MONITORING THE STATE OF AGRICULTURAL LANDS IN THE CHECHEN REPUBLIC USING GIS TECHNOLOGIES

Nurbek Adaev[1], Aset Amaeva[1], Malika Israfilova[2]

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[1]Kadyrov Chechen State University, RUSSİA
[2]Chechen Research Institute of Agriculture, RUSSIA
mr.adaev61@mail.ru

Abstract

Monitoring the condition of agricultural lands in the Chechen Republic using geographic information systems (GIS) is an important tool for assessing and managing agricultural resources in the region. This paper discusses modern GIS methods and technologies used to analyze land conditions, including their use to identify land use changes, assess soil quality, and monitor the impact of climate change. The focus is on collecting and processing data using remote sensing, as well as using analytical tools to create maps and models that help make informed decisions in agriculture. The monitoring results help optimize the use of land resources, increase their productivity, and improve resilience to external factors. As a result, the use of GIS technologies becomes an integral part of effective land management in the Chechen Republic, contributing to the sustainable development of agriculture in the region.

Keywords: GIS technologies, land monitoring, agricultural lands, Chechen Republic, remote sensing, resource management, land use change, soil quality, climate change, sustainable development

I. Introduction

Monitoring agricultural lands plays a key role in ensuring sustainable development of the agricultural sector. These lands are important for food production, maintaining ecological balance and socio-economic progress in rural areas. However, they are subject to various problems that require constant monitoring and control.

One of the main problems is the change in the use of these lands. The expansion of urban areas, infrastructure development and construction of industrial facilities often lead to the loss of fertile soils and a reduction in the area allocated for agriculture. If not monitored, such processes can have serious consequences for food security and environmental sustainability of the region.

Agricultural lands are also susceptible to pollution. The use of chemical fertilizers and pesticides can lead to the accumulation of harmful substances in the soil, which negatively affects the quality of agricultural products and the environment. In addition, a high degree of erosion can lead to the loss of the topsoil and a decrease in crop yields. Monitoring helps to identify contaminated areas and take the necessary measures to eliminate them.

Climate change is another issue that requires attention. Global warming and fluctuations in precipitation patterns affect the agricultural sector, creating imbalances in food production. Monitoring climate parameters allows agricultural practices to be adapted to new conditions and potential risks to be minimized.

In addition to the problems, monitoring agricultural land also opens up new opportunities for improving agricultural activities. Modern technologies of geographic information systems

(GIS) and satellite observation provide accurate data on soil conditions, changes in land use and other parameters. This facilitates effective planning, pollution control and optimization of agricultural production processes.

In addition, monitoring facilitates the development and implementation of new methods of soil cultivation, crop production and resource use. Innovative approaches, such as integrated farming and organic agriculture, require continuous monitoring and analysis of results. This allows assessing the effectiveness of new methods and developing strategies to improve the sustainability of agricultural production. Thus, monitoring of agricultural lands is a key aspect of sustainable development of the agricultural sector. It not only allows for prompt identification and resolution of emerging problems, but also helps to identify new opportunities to improve the efficiency and sustainability of agriculture.

In addition, systematic monitoring ensures the integration of modern technologies and management methods, such as the use of geographic information systems (GIS), which allows for a more accurate analysis of the state of land and planning of its use. This, in turn, leads to a more rational distribution of resources, a reduction in the negative impact on the environment and an increase in food security. Ultimately, monitoring becomes an important tool for the formation of sustainable agricultural policy and the provision of future generations with high-quality food products.

II. Methods

The main research methods in this work included comparative-geographical and geoinformation -cartographic approaches.

1. **Comparative-geographical method** : This method allows for the analysis and comparison of various geographical phenomena and processes in different regions. It is used to identify patterns in the use of land resources, assess their condition and identify factors that influence agricultural productivity. Comparative analysis allows for a deeper understanding of how various conditions and factors (climatic, soil, socio-economic) affect land and its use.
2. **Geoinformation and mapping method** : This method involves the use of geographic information systems (GIS) and mapping technologies to collect, process and analyze spatial data. It allows for the visualization of information about land resources, their distribution, condition and use. GIS can be used to create detailed maps that help in making decisions on land management and agricultural production planning.

