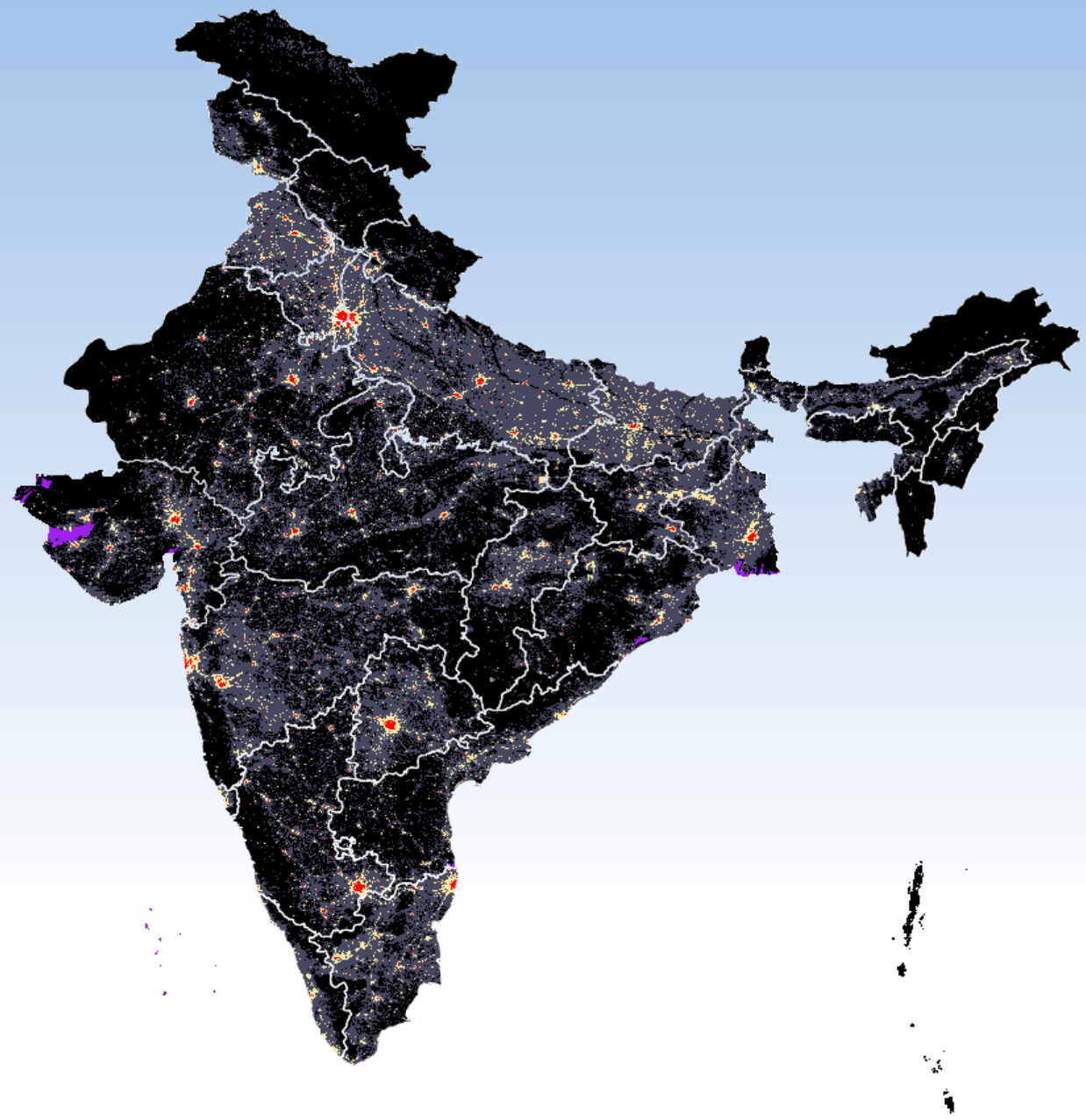
Decadal Change of Night Time Light (NTL) over India from Space (2012 – 2021)



November 2022

National Remote Sensing Centre
ISRO, Dept. of Space, Govt. of India
Hyderabad – 500 037

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Message

Harnessing Space technology for monitoring and analysis of development activities with emphasis on Scocio-economic and environmental changes etc., is one of the trust areas of Indian Space program. Night Time Lights (NTL), which provides important insights, can be considered as one of the indicators to assess the developmental patterns over a period of time. These radiances can be correlated with infrastructure development, economic growth and the impact of the pandemic like COVID-19. National Remote Sensing Centre (NRSC), ISRO, has carried out Decadal trend analysis of Night Time Lights at National, State and District level and the outcome is depicted in this Atlas titled, "Decadal Change of Night Time Light (NTL) over India from Space (2012-2021)". The Atlas can be of immense help to those who are concerned with GDP vis-a-vis Socio-Economic and Environmental parameters. I applaud the efforts made by the team for their remarkable contribution in bringing out this National level Atlas as a ready reference for the users.

श्री एस. सोमनाथ / Shri S. Somanath,
अध्यक्ष इसरो, सचिव अंतरिक्ष विभाग/ Chairman ISRO, Secretary DOS

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Preface

Night Time Lights (NTL) represents the intensity of artificial lights which can be related to many dimensions of developmental activities on Earth. NTL data is obtained from VIIRS / DNB sensor on board combined mission of NASA and NOAA from space platform even in poor illumination conditions. NTL radiance of DNB is available in the mode of Daily, Monthly and Annual composite products and can be used for Spatio-temporal trend analysis over given time periods to understand its relationship with Environmental changes and Socio-Economic parameters like Electricity Consumption, GDP, Population, urban expansion, poverty etc.

NRSC carried out decadal analysis on NTL for the period 2012 to 2021. It involves processes like geo-tagging of NTL dataset, mosaic and extracting state and district level images and generate corresponding statistics. The complete process chain is automated which enables to perform data analytics with improved Turn Around Time(TAT).

The entire efforts are converted into an ATLAS for visualization and to circulate the same for decision makers. NTL statistics can also be published in Bhuvan to enable the users to get near real time information. I compliment all the Team Members of the project for their efforts in bringing out this NTL Atlas in more efficient way.

डॉ. प्रकाश चौहान/ Dr. Prakash Chauhan,

निदेशक, राष्ट्रीय सुदूर संवेदन केंद्र / Director, National Remote Sensing Centre

Executive Summary

There are many indicators available to keep and build economical and ecological resilience. Night Time Lights (NTL) which provide important insights can be considered as one of the indicators to monitor these activities. VIIRS/DNB a combined mission of NASA and NOAA, acquires Night Time Lights even in poor illumination conditions. Black Marble NTL product derived from VIIRS-DNB @ 15 arc-second spatial resolution are available in Daily, Monthly and Annual Composite from January 2012 onwards, addressed most of the NTL uncertainties. These products are processed through a chain of algorithms include Lunar BRDF, terrain and atmospheric corrections like Atmospheric airglow contamination, Stray light correction, Aurora removal, AOD effects, Cloud contamination etc.

NTL Annual composite is chosen for Decadal time series analysis for the period 2012 to 2021 covering entire India, to analyse National, State and District wise Night Time Light trend. The datasets are processed for Geo-Tag, Mosaic, Extract as per administrative boundaries and calculate statistics to perform trend analysis. Annual normalized Sum Of Lights (SoL) is calculated by aggregating the total radiance divided by total geographic area at different administrative units. To avoid background noise, the NTL radiance < 1.6 nW.cm-2.sr-1 [16*scale factor (0.1)] are excluded while calculating statistics.

Pan India, State/Union territories and most prominent Districts are considered for visual interpretation. Top most prominent Districts are selected considering Standard Deviation. Decadal trend for the period 2012 to 2021 are plotted in a graph. Due to Covid-19 pandemic, it is observed that in almost all of the states there is a dip in the year 2020. Therefore statistics to calculate change in NTL radiance over a period of time is calculated in three levels, between 2012 to 2019, 2019 to 2020 and 2020 to 2021. Trends can be very useful for correlating socio-economic and environmental parameters.

Acknowledgement

We sincerely thank **Team Black Marble and NOAA** for providing **NTL datasets**.

We would like to place on record our deep sense of gratitude to **Shri S. Somanath** Chairman, Indian Space Research Organisation (ISRO) and Secretary, Department of Space for inspiration and providing opportunity to work on "Decadal (2012-21) Change of Night Time Light(NTL) over India from Space".

We are grateful to **Dr. Prakash Chauhan**, Director, National Remote Sensing Centre (NRSC), ISRO for his constant encouragement, supervision and guidance during various phases of carrying out the project.

We express our sincere gratitude to **Shri Shantanu Bhatawdekar**, Scientific Secretary, ISRO for his overall support and encouragement.

We convey our sincere thanks to **Shri Ashish Desai**, Director DMEO, NITI Aayog for giving initial requirements and direction for correlation of socio-economic parameters with NTL datasets.

We also convey our sincere thanks to **Dr. M V Ramana,** ECSA, **Dr. Girish S Pujar**, RSAA for their valuable advises and **Team BGWSA** for their support during project execution.

Project Team

Project Guidance

- Dr. T Ravi Sankar (Deputy Director, BGWSA)
- Dr. S. Srinivasa Rao (Group Director, CGVAG)

Project Execution Team

- Mrs. Anjani RN (Scientist-SG, Head VASD)
- Mr. Nitin Mishra (Scientist- SE, VASD)
- Mrs. Savitha S (Scientist-SE, VASD)
- Mr. Kalyan Deep K (Scientist-SF, VASD)

Disclaimer

NRSC ensures that data analysis is generated through appropriate quality designed processes at each stage. If, despite these procedures, users find obvious errors or incorrect details in the data, they should contact Bhuvan NRSC, Hyderabad by email bhuvan@nrsc.gov.in. Since the results are calculated based on a combination of satellite based VIIRS night light radiance, geospatial datasets for admin boundary, where accuracy depends on various factors such as: environmental parameters, processing issues, digitization accuracy and human error. Therefore NRSC/ISRO does not confirm or guarantee the accuracy, reliability or completeness of any data provided. NRSC provides this data without warranties of any kind, whether express or implied. NRSC shall not be liable for incidental, consequential or special damages arising out of the use of any data provided by NRSC.

Table of Contents

Decadal Change of Night Time Light (NTL) over India from Space (2012 - 2021)

Introduction

For sustainable future, monitoring and analysing human activities on Earth is a very crucial factor to be done periodically. Night Time Lights (NTL) acquired by satellites is now-a-days becoming one of the indicator to analyse wide-range man made activities by correlating NTL with Land Use patterns, Socio-Economic parameters (like GDP, Poverty, Population, Electrical Consumption, Crime rates etc), Environment Variables (like Climate change, Carbon emissions etc)).

To carry out such analysis, a high quality, high spatio-temporal resolution and with a sufficient bandwidth of NTL data is required. Initially, in late 1960s the Defense Meteorological Satellite Program's Operational Line Scanner (DMSP/ OLS) acquired NTL imagery which were very useful during that period, however data was at low quality with lack of onboard calibration, atmospheric corrections and coarser resolution.

Visible Infrared Imaging Radiometer Suite (VIIRS) Day/Night Band (VIIRS / DNB) drawing heritage from DMSP/OLS, AVHHR, MODIS. It is a combined mission of National Aeronautics and Space Administration (NASA) and National Oceanic and Atmospheric Administration (NOAA). Soumi National Polar-orbiting Partnership (NPP) launched in the year 2011 and NOAA-20 launched in the year 2017 carried Visible Infrared Imaging Radiometer Suite (VIIRS) sensors have same specifications. Day/Night Band (DNB) is a broadband radiometer with spectral bandwidth 500-900nm, which is sensitive to retrieve Night light phenomena in Visible and Near Infrared Regions(VNIR) with spatial resolution of 750m. Then using the acquired DNB data, derived products are available at 15arc second spatial resolution from NASA Earth data. The performance of VIIRS/DNB is highly improved than DMSP/OLS, many processing elements were incorporated by NASA's Black Marble Product Suite to generate VIIRS-derived products, attained high quality NTL radiance by addressing removal of atmospheric effects like Lunar BRDF, Stray lights, Aurora, Atmospheric Airglow contamination, AOD etc. In addition to this more corrections like: Terrain correction, Vegetation phenology correction, Snow effects, Maximum Cloud Free etc., were also addressed.

Decadal Change of Night Time Light (NTL) over India from Space (2012 - 2021)

VIIRS in Soumi NPP and NOAA-20

➢ About the Mission

VIIRS is sensitive in VNIR region for land, ocean, and atmosphere. It is a combined mission of NASA and NOAA . It is a whiskbroom radiometer suite onboard Suomi NPP launched in 2011 and NOAA-20 launched in 2017. It has 22 channels ranging from 0.41 µm to 12.01 µm. Five of these channels are high-resolution image bands or **I-bands**, and sixteen serve as moderate-resolution bands or **M-bands**. VIIRS also hosts a unique panchromatic **Day/Night band** (DNB), which is ultra-sensitive in low-light conditions that allows us to observe night time lights(NTL) with better spatial and temporal resolutions compared to previously provided NTL data by the DMSP/OLS.

➢ Technical Specifications

Orbit:	**830km, 1:30pm mean local solar time. sun-synchronous, polar**
Repeat Cycle:	16 days
Swath Dimensions:	3000km, nearly global coverage every day
Weight:	275kg
Spatial Resolution:	750m
Data Rate:	5.9 Mbps
Quantization:	12 bits
Field of View:	deg
Wavebands:	9 visible/NIR bands plus day/night pan band 8 mid-IR 4 LW IR
Design Life:	7 years
Duration:	Operational

Source: https://ladsweb.modaps.eosdis.nasa.gov/missions-and-measurements/viirs/

Decadal Change of Night Time Light (NTL) over India from Space (2012 - 2021)

- **Spectral Bands**

Sno	Primary Earth Data Records	Band Name	Center (microns)	Width (FWHM)
1	Ocean Color Aerosol	M1	0.415	0.02
2		M2	0.445	0.02
3		M3	0.49	0.02
4		M4	0.555	0.02
5	Imagery band	I1	0.64	0.075
6	Ocean Color Aerosol	M5	0.673	0.021
7	Day/Night Band	DNB	0.7	0.4
8	Atmospheric Correction	M6	0.746	0.021
9	NDVI	I2	0.865	0.039
10	Ocean Color Aerosol	M7	0.865	0.039
11	Cloud Particle Size	M8	1.24	0.02
12	Cirrus Cloud Cover	M9	1.378	0.02
13	Binary Snow Map	I3	1.61	0.06
14	Snow Fraction	M10	1.61	0.06
15	Clouds	M11	2.25	0.05
16	Imagery band Clouds	I4	3.74	0.38
17	Sea Surface Temperature	M12	3.7	0.18
18	Sea Surface Temperature/Fires	M13	4.05	0.155
19	Cloud Top Properties	M14	8.55	0.3
20	Sea Surface Temperature	M15	10.763	1
21	Imagery band Clouds	I5	11.45	1.9
22	Sea Surface Temperature	M16	12.013	0.95

Source: https://ladsweb.modaps.eosdis.nasa.gov/missions-and-measurements/viirs/

Decadal Change of Night Time Light (NTL) over India from Space (2012 - 2021)

➢ **NASA's Black Marble VIIRS Day/Night Band Derived Products**

Black Marble NTL product @ 15 arc-second spatial resolution is available from January 2012 onwards, generated from VIIRS-DNB. These products are available with latency of 3 to 5 hours after acquisition, which enables users near real time access and long-term monitoring applications. The VNP46 product suite includes 4 types of products :

- **VNP46A1:** Daily at-sensor top of atmosphere (TOA) NTL Radiance.
- **VNP46A2:** Daily Lunar Bidirectional Reflectance Distribution Function(BRDF) and atmospherically corrected NTL Radiance. Atmospheric-Correction includes Atmospheric airglow contamination, Stray light correction, Aurora removal, AOD effects, Cloud contamination etc.
- **VNP46A3:** Monthly composites derived from VNP46A2 NTL radiance. Snow and Vegetation phonology effects are also removed.
- **VNP46A4:** Annual composite derived from VNP46A2 NTL radiances. Snow and Vegetation phonology effects are also removed.

VNP46A4 All Angle products are used for Atlas preparation

➢ **Decadal Trend Analysis**

In trend analysis relative comparison of values are important, among 3 view angle categories (all angle, near nadir, and off nadir), any one view angle category can provide significant information. In atlas VNP46A4 annual composites of All angle Snow Free NTL radiance are considered along with quality flag. The “all-angles” composite radiance are calculated based on all valid high-quality clear-sky observations. All angles sense more light from direct lights installed on building facade, building reflected lights, indoor lights through windows etc., and quality layer ensures elimination of poor quality pixels from analysis. Radiance value are unsigned 16 bits (i.e. 0- 65535) with 0.1 scale factor.

Decadal Change of Night Time Light (NTL) over India from Space (2012 - 2021)

Since VNP46A4 products are derived from VNP46A2 where NTL uncertainties like view geometry, surface BRDF/albedo, lunar irradiance, aerosol, cloud, snow, vegetation, geometric, and aurora were addressed. VNP46A2 products have geo-location uncertainty of 50m and NTL radiance robustness of +/- 0.1nW.cm^{-2}.sr^{-1}.

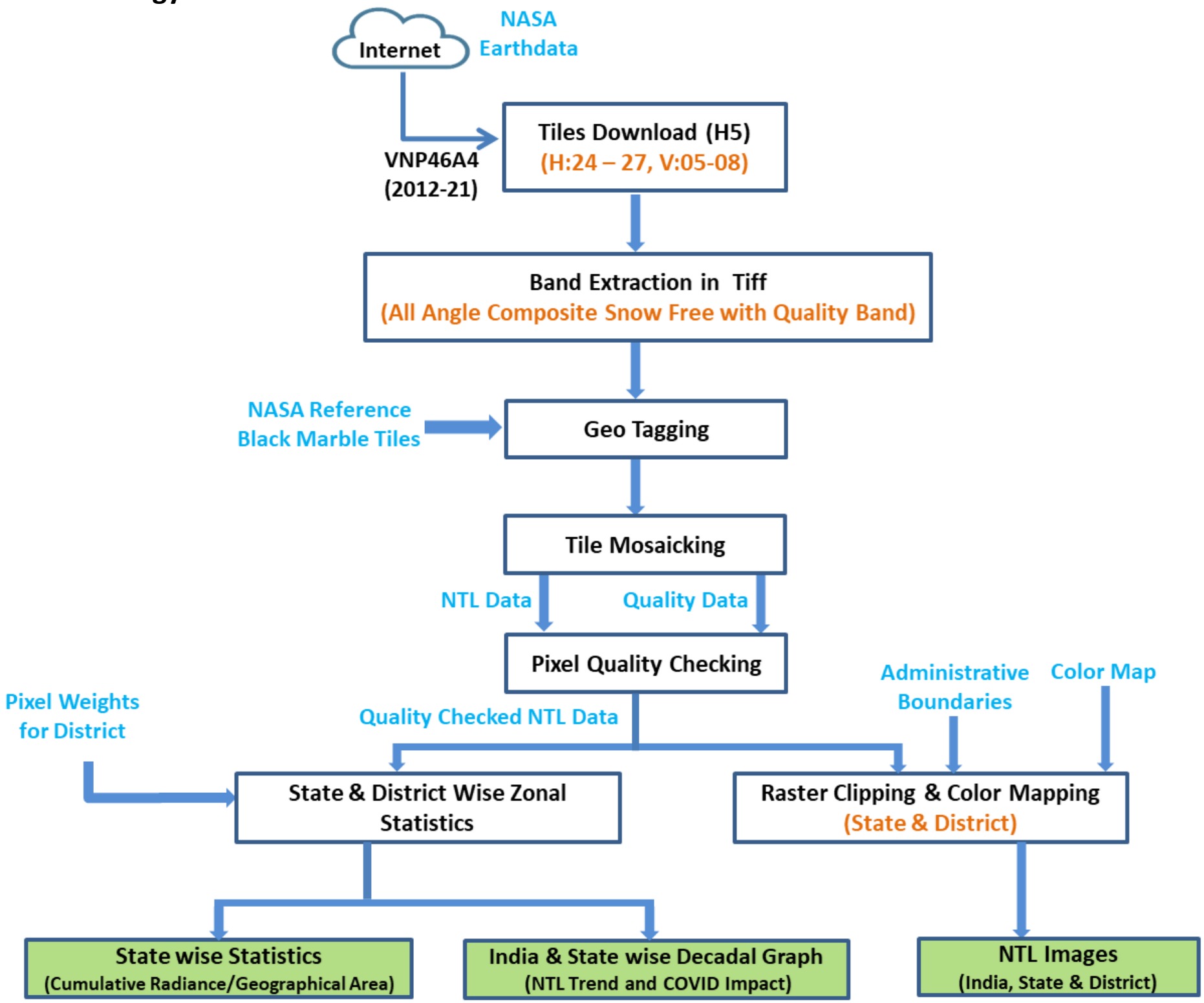
Upwelling NTL lights varies greatly not only due to human activities but also due to other factors like: more oblique view geometries, three-dimensional structure of vegetation canopies like: leaf-off and leaf-on periods etc.

Annual composites are derived from VNP46A2 daily products considered good quality NTL radiance as valid number of observations (max 365 observations) after removing outlier using boxplot metric. To avoid background noise NTL radiance less than 1.6 nW . cm^{-2} . sr^{-1} [16*scale factor(0.1)] are excluded while calculating statistics.

National level, State level and District level statistics are calculated for each year and derived normalized value by sum of NTL radiance for region/total area of region, where excluded poor quality NTL radiance. Most prominent districts are selected using standard deviation. Graphs are plotted for the period of 2012 to 2021 for trend analysis. The percentage of change is calculated using with formulae **[100 *[Normalized Rad (2021) – Normalized Rad (2012)] / Normalized Rad(2012)]** for the period 2012 to 2021. Accordingly, the percentage change from 2019 to 2020 and between 2020 to 2021 are calculated for each state.

Decadal Change of Night Time Light (NTL) over India from Space (2012 - 2021)

➢ **Methodology Workflow**

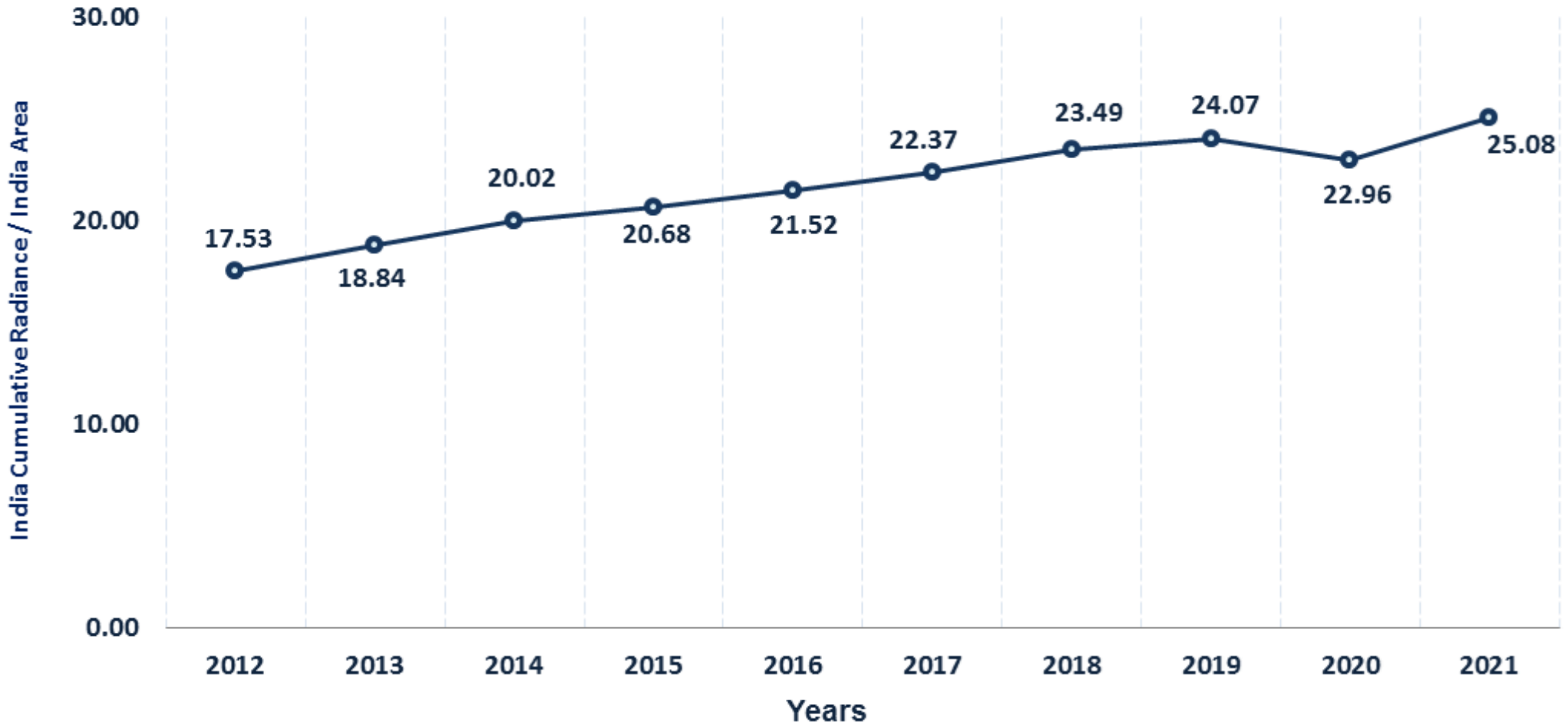


Results and Statistics

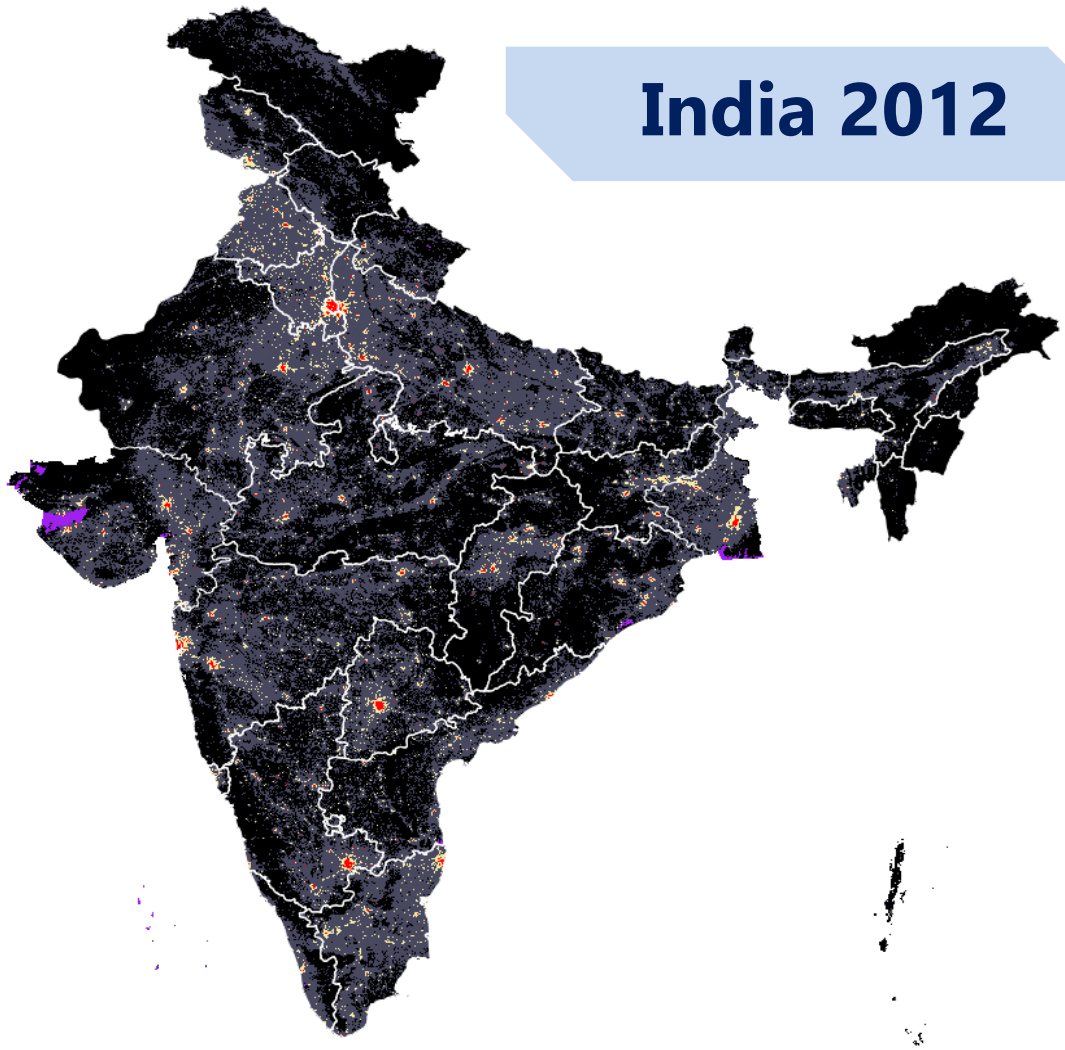
- *Overall at National level, normalized NTL radiance (**Cumulative NTL radiance / Geographic Area**) is increased by 43% in the year 2021 w.r.t 2012*
- *Significant increase observed in Bihar, Manipur, Ladakh and Kerala.*
- *Good increase observed in Arunachal Pradesh, Madhya Pradesh, Uttar Pradesh and Gujarat.*
- *Moderate increase observed in Lakshadweep, Maharashtra, Tamilnadu, Jharkhand, Haryana, Punjab, West Bengal, Uttaranchal, Karnataka, Odisha, Telangana, Andhra Pradesh, Nagaland, Chandigarh, Himachal Pradesh, Rajasthan, Tripura, Goa, Chhattisgarh, Assam, Andaman And Nicobar, Meghalaya, Jammu & Kashmir.*
- *In most of the States, a fall in NTL cumulative radiance observed in the year 2020, and this could be the impact of COVID-19 Pandemic.*
- *Again, in most of the States there is a rise observed in the year 2021 for NTL cumulative radiance.*

S No.	State / Union Territories	Geograhical Area	Cumulative Radiance of State / State Area	
			$nW.cm^{-2}.sr^{-1}$/sq.km [Scale Factor 0.1]	
		Sq. Km	2012	2021
1	ANDAMAN AND NICOBAR	6841.05	2.28	2.52
2	ANDHRA PRADESH	163095.77	12.05	15.34
3	ARUNACHAL PRADESH	82115.12	0.78	1.30
4	ASSAM	78481.76	10.81	12.06
5	BIHAR	94110.01	8.36	47.97
6	CHANDIGARH	118.31	1100.69	1361.69
7	CHHATTISGARH	135225.82	14.42	16.13
8	DADRA & NAGAR HAVELI	493.41	177.17	147.83
9	DAMAN AND DIU	109.20	392.55	335.25
10	DELHI	1504.14	1640.33	1512.98
11	GOA	3628.94	56.88	63.73
12	GUJARAT	185787.78	20.69	32.68
13	HARYANA	44117.14	58.75	80.12
14	HIMACHAL PRADESH	55701.22	3.53	4.33
15	JAMMU & KASHMIR	53248.44	16.83	17.78
16	JHARKHAND	79880.47	19.15	26.76
17	KARNATAKA	191736.54	25.25	32.99
18	KERALA	38821.63	11.25	24.64
19	LADAKH	168646.90	0.07	0.28
20	LAKSHADWEEP	457.42	0.93	1.36
21	MADHYA PRADESH	308145.56	8.99	14.95
22	MAHARASHTRA	307683.71	18.34	26.36
23	MANIPUR	22302.20	0.88	4.76
24	MEGHALAYA	22448.17	3.77	4.01
25	MIZORAM	21101.53	0.74	0.74
26	NAGALAND	16598.85	3.34	4.19
27	ODISHA	155873.56	12.18	15.88
28	PUDUCHERRY	487.07	255.25	221.20
29	PUNJAB	50426.66	46.88	61.94
30	RAJASTHAN	342463.04	12.42	15.15
31	SIKKIM	7134.82	3.66	2.19
32	TAMILNADU	129945.69	27.00	38.67
33	TELANGANA	111802.53	29.60	38.38
34	TRIPURA	10440.54	13.57	15.66
35	UTTAR PRADESH	240778.68	26.96	43.50
36	UTTARANCHAL	53694.66	14.70	19.24
37	WEST BENGAL	85307.81	34.21	44.97

Decadal Change of Night Time Light (NTL) over India from Space (2012 - 2021)



Approx. **43% increase** observed from 2012 to 2021 with respect to base year 2012, then **5% decrease** observed in 2020 with respect to 2019, which could be due to COVID-19 pandemic and **9% increase** observed in 2021 with respect to 2020.



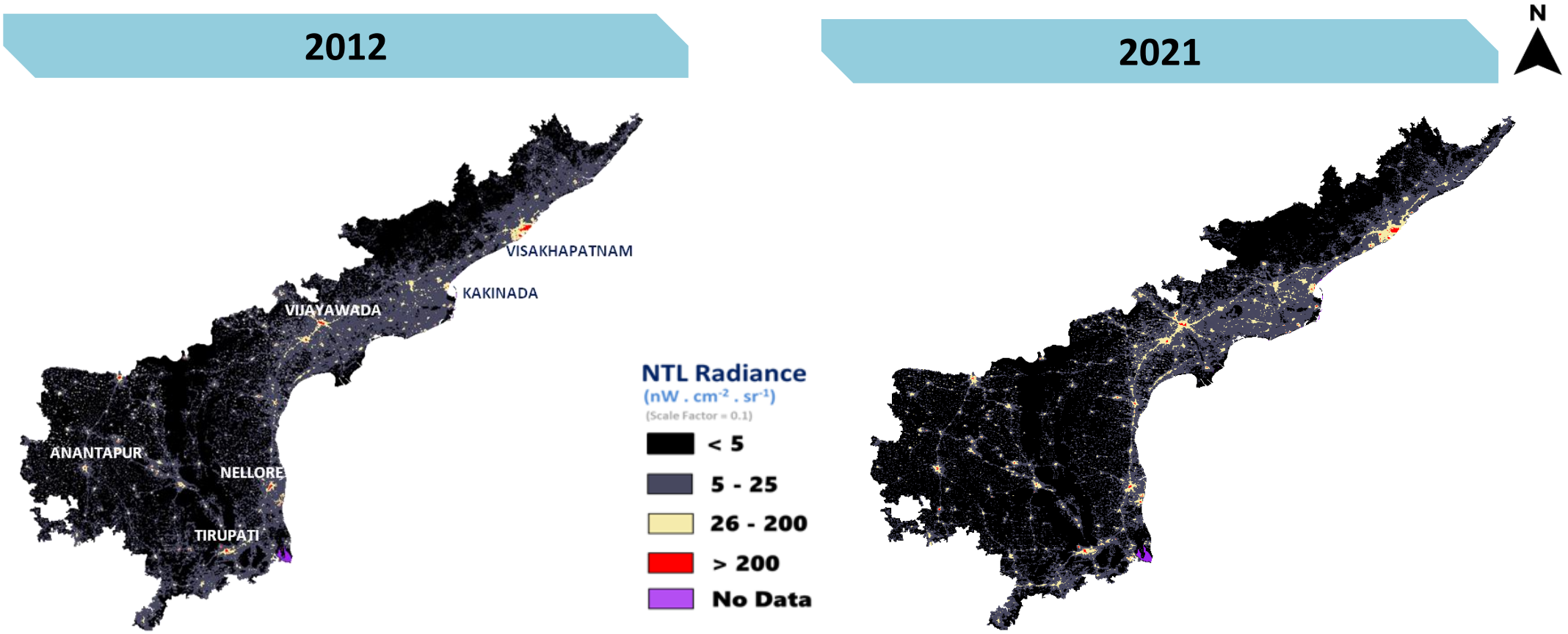
India 2012

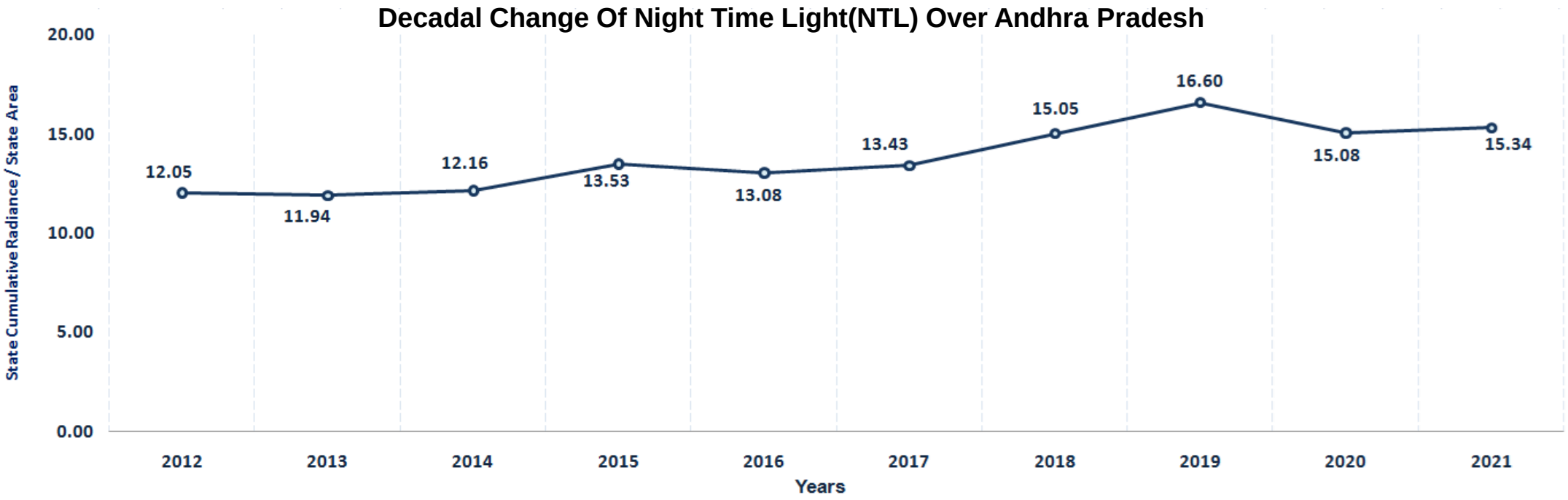
India 2021

NTL Radiance
(nW . cm^{-2} . sr^{-1})
(Scale Factor = 0.1)

- < 5
- 5 - 25
- 26 - 200
- > 200
- No Data

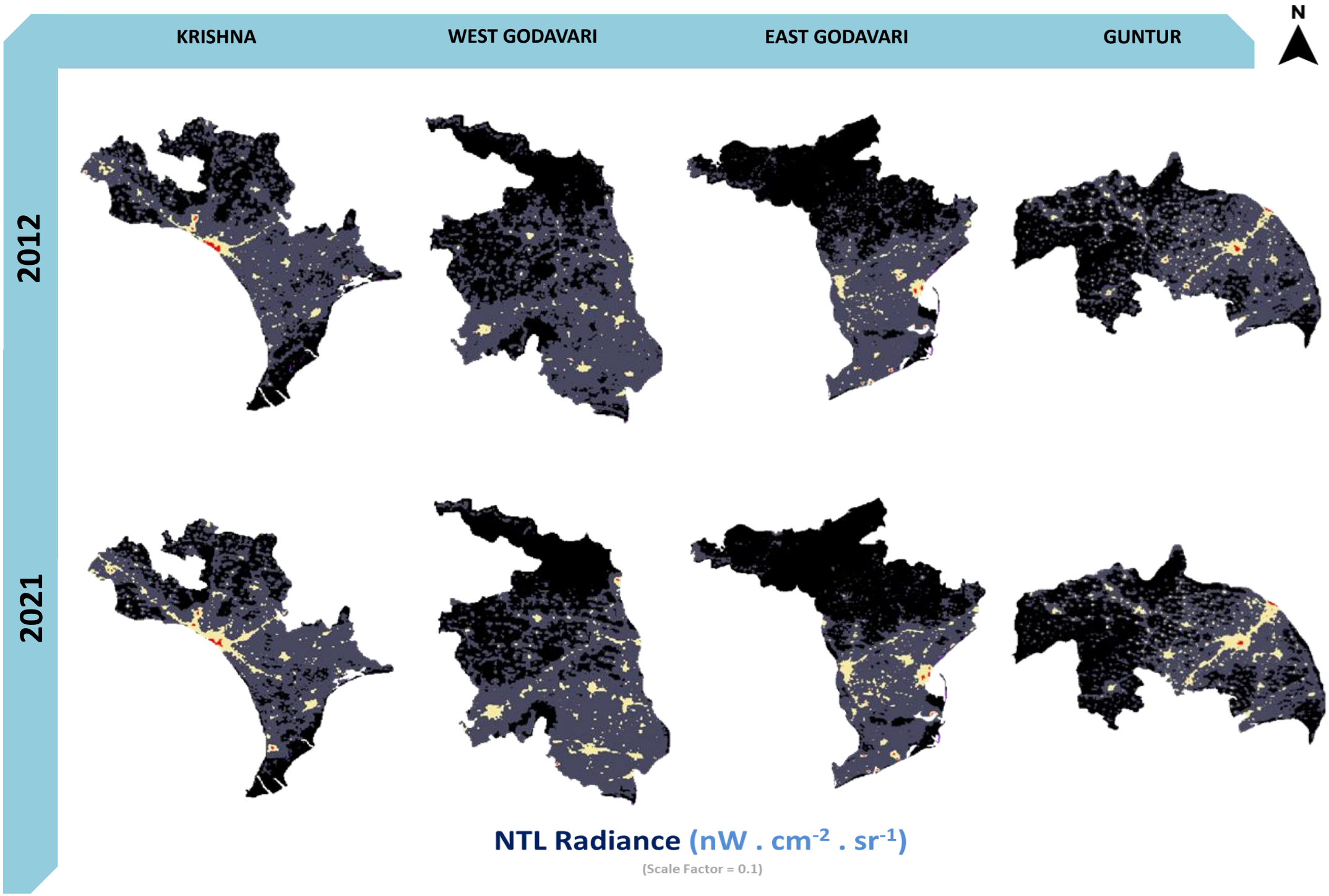
Andhra Pradesh





Approx. **27% increase** observed from 2012 to 2021 w.r.t. 2012, then **9% decrease** observed in 2020 w.r.t 2019 and **2% increase** observed in 2021 w.r.t 2020.

