11 CHAPTER

Tracking Development through Satellite Images & Cartography

An important theme of this year's Economic Survey is the use of new forms of data and information for tracking economic activity and development. Chapter 1 looked at the use of high-frequency data for the real-time management of an economy through uncertain times. This chapter looks at the use of another kind of data – geo-spatial data and cartographic techniques – to track, compare and represent longer term developments. Geospatial maps not only lets users visualize data but also helps users to better understand trends, relationships and patterns. The use of maps is not entirely new and previous Economic Surveys have used them for years, but there is now a plethora of information from satellites, drones, mobile phones and other sources. Moreover, there has also been a dramatic improvement in cartographic technology that allows for better representation of the information. This chapter illustrates some of the interesting ways of depicting geospatial data.

Using satellite images, India's night-time luminosity is compared between 2012 and 2021 in Figures 1A and 1B. Night-time luminosity provides an interesting representation of the expansion of electricity supply, the geographical distribution of population and economic activity, urban expansion as well as growth of ribbon developments between urban hubs. Similarly, using geospatial and cartographic techniques, the subsequent maps show the extent of physical as well as financial infrastructure development in India. This includes expansion of national highways, airports, commercial bank branches, metros, etc. The maps in Figure 5A & 5B depict change in net sown area of India over the last 15 years. The maps have been created by combining satellite data over the course of a 12 month period in each year.

The images in Figures 6A & 6B compare the Kharif crop cycle in Moga district, Punjab during 2005 and 2021. The images show that Kharif sowing cycle has shifted ahead by around two-to-three weeks causing the Kharif harvest to almost coincide with Rabi sowing in November. The closing of the gap is a likely factor that encourages farmers to burn stubble and may be related to restrictions on early transplanting of Kharif paddy. These restrictions were introduced in 2009 in order to reduce pumping of ground-water but may have had the unintended consequence of damaging air quality.

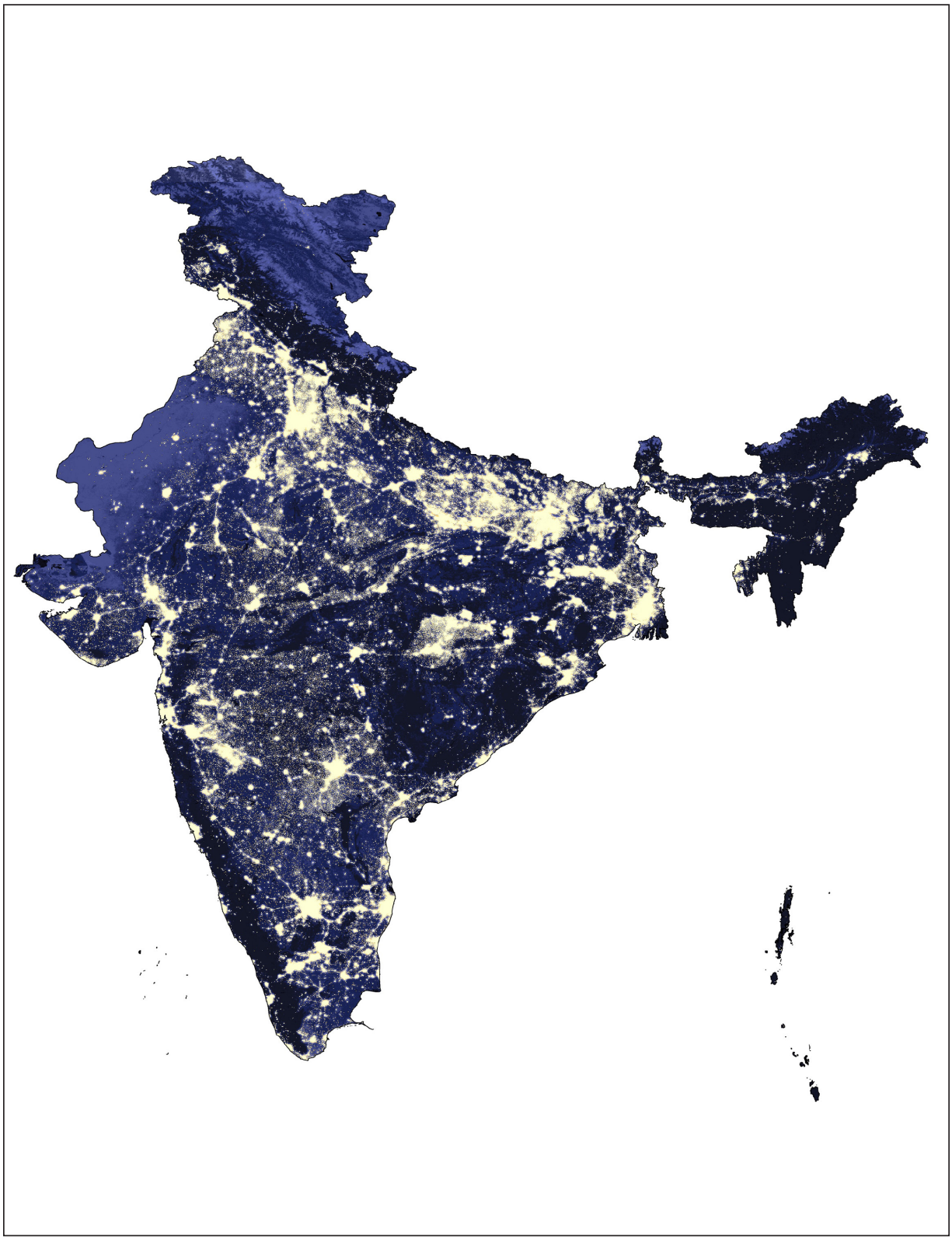
Satellite imagery is used to show annual water storage cycle at Stanley Reservoir, Tamil Nadu in Figure 7A & 7B. Using new geo-spatial methods, population density of select Indian cities is compared over time, showing the extent of urban expansion in Delhi-NCR and Bangalore between 2001 and 2021. Finally, using satellite imagery, Figures 18A, 18B, 19A & 19B illustrate wasteland redeployment in Andhra Pradesh and Gujarat.