The work is based on the results of the author's research obtained between 1999 and 20 23. These data include:

- **Materials of the V.V. Dokuchaev Soil Institute** : This institute provides scientific research and data concerning the condition and properties of soils, which is an important aspect for assessing the quality of land resources.
- **Data from the High-Mountain Geophysical Institute of Roshydromet and the Russian Academy of Sciences** : These materials contain information on the geophysical characteristics of the territory, which helps in the analysis of climatic conditions and their impact on agriculture.
- **Information from the Directorate of Environmental Security of the Armed Forces of the Russian Federation** : This data provides an assessment of the environmental situation and the state of natural resources in the context of security.

Modern methods and techniques of geoinformation mapping were used to create cartographic images. This allows for accurate visualization and analysis of data related to land resources.

The following software packages were used during the work:

- **ABRIS** : Used to automate the process of processing geodetic data and cartographic information.
- **ARC / INFO** : A powerful spatial data management and analysis tool that allows you to perform various geospatial analyses.
- **Arc View** : A software package that provides capabilities for visualizing and analyzing geographic information, with a user-friendly interface for working with maps.
- **EOSDA Crop Monitoring** : Software designed for processing and analyzing remote sensing data, which is important for monitoring the state of land resources.

These methods and tools provide a robust approach to the study and analysis of land resources, which is essential for their effective management and use.

Figure 1: *Crop Technology Monitoring*

The number of GIS applications in agriculture has increased dramatically in recent years due to technological advances. Let's discuss some of the most popular applications today.

Precision farming GIS software provides detailed vegetation and productivity maps, including yield information, to help you make informed decisions. GIS tools for agriculture can determine the vegetation levels in your field or any of its areas. Farm equipment can then use this information to adjust the amount of seeds, nutrients, herbicides, and fertilizers for each area.

EOSDA Crop Monitoring allows you to create productivity maps of your fields using data from previous years. With their help, you can identify productive and unproductive areas and fertilize unproductive ones with potassium-phosphorus solutions.

The methodology for monitoring agricultural lands takes into account all key factors affecting the condition and use of land plots, such as climatic conditions, soil type, hydrological regime, etc. As part of the monitoring, activities are carried out to collect information on the condition of the land, its processing and storage.

Figure 2: *Land fertility map based on historical data*

A productivity map based on historical data highlights areas of varying productivity in a field, showing areas that were more or less productive over a given period of time.

Continuous monitoring of land use, based on their legal regime, allows for analysis and assessment of the quality of land plots, taking into account the impact of both natural and anthropogenic factors. Current problems in monitoring agricultural lands significantly affect the efficiency and sustainability of the agricultural sector.

Despite the importance of this process for ensuring food security and sustainable agricultural development, there are several major difficulties that hinder full-fledged land monitoring. These problems include lack of funding, the absence of modern equipment and technologies, insufficient personnel qualifications, and an ineffective system for collecting and processing data. All these factors can lead to distortion of information on the state of the land, which, in turn, negatively affects management decision-making and the implementation of agricultural policy.

III. Results

The structure of the land fund of the Chechen Republic includes various categories of land. The total area of the Chechen Republic is about 15.3 thousand square kilometers (1.53 million hectares). Agricultural lands occupy about 56% of the total land fund, including arable lands - about 600 thousand hectares, pastures - about 800 thousand hectares and garden and vegetable plots - about 50 thousand hectares. Forest lands make up about 30% of the total land fund, the area of forests is about 460 thousand hectares. Settlement lands occupy about 7% of the total land fund, the area of land allocated for settlements is about 80 thousand hectares. Industrial lands occupy about 1% of the total land fund, the area of land used for industry is about 15 thousand hectares. Water fund lands, including rivers, ponds and reservoirs, make up about 2% of the total land fund, the area of reservoirs is about 30 thousand hectares. Reserved and protected natural areas occupy about 4% of the total land fund, the area of protected natural areas is about 60 thousand hectares. Public lands include roads, parks and other objects, occupying a small area. This structure of the land fund emphasizes the importance of agriculture and forestry in the economy of the Chechen Republic and the need for integrated land management to achieve sustainable development of the region.