Most prominent changes in the districts of Andhra Pradesh

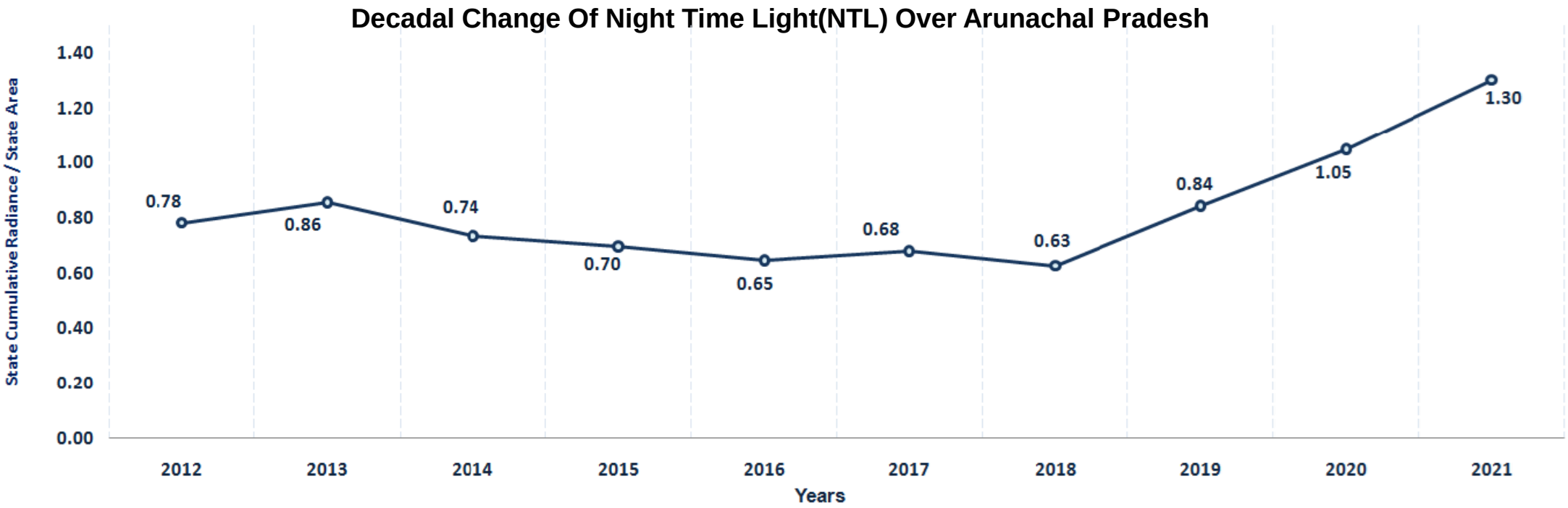


Arunachal Pradesh

NTL Radiance (nW . cm^{-2} . sr^{-1})

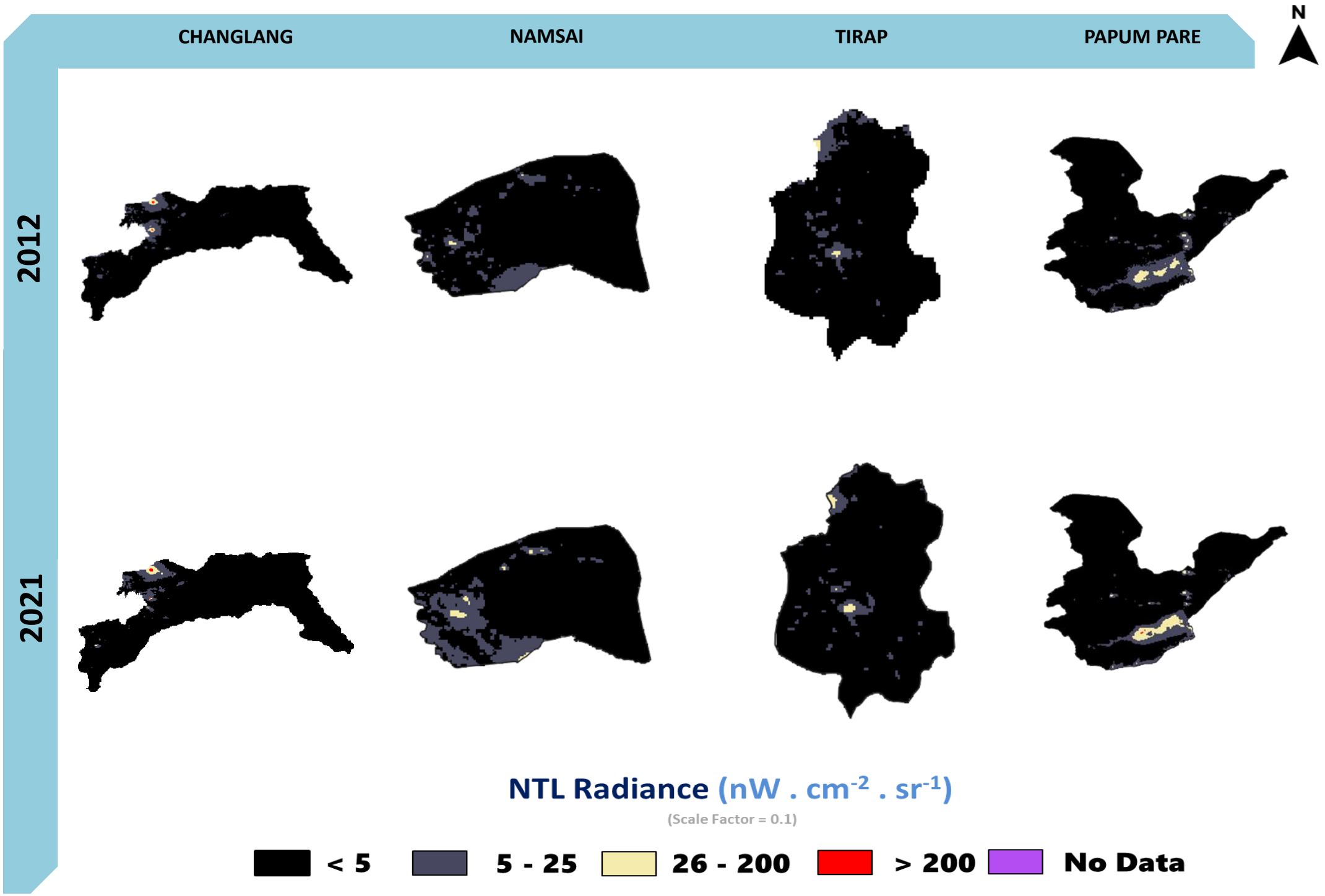
(Scale Factor = 0.1)

< 5 | 5 - 25 | 26 - 200 | > 200 | No Data

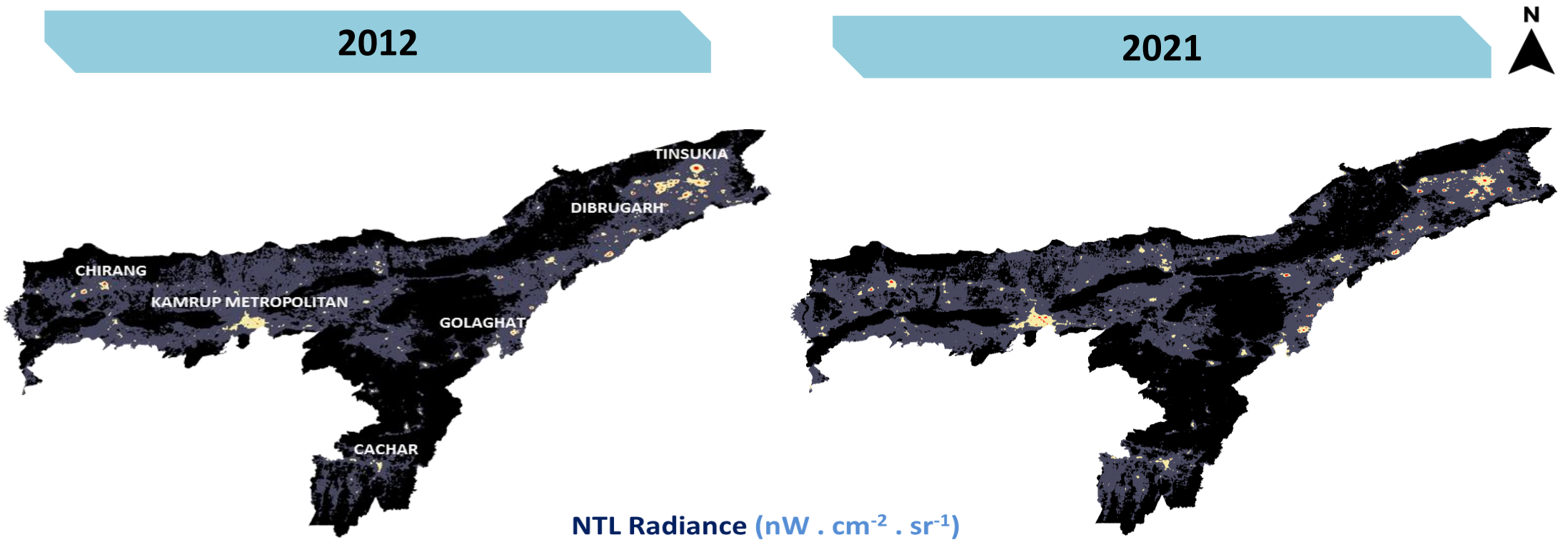


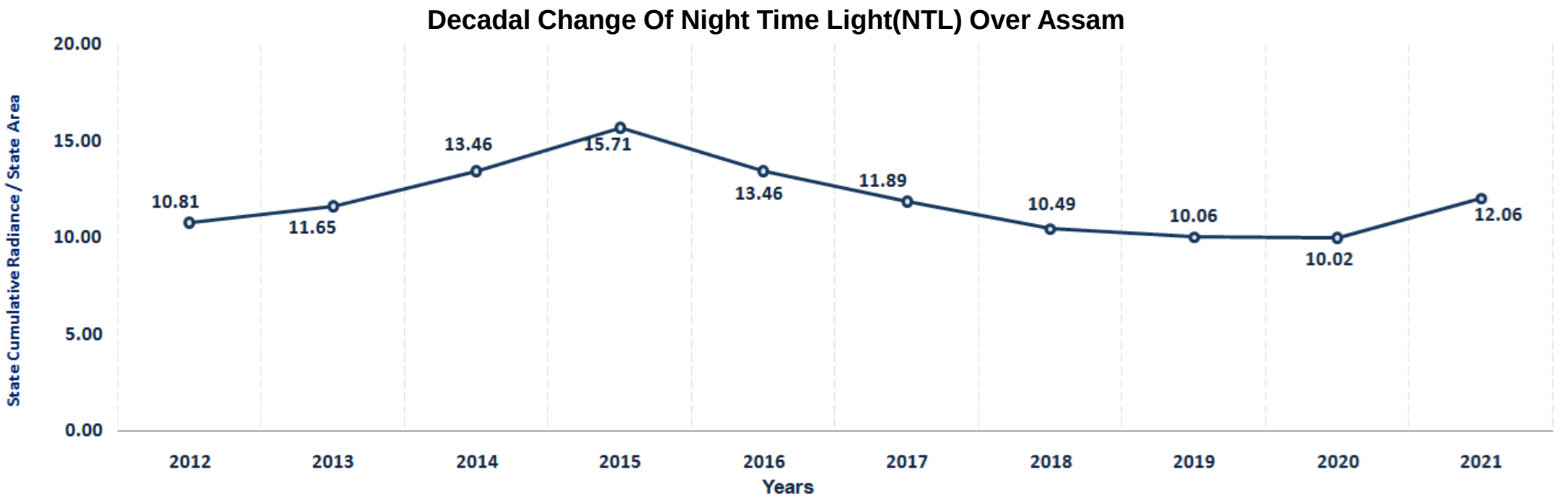
Approx. **66% increase** observed from 2012 to 2021 w.r.t. 2012, then **24% decrease** observed in 2020 w.r.t 2019 and **24% increase** observed in 2021 w.r.t 2020.

Most prominent changes in the districts of Arunachal Pradesh



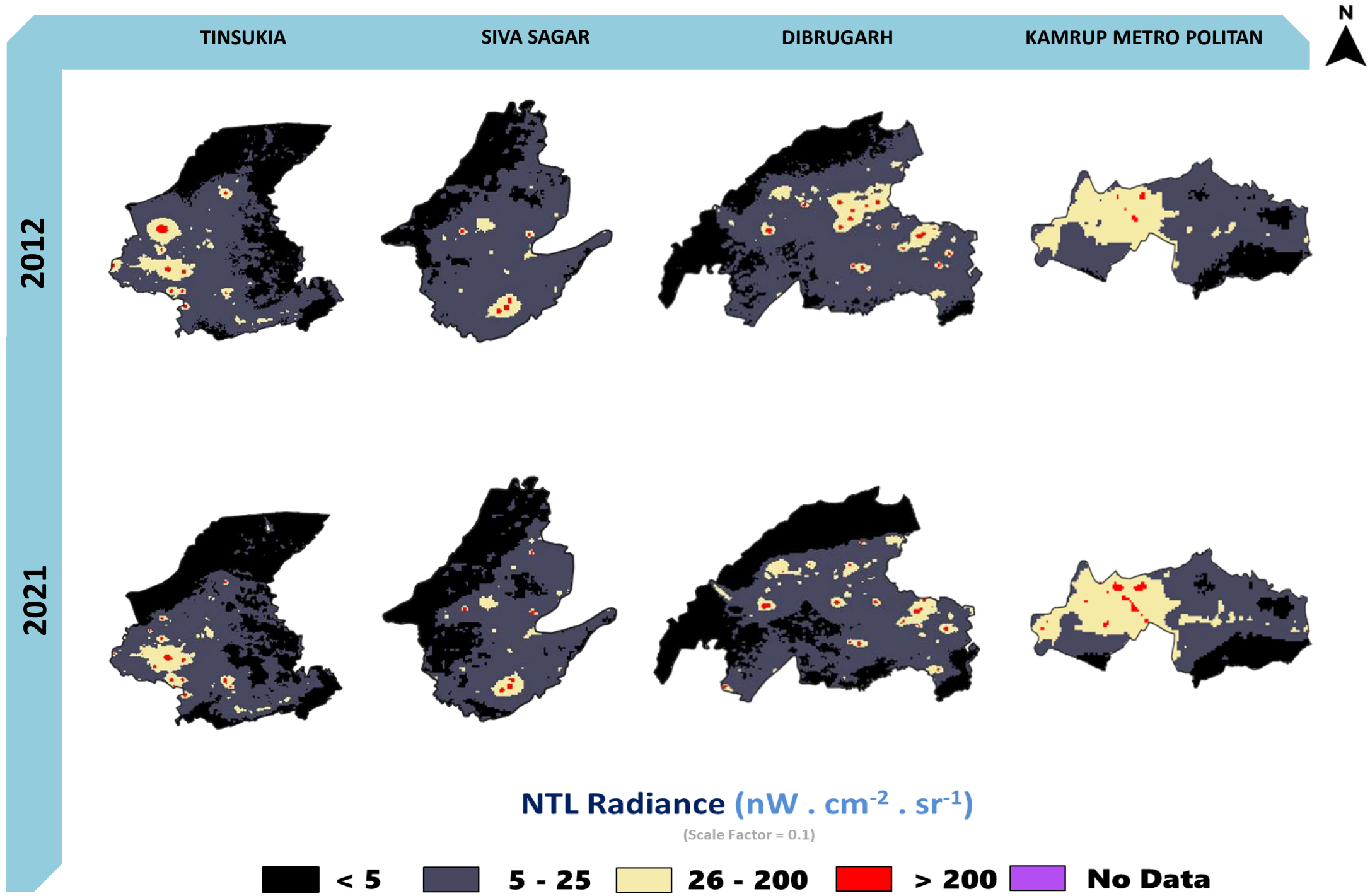
Assam



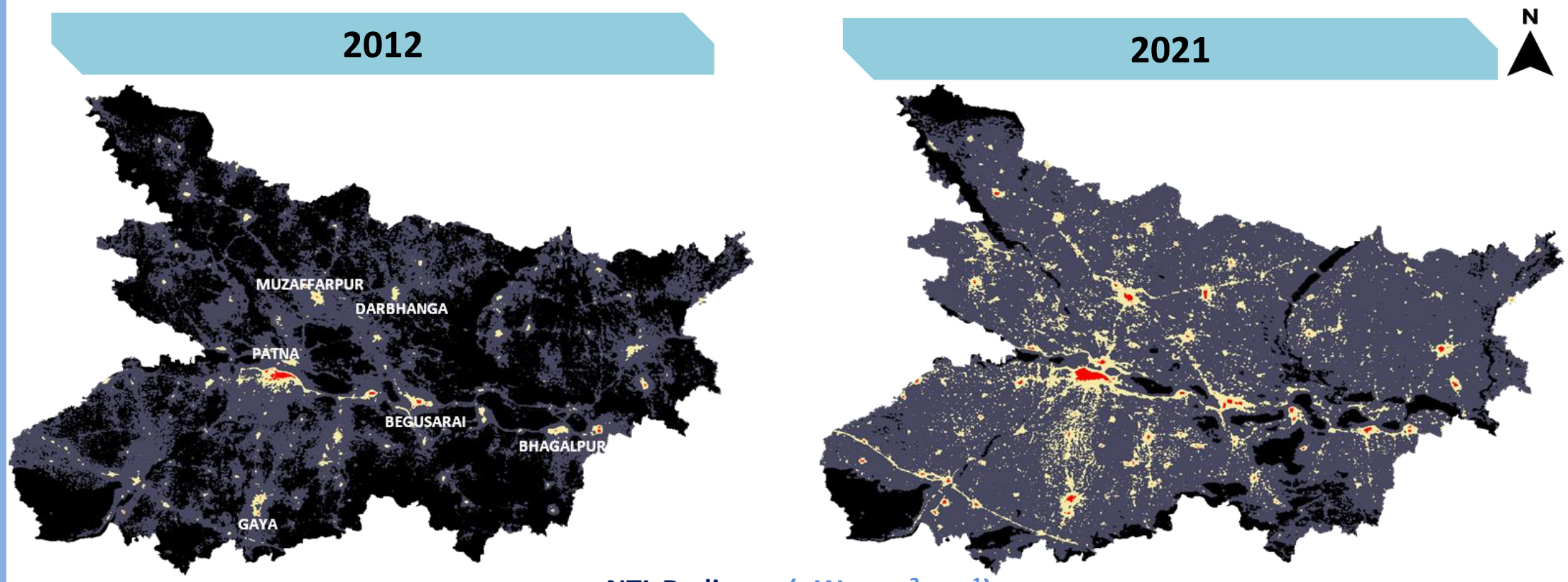


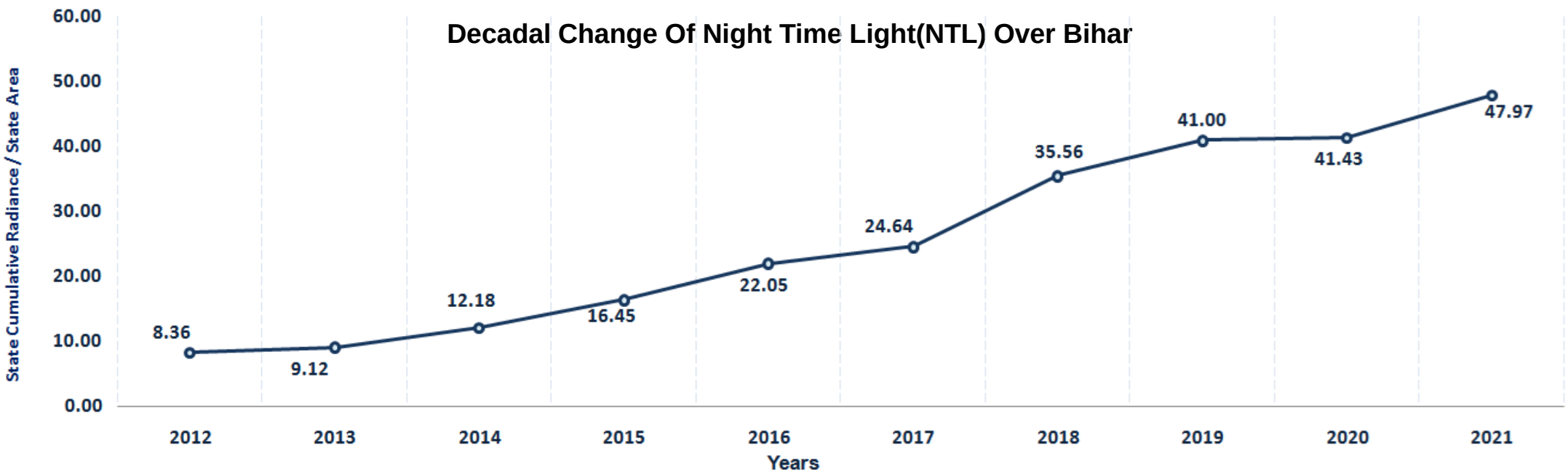
Approx. **12% increase** observed from 2012 to 2021 w.r.t. 2012, then **0.4% decrease** observed in 2020 w.r.t 2019 and **20% increase** observed in 2021 w.r.t 2020.

Most prominent changes in the districts of Assam



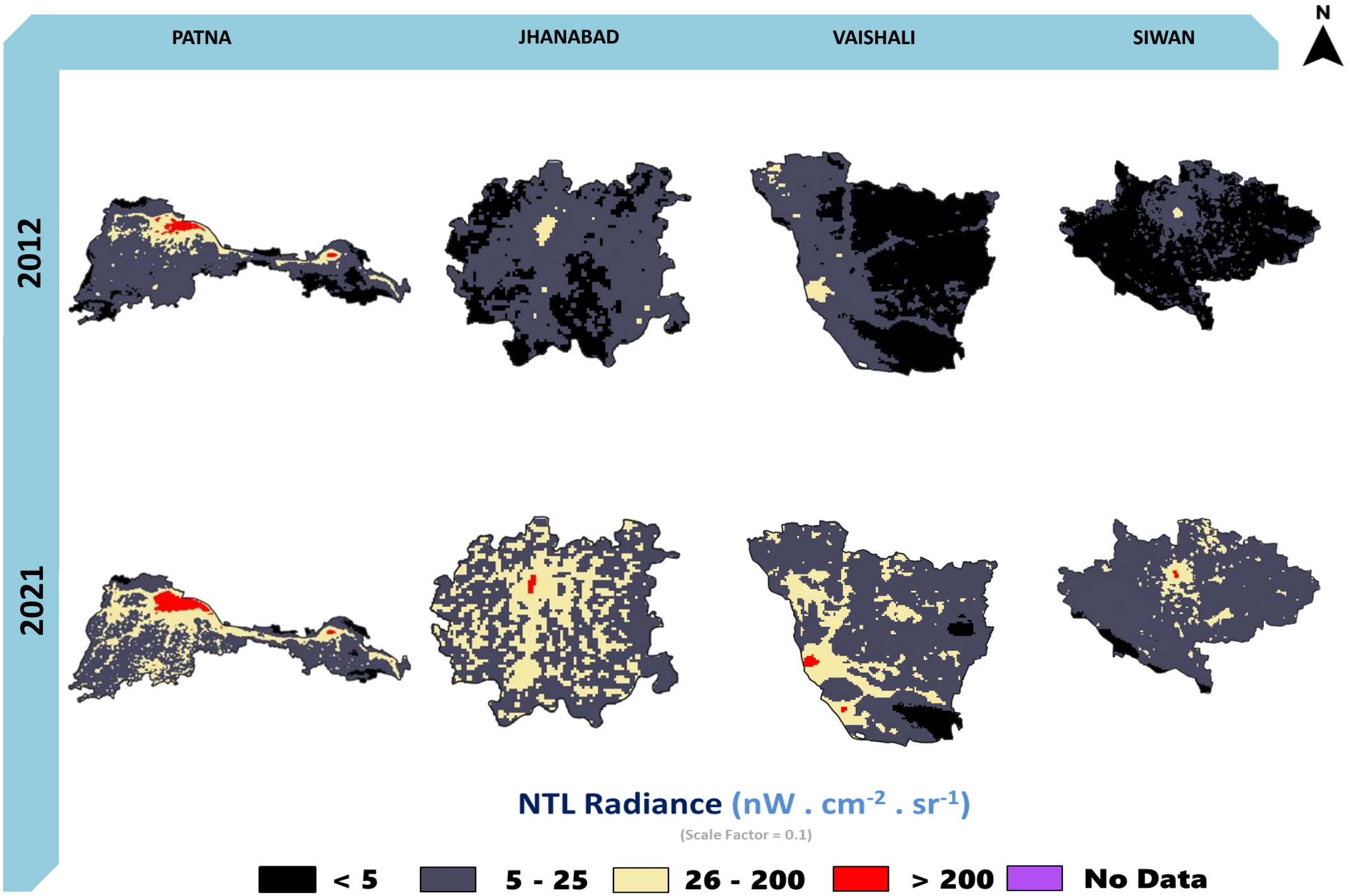
Bihar



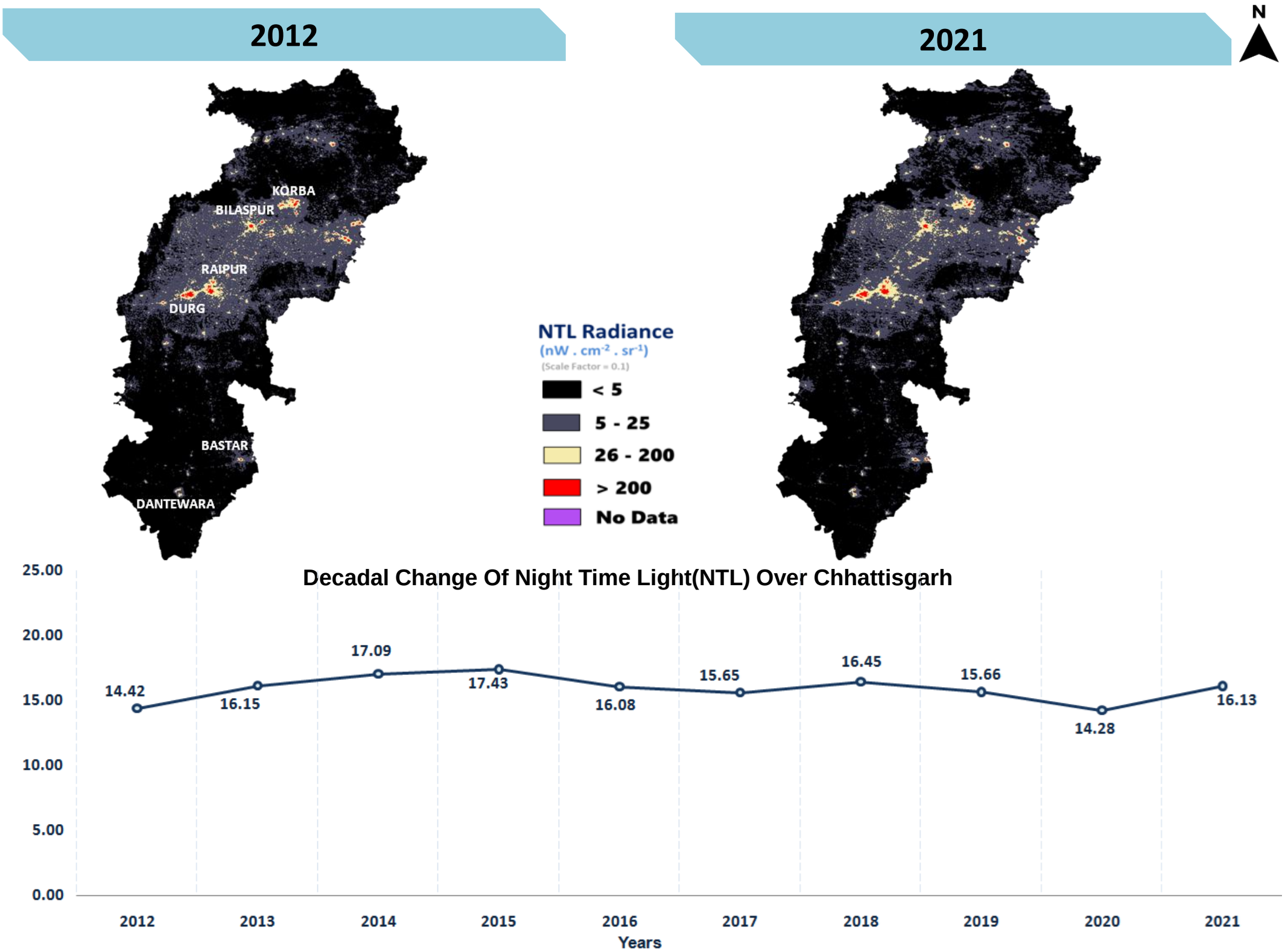


Approx. **474% increase** observed from 2012 to 2021 w.r.t. 2012, then **1% increase** observed in 2020 w.r.t 2019 and **16% increase** observed in 2021 w.r.t 2020.

Most prominent changes in the districts of Bihar

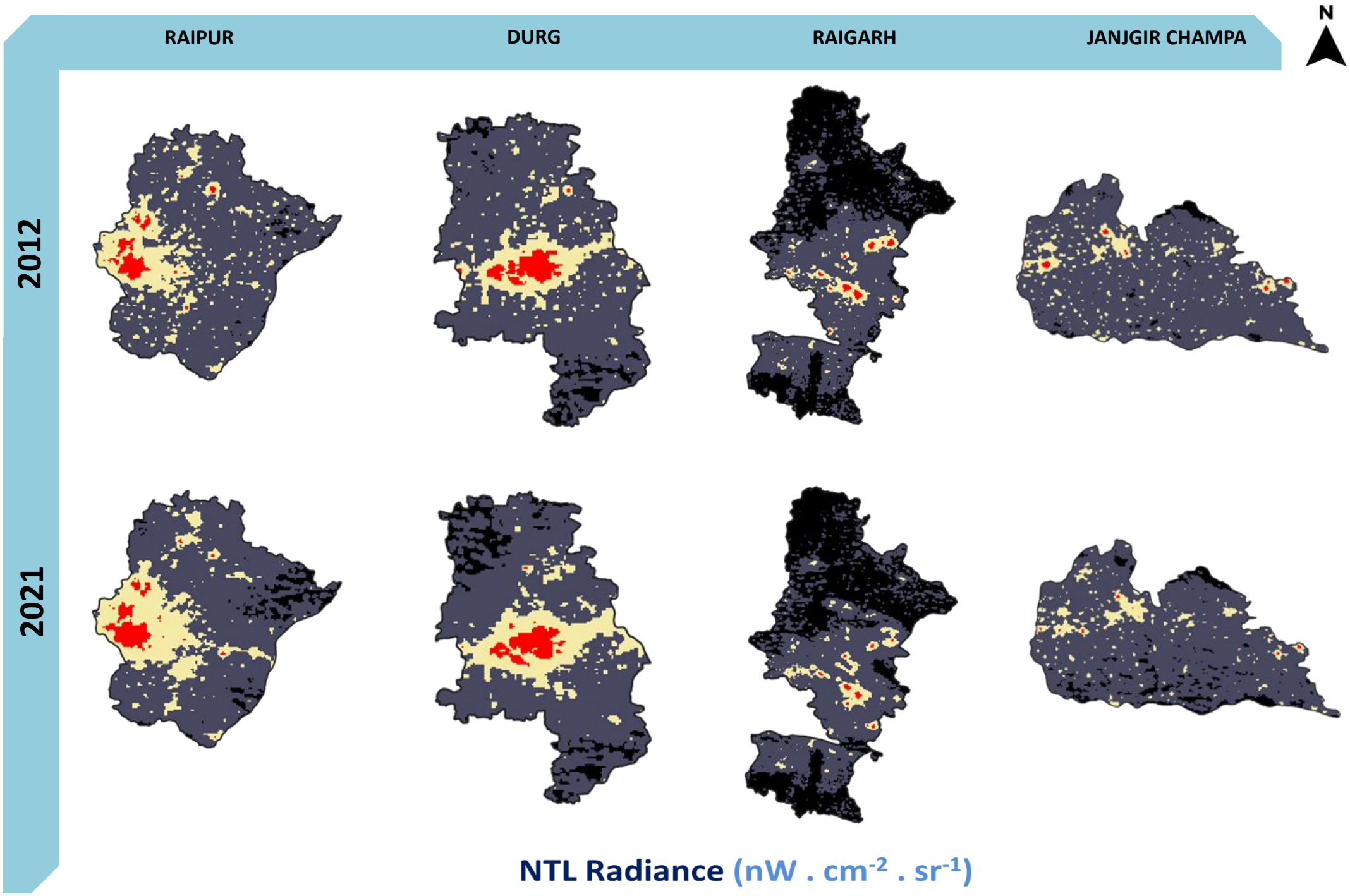


Chhattisgarh

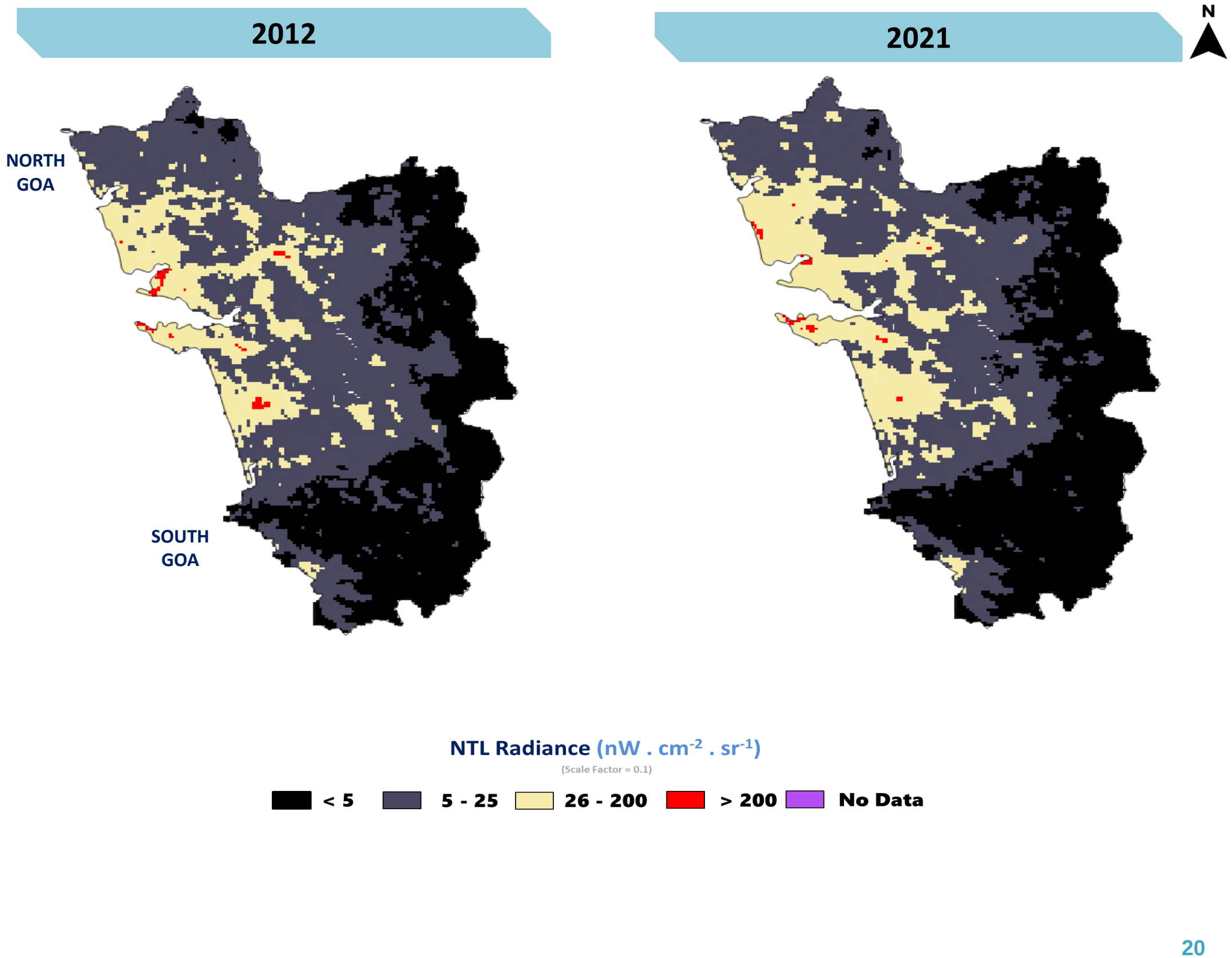


Approx. **12% increase** observed from 2012 to 2021 w.r.t. 2012, then **9% decrease** observed in 2020 w.r.t 2019 and **13% increase** observed in 2021 w.r.t 2020.

Most prominent changes in the districts of Chhattisgarh

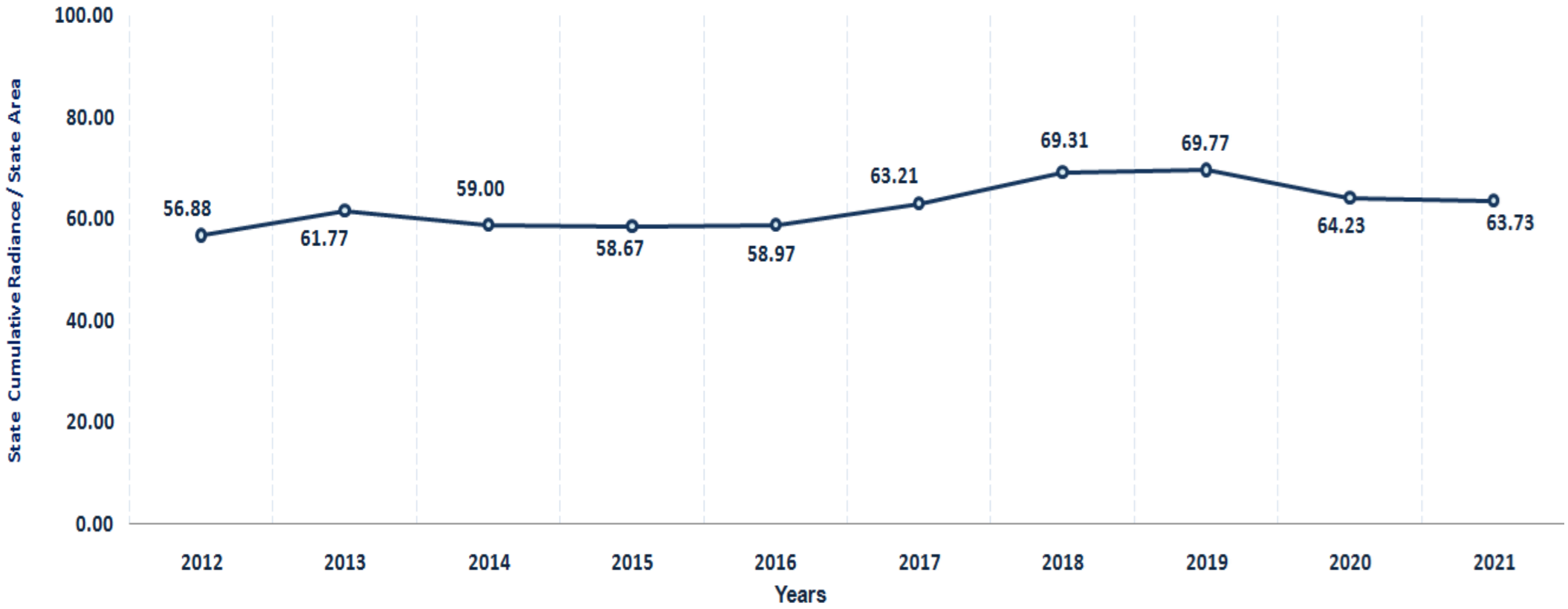


Goa


2012
2021
N
NORTH GOA
SOUTH GOA
NTL Radiance (nW . cm-2 . sr-1)
(Scale Factor = 0.1)
< 5
5 - 25
26 - 200
> 200
No Data

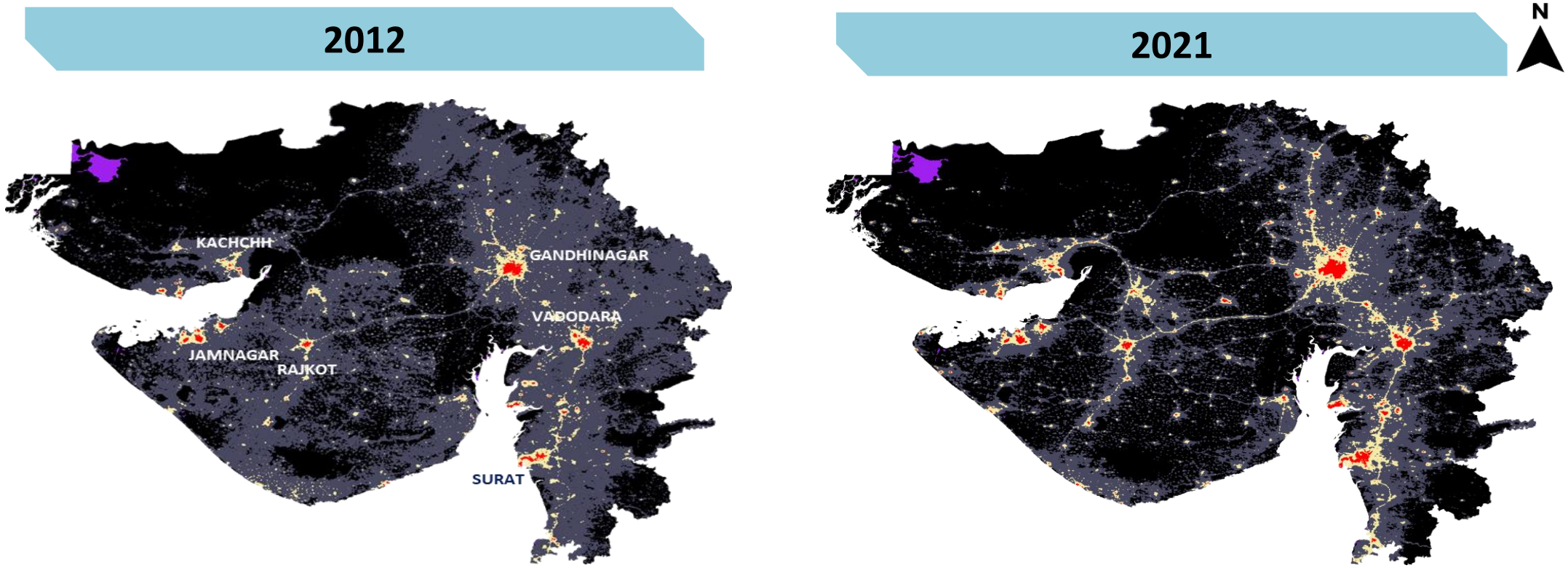
Goa

Decadal Change Of Night Time Light (NTL) Over Goa



Approx. **12% increase** observed from 2012 to 2021 w.r.t. 2012, then **2.6% decrease** observed in 2020 w.r.t 2019 and **9.5% increase** observed in 2021 w.r.t 2020.

