Assessing Land Surface Temperature and NDMI Variations in Zomin National Park Using Sentinel-2 Data

Kurbon Juraev Hafiz o'g'li[1]
[1] "Tashkent Institute of Irrigation and Agricultural Mechanization Engineers" National research University. Republic of Uzbekistan, Tashkent city 39, 100000, 39 Kori Niyazi street.
E-mail: kurbonjuraev1995@gmail.com

Aziz Inamov Nizamovich[1]
[1] "Tashkent Institute of Irrigation and Agricultural Mechanization Engineers" National research University. Republic of Uzbekistan, Tashkent city 39, 100000, 39 Kori Niyazi street.

ABSTRACT

This study focuses on the analysis of Land Surface Temperature (LST) and Normalized Difference Moisture Index (NDMI) in Zomin National Park for August 2021, using Sentinel-2 satellite imagery. The study aims to assess the spatiotemporal variations in LST and NDMI, providing insights into the environmental conditions and vegetation health of the park. Sentinel-2 data was processed to extract both LST and NDMI, which were then analyzed to observe the relationship between temperature fluctuations and vegetation moisture content. The results highlight the seasonal dynamics of the park's ecosystem, contributing to the understanding of climate change impacts and vegetation stress. This research offers valuable information for monitoring and managing the park's natural resources.

Keywords: Land Surface Temperature, NDMI, Sentinel-2, Zomin National Park, Remote Sensing, Vegetation Health, Climate Change, Environmental Monitoring, August 2021.

Introduction

Zomin National Park, located in the picturesque Tien Shan Mountains of Uzbekistan, represents a critical area for biodiversity conservation and environmental sustainability in the country. Covering an area of over 250 square kilometers, the park is home to a diverse array of flora and fauna, some of which are endemic to the region. Its strategic location and ecological importance make it a vital component of Uzbekistan's natural heritage, contributing significantly to the country's environmental and tourism sectors. Zomin National Park is not only a natural reserve but also a valuable site for scientific research, particularly in the study of climate change, ecosystem dynamics, and conservation practices [1,2].

Monitoring the environmental conditions of Zomin National Park is essential for understanding and mitigating the impacts of climate change, deforestation, and human activities on its ecosystems. Remote Sensing (RS) and Geographic Information Systems (GIS) have emerged as powerful tools in environmental monitoring, enabling the collection, analysis, and visualization of spatial data over large areas. These technologies offer precise, timely, and cost-effective methods for tracking land surface temperature (LST), vegetation health, and moisture content, allowing researchers and park management to make informed decisions regarding conservation strategies and sustainable land use. Sentinel-2 imagery, in particular, has proven invaluable for its high-resolution data and frequent revisit cycles, making it an ideal resource for monitoring seasonal changes and environmental stress in protected areas like Zomin National Park [3].

On the global scale, environmental legislation has evolved to emphasize the need for sustainable management of natural resources and protection of biodiversity. International agreements such as the United Nations Framework Convention on Climate Change (UNFCCC) and the Convention on Biological Diversity (CBD) underscore the importance of preserving ecosystems and mitigating environmental degradation. At the national level, Uzbekistan has taken significant steps to strengthen its environmental protection policies. The country's Environmental Code, adopted in 2019, aims to ensure sustainable development, conserve biodiversity, and protect natural resources [4,5]. Additionally, Uzbekistan is a party to several international conventions related to climate change and biodiversity, committing to the global efforts to combat environmental challenges.

In this context, the use of RS and GIS technologies in Zomin National Park is aligned with both national and international priorities for environmental monitoring and management. By utilizing these tools, we can enhance our understanding of the park's ecological processes, support the conservation of its unique biodiversity, and contribute to the broader goals of environmental protection and sustainable development in Uzbekistan [6,7].

Methods and Materials

Study Area: Zomin National Park, located in the Tien Shan Mountains of Uzbekistan, was selected as the study area for this research. This park, covering over 250 square kilometers, represents a rich natural environment, with diverse ecosystems and a variety of endemic species. The region is also prone to environmental changes due to factors such as climate fluctuations, human activity, and deforestation.

Data Collection: The primary data used for this study was obtained from Sentinel-2 satellite imagery for August 2021, which provides high spatial resolution (10 to 60 meters) and frequent revisit intervals. The data was pre-processed to correct for atmospheric distortions, cloud cover, and other potential image artifacts using the Sentinel-2 toolbox in the Sentinel Hub environment.

Additionally, Landsat 8 imagery was utilized for index calculation and comparison. Landsat 8 provides 30-meter resolution multispectral data, which was used to compute both Land Surface Temperature (LST) and the Normalized Difference Moisture Index (NDMI). The selected Landsat imagery corresponds to a time period close to that of the Sentinel-2 data, ensuring temporal consistency in environmental monitoring.

Results and Discussion:

The Land Surface Temperature (LST) analysis for Zomin National Park in August 2021 revealed distinct spatial variations in temperature across the park's landscape. The LST maps derived from Landsat 8 imagery showed higher temperatures in the lower elevation areas, particularly in regions with minimal vegetation cover and human activity. Conversely, higher altitudes and areas covered by dense forest and vegetation exhibited relatively lower LST values. This pattern aligns with general expectations, where areas with lush vegetation have a cooling effect due to evapotranspiration and shading.