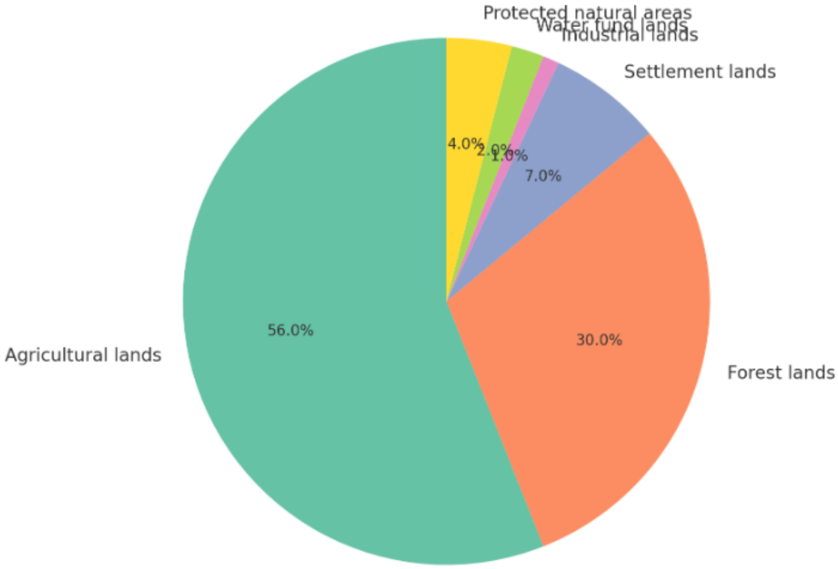

Figure 3: *Structure of the land fund of the Chechen Republic*

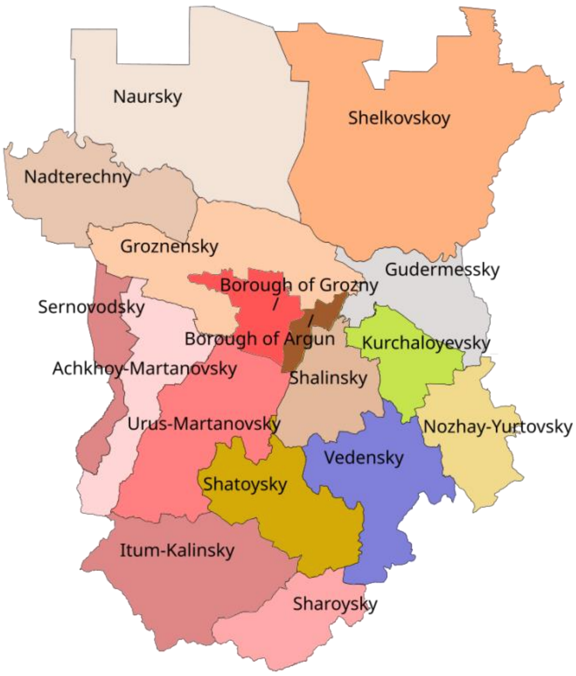

Figure 4: *Administrative divisions of Chechnya*

High mountain landscapes, mainly in the subalpine and alpine belts, are subject to significant pasture impact. The degree of disturbance of pasture lands varies from 0.4 to 0.6. In the alpine belt, this indicator varies in the range from 0.2 to 0.4. Similar values are characteristic of the mountain forests of the Bokovoy Ridge and its spurs. Landscapes of the nival belt are almost unaffected by economic activity. In the floodplain of the Terek River in the north of the republic, meadows are slightly altered and are used mainly as hayfields. The greatest destruction is observed on lands allocated for pastures and arable lands. In populated areas, the degree of disturbance can reach 4-

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The anthropogenic load map was compiled by combining the landscape map with the land use map, which made it possible to analyze the ratio of areas of different types of land and determine the economic profile of each anthropogenic landscape, its degree of development and ecological state.

Regional landscape-ecological diagnostics in the Chechen Republic should be based on the identification of landscape indicator complexes, such as arid, mountain-forest and mountain-meadow landscapes:

– A) Arid landscapes are characterized by high instability to natural and anthropogenic influences, and their coincidence in time can lead to irreversible processes, including desertification.

Arid landscapes are widespread in the north of the Chechen Republic. Within their boundaries, a subtype of semi-desert and desert landscapes is distinguished, which includes low-lying flat accumulative territories with various types of vegetation: wormwood, saltwort and wormwood-grass.

Anthropogenic degradation of arid landscapes has led to the formation of a new state of the environment, which can be characterized as geoecologically tense and destabilized. Under the influence of anthropogenic and climatic factors (hot summers, lack of precipitation, frequent dry winds, etc.), the processes of degradation, deflation and loss of soil fertility are intensifying. Valuable forage plants are falling out of the grass stand. Restoration of pasture ecosystems should be based on the scientific principles of biogeocenology, ecology and geoecology.

