ASSESSMENT OF VEGETATION INDEX FOR RESERVE FORESTS ON WESTERN GHATS, TAMILANDU USING REMOTE SENSING AND GIS TECHNIQUES

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ABSTRACT

Reserve forests serve as crucial biodiversity hotspots and habitats for various bird and wildlife species. This study employs the Normalized Difference Vegetation Index (NDVI), a key remote sensing metric, to assess vegetation health in the reserve forests of the Western Ghats, Tamil Nadu. Utilizing Landsat imagery, NDVI maps were generated for the years 2015 and 2021 using ENVI Image Processing Software. The specific reserve forests analyzed include Agamalai, Megamalai, Palani Hills Conservation Area, Palani Hills Northern Slope East, Alagar Kovil, Semmalai, Settur, Srivilliputhur Grizzled Squirrel Wildlife Sanctuary, Karandamalai, and Suruli. A 5 Km buffer zone was established for each forest to enhance the precision of the analysis. In 2015, NDVI map revealed a maximum vegetation index value of 0.6 and a minimum of -0.1, while the 2021 map indicated a maximum of 0.5 and a minimum of 0.1. These findings suggest a slight decline in vegetation health over the six-year period. The study's primary objective is to evaluate the temporal changes in vegetation cover, providing insights into the ecological status of these forests. Results highlight areas requiring conservation efforts and underscore the utility of remote sensing and GIS technologies in environmental monitoring and management. This research contributes to the understanding of vegetation dynamics in reserve forests and supports sustainable forest management practices in the region.

Keywords: - NDVI, Landsat, Buffer zone, Vegetation Index

1. INTRODUCTION

The Western Ghats, a UNESCO World Heritage site, is one of the eight "hottest hotspots" of biological diversity in the world. This mountain range, extending along the western coast of India, hosts a variety of ecosystems and species, many of which are endemic (Myers, 2000). In Tamil Nadu, the Western Ghats' reserve forests play a crucial role in maintaining regional biodiversity, hydrology, and climate regulation. However, these forests are under increasing pressure from anthropogenic activities, including deforestation, agricultural expansion, and infrastructure development (Jha, 2000).

Remote Sensing (RS) and Geographic Information System (GIS) techniques have emerged as powerful tools for monitoring and assessing vegetation health and changes over large spatial scales. These technologies provide timely and accurate data that are essential for effective forest management and conservation strategies (Lu, 2004). Vegetation indices, derived from satellite imagery, are particularly useful for quantifying vegetation cover, health, and productivity. They offer a cost-effective means to assess and monitor forest ecosystems, especially in remote and inaccessible areas (Tucker, 1979).

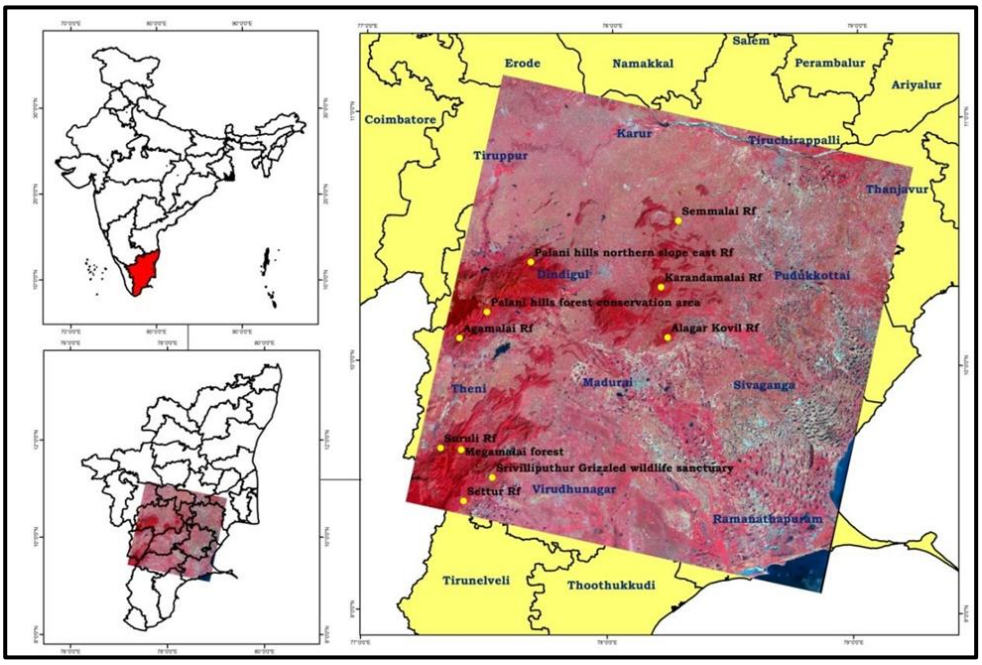
The Normalized Difference Vegetation Index (NDVI) is one of the most widely used vegetation indices. It measures the difference between near-infrared (which vegetation strongly reflects) and red light (which vegetation absorbs) and is indicative of vegetation density and health (Rouse, 1974). Other indices, such as the Enhanced Vegetation Index (EVI) and Soil-Adjusted Vegetation Index (SAVI), have been developed to address specific challenges in vegetation monitoring, including atmospheric conditions and soil background effects (Huete, 2002).

