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MACHINE LEARNING–BASED LULC CLASSIFICATION IN THE ASAKA DISTRICT (1995–2025)

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Abstract: In this study, Landsat 5 data from 1995 and Landsat 8 data from 2025 were used, with both datasets acquired in May. A supervised machine learning approach based on the Support Vector Machine (SVM) algorithm was applied to classify land use and land cover (LULC) in the Asaka District. As a result, LULC maps and land use change maps of the study area were generated.
Keywords: Landsat 5, Landsat 8, classification, SVM, remote sensing, LULC.

КЛАССИФИКАЦИЯ ЗЕМЛЕПОЛЬЗОВАНИЯ И ЗЕМНОГО ПОКРОВА (LULC) В АСАКИНСКОМ РАЙОНЕ НА ОСНОВЕ МЕТОДОВ МАШИННОГО ОБУЧЕНИЯ (1995–2025 ГГ.)

Аннотация: В этом исследовании использовались данные спутника Landsat 5 за 1995 год и Landsat 8 за 2025 год, при этом оба набора данных были получены в мае. Для классификации землепользования и земного покрова (LULC) в Асакинском районе был применён контролируемый метод машинного обучения на основе алгоритма Support Vector Machine (SVM). В результате были созданы карты LULC и карты изменений землепользования исследуемой территории.
Ключевые слова: Landsat 5, Landsat 8, классификация, SVM, дистанционное зондирование, LULC.

INTRODUCTION

Remote sensing refers to the acquisition of information about a specific area without direct physical contact. Remote sensing data are widely used for change detection analysis [1–4]. The integrated use of remote sensing and Geographic Information System (GIS) tools enables the acquisition and processing of relevant data for addressing climate change–related challenges [5–6]. Among various classification algorithms, the Support Vector Machine (SVM) model is distinguished by its high accuracy and robustness in analyzing complex landscapes. In combination with GIS techniques, multitemporal satellite imagery and LULC data are widely applied to assess land suitability for agriculture, detect urban growth and land use changes, and identify stress factors affecting urban vegetation [7–9].

MATERIALS AND METHODS

The Asaka District is located in the central part of the Andijan Region, with Asaka city serving as its administrative center (Figure 1). The district covers an area of approximately 270 km² and has a population of about 340,000. The terrain is predominantly flat, with some undulating and

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hilly areas. Major water resources, including the Great Fergana Canal, Shahrixonsoy, Oqboyra, and Aravonsoy streams, play a significant role in the local economy, particularly in agriculture. The climate of the district is continental, with an average temperature of about 26 °C in July and −3 °C in January. Annual precipitation ranges between 180 and 190 mm, and the growing season lasts approximately 220 days, providing favorable conditions for crop farming, horticulture, and cotton cultivation.

