

LST role in Forest Disturbance in Western Ghats, India

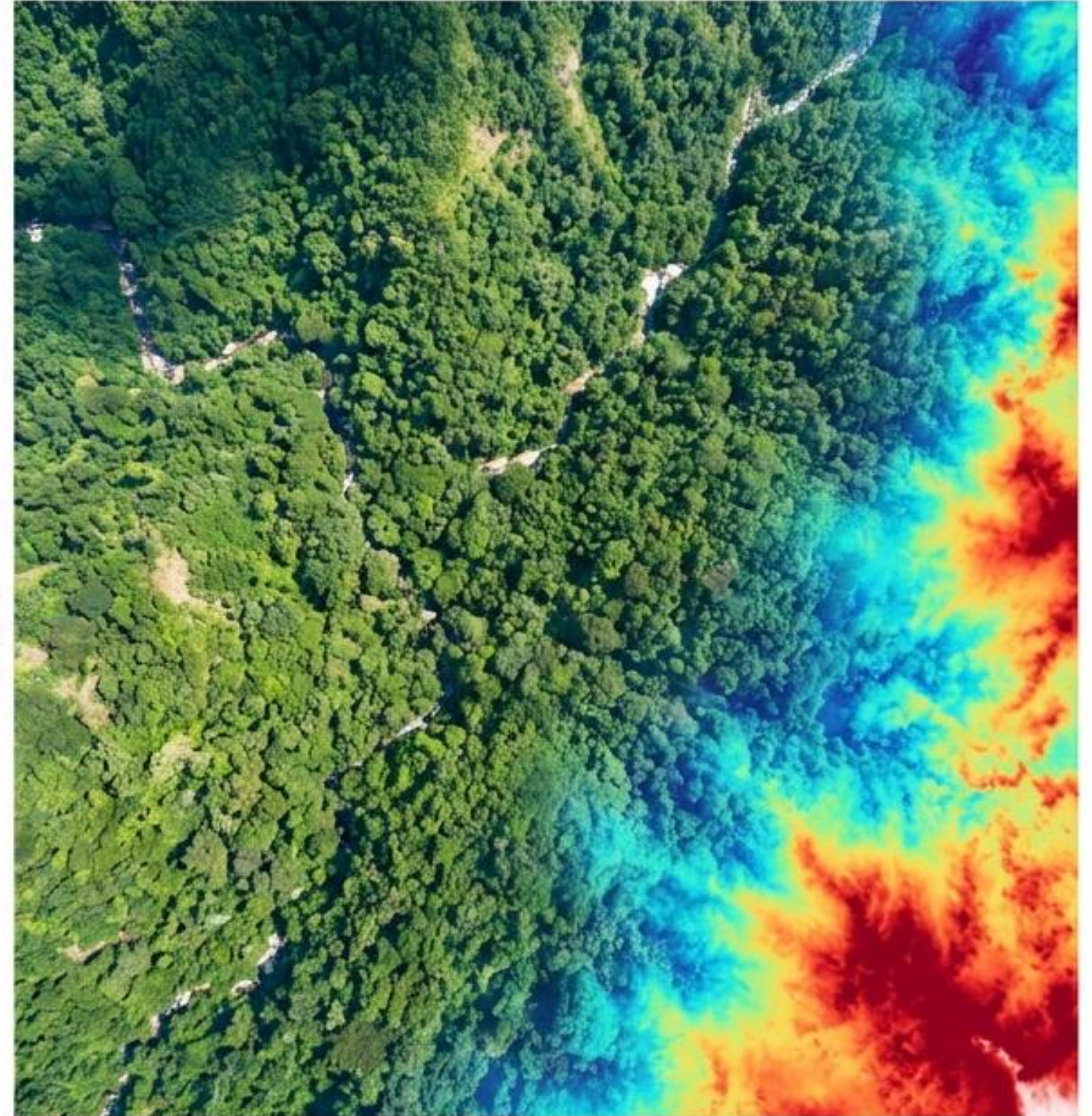
Presented By :

Komal Rai (PhD Scholar , IIT Bombay, India)



The Thermal Pulse: Decoding Forest Disturbance in the Western Ghats

Analyzing 20 years of Land Surface Temperature (LST) anomalies to track ecosystem health, thermal volatility, and climatic whiplash.



EXECUTIVE SUMMARY



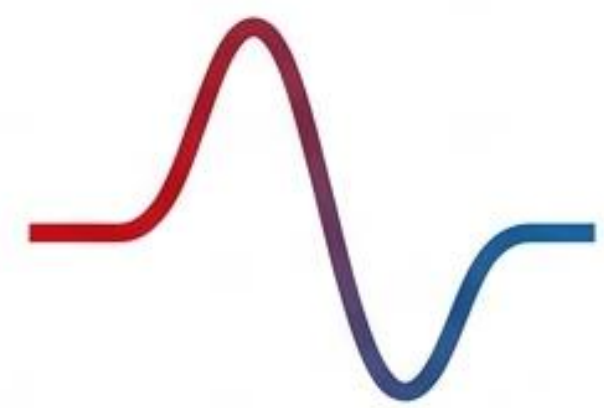
LST as an Ecological Proxy

Land Surface Temperature is highly diagnostic. Variations directly correlate with canopy density, evapotranspiration rates, and localized disturbances like deforestation or fires.



Extreme Topographical Variance

The Western Ghats exhibit radical thermal microclimates, with LST spanning from 20°C in dense, high-altitude Shola forests to 45°C in degraded foothills.



Severe Climatic Whiplash

Macro data from 2002–2024 reveals a complex downward trajectory, punctuated by a drastic shift from extreme thermal stress (2017–2019) to intense, anomaly-driven cooling events (2020–2024) linked to severe monsoons.

