

## Digital land management technologies

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**Abstract.** The article deals with issues related to the support of digital land management with modern technologies, the main purpose of which is to create and maintain a spatial platform for digital agriculture and the digital economy. Modern digital technologies form a new system infrastructure for supporting land management, which makes it possible to comprehensively optimize the processes in the management of country land resources from top to bottom. The changes caused by the reformations of 1991-2021 have accumulated a lot of recurring problems in the matter of Russia land structure. Moreover, the solution of many of them will allow us to optimize the achievement of significant positive economic changes in related sectors of the economy that depend on spatial development. Many of the problems that need to be solved are massive tasks (for example: a complete inventory of the country's land, monitoring the use of real estate, effective management of real estate, etc.). It is the processes of digitalization of land management, based on modern technologies GIS, CAD, BIM, Big Data, Blockchain, etc. They can effectively and in a short time systematically solve the entire complex of tasks, while creating a new information base that can fully automate the collection, storage and interpretation of spatial and related data in the future. Thus, new modern information, communication and computer technologies can provide a complete modernization of the industry. Digitalization of land management is a complex system task that requires a different attitude to land policy on the part of the state. A comprehensive (package) linking of all lands' legislation with simultaneous systematic state support for land management is necessary. Modernization of land management will require both its reorganization and re-equipment, which in turn will require significant financial investments.

### 1. Introduction

The sphere of modern technologies is a priority for development in Russia, which is confirmed by the adoption and implementation of the program "Digital Economy of the Russian Federation", approved by the decree of the Government of the Russian Federation No. 1632-r of July 28, 2017 [1, 2].

The creation of digital agriculture as part of the digital Russian economy on the basis of smart land use cannot be carried out without the creation of digital land management. In fact, digital land management is the basis, the territorial spatial reference of all digital agriculture.

Land management design is the most important stage of the land management process. The main purpose of land management design is to restore order in the use of land, to ensure the provision and withdrawal of land and to organize their rational use and protection [3–8, 12].



This is associated with the processing of quantitative, qualitative, price and legal data abundance, tracking and analyzing the dynamics of their changes, conducting land monitoring, modeling economic, environmental and other situations. For these purposes, a wide variety of methods are used: economic and mathematical modeling, network planning, mathematical programming, game theory, graph theory, methods for choosing the optimal strategy, etc. Their use requires a deep study of land management problems, the organization of initial and normative information on a scientific basis, and an unconventional approach to solving land management problems [8, 9].

Land management projects on irrigated and eroded lands are the most difficult in terms of detailed development of the project on an ecological and landscape basis.

Information support for such works is several times higher than when designing on non-reclaimed and non-erosional agricultural land.

The land management projects do not fully address the issues of using materials for on-farm assessment of irrigated and erosion-hazardous agricultural landscapes, there is no concept and methodology for creating and using information support for Computer-aided design (CAD) in land management, the principles and methods of forming land management CAD are not sufficiently developed, the methodological foundations for allocating primary territorial areas of irrigated and erosion-hazardous agricultural landscapes are not improved, there is no methodology for determining the structure of acreage on the basis of on-farm land assessment with the use of Automated Land Management Design System (SAZPR) elements, there are no methodological provisions for determining the economic efficiency of the use of SAZPR elements in the organization of the use of irrigated and erosion-hazardous agricultural landscapes and the arrangement of their territories, and a number of others.

A rule of thumb states that the solution of these tasks to increase labor productivity and improve the quality of design and survey work in land management is possible on the basis of new technologies and the organization of land management works using personal computers and computer equipment.

The availability of powerful modern electronic and computer technology contributes not only to a more in-depth formulation and solution of technical and economic problems, but also allows the use of economic and mathematical methods and models in the forecasting practice, planning and designing measures for the organization of effective use and comprehensive protection of land resources.

When introducing advanced technologies in land management design and its improvement, of particular interest are unified systems of automated land management design for land management services and organizations, which would ensure the formation of end-to-end technological lines, complexes of multidimensional and multivariate design based on a single system approach.

The main changes in the introduction of advanced technologies in land management design and its improvement are possible through the use of computer-aided design (CAD) systems based on software and hardware complexes.

