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Article

Smart Monitoring Systems for Efficient Land and Water Resource Management in Agriculture of Uzbekistan

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Abstract: This article examines the role of smart monitoring systems (drones) in improving the efficiency of land and water resource management in the agriculture of Uzbekistan. The study focuses on the application of modern digital technologies such as satellites, GIS, drones, and automated data analysis for monitoring soil conditions, irrigation processes, and water consumption. The paper analyzes existing challenges related to water scarcity, inefficient irrigation, and land degradation, while highlighting the potential of smart technologies to support sustainable agricultural development. Furthermore, practical recommendations are proposed for the integration of innovative monitoring systems into the national agricultural management framework to increase productivity and ensure rational use of natural resources.

Keywords: smart monitoring systems, drones, the efficiency of land and water resource, management in the agriculture, digital technologies, satellites, GIS, data analysis, irrigation processes, water consumption, inefficient irrigation, land degradation, smart technologies.

1. Introduction

Sustainable management of land and water resources in Uzbekistan's agriculture should be implemented through an effective monitoring system. In the modern era, digital technologies and geoinformation systems (Geo Information Systems - GIS) allow for a realistic and rapid assessment of resource use, their condition and efficiency. Therefore, this article considers the scientific and practical directions, methods and proposals for the development of a monitoring mechanism based on drones, suitable for Uzbekistan's agriculture[1].

2. Materials and Method

In recent years, there has been a significant increase in interest in the use of digital technologies, especially UAV (Unmanned Aerial Vehicles) and drone technologies, in the effective management of land and water resources. In scientific research, drones are recognized as an important tool for monitoring agricultural land, controlling water resources, and developing agricultural systems.

International studies have widely covered the application of remote sensing and UAV technologies in agriculture. The research of Hunt and Daughtry is based on the effectiveness of determining vegetation indices and monitoring crop conditions using drones equipped with multispectral cameras. The authors noted that NDVI and other spectral indices can be used to determine water stress, plant diseases, and biomass status[2].

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Scientific research conducted by Zhang and Kovacs analyzed the role of UAV technologies in agricultural systems. According to the results of the study, it is possible to obtain high-resolution images, organize real-time monitoring, and formulate yield forecasts using drones. In particular, drone monitoring has been noted to increase irrigation efficiency in water resource management[3].

Bernie et al. have developed methods for determining crop water consumption using UAV systems equipped with thermal cameras. The studies have shown that soil moisture can be estimated based on thermal images. This is an important scientific basis for developing smart irrigation systems in water scarcity conditions.

There are many studies on the integration of GIS and remote sensing technologies with drones. Methods for processing UAV data, creating 3D models, and assessing land resources have been developed using the ArcGIS and Google Earth Engine platforms. This approach is effective in determining land degradation, salinization, and erosion processes[4].

Uzbek scientists are also studying the use of drones and GIS technologies in monitoring land and water resources. The studies focus on monitoring irrigation systems, determining soil salinization, and assessing the vegetation status of cotton and grain fields. At the same time, scientific research is being conducted on the economic efficiency of introducing agricultural technologies in agroclusters.

The analysis shows that drone technologies provide high accuracy, rapid monitoring and resource efficiency in the integrated management of land and water resources. However, existing studies have not sufficiently developed the methodology for managing UAV, GIS, IoT and artificial intelligence technologies based on a single integrated system. Therefore, the implementation of complex scientific research in this area is of urgent importance[5].

The study used a comprehensive approach to general and special scientific research methods. In particular, the analysis and synthesis method, the comparison and grouping method, and statistical analysis methods were used.

3. Result and Discussion

Satellite monitoring is essential for effective land and water resource management. Satellite monitoring allows for continuous monitoring of land and water resources, assessment of irrigation and cropland efficiency, detection of soil salinity, erosion and degradation, and provision of information for decision-making on sustainable resource use. Satellite imagery has become a very important tool in monitoring agricultural land[6].

Satellite imagery is a great help in determining which crops are grown in which area, the size of the crop area, and the state of crop rotation. In this case, different crops are distinguished from each other by their spectral characteristics.