IV. Discussion

One of the key aspects of effective monitoring is the use of modern technologies and tools. Currently, many technologies are available that facilitate the analysis of land use data and the monitoring of its changes. One such technology is remote sensing, which allows obtaining high-quality satellite and aerial images of the Earth with high spatial resolution. These images help to determine the type of soil, the level of pollution, the presence of vegetation and other important parameters for assessing the quality of land plots. Moreover, remote sensing provides the ability to track changes in land use over time, which is necessary for analyzing the effectiveness of agricultural activities. Another important tool actively used in monitoring agricultural land is a geographic information system (GIS). GIS integrates spatial data and attribute characteristics of the land into a single system, which allows creating maps and modeling various land use scenarios. This is very useful for planning and decision-making in the agricultural sector, as it allows you to determine the optimal options for using land, taking into account its potential and environmental constraints. The importance of automating monitoring processes should also be emphasized. With the advent of new technologies, it has become possible to automate the collection of data on the state of the land. For example, specialized sensors can continuously monitor soil moisture levels, lighting, and other parameters, transmitting this data to a processing center for analysis and decision making.

However, despite all the technological advances in agricultural land monitoring, there are still some issues and challenges. One of these issues is the availability of technology for all participants in the agricultural sector. Not all farmers or land owners can afford to purchase and use modern monitoring tools. This creates inequality in access to information and makes it difficult to develop effective strategies for the development of the agricultural sector.

In recent years, monitoring of agricultural land has become increasingly relevant and in demand. The development of agriculture, changing climate conditions and the growing needs of the population require more rational use of agricultural land. One of the prospects for the development of monitoring of agricultural land is the introduction of new technologies and methods. Modern satellite systems make it possible to obtain detailed data on the condition of soil, vegetation and water resources over vast territories. Aerial photography and remote sensing help to identify problem areas of land, determine the level of soil and water pollution, and monitor the implementation of agricultural activities.

The creation of digital databases is also a significant area for monitoring agricultural land. Digital information on soil conditions, climate conditions, crops and other factors helps reduce risks and increase productivity. Databases allow tracking long-term trends, predicting changes and taking preventive measures.

However, the development of agricultural land monitoring faces certain difficulties. One of these difficulties is the lack of a unified methodology and standards for collecting and analyzing data. Different organizations use different approaches, which makes it difficult to compare results and objectively assess the state of land resources.

The first agroclimatic region is located in the northern part of the Tersky sand massif and covers the northern regions of the Shelkovsky and northeastern part of the Naursky administrative districts. This region is the driest, hottest and most continental in the republic. The average annual humidity coefficients in this region do not exceed 0.30–0.33, and the sum of temperatures above 10 °C varies from 3720 to 3800 °C. The continentality coefficient is about 190.

The vegetation period is characterized by low precipitation: less than 300 mm falls per year, and less than 200 mm during the vegetation period. From April to October, there are more than 90 days with droughts and dry winds, which creates difficult conditions for agricultural production.

The second agroclimatic region is located in the southern part of the Tersky sand massif and covers the central regions of the Naursky and Shelkovsky administrative districts. This region is also characterized by high temperatures and low humidity. Average annual humidity coefficients vary from 0.32 to 0.37, and the sum of temperatures above 10 °C ranges from 3700 to 3780 °C. The continentality coefficient remains at about 190.

During the growing season, this area receives 200 to 230 mm of precipitation, and 300 to 350 mm per year. From April to October, 85-90 days with droughts and dry winds are recorded.

The third agroclimatic region is located in the territories adjacent to the Terek River from the north and south, as well as to the lower reaches of the Sunzha River . It covers the southern parts of the Naursky and Shelkovsky administrative districts, the northern parts of the Nadterechny , Grozny and Gudermes districts, as well as the extreme north of the Shali district.

This agroclimatic region is characterized by high heat and insufficient moisture. Average annual moisture coefficients vary from 0.37 to 0.48, and the sum of temperatures above 10°C is from 3600 to 3750. The continental coefficient is within 185-190. The vegetation period here is accompanied by precipitation in the amount of 230-270 mm, and the annual precipitation reaches 350-440 mm. From April to October, there are 80-85 days with droughts and dry winds.