This study aims to assess the vegetation index of reserve forests in the Western Ghats of Tamil Nadu using remote sensing and GIS techniques. By analyzing temporal changes in vegetation indices, we seek to understand the dynamics of forest cover and health, identify areas of degradation, and provide insights for conservation and sustainable management. This research contributes to the growing body of knowledge on forest monitoring and highlights the importance of integrating advanced technological tools in environmental management.

2. STUDY AREA

The study focuses on a selection of reserve forests located in the western part of Tamil Nadu, a region known for its rich biodiversity and ecological significance. The specific areas included in this study are:

1. **Agamalai Reserve Forest**
2. **Megamalai Forest**
3. **Palani Hills Forest Conservation Area**
4. **Palani Hills Northern Slope East Forest**
5. **Alagar Kovil Reserve Forest**
6. **Semmalai Reserve Forest**
7. **Settur Reserve Forest**
8. **Srivilliputhur Grizzled Squirrel Wildlife Sanctuary**
9. **Karandamalai Reserve Forest**
10. **Suruli Forest**



These forests are integral components of the Western Ghats, a UNESCO World Heritage site and one of the most significant biodiversity hotspots globally. The region's varied topography and climate create diverse habitats that support a wide range of flora and fauna, many of which are endemic. This study aims to assess the vegetation index across these forests to understand their ecological health and dynamics using remote sensing and GIS techniques.

3. MATERIALS AND METHODS

1. Data Acquisition

Landsat 8 Operational Land Imager (OLI) images for the study area (Path/Row – 144/52) were downloaded from the USGS Earth Explorer website. The images were pre-rectified to the WGS-1984-UTM Zone.

2. Map Preparation

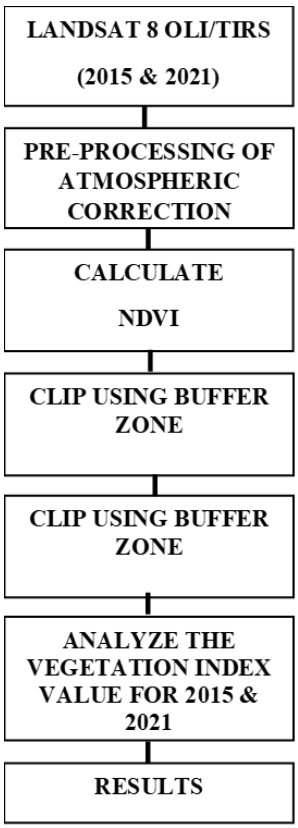
Satellite data collected from the USGS website were processed using ENVI 5.1 Image Processing Software. The data analysis involved using band matching techniques to generate the Normalized Difference Vegetation Index (NDVI). The NDVI calculation uses the near-infrared (NIR) and red (RED) bands of the Landsat imagery. The formula for calculating NDVI is as follows:

NDVI=NIR-RED/NIR+RED

OR

NDVI=Band 5−Band 4/Band 5+Band 4

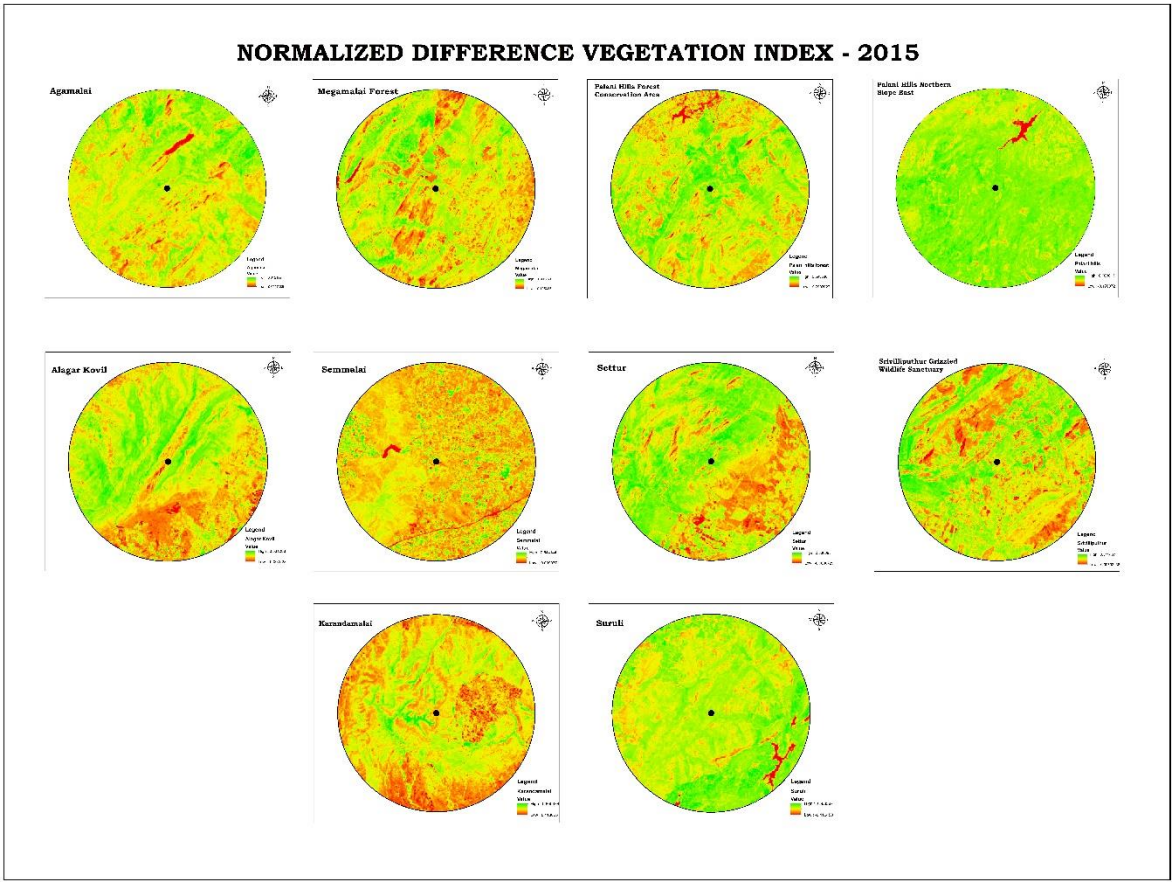
After performing the band matching process, the data were compressed into a single band representing the NDVI values, which range from -1 to +1. This NDVI band was then used to create maps illustrating the vegetation index for the various reserve forests in the study area.