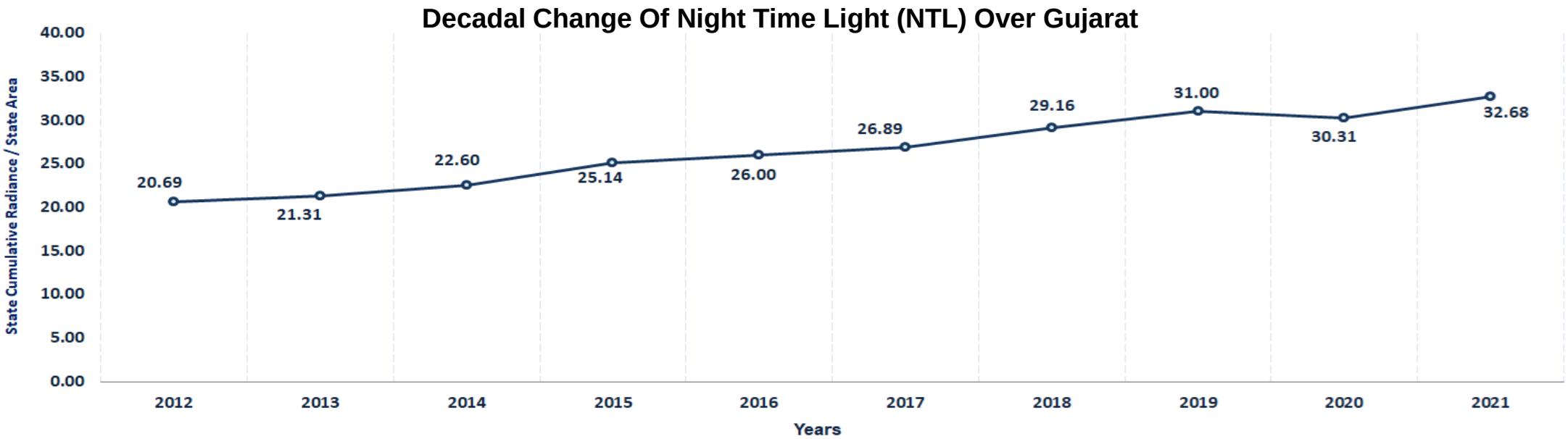
Gujarat



NTL Radiance ($nW \cdot cm^{-2} \cdot sr^{-1}$)

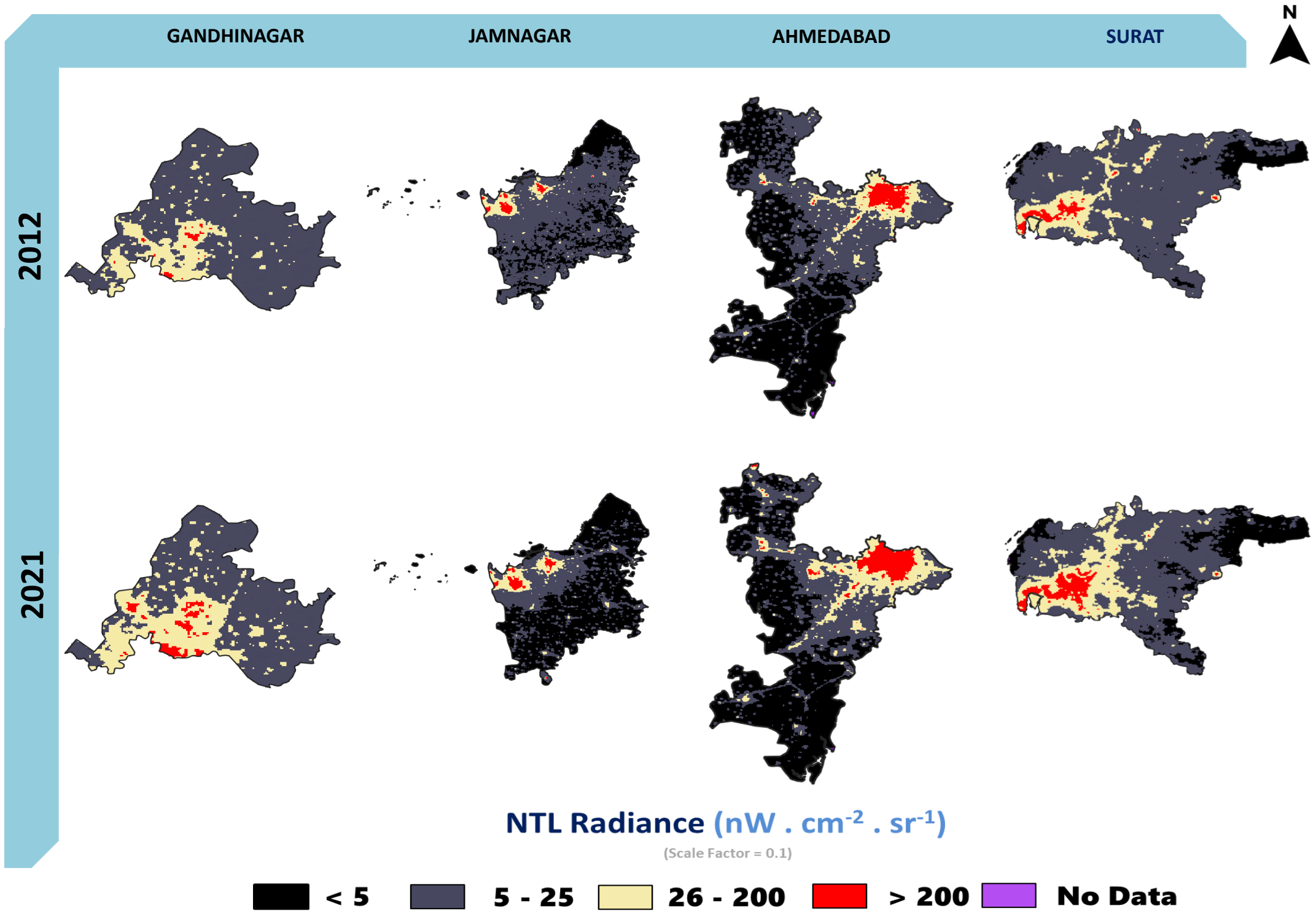
(Scale Factor = 0.1)

< 5 | 5 - 25 | 26 - 200 | > 200 | No Data

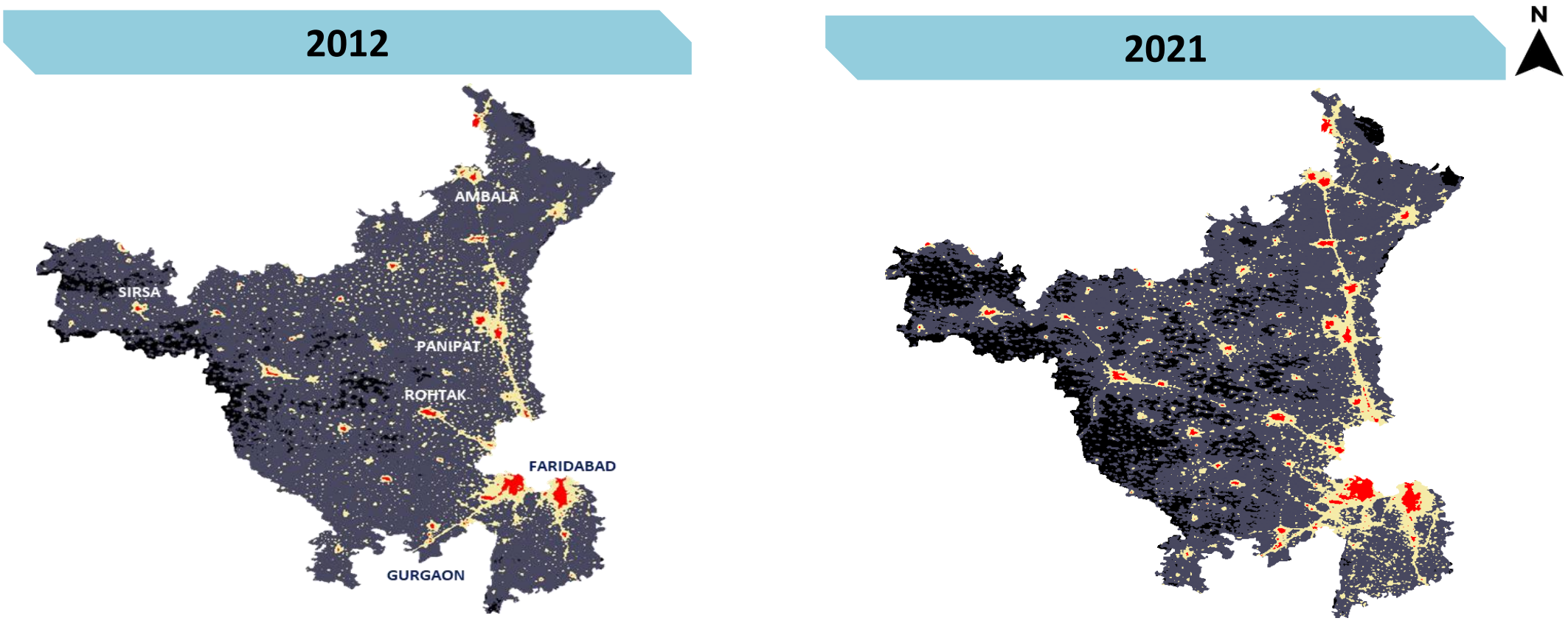


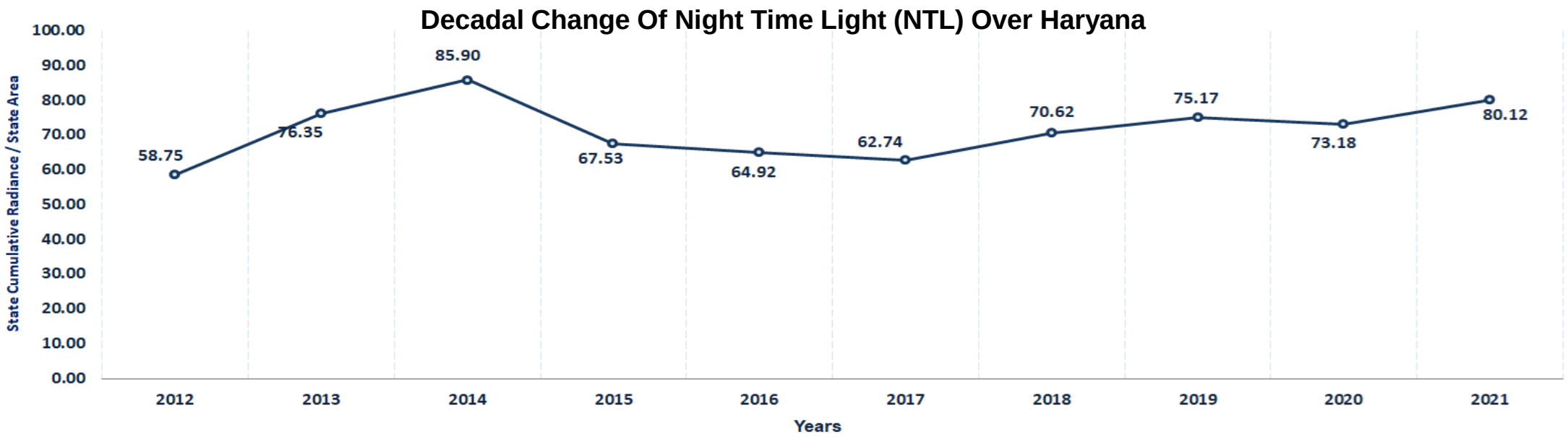
Approx. **58% increase** observed from 2012 to 2021 w.r.t. 2012, then **2.2% decrease** observed in 2020 w.r.t 2019 and **7.8% increase** observed in 2021 w.r.t 2020.

Most prominent changes in the districts of Gujarat



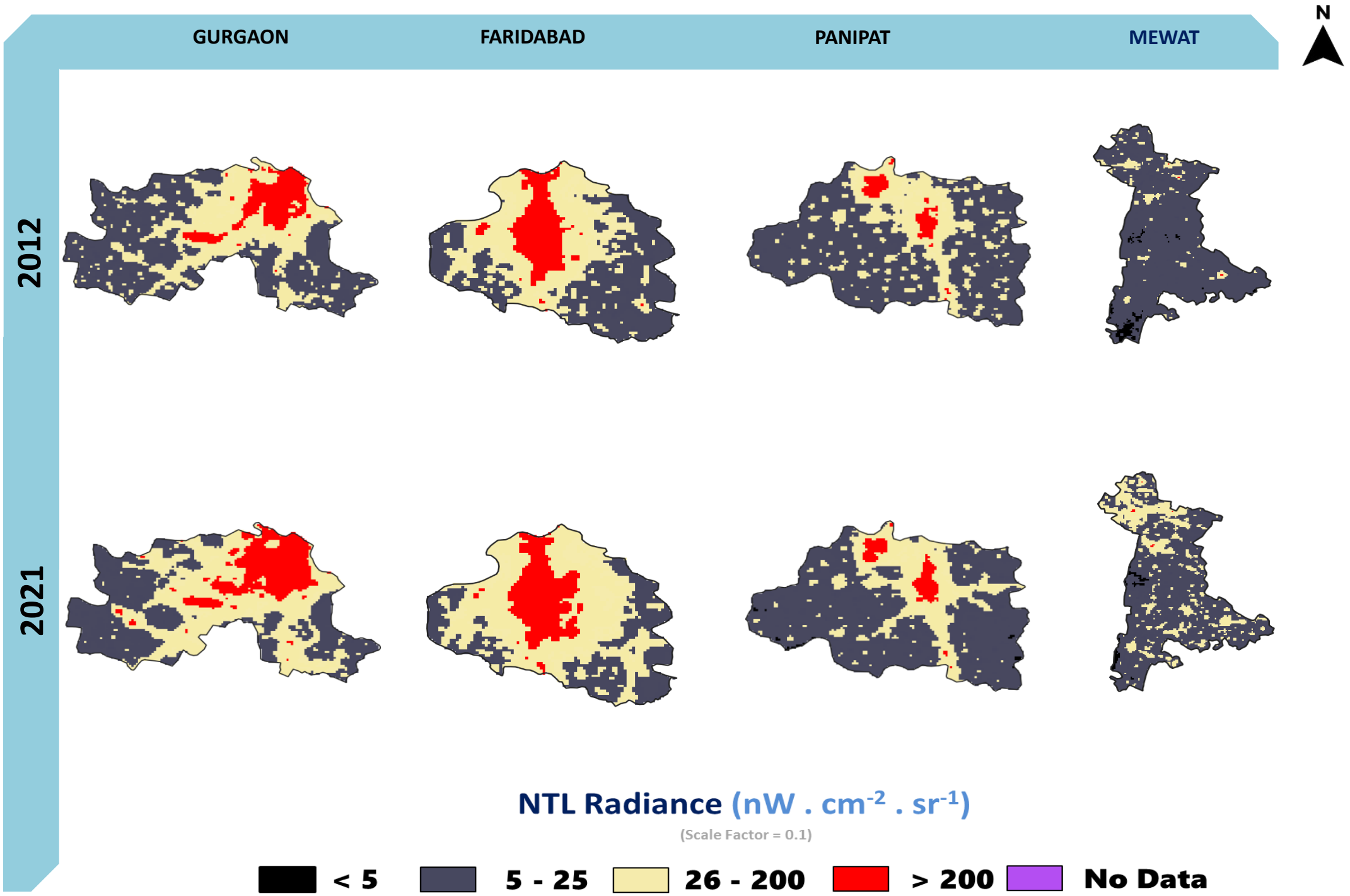
Haryana



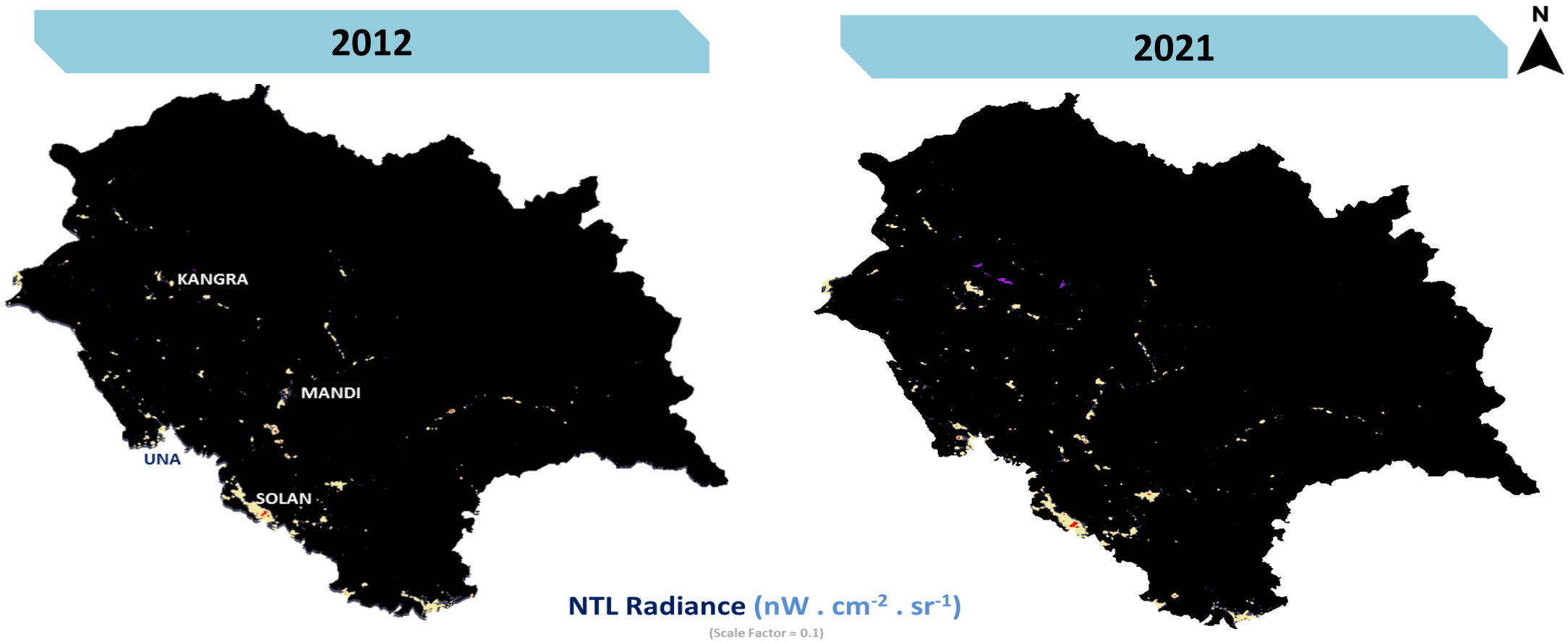


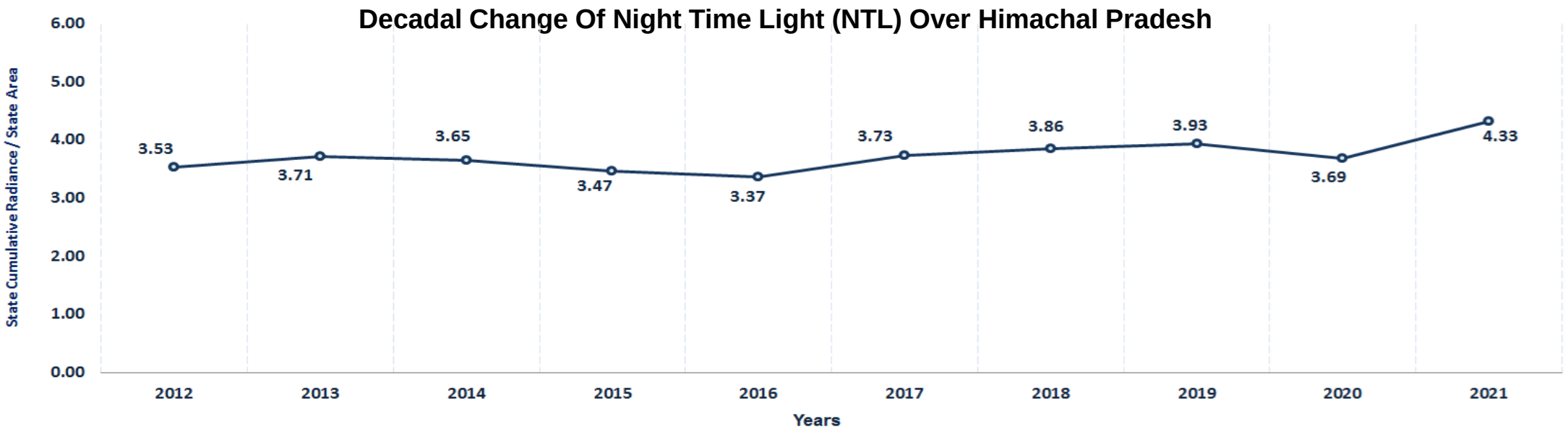
Approx. **36% increase** observed from 2012 to 2021 w.r.t. 2012, then **2.6% decrease** observed in 2020 w.r.t 2019 and **9.5% increase** observed in 2021 w.r.t 2020.

Most prominent changes in the districts of Haryana



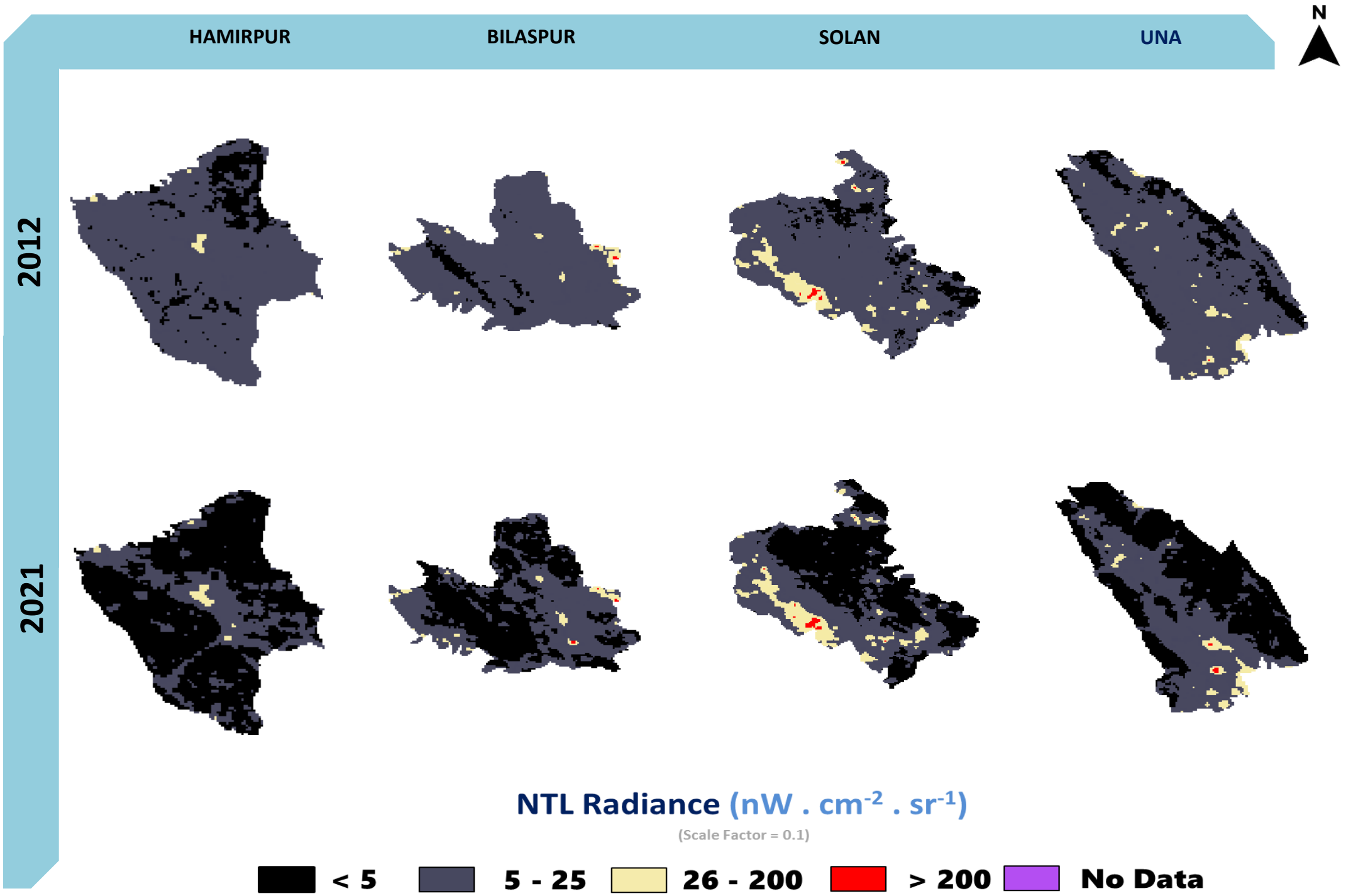
Himachal Pradesh



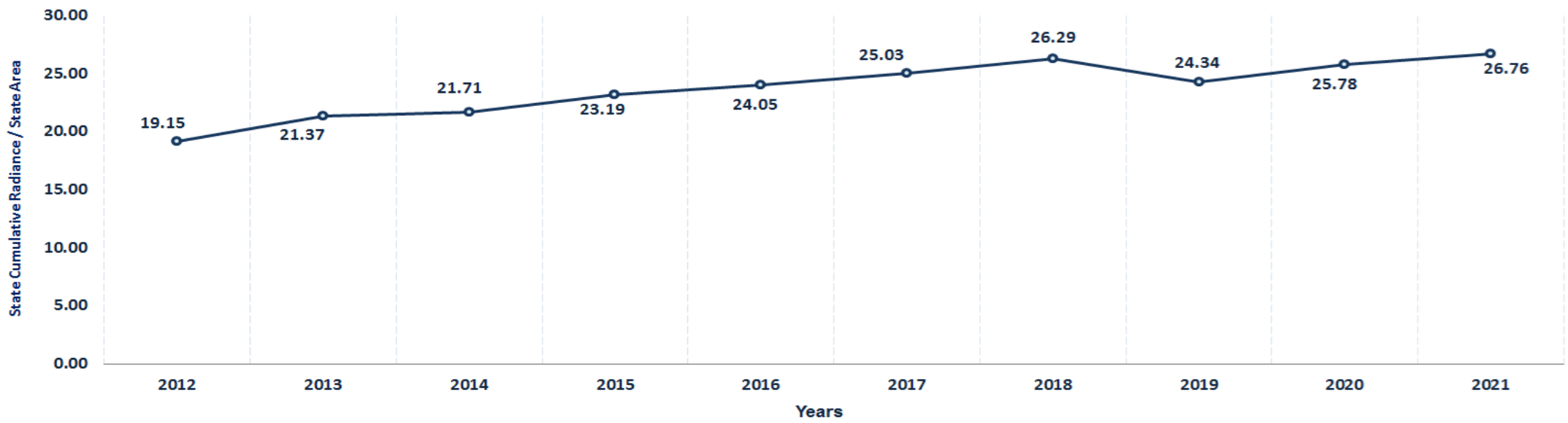


Approx. **22% increase** observed from 2012 to 2021 w.r.t. 2012, then **6% decrease** observed in 2020 w.r.t 2019 and **17% increase** observed in 2021 w.r.t 2020.

Most prominent changes in the districts of Himachal Pradesh

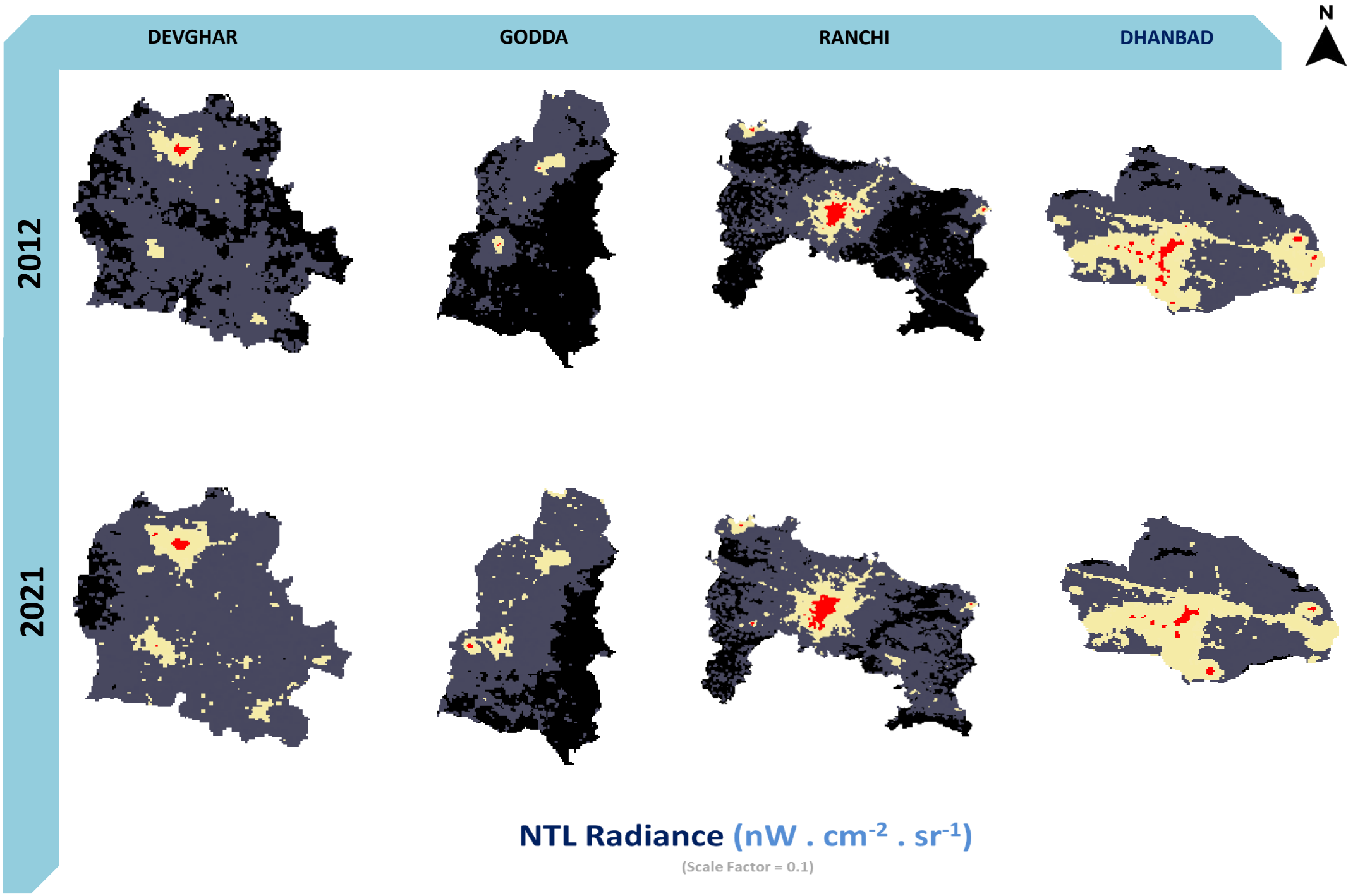


Jharkhand



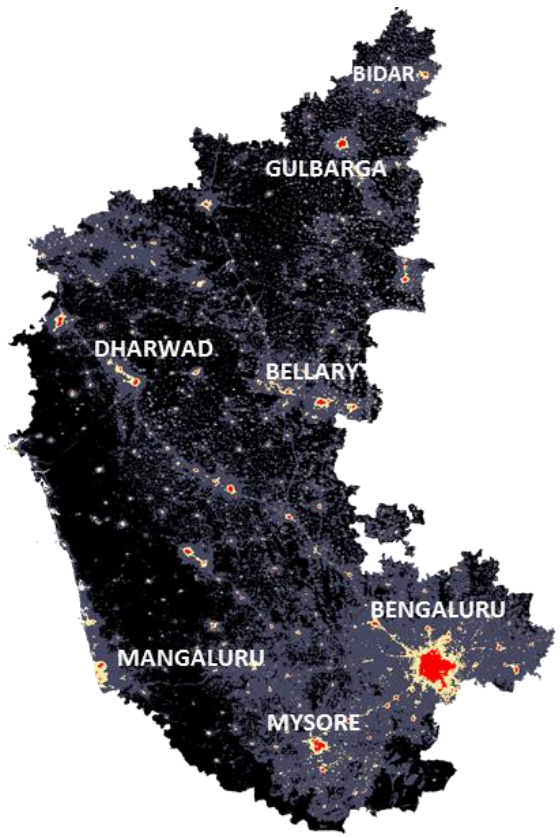
Approx. **40% increase** observed from 2012 to 2021 w.r.t. 2012, then **6% increase** observed in 2020 w.r.t 2019 and **4% increase** observed in 2021 w.r.t 2020.

Most prominent changes in the districts of Jharkhand

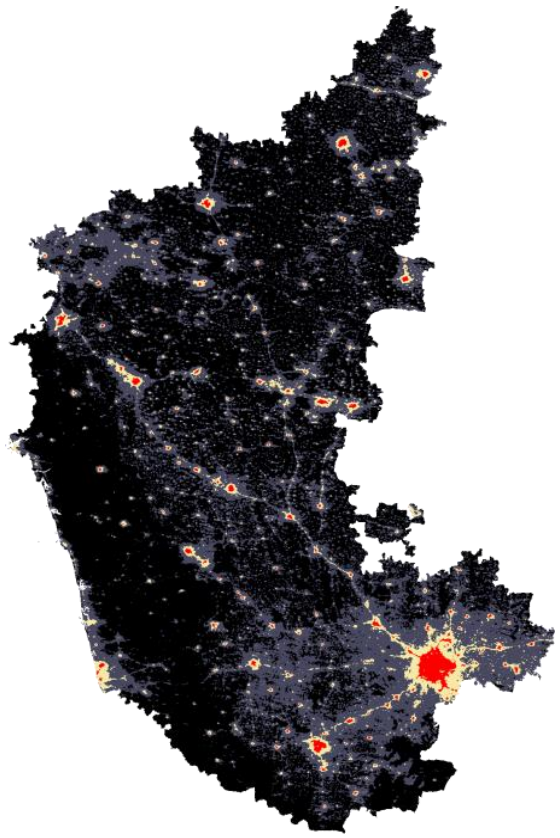


Karnataka

2012



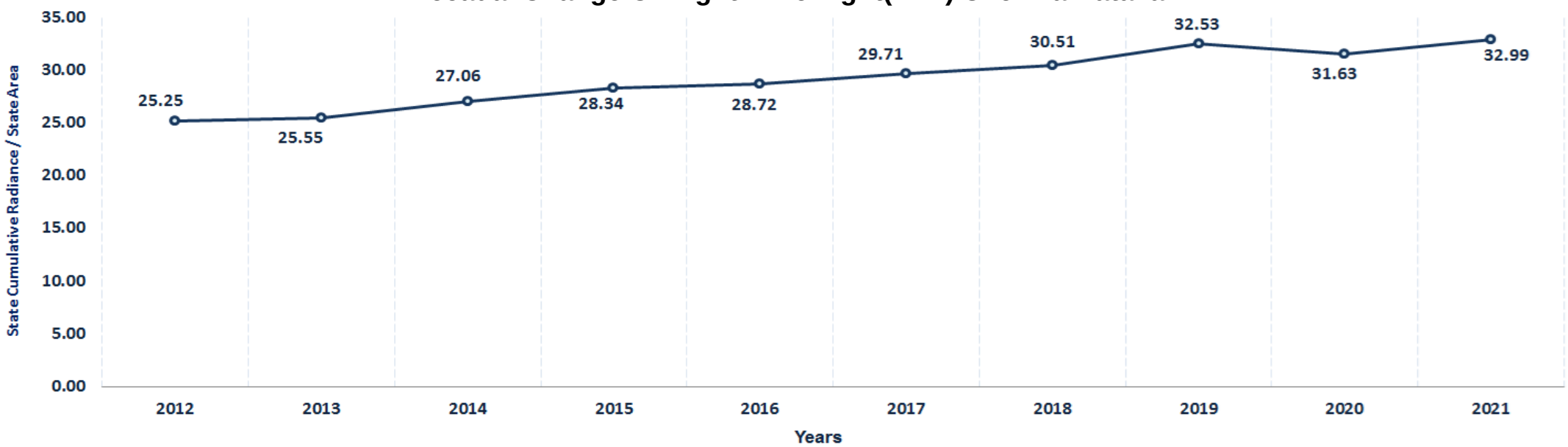
2021



NTL Radiance
(nW . cm^{-2} . sr^{-1})
(Scale Factor = 0.1)

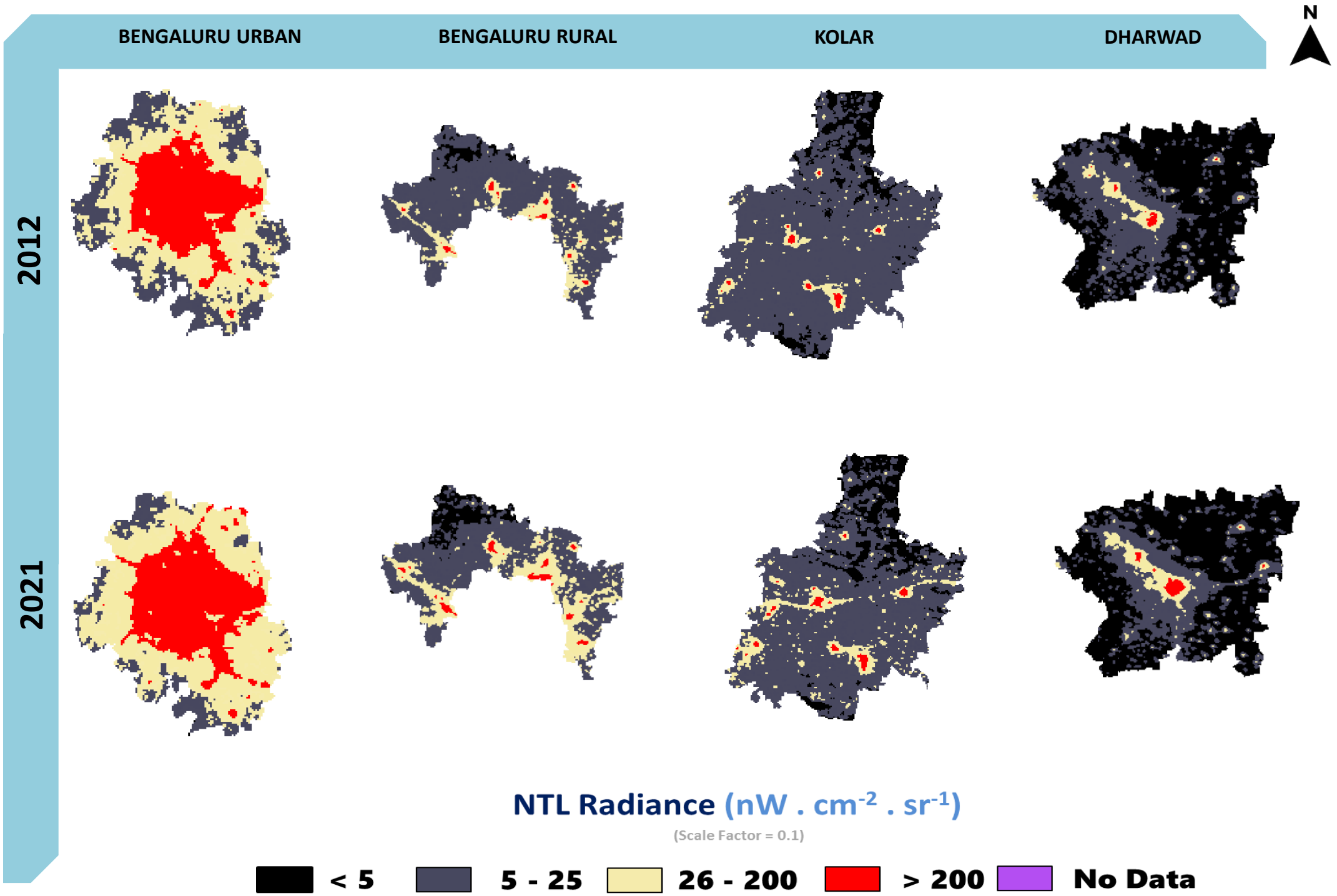
- < 5
- 5 - 25
- 26 - 200
- > 200
- No Data

Decadal Change Of Night Time Light(NTL) Over Karnataka

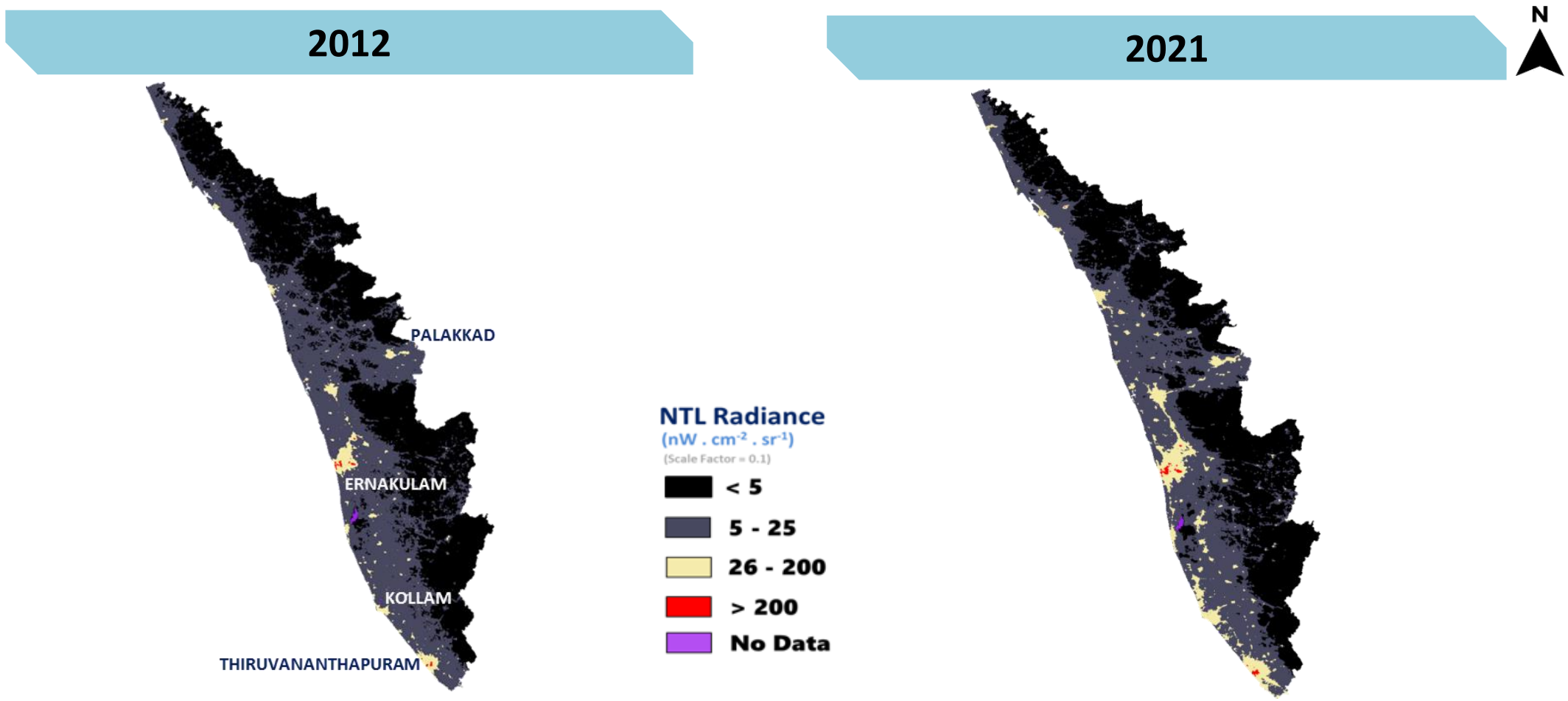


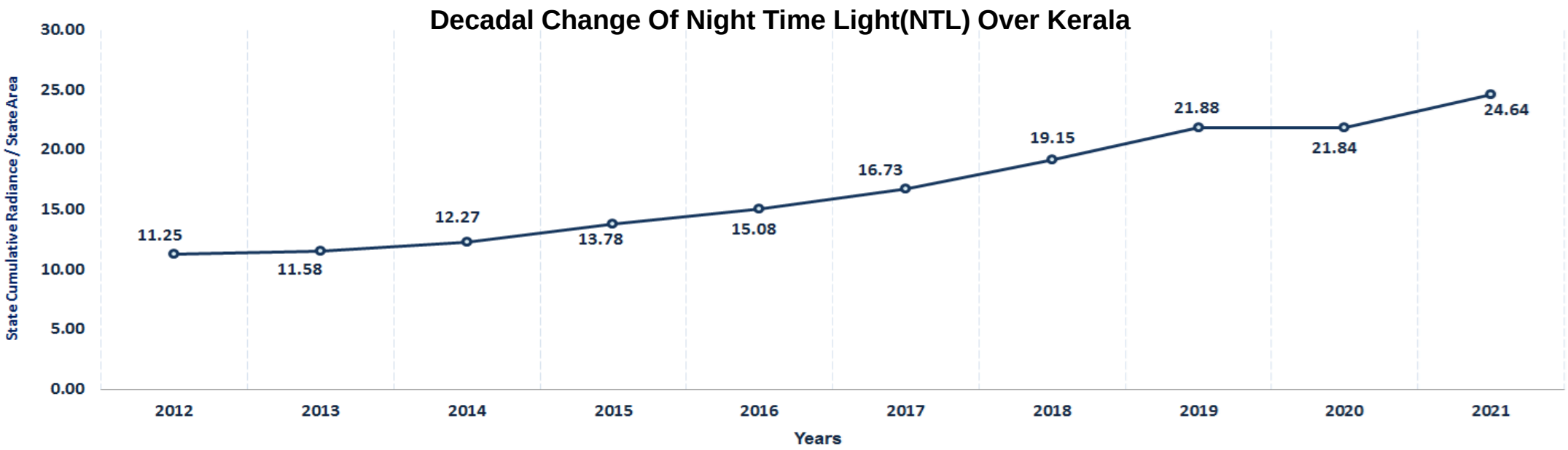
Approx. **31% increase** observed from 2012 to 2021 w.r.t. 2012, then **3% decrease** observed in 2020 w.r.t 2019 and **4% increase** observed in 2021 w.r.t 2020.