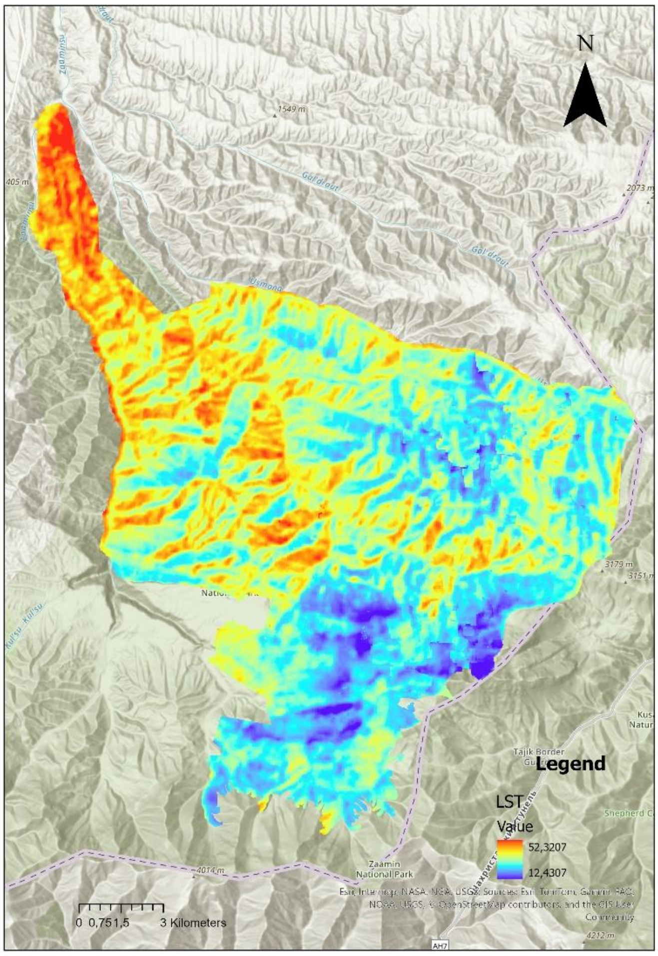

Figure 1. Land surface temperature in august, 2021.

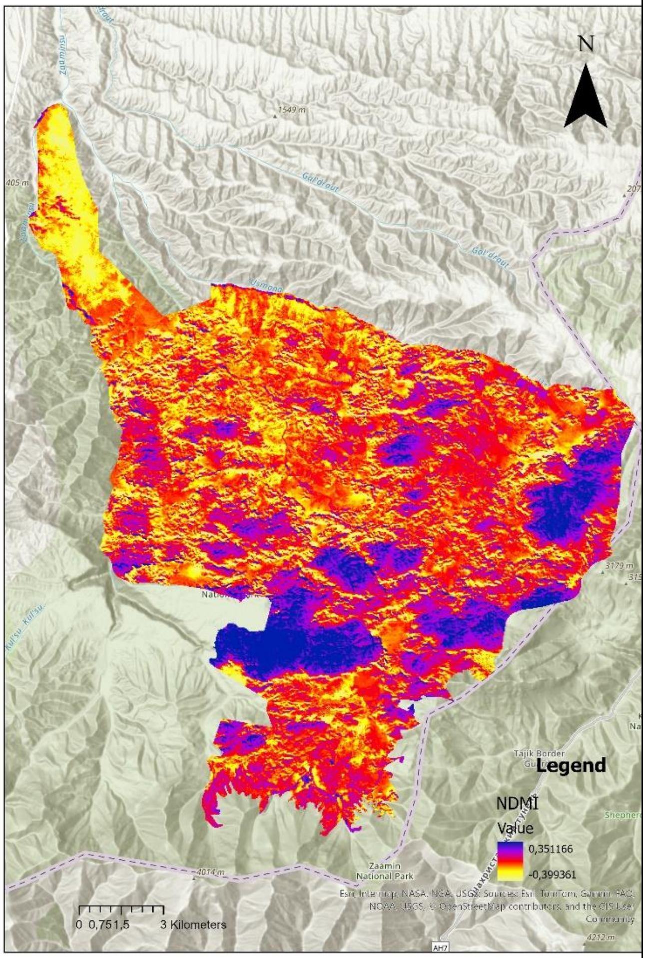

Figure 2. Normaized difference moisture index in august, 2021.

The average LST for the park in August 2021 was found to be approximately 28°C, with some areas in the lowlands reaching up to 35°C. These temperature variations are significant as they highlight the role of topography and vegetation in regulating local climate conditions. The LST values also indicated potential areas of concern, such as regions where LST exceeded typical seasonal values, which may be attributed to deforestation or land degradation. The thermal contrast between different land cover types in the park underscores the importance of maintaining healthy ecosystems to mitigate the adverse effects of temperature fluctuations on the local environment.

Conclusion:

The inverse relationship between LST and NDMI underscores the vulnerability of certain park areas to environmental stress, particularly in the context of climate change. These findings suggest that monitoring LST and NDMI over time can serve as an effective tool for assessing the health of the park's ecosystems and identifying areas at risk due to temperature fluctuations and moisture stress. The use of remote sensing and GIS technologies in this study has proven invaluable in providing detailed, high-resolution data that can inform conservation efforts and resource management strategies.

The results of this study have important implications for the future management and conservation of Zomin National Park. By identifying regions with high temperature extremes and moisture stress, park authorities can prioritize areas for restoration and implement targeted interventions to mitigate the impacts of climate change. In conclusion, the integration of satellite-based LST and NDMI analysis with GIS tools offers a cost-effective and efficient approach for monitoring and managing the environmental health of Zomin National Park. Continued use of these technologies will be essential in adapting to ongoing environmental changes and ensuring the long-term preservation of this important natural reserve.

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