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IMPLEMENTATION OF MODERN TECHNOLOGIES IN THE ACCOUNTING OF DEGRADED LANDS

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Abstract

This article examines the problems of accounting for degraded lands in the Republic of Uzbekistan and the role of modern technologies in solving them. The possibilities of effective land resource management through the use of GIS, remote sensing, GNSS, artificial intelligence, and mobile applications are analyzed. The practical experience of Bukhara region, as well as that of the European Union, the USA, China, and Australia, is studied. As a result, opportunities for accurate and rapid accounting, the formation of a unified electronic database, efficient use of resources, and increased economic efficiency are highlighted.

Keywords

degraded lands, monitoring, GIS, remote sensing, GNSS, artificial intelligence, electronic database.

Introduction. Land resources are one of the fundamental pillars of any country's economy, and their effective management plays a decisive role in increasing agricultural productivity, maintaining ecological balance, and ensuring food security for the population. Today, due to global climate change, intensive economic activity, improper irrigation, and insufficient land reclamation measures, a significant portion of land resources is undergoing degradation.

The accounting of degraded lands is not merely a statistical process; rather, it represents a strategic task of the state aimed at the rational use of resources, restoration of the land fund, and its preservation for future generations. At the same time, traditional accounting and assessment methods are no longer capable of fully meeting modern requirements.

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In recent years, substantial reforms have been implemented in the Republic of Uzbekistan in the field of land resource management. In particular, based on Presidential Decree PF-5742 (2019) and Resolution PQ-277 (2022), comprehensive measures have been undertaken to digitalize the state land cadastre system, establish a unified electronic database, and introduce remote sensing technologies. This, in turn, demonstrates that the implementation of modern technologies in the accounting of degraded lands has become an increasingly relevant and urgent issue.

Research Object and Methods. The object of the research is the system of accounting for degraded lands in the Republic of Uzbekistan and the ways of its improvement. In preparing this article, legal and regulatory documents, materials of the State Land Cadastre, maps created using GIS software, aerospace (remote sensing) data, and sources reflecting international experience were widely utilized.

The methodological framework of the study is based on scientific analysis, comparative assessment, cartographic methods, and statistical approaches, which ensured a comprehensive and objective evaluation of the current state of degraded land accounting and the identification of priority directions for its improvement.

Research Results. The analysis shows that the current system for accounting degraded lands faces a number of significant challenges. These include outdated data, the absence of a unified electronic database, difficulties in the rapid identification of natural degradation processes, shortages of qualified specialists and technical resources, as well as non-compliance with international standards.

According to the United Nations *Global Land Outlook* (2022) report, degradation processes are observed on more than 20 percent of agricultural lands worldwide. In certain regions of Uzbekistan, this indicator reaches 30–35 percent, highlighting the increasing severity of land degradation and the urgent need for improved accounting and monitoring mechanisms.

Table 1. Results Obtained through the Use of Modern Technologies in the Accounting of Degraded Lands

Technology Type	Main Application Area	Accuracy Level (%)	Accounting Speed	Practical Outcome
GIS	Land mapping, layered (spatial) analysis	90–95	Moderate	Development of degradation maps
Remote Sensing	Salinity, moisture, NDVI analysis	85–90	Rapid	Use of satellite and drone-based data
GNSS	Land parcel boundary determination	95–98	Rapid	Precise coordinates and area calculations

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Mobile Applications	Real-time data recording	80–85	Very rapid	On-site data entry under field conditions
Artificial Intelligence (AI)	Forecasting and analytical assessment	85–92	Rapid	Development of salinity and erosion forecasts

Lack of a Unified Electronic Database. At present, data on degraded lands at the regional level are stored separately across different institutions. For instance, the State Land Cadastre, the Ministry of Agriculture, Water Management Authorities, and the Environmental Protection Committee each maintain their own datasets; however, these data are not integrated into a unified electronic database. This fragmentation results in discrepancies in figures referring to the same land parcels. Consequently, official statistics are often inaccurate and, in some cases, differ from the actual situation by 10–15 percent.

