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The current state analysis of the agro-forest landscape components based on the geoinformational systems usage

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Abstract. The implementation of the modern geoinformational technologies allows to structure all components of the agro-forest landscape, define their qualitative and quantitative condition, dynamic pattern and make long-term and long-range programmes for the sustainable territory development absolutely precisely.

An important social and economic challenge facing the government nowadays is the building of the environmentally sustainable systems aimed at the national security protection of the entire country. Nevertheless, the anthropogenic activities lead both to the disruption of natural systems and the degradation and destruction of landscape complexes. This is especially noticeable in the agricultural sector, where land resources act as a connecting link of agrolandscape, and their damage implicates an upsetting of biological and geological diversity, structural change and their denaturalization. Such changes appear rather significant. The climate dryness increases, soil loss tolerance decreases, the balance of organic and chemical soil elements discolates, agrolandscape existence conditions change which affects the sustainability and effectiveness of agriculture.

Agrolandscape is a natural system that makes a connection between such components as natural atmospheric layer, soil, water and plant resources. Economic activity is also a modern component of agrolandscape. Analysis of separate parts, components or single factors and agrolandscape processes is insufficient for their successful operation and development.

The rational for allocation and establishment of optimized relationship between arable lands, forest stands, meadows and water was carried out more than one hundred years ago by Dokuchaev V.V. He proved the norms regulating of arable lands, meadows, forests and water objects that must be compared to local climate, soil conditions and staple crop.

The most important principles of the nature management optimization in forest-steppe landscapes that were formulated by Dokuchaev V.V. are still relevant to this day. They include:

- defining the tail area norms of arable lands, meadows, forests and water objects;
- river regulation with the purpose of decreasing their silting and flood prevention;
- regulation of gullies and gills with the purpose of preventing the further bottom and bank erosion and their transformation into meadows;



- efficient use of rainfall and snow-melt waters on the fields, water interception in the ponds and water reservoirs;
- use of the shelter-belt and amelioratory forests for water reservoirs protection, gully and sand massifs detention, prevention of water and wind erosion of soil;
- use of the groundwater for watering and irrigation;
- implementation of the most favorable management practice for water conservation and collection and breeding of variety of seeds and plants adapted to the local soil and climate conditions.

Climatic and soil conditions of the Volgograd Region are rather unique. Relief is diverse and varies from the drainless lowland in the trans-Volga region (Zavolzhye) to the elevated fissured land on the right bank of the Volga and Don rivers, in the north and in the west of the region. The region is located in between of 2 types of soil zones: chernozemic and chestnut and is a part of 4 soil provinces: South-Russian, Manychsko-Donskaya, Zavolzhskaya and Prikaspiyskaya.

The region is divided into three land estimated zones. The first zone includes regions with primarily typical and southern chernozem. In the second zone dark chestnut soils prevail and the third one covers chestnut and light-chestnut soils in a subcomplex with solonchaks. This division in the first place is based on the necessity of distinction of the land areas that are relatively equable in their ecological, agroclimatic and landscape conditions that directly impact on the profile and intensity level of agriculture.

First land estimated area comprises 28.1 % of arable land and has the highest average compound score which is 85. The bulk of arable land falls on the third land estimated area (53.6 %) but the average compound score here is the lowest – only 50. Such land distribution is driven by the fact that the regions relating to the third land estimated area are located in a close proximity to the city of Volgograd where distribution and agriproduct processing centers are situated and therefore these regions are heavily used which implies great anthropogenic effect.

Throughout the entire territory of the region processes of soil degradation, erosion and blowout are largely observed. Foremost, this is caused both by the deficiency of the required space of forest planting that accomplish ecological, hydroecological, soil-forming, soil-protective, environment regulating and recreational functions and lack of the conservation agriculture technologies.

Erosion process evolution in the entire territory of the region directly depends on the intensity of land use and is confirmed by land evaluation zoning, which means that according to the total occurrence of all the erosional processes the agriculturally used areas of the first land estimated zone are the least degraded and the agriculturally used areas of the third zone experience all forms of degradation such as erosion, blowout, salinification and soil alkalinity.

Efficient use implies the implementation of economical, administrative and organizational-economic methods of land management where the soil resources structure improves. The agriculturally used areas must be structured in accordance with the modern issues of farming sector with the particular production and growing region in mind. Industrial areas of other non-agricultural lands must be kept to a minimum in order to decrease the negative impact. For the forestry land forest restoration work must be performed as well as new green belting on the fields, pastures and unsuitable land must be constructed.

