 4, (Ukraine-wide – 3.4).

To analyze the environmental agricultural landscapes durability in the modern and optimized Poltava region land structure, the coefficient of agricultural landscapes stability (Kes.) was calculated. According to the current agriculturally used areas structure, coef. Kes. amount to 0.33, which is below 0.7 – the value considered as the lower limit of landscape structure stability and indicates the extremely critical land use condition. In the districts Poltava region, Kes ranges in central districts – 0.33; northern – 0.35; southern – 0.34, so, the region territory is ecological unstable [4-6].

The principles of agricultural landscapes durability formation are presented in the donut chart form Fig. 2.

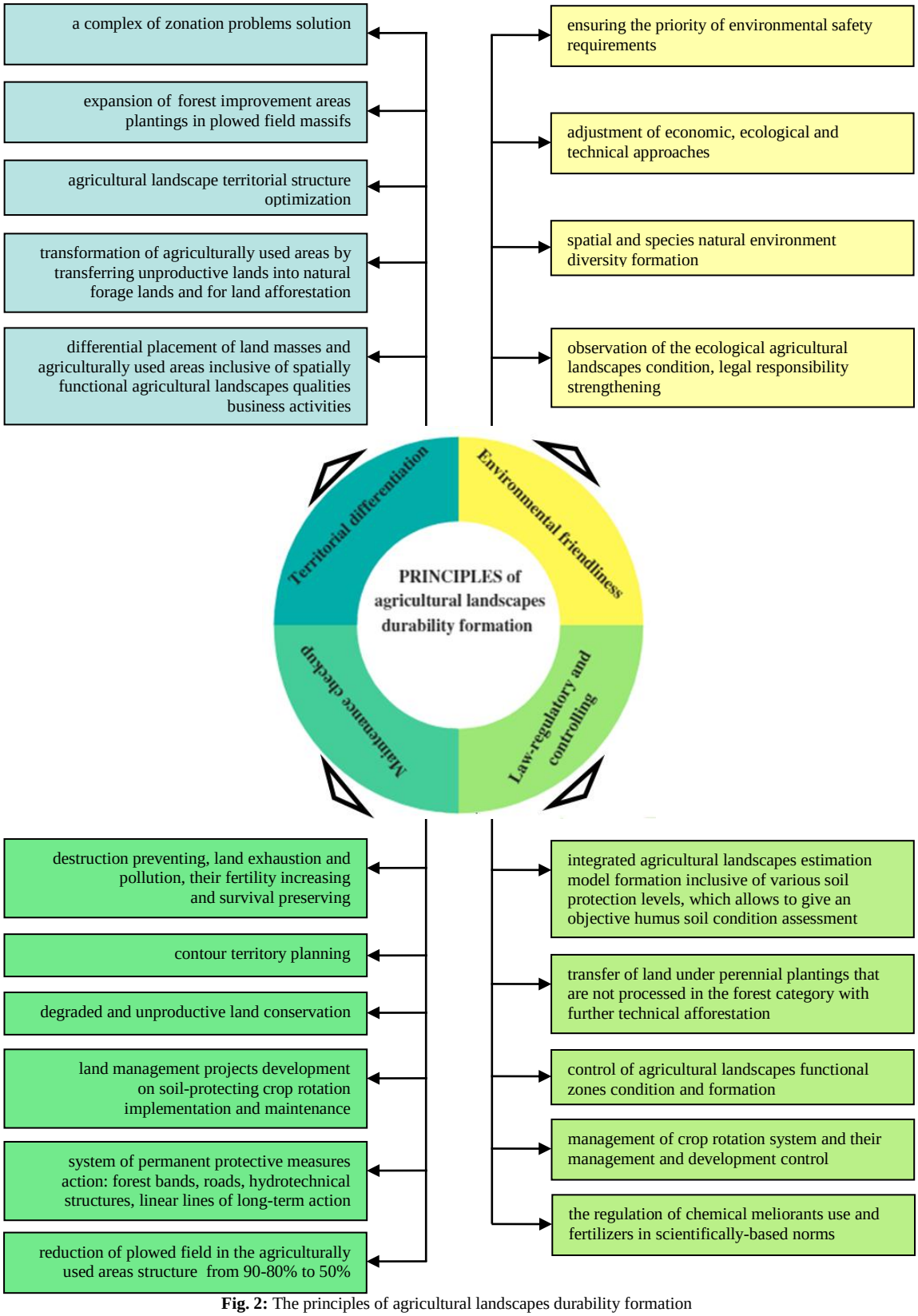


Fig. 2: The principles of agricultural landscapes durability formation

3. Conclusions

On average in Poltava region, the territory development is 77.3%, and plowed field is 62%. The most developed and plowed field of the region is central region zone, where indicators of development and ploughness refer 83.7% and 65.0% respectively of the total land area.

