A Quarterly Newsletter of **Odisha Forestry Sector Development Project,** Phase-II OCT - DEC , 2024, VOL-8, ISSUE-3

From Project Director's Desk

Odisha Forestry Sector Development Project Phase II aims to enhance forest ecosystems and promote sustainable livelihoods for local communities by strengthening sustainable forest management, conserving biodiversity, and fostering community development. The project seeks to achieve a balance between environmental conservation and socio-economic development in the project areas across Odisha, ensuring long-term ecological sustainability and improved quality of life for forest-dependent communities. For improving the quality of life for these forest fringe communities the project strives to provide numerous income augmentation opportunities.

During last quarter, community members of OFSDP-II along with Ama Jangala Yojana and OFSDS-OMBADC participated in the 17th State level Kalinga Herbal Fair -2024-25. The platform offered an unique opportunity for the project VSSs and SHGs to sale herbal products, non-timber-based forest produces (NTFPs) and showcase their project activities while augmenting their income substantially during the fair. In this year's Herbal Fair, the community members of the respective VSSs and SHGs doubled their business as compared to that of last year. Total turnover of the 13 stalls allotted to OFSDS for business rose up to twenty lakhs rupees, which is a remarkable achievement. Our focus on augmenting income generating activities (IGAs) through convergence and disbursement of Revolving Fund in project VSSs are reflection of the growing businesses opportunities in different forum. It is due to this collective effort of all the Divisions, OFSDS stall was awarded as the Best Stall in Government segment with maximum participation and maximum business from forest fringe communities for the fifth consecutive time.

Apart from this the issue also incorporates, a comprehensive analytical report on long-term vegetation trends in Badrama and Bhitarkanika Wildlife Sanctuaries, two ecologically significant protected areas in Odisha. The findings of this report are expected to contribute to evidence-based conservation strategies to ensure the long-term sustainability of these biodiverse sanctuaries.

Dr Meeta Biswal, IFS
PCCF (Projects) & Project Director
OFSDS

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"What we are doing to the forests of the world is but a mirror reflection of what we are doing to ourselves and to one another"

COVER STORY

17TH STATE LEVEL KALINGA HERBAL FAIR- 2024

OFSDS PARTICIPATED IN 17th STATE LEVEL KALINGA HERBAL FAIR 2024-25

Awarded as the Best Stall in Government segment with maximum participation from VSSs and SHGs represented by forest fringe communities for the Fifth consecutive time.

The Odisha Forestry Sector Development Society (OFSDS) participated in the 17th State Level Kalinga Herbal Fair 2024-25 organized by Odisha State Medicinal Plant Board for seven days from 6th November to 12th November 2024 at IDCO Exhibition Ground, Bhubaneswar. The exhibition-cum-sale counters in the Herbal Fair were put up by the seventeen Territorial Forest Divisions under OFSDP-II, AJY and OMBADC projects of Odisha Forestry Sector Development Society (OFSDS). The OFSDS stall was inaugurated by Shri Ganesh Ram Singh Khuntia, Hon'ble Minister, Forest, Environment & Climate Change Dept., Govt of Odisha in presence of Shri Satyabrata Sahu, IAS, Additional Chief Secretary, Shri Debidutta Biswal,IFS, PCCF & HoFF and Dr. Meeta Biswal, IFS, PCCF (Projects) & Project Director, OFSDS.

Along with the sale of herbal products, the OFSDS stalls ensured the display of project activities and achievements in the exhibition. As many as 22 Self Help Groups from 17 Forest Divisions functioning under OFSDP-II and Ama Jangala Yojana participated in the exhibition. Total 54 participants from the VSS and SHG members representing the Forest Divisions of OFSDP- II viz. Athamallik, Baripada, Boudh, Ghumusur – South, Ghumusur – North, Rairangpur, Jharsguda, Sundargarh and Dhenkanal and Forest Divisions of AJY viz. Keonjhar, Rourkela, Bonai, Khariar, Angul, Baliguda, Phulbani and rayagada under OFSDS took active part in the Herbal Fair during the seven days' exhibition.

Honble Minister, FE& CC inaugurating OFSDS stall at 17th State Level Kalinga Herbal Fair 2024 in the presence of ACS, FE&CC, PCCF & HoFF & PCCF(Projects) & PD, OFSDS on 6th November 2024.

This was the fifth consecutive time, the VSS/SHG members of OFSDP, Phase-II and AJY participated in the State Level Kalinga Herbal Fair. This fair has special focus on harnessing natural environment with a thrust on herbal and organic products and health care activities. The VSSs/SHGs were chosen based on the NTFP and herbal product-based clusters which were promoted actively by OFSDS for the participation in the fair.

The exhibition paved the way for maximization of resource augmentation and livelihood earnings of these community stakeholders. A special millet-based food stall was also put up by the SHGs of Ghumusur North Division which became most popular among the visitors of the fair.

