

Digitalization of the agro-industrial complex in the Russian Federation: current status and development prospects

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Abstract. The article is concerned with the current state of digitalisation of the agro-industrial complex (AIC) in the Russian Federation. It lists a number of legal instruments that have been approved by the legislative authorities and establish the digitalisation trends of the agro-industrial complex at the federal and regional levels. It shows GIS technology opportunities in the process of the AIC digitalisation. It deals with the implementation of the Decree of the Russian Federation Government, which has determined the establishment of excellent scientific and educational centres in connection with the implementation of one of such projects in the Belgorod Region. It examines the experience of both project development for the basin-based agricultural landscapes using GIS technologies and the introduction of soil protection agriculture within the entire region in relation to the territory of the Belgorod Region. It shows changes in the available land structure in the Belgorod Region due to the introduction of basin-based nature management projects. It considers the advantages of the basin approach to be used in the course of the AIC digitalisation.

1 Introduction

The AIC digitalisation provides for widespread introduction of digital technologies in this sector of the economy, which is strategically important for the country due to the need to ensure food security and thanks to its high export potential. In the agricultural sector, several concepts emerged, which show various forms of digitalisation in agricultural production systems, value chains, and, more broadly, in food systems [1]. These include Smart Farming [2], Precision Agriculture or Precision Farming [3], Decision Agriculture [4], Digital Agriculture [5], Agriculture 4.0 [6].

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2 Materials and Methods

2.1 Digitalization of the agro-industrial complex in the Russian Federation

Russia ranks No. 15 in the world in terms of agricultural sector digitalisation. With its huge resource potential, Russia is striving to strengthen its competitive position in the agricultural market [7]. The prerequisites for agriculture digitalisation in the Russian Federation are legally approved by the Decree of the Russian Federation Government on the Establishment of National System of Agricultural Information Support on March 7, 2008 under No. 157 [8]. The subsequent legal instruments, such as the Food Security Doctrine of the Russian Federation approved by the Russian Presidential Decree on January 30, 2010 under No. 120 [9], the Russian Presidential Decree on National Goals and Strategic Development Objectives of the Russian Federation for the period up to 2024 on May 7, 2018 under No. 204 [10] and the Russian Federation Digital Economy programme (The order of the Government of the Russian Federation on July 28, 2017 No. 1632-R) [11] have made the basis for the development of the Digital Agriculture project of the Ministry of Agriculture [12]. This project began to be implemented in 2019, and it consists of the following five areas: “Effective hectare”, “Smart contracts”, Agroexport “From Field to Port”, “Agro solutions for agribusiness”, “The Land of Knowledge [13]. The following technological platforms make the basis for the Digital Economy of the Russian Federation: big data, distributed ledger systems (block chain technologies), quantum technologies, new production technologies (NPT), Industrial Internet of Things (IoT), robotics and sensor components, wireless communication technologies (ZigBee, Bluetooth, Wi-Fi), and virtual and augmented reality technologies [14]. Some of these technological platforms are already actively used in agriculture and some of them will be used in the near future. For example, Big Data is used by the Central Agricultural Information and Analysis System (CAIAS) and the Unified Federal Information System of Agricultural Lands (UFIS AL).

One of the key components of the agro-industrial complex digitalisation is the use of geographic information systems (GIS), which make it possible to monitor crops in a comprehensive manner, to assess and monitor the vegetation state (using NDVI), to perform land inventory, quality control of agro-technological measures, and to control soil degradation, including water erosion. To solve such problems, GIS uses high-resolution satellite images and orthophotomaps that can be obtained using UAVs.

In the Russian Federation, a number of companies can provide services for the development of agricultural GIS. Such GIS services include, for example, the Agroanalytics system by SmartAgro, the Geoanalytics.Agro cloud geoinformation webservice by Sovzond, and the CPS: AgroManagement geoinformation system by CenterProgrammSystem.

The interest in digital technologies for the agro-industrial complex results in forums for topical issues discussion. These include, for example, the International Digital Agro-Industrial Forum [15] and the Federal IT-Forum of the Russian Agro-Industrial Complex Smart Agro: Digital Transformation in Agriculture [16].