Canopy microclimates dictate localized surface temperatures

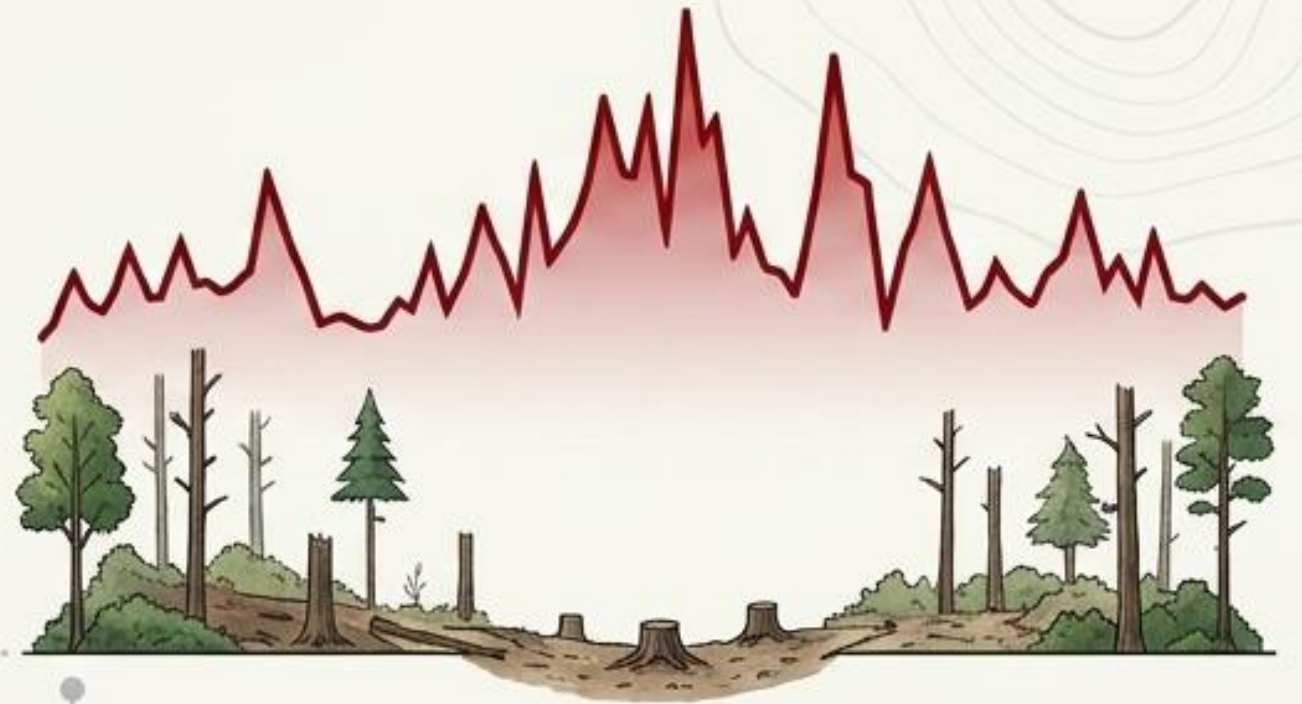
Intact Forest



High Evapotranspiration

Dense canopy cover traps moisture and reflects direct solar radiation, acting as a natural air conditioner. Results in uniformly low LST.

Disturbed Forest



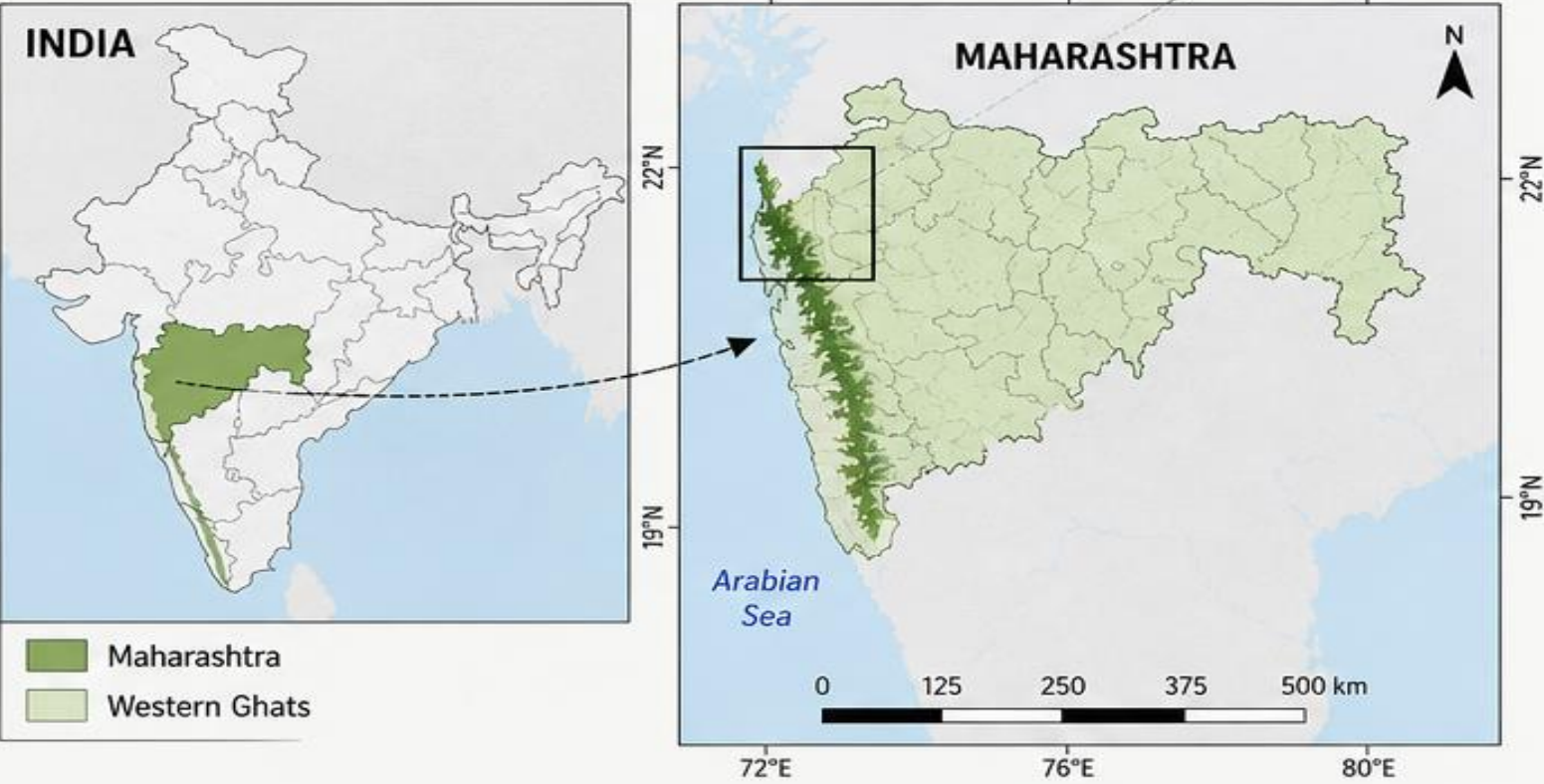
High Solar Absorption

Canopy gaps from logging, fires, or degradation expose the soil. Moisture evaporates rapidly, causing stark, localized spikes in LST.

