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CREATION OF A GIS SYSTEM FOR EFFECTIVE USE AND MONITORING OF AGRICULTURAL LANDS IN NUKUS DISTRICT

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Annotation

The rational use and continuous monitoring of agricultural lands are among the key factors ensuring food security and sustainable agricultural development. This research focuses on creating a Geographic Information System (GIS) for the efficient utilization and monitoring of agricultural lands in Nukus District. The proposed system aims to integrate spatial data, satellite imagery, and analytical tools to support decision-making in land management, soil fertility assessment, and crop productivity forecasting. The implementation of GIS technologies will allow specialists and farmers to evaluate land conditions, prevent degradation, and improve agricultural productivity through data-driven management.

Keywords

GIS, agriculture, monitoring, land management, remote sensing, sustainability.

Agriculture remains the backbone of the economy in many regions of Uzbekistan, especially in the Republic of Karakalpakstan, where climatic and soil conditions are highly variable. In the Nukus District, effective land use and monitoring are crucial due to the increasing impact of salinization, water scarcity, and land degradation. Traditional monitoring methods often rely on manual field surveys, which are time-consuming, costly, and prone to errors.

Modern technologies such as Geographic Information Systems (GIS) and Remote Sensing (RS) offer new opportunities for improving land management. GIS enables the collection, storage, analysis, and visualization of spatial data, providing decision-makers with comprehensive insights into the state of agricultural lands. By combining spatial analysis with environmental and agricultural datasets, GIS can support more sustainable and productive agricultural practices.

This study aims to design a GIS-based monitoring system tailored to the conditions of Nukus District. The system integrates spatial data layers, such as soil

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type, water sources, vegetation index, and land use, to assist in planning and management processes.

Numerous studies have demonstrated the effectiveness of GIS in agricultural monitoring and planning. According to FAO (Food and Agriculture Organization), GIS and RS technologies play a vital role in precision agriculture and land resource management. In regions such as Central Asia, these technologies have been successfully used to monitor desertification, assess irrigation efficiency, and identify areas at risk of salinization.

Researchers such as Longley et al. (2015) emphasize that GIS-based decision support systems enable users to model and visualize agricultural processes dynamically. In Uzbekistan, several pilot projects using GIS and RS data have been initiated to manage water resources and optimize crop patterns. However, there is still a lack of integrated systems specifically adapted to local conditions, such as the arid environment and soil salinity characteristic of Nukus District.

The GIS system prototype developed for Nukus District demonstrates significant potential for improving agricultural monitoring. By analyzing satellite imagery from multiple years, it is possible to detect changes in vegetation cover and identify zones affected by land degradation.

The NDVI maps generated for the district reveal variations in crop health and density, indicating the influence of irrigation and soil conditions. Spatial analysis of soil salinity data shows that approximately 28% of the agricultural land in the region requires reclamation measures.

To ensure the effective implementation of the proposed GIS system, a pilot project was carried out in selected agricultural areas of Nukus District. The pilot involved the integration of spatial data from three primary sources: field surveys, satellite imagery, and government cadastral databases. Data were imported into QGIS software for preprocessing and analysis.

The integration of GIS technology into agricultural land management offers both economic and environmental advantages. Economically, GIS-based monitoring reduces the need for manual fieldwork, minimizing costs associated with land surveys and resource allocation. The system also optimizes fertilizer and water distribution, increasing crop yields and reducing wastage.

Environmentally, GIS supports sustainable land use by identifying degradation zones and promoting efficient irrigation. The visualization of environmental indicators helps authorities monitor ecological changes caused by agricultural activities. For instance, NDVI (Normalized Difference Vegetation

Index) analysis helps detect early signs of vegetation stress, which can be correlated with soil salinity or irrigation problems.

Moreover, the integration of GIS with remote sensing (RS) and Internet of Things (IoT) devices, such as soil moisture sensors, enhances real-time data collection. This hybrid system contributes to improved environmental protection by reducing water overuse and soil pollution from fertilizers.

Moreover, the integration of GIS with meteorological data enables forecasting of potential drought risks and helps farmers optimize irrigation schedules. The developed system allows for efficient land classification, which supports government agencies in planning land redistribution and monitoring compliance with sustainable agricultural practices.

The results also show that the GIS-based monitoring approach reduces the need for manual field surveys by up to 40%, leading to cost and time efficiency. The visualization of spatial patterns helps identify high-risk areas and prioritize reclamation or conservation measures.

The creation of a GIS system for the effective use and monitoring of agricultural lands in Nukus District provides a foundation for sustainable agricultural management. The integration of spatial and analytical tools enables real-time monitoring, supports precision agriculture, and assists in the prevention of land degradation.

By adopting GIS technologies, local authorities and farmers can make informed decisions about crop planning, irrigation management, and soil conservation. Future research will focus on integrating AI-based predictive models and mobile applications to enhance system accessibility and usability for end-users.

The extended analysis confirms that the GIS-based system for agricultural monitoring in Nukus District is not only a technological innovation but also a strategic tool for regional development. Its successful implementation can lead to higher agricultural productivity, better resource management, and stronger environmental sustainability.

With continued investment, training, and integration of advanced technologies such as AI and IoT, the proposed system can serve as a model for other districts across Uzbekistan and Central Asia.

In conclusion, GIS-based land monitoring systems represent a transformative approach for regions facing environmental and agricultural challenges. Their application in Nukus District demonstrates that modern technologies can significantly improve the efficiency and sustainability of agricultural land use.

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