

SUMMER INTERNSHIP PROGRAM
at
NATIONAL REMOTE SENSING CENTER,
INDIAN SPACE RESEARCH ORGANIZATION



FROM 13TH MAY TO 23TH JULY

A REPORT BY

S. SATHEESH

2071

MASTER OF BUSINESS ADMINISTRATION

HOSPITAL AND HEALTH MANAGEMENT

2024-26

UNDER THE MENTORSHIP OF

DR. P. R. SODANI

PRESIDENT



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Date: July 23, 2025

CERTIFICATE

This is to certify that the project entitled, “ASSESSING THE IMPACT OF AIR QUALITY, HEAT, AND UV RADIATION ON HUMAN HEALTH IN INDIA ” is a bonafide work carried out by **Mr. Satheesh.S**, MBA (Hospital and Health Management), IIHMR University Jaipur, Rajasthan at National Remote Sensing Centre, Hyderabad during the period from 12th May 2025 to 23 July 2025.

Mr. **Satheesh.S** has demonstrated sincerity, dedication, and a high degree of reliability throughout his project work. His consistent efforts and commitment to excellence were evident in all aspects of the project. I wish him continued success in his future endeavors and a rewarding career in the field of research.

 22/7/25
(Signature of the Guide)

DR. HAREEF BABA SHAEB. K
Scientist 'SF'
Atmospheric Sciences Division
Earth & Climate Science Area
National Remote Sensing Centre
Dept of Space (ISRO),
Balanagar, Hyderabad,
Telanagana-500037

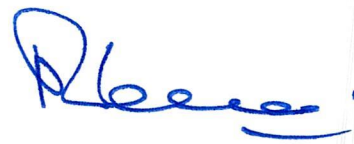
डॉ. हरीफ बाबा साहेब .के/ Dr. Hareef Baba Shaeb K
वैज्ञानिक/ इंजिनियर-एसएफ/ Scientist/Engineer-'SF'
वायुमंडलीय रसायन विज्ञान प्रभाग/Atmospheric Chemistry Division
पृथ्वी और जलवायु विज्ञान क्षेत्र/ Earth and Climate Science Area
राष्ट्रीय सुदूर संवेदन केन्द्र (एन आर एस सी)/National Remote Sensing Centre (NRSC)
भारत सरकार, अंतरिक्ष विभाग (इसरो)/Govt. of India, Dept. of Space (ISF)
हैदराबाद तेलंगाना-500 037/Balanagar, Hyderabad, Telangana

IIHMR University Faculty Mentor Approval

This is to certify that **Mr. S. Satheesh** of academic year 2024-26 of **Institute of Health Management Research** has prepared a poster with respect to his summer internship held during May-July 2025.

He has carried out work as per the guidelines. His poster is approved for presentation.

Date : 28/07/2025

A handwritten signature in blue ink, appearing to read 'Dr. P.R. Sodani'.

Dr. P.R. Sodani

President

IIHMR University

PROBLEM STATEMENT	SWOT		Data Sources	Analysis Steps	Tools Used
- India's rising population faces increasing exposure to PM2.5, heat, and UV radiation - These environmental factors are linked to respiratory illness, heatstroke, and Vitamin D deficiency - There is a lack of long-term spatial-temporal analysis integrating all three variables - This research bridges that gap using satellite data to support evidence-based health planning	STRENGTHS Satellite-driven data mapping used to visualize PM2.5, heat, and UV trends over 25 years	WEAKNESS Health data was not available at district or city level	Data Sources - ERA5 - (Surface Temperature) (ECMWF atmospheric reanalysis) - CAMS (PM2.5) (Copernicus Atmosphere Monitoring Service) - OMI/NASA (UV Radiation) (Ozone Monitoring Instrument)	Analysis Steps - Annual mean computation (1998-2024) - Seasonal trend analysis (PM2.5 only) - Sen's Slope + Mann-Kendall for trend significance (95% CI)	Tools Used - Python, VSC (karray, rasterio, pandas) - QGIS (Spatial Visualization, Sen Slope + Mann-Kendall test) - ArcGIS (Map exports)
OBJECTIVES	ANALYSIS AND MAPPINGS				
- To assess long-term trends of PM2.5, surface temperature, and UV radiation across India using satellite and reanalysis data - To identify spatial hotspots and seasonal variations in exposure - To apply Sen's Slope and Mann-Kendall test for trend significance - To visualize patterns through GIS maps for public health relevance - To compare environmental trends with mortality and Vitamin D deficiency data for risk insight	PM2.5 Deaths 2021 Source: Global Burden of Disease (GBD), IHME	PM2.5 1998 Source: Copernicus Climate Data Store (CAMS)	PM2.5 2023 Source: Copernicus Climate Data Store (CAMS)	PM2.5 Sen Slope 95%	
	Vitamin D Deficiency in 1-4 years old Source: Nutrition India Dashboard	UV Radiation 2001 Source: CERES/CNVIuding Edition 4.1	UV Radiation 2023 Source: CERES/CNVIuding Edition 4.1	UV Sen Slope 95%	
	Heatstroke Deaths 2016 Source: Data.gov.in (Deaths due to natural fever, Heatstroke / Sunstroke)	Surface Temperature 2001 Source: ERA 5 Satellite Re-analysis Data	Surface Temperature 2016	Heat Sen Slope 95%	
KEY FINDINGS					
- Maps showed consistently high PM2.5 levels across the Indo-Gangetic Plain, with a steady rise in pollution-linked deaths peaking above 140,000 annually, especially in Uttar Pradesh and Bihar. - Warming trends were strongest in central and western India (up to +0.06°C/year), aligning with heat-related deaths that peaked in 2016 and 2019, notably in Telangana and Andhra Pradesh - Despite high UV levels in the south, northern and northeastern states had low seasonal UV exposure, correlating with widespread Vitamin D deficiency, especially in children aged 0-19 years					

WEEKLY REPORTING OF 1/10 WEEKS

Name of the Organization: National Remote Sensing Center, ISRO

Area/ Department/ Project of Summer Internship Program: Earth and Climate Studies