Most prominent changes in the districts of Karnataka



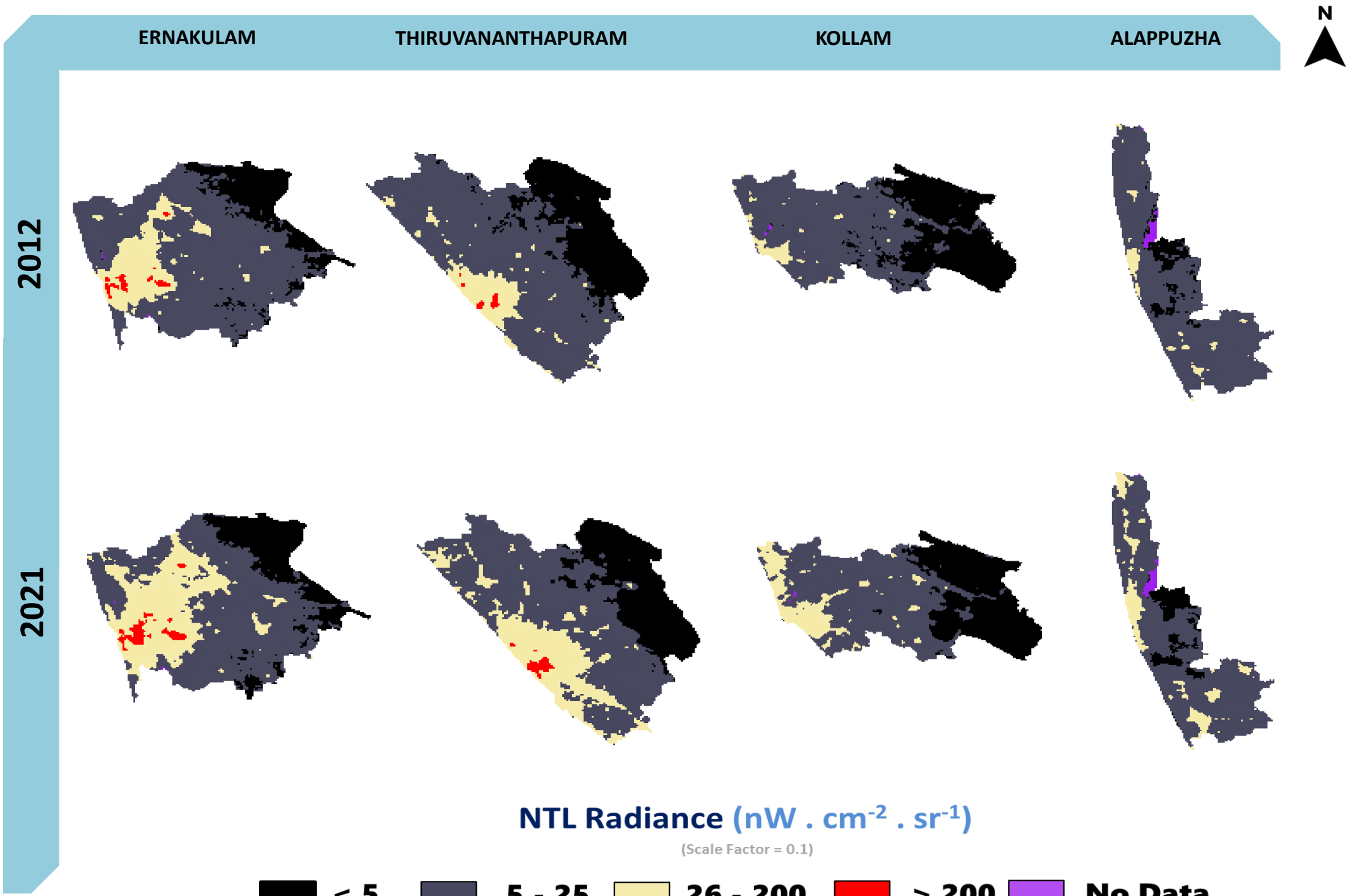
Kerala



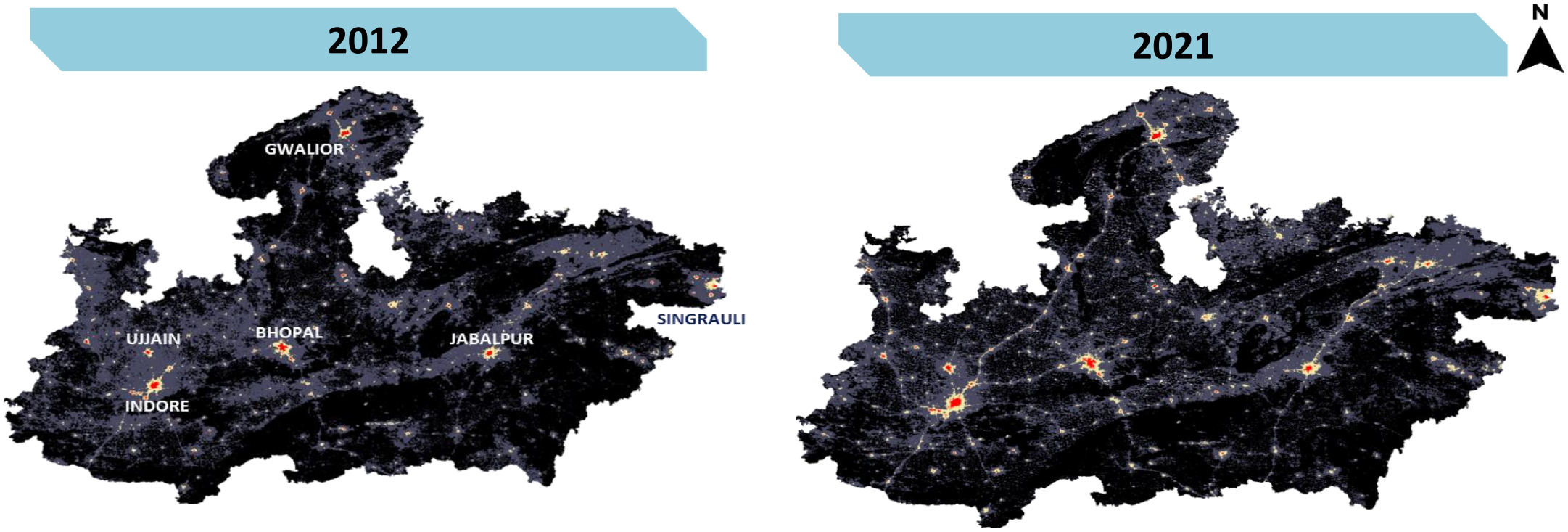


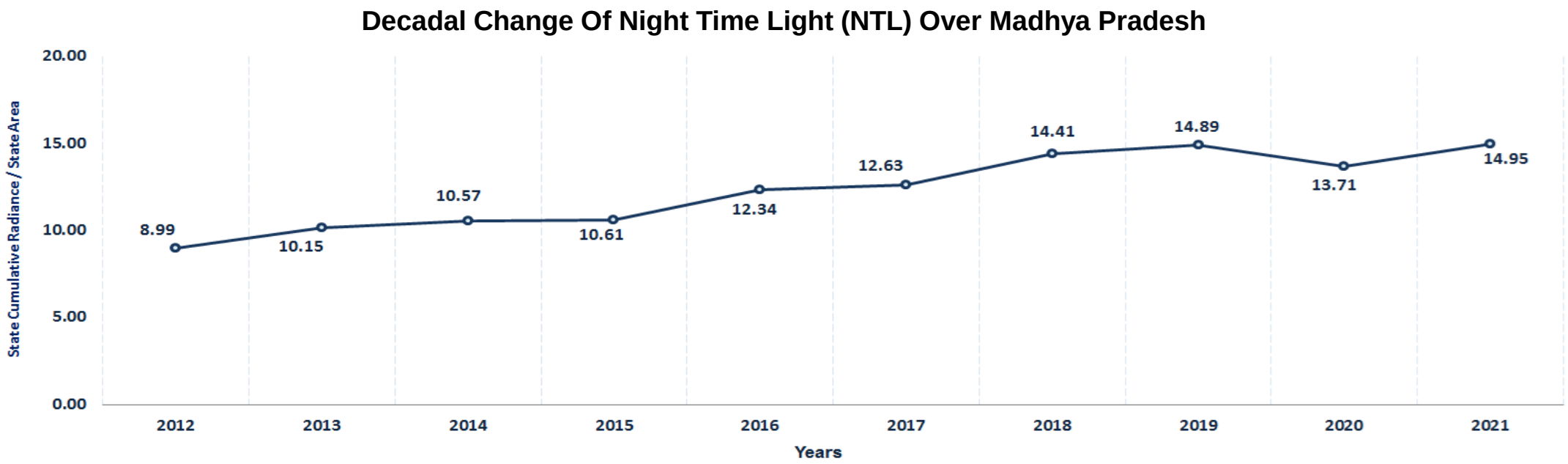
Approx. **119% increase** observed from 2012 to 2021 w.r.t. 2012, then **0.2% decrease** observed in 2020 w.r.t 2019 and **13% increase** observed in 2021 w.r.t 2020.

Most prominent changes in the districts of Kerala



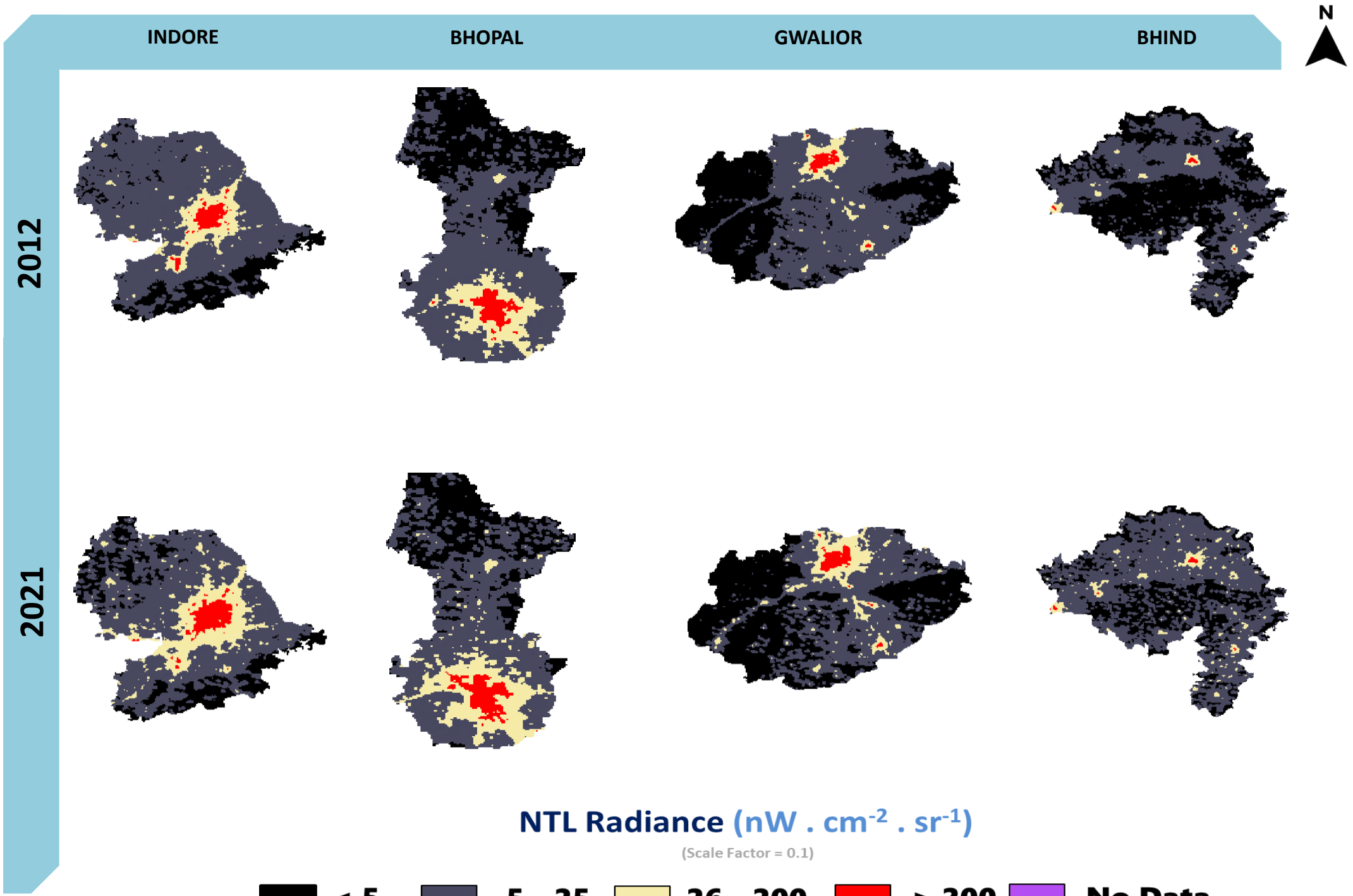
Madhya Pradesh



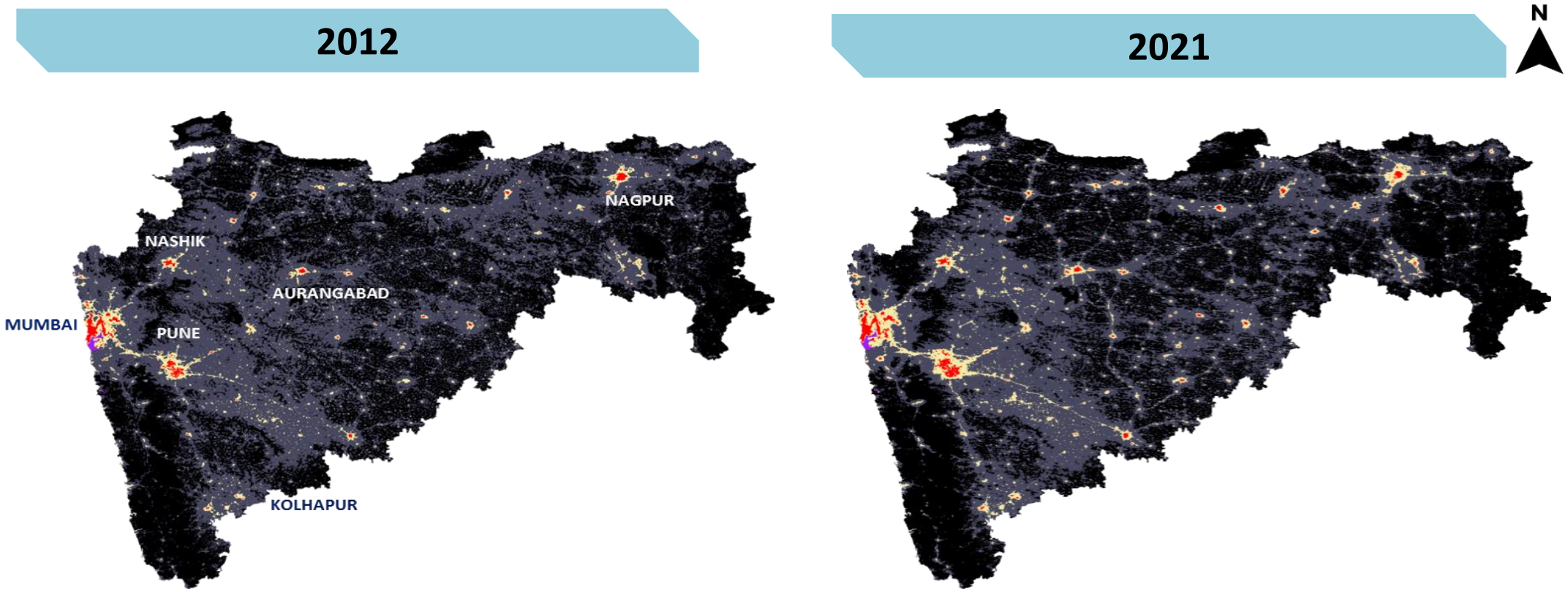


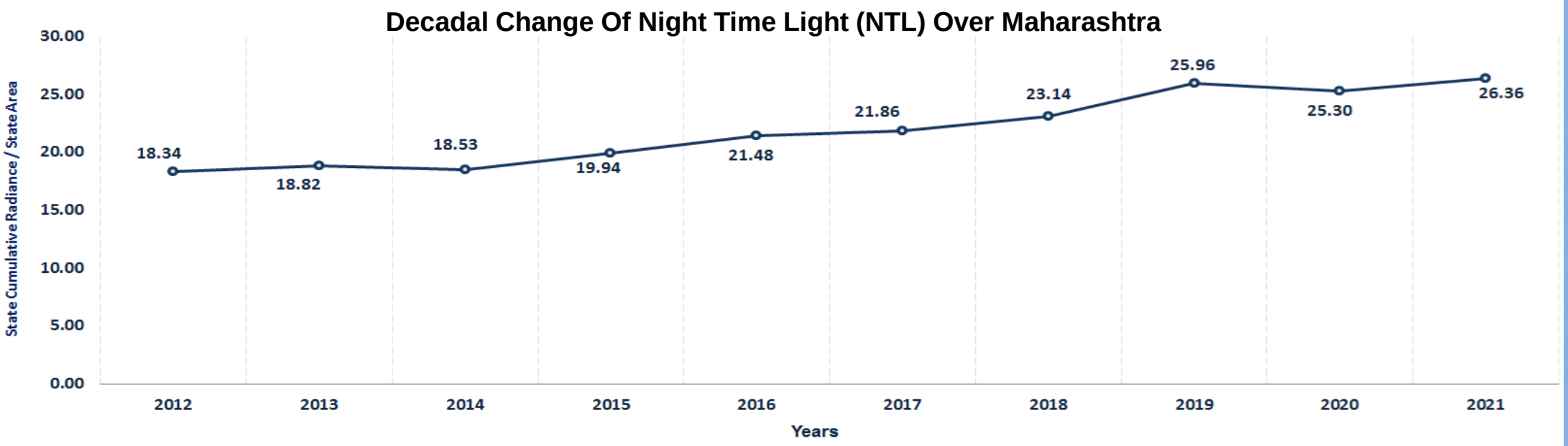
Approx. **66% increase** observed from 2012 to 2021 w.r.t. 2012, then **7.9% decrease** observed in 2020 w.r.t 2019 and **9.1% increase** observed in 2021 w.r.t 2020.

Most prominent changes in the districts of Madhya Pradesh



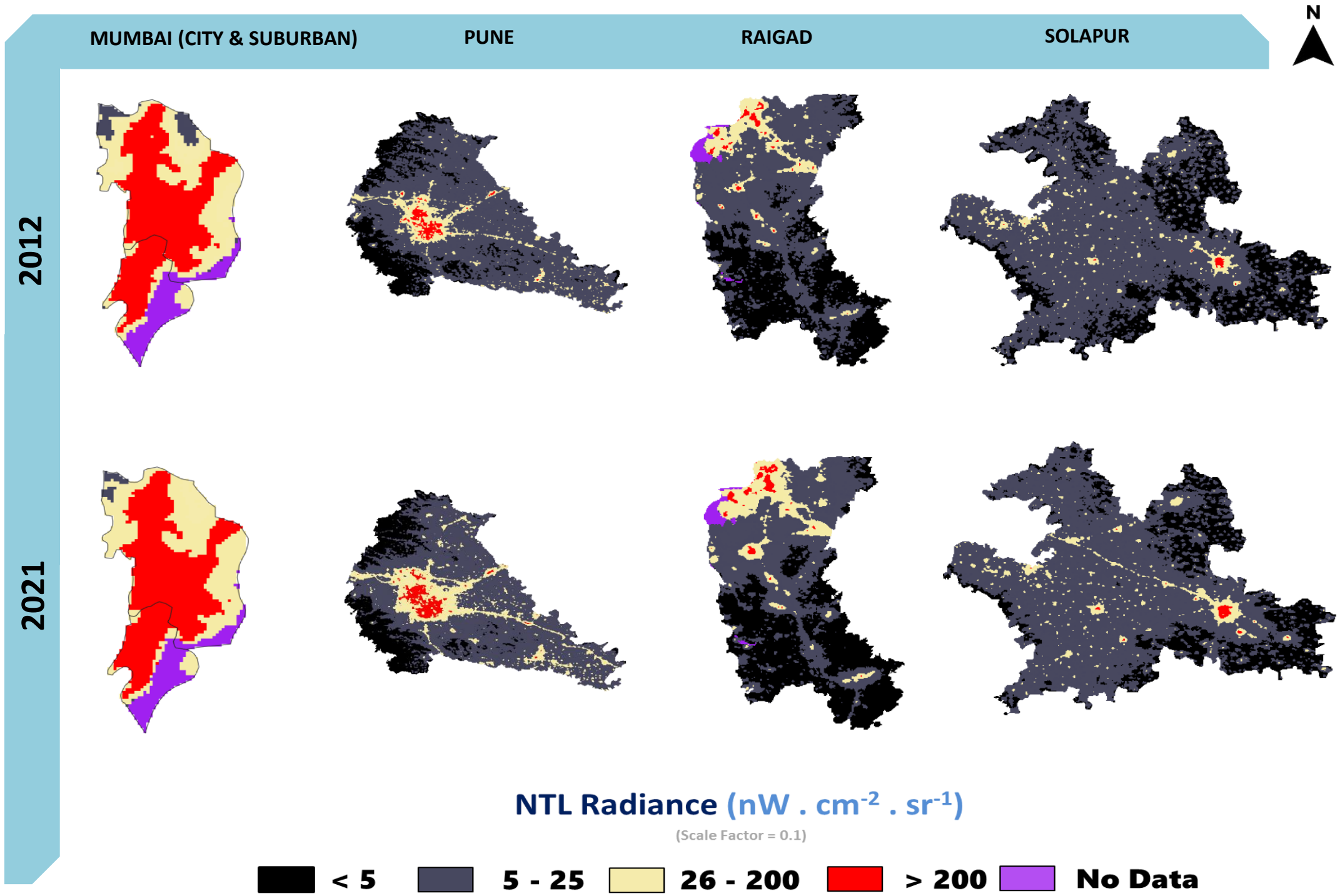
Maharashtra



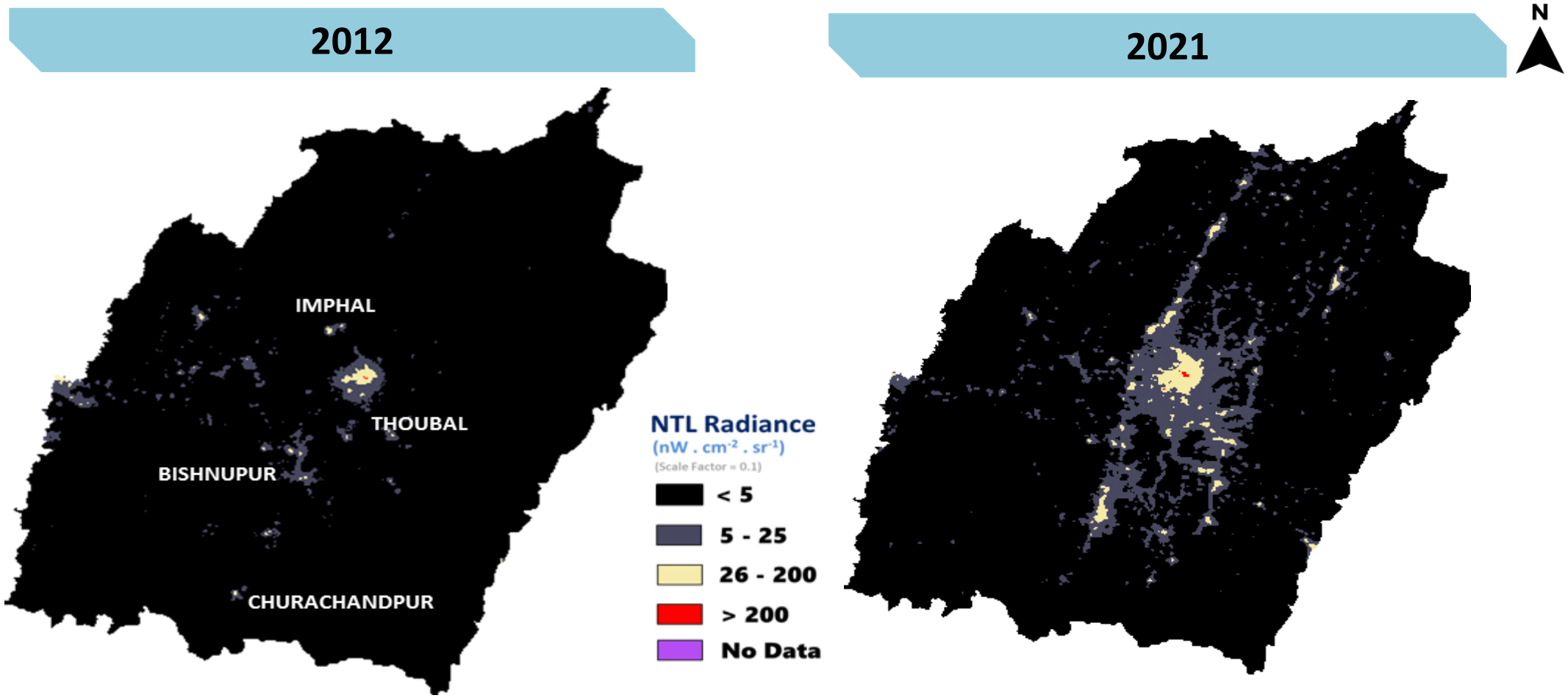


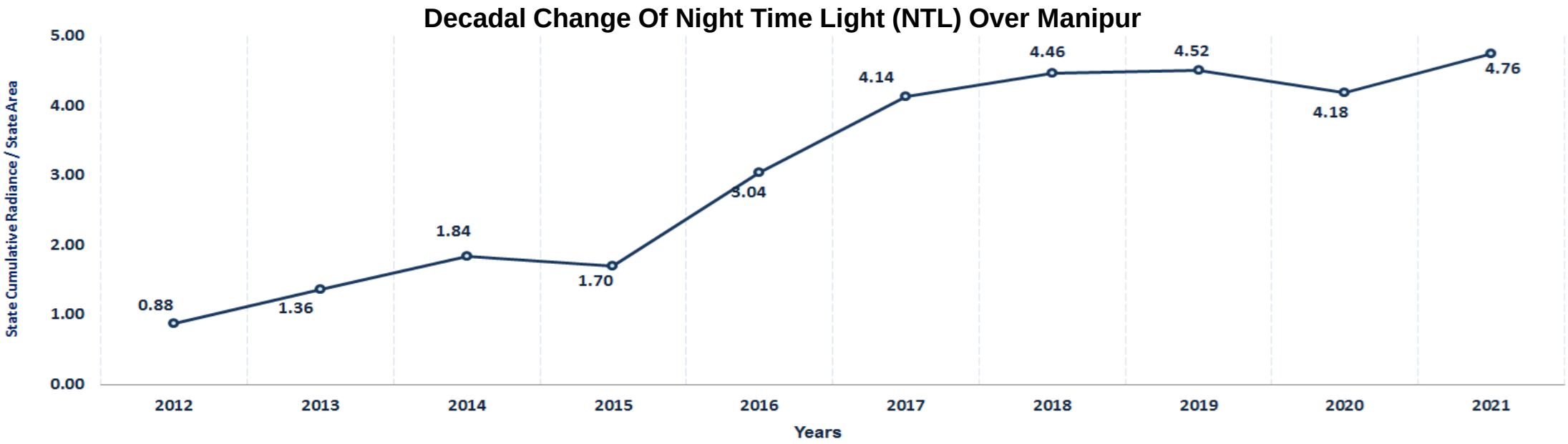
Approx. **44% increase** observed from 2012 to 2021 w.r.t. 2012, then **2.5% decrease** observed in 2020 w.r.t 2019 and **4.2% increase** observed in 2021 w.r.t 2020.

Most prominent changes in the districts of Maharashtra



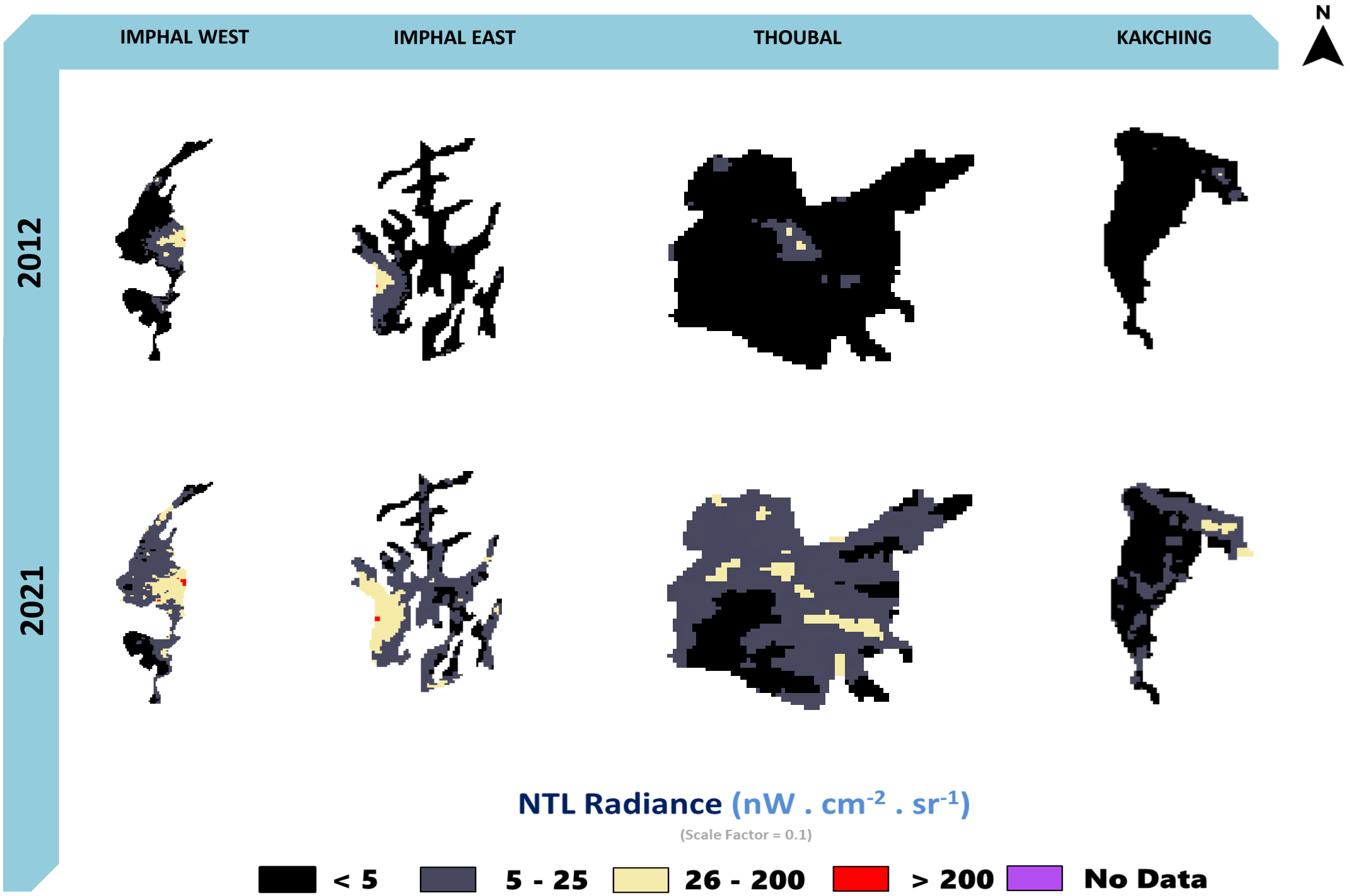
Manipur





Approx. **441 increase** observed from 2012 to 2021 w.r.t. 2012, then **7.4% decrease** observed in 2020 w.r.t 2019 and **13.7% increase** observed in 2021 w.r.t 2020.