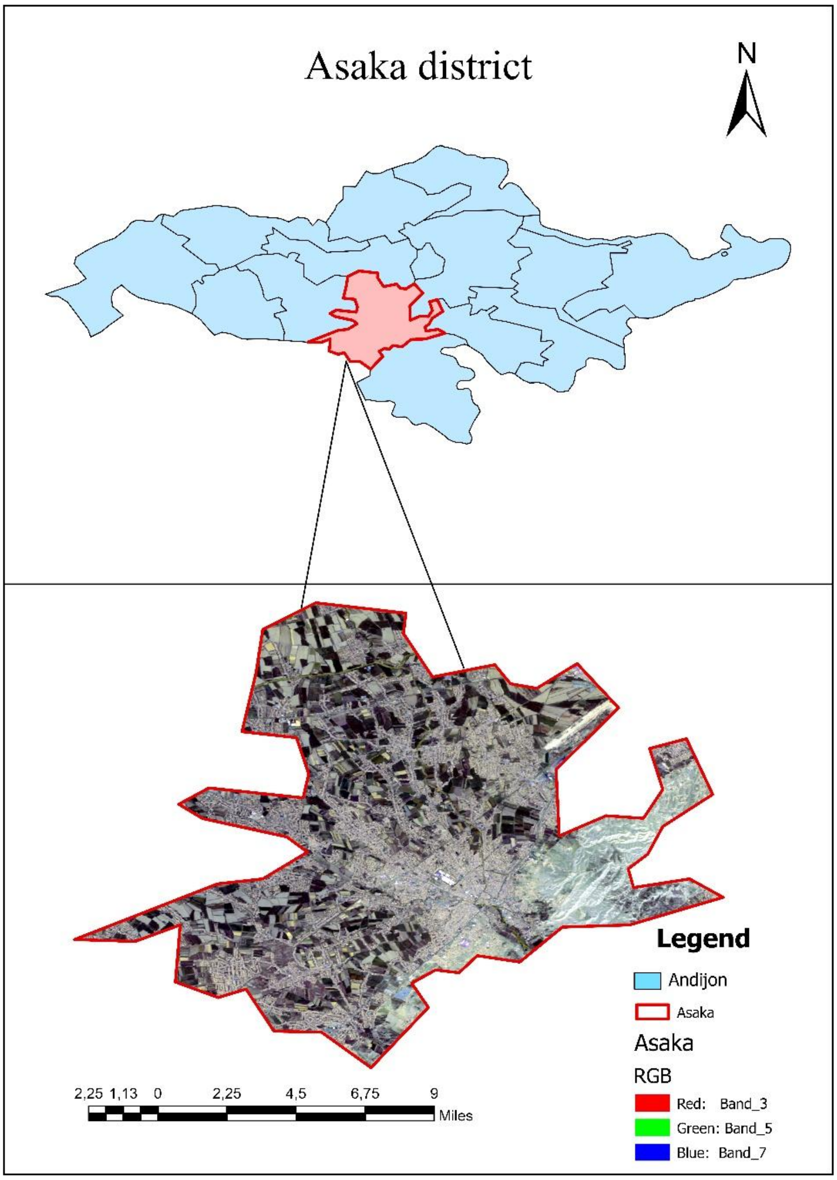

Figure 1. Location map of the study area

RESULTS

This study classified the landscape of the Asaka District in the Andijan Region into four main land use and land cover (LULC) classes based on their spectral, spatial, and environmental characteristics. These classes include water bodies, built-up areas, croplands, and mountains. Each class represents an important component of land dynamics in the study area, reflecting the effects of agricultural activities, urbanization, natural ecosystems, and climate change. The main LULC classes and their descriptions are presented in the following table 1.

LULC Class	Description	Key Characteristics	Environmental Significance
Water Bodies	Areas with surface water, including rivers, canals, lakes, and reservoirs.	Water Bodies: The area varies seasonally in extent; distinguished by water clarity, depth, and flow rate.	Provides irrigation for agriculture, serves as a source of drinking water, and maintains ecosystem stability.
Built-up Areas (Urban Areas)	Areas containing residential settlements, industrial zones, administrative facilities, and infrastructure objects.	Built-up Areas (Urban Areas): High building density; dominated by asphalt and concrete surfaces; very limited vegetation cover.	Contributes to the urban heat island effect and air pollution, but plays a crucial role as a center of economic activity.
Croplands (Agricultural Areas)	Land used for agricultural purposes, where seasonal or perennial crops are cultivated	Croplands (Agricultural Areas): Includes cotton, cereals, vegetables, and horticultural crops; comprises both irrigated and rainfed farming systems	Ensures food security and positively impacts economic stability.
Mountains and Foothills	Natural landform features located in the peripheral parts of the Asaka district, including elevations, ridges, and foothills	Mountains and Foothills: Sparse vegetation cover; strong soil erosion; relatively colder climate.	Important for preserving biodiversity, forming water sources, and maintaining ecological balance.