Area

Name of the Student: S. Satheesh

Roll no: 2071

Stream: MBA (HHM) 29

Week no: 01

From: 13/05/2025 to 16/05/2025

Activity Done	• Learnt Python for visual data analysis and big data management • Learnt QGIS Software and plotted death rates of PM2.5 Attributed deaths
Linking theory (Classroom learning) with practice at your organization	• Applied concepts such as data handling, plotting Principles
Gaps identified on the working area.	• Since it is the first few days of using python there was a fluency gap in working
Suggestions for improvement	• Seeking peers or mentors who are proficient in python, keeping a note desk documenting common area of errors
Plan for the next week	• Starting to integrate python with satellite datasets, Specifically NetCDF files from Era5, CAMS and using libraries such as xarray and rasterio in python

S. Satheesh

Signature of the student

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WEEKLY REPORTING OF 2/10 WEEKS

Name of the Organization: National Remote Sensing Center, ISRO

Area/ Department/ Project of Summer Internship Program: Earth and Climate Studies

Area

Name of the Student: S. Satheesh

Roll no: 2071

Stream: MBA (HHM) 29

Week no: 02

From: 19/05/2025 to 23/05/2025

Activity Done	- Downloaded Era5 and CAMS satellite data for PM2.5 and surface temperature (2m) - Learnt to extract variables from NetCD4 files into CSV Format
Linking theory (Classroom learning) with practice at your organization	- Connected air pollution data with health implications such as respiratory and CVD - Understood how regional air quality trend impacts human health
Gaps identified on the working area.	Limited prior working experience to handle geospatial environmental data
Suggestions for improvement	Using the WHO and ICMR studies to better interpret the health impacts of the environmental stressors like PM2.5
Plan for the next week	- Preparing regional wise pollution maps in QGIS for India - Begin comparing the pollution patterns with publicly available mortality data to find the hotspots

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WEEKLY REPORTING OF 3/10 WEEKS

Name of the Organization: National Remote Sensing Center, ISRO

Area/ Department/ Project of Summer Internship Program: Earth and Climate Studies

Area

Name of the Student: S. Satheesh

Roll no: 2071

Stream: MBA (HHM) 29

Week no: 03

From: 26/05/2025 to 30/05/2025

Activity Done	• Converted all the Era5 data into GeoTIFF Format and imported into QGIS for visualization • Created Annual and Seasonal Mapping
Linking theory (Classroom learning) with practice at your organization	• Learnings from environmental health and disease surveillance by visualizing how air pollution and temperature trends vary from season to season and annually.
Gaps identified on the working area.	• Lack of training/work experience in QGIS and other geo spatial tools
Suggestions for improvement	• Reviewing published public health maps to better design visual suited for healthcare stakeholders
Plan for the next week	• Begin identifying long term PM2.5 and Heat using non parametric method (Sen slope and Mann-Kendall Test) • Focusing on interpretation which states shows the increase in trends

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WEEKLY REPORTING OF 4/10 WEEKS

Name of the Organization: National Remote Sensing Center, ISRO

Area/ Department/ Project of Summer Internship Program: Earth and Climate Studies

Area

Name of the Student: S. Satheesh

Roll no: 2071

Stream: MBA (HHM) 29

Week no: 04

From: 02/06/2025 to 06/06/2025

Activity Done	• Applied Sen Slope Estimator and Man Kendall test for PM2.5 and Heat Trends (2m) • Generated spatial trends for both PM2.5 and Surface Temperature (2m)
Linking theory (Classroom learning) with practice at your organization	• Related how persistent environmental exposure can contribute to the chronic disease burden
Gaps identified on the working area.	• Finding and using statistical tool such as the sen slope estimator and Man-Kendall Test in QGIS
Suggestions for improvement	• Reviewing case studies where environmental trend data has been used in national health policy or urban planning
Plan for the next week	• Begin Preparing the overlays to identify areas where environmental trends coincide with increased health burdens in India.

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WEEKLY REPORTING OF 5/10 WEEKS

Name of the Organization: National Remote Sensing Center, ISRO

Area/ Department/ Project of Summer Internship Program: Earth and Climate Studies

Area

Name of the Student: S. Satheesh

Roll no: 2071

Stream: MBA (HHM) 29

Week no: 05

From: 09/06/2025 to 13/06/2025

Activity Done	- Collected health outcome datasets from GBD for PM2.5 and Data.gov.in for heat - Imported and mapped the data in QGIS
Linking theory (Classroom learning) with practice at your organization	Applied concepts from public health surveillance and HIS to understand how mortality data can guide resource allocation
Gaps identified on the working area.	Limited access to the mortality data sets, such as District Wise, City Wise. Monthly data sets were not available
Suggestions for improvement	Focusing on state level or macro regional pattern where data is complete
Plan for the next week	Incorporate Vitamin D deficiency prevalence data and begin mapping it against UV Radiation levels.

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WEEKLY REPORTING OF 6/10 WEEKS

Name of the Organization: National Remote Sensing Center, ISRO

Area/ Department/ Project of Summer Internship Program: Earth and Climate Studies

Area

Name of the Student: S. Satheesh

Roll no: 2071

Stream: MBA (HHM) 29

Week no: 06

From: 16/06/2025 to 20/06/2025

Activity Done	• Integrated NFHS-5 Vitamin D deficiency data for Children from (1-19) • Mapped UV radiation CERES Synderg1 Data
Linking theory (Classroom learning) with practice at your organization	• Observing the real-world public health issues, where even if the UV radiation is high, The vitamin D deficiency is higher, Due to lifestyle change.
Gaps identified on the working area.	• Lack of data from the age group of 19+ on Vitamin D deficiency in Health Nutrition Dashboard
Suggestions for improvement	• Focusing on Policy relevant outcomes, such as identifying states that may benefit from sunlight promotion campaigns or dietary supplementation programs
Plan for the next week	• Begin writing the methodology, Section of Report, integrating both technical and the health components at Journal for publication along with guide at NRSC

