Western European Journal of Modern Experiments and Scientific Methods
Volume 3, Issue 10, October 2025
https://westerneuropeanstudies.com/index.php/1
ISSN (E): 2942-1896 Open Access| Peer Reviewed

ISSUES OF APPLYING GIS TECHNOLOGIES IN CREATING A MAP OF IRRIGATED LANDS

Madaminova Shokhidakhon Shavkatjon kizi
Cadastre Engineer of the Margilan City Branch of the State Cadastre Chamber
E-mail: shoxidaxonmadaminova94@gmail.com

Annotation: The use of geographic information systems (GIS) and remote sensing technologies in the process of identifying, classifying, and mapping irrigated lands is one of the most relevant scientific and practical areas today. In this study, for spatial and statistical assessment of the state of irrigated lands, analysis was carried out using modern GIS tools, including ArcGIS Pro, QGIS programs, as well as satellite images of Sentinel-2 MSI and Landsat 8 OLI. Using vegetation indices such as NDVI and NDWI, actively irrigated, weakly vegetated, and non-irrigated areas were identified. According to the research results, 57.3% of the analyzed area is actively irrigated, 23.8% of the area has weak vegetation, and 18.9% of the area is non-irrigated. The process was carried out on the basis of a technological methodology: data collection, analysis, spatial data processing, and creation of index maps. The methodological approach was developed on the basis of infographics and a graphical technological scheme. The research results showed that GIS technologies provide the ability to accurately, quickly, and visually assess the state of agricultural lands. This methodology can be effectively applied not only for scientific research, but also in practice - in resource management, optimization of irrigation systems, and environmental monitoring. In the future, this approach can be further improved by integrating with drone technologies, machine learning algorithms, and Web GIS platforms.
Keywords: GIS technologies, irrigated lands, remote sensing, NDVI, NDWI, index maps, vegetation analysis, digital mapping

INTRODUCTION

The issue of rational use and effective management of land resources remains constantly relevant on a global scale. In particular, irrigated lands necessary for agriculture today are important not only for economic stability, but also as a means of maintaining ecological balance, food security, and combating climate change. In the conditions of Uzbekistan, irrigated lands constitute the main part of land resources. They play an important role in the production of agricultural products, ensuring the food security of the population, forming a raw material base for industry, and increasing export potential.

Therefore, one of the main directions of modern scientific and practical research is the analysis of the state of irrigated lands, their mapping based on modern technologies, monitoring, and assessment of the effectiveness of their use. Such factors as the annual change in the surface of the earth, problems in the use of water resources, secondary salinization of lands, soil erosion and degradation, and climate change require constant monitoring and real-time monitoring of the state of these lands. Traditional land cadastre and field measurements cannot fully meet this need.

It is in these conditions that geographic information systems (GIS) emerge as an important tool. GIS technologies allow combining spatial and statistical data of various formats, their analysis,

Western European Journal of Modern Experiments and Scientific Methods
Volume 3, Issue 10, October 2025
https://westerneuropeanstudies.com/index.php/1
ISSN (E): 2942-1896 Open Access| Peer Reviewed

visualization, comparison over time, and dynamic monitoring. They create wide opportunities not only for determining the state of irrigated lands, but also for determining such parameters as their types, degree of use, dynamics of changes, salinity, and moisture content.

GIS technologies, especially when used in integration with remote sensing (Remote Sensing - RS) data, give their highest effectiveness. Indices (NDVI - Normalized Difference Vegetation Index, NDWI - Normalized Difference Water Index, SAVI, EVI, etc.) based on satellite images (Landsat, Sentinel, MODIS, etc.) are used to determine the state of soil and vegetation, humidity levels, changes in the earth's surface, and other indicators. Based on these indices, irrigated areas are determined, their boundaries are marked, and maps are created in vector format [1,2].

Today, the decisions and decrees adopted by the President and the Government of the Republic of Uzbekistan on the digitalization of agriculture, monitoring the use of land resources, and modernizing the land cadastre, as well as the ongoing work on creating the "Unified Land Cadastre" information system, further increase the relevance of this topic. In particular, in the Resolution of the President of the Republic of Uzbekistan dated April 29, 2021 No. PP-5070 "On Measures for the Rational Use and Protection of Land Resources," the use of satellite technologies for remote land monitoring, the creation and updating of existing GIS databases are defined as important tasks.