Hon'ble Minister, Senior Officials and Guests visiting OFSDS stall at 17th State Level Kalinga Herbal Fair 2024

After the inauguration of the OFSDS stalls in the herbal fair, Dr. Meeta Biswal, IFS, PCCF(Projects) and Project Director, OFSDS PD, OFSDS led the minister and other dignitaries for the visit to different stalls put up by the SHGs and VSSs operating under OFSDP-II, AJY and OFSDS-OMBADC projects. The SHG/VSS members apprised the visitors about the process adopted from the product & resource mobilization to product packaging by the community groups with the guidance and support of project staff and the personnel of PNGOs. The visiting dignitaries, including the Hon'ble Minister, ACS, PCCF & HoFF and the PD, OFSDS encouraged the SHG members to utilize this exhibition as a platform to augment their livelihood options by selling their herbal and organic produces under the patronage of OFSDS.

A large segment of public visited the OFSDS stall to purchase their preferred products. The SHGs ensured availability of different types of products in varied categories viz. health care, wellness, grocery products, natural and forest products etc. The forest fringe community groups sold record number of products in this Mela and the overall sale was very encouraging to the participants and all stakeholders. The stalls generated business of Rs. 20,03,350/- from the sale of products during the seven days of exhibition.

Participating SHG members and VSS members represented by OFSDP-II and AJY at OFSDS Stall at 17th State Level Kalinga Herbal Fair 2024

GLIMPSES OF 17TH STATE LEVEL KALINGA HERBAL FAIR – 2024

SPECIAL ANALYTICAL REPORT

Monitoring Vegetation Trends in Odisha's Wildlife Sanctuaries Using MODIS EVI and Cloud Computing – A case study in Badrama Wildlife Sanctuary and Bhitarkanika Wildlife Sanctuary.

ABSTRACT

Monitoring forest vegetation dynamics is crucial for assessing ecosystem health and guiding conservation efforts. In order to monitor vegetation dynamics this study employs Google Earth Engine (GEE) to analyze long-term vegetation trends in Badrama and Bhitarkanika Wildlife Sanctuaries, two ecologically significant protected areas in Odisha, India. These are the 2 protected areas where activities under Odisha Forestry Sector Development Project – II are being currently implemented. Using the Enhanced Vegetation Index (EVI) from the MOD13Q1.061 dataset of MODIS, the changes in vegetation condition from 2000 to 2024 was examined. Time-series analysis and spatial mapping techniques were applied to detect trends and seasonal variations in forest health. The study highlights the influence of climatic variability and anthropogenic pressures on vegetation cover. Results provide insights into forest resilience and degradation patterns, supporting sustainable management practices. By leveraging cloud-based geospatial analysis, this study demonstrates the potential of GEE for efficient, large-scale environmental monitoring. Findings contribute to evidence-based conservation strategies, ensuring the long-term sustainability of these biodiverse sanctuaries.

INTRODUCTION

Forests are essential components of the Earth's biosphere, providing critical ecosystem services such as carbon sequestration, climate regulation, biodiversity conservation and livelihood support for millions of people. Monitoring forest vegetation dynamics is crucial for understanding ecological changes, assessing environmental impacts and formulating effective conservation strategies. Remote sensing technologies have revolutionized forest monitoring by offering consistent, long-term and large-scale observations of vegetation conditions. Among the various remote sensing approaches, vegetation indices derived from satellite imagery serve as reliable indicators of forest health, productivity and disturbances over time.

With the advancement of cloud computing and big data analytics, platforms like Google Earth Engine (GEE) have become powerful tools for large-scale environmental monitoring. GEE provides access to a vast archive of satellite datasets, including imagery from the Moderate Resolution Imaging Spectroradiometer (MODIS) and Landsat missions, which are widely used for vegetation analysis. The Enhanced Vegetation Index (EVI), derived from MODIS imagery, is particularly effective for monitoring vegetation dynamics due to its improved sensitivity to dense vegetation, reduced atmospheric influence and minimized soil background effects compared to the traditional Normalized Difference Vegetation Index (NDVI). The MOD13Q1.061 dataset provides 16-day composite EVI data at a 250-meter spatial resolution, making it well-suited for long-term vegetation studies.

India's forests, particularly those within protected areas, face growing challenges from climate change, habitat fragmentation and anthropogenic pressures. This study focuses on Badrama Wildlife Sanctuary and Bhitarkanika Wildlife Sanctuary, two ecologically significant protected areas located in the state of Odisha.

Badrama Wildlife Sanctuary, located in the Eastern Ghats, is dominated by tropical dry deciduous forests and is home to diverse fauna, including elephants, leopards and deer. This forested region is highly sensitive to climate variability and land-use changes. Bhitarkanika Wildlife Sanctuary, a Ramsar-listed wetland ecosystem, comprises extensive mangrove forests, estuarine habitats and intertidal zones. It serves as a critical breeding ground for saltwater crocodiles, migratory birds and several endangered species. The sanctuary is particularly vulnerable to sea-level rise, cyclones and human encroachments, making long-term vegetation monitoring essential for conservation planning.