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WEEKLY REPORTING OF 7/10 WEEKS

Name of the Organization: National Remote Sensing Center, ISRO

Area/ Department/ Project of Summer Internship Program: Earth and Climate Studies

Area

Name of the Student: S. Satheesh

Roll no: 2071

Stream: MBA (HHM) 29

Week no: 07

From: 23/06/2025 to 27/06/2025

Activity Done	Drafted the materials and methods section for report combining data sources spatial (QGIS, Python)
Linking theory (Classroom learning) with practice at your organization	Applied the structure learnt in research methodology subjects for the methodology section in Journal for publication
Gaps identified on the working area.	Limited availability of studies on the environmental stressors and Health as a whole compiled
Suggestions for improvement	Reviewing more journals and publication done outside India to relate the structure with my journal
Plan for the next week	Starting to draft the results and interpretation section

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WEEKLY REPORTING OF 8/10 WEEKS

Name of the Organization: National Remote Sensing Center, ISRO

Area/ Department/ Project of Summer Internship Program: Earth and Climate Studies

Area

Name of the Student: S. Satheesh

Roll no: 2071

Stream: MBA (HHM) 29

Week no: 08

From: 30/06/2025 to 04/07/2025

Activity Done	Drafted the results and interpretation section, incorporating spatial trends and UV exposure along with the Vitamin D deficiency in India
Linking theory (Classroom learning) with practice at your organization	Applied insights learnt in class to interpret from public health risk perspectives (Resource allocation)
Gaps identified on the working area.	Vitamin D deficiency data was not available on a monthly scale and separate for each year to do better interpretation
Suggestions for improvement	Using more Maps, Symbology Gradients, Comparisons tables to make findings in QGIS
Plan for the next week	Finalize the discussion and Conclusion Section in the thesis

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WEEKLY REPORTING OF 9/10 WEEKS

Name of the Organization: National Remote Sensing Center, ISRO

Area/ Department/ Project of Summer Internship Program: Earth and Climate Studies

Area

Name of the Student: S. Satheesh

Roll no: 2071

Stream: MBA (HHM) 29

Week no: 09

From: 07/07/2025 to 11/07/2025

Activity Done	- Completed the final chapters of the report - Compiled all the exported maps and graphs
Linking theory (Classroom learning) with practice at your organization	Linked with the importance of data driven decision making in hospital and health management
Gaps identified on the working area.	ArcGIS software was used to export the maps, since QGIS was not supporting 3D India Maps
Suggestions for improvement	Taking up more health projects related with Geo spatial remote sensing, to understand and learn for future solutions.
Plan for the next week	Preparing final reports for publication of the study in an International Journal (Springer) Air Quality, Atmosphere and Health

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WEEKLY REPORTING OF 10/10 WEEKS

Name of the Organization: National Remote Sensing Center, ISRO

Area/ Department/ Project of Summer Internship Program: Earth and Climate Studies

Area

Name of the Student: S. Satheesh

Roll no: 2071

Stream: MBA (HHM) 29

Week no: 10

From: 14/07/2025 to 18/07/2025

Activity Done	Aligned formatting, Reporting style, and figures as per the guidelines according to the Springer Report Format
Linking theory (Classroom learning) with practice at your organization	Worked on changing the SIP into a publishable study by integrating the epidemiological insights with geo spatial and remote sensing through ISRO.
Gaps identified on the working area.	Overall, there was a few gaps in learning the software but it went on as we started to practice the engines.
Suggestions for improvement	Taking up more Remote Sensing satellite data for more projects such as Soil Health, Lightning, Flood etc. To predict and forecast the deaths using Machine Learning such as Deep learning, Random Forest, Gradient Boosting

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COMPILED REPORT

Name of the Organization: National Remote Sensing Center, ISRO

Area/ Department/ Project of Summer Internship Program: Earth and Climate Studies

Area

Name of the Student: S. Satheesh

Roll no: 2071

Stream: MBA (HHM) 29

Activity Done	• Reviewed literature on the health impacts of PM_{2.5}, Surface Temperature, and UV radiation in India • Collected and pre-processed satellite and reanalysis datasets (ERA5, CAMS, CERES) for the period 1998–2023 • Performed spatiotemporal trend analysis using Python (xarray, rasterio, pandas) • Applied Sen’s Slope Estimator and Mann-Kendall Test to identify statistically significant trends • Generated seasonal and annual composite maps using QGIS and ArcGIS Pro • Integrated public health datasets (e.g., PM_{2.5}-attributed deaths, heat mortality, Vitamin D deficiency) • Compared UV radiation trends with sunlight exposure needs and Vitamin D deficiency in children (0–19 yrs) • Created clear, multi-layered visualizations and interpretation maps to identify environmental-health hotspots • Documented all findings in a research thesis and prepared a poster for academic dissemination
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Linking theory (Classroom learning) with practice at your organization	• Concepts from environmental health, disease burden, and population vulnerability were directly connected with spatial data on air pollution, heatwaves, and UV exposure • Topics such as health indicators, surveillance systems, and policy evaluation from the classroom helped me understand the significance of mapping these environmental risks • Exposure to tools like Python and GIS, though not part of my coursework, enhanced my ability to bridge scientific data with public health decision-making, a key skill in climate-health policy domains • No existing central framework to combine pollution, heat, and UV trends for early warning or intervention planning
Gaps identified on the working area.	• Lack of integration between environmental data and public health systems satellite insights are underutilized in health planning • Health outcome data (e.g., morbidity, Vitamin D deficiency) is not available at fine spatial resolution, limiting deeper correlation studies • Limited awareness or use of GIS and remote sensing tools among public health professionals • No existing central framework to combine pollution, heat, and UV trends for early warning or intervention planning
Suggestions for improvement	• Develop a centralized environmental-health monitoring system that integrates satellite data with health outcomes at district level • Conduct training workshops on tools like Python and QGIS for public health professionals and students from non-technical backgrounds

	• Promote interdepartmental collaboration between remote sensing agencies (like NRSC) and health departments for real-time data sharing • Encourage data granularity in public health surveys (e.g., Vitamin D deficiency, heatstroke cases) to support local-level spatial analysis • Design region-specific awareness campaigns on air quality, UV safety, and climate-health links based on mapped risk zones
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Assessing the Impact of Air Quality, Heat, and UV Radiation on Human Health in India

INTRODUCTION

India's growing population and rapid urbanization have brought major environmental stressors to the forefront including PM2.5 (air pollution), extreme heat, and UV radiation. Each of these is independently linked to health outcomes like respiratory illnesses, heatstroke, and vitamin D deficiency, yet they are rarely studied together in a spatial and long-term context.