STUDY AREA

UPPER WESTERN GHATS IN MAHARASHTRA

The study area focuses on the upper part of the Western Ghats within Maharashtra state, a globally recognized biodiversity hotspot. This region is characterized by high rainfall, steep topography and dense evergreen forests, making it ecologically sensitive and vulnerable to disturbance and forest fires.



LOCATION
18°30'–20°30' N
72°30'–74°30' E
Upper Western Ghats, Maharashtra

ELEVATION
~100 – 1500 m
(Steep escarpments and deep valleys)

CLIMATE
Tropical humid
High rainfall (>3000 mm/year in many areas)

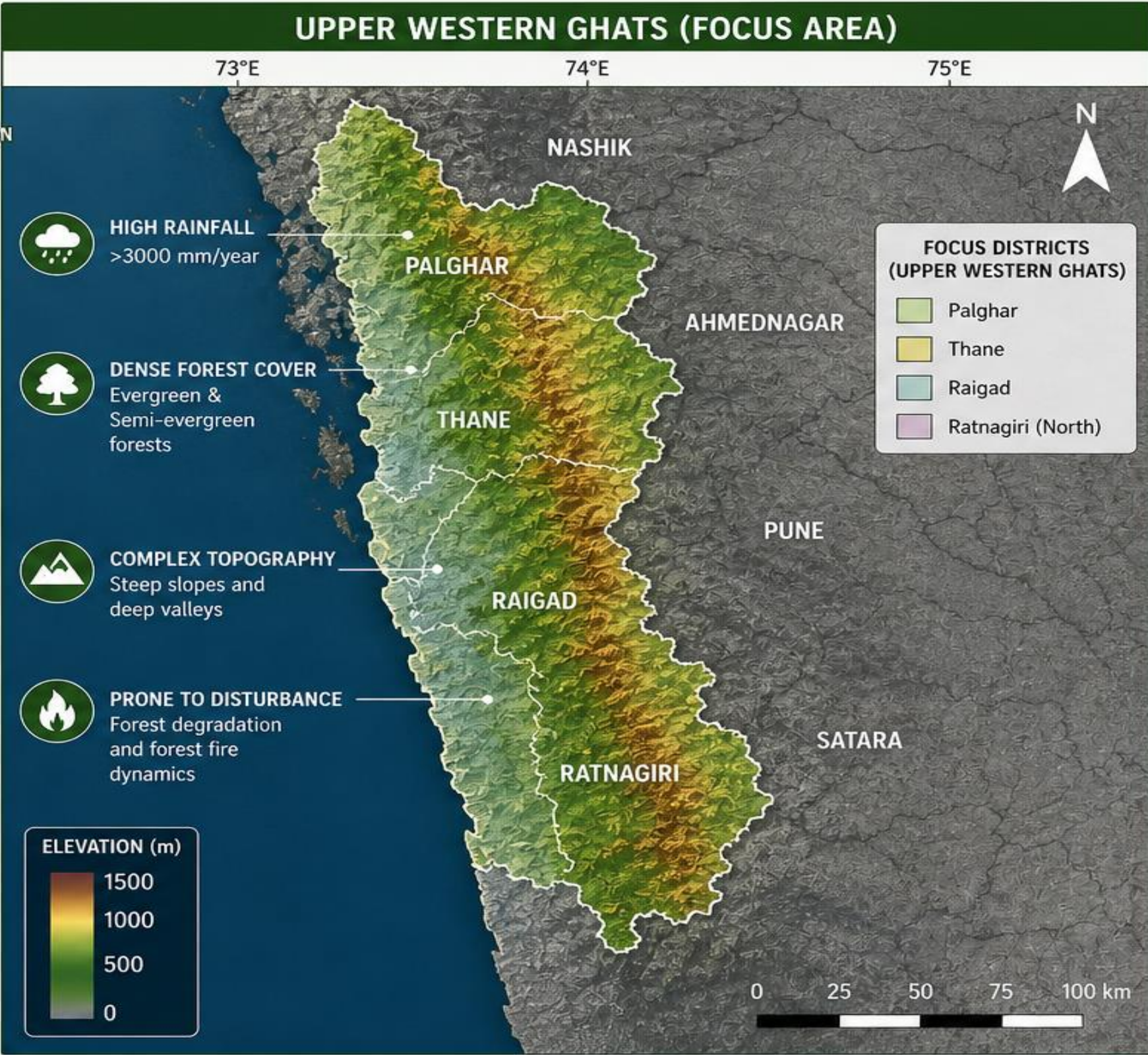
ECOSYSTEM
Tropical evergreen, semi-evergreen and moist deciduous forests
Part of global biodiversity hotspot

RELEVANCE
Highly vulnerable to forest disturbance, degradation and forest fire events

DATA AND PARAMETERS

- NDVI
- NDWI
- LST
- Forest Disturbance Index (FDI)
- Time Period: 2004 – 2024
- Data Sources: Landsat (5, 7, 8, 9)

The Western Ghats are one of the world's most important biodiversity hotspots, supporting unique flora, fauna and vital ecosystem services.