The constant improvement of land legislation, the variety of forms of ownership and use of land plots, the reorganization of agricultural organizations require solving a large number of issues to optimize the organization of the territory. In this regard, the need to improve the theory and methods of land management using new computer technologies has increased.

The development and wide application in the design practice of computer technologies in the organization of the use of irrigated and erosion-hazardous agricultural landscapes is in modern conditions one of the priority problems of land management science and improving the technology of land management works [8].

This study is devoted to the combined solution of these problems, the leading role in which belongs to the use of GIS, CAD, BIM, Big Data, Blockchain, etc. in land management.

Thus, the improvement of the scientific and theoretical provisions of on-farm land management, taking into account the use of computer technologies, is an important scientific task in the theory of land management. At the same time, for the purposes of organizing land and crop rotations, it is very important to formulate the principles of forming a data bank of a land management design object and

take into account fully the features of the information used in it, the nature of which is directly related to the natural and anthropogenic conditions in this territory.

## 2. Results and Discussion

Since the transition to an information society strengthens the role of information in solving problems of public administration, including land resources, obtaining, storing, searching for information, objective understanding and actual use of it become a state task that requires time, money and personnel to create special systems using innovative approaches, the latest technology and technologies.

The search for ways of rational use of natural resources is one of the main directions of the environmental program in the country. At the same time, the development of new technologies and the widespread use of environmental knowledge and information make it possible to obtain high and stable crop yields without significant damage to the biosphere. Earth's remote sensing (ERS) with the use of space technology and aviation (pilot and unmanned) allows you to quickly obtain information about the state of the natural environment.

To obtain information about the potential use, productivity and comparative quality of each plot of agricultural land, it is necessary to use statistical reporting, information collected throughout the life cycle of the plot.

Based on the comparison of the identified tasks, we will highlight the following necessary areas for improving information collection.

1. Establishment of a set of integral indicators that characterize the level of development of the natural resource potential as a whole and its individual components in the context of the territory and the country as a whole.
2. Justification of the set of indicators of the impact of anthropogenic and natural factors on the natural resource potential and its components.
3. Determination of optimal indicators that characterize the elements of natural resource potential for statistical reporting.
4. Comparison of actual characteristics with standards and levels of impact on the elements of the environment based on Information and Communication Technologies.
5. Systematization of information on incentives and economic sanctions for the results of environmental activities, as well as on payments for the use and excess costs of natural resources.
6. Generalization of the characteristics of land and territory pollution, atmospheric air and water bodies in the forms of statistical reporting.

Thus, the information systems used in land management (Land Information System -LIS, Geographical Information System - GIS, Geoinformation and Land Information Systems - GISIS, etc.) should solve both design and management tasks. Therefore, the most important source of updating the land management databases and keeping it up to date is the land monitoring system. The general classification of information systems and its place in modern land management is carried out by us according to a number of key features: purpose, structure of hardware, mode of operation, type of activity, etc. (Figure 1).

The strategy of agriculture to create resource-and moisture-saving technologies allows expanding the production of agricultural products without compromising land and water resources. In this regard, a large role should be given to the organization of multi-purpose land monitoring and a landscape-ecological approach to the organization of the territory, which ensures an increase in the effectiveness of measures to protect land from erosion and combat drought, and improve the agro-sphere for sustainable agriculture [3–5, 8, 10, 11]. It is the multi-purpose monitoring of land that should become the most important component of the information support of land management.

