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SPATIOTEMPORAL DYNAMICS OF VEGETATION COVER IN THE NAZINON WATERSHED: EVIDENCE FROM LANDSAT NDVI MULTI-DATE ANALYSIS (2006, 2015 AND 2025)

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ABSTRACT

Understanding vegetation dynamics is essential for assessing ecosystem responses to climate variability and anthropogenic pressure in semi-arid environments. This study analyzes the spatiotemporal evolution of vegetation cover in the Nazinon Watershed, central-southern Burkina Faso, based on Landsat-derived Normalized Difference Vegetation Index (NDVI) over a multi-date period (2006, 2015 and 2025).

Multi-temporal Landsat imagery (TM, ETM+, OLI) acquired during peak vegetation seasons (August–October) with minimal cloud cover (<10%) was processed using Google Earth Engine. Standard pre-processing steps including atmospheric correction, cloud masking and geometric harmonization were applied to ensure inter-sensor comparability. NDVI was computed from red and near-infrared spectral bands and annual composites were generated for the selected years to characterize vegetation conditions.

Statistical descriptors (NDVI_max, NDVI_mean, NDVI_min, NDVI_stdDev) were extracted to assess spatial and temporal variations. Results show a gradual increase in mean NDVI from 0.14 (2006) to 0.18 (2025), indicating a slight variation in vegetation greenness over time. Maximum NDVI values increase slightly from 0.37 to 0.40, suggesting localized changes in vegetation vigor. However, minimum NDVI values decrease from -0.13 to -0.24, reflecting expansion of non-vegetated or highly disturbed surfaces. The standard deviation remains stable at 0.03, indicating relatively constant spatial variability across the study period.

Overall, the findings reveal contrasting vegetation dynamics characterized by localized increases in vegetation greenness alongside persistent degradation in other areas. These results highlight the importance of integrated land management strategies and provide useful insights for sustainable watershed management under changing climatic and anthropogenic pressures in the Nazinon basin.

Keywords: NDVI, vegetation dynamics, Landsat image, Nazinon Watershed, Burkina Faso, GIS, remote sensing

1. INTRODUCTION

Vegetation plays a fundamental role in maintaining ecosystem functions, regulating hydrological processes, preserving biodiversity and mitigating the impacts of climate change. Monitoring changes in vegetation cover is therefore essential for understanding environmental dynamics and supporting sustainable land management, particularly in semi-arid regions where ecosystems are highly sensitive to climatic fluctuations and human activities (Frappart et al., 2020), (Almalki et al., 2022).

Over the last decades, West Africa has experienced significant environmental changes driven by climate variability, population growth, agricultural expansion and land-use transformations. These processes have altered vegetation patterns and ecosystem services, especially in watersheds that constitute critical ecological and socio-economic units (Tian et al., 2016). In Burkina Faso, increasing pressure on natural resources combined with recurrent droughts and rainfall variability has contributed to substantial modifications in vegetation cover, affecting water resources, soil fertility and agricultural productivity (Kumar et al., 2022),(B. J. B. Zoungrana et al., 2018)

Remote sensing has become one of the most effective approaches for monitoring vegetation dynamics over large spatial and temporal scales. Satellite imagery provides continuous and consistent observations of land surface conditions, enabling the assessment of vegetation changes and ecosystem responses to environmental drivers (B. J.-B. Zoungrana & Dimobé, 2023). Among the various vegetation indices developed for this purpose, the Normalized Difference Vegetation Index (NDVI) remains the most widely used due to its simplicity, robustness and strong relationship with vegetation biomass, chlorophyll activity and photosynthetic vigor (Bamba et al., 2015).

The availability of long-term Landsat archives offers unique opportunities for investigating vegetation dynamics over several decades. Landsat imagery has been extensively used to assess land cover changes, vegetation degradation, ecosystem restoration and climate-induced

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environmental transformations across Africa and other regions of the world (Mabula et al., 2025), (Liu et al., 2016). Time-series analyses based on NDVI have demonstrated their effectiveness in identifying trends of greening, browning and vegetation resilience under changing climatic and anthropogenic conditions (Ibrahim et al., 2015).

The Nazinon Watershed, located in central-southern Burkina Faso, constitutes an important hydrological and ecological system within the Volta Basin. The watershed supports agricultural production, livestock activities and local livelihoods, while simultaneously facing increasing environmental pressures resulting from land-use changes, deforestation and climate variability. Despite its ecological and socio-economic importance, comprehensive assessments of long-term vegetation dynamics within the watershed remain limited.

This study aims to analyze the spatiotemporal dynamics of vegetation cover in the Nazinon Watershed between 2006 and 2025 using Landsat-derived NDVI time series. Specifically, the study seeks to (i) characterize the spatial distribution of vegetation cover, (ii) evaluate temporal changes in NDVI patterns over a twenty-one-year period and (iii) identify trends of vegetation improvement and degradation within the watershed. The findings are expected to contribute to a better understanding of environmental changes in the Nazinon basin and provide scientific evidence for sustainable watershed management and ecosystem conservation strategies in Burkina Faso.

2. METHODOLOGY

2.1. Study Area

The study was conducted in the Nazinon watershed (figure 1), located in south-central Burkina Faso. The watershed boundaries were delineated using a Digital Elevation Model (DEM) and used as the spatial extent for the extraction and processing of satellite data.