2.2 Digitalization of the agricultural sector at the regional level (on the example of the Belgorod region)

The Decree of the Russian Federation Government on National Support Measures to World-Class Scientific and Educational Centres Based on Integration of Higher Education Organisations and Scientific Institutions and their Cooperation with Organisations Operating in the Real Economy Sector on April 30, 2019 under No. 537 has stipulated for the establishment of world-class scientific and educational centres in a number of constituent entities of the Russian Federation [17]. These included Perm, Belgorod,

Kemerovo, Nizhny Novgorod and Tyumen Regions. Based on Russian Federation Decree on April 30, 2019 under No. 537, E. Savchenko, the Governor of the Belgorod Region, has signed an order on the establishment of an excellent scientific and educational centre on July 12, 2019 under No. 565-r [18]. REC “Innovative solutions in the agricultural sector”, which was created on the basis of the Belgorod State National Research University, contains platforms on the basis of which research is carried out in various fields of science. These include biotechnology, genetics and breeding, cell technology, genetic engineering, food and veterinary medicine production, and sustainable nature management [19].

3 Results and Discussion

As one of the most large-scale projects, the digitalisation of the agro-industrial complex in the Belgorod Region includes the development and implementation of basin-based nature management projects within the entire constituent entity of the Russian Federation. The advantage of basin-based nature management is that its implementation can overcome the most critical imbalances in the existing available land structure and curb the development of soil degradation and water resource depletion processes [20, 21], which will ultimately make it possible to reach a compromise between the economic efficiency of land use and environmental sustainability of the territory [22]. Using the developed concept, the author's methodology and the design results, Federal State Autonomous Educational Institution of Higher Education «Belgorod National Research University» (NRU “BelSU”) it was for the first time in Russia when scientific support for the implementation of basin-based nature management was ensured for one of the country's regions (the Belgorod Region). Pursuant to Order on Approval of Basin-Based Nature Management Concept for the Belgorod Region issued by the Belgorod Region Government on February 27, 2012 under No. 116-RP [23] based at Federal and regional centre for aerospace and surface monitoring of the objects and natural resources (“BelSU”), basin-based nature management projects have been developed for all river basins of the Belgorod Region. An example of a project implemented using the tools of the ArcGIS 10.2.2 software package is shown in Figure 1. As a result of the implementation of basin-based nature management projects in the territory of the Belgorod Region, some elements have appeared in the structure of the available land, such as bee parks (melliferous crops), arable land conservation, grassing of the spillway, remises, micro-reserves, self-growth of wood and shrub vegetation of fodder land, which were absent earlier. The balance for available land structural elements (+/-) achieved as a result of design solutions for the entire territory of the Belgorod Region is shown in Figure 2.

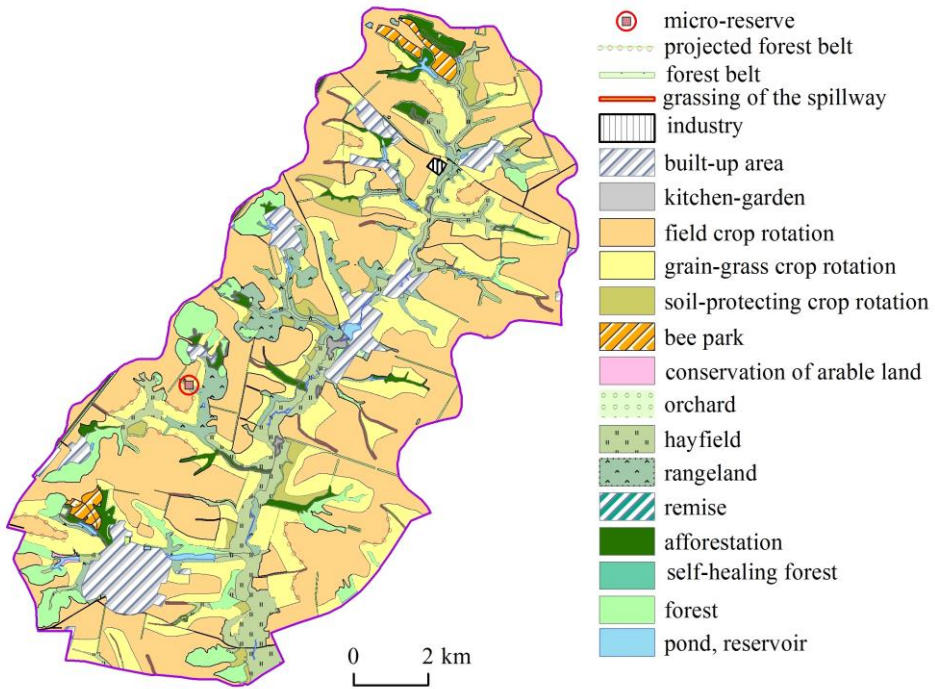


Fig. 1. An example of the development of a basin management project within the catchment area of the Kharkov River.

