

SATELITE AND DRON MONITORING SYSTEMS FOR EFFICIENT LAND RESOURCE MANAGEMENT

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Abstract. This article examines the role of satellite and dron monitoring systems in improving the efficiency of land resource management in the agriculture of Uzbekistan. The study focuses on the application of modern digital technologies such as satellites and drones 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.

Keywords: 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.

Analysis and discussion of results. 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.

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.

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.

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

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.

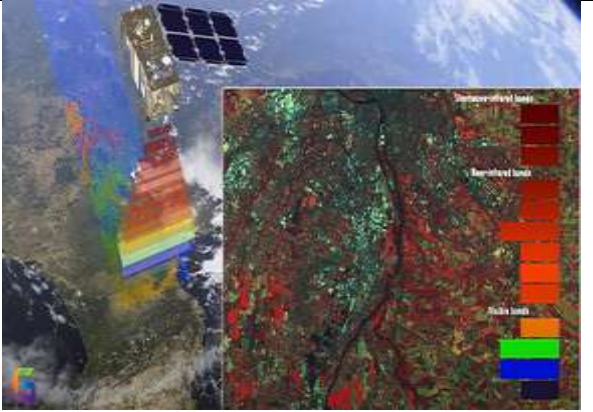

The practical benefit of the NDVI value is the early detection of drought, optimization of fertilization, and increased yield.


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.

Table 1

Comparison of satellites used in Uzbekistan¹

¹ The table was prepared by the author based on data from "Google Earth Engine Team. (2022). Earth Engine Data Catalog and Remote Sensing Applications Documentation".

N	Satellite name	Advantages	Which platforms will it be distributed on?	Image
1	Sentinel-2 (European Space Agency)	<ul style="list-style-type: none"> • 10 meter accuracy, • free data, • updated every 5 days, • perfect for q/x monitoring. 	Copernicus Open Access Hub and Copernicus Data Space Ecosystem.	 <p>The image shows the Sentinel-2 satellite in orbit above Earth. To the right, there is a land use classification map with a legend. The legend includes categories like 'Forest', 'Agriculture', 'Urban', and 'Water' with corresponding color swatches.</p>
2	Landsat 8 (NASA and USGS, USA)	<ul style="list-style-type: none"> • long-term archive, • convenient for analyzing land changes. 	OLI (Operational Land Imager) and TIRS (Thermal Infrared Sensor)	 <p>The image shows the Landsat 8 satellite in orbit above Earth, with its solar panels and instruments clearly visible against the blackness of space and the curvature of the planet.</p>

3	Planet Labs (USA Planet Labs PBC)	<ul style="list-style-type: none"> • long-term archive, • convenient for analyzing land changes. 	Dove/ SuperDove, Black Bridge (Rapid Eye), Terra Bella	
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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.

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.

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.



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.
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.
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.
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.

Table 2

Drones used in Uzbekistan and their characteristics²

N	Drone name	Advantages	Use in Uzbekistan	Image
1	DJI AGRAS T40	<ul style="list-style-type: none"> • 40 kg spraying payload, • Up to 50 kg fertilizer distribution, • Dual rotor system, • High-precision radar, • AI-based safety systems. 	<ul style="list-style-type: none"> • cotton, • wheat, • rice, • horticulture 	
2	Parrot Bluegrass Fields	<ul style="list-style-type: none"> • early detection of diseases, • detection of water shortages, • optimization of fertilization. 	<ul style="list-style-type: none"> • cotton monitoring, • horticulture, • water stress detection, • salinity monitoring 	

² The table was prepared by the author based on data from "Google Earth Engine Team. (2022). Earth Engine Data Catalog and Remote Sensing Applications Documentation".

3	eBee X (sense Fly)	<ul style="list-style-type: none"> • accurate scouting of agricultural crops, • plant health analysis, • plant mapping, • yield monitoring. 	<ul style="list-style-type: none"> • cotton clusters, • large wheat fields, • water monitoring, • salinity control, • land cadastre 	
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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.

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.

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