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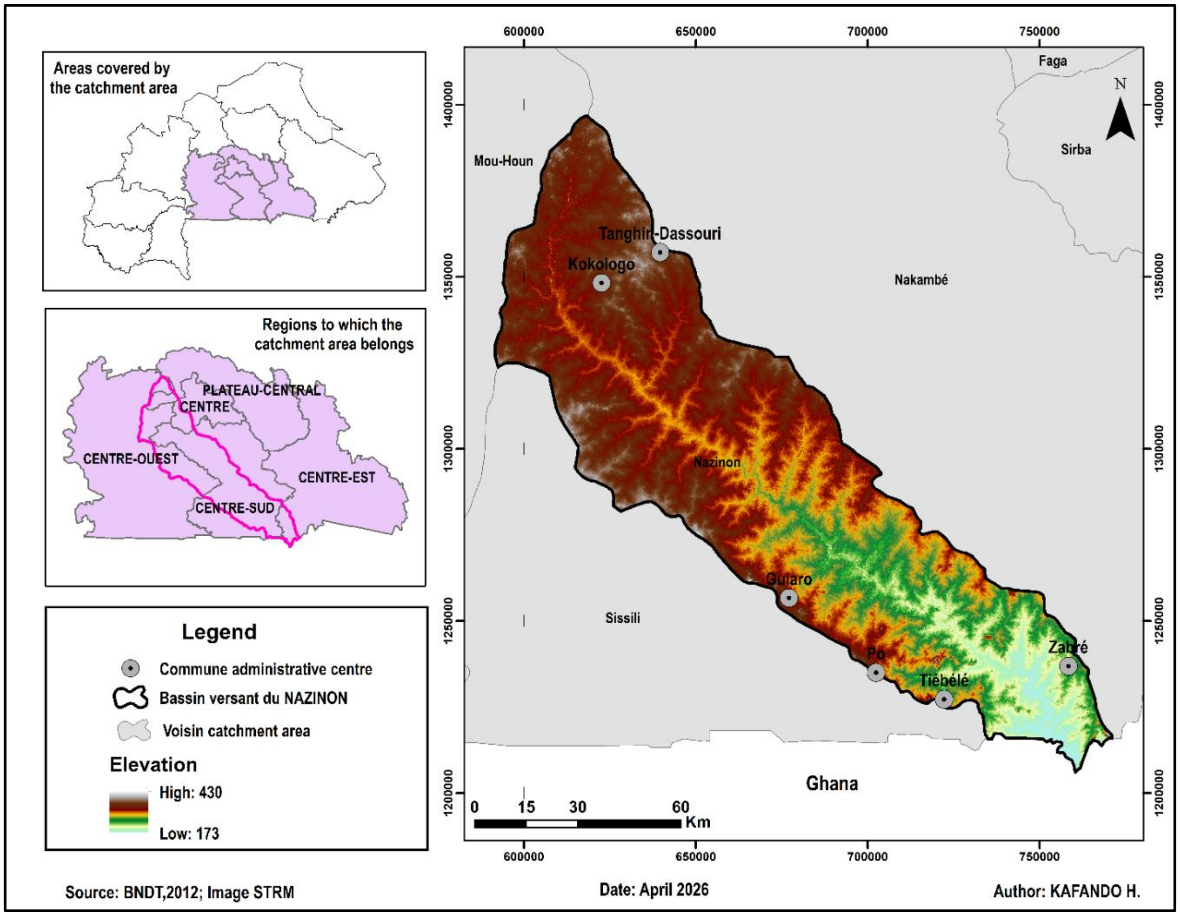

Figure 1: study Area

2.2. Satellite Data Acquisition

A total of 12 Landsat scenes were used for 2006, 88 scenes for 2015 and 82 scenes for 2025. All images were selected during the peak vegetation season (August–October) with less than 10% cloud cover. The scenes cover three overlapping Path/Row footprints (195/052, 195/053, 196/052) ensuring full spatial coverage of the Nazinon Watershed

2.3. Image Preprocessing

To ensure temporal consistency across Landsat sensors (TM, ETM+, OLI), Collection 2 Surface Reflectance products were used and inter-sensor harmonization was applied following standardized radiometric normalization procedures (Wulder et al., 2019)(Roy et al., 2014). These products are already atmospherically corrected and radiometrically calibrated, reducing differences between sensors. In addition, QA_PIXEL bands were used to mask clouds, cloud shadows, snow and saturated pixels. Spectral consistency was ensured by using sensor-specific

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NDVI band configurations (TM/ETM+: Band 4–3; OLI/OLI-2: Band 5–4). All images were resampled to a common spatial resolution of 30 m to ensure comparability across time. No additional empirical cross-calibration was required due to the harmonized nature of Landsat Collection 2 products.

2.4. NDVI Calculation

Vegetation cover was assessed using the Normalized Difference Vegetation Index (NDVI), widely used to measure vegetation density and vigor. NDVI is computed using the following formula:

$$NDVI = (NIR - RED) / (NIR + RED)$$

where:

- **NIR** represents near-infrared reflectance;
- **RED** represents red visible reflectance.

The calculation of NDVI requires the appropriate selection of spectral bands corresponding to the near-infrared (NIR) and red regions of the electromagnetic spectrum. The specific band configurations differ slightly across Landsat sensors, as summarized in Table 1.

Table 1: Spectral Bands Used for NDVI Calculation from Landsat Sensors

Satellite	NIR	Red
Landsat 5 TM	Band 4	Band 3
Landsat 7 ETM+	Band 4	Band 3
Landsat 8/9 OLI	Band 5	Band 4

The NDVI ranges from -1 to +1, with higher values indicating dense and healthy vegetation. The NDVI maps obtained for 2006, 2015 and 2025 were stacked to analyze spatiotemporal changes in vegetation cover in the Nazinon watershed. NDVI values were classified into five vegetation density classes based on standard threshold ranges commonly used in semi-arid environments: water/bare soil or no vegetation (< 0.00), bare soil/urban areas (0.00–0.10), sparse vegetation (0.10–0.20), moderate vegetation (0.20–0.30) and dense vegetation (> 0.30).

2.5. Processing Tools

The processing was carried out in a GIS and remote sensing environment using:

- Google Earth Engine for Landsat image acquisition and automated processing;
- QGIS for cartographic analysis; statistical software for temporal trend analysis.

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This methodological approach made it possible to characterize the spatiotemporal changes in vegetation cover in the Nazinon watershed based on three selected years (2006, 2015 and 2025).

