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NOMIDAGI TATU FARG'ONA FILIALI

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NAMED AFTER MUHAMMAD AL-KHORAZMI

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COMPARISON OF MULTISERVICE REMOTE SENSING DATA FOR VEGETATION INDEX ANALYSIS

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Abstract: With advancements in satellite sensors, multi-source observation systems have become widely utilized. However, significant disparities exist among quantitative remote sensing products due to variations in observational methods and retrieval algorithms. This study investigates the quantitative relationships between the Normalized Difference Vegetation Index (NDVI), Soil-Adjusted Vegetation Index (SAVI), and a vegetation index derived using the universal decomposition method for data from Landsat 2+ and Landsat 3 sensors.

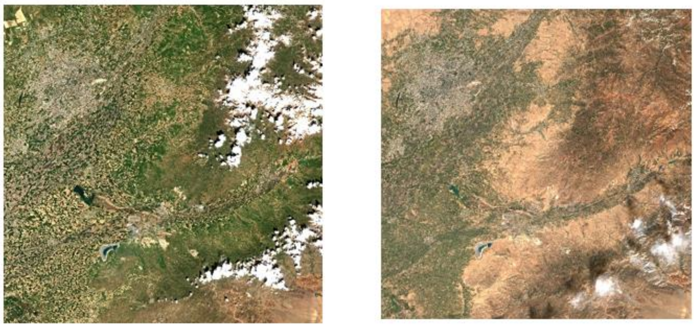
Key words: NDVI, SAVI, Indices, Sensing, Landsat

Introduction

With advancements in satellite sensors, multi-source observation systems have become widely utilized. However, significant disparities exist among quantitative remote sensing products due to variations in observational methods and retrieval algorithms. This study investigates the quantitative relationships between the Normalized Difference Vegetation Index (NDVI), Soil-Adjusted Vegetation Index (SAVI), and a vegetation index derived using the universal decomposition method for data from Landsat 2+ and Landsat 3 sensors. Vegetation is a critical component of the global ecological system. Spectral vegetation index data have been widely applied to study the interactions between climate and ecosystems, support land management and sustainability efforts, and analyze climate change and carbon sequestration. In recent years, various vegetation indices have been developed for specific applications. Comparing vegetation indices across different sensors has proven to be an effective approach for sensor calibration. For instance, studies have tested the sensitivity of NDVI, SAVI, and ARVI to the spectral and spatial properties of sensors like ETM+, SPOT, and IKONOS, revealing that IKONOS indices tend to be lower than those from ETM+ and SPOT. Notably, Landsat and ASTER share similar resolution and spectral characteristics, making their comparison highly valuable for broadening the application of these data sources [1].

Materials and methods

The research area is situated in the Tashkent region, along the Road Valley on Kamchik Mountain (Figure 1). For this study, Landsat 2 imagery from April 26, 2020, and Landsat 3 imagery from September 23, 2020, were utilized [2].



a) b)

Figure 1. Images from Landsat 2 (a) and Landsat 3 (b)

Data Preprocessing

A. Geometric Correction

The visible and near-infrared bands of Landsat images have a spatial resolution of 10 meters. To standardize the spatial resolution across datasets, geometric registration was applied to achieve uniform 10-meter resolution data.

B. Radiometric Correction

- Terrain Radiometric Correction

In regions with mountainous terrain, irregular topography greatly influences spatial climate variability and the reflectance values of pixels in remote sensing images.

- Reflectance Inversion

Radiometric calibration integrates sensor-specific records containing calibration parameters tailored to different data formats and response factors unique to each sensor.

Vegetation Indices

This study utilized two vegetation indices: NDVI and SAVI. These indices are commonly derived from red and infrared spectral bands [3].

NDVI

The Normalized Difference Vegetation Index (NDVI) is the most widely applied vegetation index in remote sensing. It serves as the primary metric for sensor comparison in this analysis:

$$NDVI = \frac{NIR - RED}{NIR + RED}$$

where ρNIR and ρred are the reflectances for the NIR and R bands, respectively.

SAVI

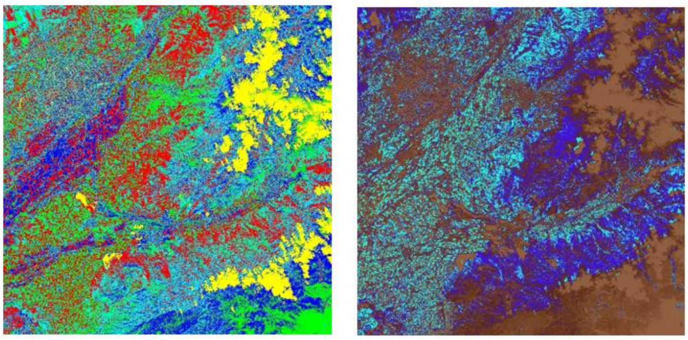
The Soil-Adjusted Vegetation Index (SAVI) addresses the impact of soil background noise by incorporating a soil brightness correction factor, *L*. The index is computed using the following formula [4]:

$$SAVI = \frac{NIR - RED}{NIR + RED + L} * (1 + L)$$

setting *L*=0.5 effectively minimizes the impact of soil background noise.