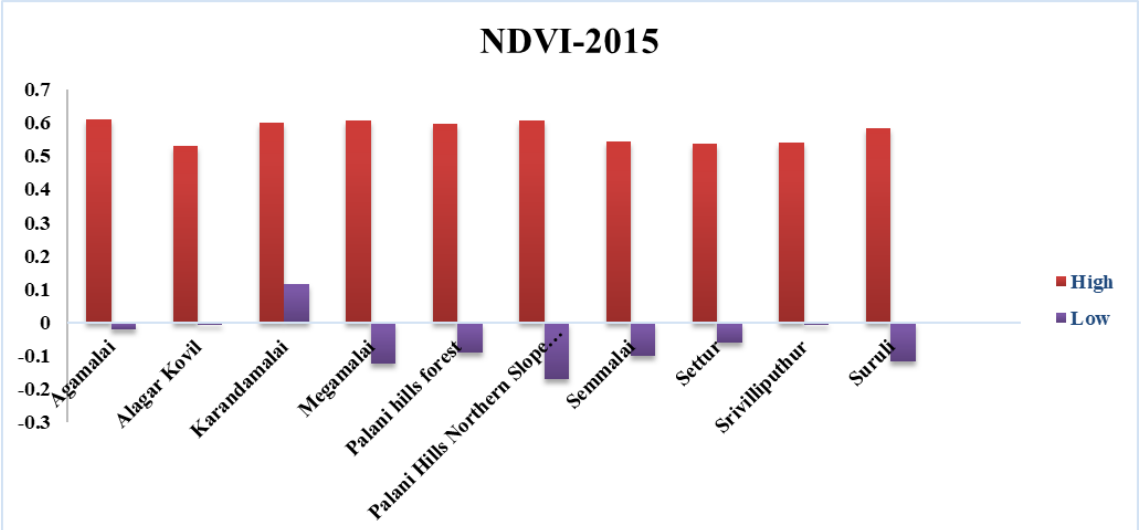


4. RESULTS & DISCUSSION

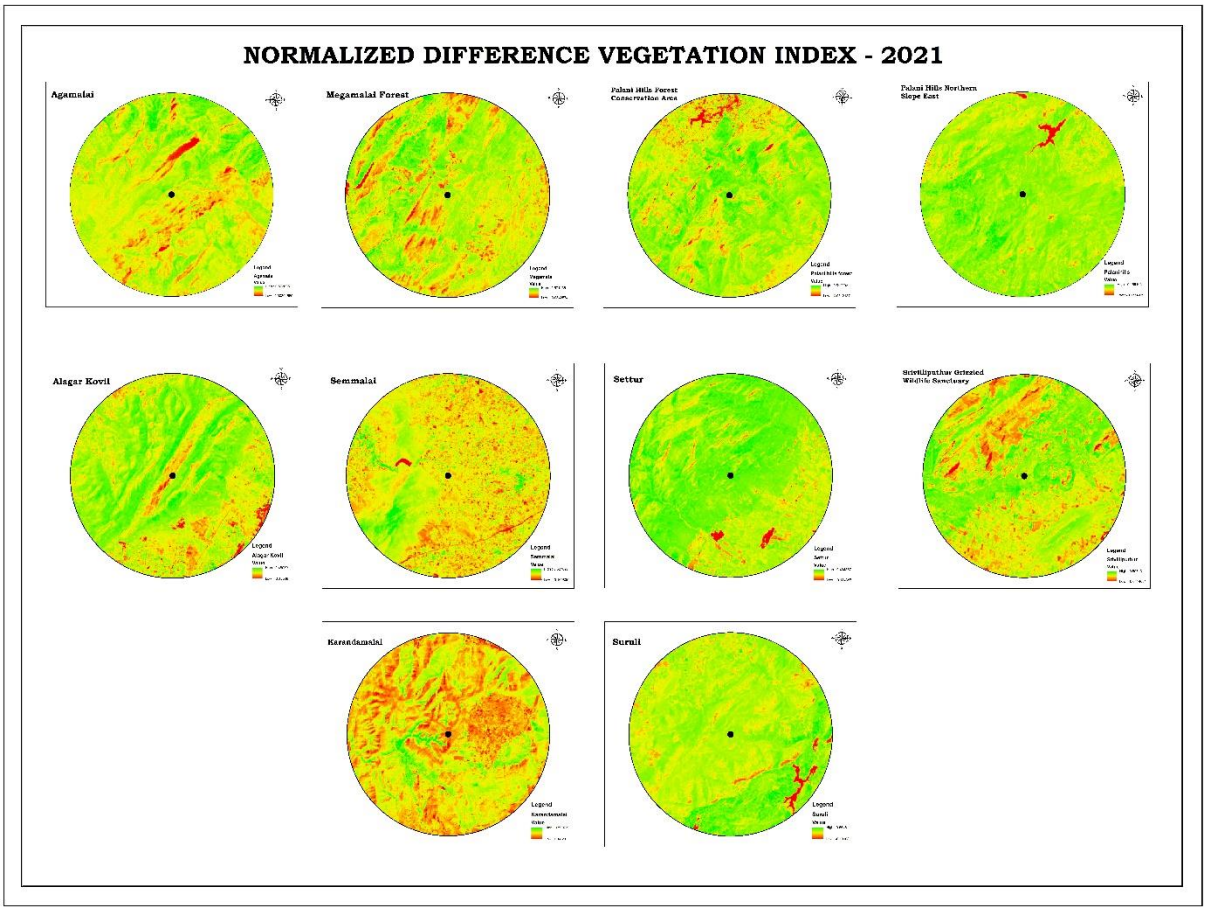
The NDVI maps for the study area were generated for the years 2015 and 2021 to assess the vegetation health and cover of the reserve forests in the Western Ghats, Tamil Nadu. The study areas include Agamalai Reserve Forest, Megamalai Forest, Palani Hills Forest Conservation Area, Palani Hills Northern Slope East Forest, Alagar Kovil Reserve Forest, Semmalai Reserve Forest, Settur Reserve Forest, Srivilliputhur Grizzled Squirrel Wildlife Sanctuary, Karandamalai Reserve Forest, and Suruli Forest.