3. RESULTS

3.1 Vegetation Cover Distribution in 2006

The NDVI map of 2006 (figure 2) shows a heterogeneous distribution of vegetation cover across the Nazinon Watershed. NDVI values range from -0.13 to 0.37, with a mean value of 0.14. Areas characterized by low NDVI values are widely distributed throughout the watershed, while moderate and relatively high NDVI values are concentrated in specific locations.

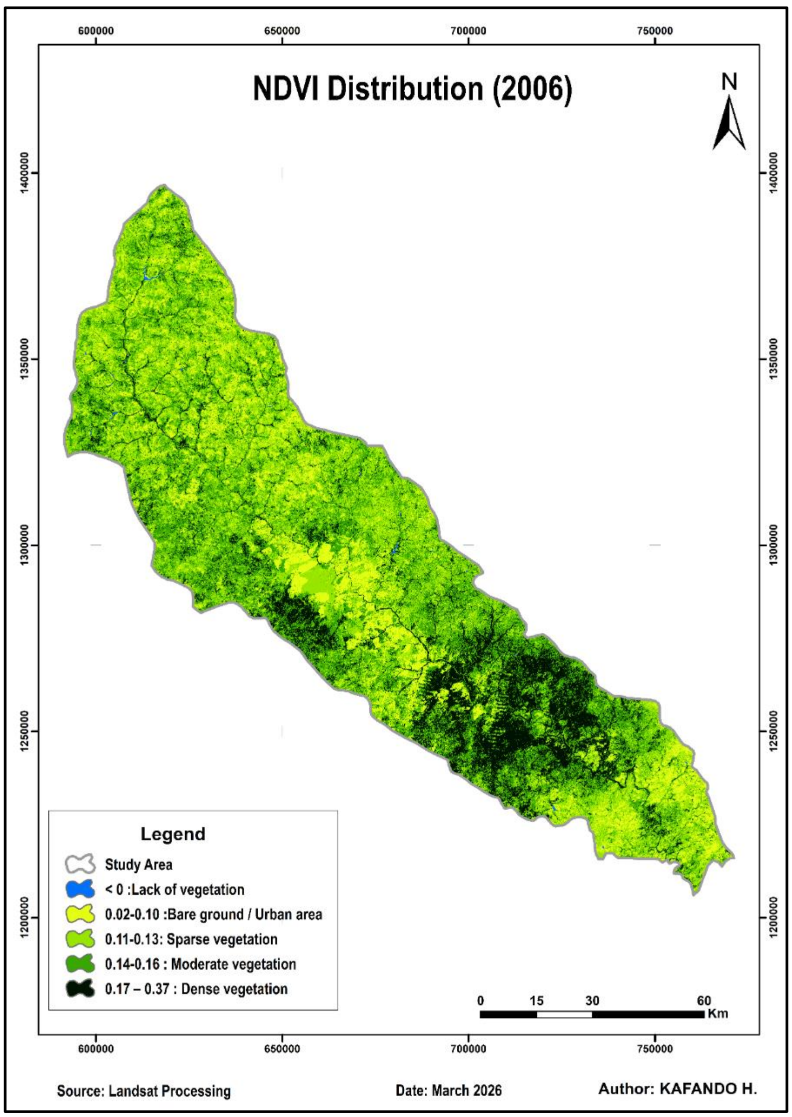

Figure 2: Vegetation status of the Nazinon catchment area in 2006

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The histogram of NDVI (figure 3) values indicates the predominance of low to moderate vegetation cover classes. The spatial distribution suggests that vegetation density was generally limited over large portions of the watershed during the study year.

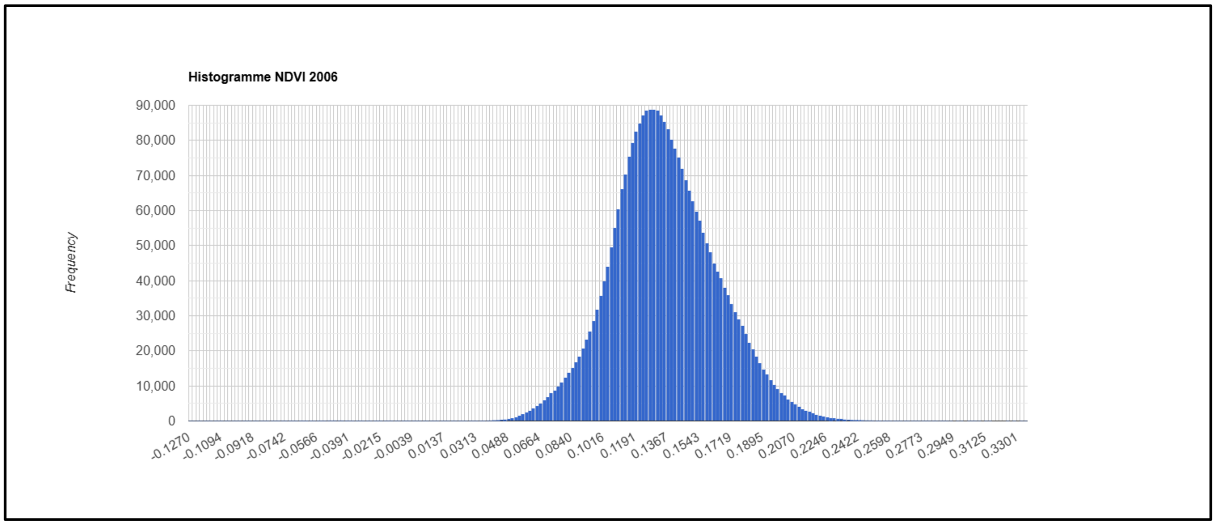

Figure 3: Histogram showing changes in vegetation in 2006

3.2 Vegetation Cover Distribution in 2015

The NDVI map of 2015 (figure 4) reveals changes in the spatial distribution of vegetation compared with 2006. NDVI values vary between -0.15 and 0.37, with an average value of 0.16. Areas exhibiting moderate NDVI values appear more extensive than in 2006.