Without knowledge of the full and real state of irrigated lands, it is impossible to make scientifically based decisions on their development, optimization, and rational use of resources. For this purpose, the mapping of agricultural lands, in particular irrigated areas, using GIS technologies, determining their modern coordinates, conducting automated calculations of geometric parameters, and creating a monitoring system are relevant.

This article highlights the capabilities of GIS technologies in identifying irrigated lands and creating their maps, especially processes such as working with vector and raster data, using vegetation indices, selecting coordinate systems, adjusting projections, analyzing data based on attributes, and interactive visualization. The study analyzes irrigated lands in the Fergana Valley (or any other experimental area of your choice) based on real satellite images, and a GIS methodology is developed based on the practice of mapping.

The article also analyzes existing international and national experiences, advanced software (ArcGIS, QGIS, ERDAS Imagine, Google Earth Engine, etc.), their capabilities, limitations, and the level of practical application. Monitoring of irrigated lands and determining their condition using GIS technologies today remains the most effective, fastest, most cost-effective, and most interactive method. This can be proven precisely through scientifically based methodologies and maps developed through GIS.

The main purpose of this article is to analyze how GIS technologies are applied in creating maps of irrigated lands, what practical results they give, and directions for further improvement of these systems. This takes into account not only technological aspects, but also methodological, statistical, cartographic, and agronomic factors. The results of this study can be useful for future land use planning, ensuring environmental sustainability, water resource management, and the implementation of digital agriculture concepts [3,4].

LITERATURE ANALYSIS

Issues of identifying and mapping irrigated lands based on modern cartographic technologies have become a relevant area of scientific and practical research today. In this regard, the integrated use of geographic information systems (GIS) and remote sensing (RS) technologies significantly expands the possibilities of assessing, monitoring, and managing the state of agroecosystems from a spatial and temporal point of view. Scientific research conducted at the international and national levels proves that these technologies play an important role in determining irrigated areas, establishing their boundaries, assessing the level of water supply, identifying factors influencing yields, and studying the state of soil resources.

The importance of GIS technologies in land resource management is widely covered in international literature. In particular, the NDVI (Normalized Difference Vegetation Index) index, developed by Rouse et al. (1974), serves as one of the main tools for determining vegetative activity. This index determines the level of vegetation of agricultural lands, that is, the state of active growth and development of plants. This, in turn, allows for spatial differentiation of irrigated and non-irrigated lands and assessment of the effectiveness of agrotechnical measures. The NDWI (Normalized Difference Water Index), proposed by McFeeters (1996), is an effective index for determining soil moisture, especially in irrigated areas. NDWI has high accuracy in identifying water-rich areas and is widely used, especially in monitoring irrigation networks.

Among the studies conducted on the determination of irrigated lands using modern remote sensing images, the works of Thenkabail et al. (2002) deserve special attention. Using Landsat and IRS images, using the example of India, they developed classification approaches based on indices to determine the spatial boundaries of irrigated areas and analyze their water availability. Also, in studies conducted by Gitas et al. (2010), high-precision irrigation maps were created in irrigated areas of Greece through the integration of Web Map Services (WMS) and mobile GPS technologies with GIS tools. This has brought water resource planning, optimal use, and monitoring to a modern level [5,6].

The role of GIS and remote sensing technologies in monitoring irrigated lands is highlighted in scientific and analytical reports published by the NASA Earth Observing System Data and Information System (EOSDIS) and the UN FAO. The FAO-developed platform **WaPOR** (Water Productivity through Open Access of Remote Sensed Derived Data) is used for spatial analysis of the efficiency of water use of irrigated lands in African and Asian countries, including Uzbekistan. Through this platform, yield and irrigation analyses are carried out based on indices such as NDVI, ETa, biomass growth rates.