While this chapter has restricted itself to static two-dimensional images due to practical considerations of publication, readers will be aware that dynamic and multi-dimensional cartography is now commonplace for every-day activities like ordering a taxi or looking for an address.

Figure 1A: India Night-time Luminosity, 2012

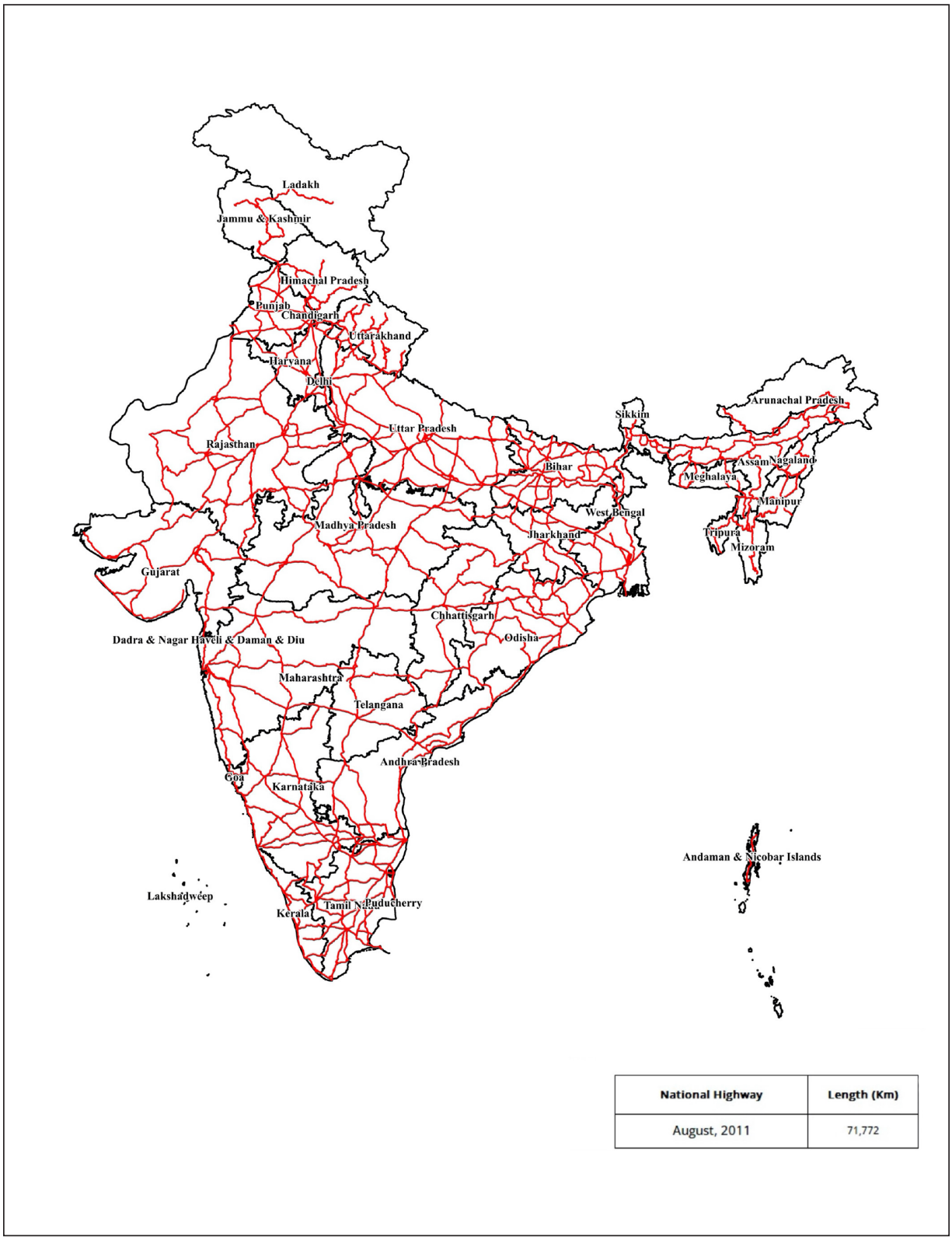
Source: NASA, MapmyIndia

Figure 1B: India Night-time Luminosity 2021



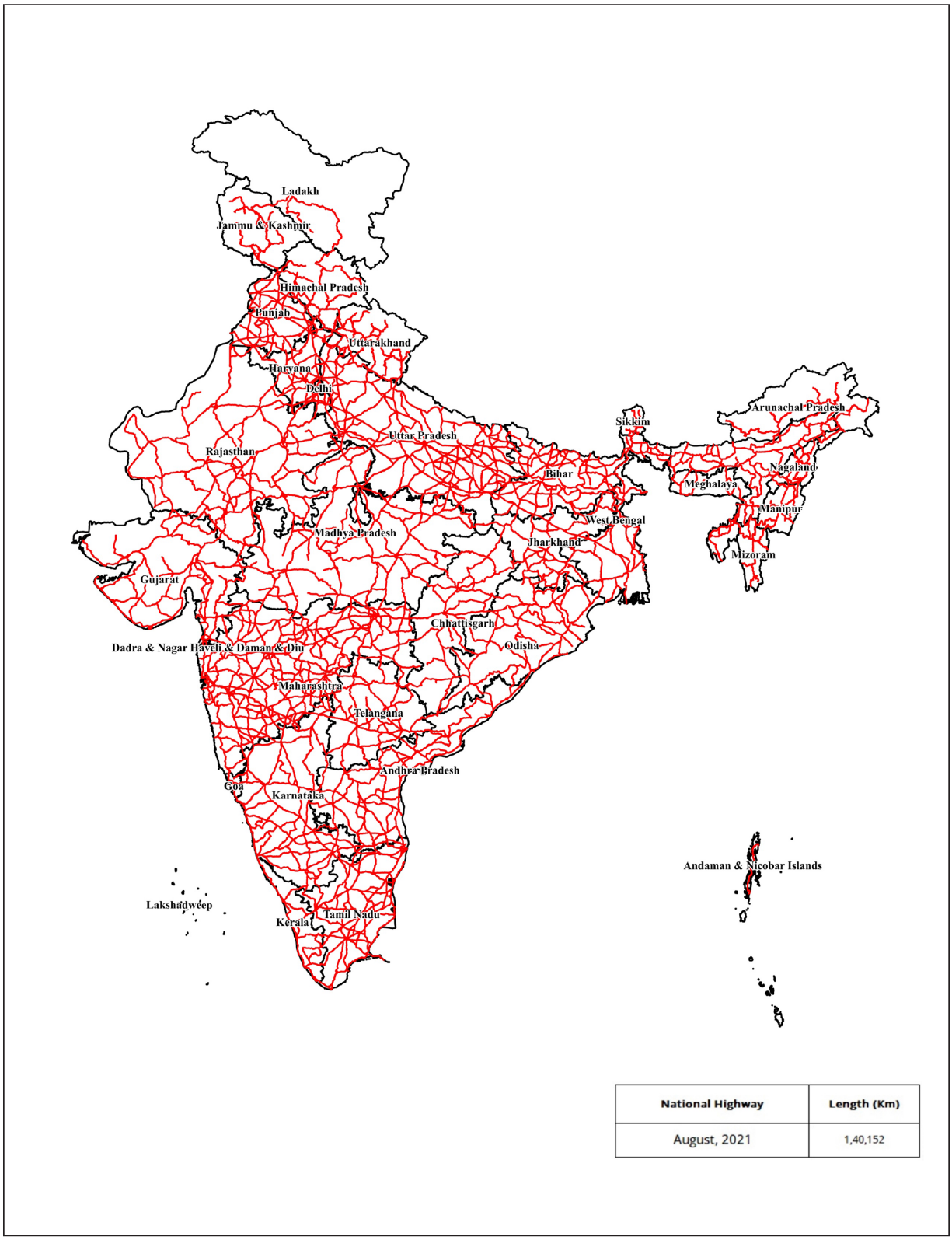
Source: NASA, MapmyIndia

Figure 2A: India's National Highway Network (As of August 2011)