Satellite images allow us to assess crop conditions using vegetation indices, the most popular of which is NDVI[7].

$$\mathrm{NDVI} = \frac{\mathrm{NIR}-\mathrm{RED}}{\mathrm{NIR}+\mathrm{RED}} \qquad \text{Formula 1}$$

Here:

- NIR is the near infrared range,
- RED is the red range.

NDVI value:

• high means the plant is healthy,

• low means stress, disease or water shortage.

The practical benefit of the NDVI value is the early detection of drought, optimization of fertilization, and increased yield.

Due to the limited water resources in Uzbekistan, satellite monitoring is very relevant. This is especially important in the Amu Darya and Syrdarya basins. In these river basins,

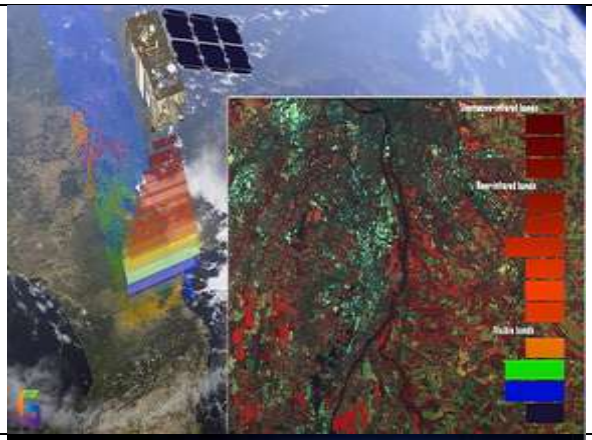
the amount of harvest is estimated in advance based on vegetation dynamics and meteorological data, which improves planning for export and domestic markets[8].

In Uzbekistan, the Sentinel-2 satellite is widely used for satellite monitoring of water resources. This satellite allows you to work with an accuracy of 10 meters, collect free data, update data every 5 days, and is very suitable for agricultural monitoring.

In addition, great importance is currently being attached to monitoring via the Landsat 8 satellite. The advantage of the Landsat 8 satellite is its long-term archive and its convenience for analyzing land changes[9].

Recently, the Planet Labs satellite has also been widely used in monitoring agricultural land and water resources. Its advantages include the ability to obtain high-resolution commercial images and provide daily monitoring. Depending on the purpose of monitoring, different satellites can be used[10].

Table 1. Comparison of satellites used in Uzbekistan

No	Satellite name	Advantages	Which platforms will it be distributed on?	Image
1	**Sentinel-2 (European Space Agency)**	• 10 meter accuracy, • free data, • updated every 5 days, • perfect for q/x monitoring.	Copernicus Open Access Hub and Copernicus Data Space Ecosystem.	
2	Landsat 8 (NASA and USGS, USA)	• long-term archive, • convenient for analyzing land changes.	OLI (Operational Land Imager) and TIRS (Thermal Infrared Sensor)	

3	Planet Labs (USA Planet Labs PBC)	• long-term archive, • convenient for analyzing land changes.	Dove/ SuperDove, Black Bridge (Rapid Eye), Terra Bella	

There are also problems with the use of satellites in monitoring agricultural land and water resources. In particular, cloudiness affects image quality, high-resolution data is expensive, specialist and GIS knowledge is required, and internet and technical infrastructure are necessary.

In Uzbekistan, Uzgidromet, economics and agricultural universities, and GIS centers can use satellites for monitoring and provide their services to agricultural enterprises. On this basis, it is expected that in the future, as in developed foreign countries, a transition to the widespread use of "smart farming", "precision agriculture", and automatic water management systems will take place.

The use of drones in agriculture in Uzbekistan has been developing rapidly in recent years. Drones help to monitor land with high accuracy, assess crop conditions, and use resources efficiently. They have become an important technology, especially in the areas of water scarcity and increasing productivity[11].

The main tasks of drones in agriculture are as follows:

1. Monitoring crop conditions. Using RGB and multispectral cameras installed on drones, crop growth rates, diseases, pests, and water shortages are determined.