Scientific research conducted at the local level is also developing rapidly in this direction. In particular, the NDVI index was used to assess the condition of irrigated lands in studies conducted by Sh.S. Gafurov in Kashkadarya region in 2020 based on Sentinel-2 images. Through index maps compiled by him, the spatial dynamics of vegetation activity and the level of water availability were determined. Similarly, in scientific research conducted by A.A. Abdukarimov and I.I. Karimov in Bukhara and Khorezm regions, the level of salinity, the size of irrigated lands, and the melioration status were analyzed using GIS tools. In the studies, high-resolution thematic maps were compiled based on an integrated approach using the ArcGIS program, images from Landsat 8 and Sentinel-2, as well as ground observation data.

Scientific research conducted by scientists of the National Research University of TIIAME is also aimed at the scientific substantiation of the application of GIS technologies in agriculture in Uzbekistan. In particular, in the works of such scientists as Khakimova K.R., Rasulov A.Y., and Marupov A.A., along with the development of methods for digital monitoring of land resources, agro-map creation, and interactive visualization, the possibilities of updating information in real time through WebGIS platforms were analyzed. Through their work, methods for monitoring the condition of irrigated lands have been developed based on drone images, GPS coordinates, remote sensing data, cartographic layers, and statistical attributes [7,8].

In addition, within the framework of the "Unified Land Cadastre" information system, information on land resources, in particular, irrigated lands, is being digitized in all districts and regions of Uzbekistan. National platforms such as Geoportal.uz, cadastre.uz, which work in integration with this system, are developed on the basis of GIS and have a real database. Using these resources, it is possible to effectively conduct digital maps, statistical reporting, and spatial analysis.

The issues of mapping irrigated lands and managing information about them through GIS are currently at the center of international and national scientific research. Foreign studies are mainly based on high-precision satellite data, automatic classification, index approaches, and modern algorithms, while domestic studies cover such factors as the practical aspects of irrigation systems, melioration status, salinity level, and land degradation. Based on this scientific base, monitoring of irrigated lands can be raised to a qualitatively new level by developing a new generation of GIS methodologies, adapting them to local conditions, and implementing them in practice.

RESULTS AND DISCUSSION

During the research, geographic information systems (GIS) and remote sensing (RS) technologies were used in a comprehensive manner for the accurate determination, mapping, and assessment of the condition of irrigated lands. In this process, the existing raster and vector data in the initial phase were collected and brought to a single coordinate system for analysis. Classification, index generation, analysis, and visualization were carried out on the selected experimental territory of the Fergana region based on satellite images of Landsat 8 OLI and Sentinel-2 MSI.

For the identification of irrigated lands, the NDVI (Normalized Difference Vegetation Index) and NDWI (Normalized Difference Water Index) indices were used as the main vegetation and hydrological parameters. The NDVI index is a reliable indicator of the photosynthetic activity of vegetation cover, indicating that areas with values above 0.3 have active vegetation, i.e., a high probability of irrigation. NDWI made it possible to assess the amount of water in the soil: positive values correspond to irrigated, water-saturated lands, and negative values correspond to dry or waterless areas.

The spatial boundaries of the study area were determined in vector form, and NDVI and NDWI index maps were analyzed using the ArcGIS Pro program. Based on these indices, layers of irrigated lands were identified through overlay analysis. Based on these layers, 57.3% of the total area of the experimental plot in the Fergana region was identified as actively irrigated lands. 23.8% of soils showed low vegetation activity due to short-term vegetation or uneven water supply. The remaining 18.9% of areas were recorded as non-irrigated or areas outside the irrigation system.

The spatial distribution of irrigated lands was visualized in the form of maps, and their location was represented by color gradients based on NDVI and NDWI values. Through the maps, a clear and accurate spatial view was created, which made it possible to determine in which districts irrigated lands are densely located, and in which areas their emptiness was observed. Especially in areas close to irrigation networks, high NDWI values and vegetation density were confirmed by NDVI, and their correlation was cartographically substantiated.

Also, the indices created on the basis of satellite images were compared over time. Images for 2016, 2020, and 2024 were compared, showing the dynamics of changes in the NDVI index. According to the analysis results, a decrease in vegetation activity was observed in some regions, which indicates the possibility of deterioration of land reclamation, secondary salinization, damage to irrigation systems, or is associated with climatic factors. On the other hand, in some areas, the increase in the NDVI index may be associated with positive agrotechnical measures, reconstruction of irrigation systems, or abundance of water resources [9,10].