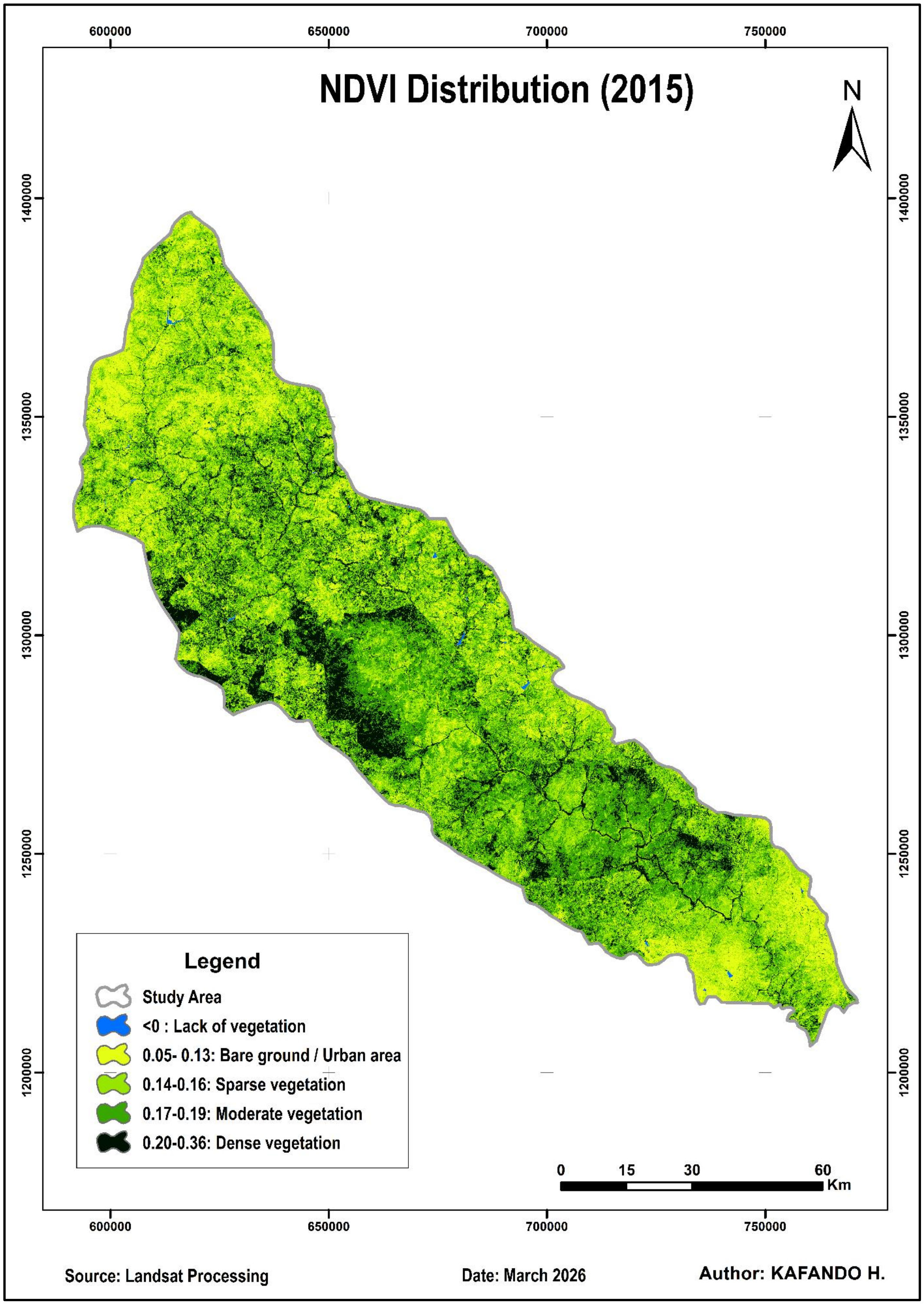

Figure 4: Vegetation status of the Nazinon catchment area in 2015

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The histogram (figure 5) confirms a slight increase in vegetation cover classes associated with moderate NDVI values. The overall distribution of NDVI values indicates an increase in average vegetation conditions across the watershed.

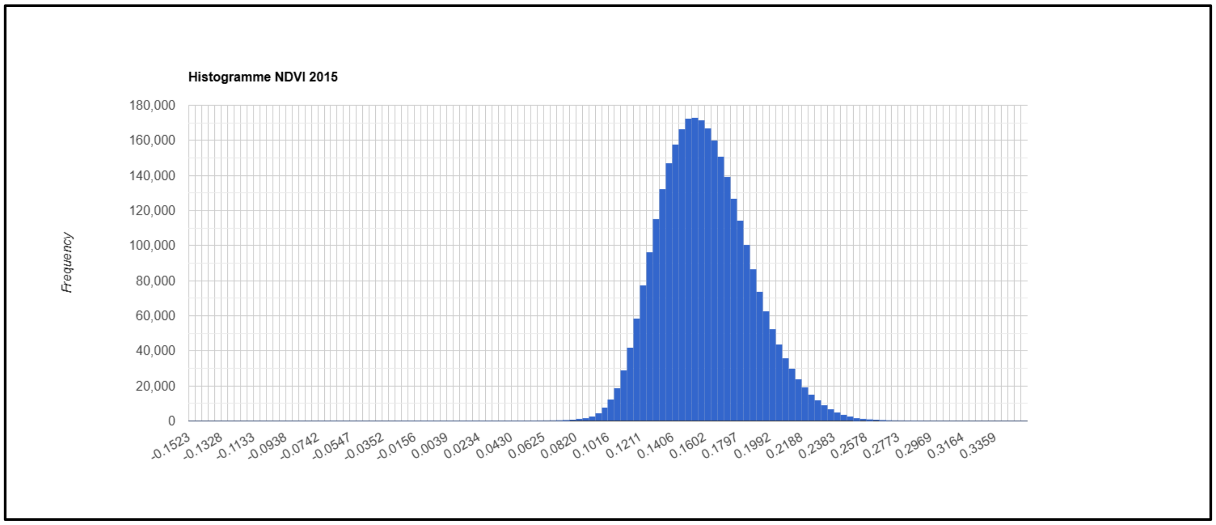

Figure 5: Histogram showing changes in vegetation in 2015

3.3 Vegetation Cover Distribution in 2025

The NDVI map of 2025 (figure 6) shows further changes in vegetation cover patterns within the watershed. NDVI values range from -0.24 to 0.40, while the mean NDVI reaches 0.18. Areas with relatively high NDVI values become more visible in several parts of the watershed.

