Agrolandscape Ecotones Potential for Rational Nature Management.

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ABSTRACT

The article deals with matters of studying mechanisms of agrolandscapes adaptation to dynamic environment based on using environment-forming and environment-stabilizing potential of such landscape components as ecotones. Premised on results of ecotones research, obtained by the authors in the territory of Russia's forest-steppe zone, the article suggests optimal parameters of the protective forest plantation system inclusive of ecotones.

Key words: ecotone, forest fringe, agrolandscape, adaptation to climatic changes, land use, use of natural resources.

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INTRODUCTION

In recent decades the climate has been tending to change. Thus far the mankind amassed significant global experience of implementation of programs of economy adaptation to global climate change negative implications. Among adaptational measures in the agricultural sector (mainly in farmery) we can mention: restructuring of agricultural land; development of water-preserving technologies; soil defense (including erosion control); development of biotechnologies and selection of new agricultural plants; increase in productivity due to increase in using of fertilizers and plant-protecting agents and so on. Reserve of increasing of landscapes' capabilities of adaptation to dynamic climate can be found in their own resources, for example environment-forming and environment-stabilizing potential of such landscape components as ecotones [1]. An ecotone as a zone of conversion between adjoining ecosystems is defined by spatial and time scales, and also by intensiveness of interaction between contacting ecosystems [2]. Ecotones in agrolandscapes are mostly depressed zones of land use or zones occupied with herbaceous vegetation, often weeds [3]. According to ecotones significance for landscapes, they are often used for solving problems of agrolandscapes spatial structure optimization [4, 5], and for improving biodiversity [6, 7], creation of ecological corridors [8], carbon sequestration [9, 10]. Lack of researches of ecotones' role in agrolandscapes' adaptation to modern changes in climate is the ground of this work's actuality. Our work's aim is to reveal ecotones' potential for improvement of agrolandscapes' capabilities to adapt to dynamic environment.

METHOD

As diagnostic indicators marking ecotones borders we chose microclimatic characteristics. Research subjects were forest fringe ecotones of different types, formed under the influence of tree plantations (table 1). Common ground of performed researches lay in regarding general conditions of weather and character of underlying terrain (in case of agrolandscapes – before gathering agricultural plants). The researches were carried out in June-July 2009-2011 in clear weather. Transects, with step size of 1 m, were disposed in the direct line perpendicularly from a forest stand (transects' length did not exceed 21 m). Each transect had 21 points. Also we put a control point over a distance of 100 meters from the forest stand on each object. Within the limits of a transect and at a control point we measured microclimatic characteristics: atmosphere pressure, relative humidity of surface air, temperature of surface air, temperature of the soil in layers of 0-20 cm and 20-40 cm and illumination of the underlying terrain. Measurements were taken in morning, midday and evening, with subsequent calculation of average values. All measurements were taken at a height of 0.25-0.30 m (average height of agricultural plants).

MAIN PART

The research's results demonstrated that all values of parameters under investigation, except for atmosphere pressure, within the borders of transects definitely (on the basis of two-sample t-test) differ from values at control points (100 m from a forest stand). Therefore, special microclimatic conditions are formed under the influence of tree plantations. The most obvious dynamics of microclimatic indicators can be seen under the influence of point objects. Objects # 4, 7, 8, 9 differ from the others because of the least amount of microclimatic parameters fluctuations. This is because of uniformity of the territory conditions, created under the influence of the system of forest belts being more than 100 years old. Temperature characteristics (air and soil) are distinctly connected in dynamics. Atmosphere pressure was excluded from the following analysis because of low variability of characteristics (variation coefficient equaled to 0.24-0.46%). Regarding each microclimatic parameter we singled out clusters via method of k-average with the program

STATISTICAL

According to Kaiser criterion, the solution about presence of two clusters is statistically valid (with a probability of 95%), and in case of illumination parameter the solution is statistically valid when it goes about presence of three clusters (fig. 1). On the basis of clusters analysis results we can name the most important mechanisms of ecotones formation.