Shortage of Specialists and Technical Resources. The accounting of degraded lands requires the extensive use of modern tools, including GNSS receivers, unmanned aerial vehicles (drones), laser scanning equipment, and specialized software. However, in several regions, such equipment is insufficient or unavailable. Moreover, there is a lack of qualified specialists capable of operating and managing these technologies effectively. According to analyses conducted by the Ministry of Agriculture in 2023, the proportion of specialists with advanced proficiency in geoinformation technologies in the regions accounts for only 20–25 percent. This shortage significantly slows down the process of introducing and implementing modern technologies.

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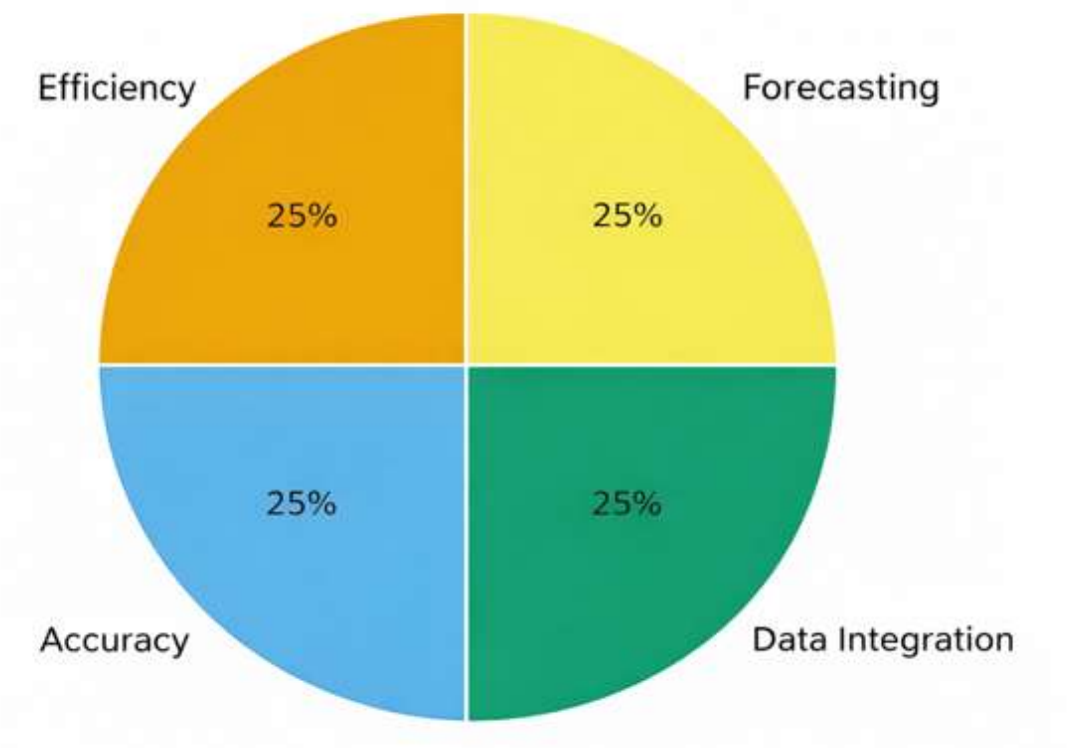

Figure 1. Advantages of GIS Technologies in Land Accounting

Remote Sensing is a method of monitoring land conditions using satellite systems and unmanned aerial vehicles (UAVs, drones).

- Satellite data enable the rapid identification of soil salinity, moisture levels, and vegetation indices (NDVI).
- The use of drones allows the acquisition of high-resolution images (5–10 cm), making it possible to accurately detect degraded land areas.
- For example, Landsat and Sentinel-2 data make it possible to monitor salinization processes in Uzbekistan with an accuracy of approximately 85–90 percent.