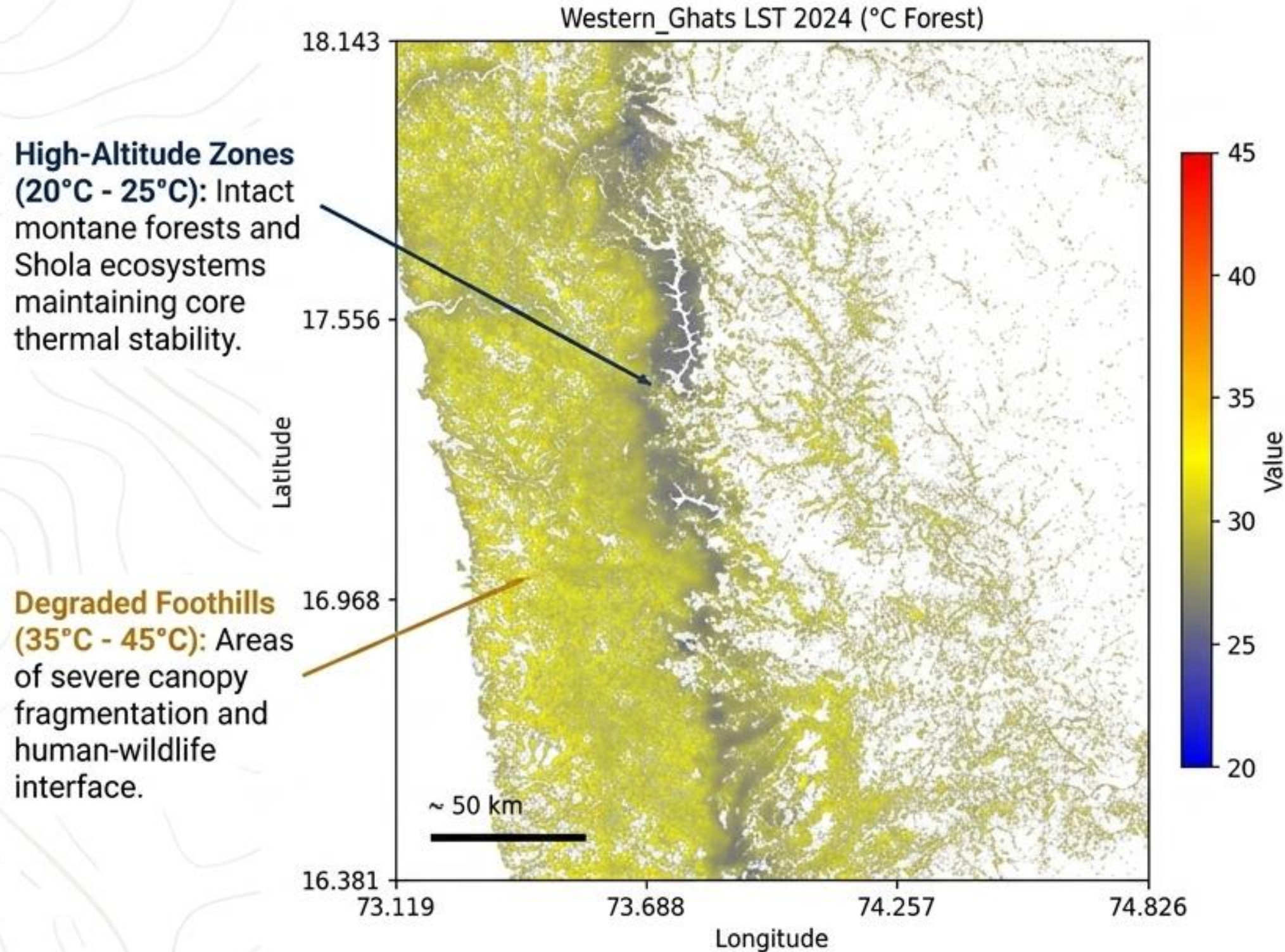
~6,000+ PLANT SPECIES
(Endemic species rich)

~325+ FAUNA SPECIES
(Endemic species rich)

CRITICAL FOR WATER SECURITY
Supports major rivers and water resources

SUPPORTS LOCAL COMMUNITIES
Livelihoods, culture and well-being

Topographical extremes create a fragmented thermal landscape.



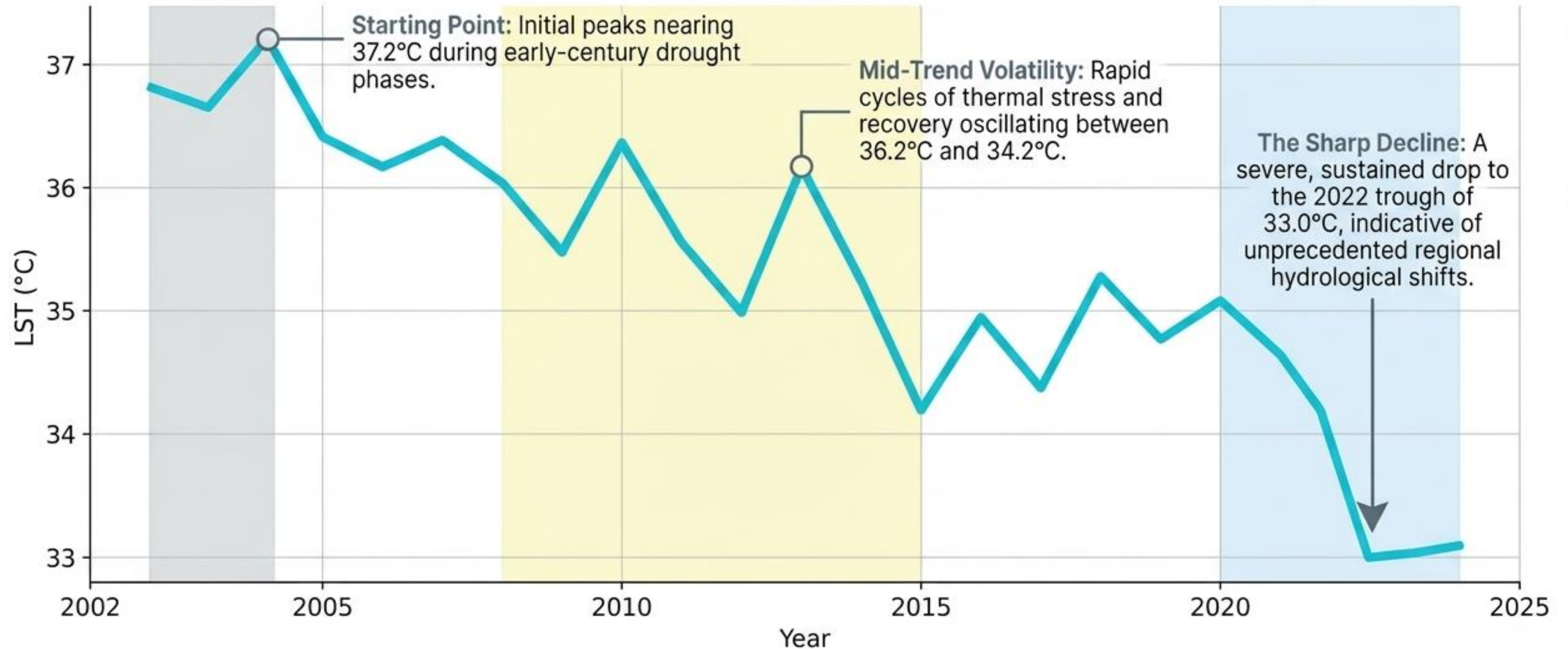
25°C Variance

The LST spans an extreme gradient across a highly compressed longitudinal strip (73.1° to 74.8°), mapping physical altitude and ecological degradation simultaneously.