Most prominent changes in the districts of Manipur



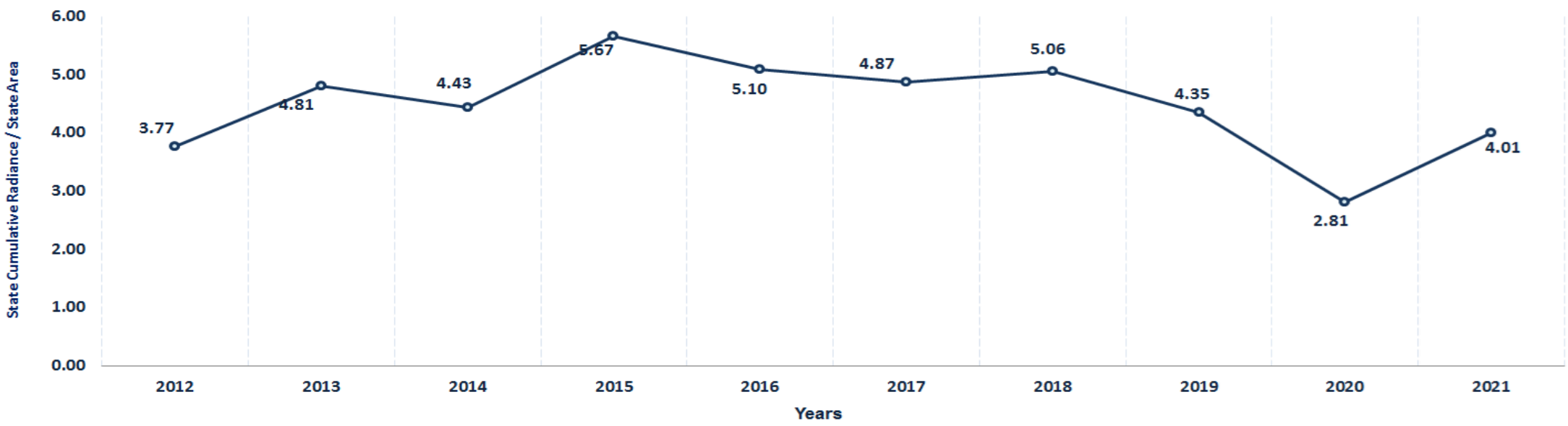
Meghalaya

2012 **2021**

NTL Radiance (nW . cm^{-2} . sr^{-1})

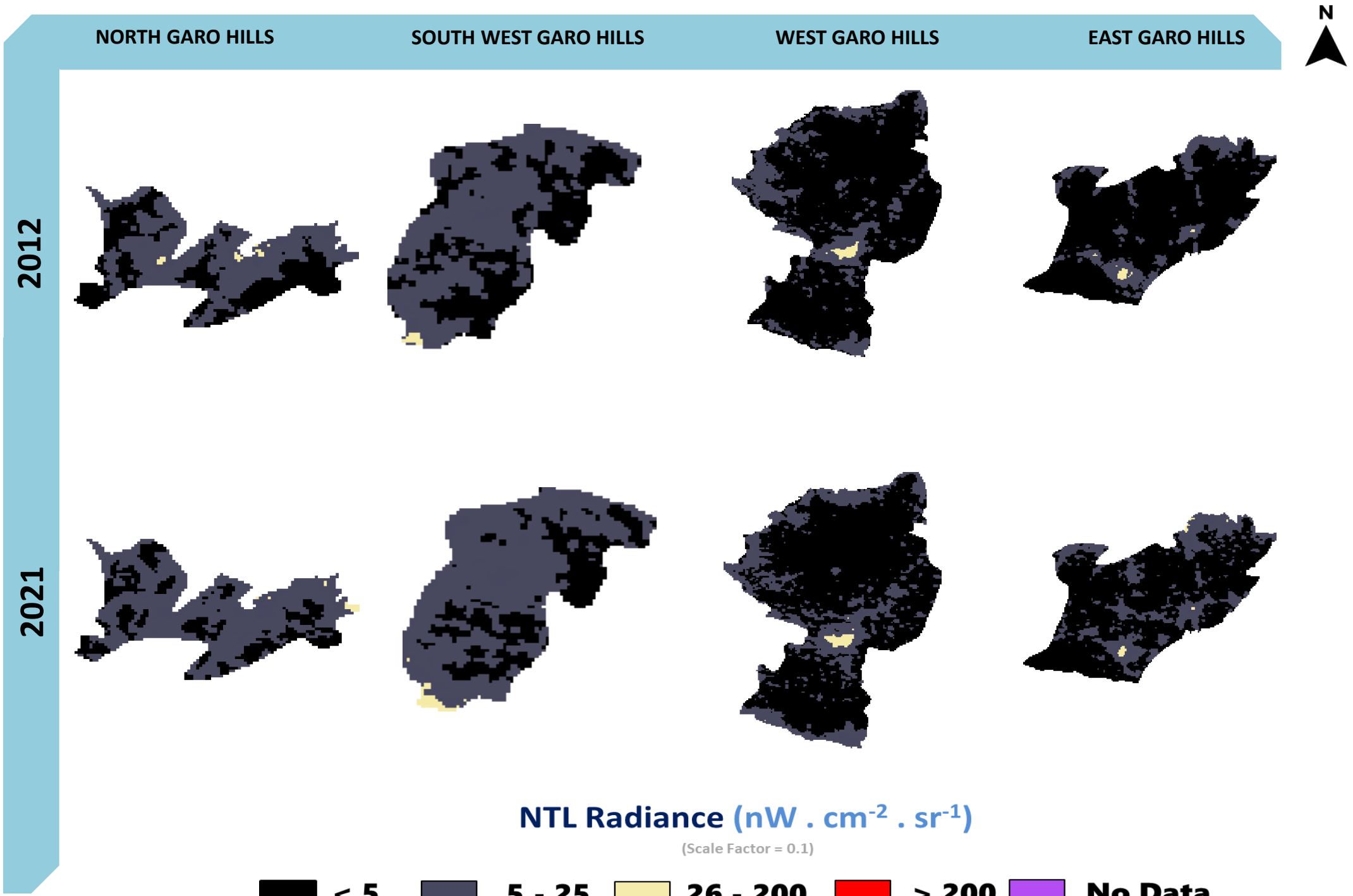
(Scale Factor = 0.1)

< 5 | 5 - 25 | 26 - 200 | > 200 | No Data

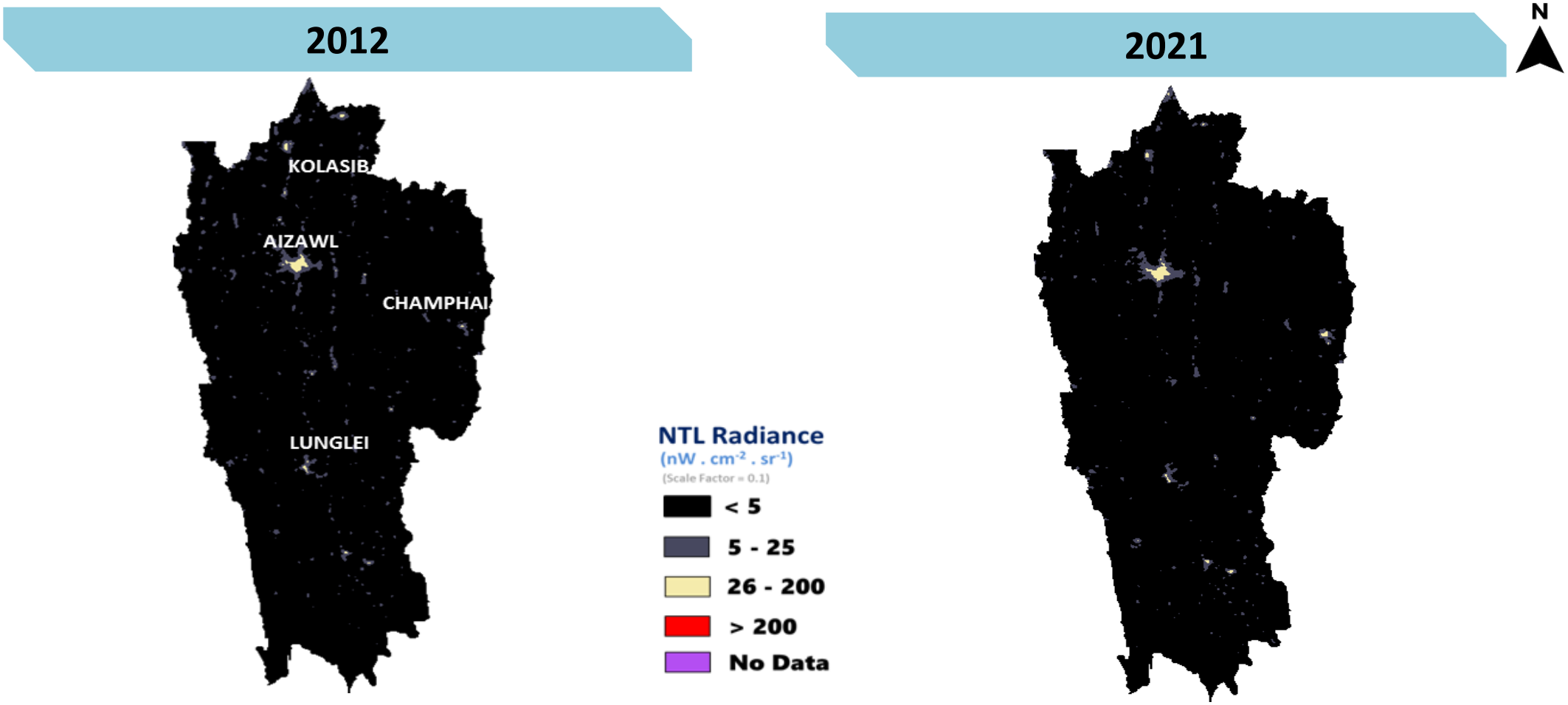


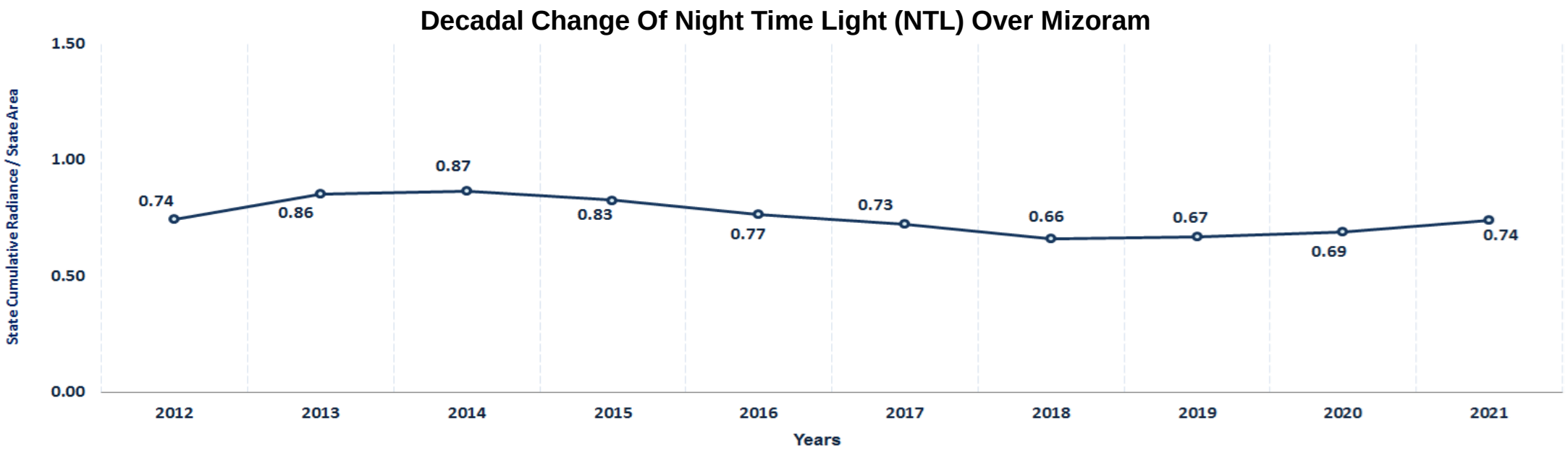
Approx. **6% increase** observed from 2012 to 2021 w.r.t. 2012, then **35.4% decrease** observed in 2020 w.r.t 2019 and **42.4% increase** observed in 2021 w.r.t 2020.

Most prominent changes in the districts of Meghalaya



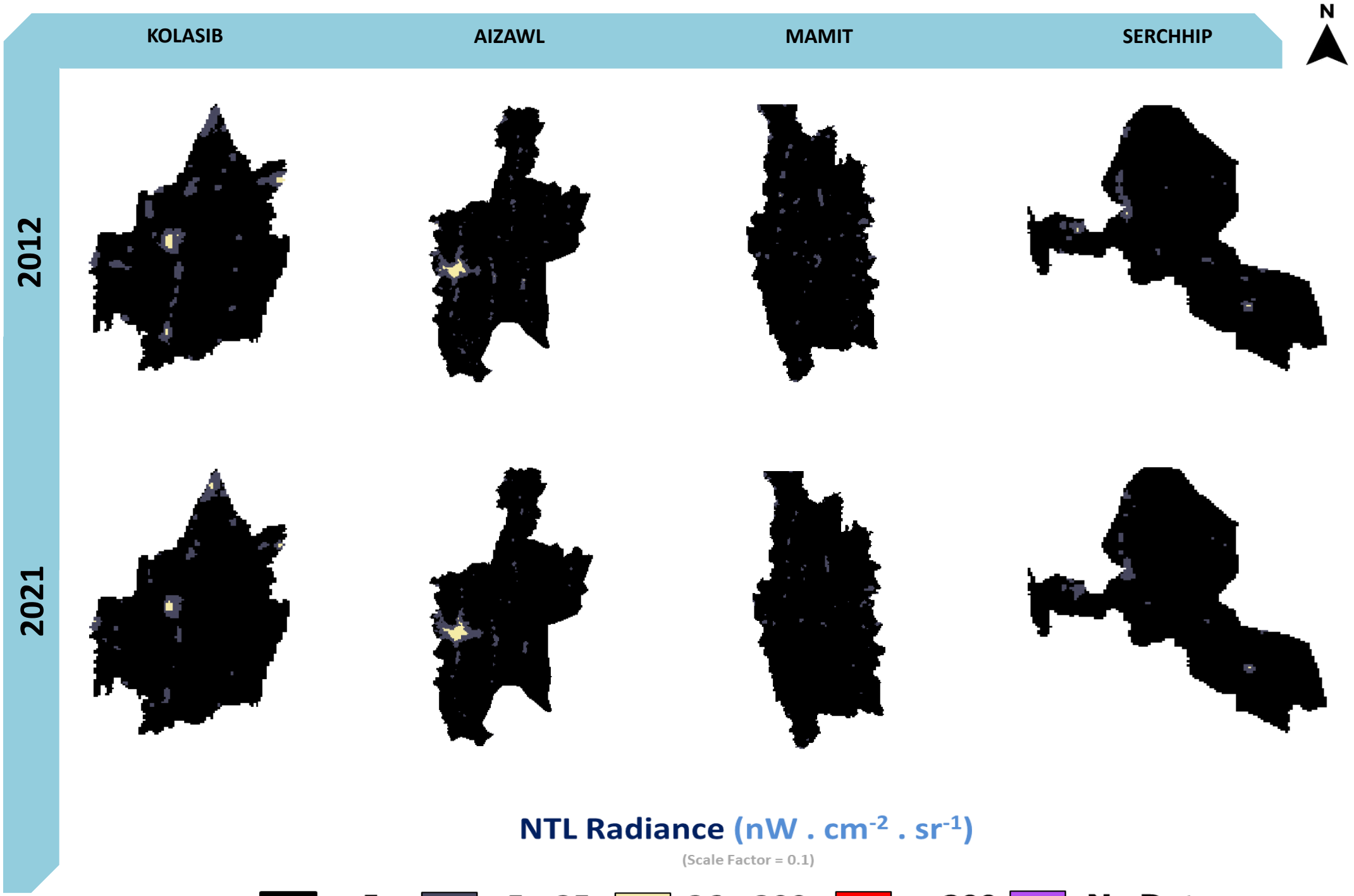
Mizoram



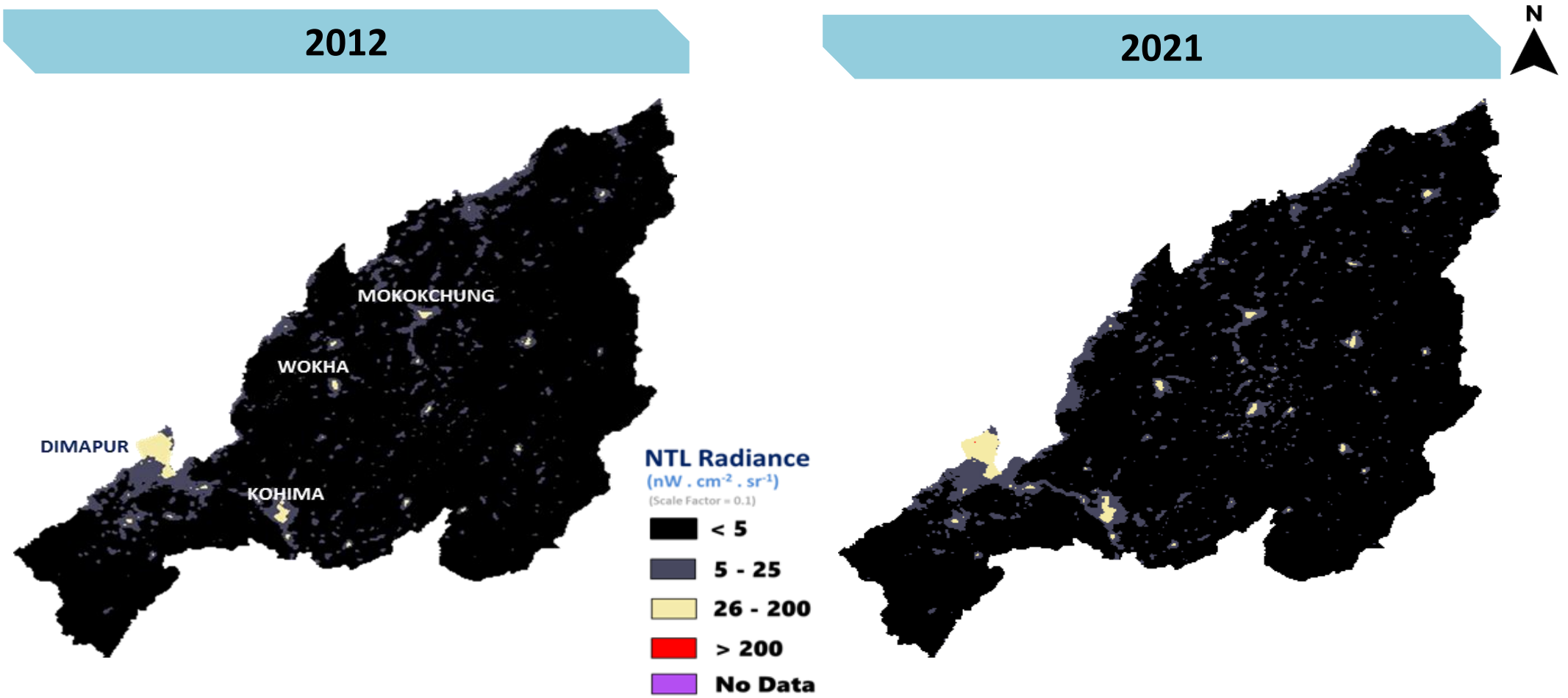


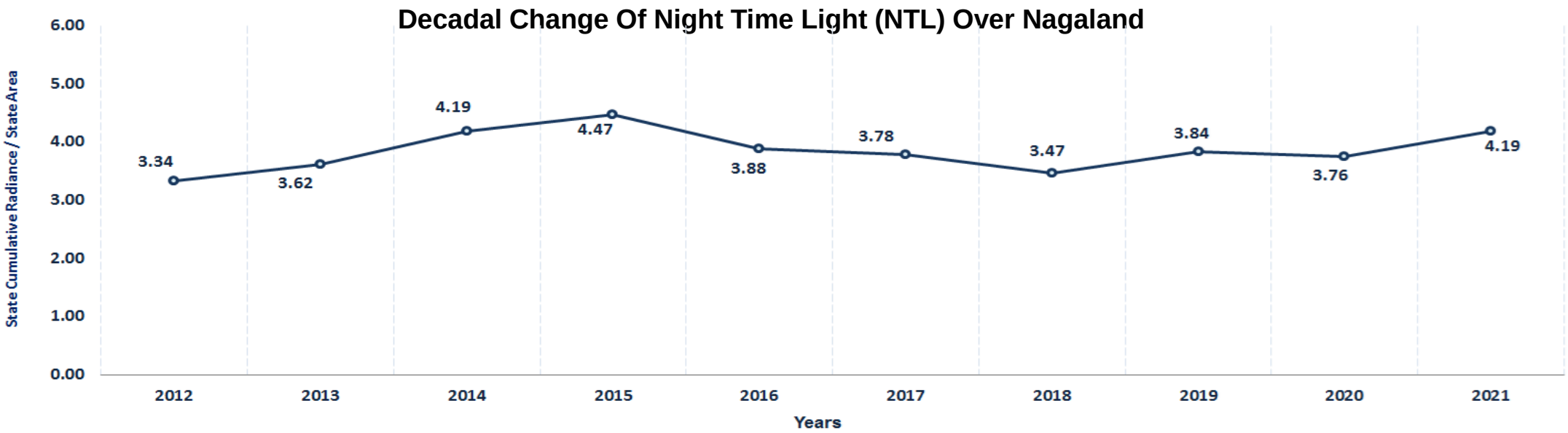
No change observed from 2012 to 2021 w.r.t. 2012, then **3.1% increase** observed in 2020 w.r.t 2019 and **7.5% increase** observed in 2021 w.r.t 2020.

Most prominent changes in the districts of Mizoram



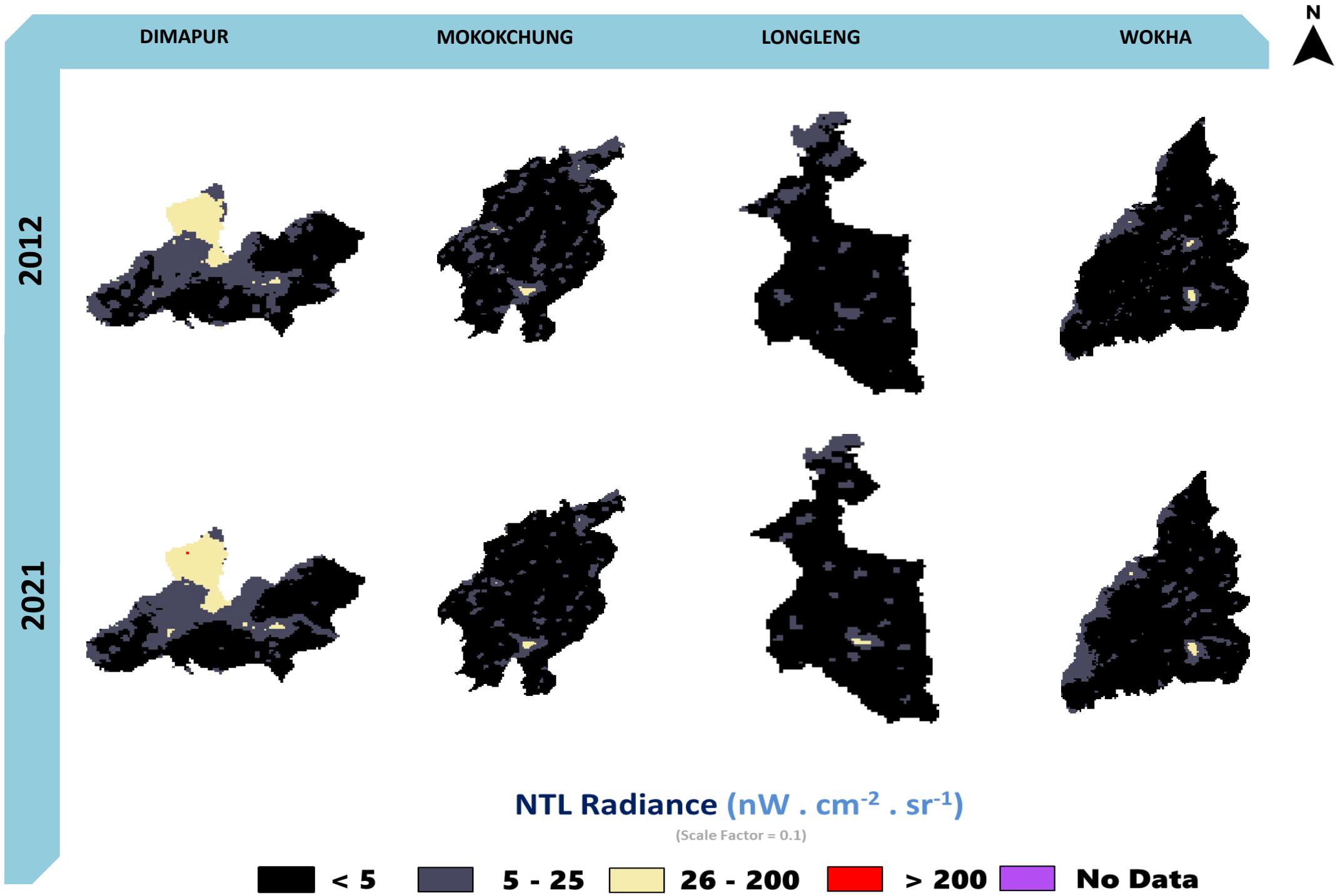
Nagaland



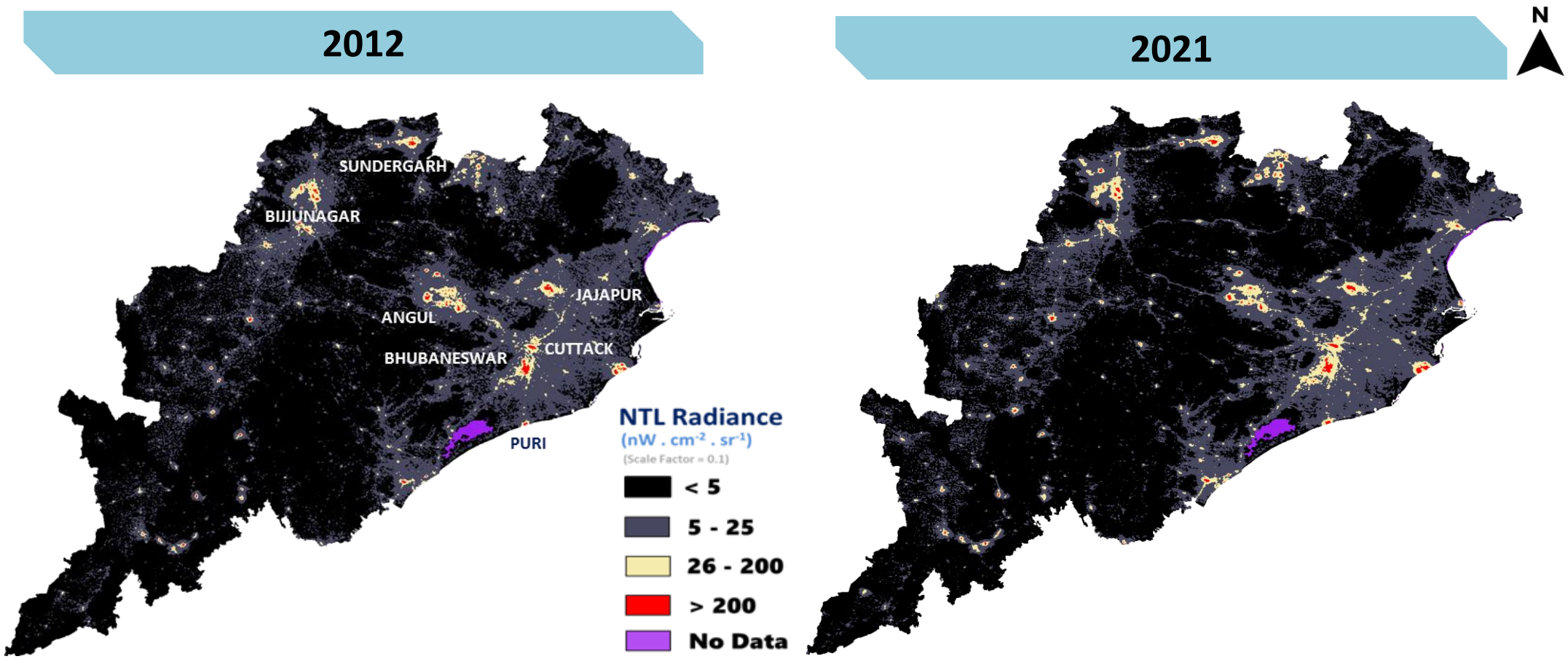


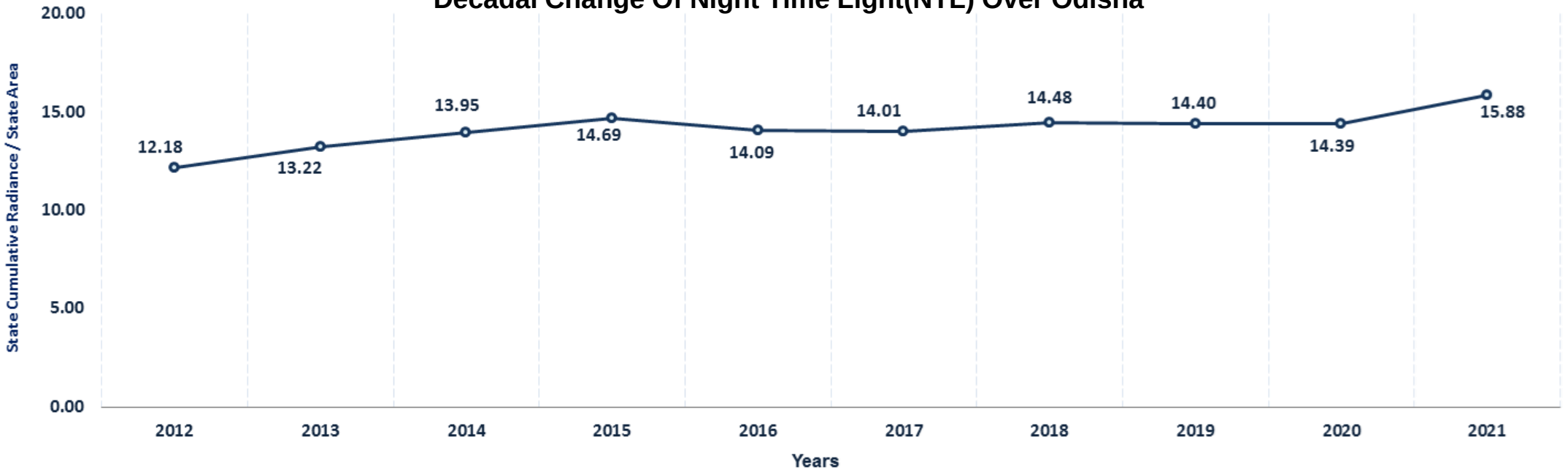
Approx. **26% increase** observed from 2012 to 2021 w.r.t. 2012, then **2% decrease** observed in 2020 w.r.t 2019 and **11.6% increase** observed in 2021 w.r.t 2020.

Most prominent changes in the districts of Nagaland



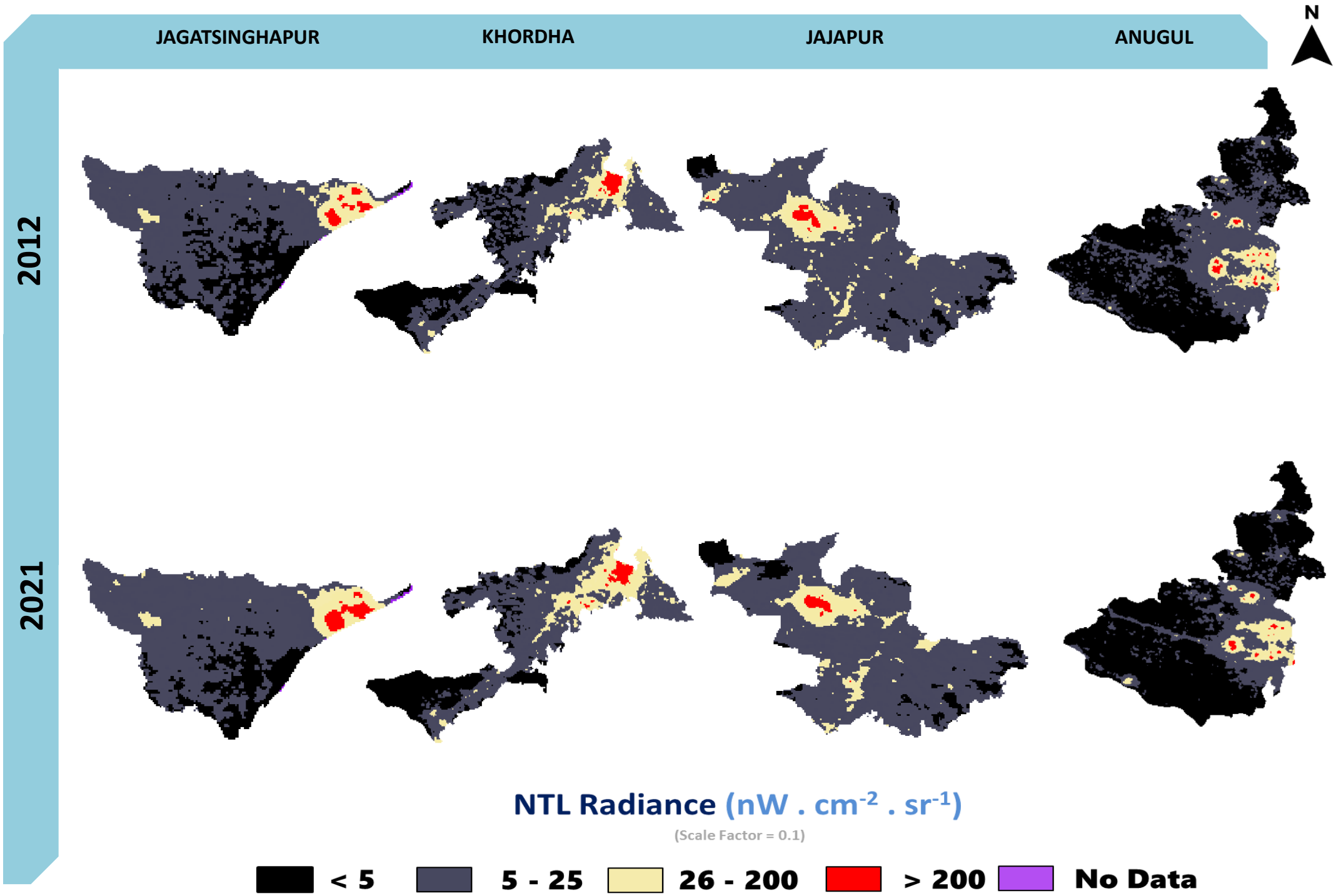
Odisha



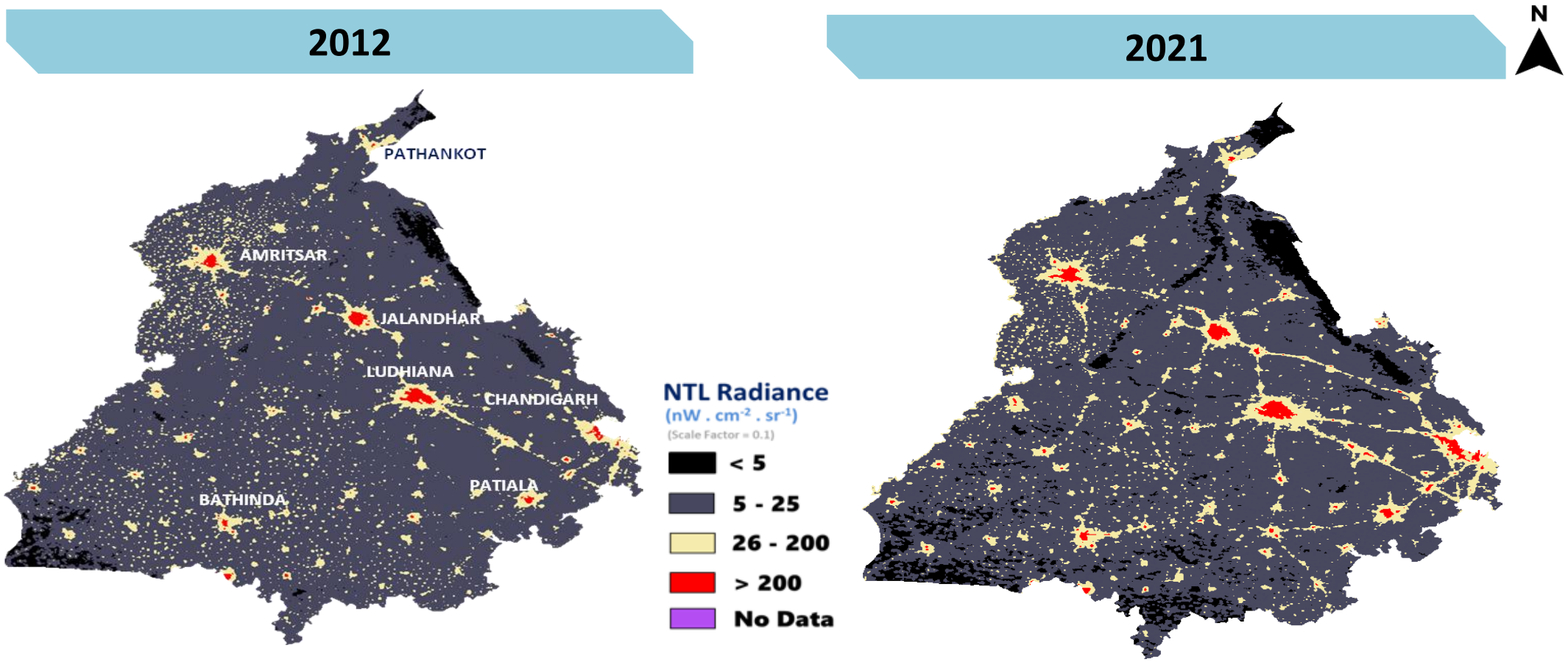


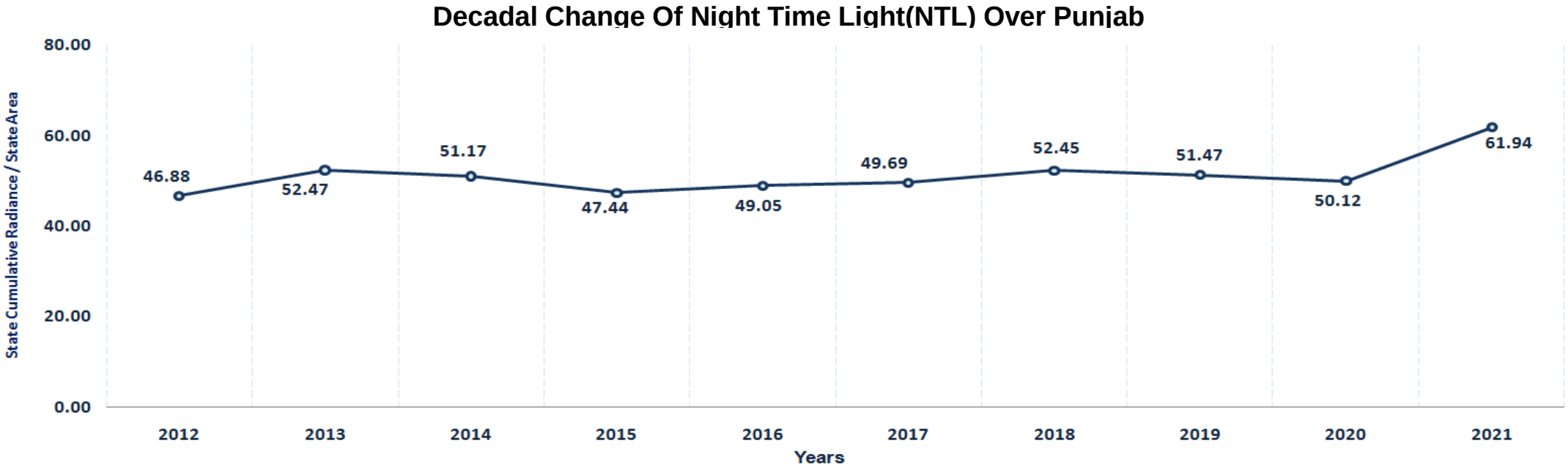
Approx. **30% increase** observed from 2012 to 2021 w.r.t. 2012, then **0.1% decrease** observed in 2020 w.r.t 2019 and **10% increase** observed in 2021 w.r.t 2020.

Most prominent changes in the districts of Odisha



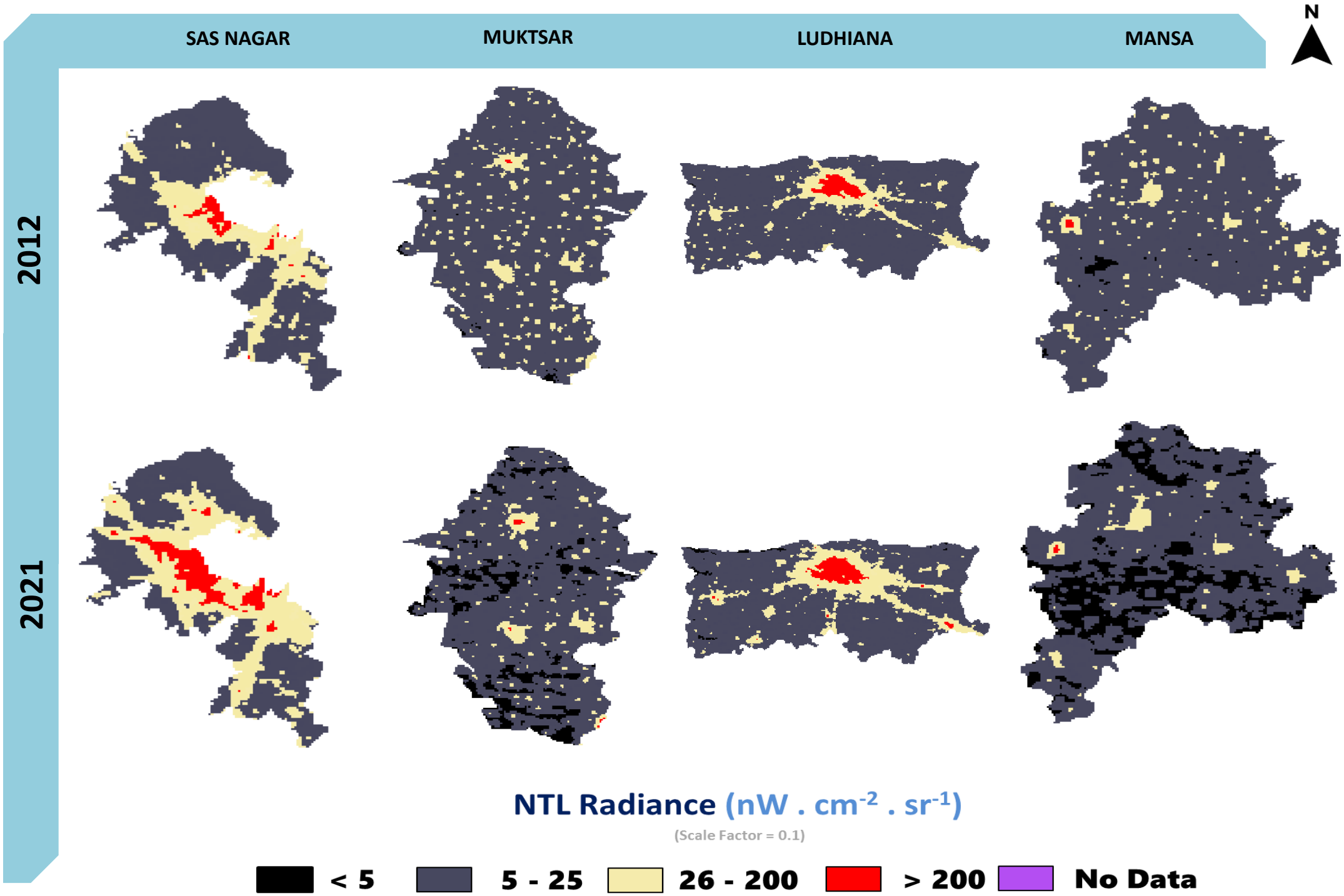
Punjab



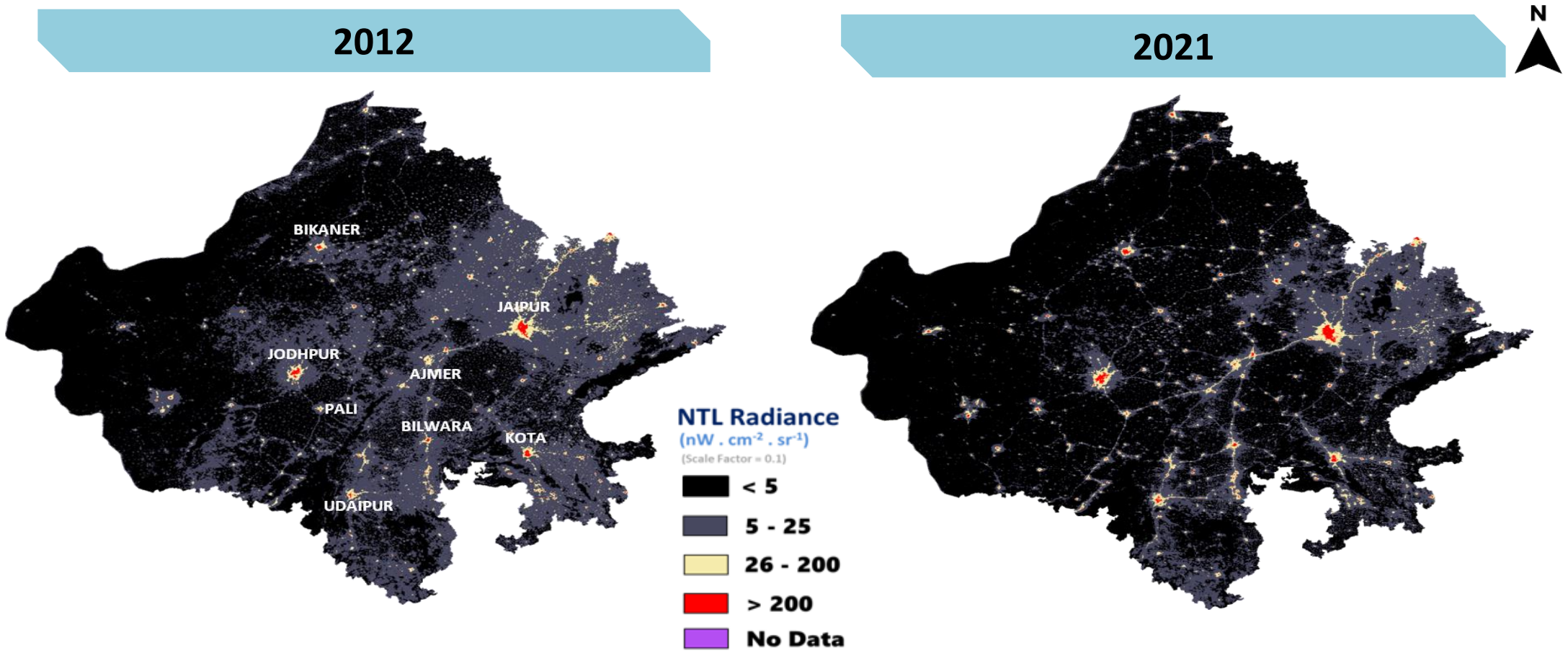


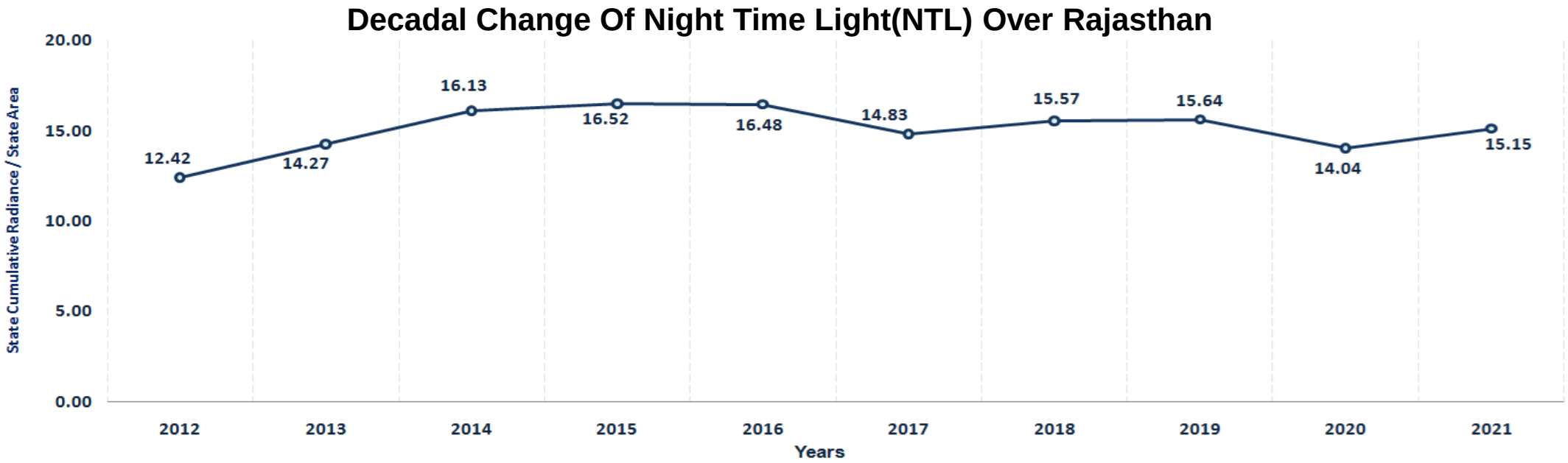
Approx. **32% increase** observed from 2012 to 2021 w.r.t. 2012, then **3% decrease** observed in 2020 w.r.t 2019 and **24% increase** observed in 2021 w.r.t 2020.

