MONITORING OF MELIORATIVE AND DEGRADATION CONDITIONS OF AGRICULTURAL LANDS USING UNMANNED AERIAL VEHICLES (UAVs)

Shokhruz Khudaykulov
Doctoral Candidate, "Samarkand State University of Architecture and Construction"
Hamzayev Saidakbar
Doctoral Candidate, "Samarkand State University of Architecture and Construction"

Abstract. *Improving the meliorative condition of agricultural lands and timely identification of degradation processes are of great importance for ensuring the sustainability of agricultural production. This article analyzes the possibilities of monitoring the meliorative and degradation conditions of agricultural lands using Unmanned Aerial Vehicles (UAVs). The study highlights the use of remote sensing, Geographic Information System (GIS) technologies, and photogrammetric methods for identifying soil salinity, moisture conditions, erosion processes, and changes in vegetation cover. The research results demonstrate that UAV-based monitoring provides faster, more cost-effective, and highly accurate data acquisition compared to conventional monitoring methods.*

Keywords: *unmanned aerial vehicle, drone, agricultural land, meliorative condition, degradation, GIS, remote sensing, NDVI, monitoring, soil salinity.*

1. Introduction

Land resources are among the fundamental factors of agricultural production. Regular monitoring of the meliorative condition of land and the identification of degradation processes contribute to increasing agricultural productivity and ensuring the rational use of land resources. In the Republic of Uzbekistan, a significant portion of irrigated agricultural lands is affected by degradation processes such as soil salinization, water erosion, wind erosion, and waterlogging.

Since traditional monitoring methods require considerable time and financial resources, the application of modern geoinformation technologies and Unmanned Aerial Vehicles (UAVs) has become increasingly relevant. UAVs provide opportunities for acquiring high-resolution imagery, rapidly detecting changes on the land surface, and generating thematic maps.

The objective of this study is to evaluate the effectiveness of using Unmanned Aerial Vehicles (UAVs) for monitoring the meliorative and degradation conditions of agricultural lands.

2. Research Methods

The following methods were employed in the study:

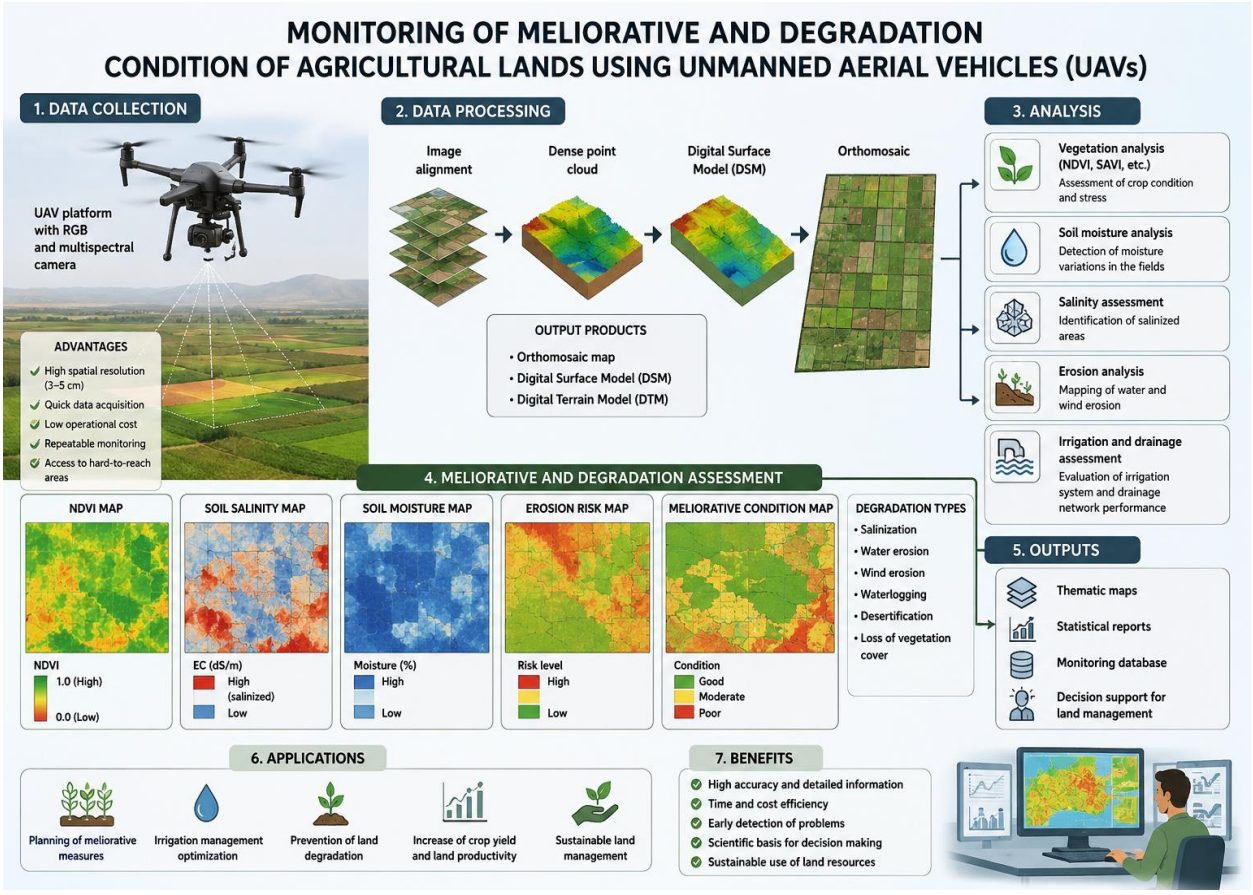
Collection of Remote Sensing Data

Monitoring activities were carried out using Unmanned Aerial Vehicles (UAVs) equipped with RGB and multispectral cameras. Aerial surveys were conducted at an altitude of 100–150 meters above ground level.