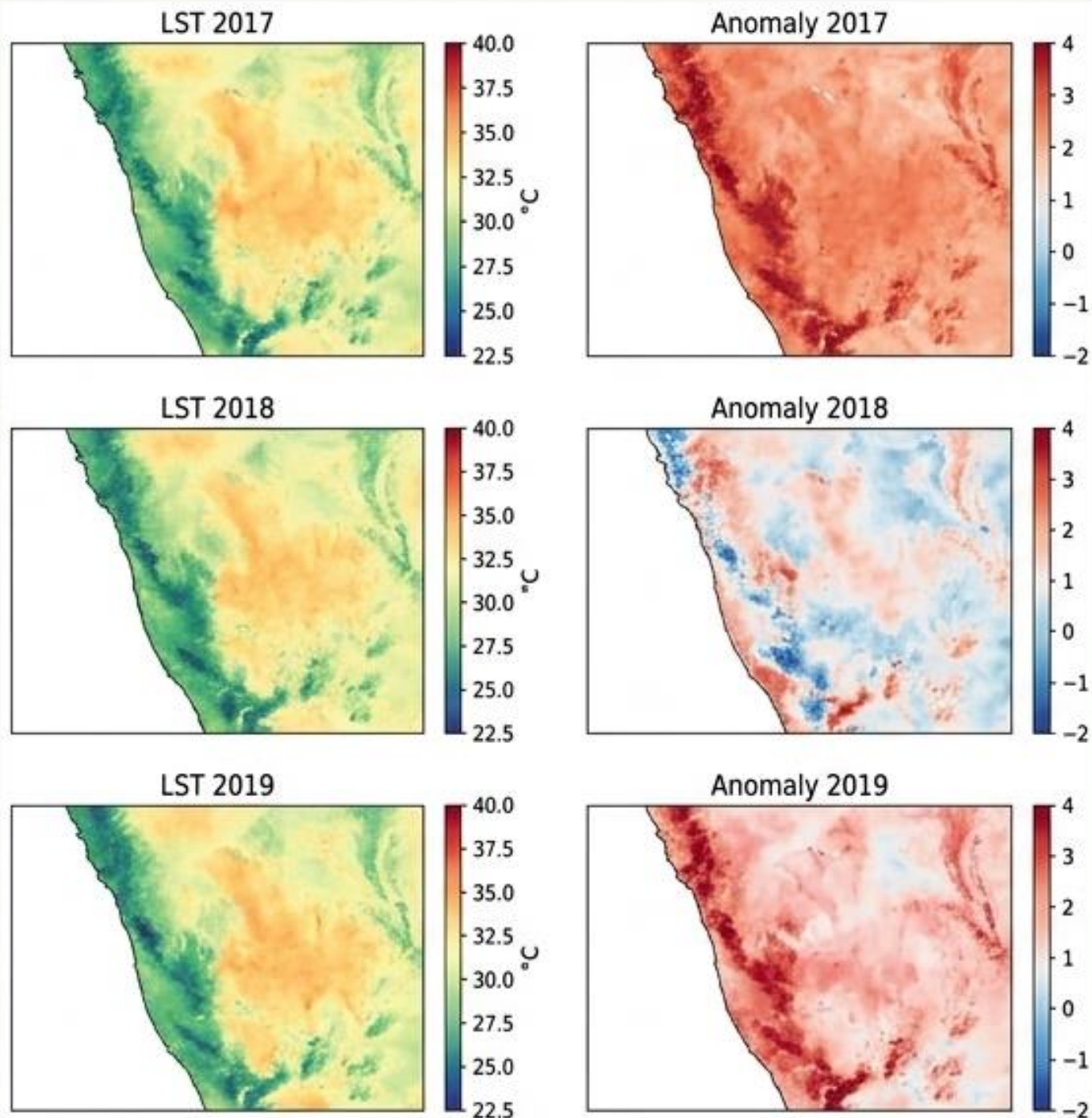
A diagnostic framework for interpreting LST anomalies

Positive Anomalies  +1 to +4	Severe Thermal Stress ▪ Primary Drivers: Drought conditions, prolonged dry spells, widespread canopy loss, active forest fires, or aggressive clear-cutting.
Negative Anomalies  -1 to -4	Extreme Hydrological Events ▪ Primary Drivers: Prolonged, abnormal monsoon intensity, extreme soil saturation, potential flood/landslide disturbances, or post-disturbance regreening.

The 20-year macro trajectory reveals increasing climatic instability rather than uniform warming



The 2017–2019 Warming Phase: Localized thermal stress and canopy vulnerability.