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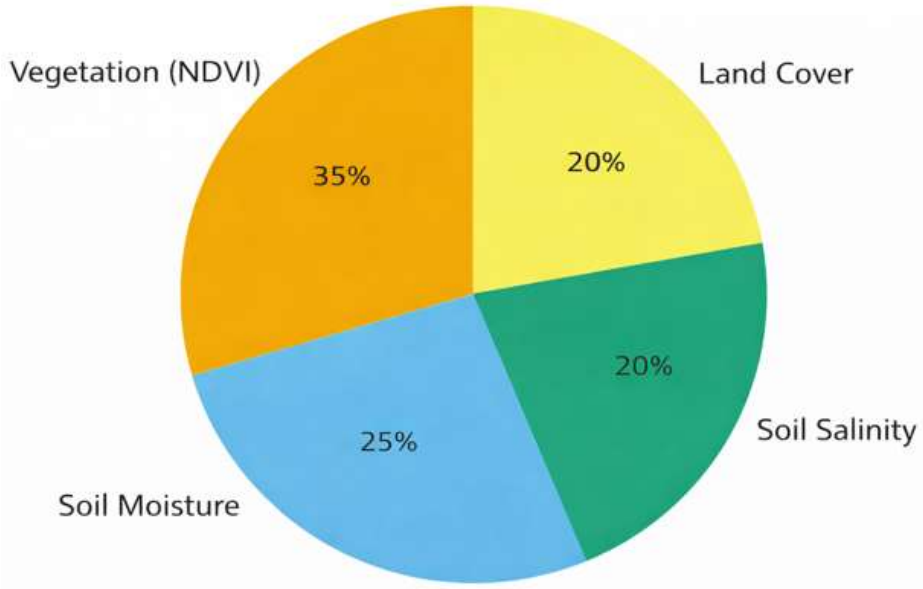

Figure 2. Data Obtained through Remote Sensing Technologies

GNSS Technologies (GPS, GLONASS, BeiDou) provide accurate determination of land parcel coordinates.

- Using coordinates with an accuracy of up to 1–2 cm, land parcel boundaries can be redefined with high precision.
- Errors in land accounting, such as incorrect area determination and boundary overlaps, are effectively eliminated.
- GNSS has become a primary tool in monitoring reclamation facilities and irrigation networks.