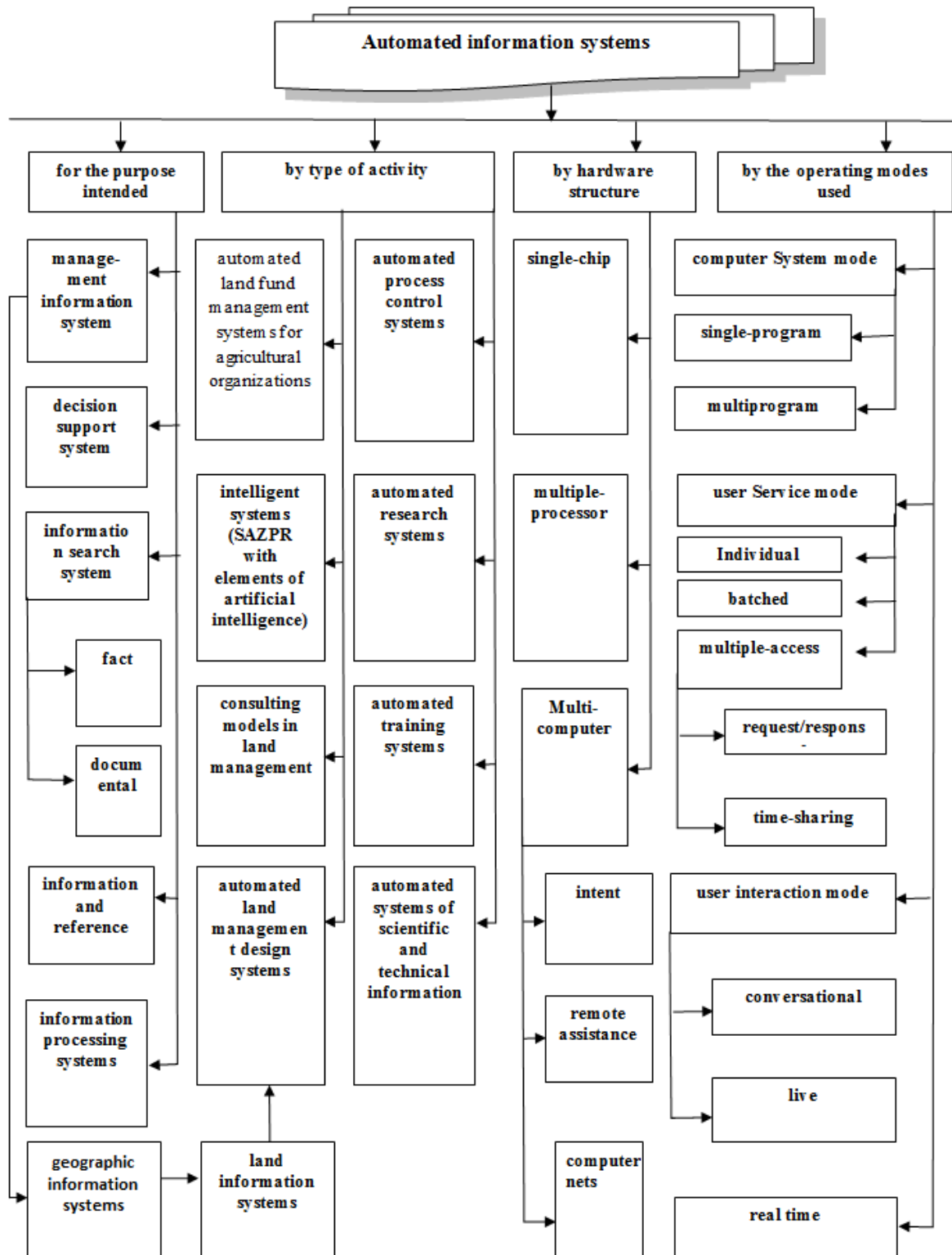


Figure 1. Positioning of land management and land information systems in the general classification of information systems [8].

In our opinion, in the differentiated assessment of land resources, the predictive agroecological zoning of the territory is crucial, which focuses production on the full use of natural and agro-climatic resources per unit of man-made energy consumed and guarantees a minimum environmental burden and an increase in its economic efficiency. In improving land monitoring, we need a theoretical concept aimed at analytical understanding of the processes occurring in the natural environment. For example, in conditions of dissected terrain, the catchment area is divided according to landscape-typological features into structural elements: dividing slopes, ravine and beam network, forest and forest belts [3–5, 8, 11]. For the formation of a land management database of information, this concept allows you to formulate the tasks of land monitoring.

1. Identification of structurally homogeneous hydrometeorological fields, land plots and agricultural landscapes and full alignment of their natural boundaries on the ground. At the same time, we remotely determine only the constant and slowly changing geological and physical-geographical parameters of the components of the geosystem. The input and output functions are obtained by ground-based methods; the other method has a different approach to aerospace information, in which significant points of agricultural monitoring are fixed - here the dynamics of processes and continuous information are important.