Table 1: Differentiation of objects chosen for ecotone effects estimation

Objects types	Land use types	# research object*	Dominant wood species in the first layer	Age, years	Average height of I layer	Average diameter	Crown cover	Adjoining cenosis	Orientation in relation to cardinal directions	Orientation in relation to wind direction	Research date
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Point	Nature protection	1	White willow	n/a	19.8	0.5	2-3	meadow	W	-	20.07.10
	City	2	Black poplar	n/a	17.1	0.6	3	lawn	E	-	26.06.10
	Rural	3	White mulberry	n/a	15.0	0.6	3-4	plough-land	N	-	24.06.11
Linear	Nature protection	4	Common ash	109	23.6	0.4	4	reserve area	N	leeward	26.06.09
	City	5	Norway maple	n/a	21.3	0.3	6	river water protection zone	N	leeward	23.06.11
	Forest	6	English oak	83	21.2	0.2	4	forest fringe	W	windward	09.07.09
	Rural	7	English oak	107	22.5	0.3	4	plough-land	S	windward	25.06.09
		8	Common ash	111	22.8	0.3	4	plough-land	W	windward	25.06.09
		9	Common ash	112	23.9	0.4	4	plough-land	N	leeward	26.06.09
Areal	City	10	English oak	>100	25.0	0.4	6	lawn	E	windward	22.06.11
	Forest	11	English oak	101	22.6	0.3	4-5	forest fringe	N	leeward	22.07.11
	Rural	12	English oak	97	24.4	0.3	3-4	plough-land	S	leeward	09.07.09
		13	English oak	111	26.0	0.3	3-4	plough-land	E	leeward	10.07.09

Note: *1* – recreational area of natural park "Nezhegol"; *2* – residential area of Belgorod, lawn; *3* – Shebekinsky district, village Titovka, "Zarya" CJSC; *4* – forest belt # 40 of work area # 2 of State Scientific Institution, Research Institute of Agriculture of Central Black-Earth Belt n.a. V.V. Dokuchaev of Russian Academy of Agricultural Sciences "Kamennaya Step"; *5* – residential area of Belgorod, bank of Vezelka river; *6* – forest belt , joining subcompartments of forest area "Korovinskaya dacha" of Shebekinsky forest district; *7* – forest belt # 34 of work area # 2 of State Scientific Institution, Research Institute of Agriculture of Central Black-Earth Belt n.a. V.V. Dokuchaev of Russian Academy of Agricultural Sciences "Kamennaya Step"; *8* – forest belt# 30 in same place; *9* – forest belt # 35 (in same place); *10* – forest-park in rural settlement Dubovoye of Belgorod district; *11* – forest land "Korovinskaya dacha" of Shebekinsky forestry, quar. 3. subcompartment 15; *12* – in same place, quar. 4, subcompartment 5; *13* – in same place, quar. 4, subcompartment 4; *n/a* – non-available.
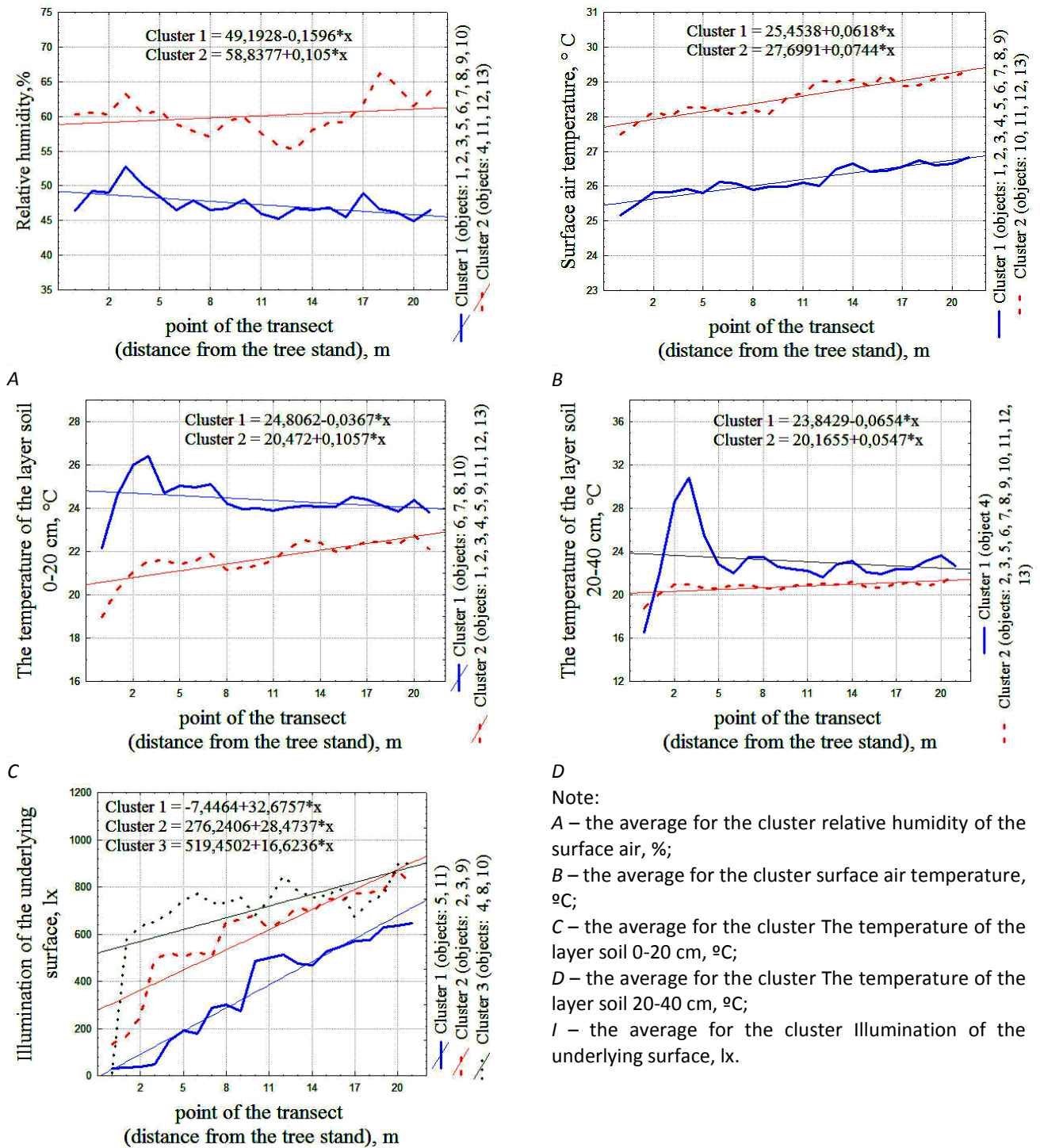
Figure 1: Results of clusterization of microclimatic transects via method of k-average