The primary objective of this study is to assess spatiotemporal changes in vegetation health across Badrama and Bhitarkanika Wildlife Sanctuaries over a 24-year period (2000–2024) using MODIS EVI data in GEE. Specifically, the study aims to:

1. Analyze seasonal and interannual variations in vegetation indices to identify trends in forest health.

2. Map spatial patterns of vegetation change to detect areas of degradation, recovery or stability.

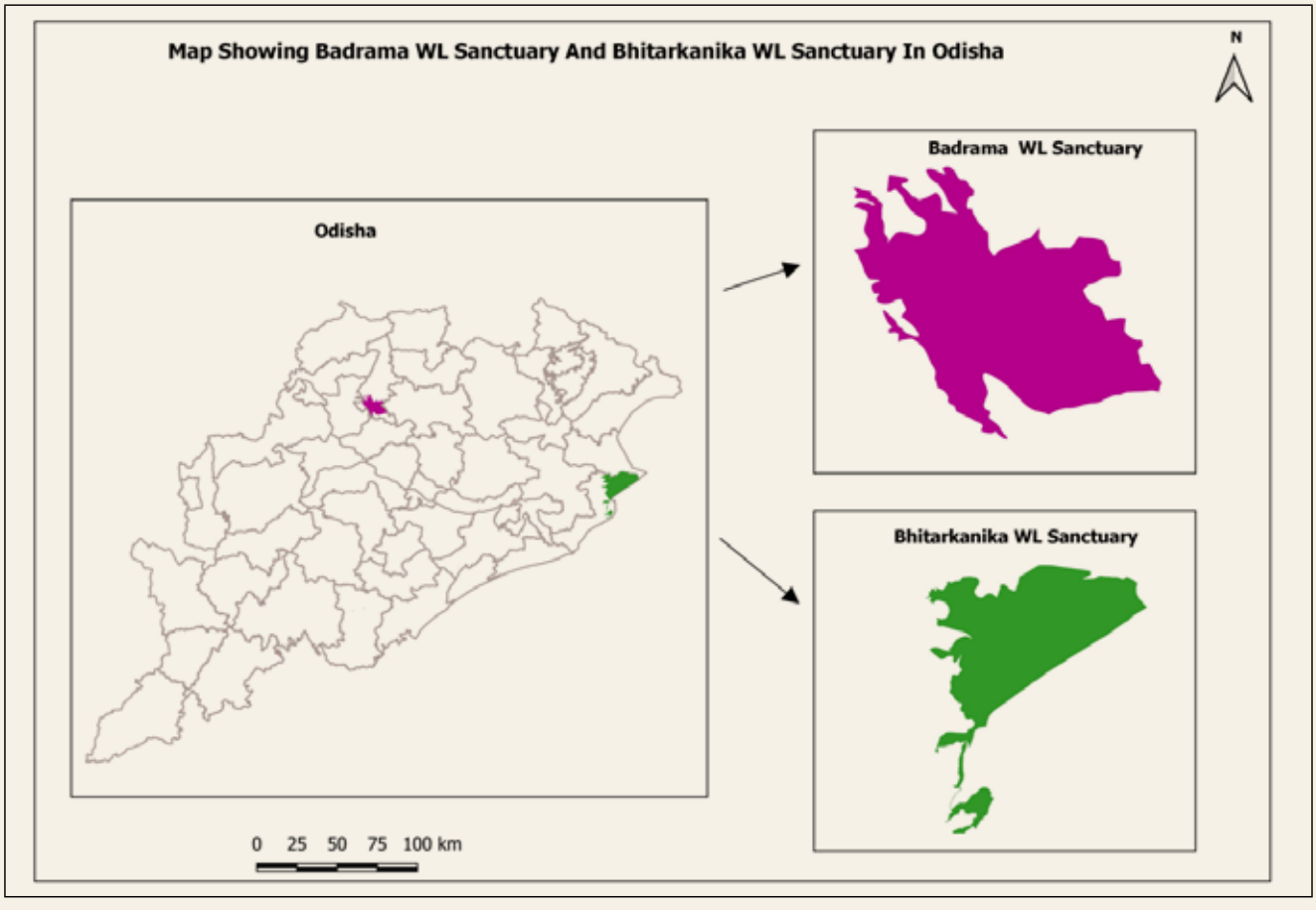
By utilizing the computational power of GEE, this study presents an efficient and scalable approach to long-term forest monitoring. The findings will provide valuable insights into vegetation resilience, degradation patterns and the overall health of Odisha's two important protected areas, aiding policymakers and conservationists in making informed decisions. Furthermore, this study contributes to the growing body of knowledge on using cloud-based geospatial tools for sustainable forest management and biodiversity conservation.