The fourth agroclimatic region is located on low foothill ranges such as Tersky, Sunzhensky, Groznensky and Gudermessky , as well as on the lower part of the Sunzhenskaya inclined foothill plain. This region covers the southern part of the Nadterechny administrative district, most of the Groznensky district, the extreme northern parts of the Achkhoy-Martanovsky and Urus-Martanovsky districts, as well as small territories in the central part of the Gudermessky district and the northern part of the Shali district.

The agroclimatic region is characterized by warmth and moderately insufficient moisture. Average annual moisture coefficients fluctuate from 0.48 to 0.60, the sum of temperatures above 10°C is 3400-3600, and the continentality coefficient is 182-186. During the growing season, precipitation here ranges from 270 to 310 mm, and over the year - from 420 to 500 mm. During the period from April to October, 70-80 days with droughts and dry winds are recorded.

Table 1: *Agroclimatic Regions of the Chechen Republic*

Region	Location	Characteristics	Humidity Coefficient	Temperature Sums (°C)	Precipitation (mm/year)	Drought/ Dry Wind Days
First Region	Northern part of the Tersky sand massif, northern Shelkovsky and northeastern Naursky districts	Driest, hottest, most continental region. Very low precipitation and extreme drought conditions.	0.30–0.33	3720 to 3800	Less than 300 (less than 200 during growing season)	More than 90
Second Region	Southern part of the Tersky sand massif, central Naursky and Shelkovsky districts	High temperatures, low humidity, slightly better moisture than the first region but still very dry during growing season.	0.32–0.37	3700 to 3780	300 to 350 (200 to 230 during growing season)	85-90

The fifth agroclimatic region covers the higher parts of the Sunzhenskaya sloping plain, the low foothill Novogroznensky ridge and other foothills whose height does not exceed 500 m. This region includes the northern part of the Achkhoy-Martan administrative district, most of the Urus-Martan and Shali districts, the southern part of the Grozny and Gudermes districts, as well as the extreme northeast of the Nozhai - Yurtovsky district.

The sixth agroclimatic region is characterized by a warm climate and moderate humidity. Average annual humidity coefficients vary from 0.60 to 0.85, and the sum of temperatures above 10 °C is from 3100 to 3400. The continental coefficient is within 177-182. During the growing season, precipitation ranges from 310 to 440 mm, and the annual precipitation fluctuates between 500 and 620 mm. Despite the generally moderate humidity, droughts and dry winds are often observed in this region, especially from April to October, when 50-70 days with such phenomena are recorded.

The sixth agroclimatic region is located in a narrow strip of low mountains, mainly represented by the dissected Black Mountains ridge. It covers the central parts of the Achkhoy-Martan administrative district, the southern districts of the Urus-Martan and Shalinsky districts, as well as the northern parts of the Vedensky and Nozhay- Yurtovsky districts, including the extreme north of the Shatoi district.

The seventh agroclimatic region covers the mid-mountain and high-mountain massifs of the Skalisty and Bokovoy ridges. This region includes the southern parts of the Achkhoy-Martanovsky, Vedensky and Nozhay- Yurtovsky districts, as well as almost the entire Shatoisky district.

Table 2: *Climate Subregions of the Chechen Republic Based on Heat Supply*

Subregion	Temperature Sums (°C)	Description
7a	2500 to 2800	The lowest subregion in terms of temperature sums. Moisture is sufficient or excessive, but heat is relatively high.
76	1800 to 2500	Moderate heat supply; suitable for some agricultural activities, depending on altitude and local conditions.
7v	1000 to 1800	Cooler subregion with limited heat supply, affecting the types of crops and grazing lands that can be supported.
7g	Less than 1000	Coldest subregion, often with no temperatures above 10°C. Areas include glaciers and snowfields.

The climate of this region is characterized by sufficient and even excessive moisture. However, the heat level is uneven due to significant changes in absolute altitudes. This region is divided into four subregions by the level of heat supply :

- 7a (the lowest) - with temperature sums from 2500 to 2800 °C,
- 76 — with temperature sums from 1800 to 2500 °C,
- 7v - with temperature sums from 1000 to 1800 °C,
- 7g — with temperature sums less than 1000 °C.

In a significant part of this subregion, temperatures above 10 °C are completely absent, and noticeable areas are occupied by glaciers and snowfields.

The climatic conditions of the Chechen Republic have a significant impact on the quality of its lands. The level of moisture and heat supply determines, along with other natural factors, the possibilities of using lands for plowing and grazing. Humidification coefficients and the sum of active temperatures have a direct correlation with the productivity of arable and forage lands, which, in turn, affects the cost of lands.