This study bridges that gap using satellite-driven datasets and geospatial analysis techniques to visualize how these environmental factors have changed over the past two decades and what they mean for public health

OBJECTIVES

- Analyze the long-term (1998–2023) trends of PM2.5, temperature, and UV radiation using satellite data.
- Identify geographic hotspots and seasonal patterns.
- Apply Sen's Slope and Mann-Kendall Test to detect statistically significant changes.
- Link environmental exposure with public health risks, including mortality and vitamin D deficiency.
- Create spatial maps that can inform health planning and policy.

METHODOLOGY

• Data Sources:

- PM2.5 – CAMS Global Reanalysis (1998–2023)
- Temperature – ERA5 Reanalysis (2000–2024)
- UV Radiation – CERES SYN1deg (2001–2023)
- Health Data – GBD (mortality), NFHS-5 & Nutrition Atlas (Vitamin D)

• Tools Used:

Python (xarray, rasterio), QGIS, ArcGIS Pro, Excel

- **Trend Detection:**

Sen's Slope Estimator (for magnitude), Mann-Kendall (for significance at 95% CI)

- **Seasonal Analysis:**

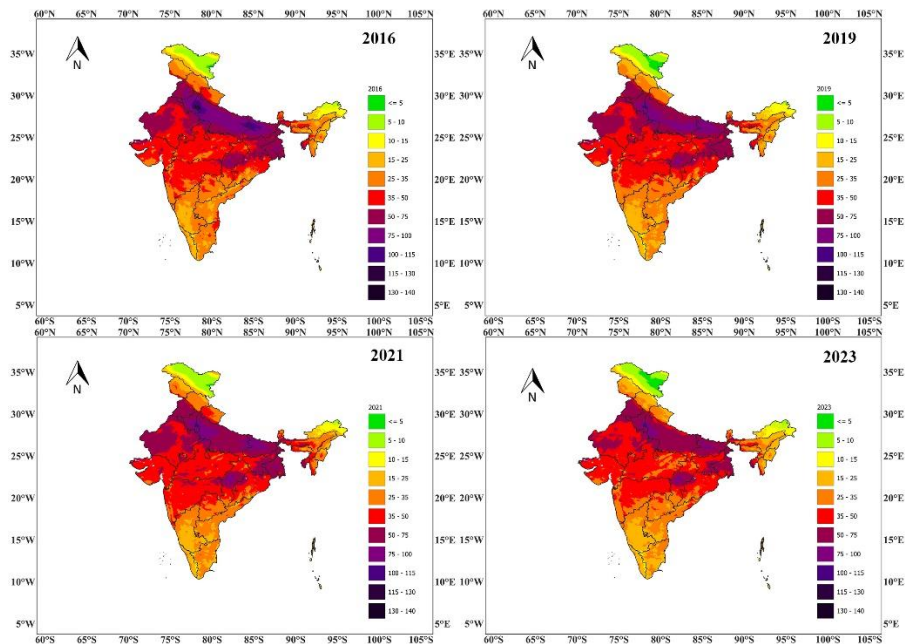
Focused on Winter, Pre-Monsoon, Summer, Monsoon, Post-Monsoon

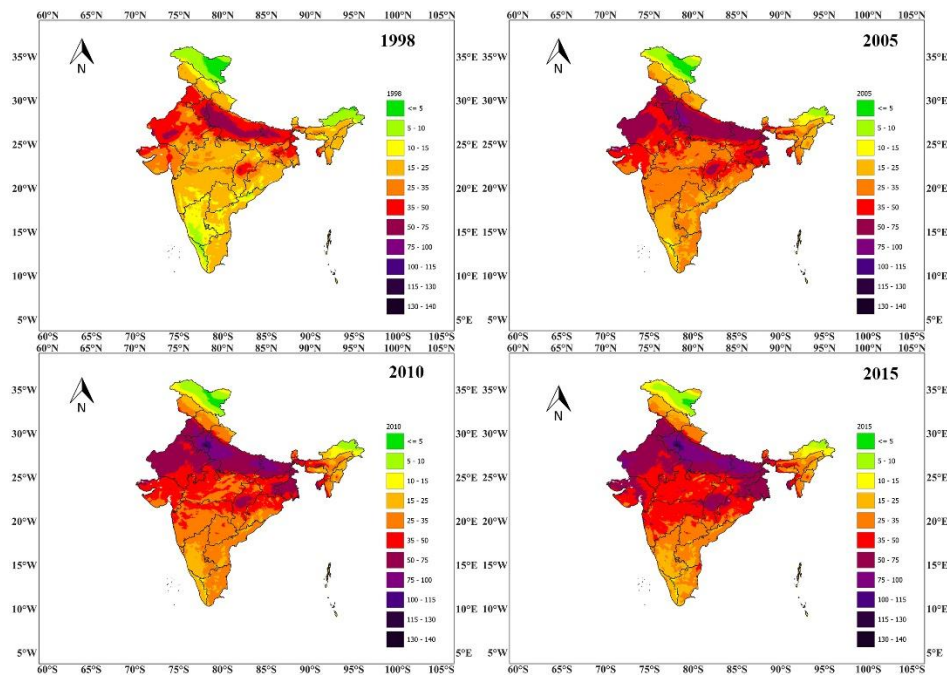
Season	Months Included	Notes
Winter	December, January, February	(12, 01, 02) Coldest season in India
Pre-monsoon	March, April	(03, 04) Transition into summer
Summer	May, June, July	(05, 06, 07) Peak UV and temperature
Monsoon	August, September	(08, 09) Rainy season with clouds
Post-monsoon	October, November	(10, 11) Cooling period after rains