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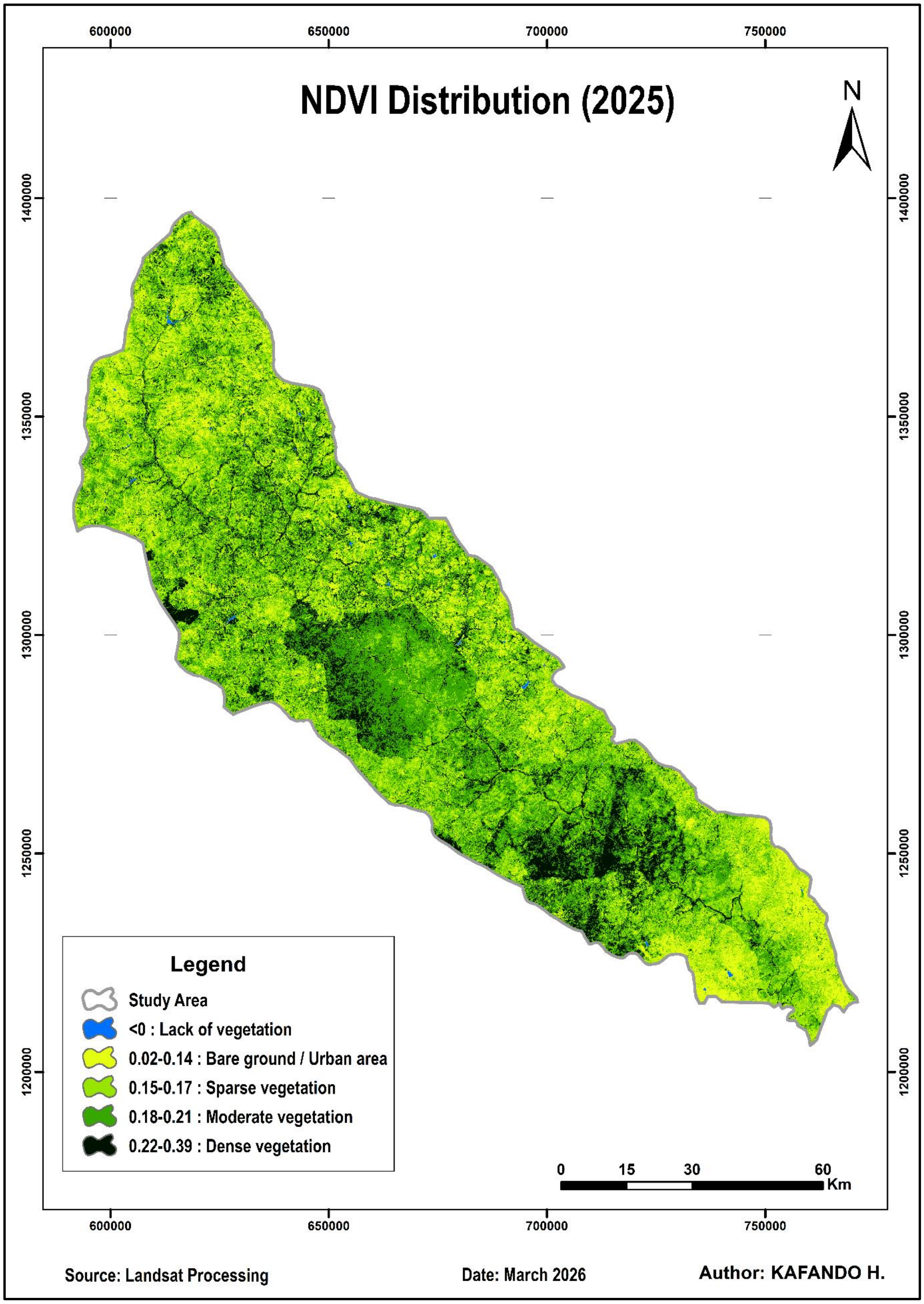

Figure 6: Vegetation status of the Nazinon catchment area in 2025

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The corresponding histogram (figure 7) highlights an increase in higher NDVI classes compared with previous years. At the same time, very low NDVI values are also observed, resulting in a wider NDVI range in 2025.

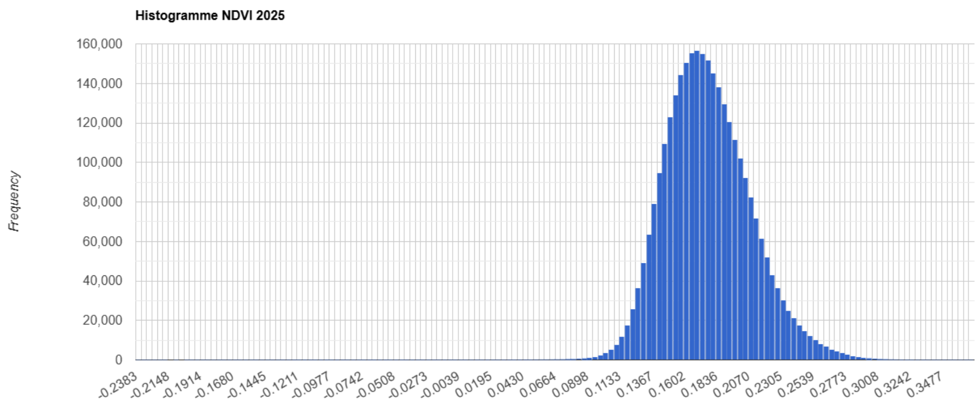

Figure 7: Histogram showing changes in vegetation in 2025

3.4 Spatio-Temporal NDVI Trends (2006-2025)

The statistical analysis of NDVI reveals notable temporal variations between 2006 and 2025 (Figure 8).

