Monitoring agricultural land areas using GIS-online program EOS DA: case study of Andijan region

Rustam Oymatov*, *Ilhomjon* Musaev, *Mukhammad* Bakhriev, and *Guljahon* Aminova

Tashkent Institute of Irrigation and Agricultural Mechanization Engineers, National Research University, Tashkent, Uzbekistan

Abstract. This research aims to look at the use of Earth observing system data analytics (EOS DA), an interactive online system, for agricultural land monitoring in Uzbekistan. With the increasing relevance of digital technology in agriculture, there is a need to investigate innovative approaches for improving land quality monitoring and benchmarking crop conditions and productivity indicators, especially concerning degraded soil processes. The agricultural sector can benefit greatly from the start-up of interactive online digital technologies. Scientific and practical research can be advanced by leveraging existing crop monitoring and forecasting systems and adding components of digital agricultural production systems. Regular crop monitoring adds to higher production and land productivity, both of which are critical in modern agriculture. To reach these goals, modern technologies and the usage of geo-information and remote sensing data must be integrated. The primary goal of this project is to use EOS DA to assist in the continued improvement of agricultural land monitoring in Uzbekistan. The study intends to provide significant insights and recommendations for optimizing agricultural practices and maximizing land productivity by utilizing this interactive online approach. Integrating EOS DA and other geospatial data can result in more informed decision-making and better resource management in the agricultural industry. Finally, using EOS DA, this work aims to contribute to the continual improvement of agricultural land monitoring in Uzbekistan. The study intends to improve agricultural practices and promote sustainable land management in the country by leveraging the potential of interactive online tools and incorporating geospatial information.

1 Introduction

Geographical Information Systems (GIS) are essential for assessing agricultural lands, analyzing field experiments, monitoring plant development, and digital modeling using Remote Sensing (RS) data [1,23]. The main goal of online interactive agricultural land monitoring is to evaluate crop productivity at the regional level, forecast major crop productivity, and diagnose cultivated areas and regions[2,3]. Crop monitoring is crucial for detecting negative processes, such as nutrient deficiency, diseases, and wind and water erosion, and implementing appropriate measures[4–6,21]. However, platforms are necessary to deliver information quickly, accurately, and with high quality to achieve this. EOS DA is one of the most widely used online platforms for providing this information[7,8].

* Corresponding author: rustam.oymatov@gmail.com

Recent advances in remote sensing data application for agricultural cropland monitoring and machine learning technologies are effectively used[9,10]. Revolutionizing the food production industry globally, enabling precision agriculture that eliminates guesswork, reduces movement, reduces waste, cuts costs, and increases efficiency [11]. EOSDA Crop Monitoring is a digital precision agriculture platform that facilitates this transformation by allowing quick and efficient remote sensing data analysis [12]. The platform continuously monitors crop performance backed by the latest available technologies. In partnership with agro consultants, the inner asset provides information ranging from 1 day to 14 days. The platform's multi-year database is valuable for analyzing agricultural land and forecasting crop yield.

2 Materials and methods

2.1 Study area

In the present research study, the Andijan region is a EOSDA Crop Monitoring system case study. The analysis will be taken into account. Planting and monitoring various crops for agricultural reasons in the Andijan region is a high priority. In this study, the Andijan region was selected for research. The Andijan region is situated in the eastern part of Uzbekistan and shares borders with the Kyrgyz Republic to the east, north-east and south-east, the Fergana region to the south-west, and the Andijan region to the north-west. It has a total area of 4.4 thousand km2 and a population of 3.2 million. Agriculture plays a significant role in the region's economy due to the limited land area, and the region is a leader in implementing innovative technologies. Therefore, we chose to focus our research on agricultural land areas in this region

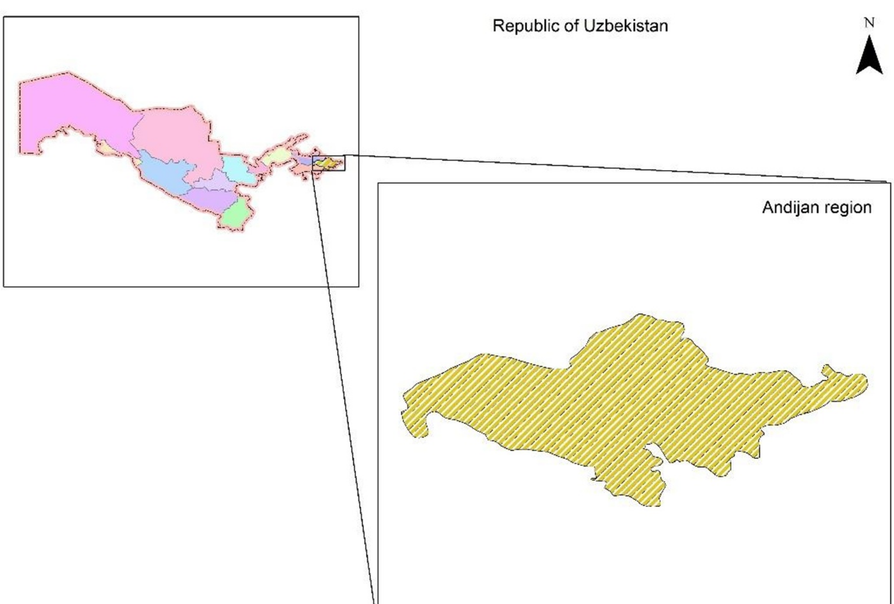

Fig. 1. Andijan region test area (Source:www.diva-gis.org modified by ArcGIS)