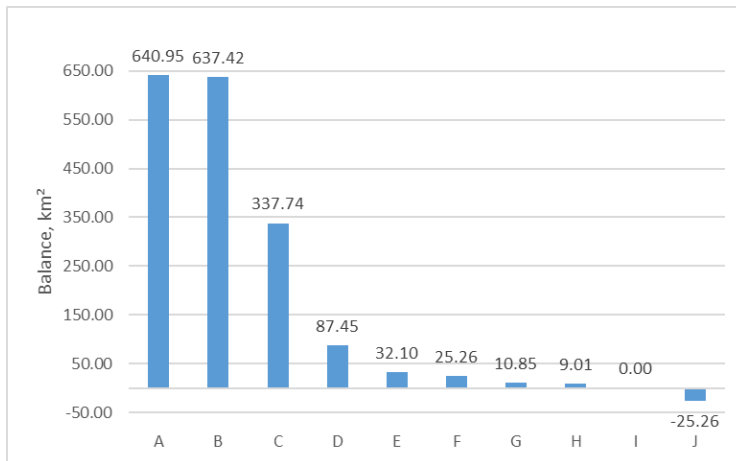


Fig. 2. The balance (+/-) of the elements of the Land Fund Structure as a result of the implementation of projects of the basin organization in the territory of the Belgorod region (A – afforestation, B – self-growth of wood and shrub vegetation of fodder land, C – bee parks (melliferous crops), D – arable land conservation, E – grassing of the spillway, F – forest belts, G – remises, H – micro-reserves, I – vegetable growing, J – arable land).

The outcome of the implementation of the Belgorod Region basin-based projects will be reflected in the following transformations of land use: part of degraded plough-lands (0.58%) will be temporarily reserved for conservation, up to 0.33 % of the arable land

provided for permanent grassing in the hollows within the area of runoff concentration, and the establishment of contoured forest strips. The forage and arable land will be partially used for honey crops (bee parks).

Currently, there is a project developed and accepted for implementation named Basin-Based Nature Management: Geoinformation Support for Design and Introduction. As a result of this project, by 2024 it is planned to establish an information and resource digital platform for intelligent management of rational natural resources use for inventory, monitoring, and analysis of natural resource conditions on agricultural land.

In addition, in 2020 the Digital Model of Nature Management of Belgorod Landscapes is presented as one of the green fields of NRU BelSU. To achieve the project goal, the following tasks are expected to be solved:

1. To improve the system of control over the activities of agricultural producers in terms of the use of fertilisers and the spread of odour-forming chemicals in the ambient air as a result of livestock breeding activities;

2. To assess the geoecological state of water bodies in the Belgorod Region and to develop a digital model of rational water use;

3. To provide scientific support to the programme for prevention of underground water pollution and depletion of their reserves in the territory of the Belgorod Region;

4. To justify design solutions for the development of additional ecological structural cores based on artificial recreation of steppe areas;

5. To develop a system of estimated figures to characterise the ecological balance of anthropogenically transformed landscapes in the context of basin-based territorial units;

6. To assess the general state of natural and anthropogenic network structures in order to supplement the recreational complex with new facilities and to identify their required number and the occupied area;

7. To use recreational network design methods not as separate self-sufficient facilities, but as elements of various intersecting network structures (tourist and recreational system, ecological structure, system of specially protected natural areas, settlement system, or transport networks);

8. To optimise traffic flows based on road network analysis techniques;

9. To use the noospheric park principles for the development of the Belgorod Region nature management strategy harmonising natural, economic, and socio-demographic processes; and

10. To develop a publicly available geo-informational web product to inform on the state and use of the environment of the Belgorod Region for the population and students of secondary and higher educational institutions, including the disclosure of permitted information.

Thus, the main result of this project will be the creation of an integrated geoinformation platform to combine spatial data on individual components of the landscape of the Belgorod Region (30 thematic layers, 200 thousand objects) and digital data on their economic use and observations (soil, surface and underground water bodies, air, flora and fauna, etc.). The integrated data on the ecological and economic situation in river water catchment areas can be associated with further development of the geoportal for river basins in the European Russia [24].

4 Conclusion

The agro-industrial complex digitalisation is a complex process, which takes place within the framework of the digitalisation of all sectors of the economy. In the course of agro-industrial complex digitalisation, it becomes relevant to use geographic information systems (GIS). They make it possible to accumulate, process, and analyse various data that

can be ultimately used to make operational decisions aimed at the rational use of natural resources. The all-round GIS structure and the databases on basin-based nature management, which make use of river network monitoring experience within the EU Water Framework Directive (WFD) and the creation of a unified Infrastructure for Spatial Information in Europe (INSPIRE), can replicate the developed approach for the process of designing an environmentally balanced structure of geosystems.

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