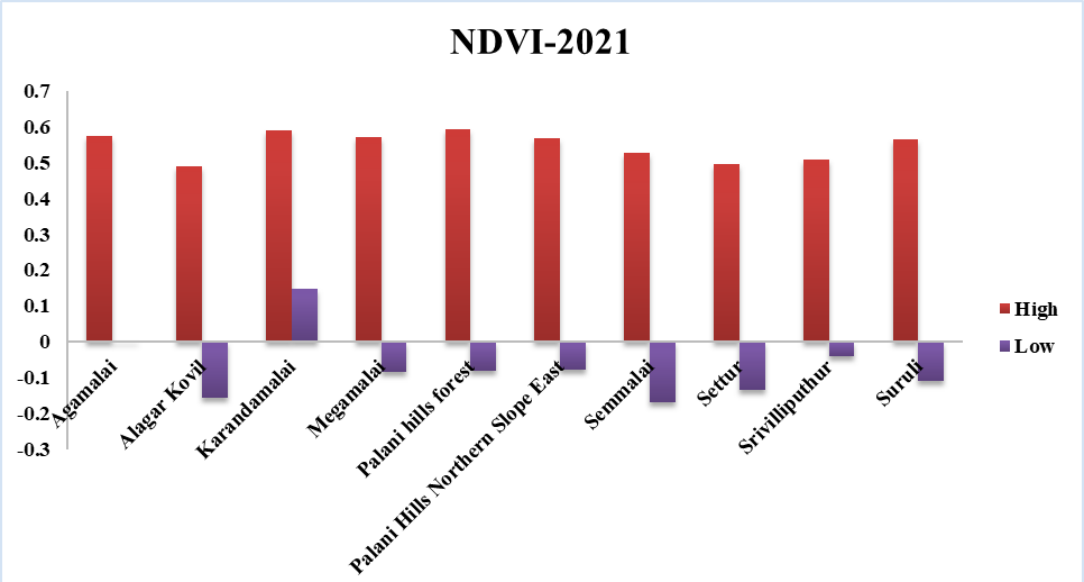
NDVI Values for 2015: The analysis revealed that the NDVI values for 2015 ranged from a minimum of -0.1 to a maximum of 0.6. The higher NDVI values indicate areas with dense and healthy vegetation, whereas lower values suggest sparse vegetation or non-vegetated surfaces.





NDVI Values for 2021: For 2021, the NDVI values ranged from a minimum of 0.1 to a maximum of 0.5. This shift in NDVI values indicates a slight decline in overall vegetation health and density over the six-year period.





The observed decline in maximum NDVI values from 0.6 in 2015 to 0.5 in 2021 suggests a reduction in vegetation density and health across the reserve forests. Several factors could contribute to this decline, including deforestation, encroachment, climate change, and

other anthropogenic pressures. The minimum NDVI value increasing from -0.1 to 0.1 may indicate a reduction in bare soil or non-vegetated areas, possibly due to changes in land use practices or natural vegetation recovery in some areas.

Spatial Variation:

High NDVI Areas: Regions with high NDVI values in both years, such as parts of the Palani Hills Forest Conservation Area and Srivilliputhur Grizzled Squirrel Wildlife Sanctuary, indicate zones of dense and healthy vegetation, crucial for biodiversity conservation.

Low NDVI Areas: Areas showing low NDVI values, particularly in 2021, highlight regions that may be experiencing stress or degradation. These areas require targeted conservation efforts to restore and maintain their ecological health.