Land, as a natural resource, has a multifunctional purpose and has its own characteristics. First of all, it is a product of nature and has no initial value, since human labor is not required for its creation. At the same time, land is the main means of producing agricultural products necessary for the existence of mankind.

The land serves as a spatial basis for all processes of social life, and its active role is manifested through the soil. Unlike other natural resources, land resources are characterized by soils that differ in quality and have various properties. This means that with equal labor and resource costs per unit of land area, the amount of agricultural products obtained can vary significantly. The main difference of the soil is its productivity, which is determined by the level of fertility - the ability to provide plants with the necessary nutrients. Thus, the soil "bears fruit" and provides humanity with 98-99% of all food products, of which 85% are protein products.

The assessment of natural resources, including land, should be carried out from three points of view: ecological or environmental, with the aim of preserving the quality of the natural environment; economic, which takes into account the profitability of the use of the natural resource; and social, which is focused on meeting the needs of society. At present, many scientists assess the ecological state of the land resources of the Chechen Republic as critical, and in some areas the situation is acquiring the character of an ecological disaster.

The potential of the land resources of the Chechen Republic was previously not used to its full extent. During the military actions, agricultural production significantly decreased, which led to the inability to meet the population's needs for food products. At present, when the economy of the republic is destroyed, land remains practically the only means of production. Therefore, the transition to economic methods of management in the republic is impossible without the presence of complete and reliable information on the quality of land plots.

Another problem is limited access to information. A lot of data on the state of the soil, water resources and other important parameters is stored in various government agencies and commercial companies, which are not always ready to share this information with specialists, which makes it difficult to conduct full-fledged monitoring.

It is also worth noting the high costs of monitoring agricultural land. The acquisition of the necessary equipment, training of specialists and processing of the collected data require significant financial resources.

However, the development of agricultural land monitoring has great potential. The use of modern technologies such as geographic information systems (GIS), as well as the assessment of the sustainability of agroecosystems and the creation of digital databases can significantly improve the efficiency of production activities and contribute to the conservation of natural resources.

To successfully implement these prospects, it is important to develop uniform monitoring methods and standards, as well as to ensure access to information and attract sufficient financial resources.

As a result, monitoring of agricultural lands plays a key role in sustainable agricultural development. It provides the necessary information to optimize land use, improve production efficiency, and ensure environmental safety. The prospects for monitoring development are closely linked to the use of new technologies that allow for more accurate and timely analysis of the state of the land fund.

Soil moisture and temperature are variable characteristics that change depending on various factors such as meteorological conditions, soil texture, vegetation type and groundwater level.

Humus content is one of the key factors determining soil quality. Humus is the most important part of the soil, directly related to its fertility. The humus layer accumulates the main elements necessary for plant nutrition. In addition, humus affects such soil characteristics as its absorption capacity, moisture, aeration, color and structure.

The main characteristics of the soil also include acidity. The degree of soil acidity is an important indicator for the economic assessment of land, since it determines what types of plants can grow in a given area. When assessing the lands of the Chechen Republic, negative soil parameters are also taken into account, such as erosion, deflated, solonetzic, salinity, as well as the content of rubble and stones.

It is important to assess soils taking into account all of these characteristics, as well as their toxicity and potential hazard to humans and plants caused by pollution.

The influence of climatic conditions on the assessment indicators of land plots is complex. However, for each physical-geographical region of the republic, the accounting and registration of this influence must take into account specific features, such as agricultural methods, types of vegetation, characteristics of soils and grounds, as well as relief forms.

Climate also significantly affects the relief and causes exogenous processes. The assessment of the degree of this impact is based on the registration of the amount and types of precipitation for a given territory, the intensity of their seasonal fallout, as well as wind characteristics and temperature fluctuations.

Soils and grounds can undergo significant changes under the influence of climatic factors. For example, strong winds in the steppe zone can destroy the fertile humus layer, and intense precipitation, especially heavy rainfall, in the foothill and mountain zones can lead to its erosion, which reduces fertility and, accordingly, worsens the assessment indicators.

The influence of climate on vegetation is most noticeable, since it is climate that determines the types and forms of plants that can adapt to specific conditions. Even small changes in precipitation or average annual temperature can significantly affect crop yields. Thus, climatic factors have a constant, although changing, effect on land quality. The main climatic factors affecting land quality are temperature and moisture conditions.