KEY RESULTS & INTERPRETATION

PM2.5 Trends

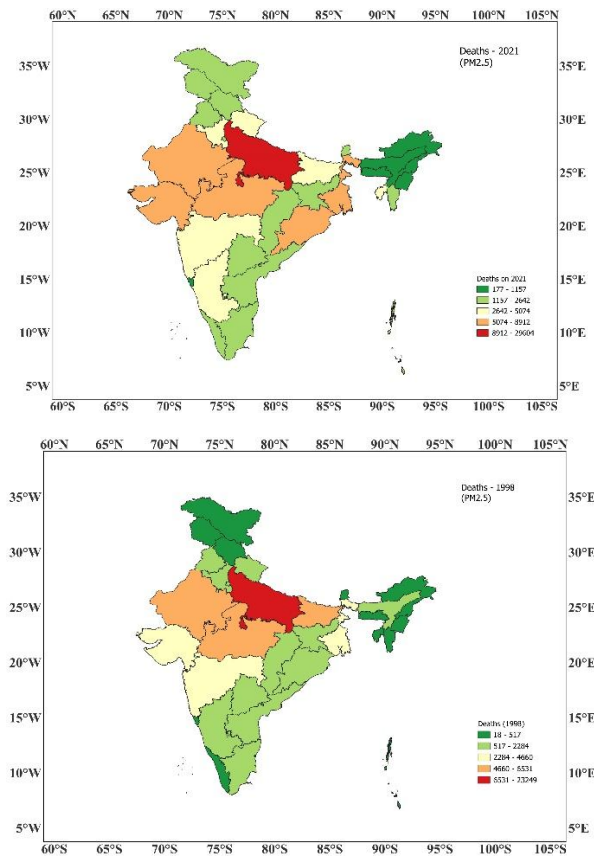
PM2.5 levels were highest in the Indo-Gangetic Plain, particularly Uttar Pradesh, Bihar, and Delhi NCR. Seasonal spikes were most severe in winter and post-monsoon due to stubble burning and atmospheric stagnation





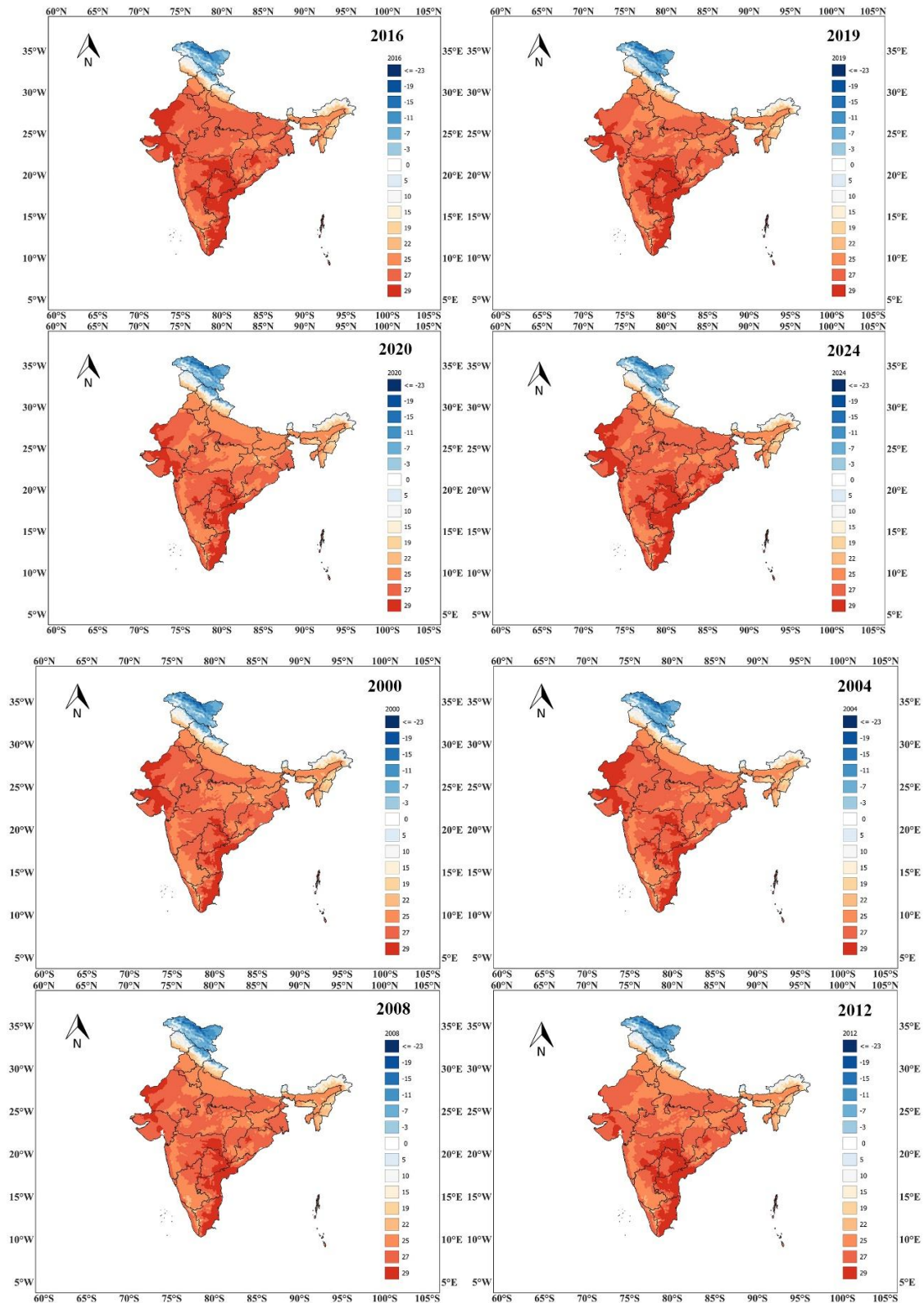
Health Data:

PM2.5-attributed deaths rise significantly over 24 years peaking Indo Gangetic Plains annually

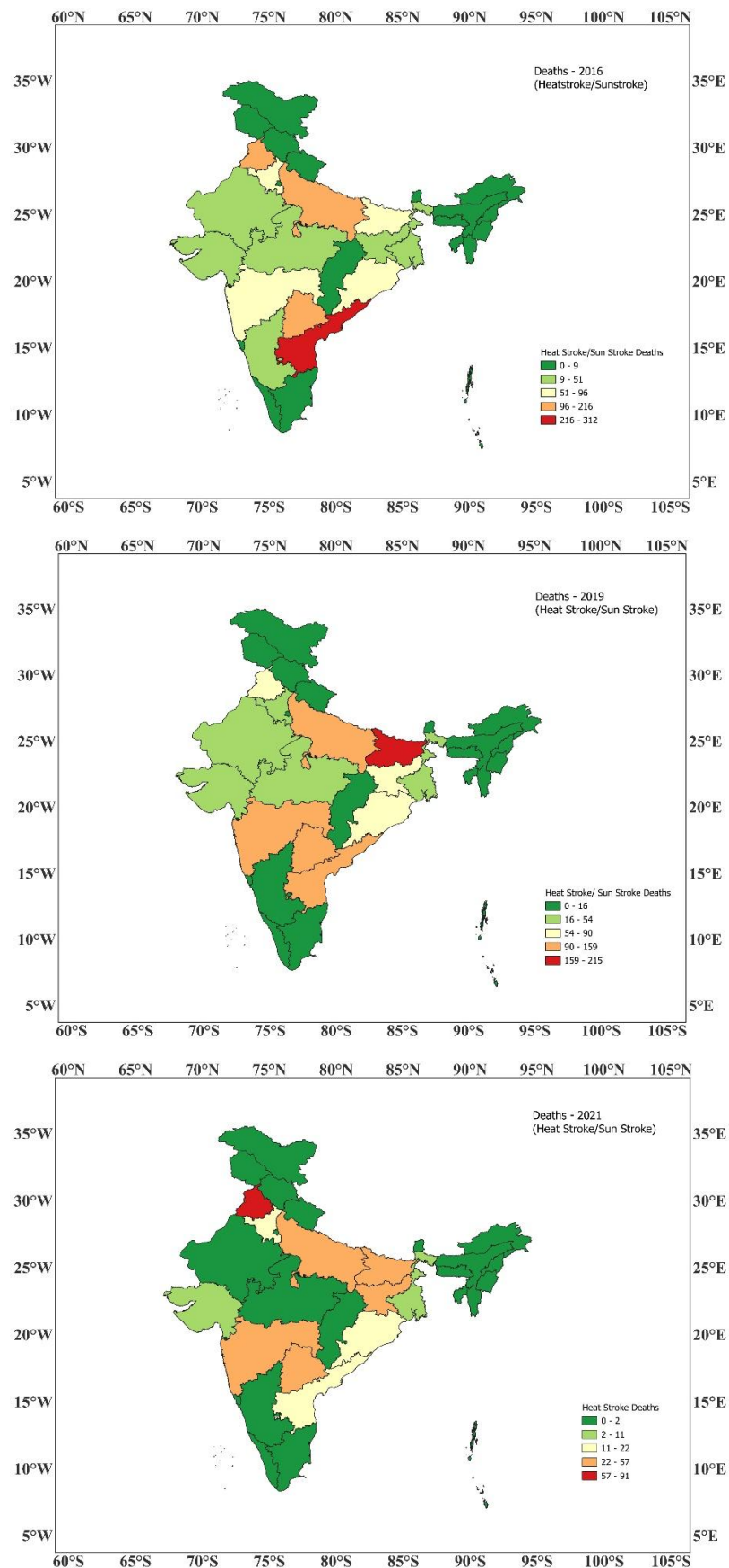


Heat Trends

Central and western India showed consistent warming, with Sen's Slope reaching $+0.06^{\circ}\text{C}/\text{year}$ in parts of Madhya Pradesh and Rajasthan. Southern and northeastern states saw mild cooling