More detailed research of the efficient arable land use has been carried out within the Uryupinsky District of the Volgograd Region. Research methodology of the structural change of the chernozem soil agrolandscape included aerospace exploration methods together with the geoinformational technologies and computer modeling. This methodology allowed to define the agrolandscape structure, its components and condition of each of them within the boundaries of the testing area precisely and in due time.

The source of this remote sensing for the landscape analysis were the multispectral images received from satellites Resurs P [Resource P], Kanopus [Canopus], Worldview 3, Sentinel 2, Landsat-8 and others and the data from the global digital terrain model (available at:

<https://scihub.copernicus.eu/dhus>, 2018; <https://srtm.csi.cgiar.org>, 2018).

According to the results of the land evaluation zoning, the Uryupinsky District is 343852.91 ha in area. Forestry land occupies an area of 25350.5 ha which is equivalent to 7.4 % of the total district area.

The testing area is located in the north of the district under research. Its total area is 948.6 ha whereof the arable land area amount to 877.8 ha and homogeneous forest stands amount to 67.7 ha which is equivalent to 7.1 %. The parcel of arable land square within the boundaries of the testing area varies from 44.8 ha to 273.07 ha. The difference in elevation throughout the testing area is estimated from 127 to 131 meters. The maximum slope angle of the arable land is 0.5 degrees, the quantity of forest strips is 0.8 degrees (Table № 1).

The aerial photographs show that the entire territory of the testing area is actively tilled and the agricultural activity takes place. However, according to the public cadastral map, only one land parcel is registered and has fixed on-site boundaries (Figures 1 and 2). Such land use contradicts the current legislation because the land owners are obliged to use land efficiently, pay taxes etc.

Table № 1. The testing area characteristics.

Feature Name	Feature Type	Area, ha	Length/Perimeter	AVG_ELEV,m	AVG_SLOPE 1	ELEVATION	MAX_SLOPE, deg	MAX_SLOP, pct
AL72	arable land	139.82	5.97	124.23	0.71	127	0.53	0.92
AL73	arable land	52.558	3.44	125.292	0.64	127	0.45	0.79
AL88	arable land	109.03	5.377	125.189	0.74	130	0.53	0.92
AL89	arable land	258.51	7.81	125.843	0.71	131	0.5	0.86
AL116	arable land	44.811	3.291	125.725	0.64	129	0.43	0.76
AL117	arable land	273.07	7.043	126.632	0.71	130	0.51	0.9
Arable land total		877.8	32.9					
TBA 507	tree belt area	17.846	7.298	127.324	0.87	131	1.67	2.91
TBA 528	tree belt area	17.054	6.008	126.843	0.93	131	1.77	3.09
TBA 532	tree belt area	2.676	2.008	126.786	0.7	129	0.56	0.98
TBA 529	tree belt area	7.317	3.962	127.332	0.6	129	0.42	0.74
TBA 531	tree belt area	4.094	2.056	126.616	0.71	130	0.54	0.95
TBA 530	tree belt area	0.922	1.079	127.898	0.46	129	0.25	0.44
TBA 533	tree belt area	0.438	0.37783	125.856	0.63	127	0.44	0.78
TBA 534	tree belt area	0.784	0.44313	124.761	0.52	126	0.43	0.76
TBA 535	tree belt area	4.941	3.486	126.452	1.04	130	1.88	3.28
TBA 536	tree belt area	3.41	2.203	124.449	1.03	127	1.73	3.01
TBA 537	tree belt area	5.687	3.248	124.179	0.8	126	1.33	2.32
TBA 538	tree belt area	2.536	1.812	125.778	0.69	127	0.53	0.93
Tree belt area total		67.7	33.2					
Total		945.5						



Figure 1. The testing area. Satellite view.



Figure 2. The testing area on the cadastral map.

The methodology of the aerospace exploration method and the geoinformational technologies allow to show the current usage and state of all group of lands best possibly. Based on the research findings, the coefficient of the field-protective forest cover of the testing area is 7,7. Under dry climate conditions of the Volgograd Region the forest ranges accomplish an environment stabilizing function, are aimed at protection from blowout and serve as an ecological frame of the region.

Development and existence of the environmentally-sustainable and high-producing agrolandscapes is not conceivable without integration of the adaptive landscape farming systems, the carcass of which is the protective forest planting of both natural and human origin, in other words, the agro-forest landscapes formation. The modern computer methods with the use of satellite images of the territory under study allow to apply the innovative research technologies within a shorter period of time.

The use of the geoinformational technologies gives an opportunity to estimate the correlation of objects, their relationship and interaction, evaluate the ecological situation in the region, make the right choice and better prepare for decision making. As a result of the available technologies use the most important challenge – the optimum allocation of the anti-erosion planting in an effort to preserve and reclaim the agro-forest landscape as the most efficient mean of the rational use of natural resources – can be met.

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