2. Development of a theoretical concept that allows differentiated assessment of hydrometeorological fields, land plots and agricultural landscapes of the division of catchments into elements based on landscape-typological features. These studies can be carried out on existing runoff sites and representative gully-girder systems. More complete information is obtained by photographing hydrometeorological and other dynamic processes occurring in elementary basins from low altitudes (for example, using UAVs).

3. Development and continuation of point studies of natural systems involving the materials of all complex, sectoral and territorial environmental authorities, special observations of other organizations and experiments of specialists and scientists.

4. Determining the requirements for aerospace information based on the optimal repetition rate of the resolution of the equipment and the information content of the spectrum ranges.

In information systems classified by purpose, there are five independent types: in relation to the information and control systems used in land management, we have identified geoinformation systems, with the help of which land information systems (LIS) are formed, consisting of semantic and graphical parts.

According to the type of activity, Automated Information Systems (AIS) in the practice of modern land management should be divided into: automated systems for managing the land fund of agricultural organizations, Intelligent systems (SAZPR with elements of artificial intelligence), Land Management Expert Systems, Automated Land Management Design Systems (SAZPR), Automated Process Control Systems (APCS), Automated Training Systems, Automated Research Systems, Automated Systems of Land Management Scientific and Technical Information, etc. [2, 6, 8-10, 12].

In land management, as well as other areas of scientific knowledge on the features of the functioning of the information system in time, according to all-Union State Standard 15971, there is a real-time mode and an information processing mode, in which the interaction of the information processing system with external processes is ensured.

In the context of the rapid growth of informatization and globalization of agricultural production, the global trend of increasing the level of methodological universalization, technological unification and functional detailing of the created information support for the entire land management, including the land management process, is clearly expressed.

The creation of CAD in land management is based on GIS technologies, with a set of technical tools and software designed to collect, store, process and reproduce a large amount of graphic and text data that has a spatial reference. The basis of GIS is electronic maps (plans) of the area, based on Digital Terrain Models (DTM) and Digital Surface Model (DSM), which characterize the three-dimensional (3D) location of objects in space [3–5, 7, 8].

### 3. Conclusion

The main functions of the land management service of the country in the management of land resources should be:

- \* maintaining the state cadaster of real estate objects, monitoring and evaluation of land, as an information basis for making decisions on land management;
- \* obtaining and updating planning and cartographic material, conducting special surveys and surveys for the needs of land management and cadaster at all levels (from local to global);
- \* carrying out topographic and geodetic works for land management and cadaster;
  - planning and forecasting of land use;
- \* development and implementation of state (regional) programs and subprograms for the rational use and protection of land;
- \* organization of rational use and protection of land on the basis of land management projects on a regular and timely basis;
- \* implementation of the legal, organizational and economic mechanism for regulating land relations;
- \* implementation of state control over the use and protection of land.

It is obvious that the efficiency of the land management service and the various automated systems created within it will depend on the degree of integration with the solution of the above tasks [2, 6, 8–10, 12]. It is necessary to abandon the creation of such systems, which are interpreted as a simple set of independent (separate) tasks of automation of calculations and (or) separately computer graphic land management design.

Such a simplified approach to automation will not give the necessary effect, since it will require the creation of an individual solution technology for each individual task, as well as an information and regulatory framework, the use of the results of each task in the design, which will lead to duplication of information at all stages [8], and will significantly increase the cost of creating and maintaining such systems up-to-date.

The system of automated land management design of digital land management should provide:

- monitoring processing of land-resource information (on their quality, quantity and distribution by land users and landowners), information on land use (target, non-target) and implementation in kind of all types of land management measures (including author's supervision);
- accumulation, structuring and generalization of it in the corresponding databases at all levels of the system hierarchy;
- concentration, updating and maintenance at all levels of the system of economic and technological standards and rules for the management and organization of the use of land resources;
- generating reports and responses to all requests from SAZPR users.