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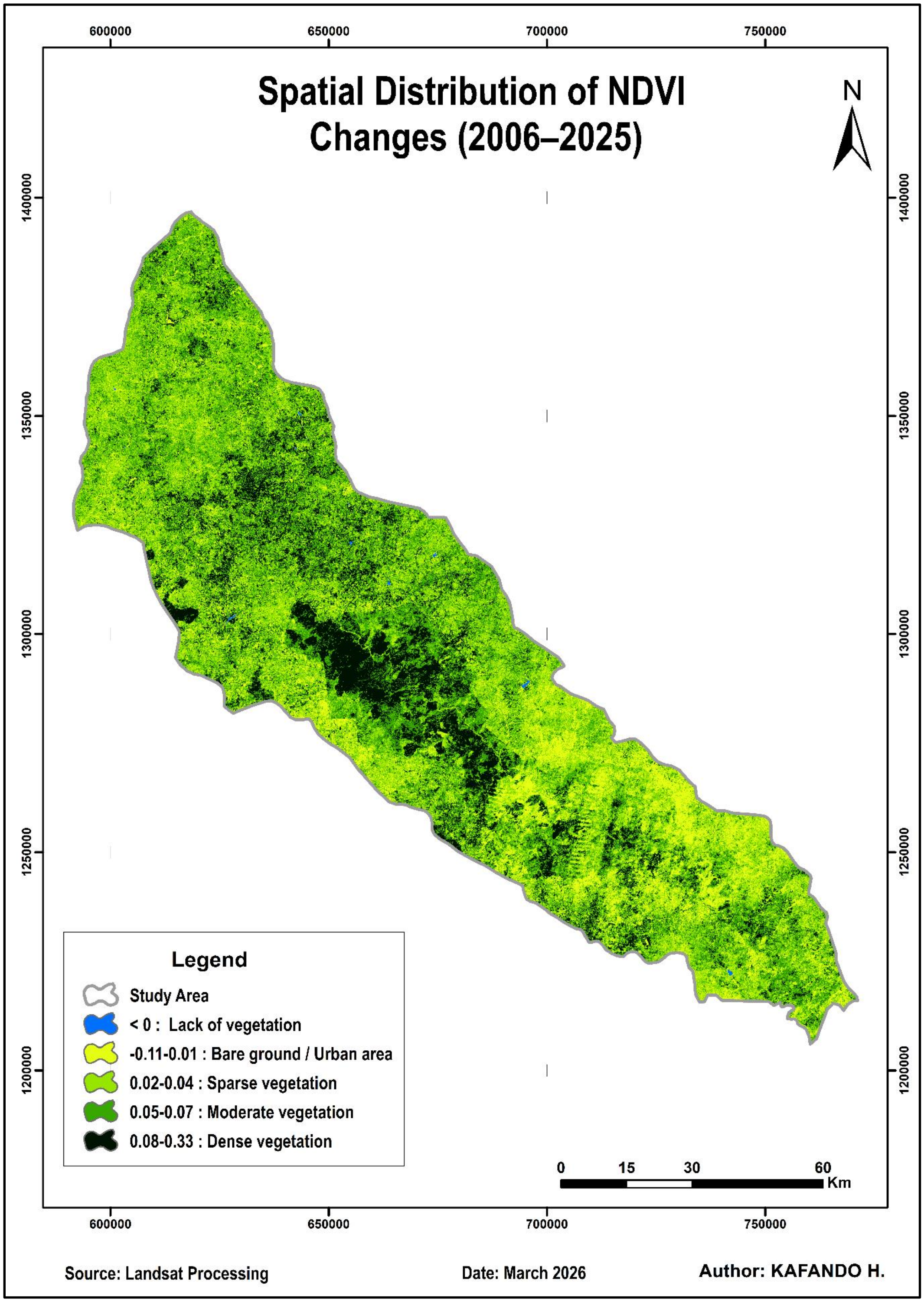

Figure 8: Temporal evolution of NDVI statistical indicators (2006–2025)

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The mean NDVI increased progressively from 0.14 in 2006 to 0.16 in 2015 and 0.18 in 2025. Similarly, the maximum NDVI remained stable at 0.37 between 2006 and 2015 before increasing to 0.40 in 2025. In contrast, the minimum NDVI decreased from -0.13 in 2006 to -0.15 in 2015 and further to -0.24 in 2025 (table 2).

Table 2: NDVI statistical indicators for the Nazinon Watershed for 2006, 2015, 2025

NDVI_max	NDVI_mean	NDVI_min	NDVI_stdDev	Year
0.37	0.14	-0.13	0.03	2006
0.37	0.16	-0.15	0.03	2015
0.40	0.18	-0.24	0.03	2025

The NDVI standard deviation remained constant at 0.03 throughout the study period. The temporal trend analysis therefore indicates an increase in mean and maximum NDVI values over time, accompanied by a decrease in minimum NDVI values. These changes are illustrated in figure 8, which summarizes the evolution of NDVI statistical indicators across the study period.

4. DISCUSSIONS

The analysis of NDVI dynamics between 2006 and 2025 reveals heterogeneous vegetation trajectories within the Nazinon Watershed, characterized by the coexistence of weak greening signals and localized degradation. The observed increase in mean NDVI from 0.14 to 0.18 suggests a gradual improvement in vegetation greenness at the watershed scale, while the concurrent decline in minimum NDVI values (from -0.13 to -0.24) indicates the persistence and possible intensification of degraded or non-vegetated surfaces. This dual pattern reflects the spatially fragmented nature of land surface processes in semi-arid environments, where ecological responses are rarely uniform across space.