Transects disposed on leeward and windward sides of the plantation were grouped together into two clusters. In a direction away from leeward side objects one can observe rise of surface soil temperature, and from windward side objects - vice versa, its decrease.

According to air temperature parameter, all areal objects belong to the one cluster. Under the influence of this type objects temperature values are higher than in case of objects belonging to the cluster 1. Therefore, object's dimension has the maximum influence on air temperature distribution.

There are 2 factors influencing air humidity distribution: object's orientation in relation to dominating wind direction and dimensions. Areal objects contribute to higher air humidity.

Regarding the parameter of temperature of soil layer at 20-40 cm a monocluster formed which included one object # 4. A transect is distinguished by the highest projective cover of herbaceous vegetation (a section of mown steppe having the conservation status). Therefore, vegetative episoil cover density has a great influence on distribution of deep soils temperature.

SUMMARY

Thus, among determinants of forest fringe ecotones formation we can mention dimension of object and its orientation in relation to dominating wind direction. The peculiarities we revealed can be used as recommendations for projecting of ecotones in agrolandscapes. Projecting of agrolandscapes protective forest plantations will allow to adapt agrolandscapes to dynamic climate.

CONCLUSION

Formation of forest fringe ecotones in landscapes mainly depends on dimension of an object and its orientation in relation to dominating wind direction. Within the limits of undercrown zone of a forest stand special ecological conditions are formed; they are found within the zone of 4-5 meters. During the constructing of protective forest plantations in agrolandscapes one should take into account the specified zone, to decrease their negative impact on plough land. To improve agrolandscapes' adaptation capabilities in dynamic climate we recommend to regulate width of protective forest plantations according to dryness of year. Forest fringe ecotones zones should be given for sodding, and they should be 1.3 times wider on a leeward side than on a windward side.

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