5. CONCLUSION

This study effectively utilized remote sensing and GIS techniques to assess the vegetation health of reserve forests in the Western Ghats, Tamil Nadu, by analyzing NDVI values derived from Landsat 8 OLI images for the years 2015 and 2021. The results indicate a noticeable decline in vegetation health over the six-year period, with maximum NDVI values decreasing from 0.6 in 2015 to 0.5 in 2021. This trend suggests increasing stress and degradation within these critical forest ecosystems, likely due to anthropogenic pressures and environmental changes.The spatial analysis revealed significant variations in vegetation density across different reserve forests, with areas like the Palani Hills Forest Conservation Area and Srivilliputhur Grizzled Squirrel Wildlife Sanctuary maintaining relatively high NDVI values, indicative of dense and healthy vegetation. Conversely, regions with lower NDVI values highlight areas that may require immediate conservation attention to mitigate further degradation. The 5Kmbuffer zone analysis around each forest provided a more precise assessment of core forest health, demonstrating the importance of such buffers in ecological studies. These findings underscore the necessity for ongoing monitoring and the implementation of targeted conservation strategies to preserve the biodiversity and ecological functions of these reserve forests. The study underscores the value of remote sensing and GIS technologies in environmental monitoring and management. By providing a comprehensive assessment of vegetation health, this research offers crucial insights for the development of effective conservation policies and practices aimed at sustaining the ecological integrity of the Western Ghats' reserve forests. Continuous monitoring and proactive management are essential to mitigate the impacts of anthropogenic activities and ensure the long-term preservation of these vital ecosystems.

6. REFERECES

[1] Huete, A. R., Didan, K., Miura, T., Rodriguez, E. P., Gao, X., & Ferreira, L. G. (2002). Overview of the radiometric and biophysical performance of the MODIS vegetation indices. Remote Sensing of Environment, 83(1-2), 195-213.

[2] Jha, C. S., Goparaju, L., Tripathi, N. K., Gharai, B., & Raghubanshi, A. S. (2000). Forest fragmentation and its impact on species diversity: An analysis using remote sensing and GIS. Biodiversity and Conservation, 9(1), 107-129.

[3] Lu, D., Mausel, P., Brondízio, E., & Moran, E. (2004). Change detection techniques. International Journal of Remote Sensing, 25(12), 2365-2401.
[4] Myers, N., Mittermeier, R. A., Mittermeier, C. G., Da Fonseca, G. A., & Kent, J. (2000). Biodiversity hotspots for conservation priorities. Nature, 403(6772), 853-858.
[5] Rouse, J. W., Haas, R. H., Schell, J. A., & Deering, D. W. (1974). Monitoring vegetation systems in the Great Plains with ERTS. In Third Earth Resources Technology Satellite-1 Symposium-Volume I: Technical Presentations (Vol. 1, p. 309). NASA SP-351.
[6] Tucker, C. J. (1979). Red and photographic infrared linear combinations for monitoring vegetation. Remote Sensing of Environment, 8(2), 127-150.
[7] Boyd, D. S., & Danson, F. M. (2005). Satellite remote sensing of forest resources: Three decades of research development. Progress in Physical Geography, 29(1), 1-26. https://doi.org/10.1191/0309133305pp432.
[8] Congalton, R. G., & Green, K. (2008). Assessing the accuracy of remotely sensed data: Principles and practices. CRC press.
[9] Gamon, J. A., & Qiu, H. (2011). Ecological applications of remote sensing at multiple scales. In Wang, G., & Weng, Q. (Eds.), Remote Sensing of Natural Resources (pp. 207-238). CRC Press.
[10] Jensen, J. R. (2007). Remote Sensing of the Environment: An Earth Resource Perspective. Prentice Hall.
[11] Kerr, J. T., & Ostrovsky, M. (2003). From space to species: Ecological applications for remote sensing. Trends in Ecology & Evolution, 18(6), 299-305. https://doi.org/10.1016/S0169-5347(03)00071-5.
[12] Pettorelli, N., Laurance, W. F., O'Brien, T. G., Wegmann, M., Nagendra, H., & Turner, W. (2014). Satellite remote sensing for applied ecologists: Opportunities and challenges. Journal of Applied Ecology, 51(4), 839-848. https://doi.org/10.1111/1365-2664.12261.
[13] Xie, Y., Sha, Z., & Yu, M. (2008). Remote sensing imagery in vegetation mapping: A review. Journal of Plant Ecology, 1(1), 9-23. https://doi.org/10.1093/jpe/rtm005.
[14] Turner, W., Spector, S., Gardiner, N., Fladeland, M., Sterling, E., & Steininger, M. (2003). Remote sensing for biodiversity science and conservation. Trends in Ecology & Evolution, 18(6), 306-314. https://doi.org/10.1016/S0169-5347(03)00070-3
[15] Wulder, M. A., White, J. C., Goward, S. N., Masek, J. G., Irons, J. R., Herold, M., ... & Woodcock, C. E. (2008). Landsat continuity: Issues and opportunities for land cover monitoring. Remote Sensing of Environment, 112(3), 955-969. https://doi.org/10.1016/j.rse.2007.07.004