Table 1. Description of LULC classes for Asaka district

SATELLITE DATA

Satellite imagery was used as the primary data source to detect land use and land cover (LULC) changes. Landsat 5 TM (Thematic Mapper) and Landsat 8 OLI/TIRS (Operational Land Imager / Thermal Infrared Sensor) images were obtained free of charge from the United States Geological Survey (USGS) web portal. The images were classified using the Support Vector Machine (SVM) algorithm to identify major LULC classes, including water bodies, built-up areas, croplands, and mountainous regions. Change detection analysis was then performed to examine landscape dynamics in the Asaka District between 1995 and 2025 (Figure 2).

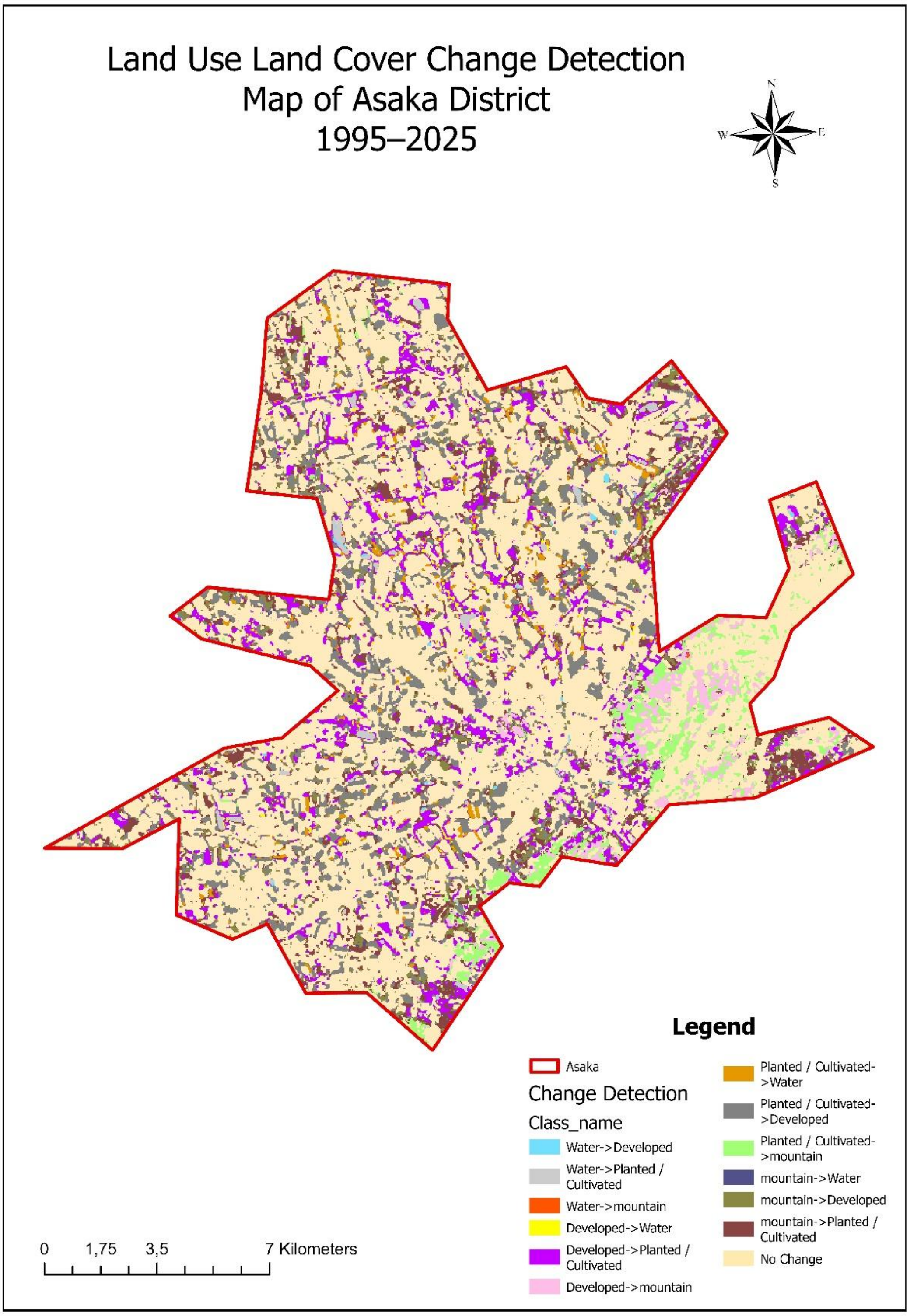

Figure 2. Landscape change (Change Detection) map of Asaka district between 1995 and 2025