At the same time, when comparing existing agrotechnical maps and maps compiled with Dalatlas cartographic resources, it was found that the proposed GIS-based mapping methodology provides high-precision analysis, especially reliable results in showing cases based on real vegetation activity. In this regard, maps created using GIS tools are distinguished by their speed, accuracy, and visual objectivity compared to agro-maps compiled on the basis of traditional field observations.

During the study, vector and raster layers were interconnected, and the coordinates, area, NDVI/NDWI values, and classification of each irrigated land contour were formed in the form of an attribute table. This will allow for the automation of statistical reporting, regional planning, resource allocation, and monitoring processes based on this data.

The accuracy of mapping irrigated lands using satellite imagery and vegetation indices based on GIS technologies is high, the data reflect the real situation, are suitable for analyzing long-term dynamics, and are easy to implement in practice. This approach can serve as a key tool not only for scientific analysis, but also for decisions made on agricultural management, land reclamation, water resource allocation, and digitalization of agriculture.

The research results showed that the integrated use of GIS technologies and remote sensing (RS) data provides a high level of accuracy and reliability in the identification of irrigated lands and the creation of their digital maps. Analyses based on vegetation indices, such as NDVI and NDWI, made it possible to study the state of these lands in spatial and temporal sections and yielded several times more effective results compared to traditional field observations. The effectiveness of this methodology has been proven, especially in the Fergana Valley, which has large agroecosystems [11,12].

Western European Journal of Modern Experiments and Scientific Methods
Volume 3, Issue 10, October 2025
https://westerneuropeanstudies.com/index.php/1
ISSN (E): 2942-1896 Open Access| Peer Reviewed

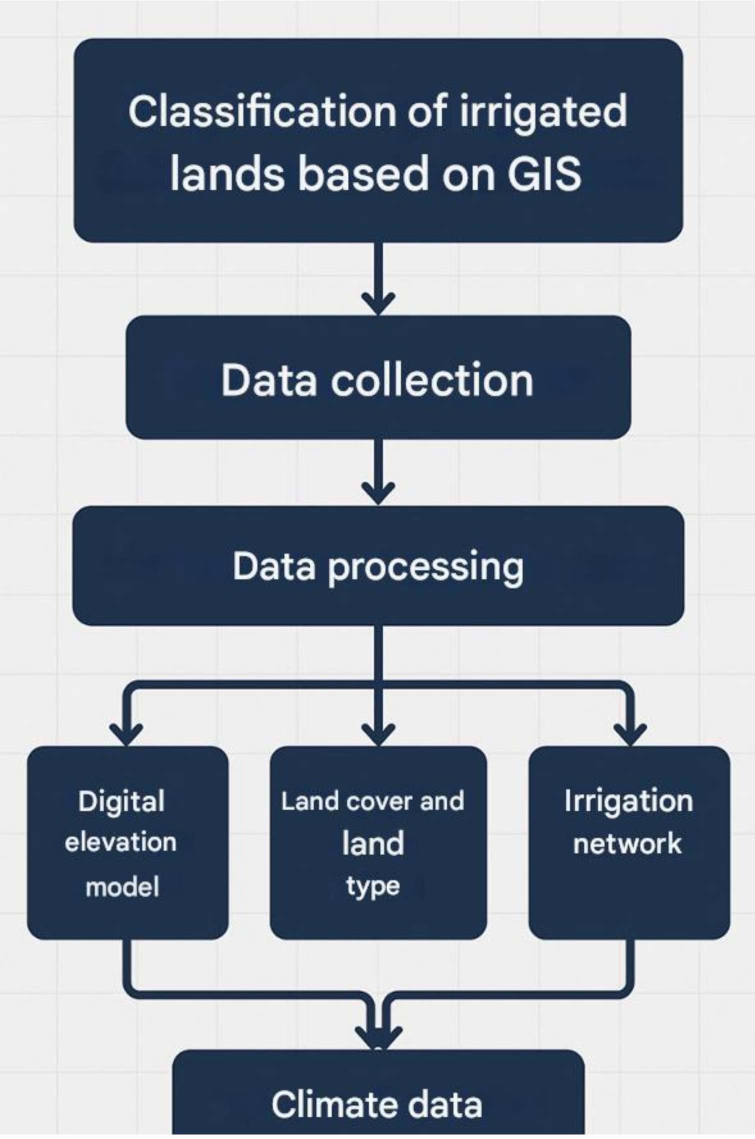

Figure 1. Classification of irrigated lands based on GIS.