METHODOLOGY

Study Area

This study focuses on two ecologically significant protected areas in the state of Odisha, India: Badrama Wildlife Sanctuary and Bhitarkanika Wildlife Sanctuary. These two sanctuaries represent distinct forest ecosystems—one comprising tropical dry deciduous forests in a hilly terrain and the other consisting of mangrove forests in a coastal environment. Their unique biodiversity, ecological significance and vulnerability to climatic and anthropogenic disturbances make them ideal sites for long-term vegetation monitoring. The map showing the location of Badrama Wildlife Sanctuary and Bhitarkanika Wildlife Sanctuary is shown in the following Figure 1

Figure 1:
Location of Badrama Wildlife Sanctuary and Bhitarkanika Wildlife Sanctuary



Badrama Wildlife Sanctuary:

Badrama Wildlife Sanctuary, also known as Ushakothi Wildlife Sanctuary, is situated in Sambalpur district of western Odisha, covering an area of 304.03 square kilometers. It lies between approximately 21°21′ to 21°34′ N latitude and 84°12′ to 84°28′ E longitude. The sanctuary is characterized by undulating terrain with hill ranges belonging to the Eastern Ghats and is drained by the Badrama and Jharjhari rivers. The sanctuary comprises of parts of Badrama Reserve Forests, Ushakothi Reserve Forests, Binjipali Reserve Forests and Additional Kansar Reserve Forests. The Sanctuary is characterized by the presence of Moist Sal Forests, Sal dominated mixed deciduous Forests and bamboo forests. The Sanctuary forms a significant part of Sambalpur Elephant Reserve. Dominant tree species include Sal (Shorea robusta), Asan (Terminalia tomentosa), Dhaura (Anogeissus latifolia), Bahada (Terminalia bellerica) and Mahua (Madhuca indica). The undergrowth includes shrubs and grasses which vary in density depending on soil moisture availability.

Bhitarkanika Wildlife Sanctuary:

Bhitarkanika Wildlife Sanctuary is located in Kendrapara district along the northeastern coast of Odisha, covering 672 square kilometres. It lies between 20°30′ to 20°50′ N latitude and 86°30′ to 87°06′ E longitude. Bhitarkanika is part of the Mahanadi delta system and is crisscrossed by a network of tidal rivers, estuaries and creeks making it one of the largest mangrove ecosystems in India. It was designated a Ramsar Wetland of International Importance in 2002 due to its rich biodiversity and critical ecological functions.

The vegetation is dominated by mangrove forests. These mangroves provide crucial ecosystem services, including coastal protection, carbon sequestration and breeding habitats for marine life.

Data Source

Remotely sensed indices such as enhanced vegetation index (EVI), normalized difference vegetation index (NDVI) and normalized difference water index (NDWI) are widely used to estimate vegetation status from satellite imagery. EVI and NDVI estimate vegetation chlorophyll content while NDWI estimates vegetation moisture content. All these indices can be derived from free public imagery of satellites like Landsat and MODIS, available in the Earth Engine data catalogue. This study uses MODIS EVI data from the MOD13Q1.061 dataset for the period from year 2000 to 2024.

The MOD13Q1 V6.1 product provides a Vegetation Index (VI) value at a per pixel basis. There are two primary vegetation layers. The first is the Normalized Difference Vegetation Index (NDVI) which is referred to as the continuity index to the existing National Oceanic and Atmospheric Administration-Advanced Very High Resolution Radiometer (NOAA-AVHRR) derived NDVI. The second vegetation layer is the Enhanced Vegetation Index (EVI) that minimizes canopy background variations and maintains sensitivity over dense vegetation conditions. The EVI also uses the blue band to remove residual atmosphere contamination caused by smoke and sub-pixel thin cloud clouds. The MODIS NDVI and EVI products are computed from atmospherically corrected bi-directional surface reflectances that have been masked for water, clouds, heavy aerosols and cloud shadows.

Approach

The MODIS 250m/pixel 16-day composite vegetation indices dataset was imported into the code editor. The boundaries of the Badrama Wildlife Sanctuary and Bhitarkanika Wildlife sanctuary were uploaded in the form of shape files. MODIS images for summer months i.e. during the period from March to June in each year were filtered. The annual summertime composites were then computed. An image collection with an image for each year from 2000 to 2024 was built. Each of these images was calculated to be the maximum EVI in the summer months of its corresponding year. This is the measure of the status of the vegetation for each year in the area of study. Also, the year as a band was added, in preparation for linear trend analysis.

A linear trend was estimated at each pixel by calculating its Sen's slope of maximum summer EVI with time. Histograms of the regression slope values for each wildlife sanctuary were calculated and visualized. Pixel-wise vegetation greening or browning based on the sign of the slope value was inferred. Summary of areas under greening and browning for each sanctuary was then calculated. The areas of vegetation greening and browning for each wildlife sanctuary was tabulated as shown in Table 1. Suitable visualization parameters were chosen and the slope values were displayed on the map to denote areas under greening and browning, along with the wildlife sanctuary boundaries.

Results and discussion

The spatial representation of vegetation condition have been shown for both Badrama Wildlife Sanctuary and Bhitarkanika Wildlife Sanctuary in Figure 2 and 3 respectively. The image shows a pixel-based vegetation analysis, where different shades of green and brown indicate variations in vegetation health. Green pixels represent areas with healthier vegetation. Brown pixels suggest areas experiencing vegetation stress, degradation or sparse vegetation.