At the regional scale, the increasing NDVI trend is broadly consistent with the long-term greening signal documented across the West African Sahel. Previous studies based on multi-decadal satellite observations have reported widespread vegetation recovery following the drought period of the 1970s–1980s, driven by partial rainfall recovery and ecosystem resilience mechanisms (Zeng et al., 2024), (Alikhanova et al., 2025). Large-scale syntheses further highlight that this greening signal is non-linear and spatially heterogeneous, with strong local variability embedded within regional averages (Tian et al., 2016),(Brandt et al., 2017),. The trend observed in the Nazinon Watershed therefore fits within this broader Sahelian context, while also reflecting local-scale environmental controls.

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The slight increase in maximum NDVI (from 0.37 to 0.40) suggests enhanced vegetation density in specific favorable zones, potentially linked to localized regeneration processes, agricultural intensification in productive areas, or improved moisture availability. Such patterns are commonly observed in Sahelian landscapes where vegetation recovery is not uniform but concentrated in ecologically favorable or human-managed areas (Hänke et al., 2016). These localized increases likely contribute disproportionately to the positive shift in mean NDVI.

Conversely, the decrease in minimum NDVI values highlights the persistence of highly degraded surfaces, which may be associated with bare soils, overexploited land, seasonal water bodies, or areas of intense human pressure. Similar low-value expansions have been reported in West African drylands under increasing land-use pressure, including agricultural expansion, fuelwood extraction and overgrazing (Aka et al., 2023), (Zeng et al., 2024). This indicates that while partial vegetation recovery is occurring, degradation processes remain active and spatially concentrated.

The coexistence of greening and degradation signals underscores the non-stationary and spatially decoupled nature of vegetation dynamics in dryland systems. Rather than a uniform trend, the Nazinon Watershed exhibits a mosaic structure of land surface change, where gains and losses occur simultaneously across short spatial distances. Similar patterns of spatial divergence between regional greening and local degradation have been widely documented in West African drylands (B. J. B. Zoungrana et al., 2018) (Sheng & Huang, 2025), reinforcing the importance of fine-scale analysis when interpreting NDVI trends.

The stability of the NDVI standard deviation throughout the study period further suggests that overall spatial heterogeneity has remained relatively constant. This implies that vegetation gains have not been widespread enough to significantly alter the distributional structure of NDVI across the watershed. Instead, opposing processes of greening and degradation appear to balance each other at the landscape scale, maintaining a stable variance over time. Overall, these results highlight that vegetation dynamics in the Nazinon Watershed are driven by interacting climatic and anthropogenic controls operating at different spatial scales. While regional climatic recovery may explain part of the greening signal, local land-use pressures likely account for persistent degradation hotspots. Future research integrating high-resolution land-use data, rainfall variability and socio-economic drivers would be necessary to fully disentangle these mechanisms and improve predictive understanding of vegetation dynamics in semi-arid West Africa.

5. CONCLUSION

This study investigated the spatiotemporal dynamics of vegetation cover in the Nazinon Watershed, Burkina Faso, using Landsat-derived NDVI time series spanning the period 2006-2025. The integration of remote sensing data and GIS techniques provided valuable insights into long-term vegetation changes across the watershed.

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The results revealed significant temporal variations in vegetation conditions over the study period. Mean NDVI values increased from 0.14 in 2006 to 0.18 in 2025, indicating an overall improvement in vegetation cover. Similarly, maximum NDVI values exhibited a slight increase, suggesting enhanced vegetation vigor and biomass accumulation in certain areas. However, minimum NDVI values declined substantially, from -0.13 to -0.24, highlighting the persistence of localized degradation processes within the watershed. The stability of the NDVI standard deviation indicates that the spatial variability of vegetation remained relatively constant throughout the study period.

These findings demonstrate that vegetation dynamics in the Nazinon Watershed are characterized by a dual pattern of change. While some areas experienced vegetation recovery and improved ecological conditions, other locations continued to exhibit signs of degradation. This spatial heterogeneity underscores the complexity of environmental change in semi-arid ecosystems and highlights the importance of local-scale assessments for understanding landscape dynamics.

The study confirms the usefulness of Landsat NDVI time series as an effective tool for monitoring vegetation cover changes and assessing ecosystem conditions over long periods. The generated information can support environmental monitoring, watershed management and land restoration initiatives aimed at improving ecosystem resilience and sustainable resource use. Future research should integrate climatic variables, land-use and land-cover change data and socio-economic indicators to better understand the underlying drivers of vegetation dynamics in the Nazinon Watershed. Such multidisciplinary approaches would contribute to more effective environmental management strategies and informed decision-making in the context of increasing climatic and anthropogenic pressures in Burkina Faso and the wider West African region.

REFERENCES

[1]. Aka, K. S. R., Akpavi, S., & Dibi, N. D. H. (2023). Toward understanding land use land cover changes and their effects on land surface temperature in yam production area , Côte d ’ Ivoire , Gontougo Region , using remote sensing and machine learning tools (Google Earth Engine). August, 1–22. https://doi.org/10.3389/frsen.2023.1221757

[2]. Alikhanova, S., Tarantino, C., & Bull, J. W. (2025). Tracking Vegetation Dynamics in Drylands with MSAVI: Insights from the South Aral Sea. Earth Systems and Environment, 1687–1699. https://doi.org/10.1007/s41748-025-00705-z

[3]. Almalki, R., Khaki, M., Saco, P. M., & Rodriguez, J. F. (2022). Monitoring and Mapping Vegetation Cover Changes in Arid and Semi-Arid Areas Using Remote Sensing Technology: A Review. Remote Sensing, 14(20). https://doi.org/10.3390/rs14205143