The Andijan region is focused on agriculture and has a significant concentration of industry, transport, and communication enterprises. The region's agricultural activities include cotton, grain, vegetable, horticulture, and animal husbandry. The agricultural land area is 256.7 thousand ha, with a total of 202.5 thousand ha of cultivated land, including grain crops, cotton, potatoes, vegetable-police crops, fodder crops, and forests. Buckwheat and soybeans are also grown, and farmers in the region typically harvest 2-3 times a year. To assess agricultural land reclamation, it is necessary to study soil salinity data, district reclamation cadastral assessment results, drainage system distribution levels, water flow and mineralization, and vegetation cover. GIS technologies and remote sensing materials are effective tools for this assessment, enabling the preparation of reclamation maps and providing information on the overall state of vegetation cover.

The materials are well-structured and focused on digital information systems for agricultural land management. However, minor edits can be made to enhance clarity and coherence[13].

First, it may be helpful to specify which developing countries the author is referring to provide a more specific context for the discussion.

Secondly, the sentence Although several systems currently operate in the developed countries, they do not fully meet the region's current information needs could be revised to provide more clarity. For instance, specifying which regions are being referred to and the specific gaps in the current systems could be helpful[14].

Additionally, it may be beneficial to provide more detail about how EOSDA's Crop Monitoring functionality establishes stakeholder trust. The paragraph currently mentions that the functionality facilitates transparent interactions, but a further elaboration on how this leads to trust-building would be useful.

Digital information systems are crucial for effective agricultural land management, allowing for assessing, monitoring, and analyzing land conditions and forecasting agricultural output. However, current systems in developing countries may not fully meet the information needs of the region[15]. To address this gap, EOSDA's Crop Monitoring functionality facilitates transparent interactions between agro-advisors and their clients, including farmers, insurers, agricultural cooperatives, and data suppliers[16–18]. Through this, EOSDA helps to establish trust among stakeholders, leading to more effective agricultural management practices. For example, the transparency provided by Crop Monitoring can increase forecasting accuracy and enable more informed policy decisions[19,22]. Clarifying which regions and information gaps are being addressed can help readers better understand the context and significance of these systems :

2.2 EOSDA Crop Monitoring structure

- Study field productivity trends and monitor crop performance
- Create precise maps for variable seed and fertilizer application
- Get a hyperlocal 14-day weather forecast
- Access historical vegetation and weather data on any given field
- Receive notifications and alerts

EOSDA data can be accessed by GIS experts through an API or white-label solution, providing them with valuable insights and information. Additionally, the experienced EOSDA group has developed several AI-powered custom solutions to address some of the most critical challenges in modern agriculture, further benefiting agricultural consultants. To improve the data, use different satellite images. First, added providing valuable insights and information to clarify the benefits of using the data. Secondly, the custom solutions to better convey the idea that they are developed by an experienced. Finally, there are

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removed the dash and used a period instead to make two separate sentences, which made the paragraph more concise and easier to read. Regarding scientific editing, the platform made sure to use clear and concise language and avoid any unnecessary simple users can understand. The revised data effectively conveys the key message while being easy to understand for general users [20].

3 Results and discussion

Remote sensing data from atmospheric and space-based sources provide a fast and efficient way to obtain semantic information about land plots. Aerial images offer objective, relevant, and rapid data, while modern satellite systems allow for high-resolution image acquisition periodically throughout the growing season. This scientific article proposes a real-time monitoring mechanism for agricultural land efficiency using remote sensing data. In the first stage of the study, an orthophoto plan of the village council territory was prepared using high spatial resolution (1-10 m) archived space imagery obtained through Sentinel A2. The space images were transformed using a catalog of coordinates of absolute reference points, including the intersection of coordinate grids, ground control points, and coordinated building corners, among others. When the coordinate system is based on a map projection, reference points are automatically recalculated, and the image is resized when the coordinate system changes. The program monitors distortions in the central part of the image and applies an affine transformation if the distortions do not exceed half a pixel. A partial linear transformation is applied in other cases. The vectorization of land plot contours was done through visual interpretation in the Sentinel A2 environment.

The Sentinel hub EOS AD resource offers up-to-date ground state information in 2023. This information is valuable for various applications, including monitoring land use and natural disasters. With the Sentinel hub EOS AD resource, users can access data on various parameters, including land cover, vegetation growth, and atmospheric conditions. This data is obtained from a combination of satellite imagery and ground-based sensors, providing a comprehensive and accurate view of the Earth's surface. The Sentinel hub EOS AD resource is constantly updated, ensuring that users have access to the latest information at all times. Researchers, scientists, and decision-makers can make informed decisions about land use, resource management, and environmental protection by utilizing this resource.