Figure 3: : Badrama Wildlife Sanctuary

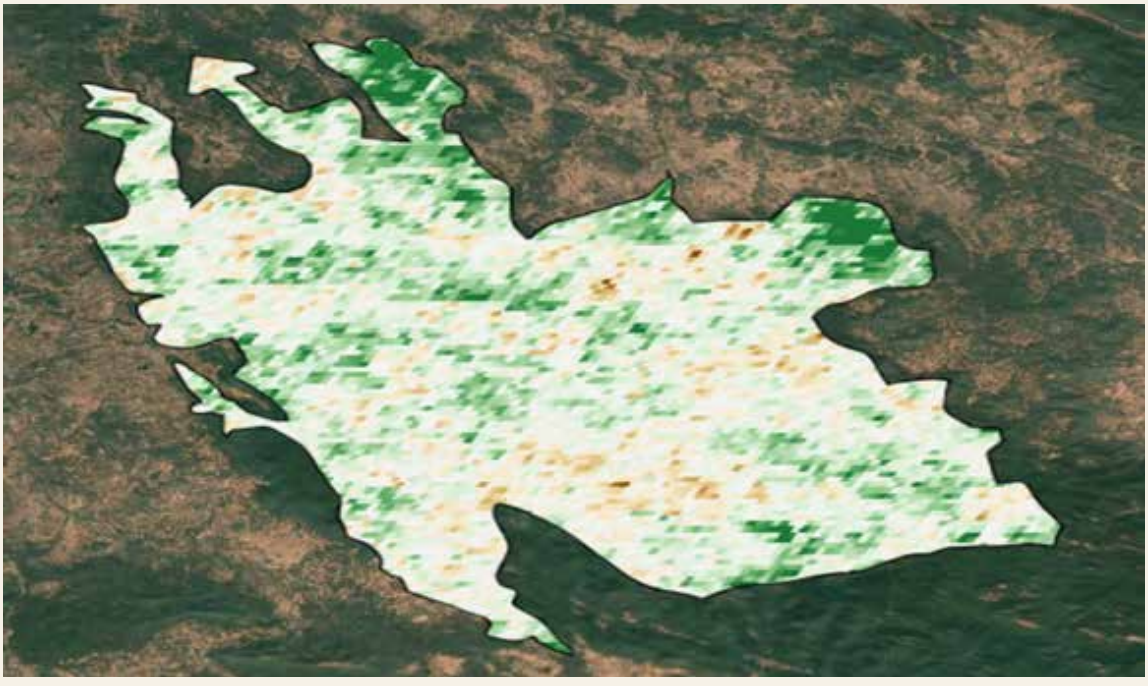
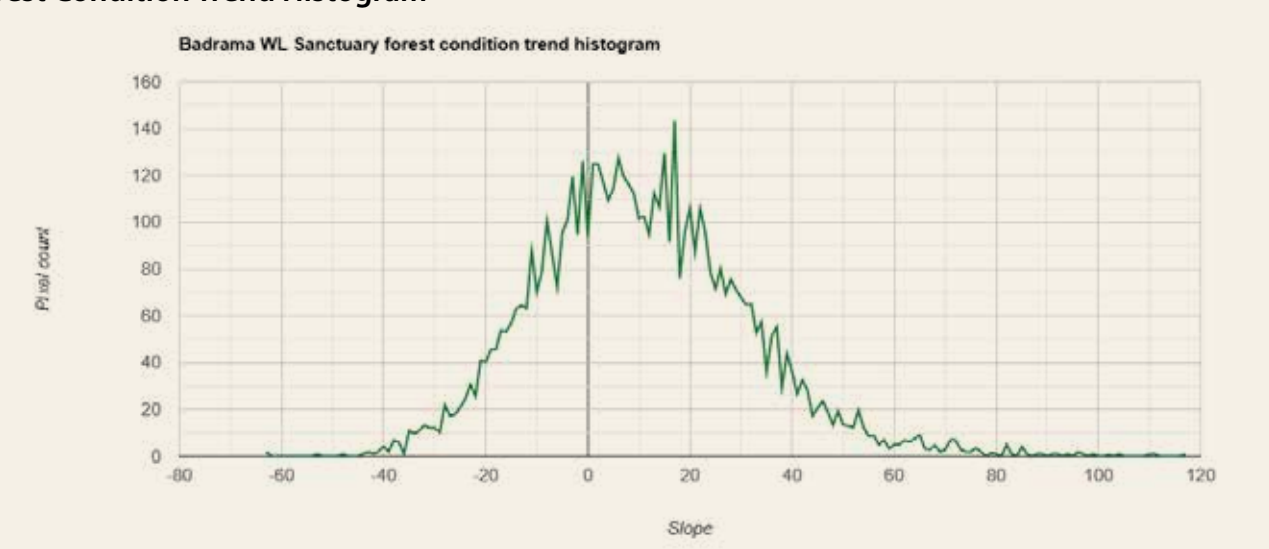