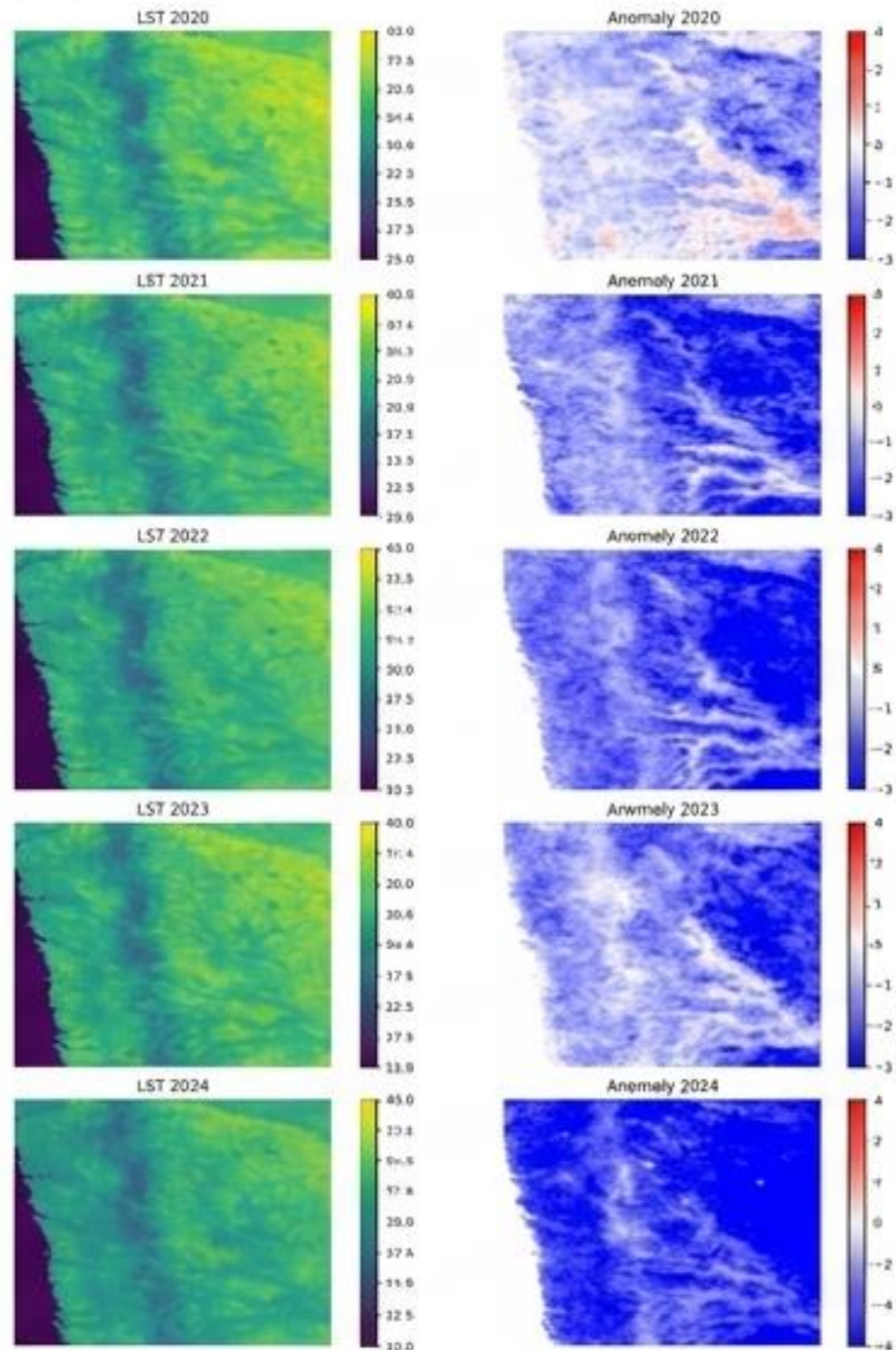
The Data

Anomaly maps from 2017 and 2019 display widespread positive deviations (up to +3 on the anomaly scale), particularly concentrating along the eastern fringes and fragmented corridors.

The Diagnosis

These widespread red anomalies highlight periods of acute moisture deficit. In the Western Ghats, consecutive years of such thermal stress weaken root systems, trigger premature leaf shedding, and vastly increase susceptibility to subsequent extreme weather events.

The 2020–2024 Climatic Whiplash: Extreme cooling anomalies signal severe hydrological disturbance.



The Data

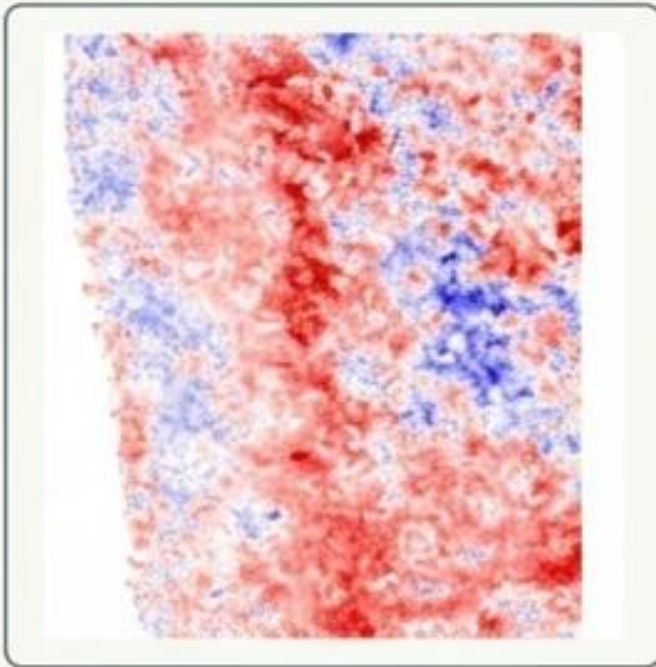
A radical inversion. The anomaly maps from 2020 onward are dominated by **extreme negative deviations** (-2 to -4 on the scale), culminating in near-total blue saturation in 2021, 2022, and 2024.

The Diagnosis

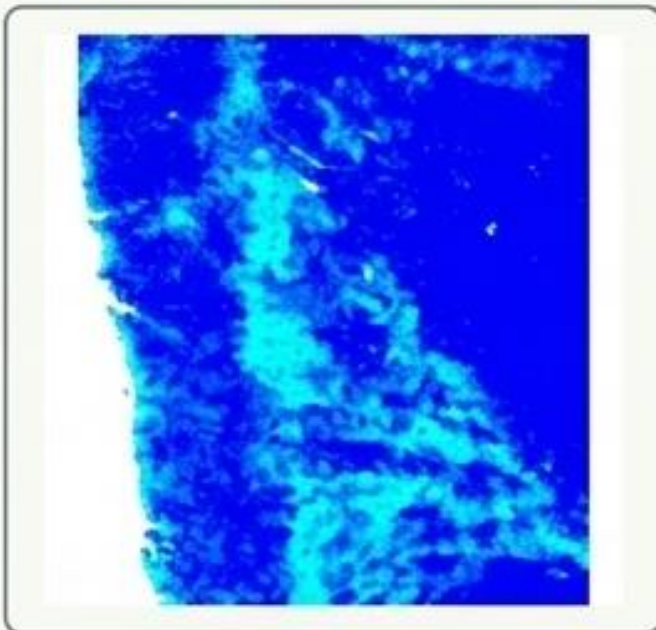
This is not a 'recovery.' These severe, sustained **cooling** signatures represent immense hydrological stress. They correlate with hyper-intense monsoons, chronically saturated soils, structural instability in the topography, and resulting high-impact events like mass landslides and large-scale tree uprooting.