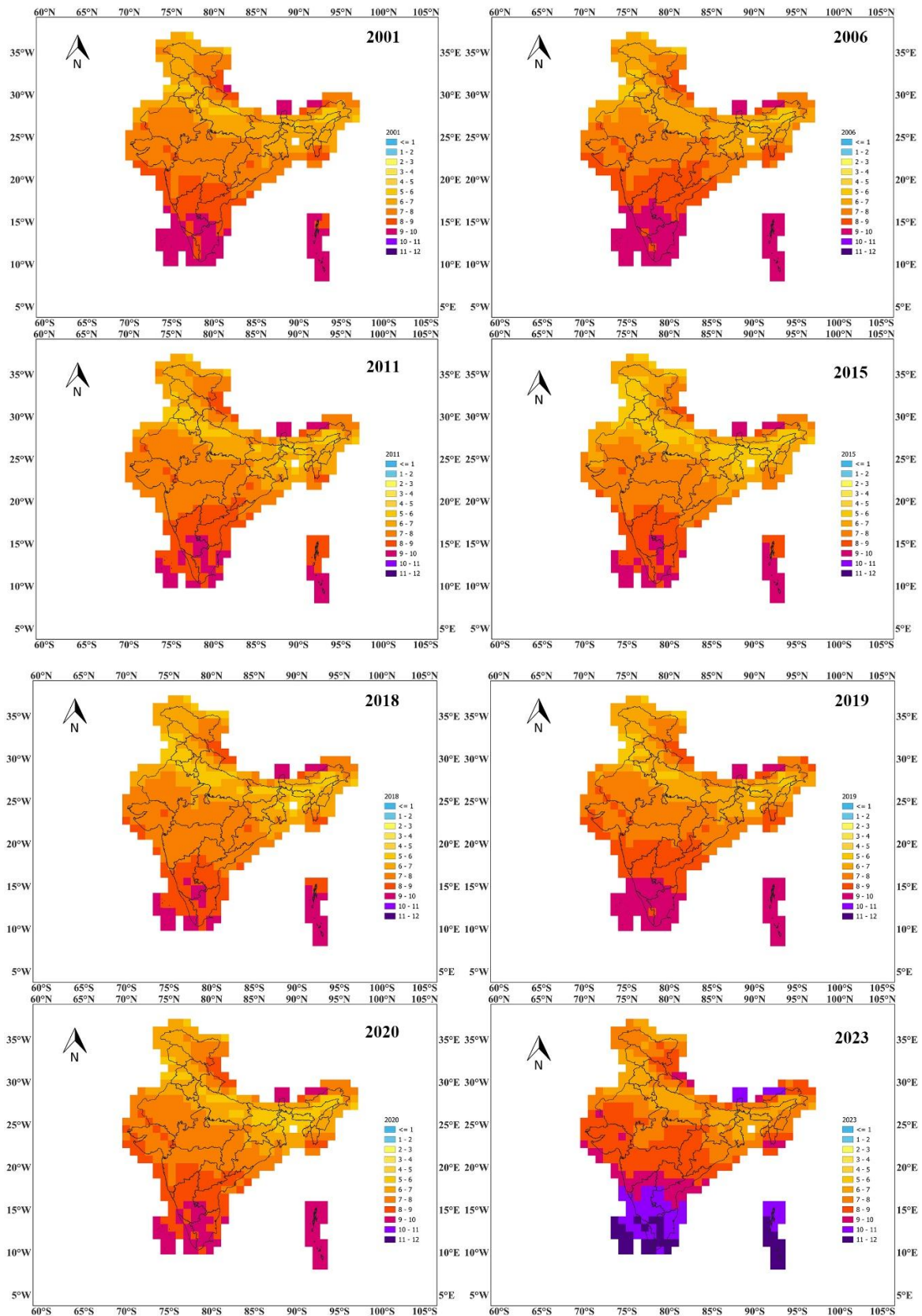


Health Data:- Heat-related deaths were highest in **2016 and 2019**, especially in Andhra Pradesh and Telangana