Landsat images from 1995 and 2025 were successfully classified using the Support Vector Machine (SVM) algorithm. Subsequently, a Change Detection analysis was performed to identify land use and land cover (LULC) changes between the two periods and to assess their dynamics. Pixel-based analysis of the classified raster layers distinguished changed and unchanged areas.

The results revealed notable landscape changes in the Asaka District over the 30-year period, including the expansion of agricultural lands, a reduction in natural vegetation, and an increase in built-up areas. Urbanization processes were mainly concentrated in the central and western parts of the district, indicating the influence of population growth, industrial expansion, and infrastructure development. Changes in water body areas were also detected, which can be attributed to climatic factors and water resource management practices (Figure 3).

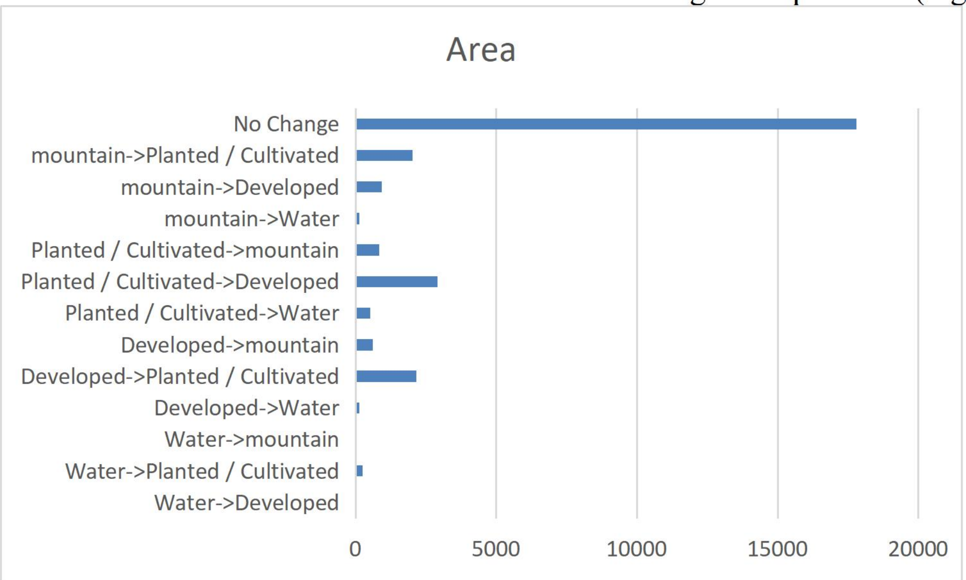

Figure 3. Distribution of land cover (LULC) change in Asaka district in 1995–2025

CONCLUSION

1. This study analyzed land use and land cover (LULC) changes in the Asaka District of the Andijan Region between 1995 and 2025 using satellite imagery. LULC classification was performed using the Support Vector Machine (SVM) algorithm applied to Landsat data, yielding high classification accuracy.
2. Based on the classification results, Change Detection analysis was conducted to identify transitions among LULC classes over different periods.
3. The results indicate a continuous increase in Planted/Cultivated and Developed areas, reflecting intensified anthropogenic impacts. In contrast, Mountain and Water classes remained relatively stable or showed slight decreases.
4. The most significant changes occurred between Planted/Cultivated and Developed areas, highlighting accelerated urbanization processes in the Asaka District.

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