Temperature is one of the most significant and constant natural factors affecting all categories of land. The impact of temperature on agricultural land is most noticeable compared to other categories. For example, a decrease in temperature in the foothill and mountainous regions of the republic can negatively affect the quality of these lands.

The amount of precipitation, like the temperature regime, plays a decisive role in the qualitative characteristics of agricultural territories. An increase in the amount of precipitation usually leads to an improvement in the quality of the land. However, when assessing precipitation, it is necessary to take into account the climatic zone in which this assessment is carried out.

The degree of moisture and heat supply has a direct correlation with the productivity of arable and forage lands, which in turn affects the cost of land. Therefore, when calculating soil-ecological indices for the conditions of the Chechen Republic, the main attention is paid to climatic indicators, such as the average annual sum of temperatures above 10 °C (Pg 10), the moisture coefficient (MC) and the continentality coefficient (CC).

The average annual sum of positive (active) temperatures above 10°C is an important indicator of the thermal regime during the vegetation period, which covers the period of plant growth and reproduction. The moisture coefficient reflects the ratio of the annual precipitation to the potential annual evaporation. This coefficient allows us to estimate how much precipitation in a given region compensates for evaporation, which is critical for agronomic and environmental calculations.

The diversity of climatic conditions in the Chechen Republic significantly affects the cadastral valuation of agricultural land. Price indices reach their highest values in areas with an optimal combination of heat and moisture reserves. However, in the northern parts of the republic, despite the high heat, price indices remain low due to a lack of moisture. A similar situation is observed in high-mountain areas, where, although moisture is generally sufficient, heat supply indicators remain very low.

Within the Chechen Republic, the following natural and economic zones are distinguished: foothill-plain, mountainous, and priterechno-lowland. The foothill-plain zone includes the Gudermes , Grozny, Shali, Achkhoy-Martanovsky, and Urus-Martanovsky districts, with the exception of their southern parts, which belong to the mountainous zone. The mountainous zone also covers the Nozhai - Yurtovsky, Vedensky, Shatoisky, and Itum-Kalinsky districts. The boundary between the foothill-plain and mountainous zones can be conditionally drawn along an isohypse at an altitude of 500 meters above sea level, since it is from these heights that noticeable dissection of the relief begins, which significantly affects the territorial organization. The priterechno -lowland zone includes the Shelkovsky, Naursky, and Nadterechny districts.

The use of geographic information systems (GIS) for monitoring agricultural lands in the Chechen Republic has demonstrated high efficiency and relevance in the context of modern land use. The use of these technologies has made it possible to comprehensively assess the current state of agricultural lands, identify key problems such as soil degradation, erosion processes, salinization, and changes in the structure of the land fund.

Table 3: *Natural and economic zones of the Chechen Republic and their distribution by provinces*

Zone	Districts	Notes
Foothill-Plain Zone	Gudermes, Grozny, Shali, Achkhoy-Martanovsky, Urus-Martanovsky (excluding southern parts)	Includes most of these districts, except for southern parts belonging to the mountainous zone.
Mountainous Zone	Nozhai-Yurtovsky, Vedensky, Shatoisky, Itum-Kalinsky, southern parts of Achkhoy-Martanovsky and Urus-Martanovsky	Covers districts in the highlands, starting from approximately 500 meters above sea level.
Priterechno-Lowland Zone	Shelkovsky, Naursky, Nadterechny	Includes lowland districts near the Terek River.

Monitoring using GIS technologies ensures regular and accurate collection of data on the state of land, which allows for prompt action to improve soil fertility, optimize the use of land resources, prevent degradation and reduce negative anthropogenic impacts. Data obtained through remote sensing and processing of satellite images allows for the identification of both short-term changes associated with natural phenomena (drought, floods) and long-term trends affecting the agroecological situation in the region.

The introduction of GIS technologies creates preconditions for more rational land use and sustainable agriculture, which is especially important for the Chechen Republic, where a significant portion of the population is employed in the agricultural sector. The monitoring results can become the basis for developing and adjusting agricultural policy, effective planning and implementation of environmental protection measures aimed at restoring and preserving soil fertility.

In the long term, continued use of GIS and integration of these data with other information sources such as meteorological data and indicators of agricultural practices will help improve land management, thereby ensuring sustainable agricultural development in the region.

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