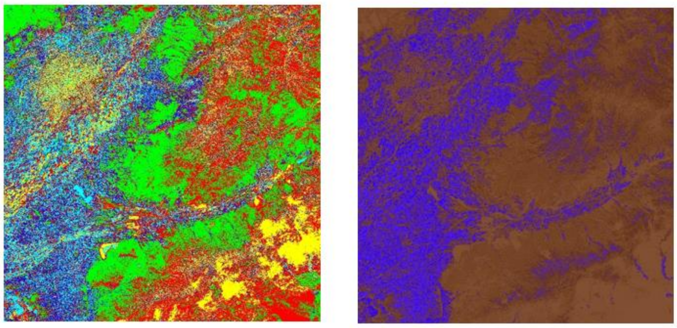
Results and discussion

Figures 2 and 3 display the NDVI and SAVI distribution maps for Landsat 2 and Landsat 3 within the study area. The findings indicate that, regardless of the data source, both vegetation indices effectively reflect vegetation growth patterns. However, notable differences exist between the indices, particularly in regions with fertile vegetation. SAVI values are significantly lower than NDVI values. Due to NDVI's non-linear response, its calculations are enhanced at lower values and compressed at higher values. Consequently, NDVI tends to exhibit greater saturation compared to SAVI across sensors [5].



a) b)

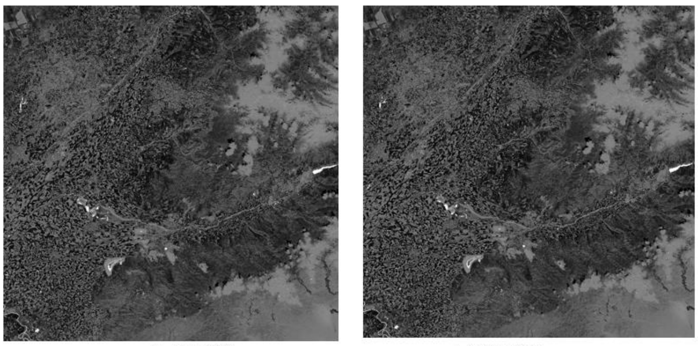
Figure 2. Landsat 2 distribution of NDVI and SAV for April 26, 2020. (a) NDVI, (b) SAVI



a) b)

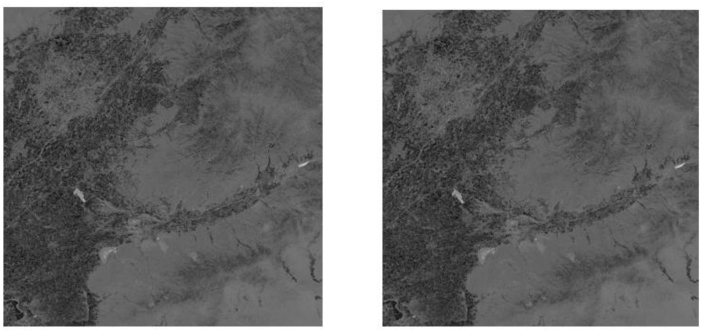
Figure 3. Landsat 2 distribution by NDVI and SAV for September 23, 2020. (a) NDVI, (b) SAVI

Figures 4 and 5 illustrate the grayscale representation of various vegetation indices for the two sensors. The findings reveal that: 1) distinguishing between NDVI and SAVI in this scenario is challenging, as their detection algorithms, which rely on red bands, perform similarly under these conditions [6].



a) SAVI b) NDVI

Figure 4. Relationship between NDVI and SAVI (Landsat 2)



a) NDVI b) SAVI

Figure 5. Relationship between NDVI and SAVI (Landsat 3)

Conclusions

In this study, Landsat NDVI and SAVI sensor data were utilized to evaluate plant health. After thoroughly analyzing the distribution of various plant indices for both sensors, the key findings can be summarized as follows: 1) A strong correlation exists between different plant indices for the same sensor, with a detection rate exceeding 0.9; and 2) In areas without vegetation, SAVI values were higher than NDVI values, while the reverse was observed in areas with high vegetation productivity.

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