Figure 3: Bhitarkanika Wildlife Sanctuary

Figure 4:
Forest Condition Trend Histogram



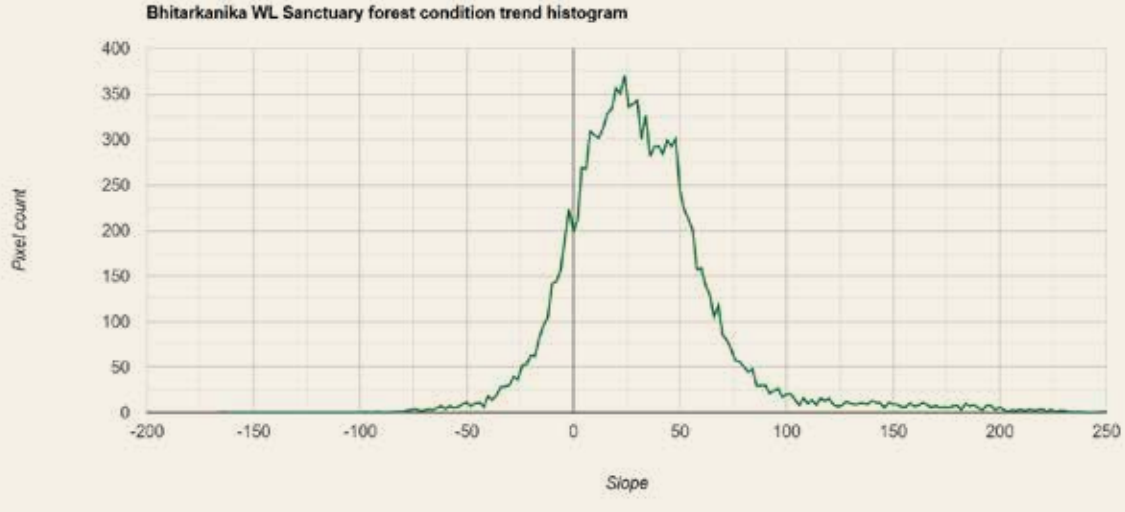
The histogram shown in Figure 4 represents the distribution of slopes derived from the vegetation trend analysis (using MODIS EVI data) for Badrama Wildlife Sanctuary. The x-axis represents the slope values (rate of change in vegetation index over time), while the y-axis indicates the pixel count (number of pixels exhibiting a particular slope value).

A key observation is the predominance of positive slope values i.e. the majority of the pixels exhibit positive slopes, indicating an overall increasing trend in vegetation health (greening trend). The highest concentration of pixel counts is observed between slopes of 0 to 20, suggesting that most of the sanctuary is experiencing moderate forest regrowth or stability.

While there are some pixels with negative slopes (browning trend), their frequency is lower. The presence of pixels with slope values below -20 indicates localized areas experiencing vegetation decline, which could be due to disturbances such as climatic stress, anthropogenic activities or natural degradation. The distribution extends further into higher positive slope values (above 40), though with a lower pixel count. This suggests that certain areas within Badrama are experiencing significant vegetation improvement, possibly due to natural regeneration, afforestation efforts or reduced disturbance.

The histogram confirms that Badrama Wildlife Sanctuary exhibits a net greening trend, with most pixels showing an increasing EVI slope. However, a small proportion of the area shows signs of vegetation decline, which may warrant localized conservation interventions. The overall results suggest that conservation and restoration efforts in Badrama have been largely successful, but continued monitoring is needed to address pockets of degradation.

Figure 5:
Forest Condition Trend Histogram



The histogram shown in Figure 5 represents the distribution of slopes derived from the vegetation trend analysis (using MODIS EVI data) for Bhitarkanika Wildlife Sanctuary. The x-axis here also have a similar interpretation representing the slope values (rate of change in vegetation index over time), while the y-axis indicates the pixel count (number of pixels exhibiting a particular slope value).

A key observation is the dominance of positive slope values. The highest concentration of pixel counts is centered around positive slope values (0 to 50), indicating that most areas in Bhitarkanika are experiencing a positive trend in vegetation health (greening). This suggests stable or improving forest conditions, likely due to mangrove regeneration and conservation efforts.

There is also a limited presence of negative slopes. Some pixels exhibit negative slopes (declining vegetation), but their frequency is relatively low. The presence of slope values below -50 suggests localized degradation, possibly due to tidal erosion, cyclonic impact or anthropogenic disturbances. The right-skewed nature of the histogram indicates that while most pixels show moderate greening, a few areas exhibit higher rates of vegetation improvement (slopes above 100). This could be attributed to active restoration, natural regeneration or favorable hydrological conditions for mangrove growth.