The results obtained during this study are consistent with international scientific research. In particular, studies conducted in India, Egypt, Turkey, and the USA analyzed the water supply of irrigated lands, the rate of vegetation cover development, and land degradation processes through vegetation indices based on satellite images such as Landsat and Sentinel. For example, Thenkabail et al. (2002) used IRS and Landsat images to monitor irrigation systems in India, accurately identifying irrigated areas through spatial separation of vegetation status based on NDVI. The methodology used in this study is similar to the methodology described in this article, which confirms the possibility of applying the methodology internationally.
At the same time, the analysis showed that GIS technologies have wide capabilities not only for spatial mapping, but also for analyzing the situation, assessing the efficiency of resource use, and identifying problem areas. The downward trend identified based on the dynamics of the NDVI index for 2016, 2020, and 2024 indicates that in some regions, it may be associated with the degradation of irrigated lands, poor land reclamation work, or a shortage of water

Western European Journal of Modern Experiments and Scientific Methods
Volume 3, Issue 10, October 2025
https://westerneuropeanstudies.com/index.php/1
ISSN (E): 2942-1896 Open Access| Peer Reviewed

resources. From a practical point of view, this requires the development of specific measures to preserve the ecological balance, prevent land degradation, and improve irrigation systems in these areas in the future.

During the analysis, vectorized layers, raster images, and the attribute database were used together. For each contour, the values of the NDVI and NDWI index, coordinates, land area, classification results were placed in the attribute database. This created a favorable environment for users working with modern digital cartography and information systems. This approach is also widely used by leading countries in agricultural statistics, water resources management, and environmental monitoring. For example, the WaPOR system developed by FAO operates on the same principles.

Compared to local studies, the proposed GIS methodology is distinguished by its sophistication and modernity. For example, in the studies of Sh.S. Gafurov, K.R. Khakimova, and A.Y. Rasulov, the main possibilities of GIS and RS technologies are highlighted in detail, however, the approach in this article emphasizes the differential analysis of irrigated lands using vegetation indices. In particular, the possibilities of showing differences between different vegetation zones through cartographic visualization, close-to-real-time mapping, and creating interactive layers are substantiated [13].

However, a number of problems were also observed in the research process. In particular, in some years, due to the coverage of satellite images with clouds, difficulties arose in reliably determining the index values. In such cases, the need arose to use cloud recognition algorithms such as Fmask. Also, the presence of artificial drainage systems in some areas led to an incorrect assessment of the NDWI index, since these lands, although saturated with water, are not classified as permanent irrigated areas. To eliminate such uncertainties, it is necessary to compare index analyses with ground observations or calibrate them using high-resolution images from drones.

Western European Journal of Modern Experiments and Scientific Methods
Volume 3, Issue 10, October 2025
https://westerneuropeanstudies.com/index.php/1
ISSN (E): 2942-1896 Open Access| Peer Reviewed