A set of application programs - modules of the system, should be interconnected to solve the problems of digital land management, using all types of effects from the use of automation by type:

- automation of unified standard solutions, when technological operations for entering and processing regulatory, reference, nomenclature and source information are set by procedural operators in the form of a composite program code (list of commands) corresponding to a set of standard operations;
- significant cost reduction when eliminating manual (routine) data processing that does not require a highly qualified operator;
- elimination of errors in the design, ensuring the quality of design land management solutions by automating computational operations, using an integrated approach, machines operation, multiple growth of the ability to process a large number of solutions, innovative methods and technical innovations that allow you to expand the professionalism of the designer in making land management decisions;
- gradual reduction of qualification requirements in the field of land management for users of systems [8], as they implement comprehensively justified intelligent algorithms, a system of innovations in technologies and methods for solving land management problems.

Thus, in the process of creating the SAZPR, it is necessary to rely on the above-mentioned basic provisions of the concept of automation of land management and land management design.

Thus, SAZPR is a complex system that should be built on a block-modular, object-oriented basis. Each module consists of separate blocks, designed to solve specific tasks. To do this, it is necessary to create appropriate application software packages that are divided into directly applied programs (building digital terrain models, designing elements of an on-farm land management project, forecasting the use of land resources, etc.) and universal ones that are used in any modules (blocks). At the same time, the prospects for the introduction of Information and Communications Technology (ICT) in land management and the development of SAZPR are primarily associated with the development of systems with artificial intelligence and expert systems.

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### References

- [1] Program "Digital economy of the Russian Federation", for the period up to 2024
- [2] Tsyarkin Y A, Orlov S V, Kamaev R A et al 2020 Increase of Quality of Provision of Social and Information Services to Population in the Conditions of Development of the Digital Economy *Lecture Notes in Networks and Systems* **111** 253-264. DOI 10.1007/978-3-030-39797-5\_26.
- [3] Volkov S N, Khlystun V N 2014 Land policy: how to make it more efficient *Int. Agricultural J.* **1-2** 3-6
- [4] Volkov S N, Cherkashina E V, Shapovalov D A 2019 Digital land management: new approaches and technologies *IOP conference series: earth and environmental science* **350** 012074. DOI 10.1088/1755-1315/350/1/012074.
- [5] Volkov S N 2017 *Land management support for the implementation of state programs and priority national projects for the development of agriculture and other sectors of the economy* (Moscow: GUZ)
- [6] Murasheva A A, Klyushin P V, Savinova S V et al 2020 Contemporary Issues of Effective Land Desertification Control in the South of Russia *Lecture Notes in Networks and Systems* **111** 39-50. DOI: 10.1007/978-3-030-39797-5\_5.
- [7] Papaskiri T V 2016 *Organizational and economic mechanism of computer-aided design system formation in land management: doctoral dissertation* (Moscow: State University of Land Use Planning) 399 p
- [8] Tsyarkin Y A, Bliznukova T V, Pakulin S L et al 2020 Improving the Control of Municipal Solid Waste Management Processes in the Region *Lecture Notes in Networks and Systems* **111** 747-759. DOI: 10.1007/978-3-030-39797-5\_73.
- [9] Klyushin P V, Shirokova V A, Savinova S V et al 2019 Development of a set of measures to reduce the anthropogenic load in the closed joint stock company "zarya" Stavropol territory of the Russian Federation *International Multidisciplinary Scientific GeoConference SGEM* **19(5.1)** 141-147. DOI: 10.5593/sgem2019/5.1/S20.018.
- [10] Cherkashina E V, Cherkashin K I 2019 Types of land massifs for essential oil crops cultivation in forest-steppe altitudinal belt of Greater Caucasus (Krasnodar territory) *IOP conference series: earth and environmental science* **350** 012055. DOI: 10.1088/1755-1315/350/1/012055.
- [11] Zhelonkina E E, Boitsenyuk L I, Gruzdev V S et al 2019 Territory monitoring and suggestions on oil filling station arrangement according to ecological standards *IOP conference series: earth and environmental science* **350** 012049. DOI: 10.1088/1755-1315/350/1/012049.
- [12] Papaskiri T V 2018 About the concept of digital land management *Land management, cadaster and monitoring of land* [in Russian – Zemleustroistvo, kadastr i monitoring zemel] **11** 5-11

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