Thermal volatility is the primary catalyst for ecosystem failure.

2019 Anomaly
(Drought)



2024 Anomaly
(Flooding)



Step 1: The Whiplash

Rapid oscillation between extreme LST highs (drought) and extreme LST lows (flooding).



Step 2: Systemic Weakening

Drought-weakened root systems face sudden, massive soil saturation.



Step 3: Compounding Disturbance

Exponential increase in catastrophic outcomes—landslides in high altitudes, irreversible canopy loss in fragmented zones.

Key Insight Box: LST data proves the Western Ghats are no longer experiencing predictable seasonal cycles, but rather compounding, multi-year climatic shocks.

Transitioning from passive observation to predictive intervention

Deploy Targeted Interventions

Utilize spatial anomaly data to identify "red-zone" fragmented foothills. Prioritize these high-variance areas for immediate reforestation and firebreak deployment before dry seasons.

Anticipate Hydrological Cascades

Treat sustained negative (blue) LST anomalies as early-warning indicators for landslides. Evacuate vulnerable human-wildlife interface zones prior to subsequent monsoon peaks.

Integrate LST Telemetry

Move beyond standard NDVI (greenness) tracking. Institutionalize real-time LST anomaly monitoring into regional forestry dashboards to detect localized microclimate collapse before visible canopy loss occurs.

EDUCATION

Jan 2023
–
Present

Indian Institute of Technology Bombay
PhD (Ongoing)

9.21

2020-22

Graphic Era (Deemed to be) University
Mtech in Geoinformatics

9.68/10

2015-19

University of Petroleum and Energy Studies
Btech in Geoinformatics

64.4/100

EXPERIENCE

26th Sep 2022
–
26th Dec 2022

**Birla Institute of Technology & Science,
Pilani K K Birla Goa Campus**
Project Associate
Project Associate under ISRO-IGBP sponsored project entitled "Modelling forest phenological parameters from time series remote sensing data" with Dr. Rajiv Kumar Chaturvedi, Assistant Professor, Department of Humanities and Social Sciences as Principal Investigator.



Dec 2018
–
Jan 2019

Uttarakhand Space Application Center
Research Intern
Website for premnagar using HTML and CSS.



May 2019
–
July 2019

Indel Institute of Resource Management Research, Jaipur
Research Intern
Worked on map maker, DBase and state level awareness project.



SKILLS

 Python (Basic)

 ArcMap

 ERDAS

 C++

 Arcpy

 HTML

 MS Office

 Global Mapper

 GRASS

PUBLICATIONS

1. K. Rai and G. Singh, "Assessing Forest Degradation in Nainital Region using SAR Imagery," 2024 IEEE India Geoscience and Remote Sensing Symposium (InGARSS), Goa, India, 2024, pp. 1-4, doi: [10.1109/InGARSS61818.2024.10984117](https://doi.org/10.1109/InGARSS61818.2024.10984117).

2. Rai, K. and Singh, G.: Advanced Backscatter Modeling for Enhanced Detection of Forest Disturbances in the Indian Subcontinent, EGU General Assembly 2025, Vienna, Austria, 27 Apr–2 May 2025, EGU25-188, <https://doi.org/10.5194/egusphere-egu25-188>, 2025.

3. K. Rai, N. Mishra, A. K. Sharma, S. Mishra and P. P. Dahale, "Flood Risk Assessment Mapping of Nainital District Using GIS Tools," 2023 International Conference on Artificial Intelligence and Applications (ICAIA) Alliance Technology Conference (ATCON-1), Bangalore, India, 2023, pp. 1-5, doi: [10.1109/ICAIA57370.2023.10169591](https://doi.org/10.1109/ICAIA57370.2023.10169591)

4. Nitin Mishra, Komal Rai, Ashish Bhandari, Remote sensing and GIS tool application for tracing the water body of Bangalore area, Materials Today: Proceedings, 2023, ISSN 2214-7853, <https://doi.org/10.1016/j.matpr.2023.07.041>.

5. K. Rai, N. Mishra and S. Mishra, "Forest Fire Risk Zonation Mapping using Fuzzy Overlay Analysis of Nainital District," 2022 International Mobile and Embedded Technology Conference (MECON), Noida, India, 2022, pp. 522-526, doi: [10.1109/MECON53876.2022.9751812](https://doi.org/10.1109/MECON53876.2022.9751812).

6. Komal Rai, Nitin Mishra, Amit Kumar Sharma and Dharam Pal S. Kandari, Change of Land Use / Land Cover impact on assessment of Groundwater Storage in Bina River Basin, GIS SCIENCE JOURNAL VOLUME 9, ISSUE 3, 2022 ISSN NO : 1869-9391

7. Nitin Mishra, Amit Kumar Sharma, Dharam Pal Singh Kandari, Komal Rai, Prem Ranjan, TREND ANALYSIS OF ANNUAL RAINFALL USING MK TEST AND SEN'S SLOPE ESTIMATOR IN BINA RIVER BASIN, MADHYA PRADESH, Mukta Shabd Journal Volume XI, Issue IV, APRIL/2022 ISSN NO : 2347-3150.