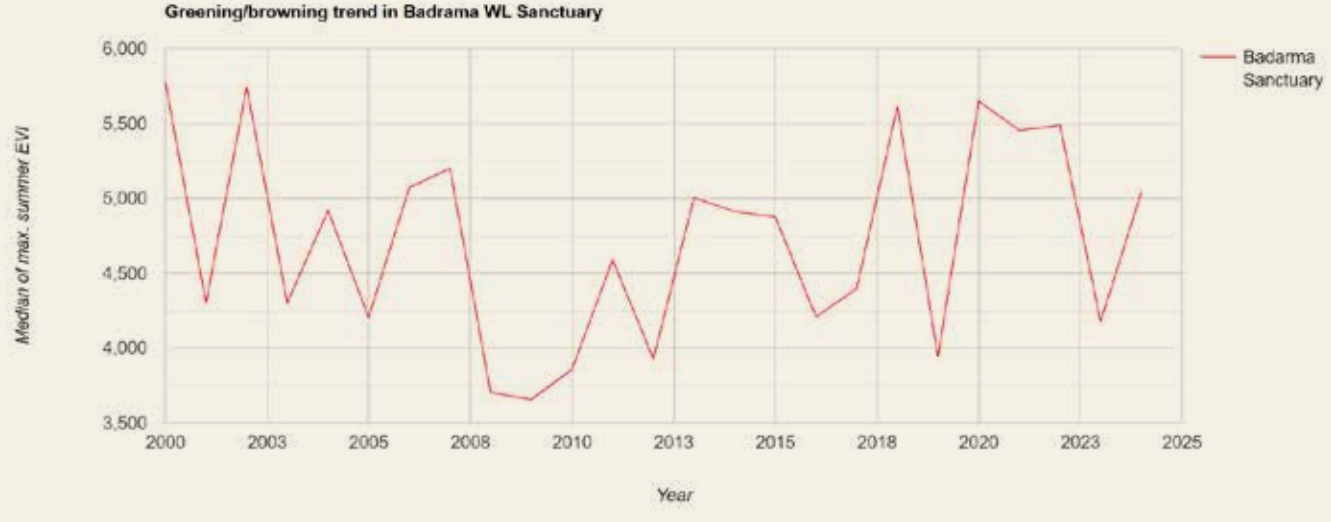
The histogram indicates that Bhitarkanika Wildlife Sanctuary is experiencing a net positive vegetation trend, with most areas showing an increase in EVI values over time. However, there are some localized areas of vegetation loss, which may require further investigation and targeted conservation actions. The overall results suggest that Bhitarkanika's mangrove ecosystem is largely stable and improving, likely benefiting from conservation initiatives and natural ecosystem dynamics.

Table 1: Status of greening and browning areas in Badrama Wildlife Sanctuary and Bhitarkanika Wildlife Sanctuary

Wildlife Sanctuary	Browning Fraction	Browning Sq. Km.	Greening Fraction	Greening Sq. Km.	Total Area
Badrama	0.311	105.889	0.686	233.217	339.106
Bhitarkanika	0.136	98.614	0.842	609.206	707.82

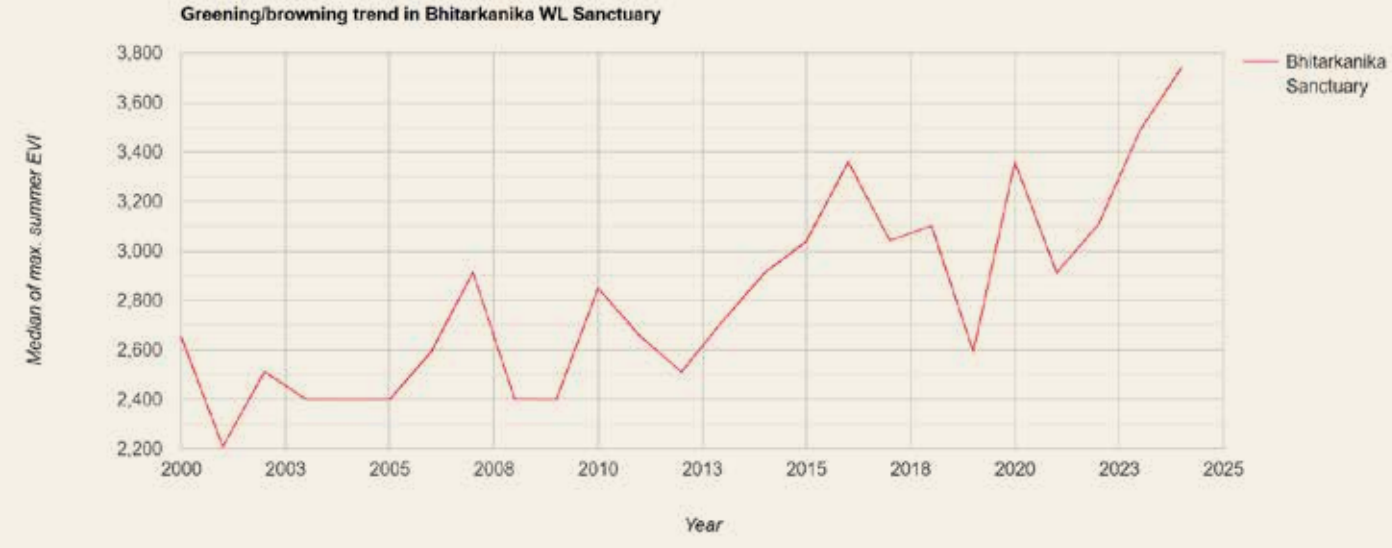
The status of greening and browning areas in Badrama Wildlife Sanctuary and Bhitarkanika Wildlife Sanctuary is shown in the Table 1.