Most prominent changes in the districts of Punjab



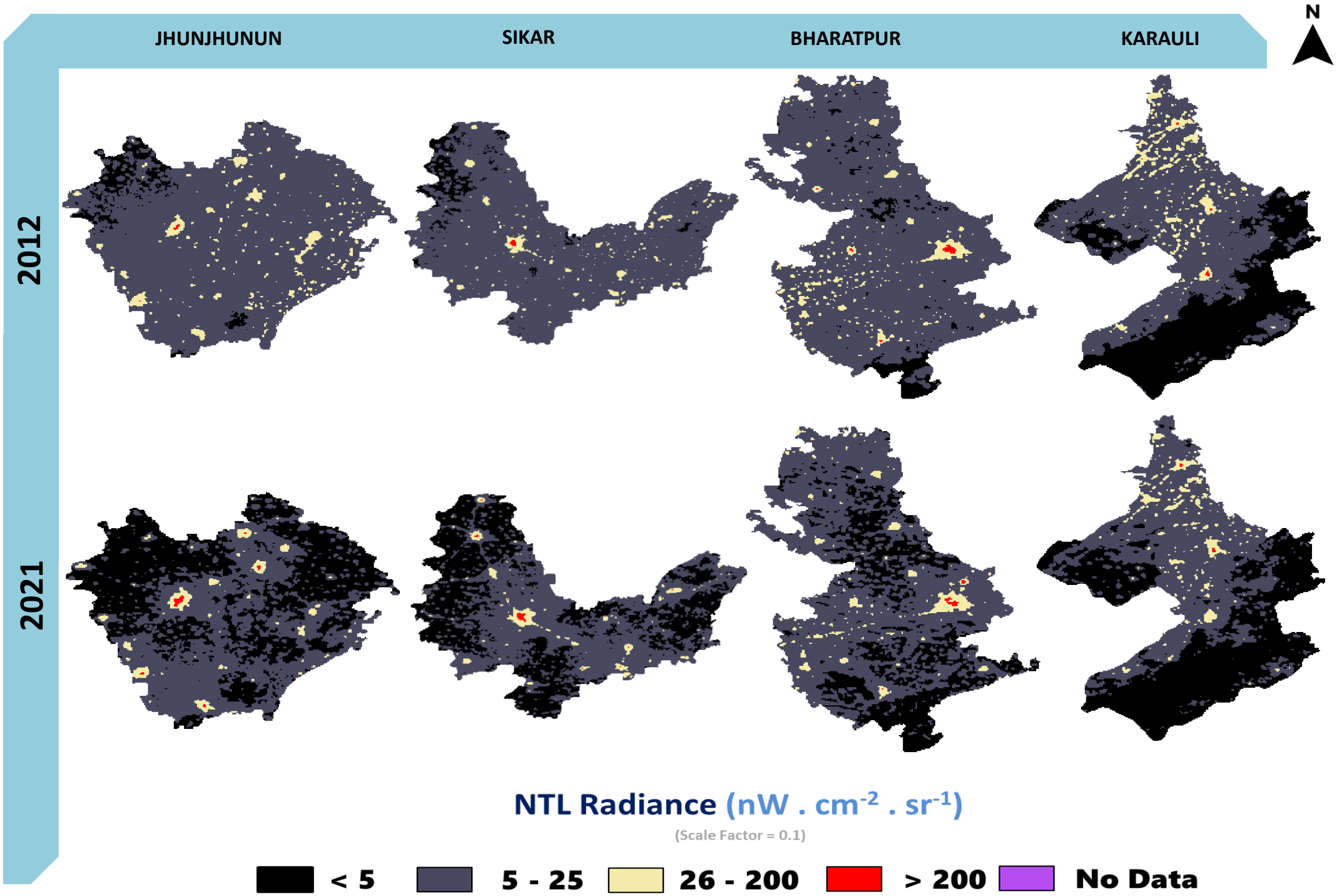
Rajasthan



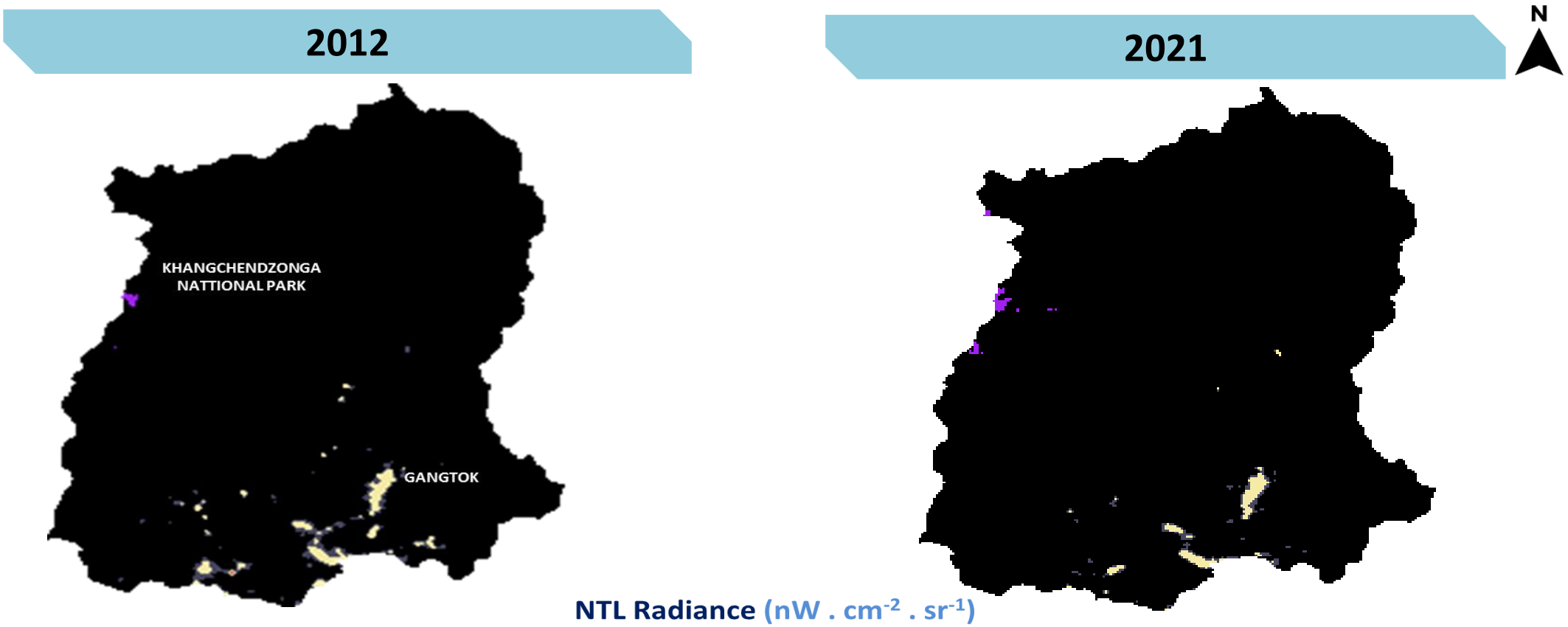


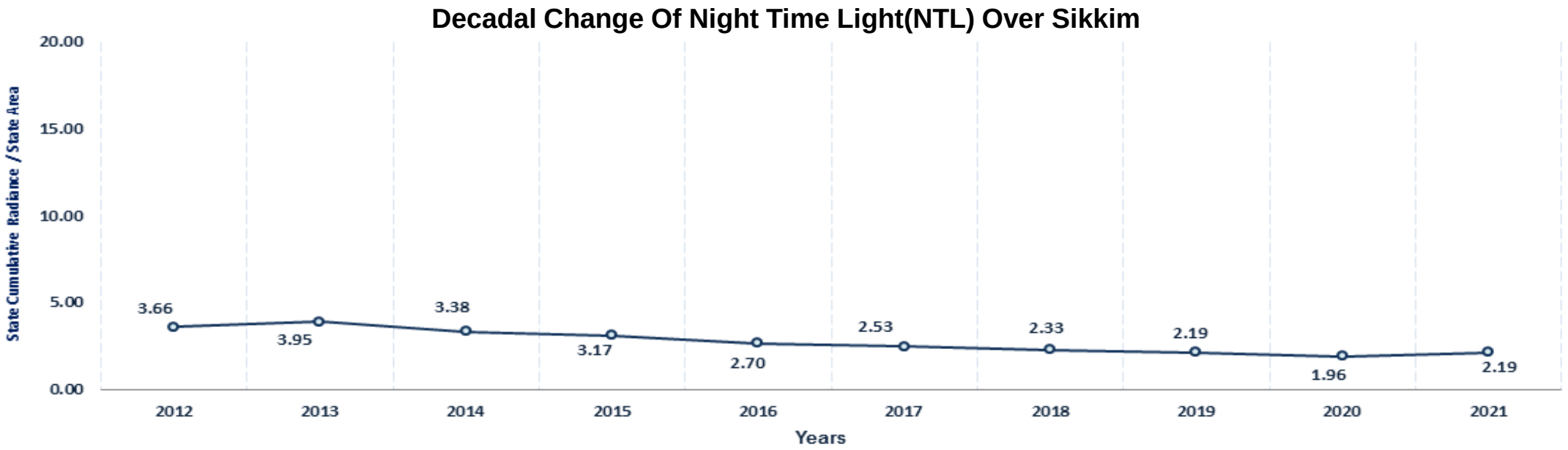
Approx. **22% increase** observed from 2012 to 2021 w.r.t. 2012, then **10% decrease** observed in 2020 w.r.t 2019 and **8% increase** observed in 2021 w.r.t 2020.

Most prominent changes in the districts of Rajasthan



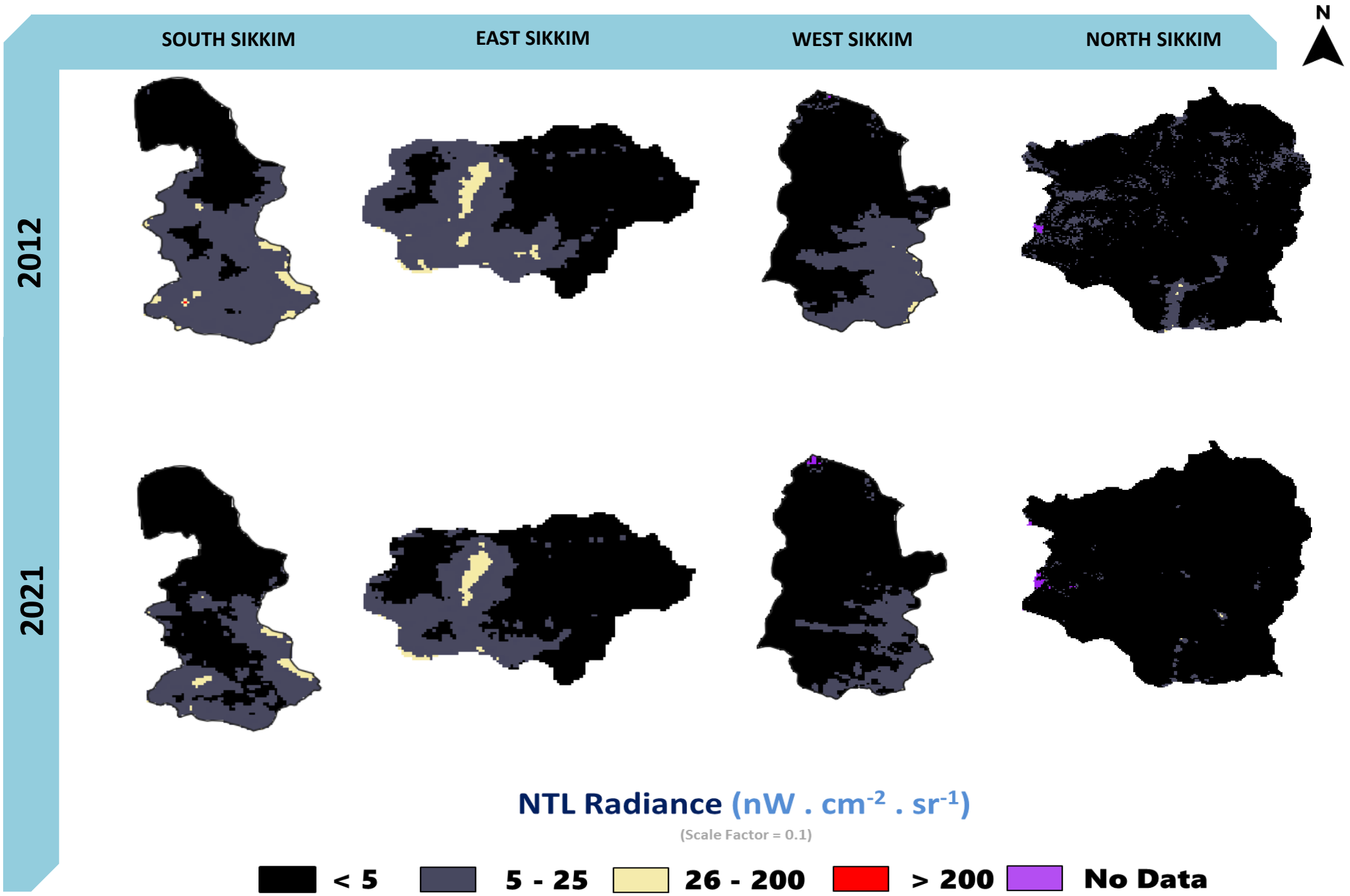
Sikkim





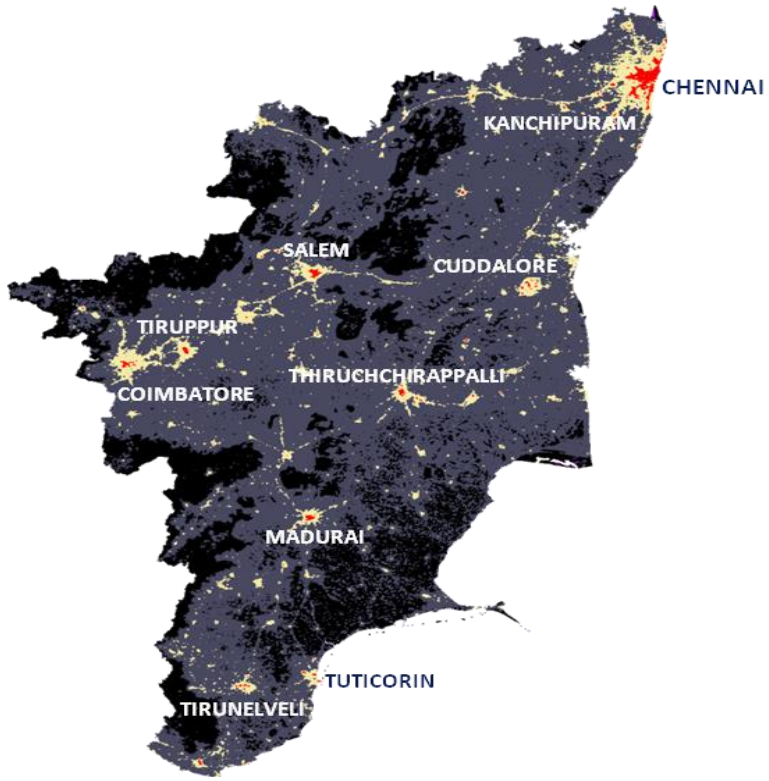
Observed decrease in 2021 w.r.t 2012 which is insignificant, **11% decrease** observed in 2020 w.r.t 2019 and **12% increase** observed in 2021 w.r.t 2020.

Most prominent changes in the districts of Sikkim

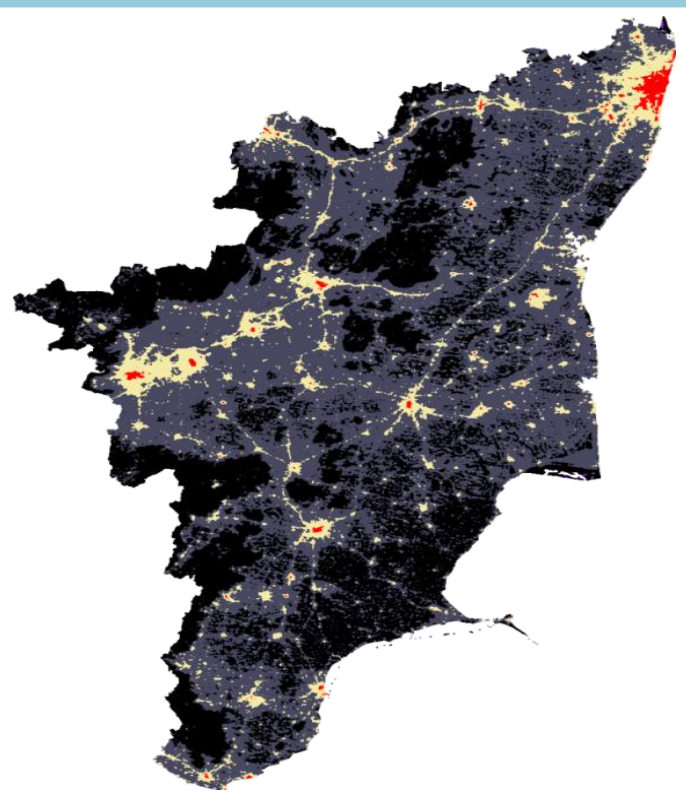


Tamil Nadu

2012



2021

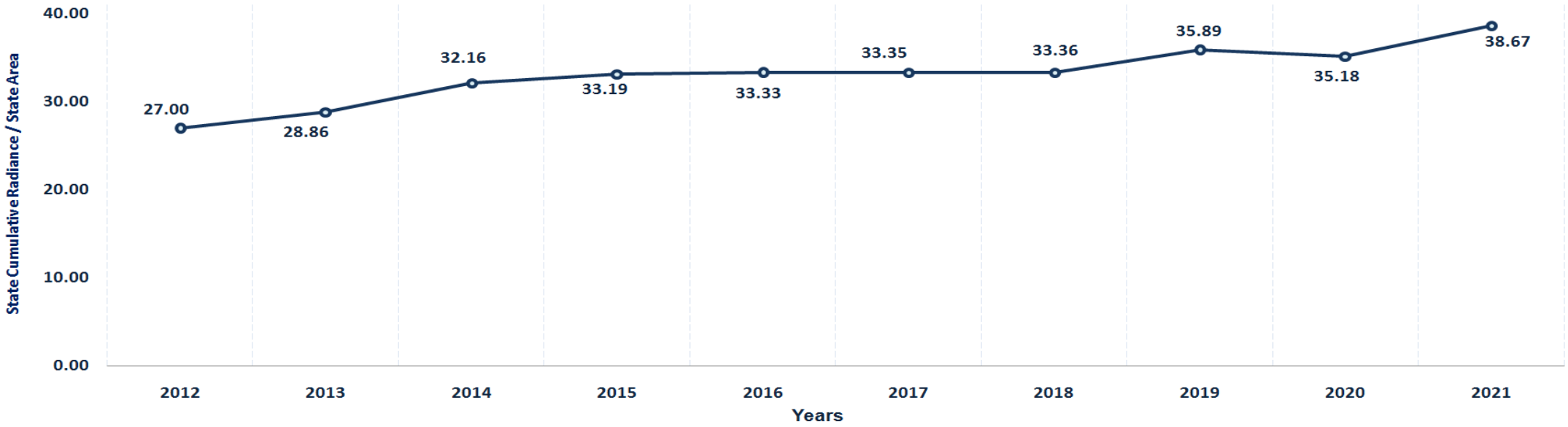


N

NTL Radiance
(nW . cm^{-2} . sr^{-1})
(Scale Factor = 0.1)

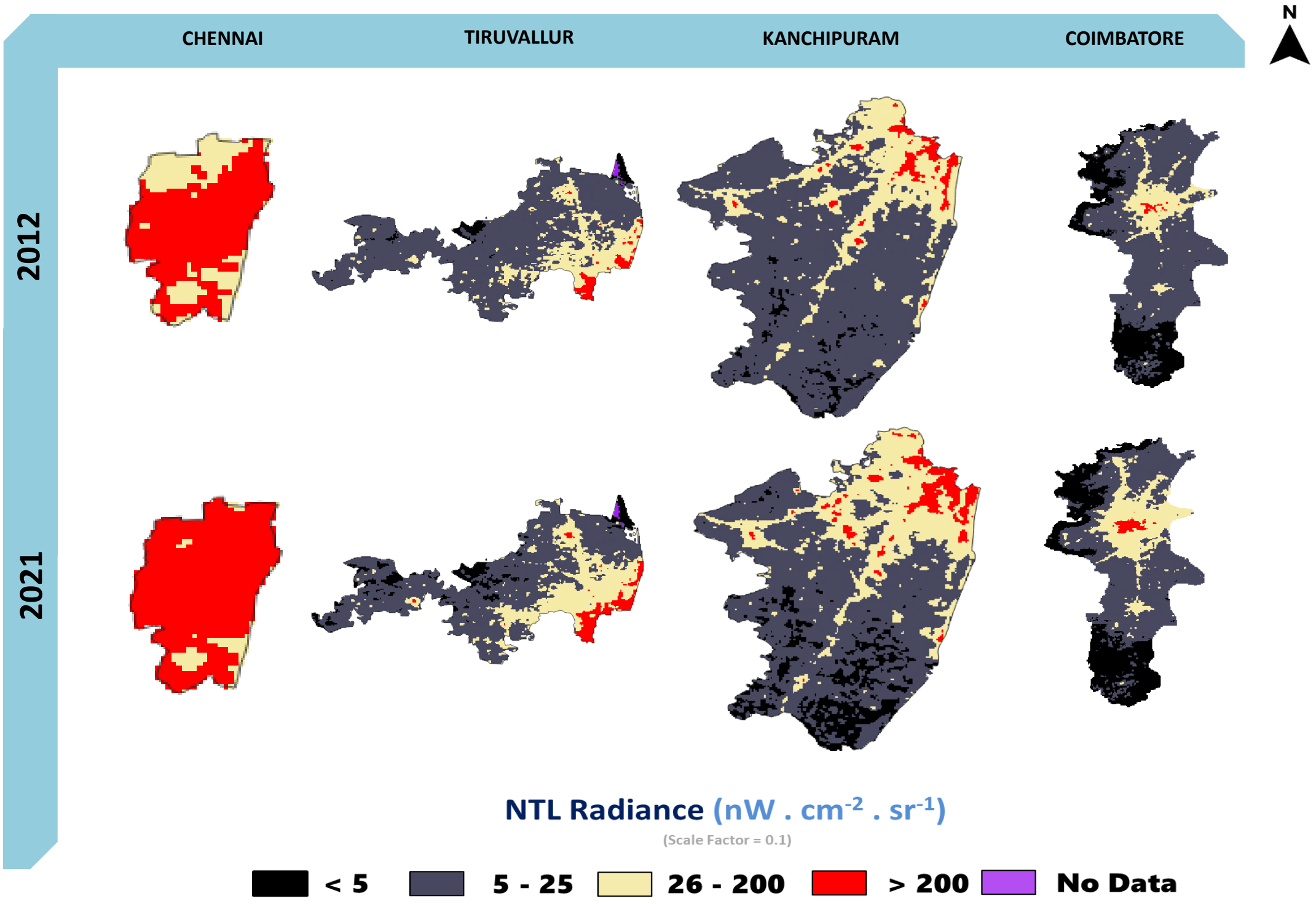
- < 5
- 5 - 25
- 26 - 200
- > 200
- No Data

Decadal Change Of Night Time Light(NTL) Over Tamil Nadu

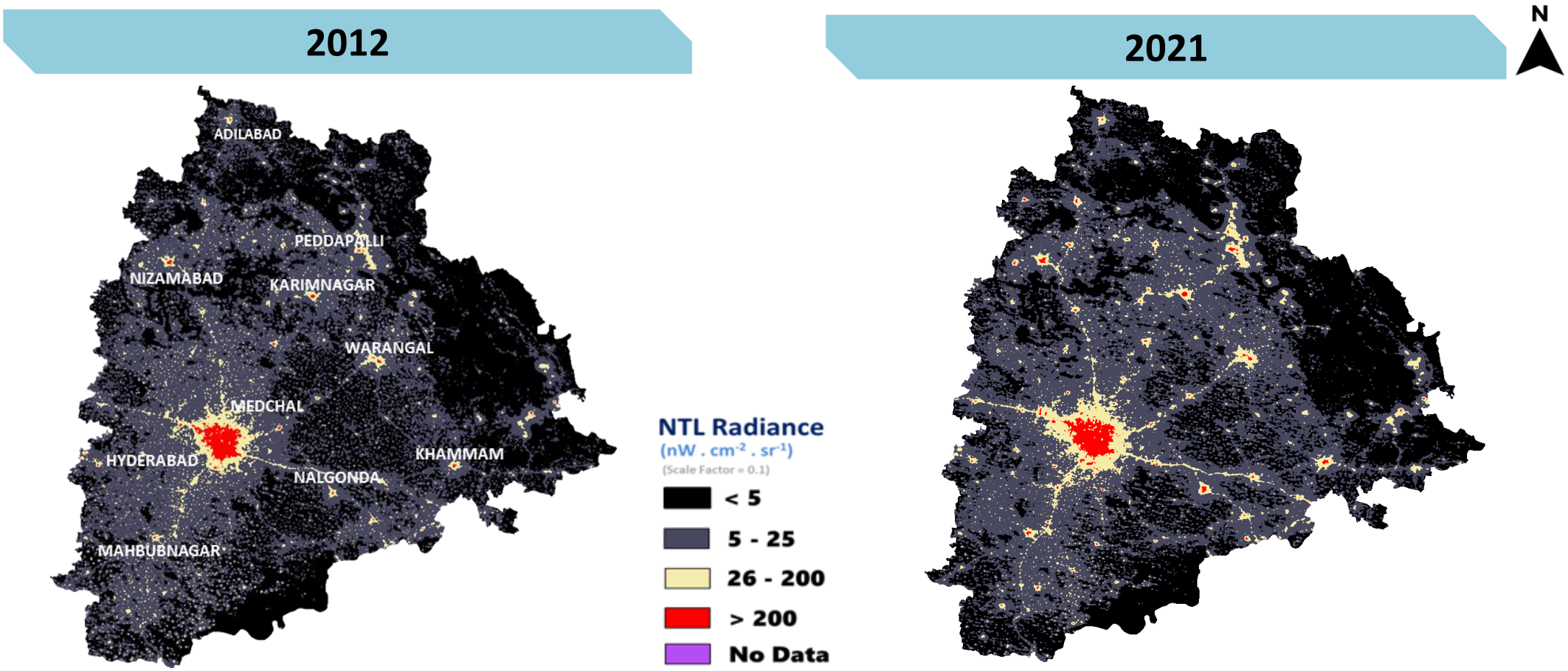


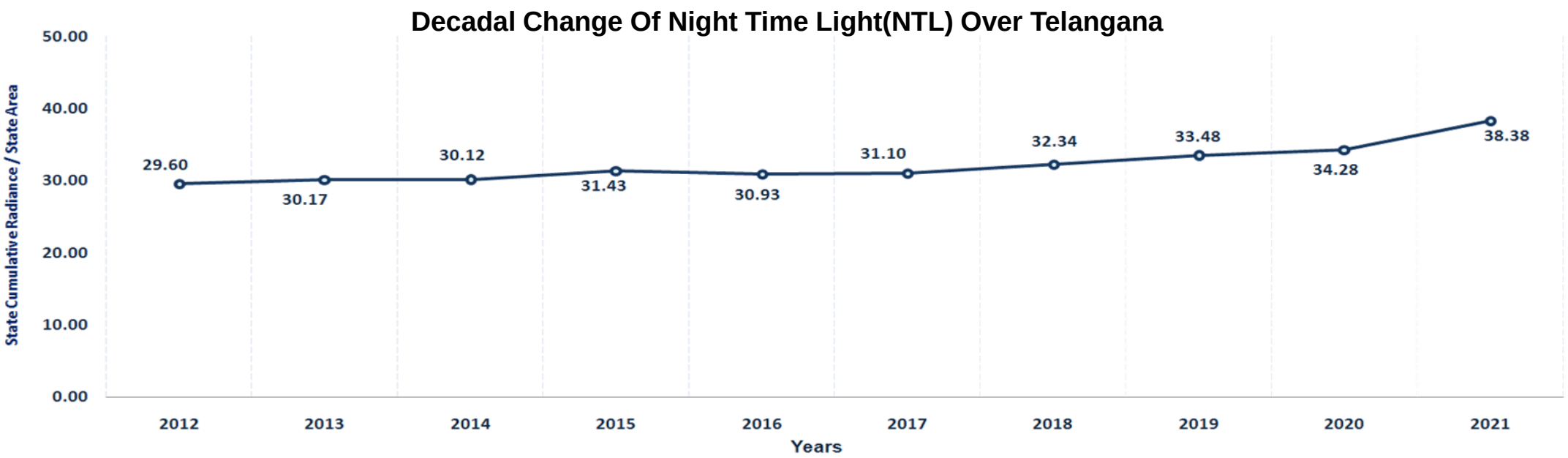
Approx. **43% increase** observed from 2012 to 2021 w.r.t. 2012, then **2% decrease** observed in 2020 w.r.t 2019 and **10% increase** observed in 2021 w.r.t 2020.

Most prominent changes in the districts of Tamil Nadu



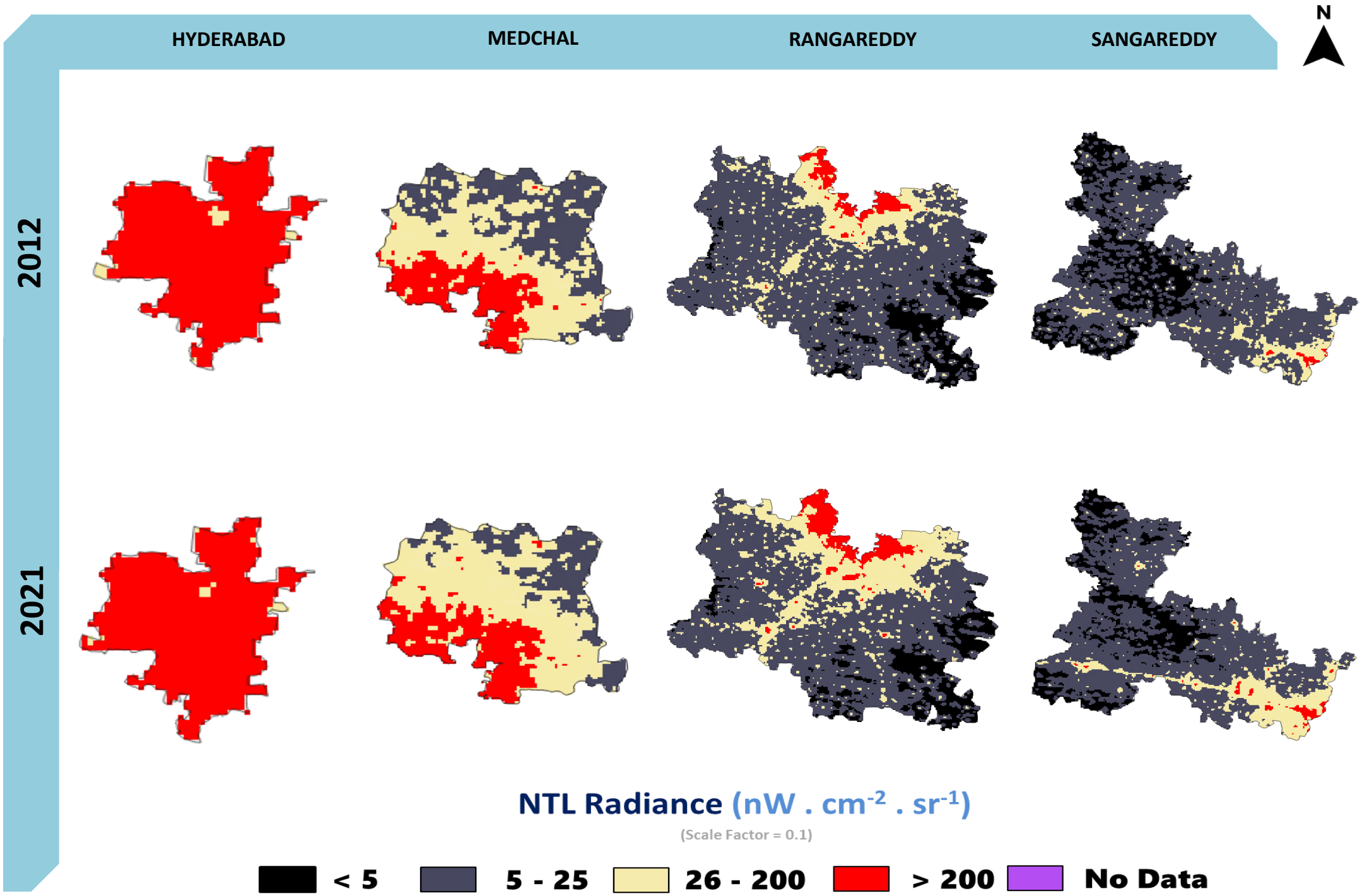
Telangana



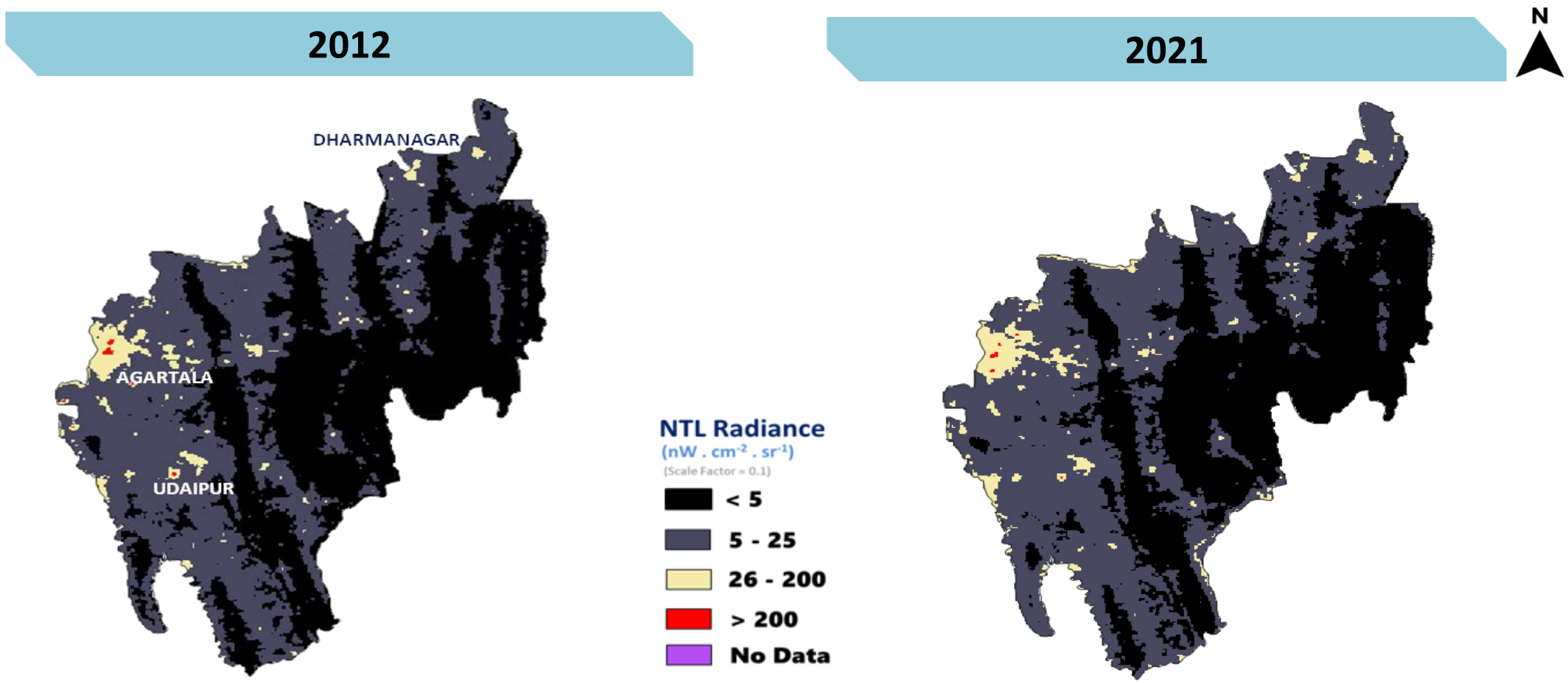


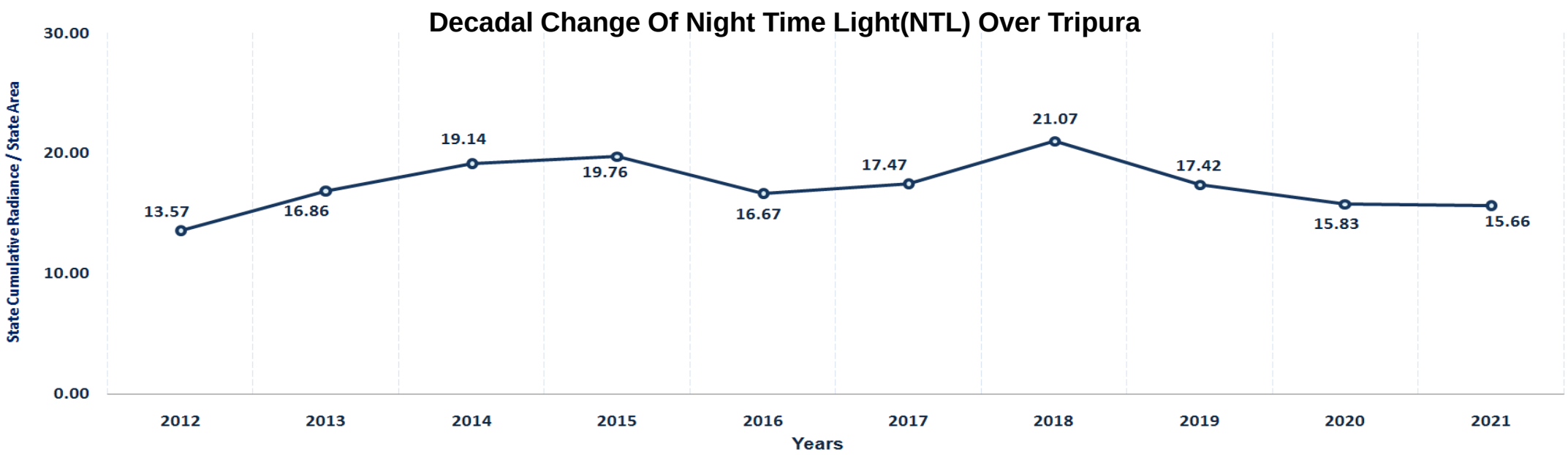
Approx. **30% increase** observed from 2012 to 2021 w.r.t. 2012, then **2% increase** observed in 2020 w.r.t 2019 and **12% increase** observed in 2021 w.r.t 2020.