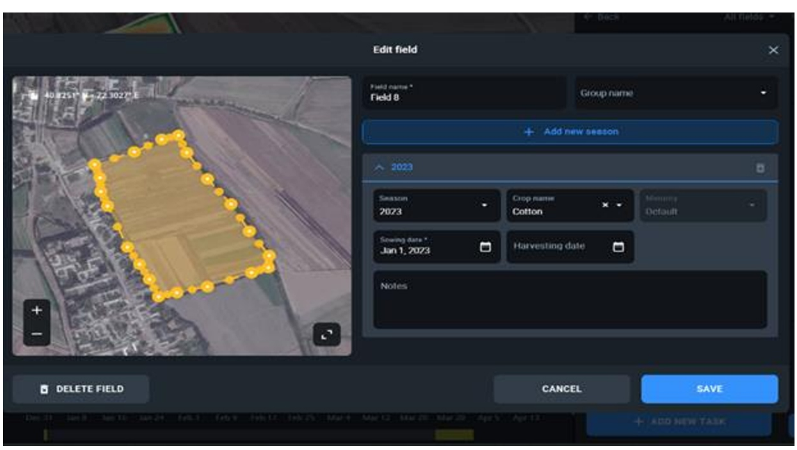

Fig. 2. Additing to EOS AD platform feild. (www.eos.com)

The Landsat and Sentinel Hub services support various data sources, including freely available and commercial satellites, digital elevation models, and the option to import user-generated data. However, due to their unique characteristics, identifying fallow lands through satellite imagery is challenging. Spectral response and textural features are analyzed to identify fallow lands, with image texture being the primary feature used for interpretation. Land type interpretation can be achieved through multi-temporal satellite data, spectral vegetation indices, and combinations of images from different sensors. However, the composition of phytocenosis may vary due to the uneven age of fallow lands, while traces of ploughing can make it difficult to distinguish fallow lands from ploughed areas. Additionally, small size and vegetation similarities to gullies, ravines, cultivated fields, and garden plots further complicate identification. To investigate the degradation processes of agricultural land overgrowth with herbaceous and woody shrub vegetation, researchers have utilized the False color index desktop method. This method maps the near-infrared spectral bands B8 with the red and green bands B4 and B3 directly onto the sRGB components. It is commonly used to assess plant density, with denser plant growth resulting in a darker red color. In contrast, cities and open soil appear grey or brown, while water appears blue or black.

Fig. 3. Long-term meteorological database and comparing in field. (www.eos.com)

This study identified different stages of overgrowing of agricultural land (arable land) during visual interpretation:

• Stage zero: No overgrowth processes and the land is being used for its intended purpose.

• Stage one: Shrub and small growth of tree species appear with a projective cover of less than 10%. They are still commensurate with the herbaceous layer and compete for space.

• Stage two: Small groups of the undergrowth of woody species and shrub thickets are formed. In most cases, trees and shrubs do not yet compete with each other, as their density is low, up to 20%.

• Stage three: The number of trees and shrubs increases, and a tree and shrub layer of varying heights forms. At this time, the density of trees and shrubs increases so that trees and shrubs actively compete with each other, and light-loving species are suppressed.

• Stage four: Young closed forest with residual shrubs. The undergrowth begins to form, forest grass species appear, but meadow species can still be found in the herbaceous layer.

Fig. 4. Modified soil adjusted vegetation index (MSAVI) in field. (www.eos.com)

A map outlining the stages of overgrowth of agricultural land (arable land) was created through visual interpretation and updating of land information [23]. Utilizing the calculation module within the GIS Panorama environment, the cultivated and fallow land areas were updated. Land resources control authorities and municipality administration can utilize the resulting information to reduce unused agricultural land and increase productivity. An economic plan was developed based on the qualitative condition of agricultural lands, natural-climatic conditions of the area, and technological indicators of the fields. The plan includes restoring arable land on 13.8 ha of land with the first, second, and third stages of overgrowth, while 12.1 ha of land with the fourth overgrowth stage is recommended for reforestation. This approach addresses land management problems and promotes effective regional perspectives on land use based on the current qualitative state of agricultural land.

4 Conclusions

One of the most significant challenges in monitoring agricultural land is that municipal governments, such as village councils, lack current information on land resources. In this study, we hypothesized that using EOSDA technology for agricultural land monitoring could offer timely and relevant data for effective resource management. As a result, it is recommended to use this platform while performing calculations to monitor land conditions while conserving money. As a result, the platform may provide information indicating that all farmed areas are being utilized correctly. It is essential in the development of land restoration plans. The findings of this study could help with remote monitoring of agricultural land and plants.

The main achievement of the platform is that it can simultaneously work based on several space images, which leads to the accuracy of monitoring of land areas and less time between them. The proposed technology for evaluating the economical use of agricultural land will help determine directions for improving the efficiency of land use by agricultural enterprises. The collected information and recommendations are aimed at assisting various organizations in developing land management projects and organizing measures for the effective use of agricultural land.

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