The NDVI index is often used to assess the state of vegetation:

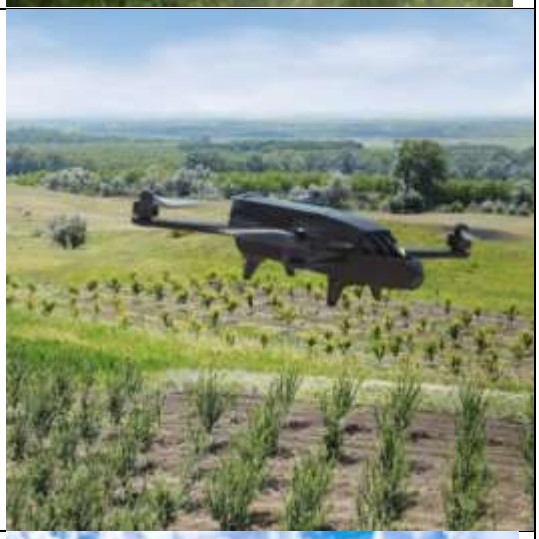
$$\mathrm{NDVI} = \frac{\mathrm{NIR}-\mathrm{RED}}{\mathrm{NIR}+\mathrm{RED}} \qquad \text{Formula 1}$$

This index distinguishes between healthy and stressed plants.

2. Irrigation monitoring. Drones can detect moisture imbalances, over-irrigated areas, and areas with insufficient water. This helps save water, especially in cotton, wheat, and horticultural fields[12].

3. Fertilizer and pesticide spraying. Special agro-drones spray fertilizers, herbicides, and insecticides accurately and in moderation. The advantages include reduced chemical consumption, reduced risks to human health, and time savings.

Table 2. Drones used in Uzbekistan and their characteristics

No	Drone name	Advantages	Use in Uzbekistan	Image
1	**DJI AGRAS T40**	• 40 kg spraying payload, • Up to 50 kg fertilizer distribution, • Dual rotor system, • High-precision radar, • AI-based safety systems.	• cotton, • wheat, • rice, • horticulture	
2	Parrot Bluegrass Fields	• early detection of diseases, • detection of water shortages, • optimization of fertilization.	• cotton monitoring, • horticulture, • water stress detection, • salinity monitoring	
3	eBee X (senseFly)	• accurate scouting of agricultural crops, • plant health analysis, • plant mapping, • yield monitoring.	• cotton clusters, • large wheat fields, • water monitoring, • salinity control, • land cadastre	

4. Land mapping and GIS. Drones create 3D maps, relief models, and field boundaries. They are important in land cadastre, land reclamation, and precision agriculture.

5. Yield forecast. Based on data obtained from drones, biomass, plant density, and vegetation dynamics are analyzed and yields are estimated in advance.

One of the most important factors for Uzbekistan is effective water resource management. Drones allow for rapid monitoring of large areas. This allows several

hundred hectares of land to be inspected in a short time. This reduces costs, including fuel, labor, and chemical resources[13].

There are also disadvantages to monitoring large areas using drones. Some drones can be expensive, require operator training for complex tasks, have limited battery and flight time, and strong winds interfere with operation.

Table 3. Comparative analysis of drones used in Uzbekistan

Feature	DJI AGRAS T40	Parrot Bluegrass Fields	senseFly eBee X
Dron type	Multirotor	Quadcopter	Fixed-wing
Flight time	15-20 min	-25 min	-90 min
Coverage area	Very big	Medium	Very big
Spray function	Very strong	No	No
Multispectral camera	Additional	Integrated	Integrated
NDVI monitoring	Yes	Very good	At a professional level
Mapping	Good	Good	Very strong
RTK accuracy	Yes	Limited	Professional RTK
GIS work	Medium	Good	Professional
Operator complexity	Medium	Easy	More complex
Price segment	High	Medium-high	Very high
Who is suitable for?	Farmer and agrocluster	Agronomists and researchers	GIS and large agro-projects

Strengths and weaknesses of drones used in Uzbekistan

The advantages of the DJI AGRAS T40 drone are 40 kg spraying capacity, 50 kg fertilizer application, automatic routing, radar and obstacle avoidance system. Disadvantages include short flight time, the need for a large battery system, and specialization in spraying rather than monitoring[14].