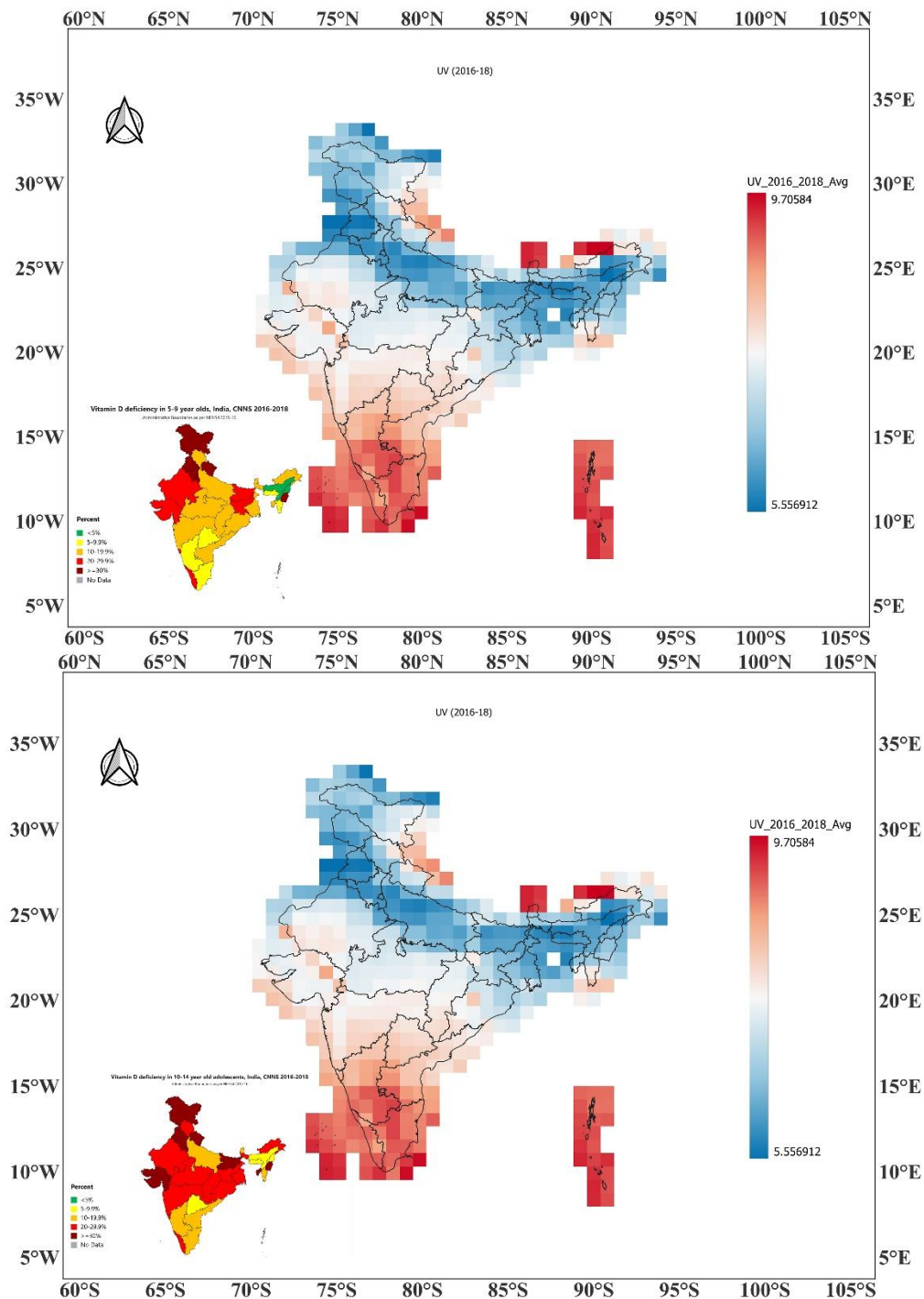


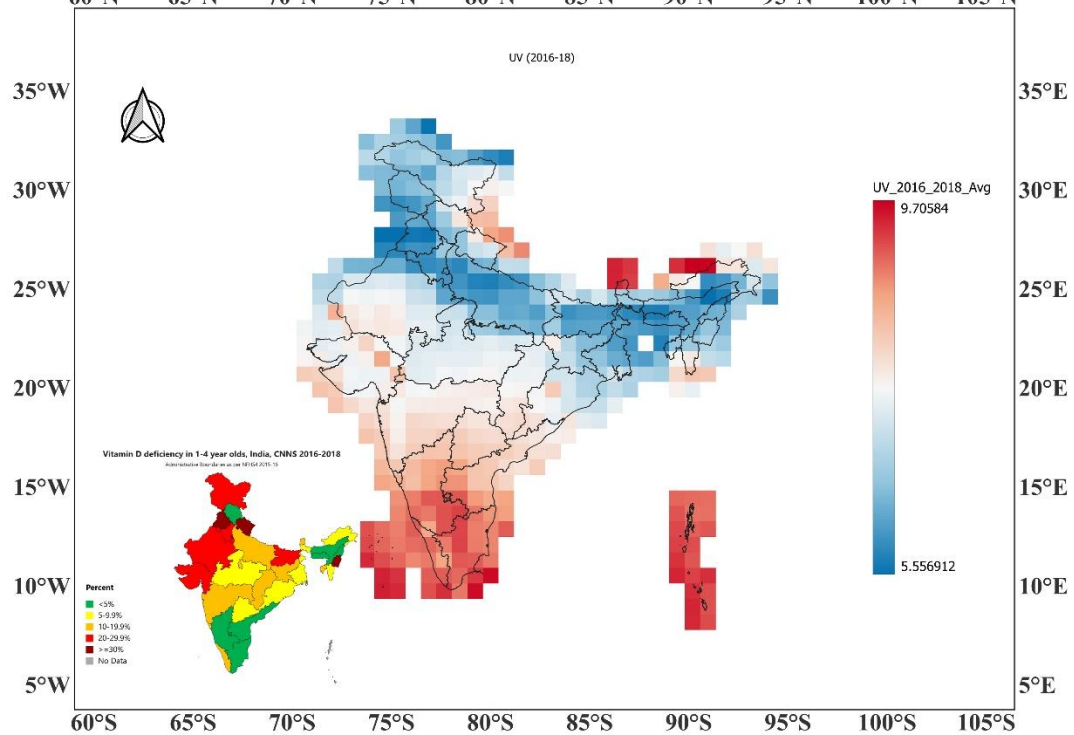
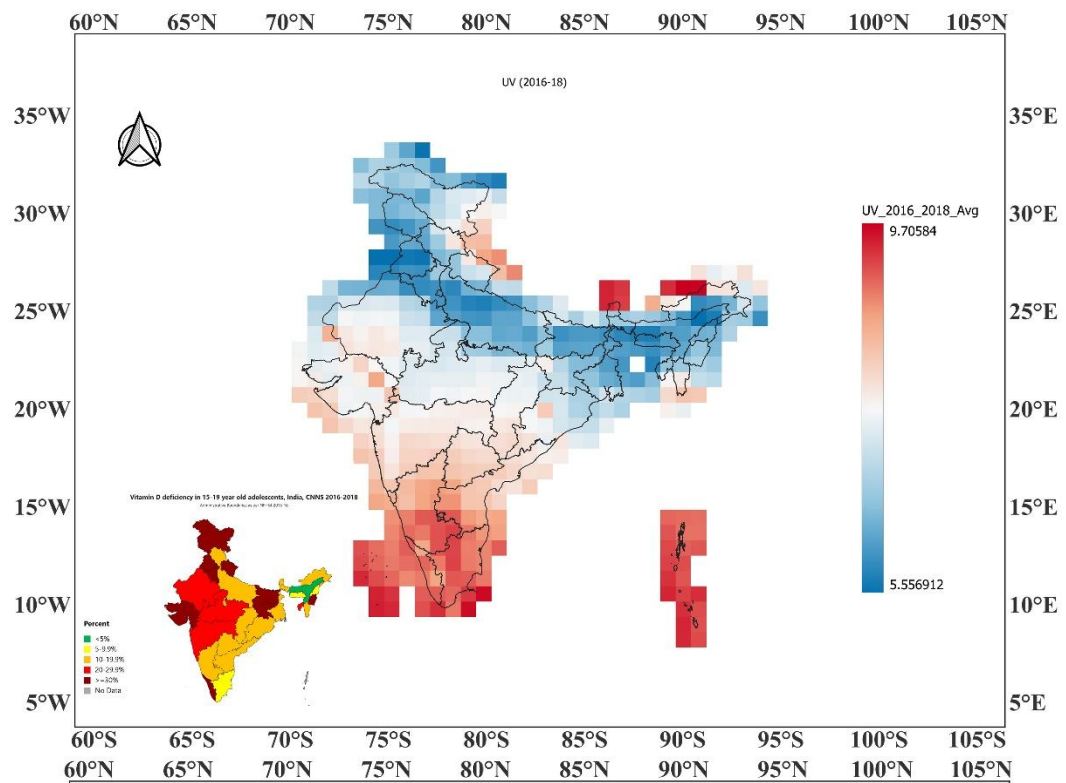
UV Radiation Patterns:

Southern India consistently received high UV exposure, while northern and northeastern states saw lower seasonal UV, particularly in winter



Health Data: - Despite India's sunny climate, Vitamin D deficiency was widespread in northern and urban regions among children and adolescents





CONCLUSION

This study offers a comprehensive picture of how environmental stressors PM2.5, heat, and UV have evolved over time in India, and how they influence public health outcomes. Through spatial mapping and statistical trend analysis, it provides evidence to support climate-resilient health planning, especially for vulnerable populations like children, the elderly, and outdoor workers