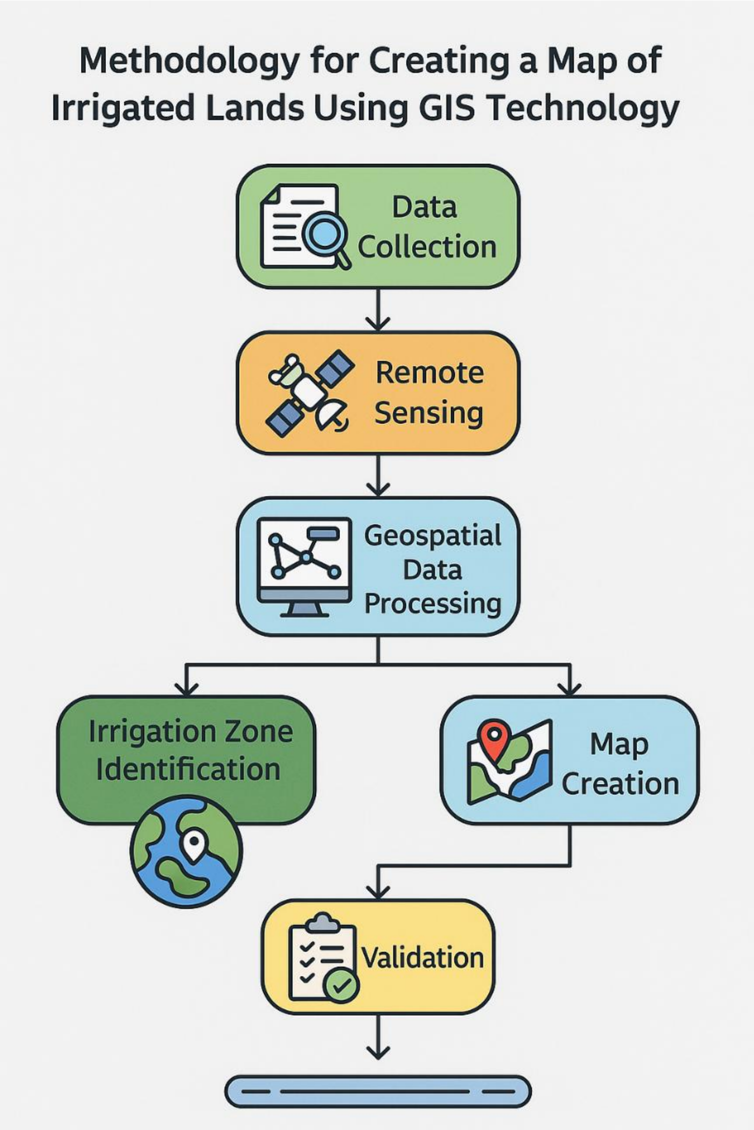

Fig. 2. Methodology for creating a map of irrigated lands using GIS technologies.

At the same time, monitoring of irrigated lands not only with passive remote sensing methods, but also in integration with active tracking technologies, UAV (drone) systems, multispectral cameras, and IoT devices is considered a promising direction. In addition, it is possible to create more accurate models of irrigated lands by implementing precise classification systems based on indices using artificial intelligence algorithms, classification methods based on machine learning, such as Random Forest, SVM, and CNN methods.

In general, the research results show that the identification and mapping of irrigated lands using GIS and RS technologies can serve as an important tool not only for scientific and analytical purposes, but also in practice. Through these approaches, the possibilities of making agrotechnical decisions, planning water resources, preventing land degradation, digitalizing agriculture, and ensuring environmental sustainability will increase significantly. In this regard, the methods and approaches used in the study have practical significance and can be

Western European Journal of Modern Experiments and Scientific Methods
Volume 3, Issue 10, October 2025
https://westerneuropeanstudies.com/index.php/1
ISSN (E): 2942-1896 Open Access| Peer Reviewed

effectively implemented in land monitoring and management systems at the state level in the future.

CONCLUSION

The results of the conducted research showed that the use of geographic information systems (GIS) and remote sensing (RS) technologies in the identification of irrigated lands, their spatial mapping, and systematic monitoring of their condition is an effective and relevant approach. Maps compiled on the basis of NDVI and NDWI indices obtained from satellite imagery, reflecting the real situation with high spatial accuracy, made it possible to clearly distinguish between actively irrigated, weakly vegetated, and non-irrigated lands. In the study, in the conditions of the Fergana Valley, 57.3% of the area was identified as actively irrigated lands, and 23.8% as zones with weak or uncertain vegetation. The remaining 18.9% of land was recorded as non-irrigated or waterless areas.

Data collected and processed using GIS tools - digital elevation model (DEM), land cover, irrigation networks, and climate data - were analyzed in an integrated manner and brought to an interactive form through spatial layers and index maps. This approach not only facilitated statistical analysis, but also provided an effective management tool for decision-makers, agricultural services, and institutions working with land resources.