The advantages of the Parrot Bluegrass Fields drone are lightweight and convenient, multispectral camera integration, suitable for precision farming. Disadvantages are no spraying function, slower than fixed-wing drones in large areas[15].

The advantages of AgEagle Aerial Systems (senseFly-eBee X) drones are up to 90 minutes of flight, covers hundreds of hectares, professional RTK/PPK accuracy, very efficient due to fixed-wing. Disadvantages are very high cost, requires an open area for landing, and is more difficult to control.

4. Conclusion

As a result of the conducted analysis, in the conditions of Uzbekistan, if the goal is:

- Spraying and fertilization - the “DJI AGRAS T40” drone is the best option;
- Crop monitoring and NDVI - the “Parrot Bluegrass Fields” drone is convenient and economical;
- GIS mapping of very large areas - “sensefly - ebee X” is the most effective combination.

In conclusion, drone technologies create high-precision monitoring, resource efficiency and rapid analysis opportunities in the integrated management of land and water resources. The use of UAV, GIS and remote sensing technologies is of great importance in increasing efficiency in agriculture and ensuring environmental sustainability.

REFERENCES

[1] E. R. Hunt and C. S. T. Daughtry, "What good are unmanned aircraft systems for agricultural remote sensing and precision agriculture?," International Journal of Remote Sensing, vol. 39, nos. 15–16, pp. 5345–5376, 2018.
[2] C. Zhang and J. M. Kovacs, "The application of small unmanned aerial systems for precision agriculture: A review," Precision Agriculture, vol. 13, no. 6, pp. 693–712, 2012.
[3] J. A. J. Berni, P. J. Zarco-Tejada, L. Suarez, and E. Fereres, "Thermal and narrowband multispectral remote sensing for vegetation monitoring from an unmanned aerial vehicle," IEEE Transactions on Geoscience and Remote Sensing, vol. 47, no. 3, pp. 722–738, 2009.
[4] M. Matkarimov and K. Sharipov, "Water use and water consumption in agriculture implementation procedure," International Journal of Biological Engineering and Agriculture, vol. 5, no. 2, pp. 10–15, 2026.

[5] M. Matkarimov, "Theoretical and legal foundations of transboundary water resources management and equitable distribution in Central Asia," Journal of Engineering and Economics, no. 3, Mar. 2026.
[6] D. J. Mulla, "Twenty five years of remote sensing in precision agriculture: Key advances and remaining knowledge gaps," Biosystems Engineering, vol. 114, no. 4, pp. 358–371, 2013.
[7] I. Colomina and P. Molina, "Unmanned aerial systems for photogrammetry and remote sensing: A review," ISPRS Journal of Photogrammetry and Remote Sensing, vol. 92, pp. 79–97, 2014.
[8] M. Matkarimov, "Legal foundations of water use and water relations in Uzbekistan," Journal of Economic Development and Analysis, no. 2, Feb. 2026.
[9] ESRI, GIS for Agriculture. Redlands, CA, USA: Environmental Systems Research Institute Publications, 2022.
[10] QGIS Development Team, QGIS Geographic Information System User Guide. Beaverton, OR, USA: Open Source Geospatial Foundation, 2023.
[11] Google Earth Engine Team, Earth Engine Data Catalog and Remote Sensing Applications Documentation, 2022.
[12] M. Matkarimov, "Implementation of water use and water consumption procedure in agriculture," Journal of Green Economy and Development, no. 2, Feb. 2026.
[13] SenseFly, eBee X Technical Specifications and Agricultural Mapping Applications. Lausanne, Switzerland: AgEagle Aerial Systems, 2021.
[14] Parrot, Bluegrass Fields: Advanced Drone Solutions for Precision Agriculture. Paris, France: Parrot Drone SAS, 2020.
[15] R. Gebbers and V. I. Adamchuk, "Precision agriculture and food security," Science, vol. 327, no. 5967, pp. 828–831, 2010.