Figure 6:
Greening/Browning trend in Badrama Wildlife Sanctuary



The line graph as shown above depicts the median of maximum summer EVI (Enhanced Vegetation Index) over time (2000–2024) for Badrama Wildlife Sanctuary. The EVI values exhibit significant interannual variation, suggesting climatic or ecological fluctuations affecting vegetation health. The vegetation index does not show a clear increasing or decreasing long-term trend, indicating that forest conditions are dynamic. Certain years (e.g., around 2010 and 2023) show notable declines, which could be linked to drought, extreme weather events, forest degradation or disturbances. These dips may be indicative of climate variability impacts, anthropogenic activities, or natural forest succession cycles. Despite fluctuations, the EVI values consistently return to high levels (~5000-6000), suggesting a resilient forest system capable of recovery after temporary declines. This resilience could be attributed to effective conservation efforts, regeneration or the sanctuary's inherent ecosystem stability. The Badrama Wildlife Sanctuary's forest condition appears stable despite periodic declines in EVI, likely due to climatic factors or temporary disturbances. There is no clear long-term greening or browning trend, but fluctuations highlight the need for continuous monitoring to assess climate-related stressors and ecosystem responses.

Figure 7:
Greening/Browning trend in Bhitarkanika Wildlife Sanctuary



The line graph as shown in Figure 7 represents the median of maximum summer EVI (Enhanced Vegetation Index) from 2000 to 2024 for Bhitarkanika Wildlife Sanctuary, illustrating vegetation changes over time. Unlike Badrama Wildlife Sanctuary, Bhitarkanika shows a gradual increase in EVI over time, suggesting a positive greening trend. This indicates improved vegetation health and productivity in the region. The EVI values were relatively low and fluctuating, with a dip around 2001 and 2009. This period might reflect mangrove degradation, extreme weather events (cyclones, tidal influences) or human disturbances. Post-2010, there is a steady upward trend, reflecting mangrove regrowth, restoration efforts or climate resilience. Peaks in 2016 and 2020 suggest favourable climatic conditions or conservation impacts. A sharp increase is observed from 2021 onwards, reaching the highest values in 2024. This could be due to mangrove expansion, effective conservation policies or reduced disturbances.

Thus Bhitarkanika Wildlife Sanctuary shows a clear greening trend, indicating mangrove forest recovery and improved ecosystem health over the years. The increasing EVI trend highlights successful conservation efforts, natural regeneration and possibly climate-driven changes. However, periodic dips suggest vulnerability to climatic factors (cyclones, sea-level rise) or anthropogenic influences, necessitating continued monitoring and conservation actions.

CONCLUSION

The analysis of the median of maximum summer EVI trends from 2000 to 2024 for Badrama and Bhitarkanika Wildlife Sanctuaries reveals contrasting vegetation dynamics. Badrama Wildlife Sanctuary exhibits a highly fluctuating EVI trend, with no clear long-term increase or decrease. The variability suggests that the forest cover and vegetation health in the region have been influenced by periodic disturbances, climate variability or land-use changes. The absence of a clear greening or browning trend highlights the need for further investigation into forest management practices, fire occurrences and seasonal climate influences.

Bhitarkanika Wildlife Sanctuary, in contrast, demonstrates a clear positive greening trend, with a gradual and consistent increase in EVI over time. The early years (2000–2010) exhibited fluctuations, but from 2010 onwards, a steady rise in vegetation health is evident. This suggests successful mangrove conservation, restoration initiatives and natural regeneration. However, occasional dips indicate potential vulnerability to cyclones, tidal variations, or other environmental stressors.

The fluctuating trend in Badrama warrants further monitoring, particularly focusing on forest fires, human disturbances and climate-induced stress factors. The positive greening in Bhitarkanika highlights effective conservation efforts, yet continued monitoring is necessary to assess resilience against extreme weather events and rising sea levels. Both sanctuaries require sustained ecological monitoring using remote sensing and adaptive conservation strategies to mitigate risks and ensure long-term ecosystem stability. Overall, the results underscore the importance of targeted conservation interventions tailored to the specific ecological and climatic conditions of each sanctuary.

conservation and community empowerment coalesce. Its innovative use of geospatial technology and information management systems has illuminated a path toward harmonious coexistence between people and forests. As the world grapples with the pressing need for environmental stewardship and inclusive development, the lessons drawn from the OFSDP serve as a testament to the transformative power of technology, community engagement, and data-driven decision-making. In the years to come, the legacy of the OFSDP will continue to inspire and inform the global discourse on sustainable forestry practices and the pursuit of a more equitable and ecologically resilient future.

References

1. MOD13Q1.061 Terra Vegetation Indices 16-Day Global 250m, https://doi.org/10.5067/MODIS/MOD13Q1.061

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