Most prominent changes in the districts of Telangana



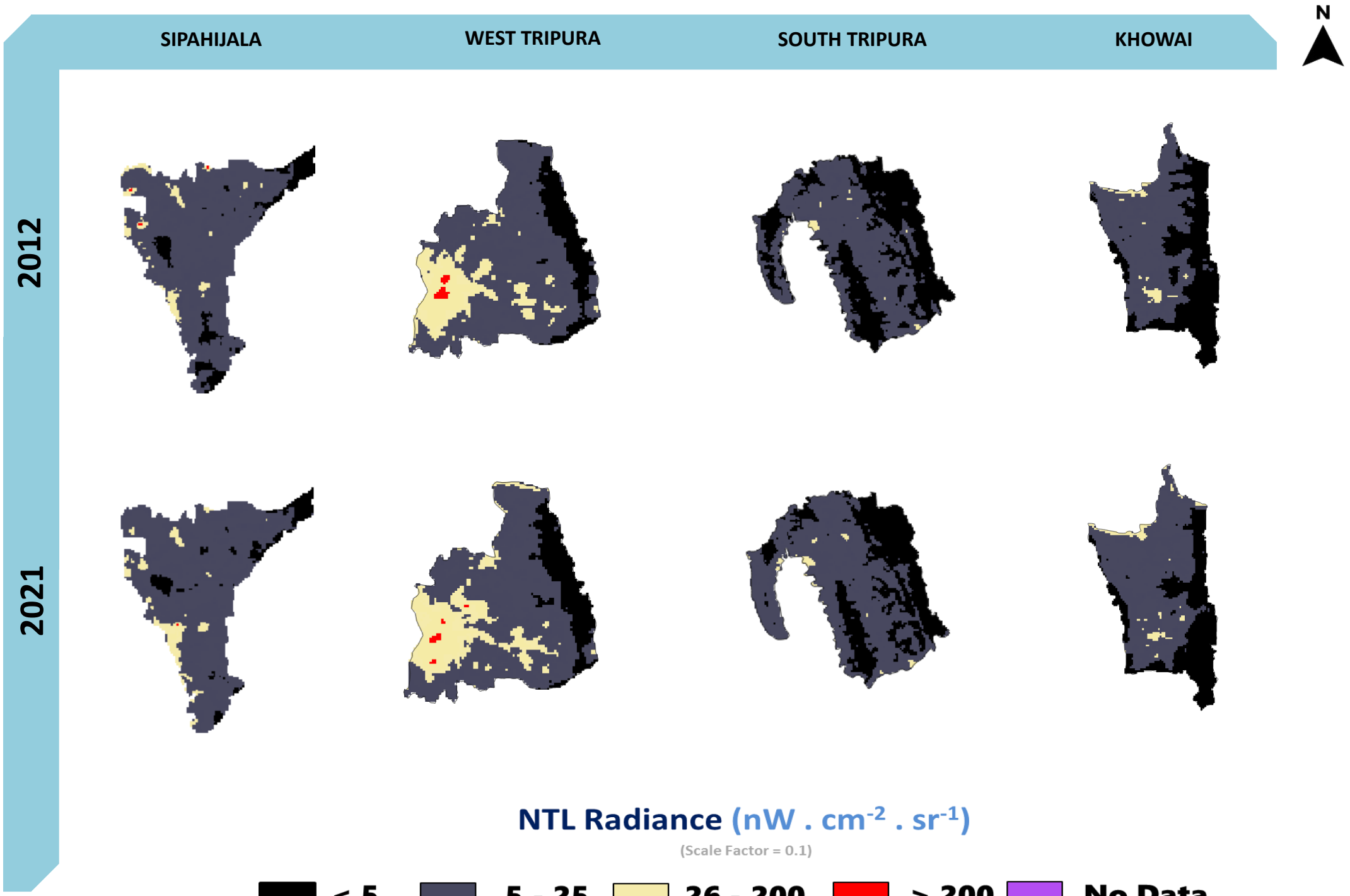
Tripura



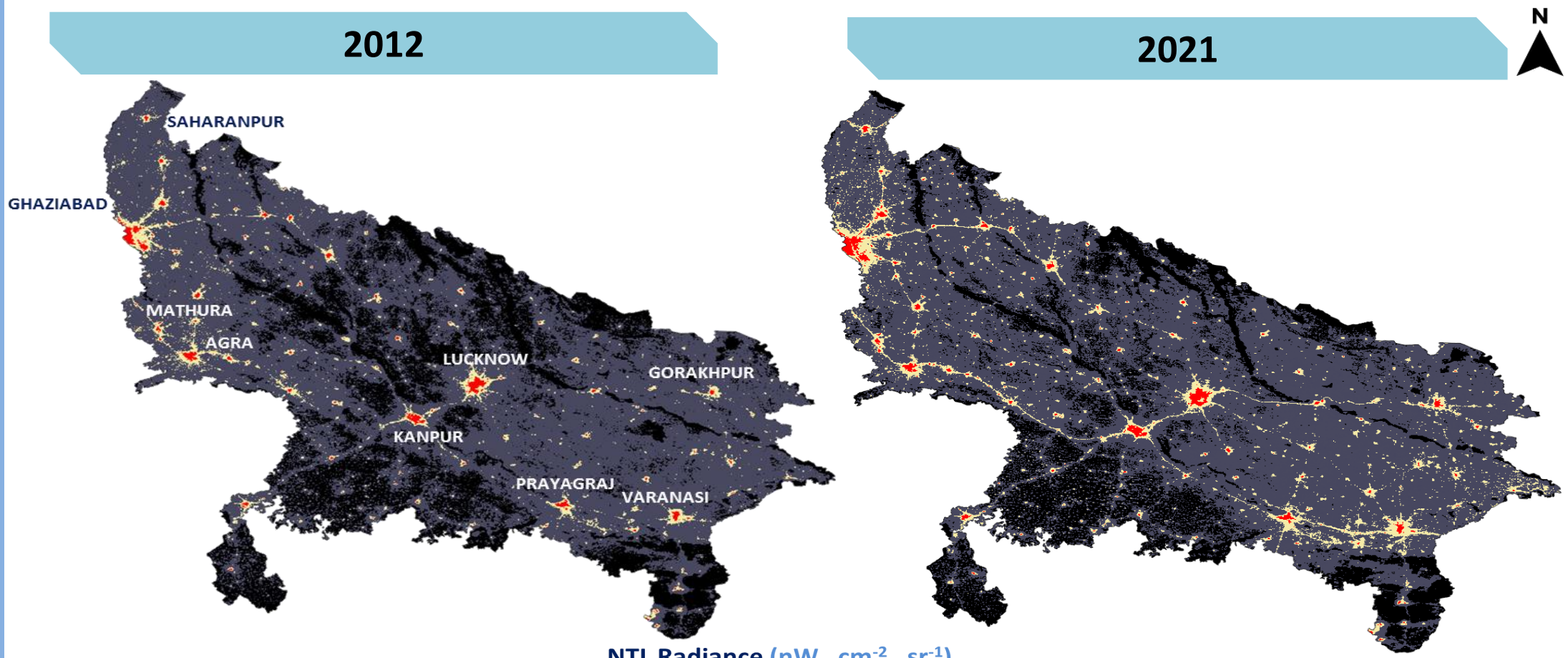


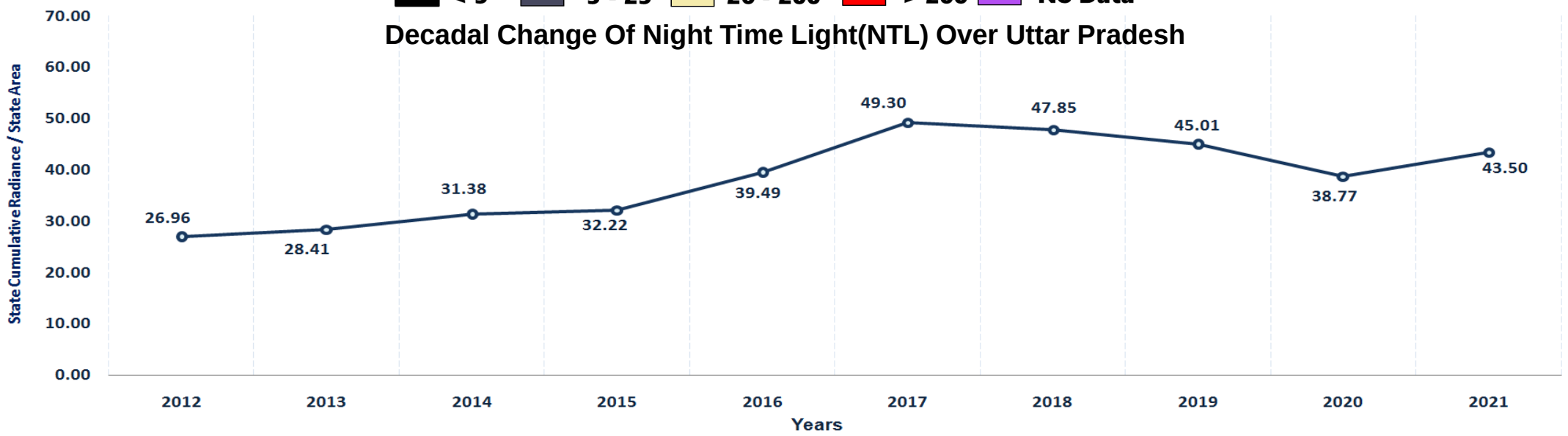
Approx. **15% increase** observed from 2012 to 2021 w.r.t. 2012, then **9% decrease** observed in 2020 w.r.t 2019 and **1% decrease** observed in 2021 w.r.t 2020.

Most prominent changes in the districts of Tripura



Uttar Pradesh





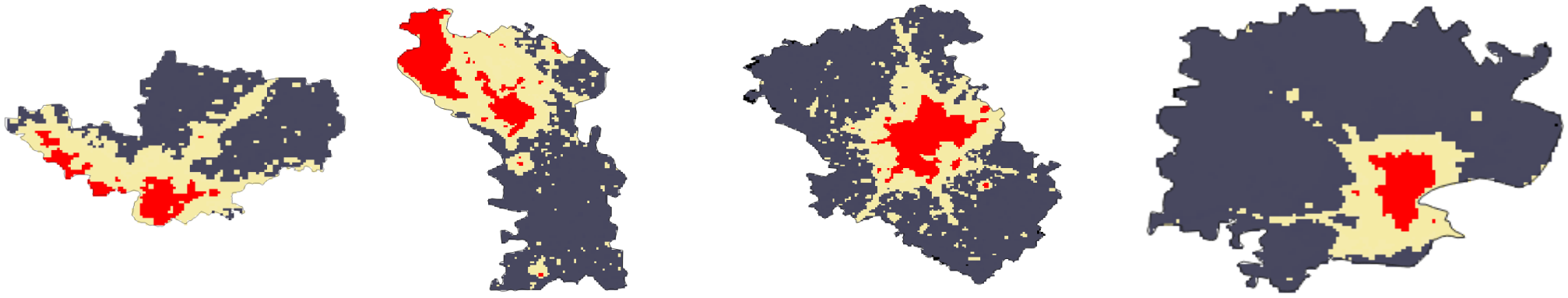
Approx. **61% increase** observed from 2012 to 2021 w.r.t. 2012, then **14% decrease** observed in 2020 w.r.t 2019 and **12% increase** observed in 2021 w.r.t 2020.

Most prominent changes in the districts of Uttar Pradesh

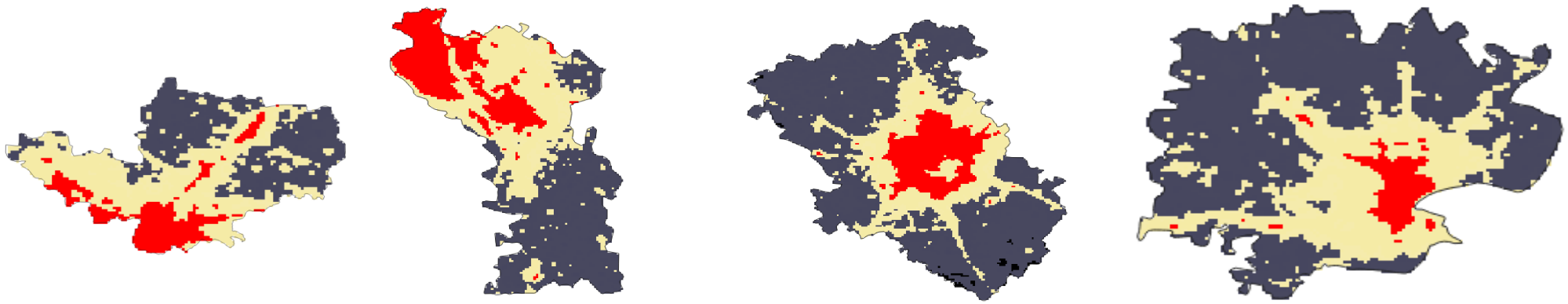
GHAZIABAD | GAUTAM BUDDHA NAGAR | LUCKNOW | VARANASI

N

2012



2021

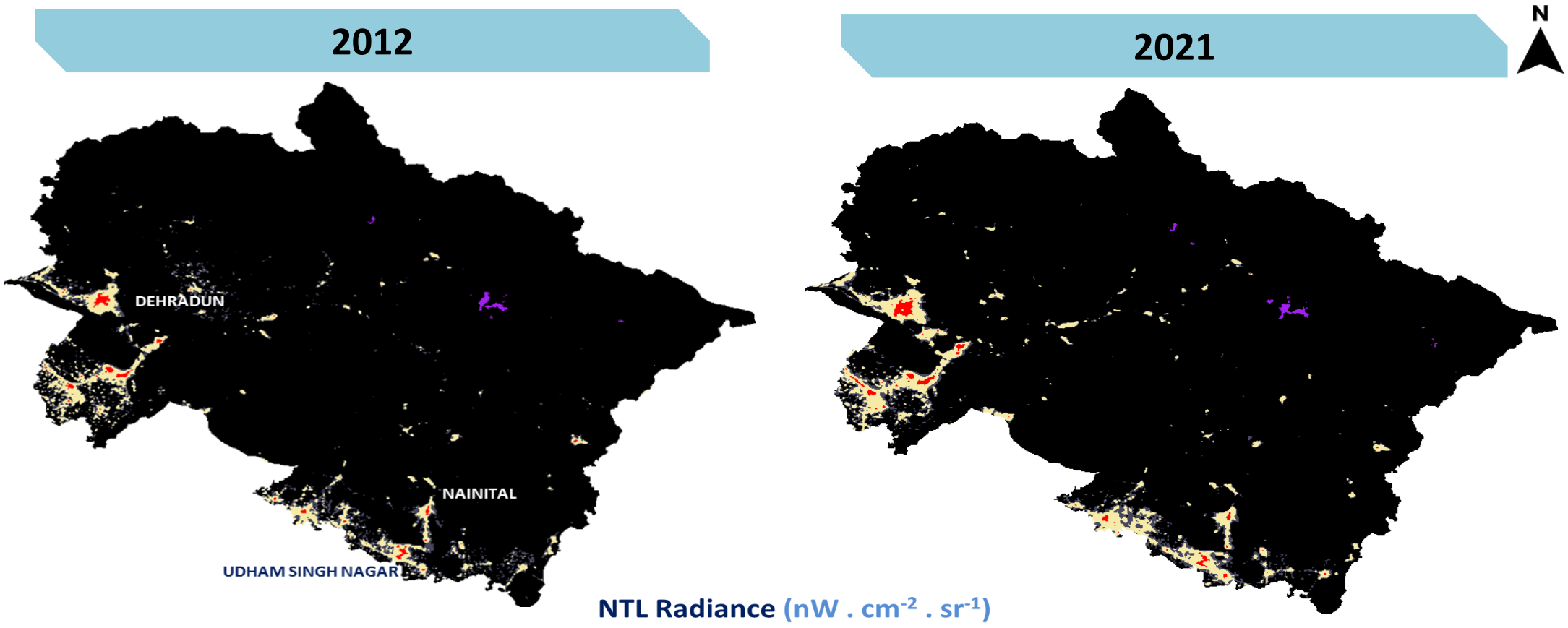


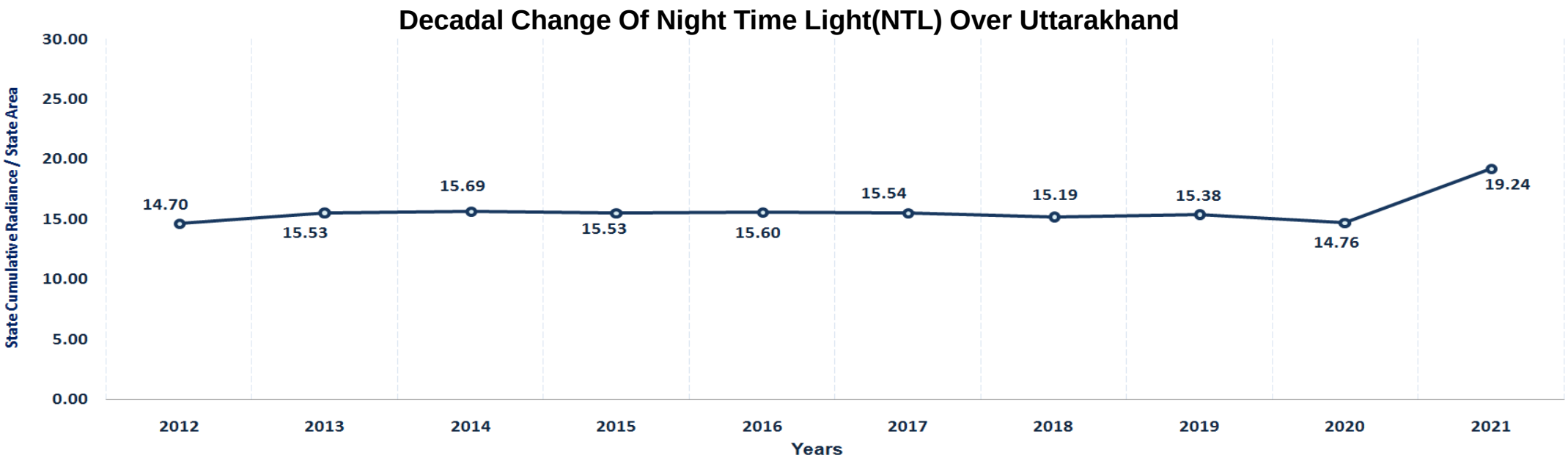
NTL Radiance (nW . cm^{-2} . sr^{-1})

(Scale Factor = 0.1)

< 5 | 5 - 25 | 26 - 200 | > 200 | No Data

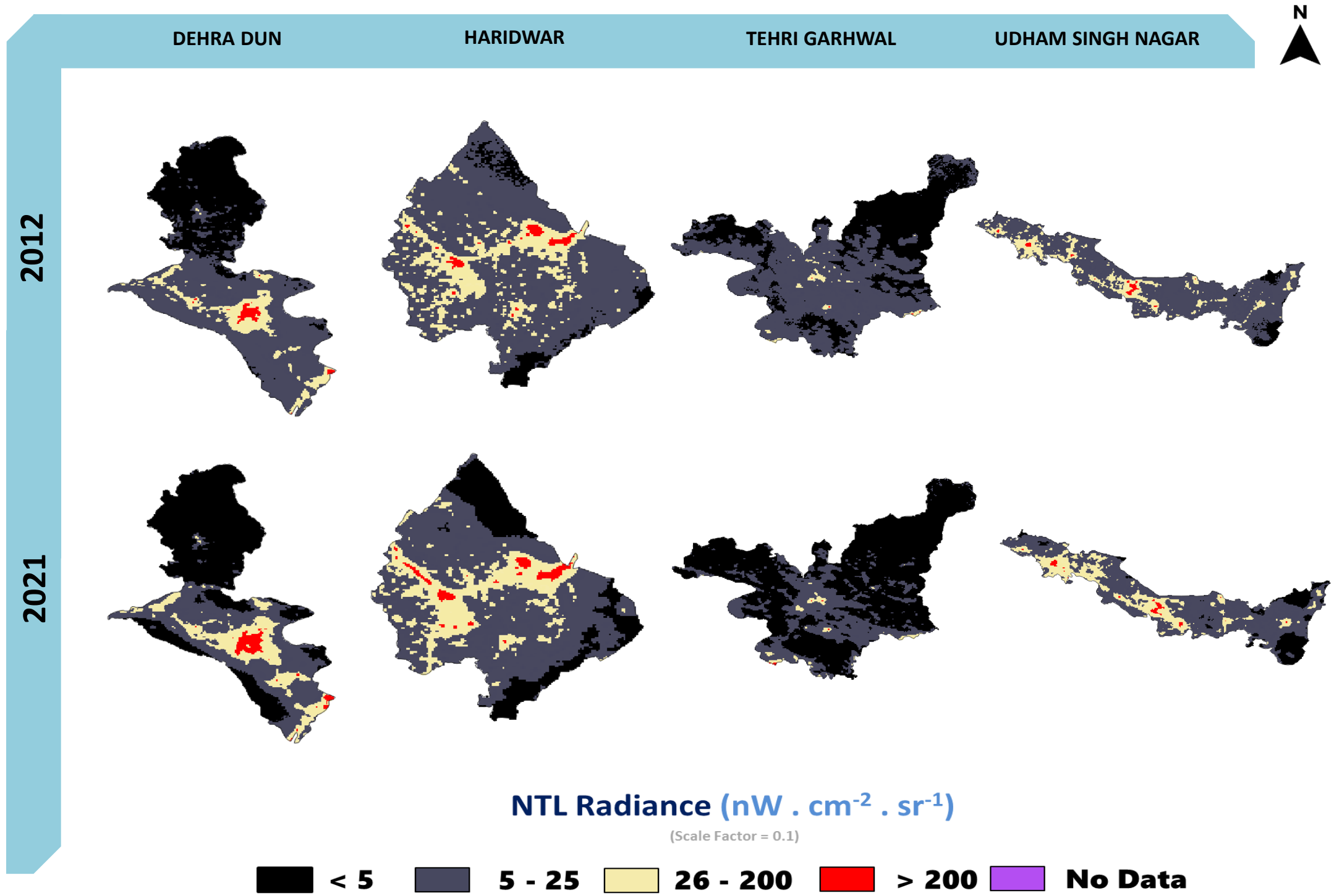
Uttarakhand



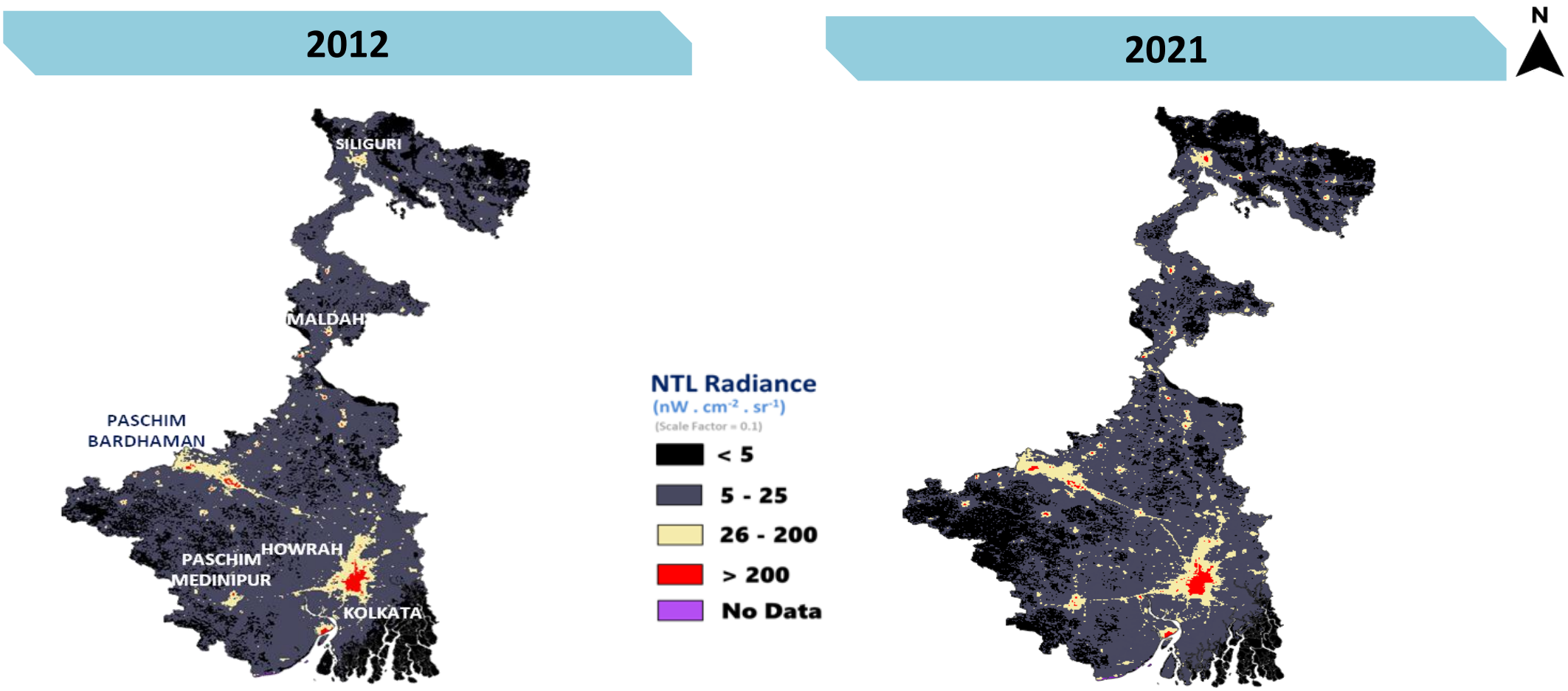


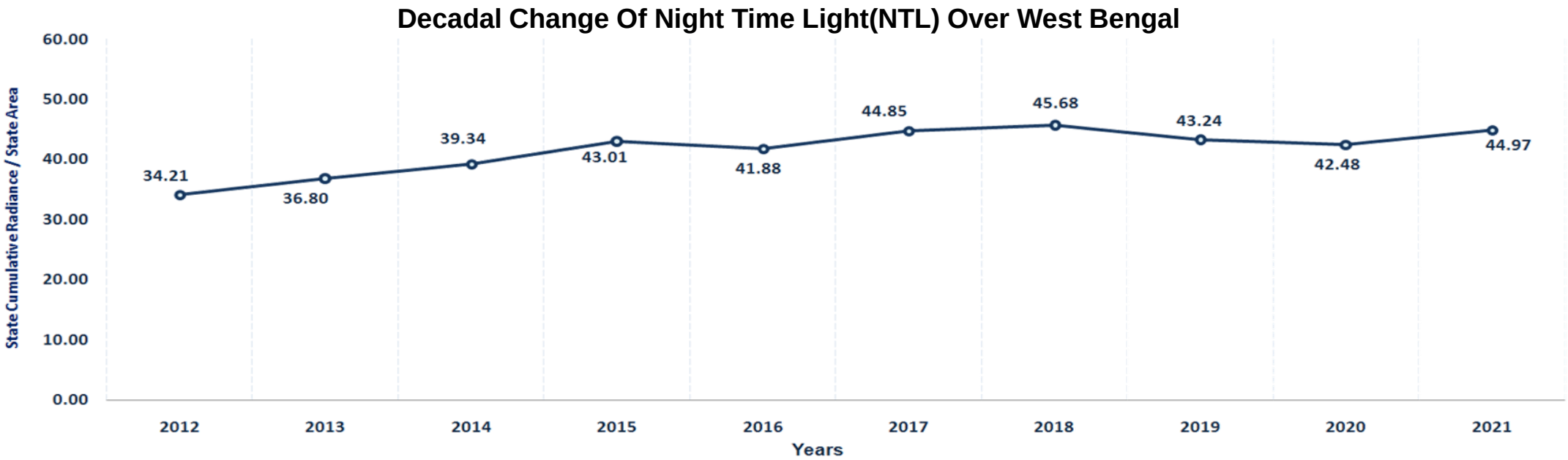
Approx. **31% increase** observed from 2012 to 2021 w.r.t. 2012, then **4% decrease** observed in 2020 w.r.t 2019 and **30% increase** observed in 2021 w.r.t 2020.

Most prominent changes in the districts of Uttarakhand



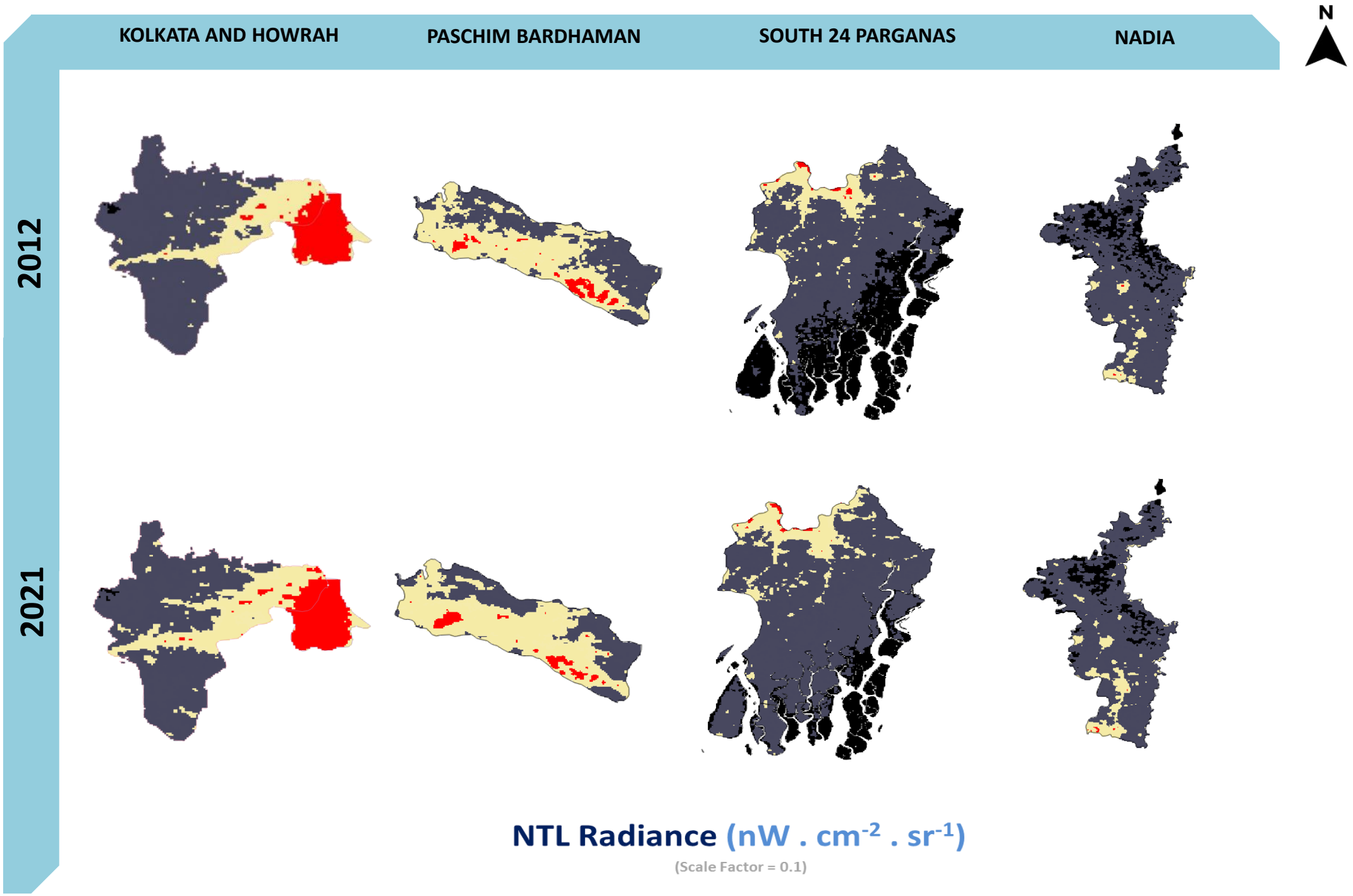
West Bengal



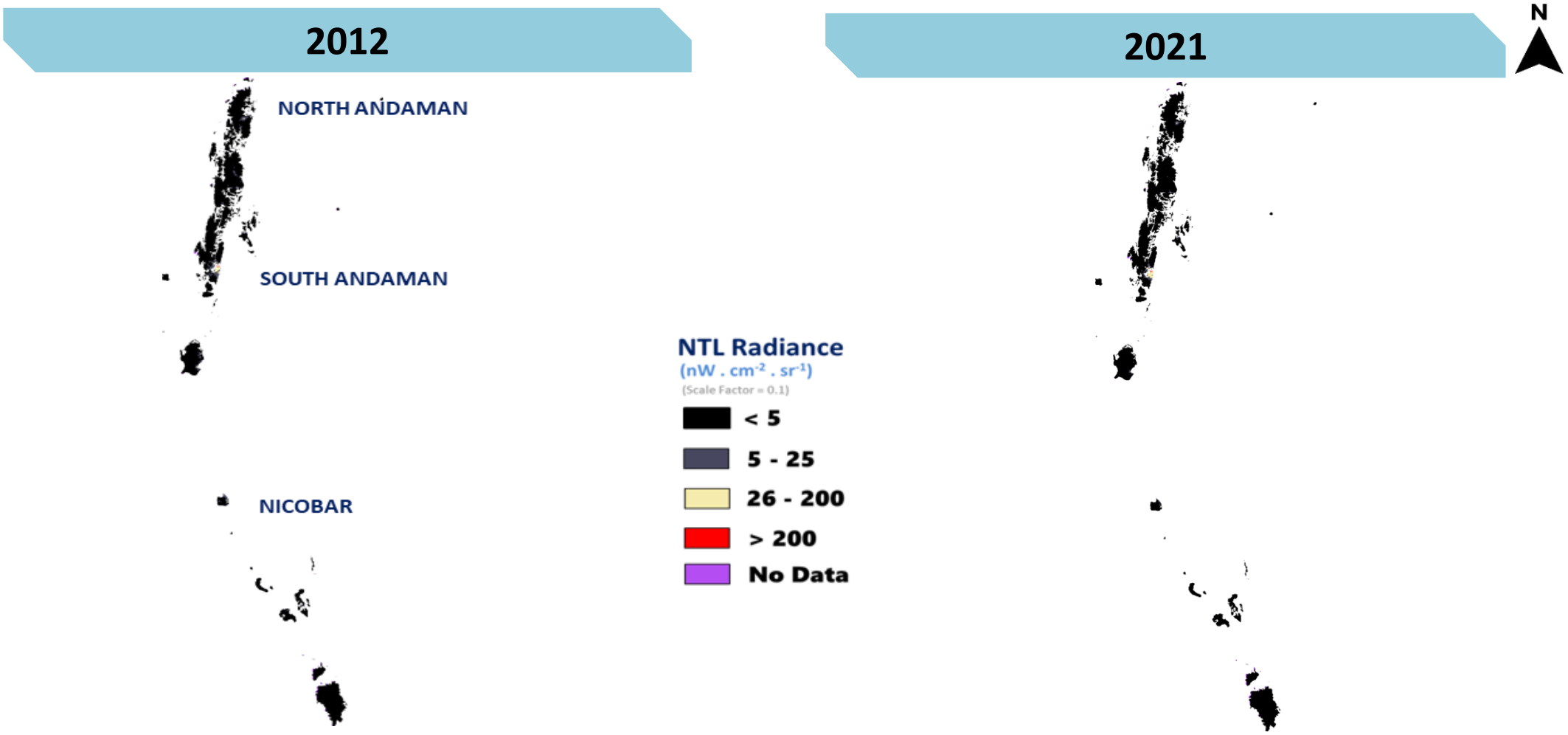


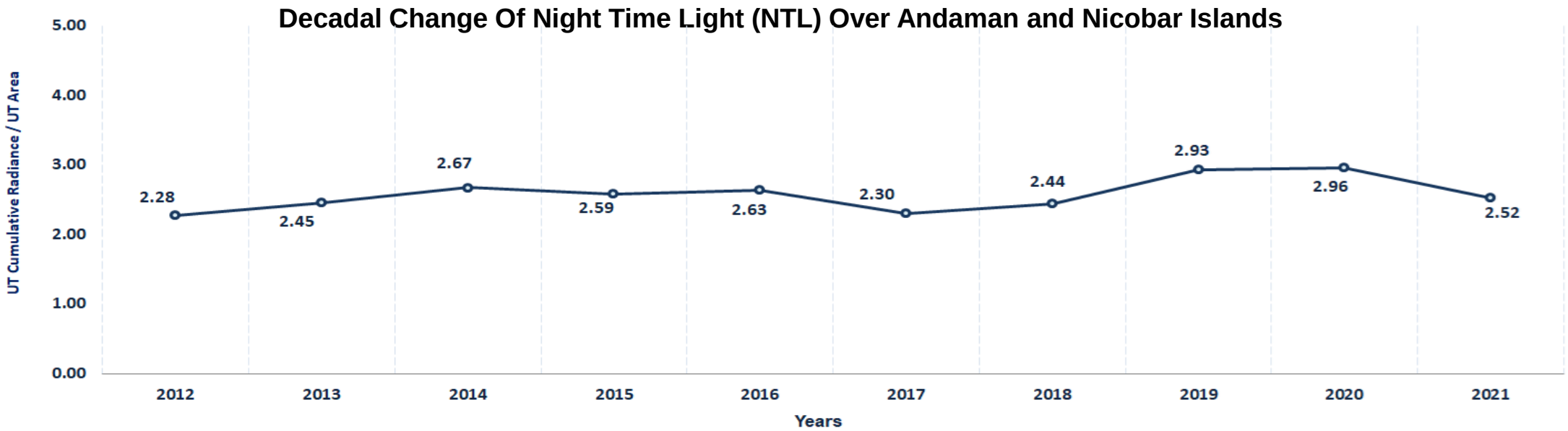
Approx. **31% increase** observed from 2012 to 2021 w.r.t. 2012, then **2% decrease** observed in 2020 w.r.t 2019 and **6% increase** observed in 2021 w.r.t 2020.

Most prominent changes in the districts of West Bengal



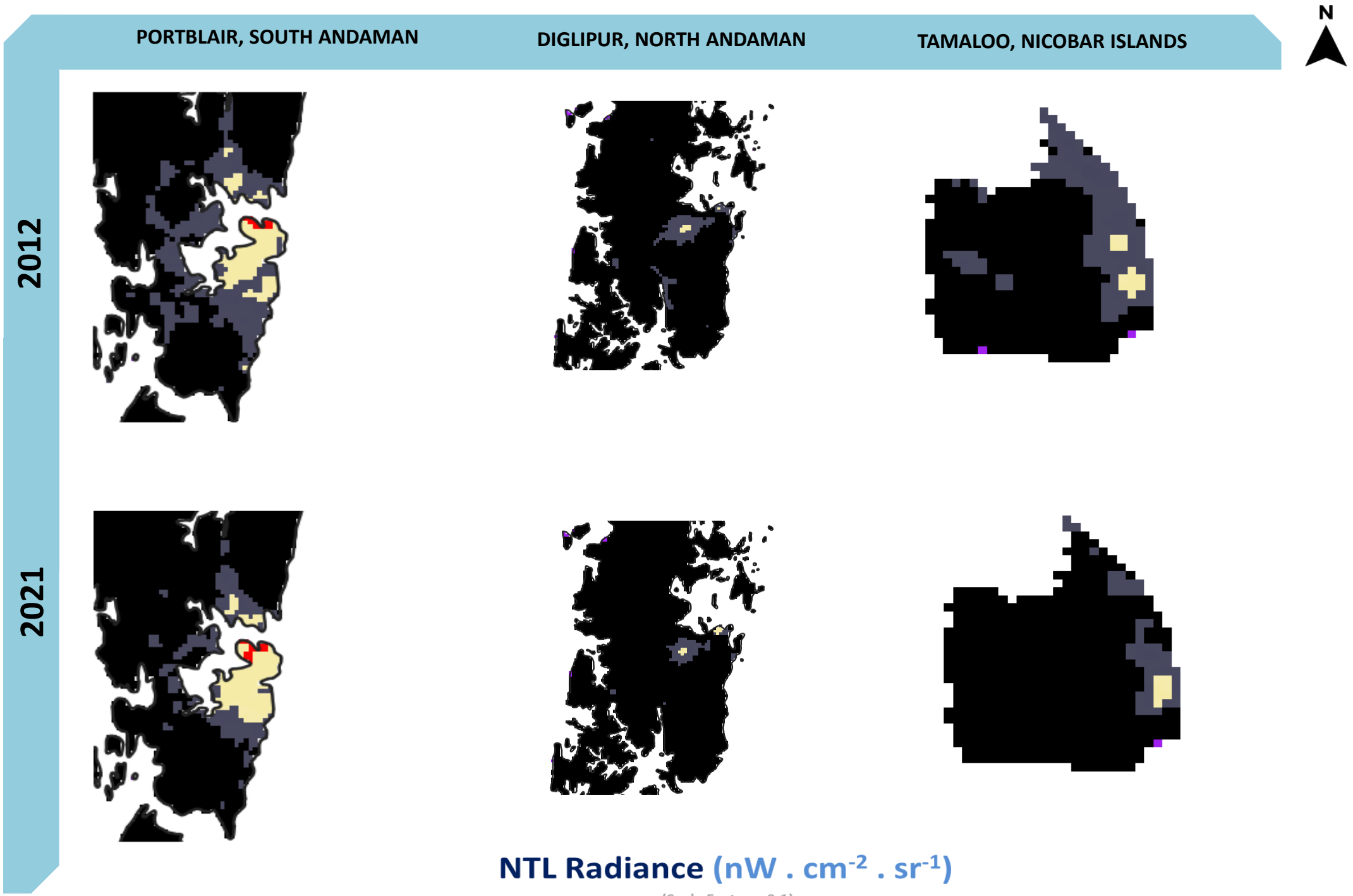
Andaman & Nicobar Islands





Approx. **11% increase** observed from 2012 to 2021 w.r.t. 2012, then **1% increase** observed in 2020 w.r.t 2019 and **14.8% decrease** observed in 2021 w.r.t 2020.