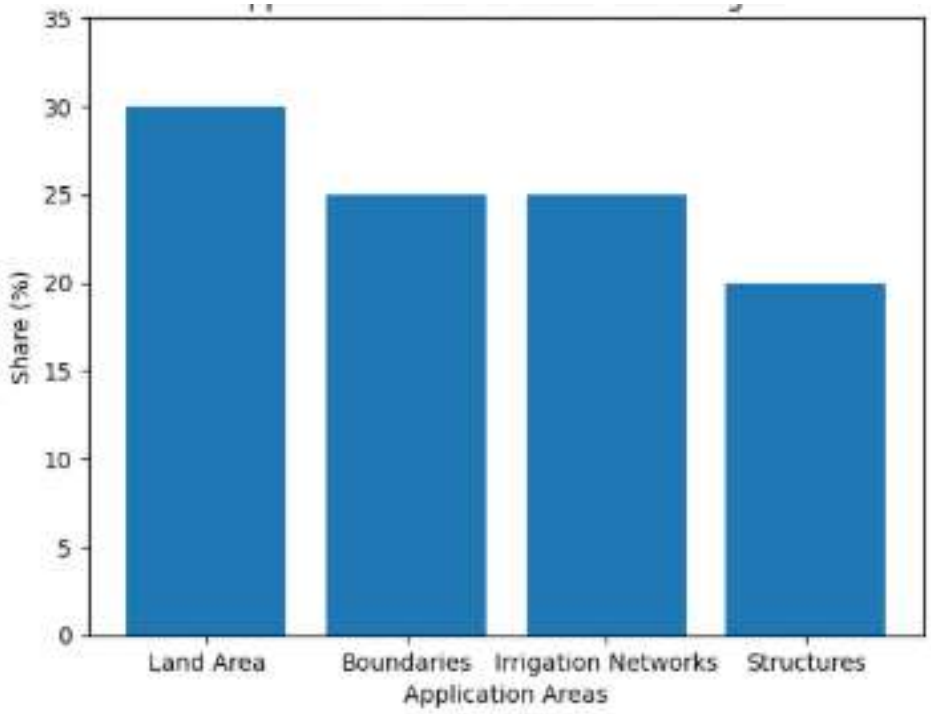

Figure 3. Application Areas of GNSS Technologies

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The implementation of modern technologies in the effective management of land resources is considered an important stage. In recent years, Uzbekistan and a number of foreign countries have widely adopted advanced technologies for accounting and monitoring the degree of land degradation. The digital cadastral system, in accordance with the Decrees of the President of the Republic of Uzbekistan No. PF-5742 (2019) and No. PQ-277 (2022), sets the tasks of fully digitalizing the state land cadastre, creating a unified electronic database, and widely introducing remote sensing technologies.

- ❖ Since 2020, electronic land cadastre systems have been initiated in all regions;
- ❖ Electronic maps of degraded lands have been developed through cooperation between the Ministry of Agriculture and the State Land Cadastre Committee;
- ❖ In Bukhara region, aerospace data on saline lands have been integrated into the GIS system, and meliorative measures have been planned accordingly.

In recent years, unmanned aerial vehicles (UAVs) have been increasingly used in several regions to monitor land areas. For instance, in the Khorezm and Kashkadarya regions, drones have been employed to conduct monitoring activities on saline and erosion-affected lands. This experience has demonstrated that the use of drones allows results to be obtained 3–4 times faster and with higher accuracy compared to traditional field surveying methods. In 2023, within the framework of the "Unified National Geoinformation Platform" project, electronic maps of degraded lands were developed. Through these maps:

- the degree of land degradation, the extent of salinization, and erosion-prone areas are displayed by thematic layers;
- farmers and agro-cluster enterprises have gained the ability to monitor the condition of their land plots online.

By widely introducing modern technologies in the accounting of degraded lands, the following results can be achieved:

- ❖ land salinization, erosion, and other degradation processes can be monitored and recorded in real time using satellite imagery and GIS systems;
- ❖ compared to traditional field surveying methods, the time required to obtain results can be reduced by 4–5 times;
- ❖ the level of errors in land accounting can be reduced from 10–15 percent to 2–3 percent;
- ❖ based on accurate monitoring, financial resources allocated for meliorative measures can be used in a more targeted and efficient manner;

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- the return of degraded lands to agricultural circulation contributes to an increase in gross agricultural output;
- overall, economic efficiency in land resource management is expected to increase by 25–30 percent.

Conclusion and Recommendations The issue of accounting for degraded lands is currently of critical importance not only for improving the efficiency of agricultural production, but also for ensuring environmental sustainability and strengthening food security. Although a number of problems persist within the existing system under the conditions of Uzbekistan, recent years have marked the beginning of a new stage in this field due to state-level decisions and the introduction of modern technologies. The application of modern technologies—such as GIS, remote sensing, GNSS, artificial intelligence, and mobile applications—creates opportunities for accurate accounting of degraded lands, rapid monitoring, and forecasting potential risks that may arise in the future. International experiences, including the Copernicus Programme of the European Union, the USGS Landsat Program in the United States, and the use of artificial intelligence and drone technologies in China, can serve as valuable benchmarks for Uzbekistan.

1. **Establishment of a unified electronic database** – integrating data on the degree of land degradation from all regions and districts into a single digital platform.
2. **Widespread implementation of GIS and remote sensing systems** – ensuring regular use of satellite imagery and drones to rapidly identify salinization, erosion, and other forms of land degradation.
3. **Application of GNSS technologies** – mandating high-precision geodetic measurements for accurately defining land parcel boundaries.
4. **Expansion of local best practices** – extending drone- and GIS-based monitoring projects initiated in the Bukhara, Khorezm, and Kashkadarya regions to other territories.

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