In Poltava region, the most ecologically sustainable are the land areas of forest-steppe zone, the least – steppe areas. The most significant anthropopression is felt by the central regions, located around the regional center.

Based on the indicators of ecological mismatch index of plowed field use and the excess of eligible tillage, it has been determined that territory ploughness, taking into account the maximum area of land suitable for use, should not exceed 56.5% of the total area.
On average, in Poltava region, the indicator of agricultural landscape stability during the transformation of plowed field into ecological stabilizing lands can improve from 0.33 to 0.49. These results indicate the need to reduce the land ploughness not only due to unproductive and inappropriate land, but also due to extraction land in which degradation features have not reached the precrisis condition.

References

[1] Bulyhin S. Yu. Formuvannia ekolohichno stalykh ahrolandshaftiv / S. Yu. Bulyhin. – Kyiv : Urozhai, 2005. – 300 s.
[2] Vyluchennia z intensyvnoho obrobitku maloproduktyvnykh zemel ta yikhnie ratsionalne vykorystannia: metodychni rekomendatsii / [za red. V. F. Saika]. – Kyiv : Ahrarna nauka, 2000. – 39 s.
[3] Dobriak D. S. Teoretychni zasady staloho rozvytku zemlekorystuvannia u silskomu hospodarstvi / Dobriak D. S., Tykhonov A. H., Hrebeniuk N. V. – K. : Urozhai, 2004. – 136 s.
[4] Sokhnych A. Ya. Problemy vykorystannia i okhorony zemel v umovakh rynkovoi ekonomiky : [monohrafiia] / A. Ya. Sokhnych. – Lviv : NVF «Ukrainski tekhnolohii», 2002. – 252 s.
[5] Tretiak A. M. Naukovi osnovy ekonomiky zemlekorystuvannia ta zemlevporiadkuvannia / A. M. Tretiak, V. M. Druhak. – Kyiv : TsZRU, 2003. – 337 s.
[6] Barvinskyi A.V. Zabezpechennia ekolohichnoi stabilnosti ahrolandshaftiv yak osnovna peredumova staloho rozvytku ahrarnoho sektora ekonomiky // «Sustainable development of economy». №22013[19]. – Mizhnarodnyi naukovo-vyrobnychyi zhurnal. – Khmelnytskyi: Universytet ekonomiky i pidpryiemnytstva. – 2013. – S. 199 – 202.
[7] Tymoshevskyi V.V. Improving Landscape Spacious Development / V.V. Tymoshevskyi, I. Yurko, G. Shariy // International Journal of Engineering and Technology (UAE) Vol 7, No 3.2 (2018). – P. 463 – 468, https://doi.org/10.14419/ijet.v7i3.2.14573
[8] T.Kizos, G. Vlahos The evolution of the agricultural landscape pp.133-143. https://www.researchgate.net
[9] Schaller L. Agricultural landscapes, ecosystem services and regional competitiveness –Assessing drivers and mechanisms in nine European case study areas / L. Schaller, S.Targetti and others // Land Use Policy, Vol.76, July 2018, pp: 735-745, https://doi.org/10.1016/j.landusepol.2018.03.001
[10] Metodychni rekomendatsii z ahroekolohichnoi otsinky struktury ahrolandshaftiv i system zemlekorystuvannia za danymy dystantsiinoho zonduvannia Zemli vysokohoprostorovoho rozriznennia – K., 2012. – 34 s. https://zenodo.org
[11] Kizos T. Agricultural landscape dynamics in the Mediterranean: Lesvos (Greece) case study using evidence from the last three centuries/ T. Kizos, M. Koulouri // Environmental Science & Policy, Vol. 9, Issue 4, June 2006, pp: 330-342, https://doi.org/10.1016/j.envsci.2006.02.002
[12] Andersen E. Land tenure in European agricultural landscapes // Landscape 2018. Frontiers of agricultural landscape research. Book of Abstracts 12–16 March 2018 Berlin, Germany, pp 229-230.
[13] Delclaux J. Project presentation: ecological permeability of agricultural landscapes, available from: Julie Delclaux, Oct 26, 2017 https://www.researchgate.net/publication/320620812 http://doi.org/10.13140/RG.2.2.30965.47840