Photogrammetric Processing

The acquired images were processed using photogrammetric software to generate:

- Orthophoto maps;
- Digital Terrain Models (DTM);
- Digital Surface Models (DSM).



Application of GIS Technologies

Spatial analyses were performed using ArcGIS and QGIS software, and maps illustrating meliorative and degradation conditions were produced.

Calculation of Vegetation Indices

The Normalized Difference Vegetation Index (NDVI) was used to assess crop conditions:

NDVI = (NIR − RED) / (NIR + RED)

where:

- NIR – Near Infrared band;
- RED – Red spectral band.

Assessment of Degradation Indicators

The following indicators were analyzed:

- Soil salinity;
- Moisture distribution;
- Water erosion;
- Wind erosion;
- Reduction of vegetation cover.

3. Results

The results of the study revealed that high-resolution imagery obtained from UAVs is highly effective for assessing the meliorative and degradation conditions of agricultural lands.

The monitoring process enabled:

- Delineation of salinized areas;
- Mapping of zones with excessive moisture;
- Identification of erosion-prone lands;
- Assessment of vegetation cover conditions;
- Development of meliorative condition maps.

The NDVI analysis indicated that vegetation index values ranged between 0.25 and 0.35 in certain areas, suggesting that crops in these zones were under stress conditions.

Furthermore, maps generated from UAV imagery demonstrated a higher level of accuracy compared to traditional field survey methods.

4. Discussion

The findings indicate that monitoring agricultural lands using UAVs offers several advantages over conventional approaches.

First, monitoring operations can be completed within a relatively short period while covering extensive areas.

Second, the high spatial resolution of UAV imagery enables the detection of even small-scale changes within agricultural fields.

Third, the integration of UAV data with GIS technologies facilitates the presentation of monitoring results in the form of thematic and cartographic products.

However, several limitations exist, including dependence on weather conditions, battery capacity constraints, and the requirement for specialized software and technical expertise.

Despite these challenges, UAV technology remains an important tool for improving land monitoring systems and enabling the early detection of degradation processes.

5. Conclusion

The study confirms that the use of Unmanned Aerial Vehicles (UAVs) is highly effective for monitoring the meliorative and degradation conditions of agricultural lands.

Based on the research findings, the following conclusions can be drawn:

1. UAVs enable rapid acquisition of highly accurate spatial data.
2. They provide opportunities for the early detection of salinity, erosion, and moisture-related problems.
3. Monitoring systems integrated with GIS technologies improve the efficiency of land resource management.
4. UAV-derived data play an important role in planning meliorative measures and preventing land degradation.
5. The wider implementation of digital technologies in agriculture contributes to the rational and sustainable use of land resources.

Scientific Novelty: The scientific novelty of this research lies in the improvement of a monitoring methodology based on the integrated application of Unmanned Aerial Vehicles (UAVs), Geographic Information Systems (GIS), and remote sensing data for assessing the meliorative and degradation conditions of agricultural lands.

References

1. Campbell, J. B., & Wynne, R. H. (2011). Introduction to remote sensing (5th ed.). Guilford Press.
2. Food and Agriculture Organization. (2015). Status of the world's soil resources (SWSR) – Main report. FAO.
3. Food and Agriculture Organization. (2019). Remote sensing for agricultural applications. FAO.
4. Hunt, E. R., Hively, W. D., Fujikawa, S. J., Linden, D. S., Daughtry, C. S. T., & McCarty, G. W. (2018). Acquisition of NIR-green-blue digital photographs from unmanned aircraft for crop monitoring. Remote Sensing, 10(2), 290–305.
5. Jensen, J. R. (2016). Remote sensing of the environment: An earth resource perspective (2nd ed.). Pearson Education.
6. Lal, R. (2015). Soil degradation and restoration in agricultural ecosystems. Sustainability, 7(5), 5875–5895.
7. Mather, P. M., & Koch, M. (2019). Computer processing of remotely-sensed images: An introduction (5th ed.). Wiley-Blackwell.

8. Republic of Uzbekistan. (2024). Land Code of the Republic of Uzbekistan. Tashkent, Uzbekistan.Republic of Uzbekistan. (2024). Regulatory documents on land monitoring and land cadastre. Cabinet of Ministers of the Republic of Uzbekistan. Tashkent, Uzbekistan.

9. Torres-Sánchez, J., López-Granados, F., & Peña, J. M. (2015). An automatic object-based method for weed mapping in UAV imagery. Remote Sensing, 7(4), 4843–4864.

10. Zhang, C., & Kovacs, J. M. (2012). The application of small unmanned aerial systems for precision agriculture: A review. Precision Agriculture, 13(6), 693–712.