8. Komal Rai, Optimization of Wind Farm Location Planning with GIS Methods, International Journal of Science and Research (IJSR) ISSN: 2319-7064 SJIF (2019): 7.583, Volume 10 Issue 3, March 2021 www.ijrsr.net

9. Komal Rai, Nitin Mishra, Amit Kumar Sharma and D.P.S. Kandari, Runoff Calculation of Solani River Watershed, International Journal of Advanced Research in Engineering and Technology (IJARET), 11(5), 2020, pp. 780-785. <https://iaeme.com/Home/issue/IJARET?Volume=11&Issue=5>

10. Nitin Mishra, Sanjeev Kumar, B.R. Nikam and Komal Rai, Assessment of Surface Runoff in Changing LU/LC by ARC-SWAT of Doon Valley, International Journal of Advanced Research in Engineering and Technology (IJARET), 11(5), 2020, pp. 749-757. <https://iaeme.com/Home/issue/IJARET?Volume=11&Issue=5>

11. Komal Rai, 3D GIS Modelling, ISSN: 2321-8819 (Online) 2348-7186 (Print) Impact Factor: 1.498 Vol. 5, Issue 3, March 2017 55 Asian Journal of Multidisciplinary Studies, 5(3) March, 2017



EXTRACURRICULAR & ACHIEVEMENTS

 Participated and presented in MedGU 2024

 Participated and presented in ISRS Lucknow 2024

 Volunteered and participated in InGARSS 2024

 Volunteered at Workshop on Remote Sensing of Cryosphere (WRSC 2023), IEEE GRSS Bombay Chapter

 Got First position on NGP DST Geoinnovation Challenge 2024

 Participated and presented my idea on NGP - DST Geo innovation challenge (among top 25 in India) on topic Flood risk assessment using latest techniques, 2022, NIH, IIT Roorkee

 Presented paper in International Conference TCSNR 2021 (23rd-24th October 2021)

 Presented paper in MECON 2022

 Certified reviewer in IEEE Access.

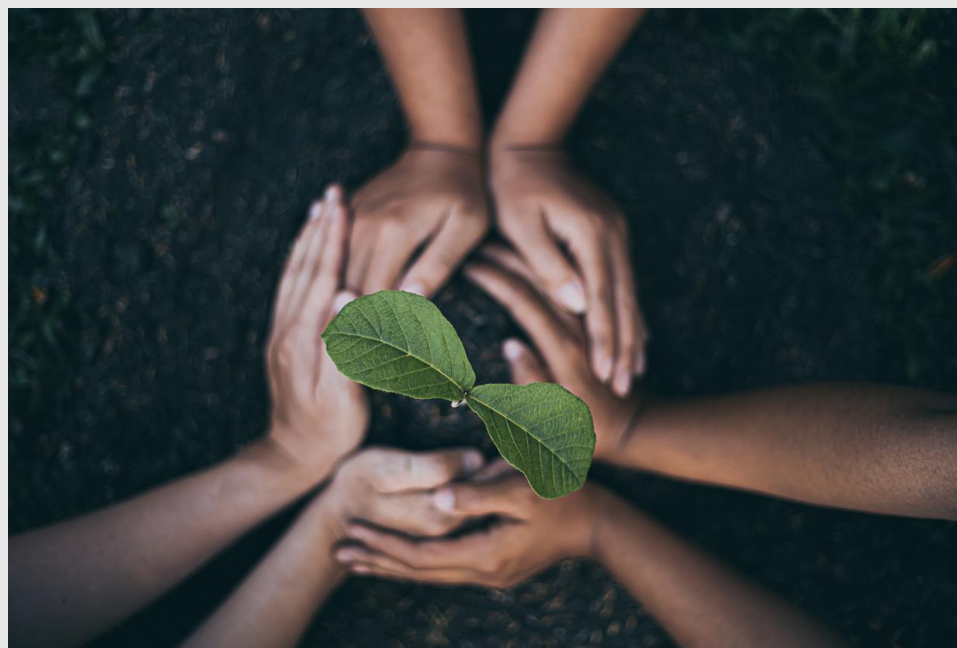
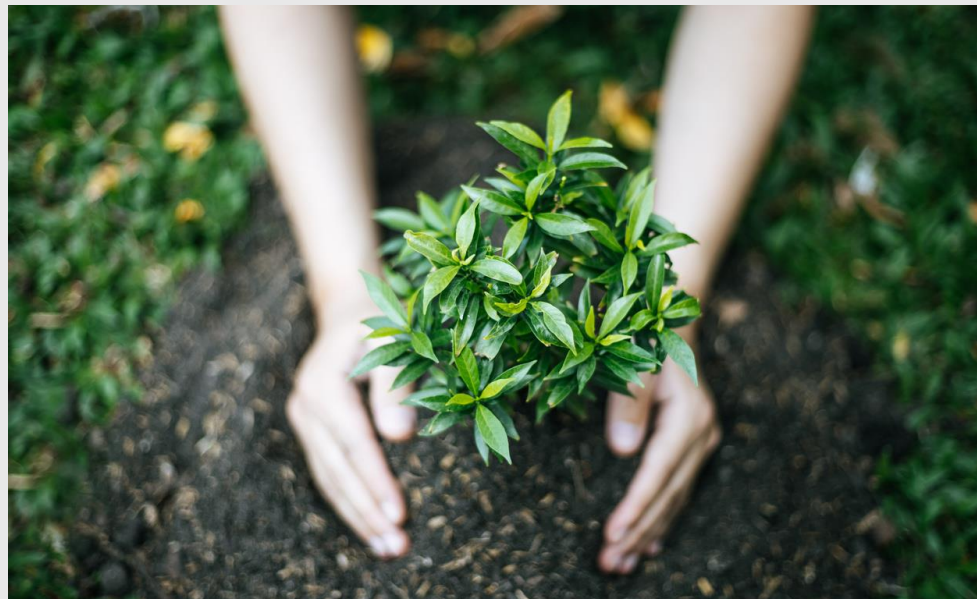
 Organised and participated in InGARSS 2024

 Presented in ESEV 2025 and EMCEI 2025

PROFESSIONAL SUMMARY

I have worked on interdisciplinary projects and maintained effective connection with researchers and renowned Professors throughout my academic and professional careers. My capacity to combine data from remote sensing with information from other sources, like social and environmental data, has produced extensive and comprehensive analyses with useful applications. As an ongoing PhD Scholar, I keep up with the most recent developments in the remote sensing and GIS domains, ensuring that my knowledge is always at the cutting edge of science. I am committed to using my abilities to support sustainable solutions and have a positive impact on society. I am motivated by a passion for environmental conservation, forestry, and disaster management.





THANK YOU!

A Pathway to a Greener Future

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