[4]. Bamba, A., Dieppois, B., Konaré, A., Pellarin, T., Balogun, A., Dessay, N., Kamagaté, B., Savané, I., & Diédhiou, A. (2015). Changes in Vegetation and Rainfall over West Africa during the Last Three Decades (1981-2010). Atmospheric and Climate Sciences, 05(04),

367–379. https://doi.org/10.4236/acs.2015.54028

[5]. Brandt, M., Rasmussen, K., Peñuelas, J., Tian, F., Schurgers, G., Verger, A., Mertz, O., Palmer, J. R. B., & Fensholt, R. (2017). Human population growth offsets climate-driven increase in woody vegetation in sub-Saharan Africa. Nature Ecology and Evolution, 1(4), 4–9. https://doi.org/10.1038/s41559-017-0081

[6]. Frappart, F., Wigneron, J. P., Li, X., Liu, X., Al-Yaari, A., Fan, L., Wang, M., Moisy, C., Le Masson, E., Lafkih, Z. A., Vallé, C., Ygorra, B., & Baghdadi, N. (2020). Global monitoring of the vegetation dynamics from the vegetation optical depth (VOD): A review. Remote Sensing, 12(18), 7–10. https://doi.org/10.3390/RS12182915

[7]. Hänke, H., Börjeson, L., Hylander, K., & Enfors-kautsky, E. (2016). Land Use Policy Drought tolerant species dominate as rainfall and tree cover returns in the West African Sahel. Land Use Policy, 59, 111–120. https://doi.org/10.1016/j.landusepol.2016.08.023

[8]. Ibrahim, Y. Z., Balzter, H., Kaduk, J., & Tucker, C. J. (2015). Land degradation assessment using residual trend analysis of GIMMS NDVI3g, soil moisture and rainfall in Sub-Saharan West Africa from 1982 to 2012. Remote Sensing, 7(5), 5471–5494. https://doi.org/10.3390/rs70505471

[9]. Kumar, B. P., Babu, K. R., Anusha, B. N., & Rajasekhar, M. (2022). Geo-environmental monitoring and assessment of land degradation and desertification in the semi-arid regions using Landsat 8 OLI / TIRS, LST and NDVI approach. Environmental Challenges, 8(June). https://doi.org/10.1016/j.envc.2022.100578

[10]. Liu, S., Wang, B., Zhang, J., Cai, D., Tian, G., & Zhang, G. (2016). Predicting the Seasonal NDVI Change by GIS Geostatistical Analyst and Study on Driver Factors of NDVI Change in Hainan Island, China. Journal of Geoscience and Environment Protection, 04(06), 92–100. https://doi.org/10.4236/gep.2016.46008

[11]. Mabula, E. L., Fan, Y., & Semgomba, D. S. (2025). Interannual Variability of the NDVI in East Africa during 1983-2022 and the Climate Impact. Journal of Geoscience and Environment Protection, 13(01), 260–291. https://doi.org/10.4236/gep.2025.131014

[12]. Roy, D. P., Wulder, M. A., Loveland, T. R., Woodcock, C. E., Allen, R. G., Anderson, M. C., Helder, D., Irons, J. R., Johnson, D. M., Kennedy, R., Scambos, T. A., Schaaf, C. B., Schott, J. R., Sheng, Y., Vermote, E. F., Belward, A. S., Bindschadler, R., Cohen, W. B., Gao, F., … Zhu, Z. (2014). Remote Sensing of Environment Landsat-8 : Science and product vision for terrestrial global change research. Remote Sensing of Environment, 145, 154–172. https://doi.org/10.1016/j.rse.2014.02.001

[13]. Sheng, S., & Huang, J. (2025). Urban expansion and the loss of potential crop yield in the North China Plain : implications for regional food security (1980 –. May, 1–13. https://doi.org/10.3389/fsufs.2025.1545907

[14]. Tian, F., Brandt, M., Liu, Y. Y., Verger, A., Tagesson, T., Diouf, A. A., Rasmussen, K.,

Mbow, C., Wang, Y., & Fensholt, R. (2016). Remote sensing of vegetation dynamics in drylands: Evaluating vegetation optical depth (VOD) using AVHRR NDVI and in situ green biomass data over West African Sahel. Remote Sensing of Environment, 177, 265–276. https://doi.org/10.1016/j.rse.2016.02.056

[15]. Wulder, M. A., Loveland, T. R., Roy, D. P., Crawford, C. J., Masek, G., Woodcock, C. E., Allen, R. G., Anderson, M. C., Belward, A. S., Cohen, W. B., Dwyer, J., Erb, A., Gao, F., Gri, P., Helder, D., Hermosilla, T., Hipple, J. D., Hostert, P., Hughes, M. J., … Zhu, Z. (2019). Remote Sensing of Environment Current status of Landsat program , science and applications. 225(March), 127–147. https://doi.org/10.1016/j.rse.2019.02.015

[16]. Zeng, Y., Jia, L., Menenti, M., Jiang, M., Zheng, C., Bennour, A., & Lv, Y. (2024). Regional divergent evolution of vegetation greenness and climatic drivers in the Sahel-Sudan-Guinea region: nonlinearity and explainable machine learning. Frontiers in Forests and Global Change, 7(May), 1–18. https://doi.org/10.3389/ffgc.2024.1416373

[17]. Zoungrana, B. J.-B., & Dimobé, K. (2023). NDVI-Derived Vegetation Trends and Driving Factors in West African Sudanian Savanna. American Journal of Plant Sciences, 14(10), 1130–1145. https://doi.org/10.4236/ajps.2023.1410077

[18]. Zoungrana, B. J. B., Conrad, C., Thiel, M., Amekudzi, L. K., & Da, E. D. (2018). MODIS NDVI trends and fractional land cover change for improved assessments of vegetation degradation in Burkina Faso, West Africa. Journal of Arid Environments, 153(September 2017), 66–75. https://doi.org/10.1016/j.jaridenv.2018.01.005