The research results are consistent with developments in international practice and offer a new methodological approach adapted to local conditions based on national experience. In particular, it creates a basis for the formation of a long-term monitoring system, taking into account not only the spatial state, but also the dynamics over time. This methodology can be effectively integrated into such systems as the "Unified Land Cadastre," "Agroplatform," and "Geoportal," which are being implemented within the framework of the digitalization strategy of agriculture of Uzbekistan.

However, the presence of certain technical and methodological problems - such as cloud images, indefinite indices in classification, or the influence of climatic factors on indices - necessitates the continuous improvement of this approach. Therefore, in the future, it is recommended to develop interactive monitoring systems based on high-resolution drone images, multispectral camera data, automatic classification methods based on machine learning (AI) (for example, Random Forest, CNN), and WebGIS interfaces.

In general, this study offers an effective approach from a practical and scientific point of view in the field of identifying and managing irrigated lands based on GIS technologies. It directly serves the rational use of land, saving water resources, preventing land degradation, optimizing land reclamation measures, and developing digital agricultural services.

REFERENCES.

1. Yokubov S. DEVELOPMENT OF AGRICULTURAL CARDS USING ARCGIS AND PANORAMA TECHNOLOGIES //Innovations in Science and Technologies. – 2024. – T. 1. – №. 1. – C. 101-107.
2. Khakimova K., Yokubov S. CREATION AND MAINTENANCE OF STATE CADASTERS IN THEREPUBLIC OF UZBEKISTAN //Innovations in Science and Technologies. – 2024. – T. 1. – №. 1. – C. 85-93.
3. Yokubov S. SCIENTIFIC AND THEORETICAL FOUNDATIONS FOR THEDEVELOPMENT OF MAPS OF THE LEGAL STATUS OF STATE

ISSN (E): 2942-1896 Open Access| Peer Reviewed

LANDCADASTERS IN THE TERRITORY USING GIS TECHNOLOGIES //Innovations in Science and Technologies. – 2024. – T. 1. – №. 1. – C. 80-84.
4. Yusufovich G. Y., Shavkat o‘g‘li S. Y. CARTOGRAPHIC RESOURCES USED IN THE CREATION OF ELECTRONIC AGRICULTURAL MAPS OF FERGANA REGION.
5. Abduvakhabovich A. A. Shavkat o’g’li, SY Improving the Method of Mapping Agriculture Using Remote Sensing Data //Finl. Int. Sci. J. Educ. Soc. Sci. Humanit. – 2023. – T. 11. – C. 1093-1100.
6. Yusufovich G. Y. et al. The use of remote sensing technologies in the design of maps of agricultural land //Texas Journal of Agriculture and Biological Sciences. – 2023. – T. 23. – C. 17-21.
7. Eshnazarov D. et al. Describing the administrative border of Koshtepa district on an electronic digital map and creating a web map //E3S Web of Conferences. – EDP Sciences, 2023. – T. 452. – C. 03009.
8. Khakimova K. et al. Application of GIS technologies for improving the content of the tourist map of Fergana province, Uzbekistan //E3S web of Conferences. – EDP Sciences, 2023. – T. 386. – C. 04003.
9. Khakimova K., Yokubov S. Creation of agricultural electronic maps using geoinnovation methods and technologies //Science and innovation. – 2023. – T. 2. – №. D1. – C. 64-71.
10. Marupov A. et al. Procedure and method of marking administrative-territorial boundaries on the basis of digital technologies //E3S Web of Conferences. – EDP Sciences, 2023. – T. 452. – C. 03007.
11. Xakimova K. et al. Theoretical and methodological issues of creating the “ECO FERGANA” mobile application of tourist objects and resources of Fergana region //E3S Web of Conferences. – EDP Sciences, 2023. – T. 452. – C. 05025.
12. **Yokubov Sh. Sh.** Development of maps of perennial tree plantations based on remote sensing data // *International Journal of Academic and Applied Research (IJAAR)*. – 2025. – Vol. 9, No. 6. – P. 126–130.
13. **Yokubov Sh. Sh.** Monitoring of perennial plantations using satellite data // *International Journal of Academic and Applied Research (IJAAR)*. – 2025. – Vol. 9, No. 7. – P. 135–139.