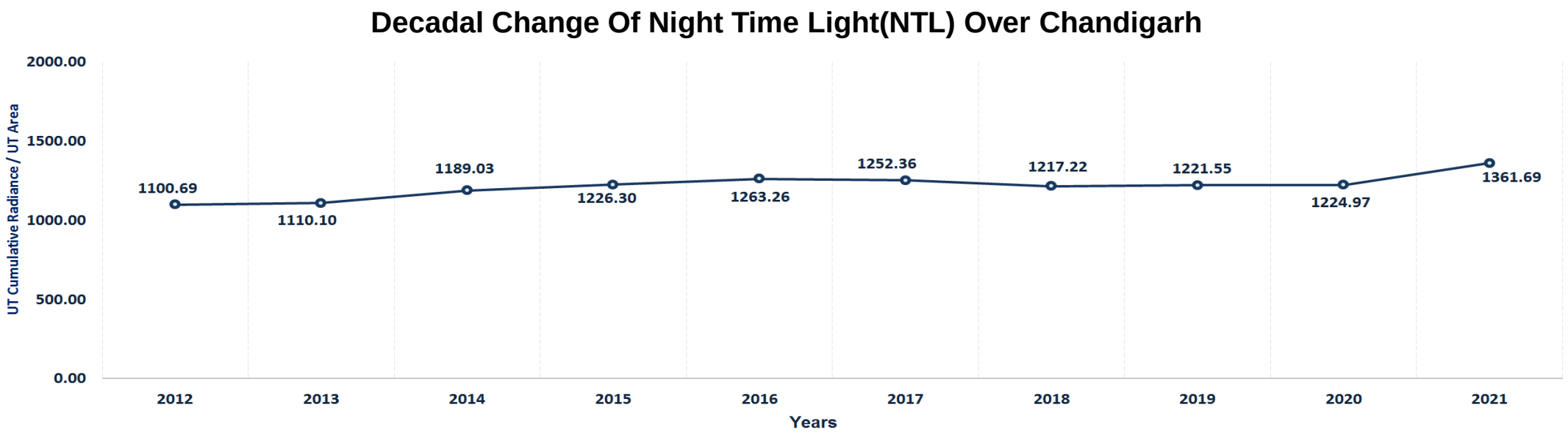
Most prominent changes in the districts of Andaman & Nicobar



Chandigarh

2012

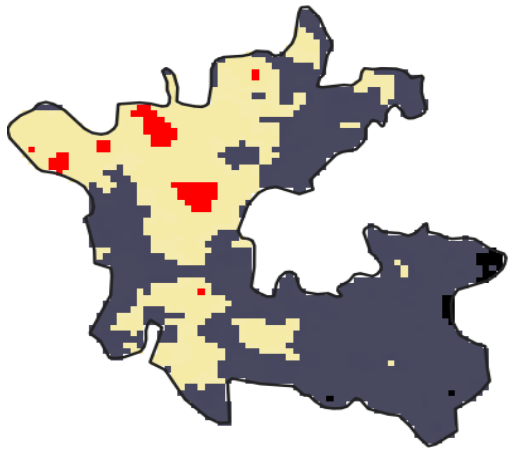
2021



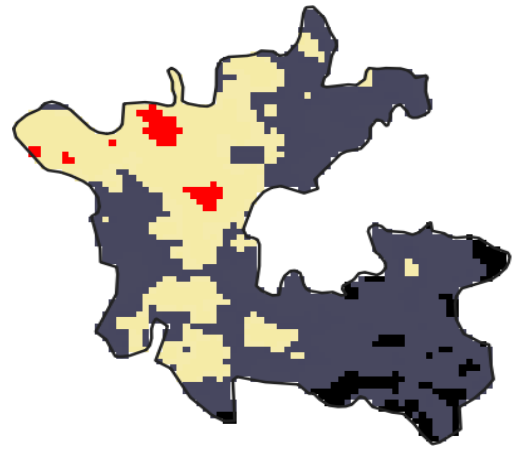
Approx. **24% increase** observed from 2012 to 2021 w.r.t. 2012, then **0.3% increase** observed in 2020 w.r.t 2019 and **11.2% increase** observed in 2021 w.r.t 2020.

Dadra & Nagar Haveli

2012



2021



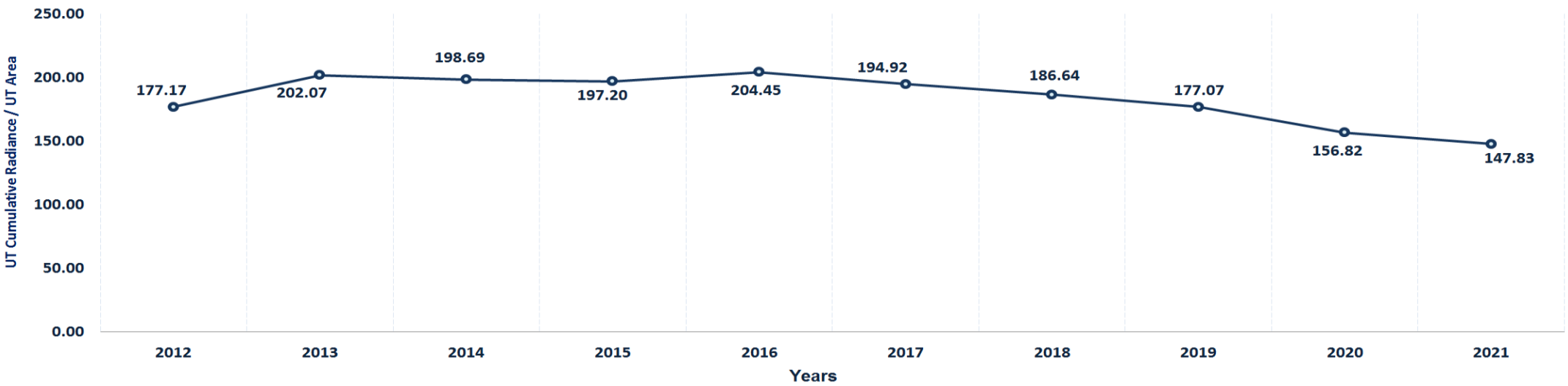
N

NTL Radiance (nW . cm^{-2} . sr^{-1})

(Scale Factor = 0.1)

< 5 | 5 - 25 | 26 - 200 | > 200 | No Data

Decadal Change Of Night Time Light(NTL) Over Dadra & Nagar Haveli

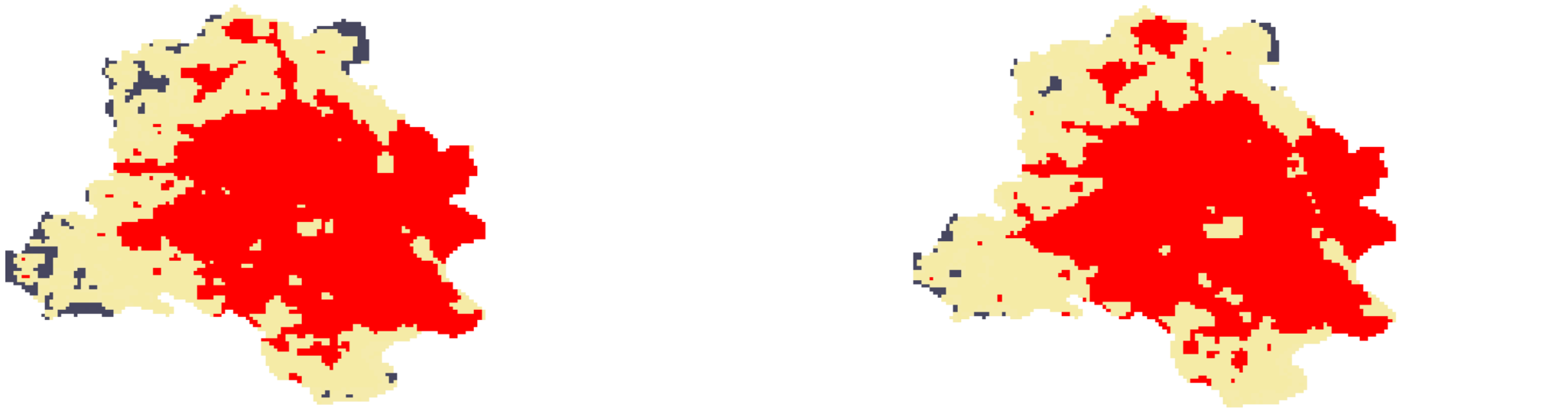


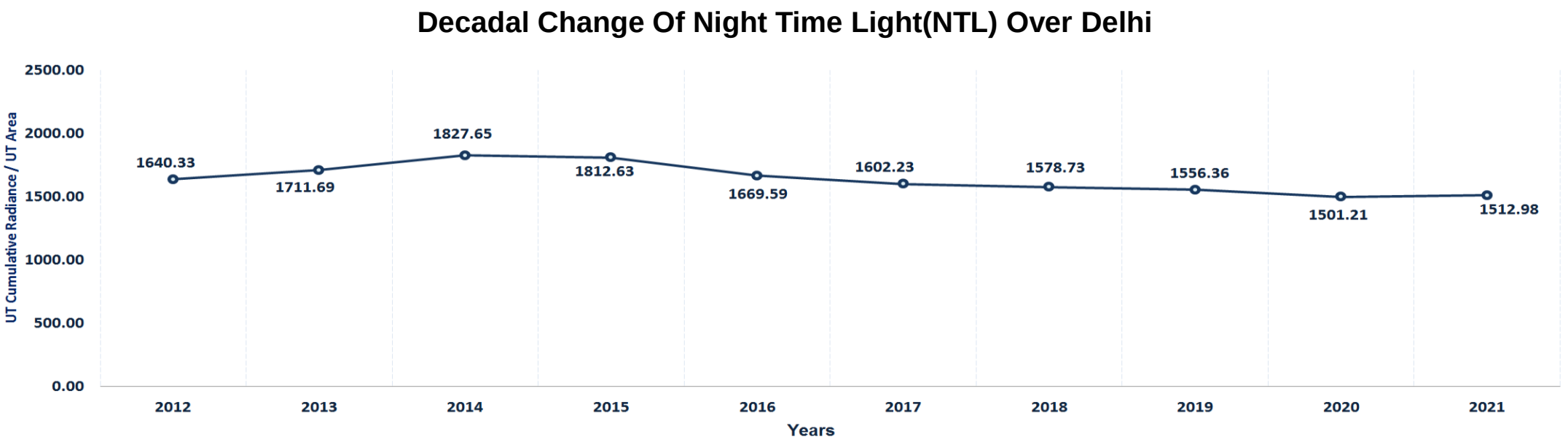
Observed decrease in 2021 w.r.t 2012 which is insignificant, **11.4% decrease** observed in 2020 w.r.t 2019 and **5.7% decrease** observed in 2021 w.r.t 2020.

Delhi

2012

2021

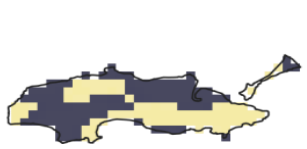




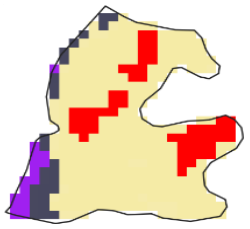
Observed decrease in 2021 w.r.t 2012 which is insignificant, **3.5% decrease** observed in 2020 w.r.t 2019 and **0.8% increase** observed in 2021 w.r.t 2020.

Diu & Daman

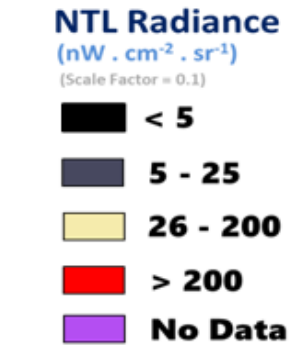
2012



DIU - 2012



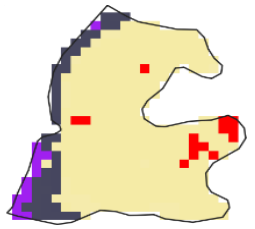
DAMAN- 2012



2021

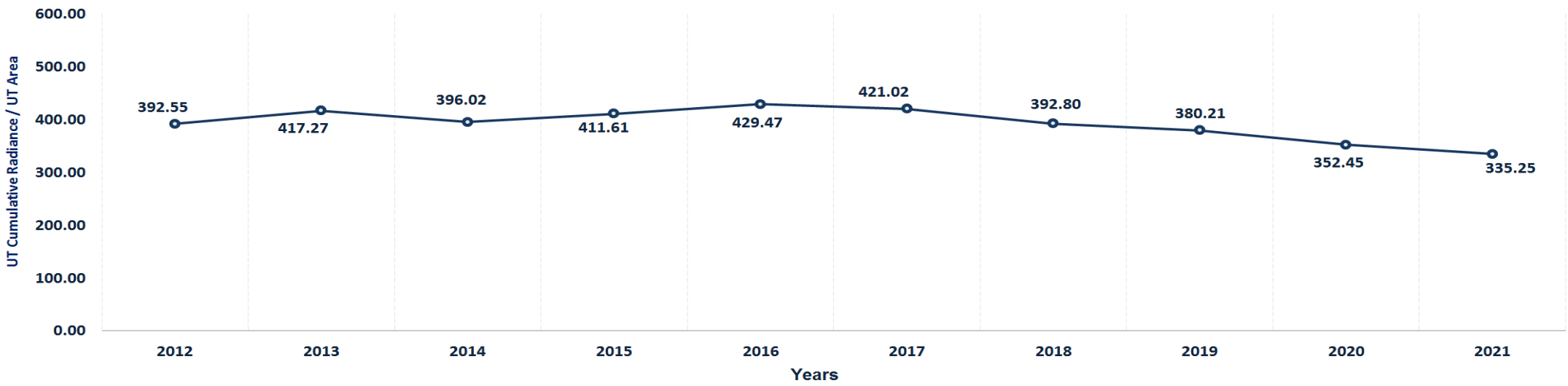
N

DIU - 2021



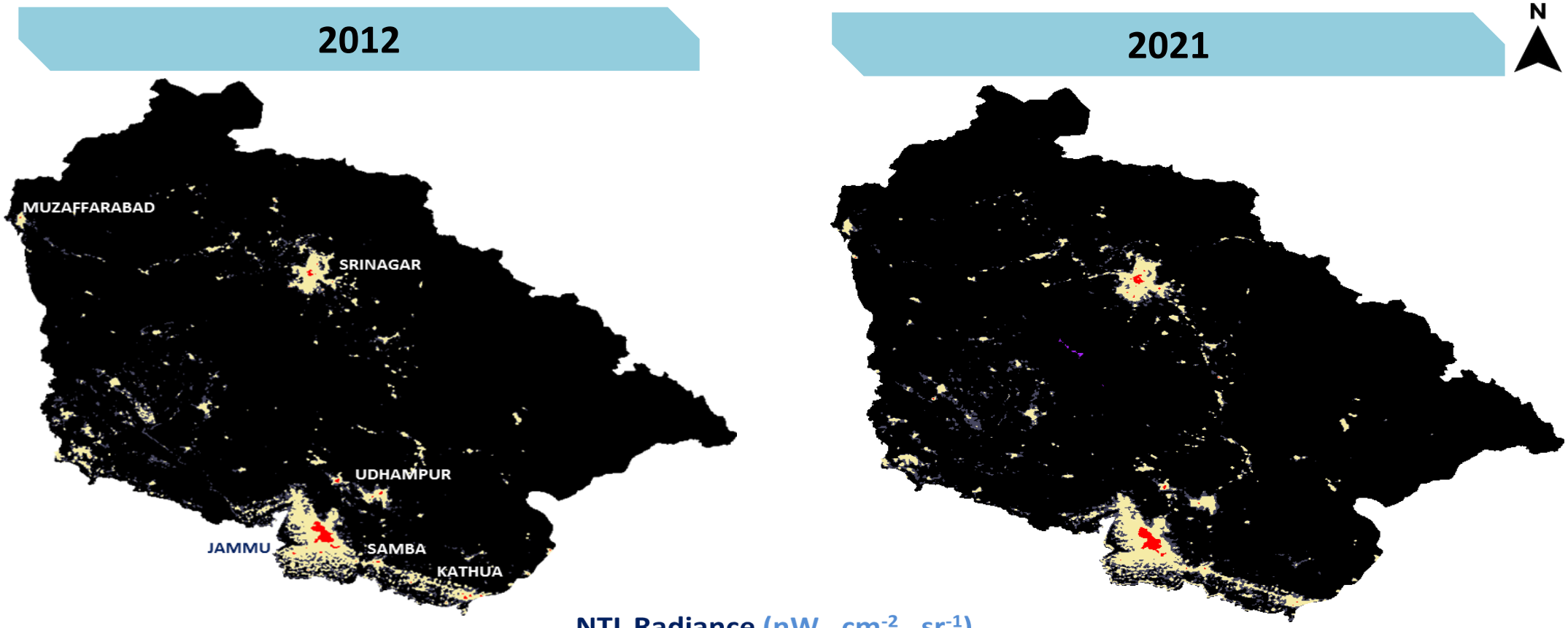
DAMAN- 2021

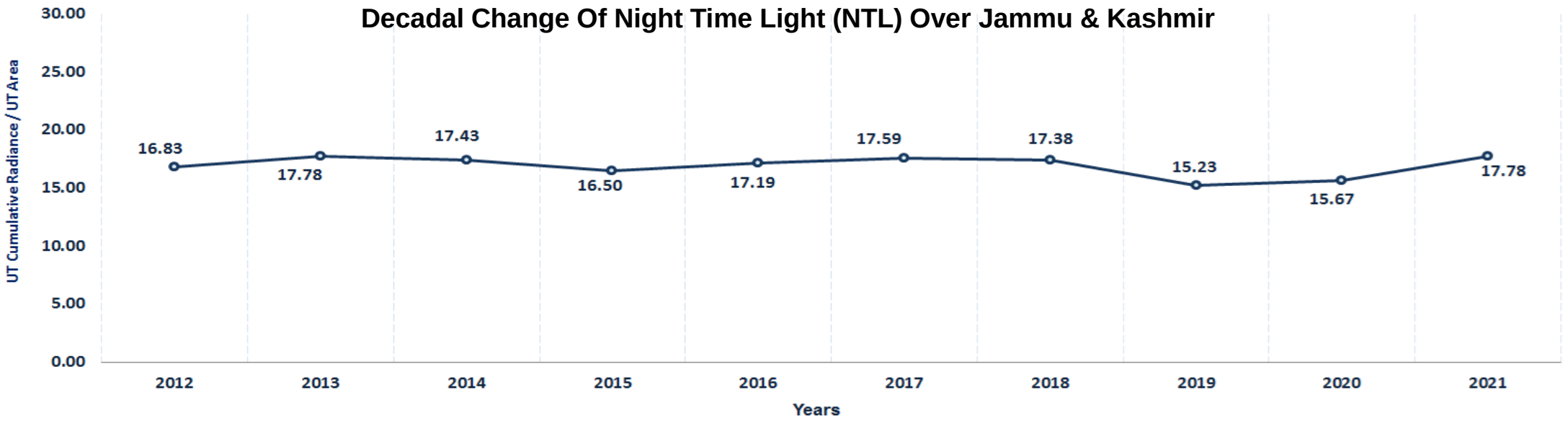
Decadal Change Of Night Time Light(NTL) Over Diu & Daman



Observed decrease in 2021 w.r.t 2012 which is insignificant, **7.3% decrease** observed in 2020 w.r.t 2019 and **4.9% decrease** observed in 2021 w.r.t 2020.

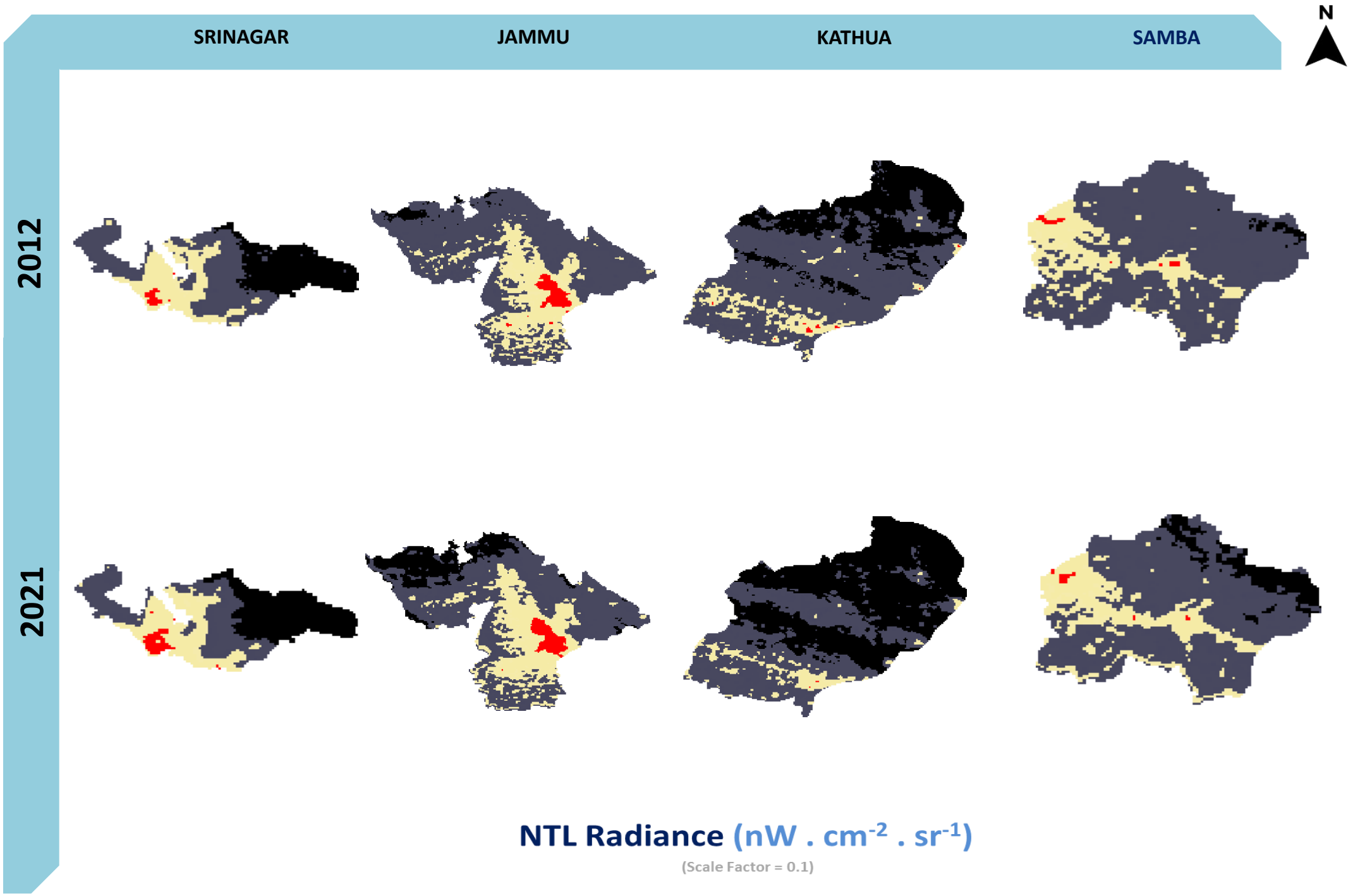
Jammu & Kashmir



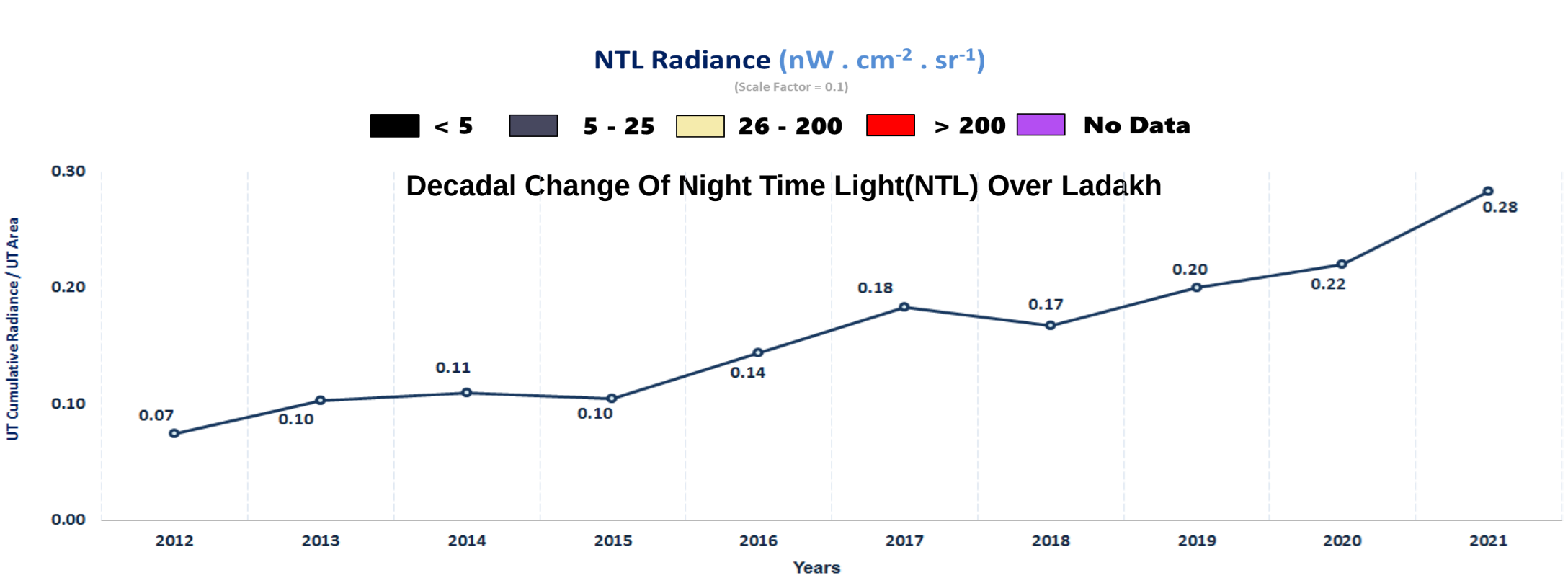


Approx. **6% increase** observed from 2012 to 2021 w.r.t. 2012, then **2.9% increase** observed in 2020 w.r.t 2019 and **13.5% increase** observed in 2021 w.r.t 2020.

Most prominent changes in the districts of Jammu & Kashmir

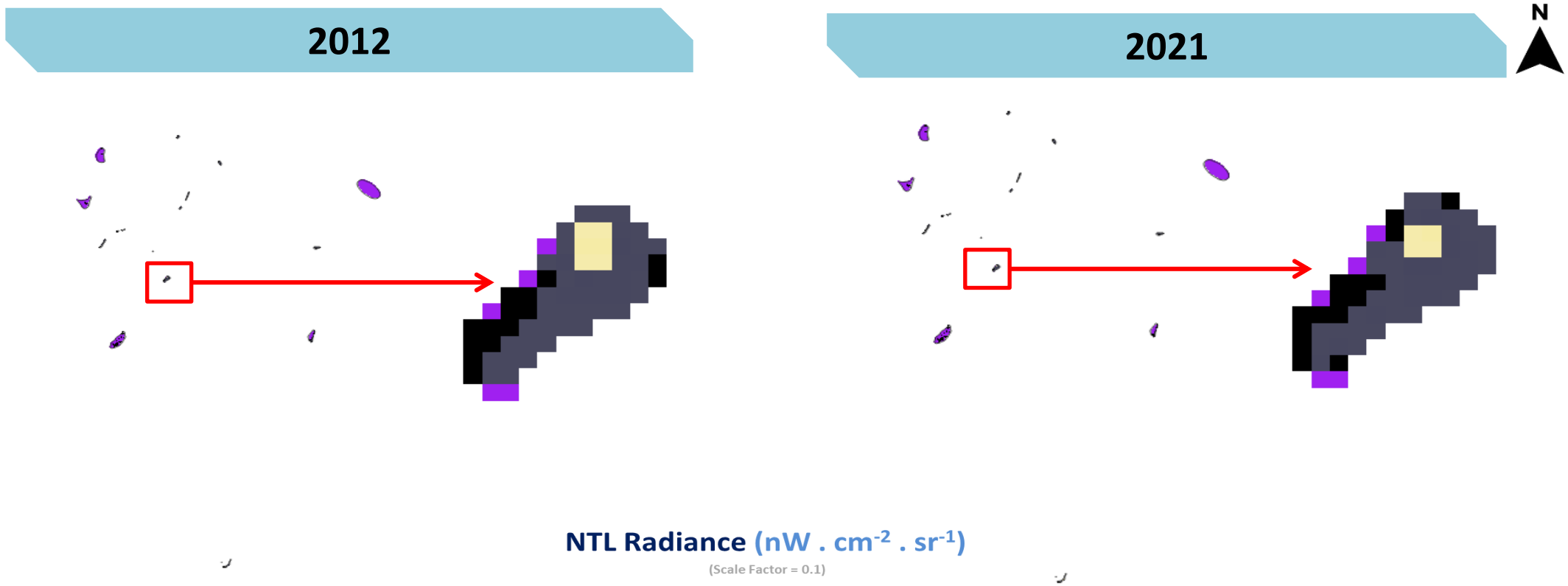


Ladakh

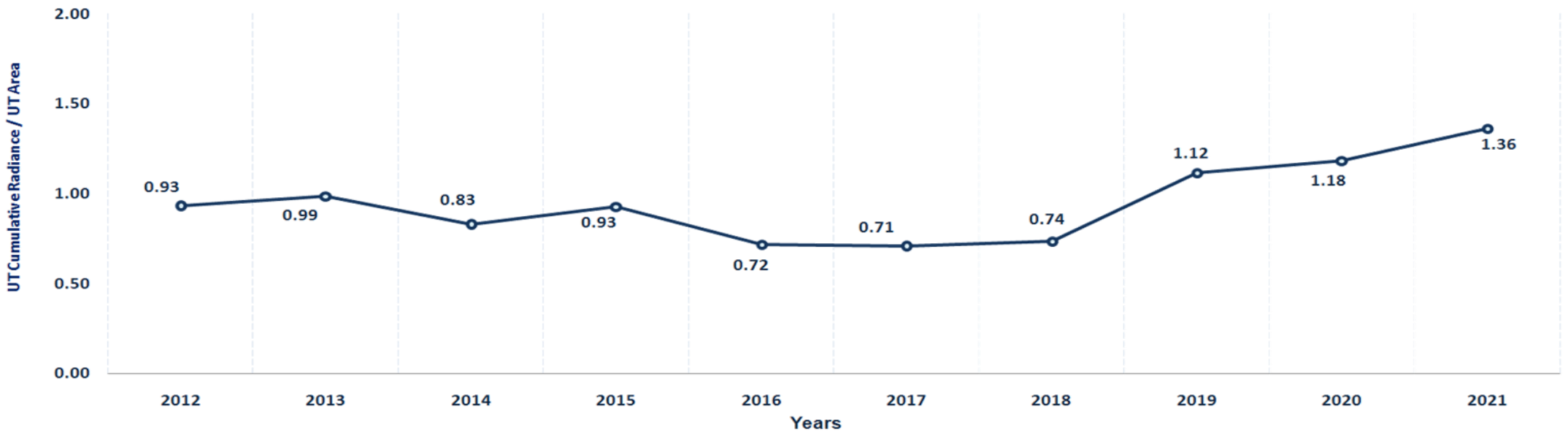


Approx. **280% increase** observed from 2012 to 2021 w.r.t. 2012, then **10.2% increase** observed in 2020 w.r.t 2019 and **28.4% increase** observed in 2021 w.r.t 2020.

Lakshadweep

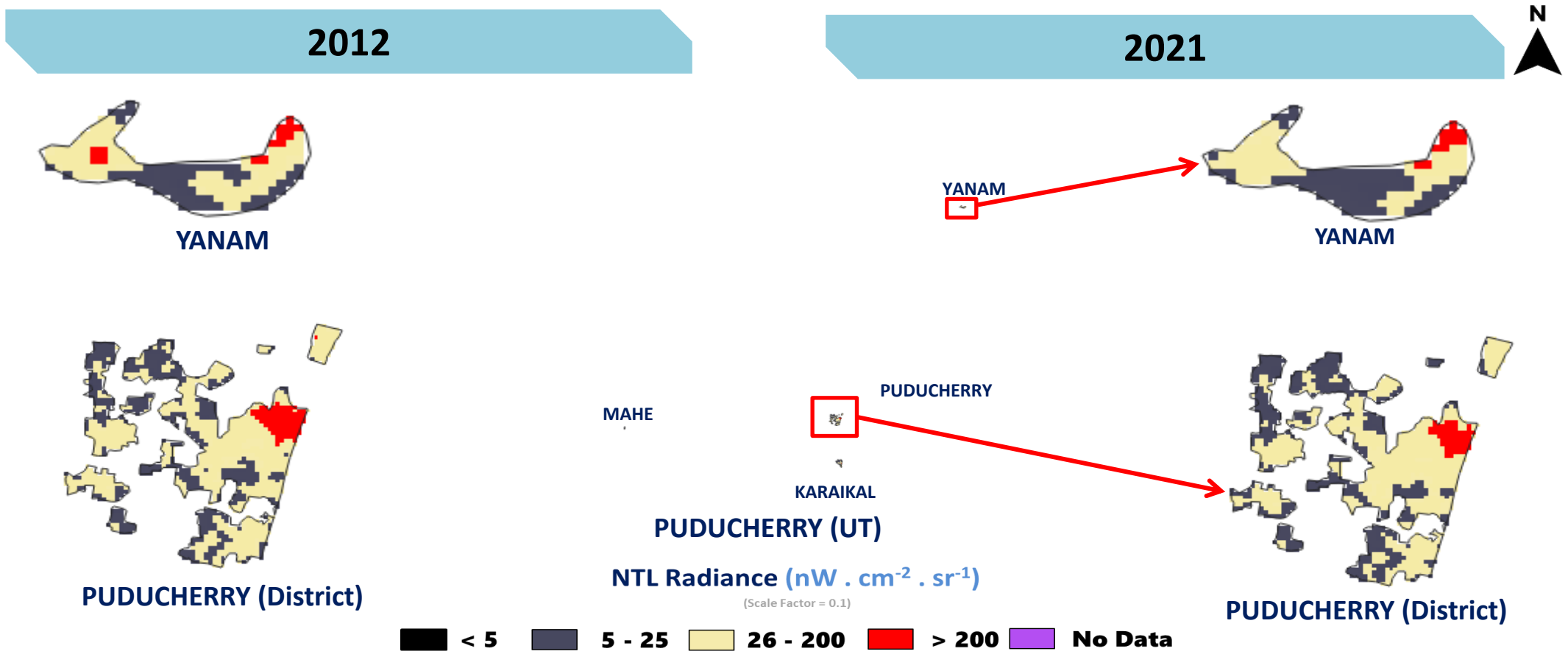


Decadal Change Of Night Time Light(NTL) Over Lakshadweep

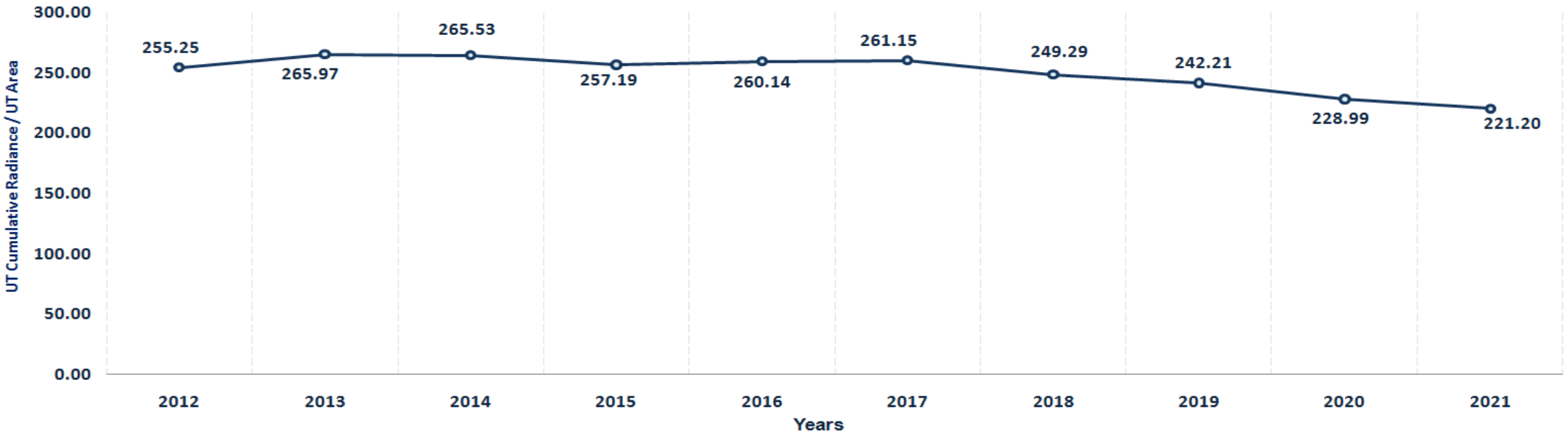


Approx. **46% increase** observed from 2012 to 2021 w.r.t. 2012, then **6% increase** observed in 2020 w.r.t 2019 and **15% increase** observed in 2021 w.r.t 2020.

Puducherry



Decadal Change Of Night Time Light(NTL) Over Puducherry



Observed decrease in 2021 w.r.t 2012 which is insignificant, **5% decrease** observed in 2020 w.r.t 2019 and **3% decrease** observed in 2021 w.r.t 2020.

References

- Zhuosen Wang, Miguel O. Román, Virginia L. Kalb, Steven D. Miller, Jianglong Zhang, Ranjay M. Shrestha,Quantifying uncertainties in nighttime light retrievals from Suomi-NPP and NOAA-20 VIIRS Day/Night Band data, Remote Sensing of Environment,Volume263,2021,112557,ISSN00344257,https://doi.org/10.1016/j.rse.2021.112557.
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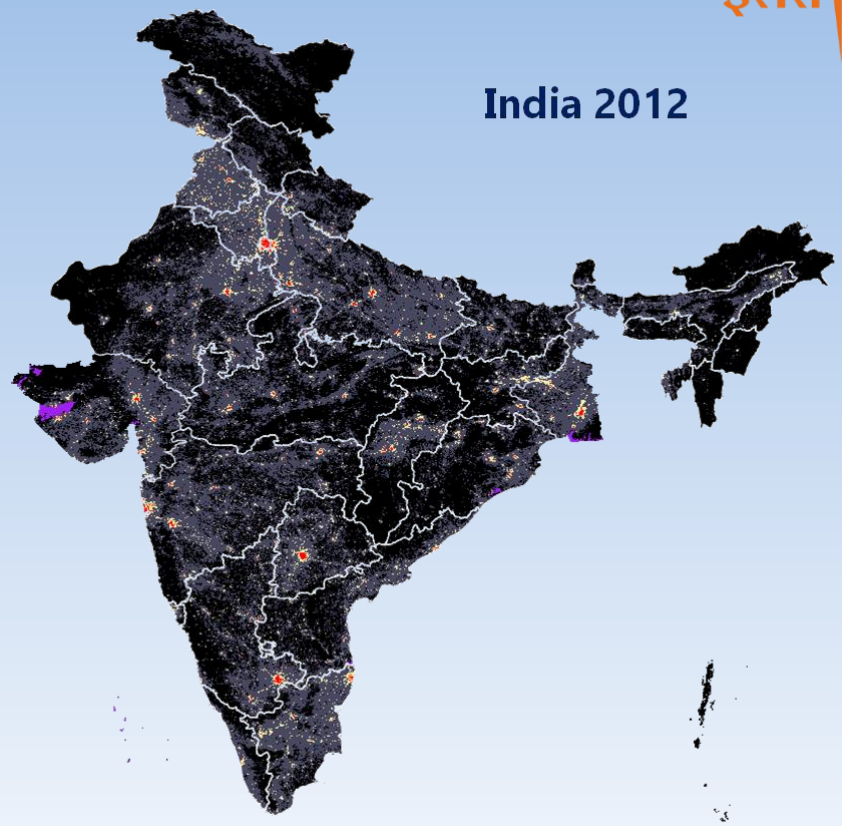
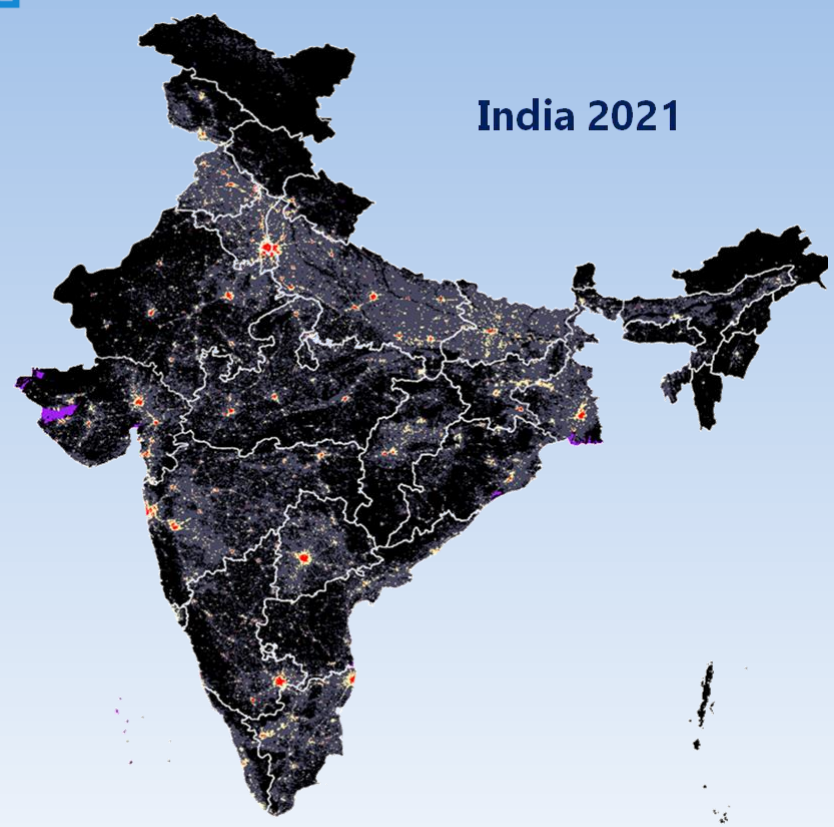
- Román, M.O., Wang, Z., Sun, Q., Kalb, V., Miller, S.D., Molthan, A., Schultz, L., Bell, J., Stokes, E.C., Pandey, B., Seto, K.C., et al. (2018). NASA's Black Marble Nighttime Lights Product Suite. Remote Sensing of Environment, 210, 113-143, doi:10.1016/j.rse.2018.03.017
- [Visible Infrared Imaging Radiometer Suite (VIIRS)] https://ladsweb.modaps.eosdis.nasa.gov/missions-and-measurements/viirs/





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Email:

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director@nrsc.gov.in