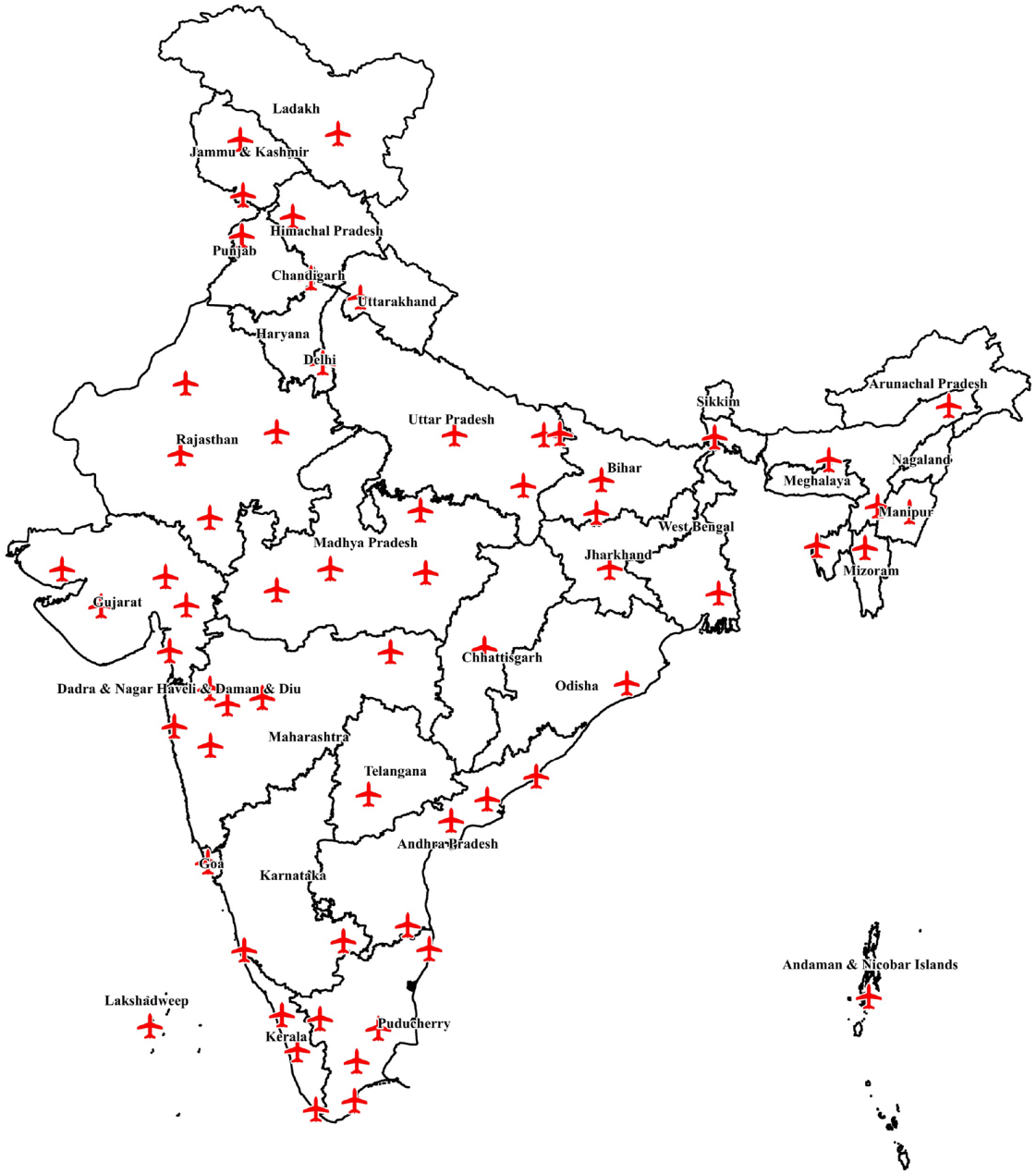
Source: Ministry of Road Transport and Highways, MapmyIndia

Figure 2B: India's National Highway Network (As of August 2021)



Source: Ministry of Road Transport and Highways, MapmyIndia

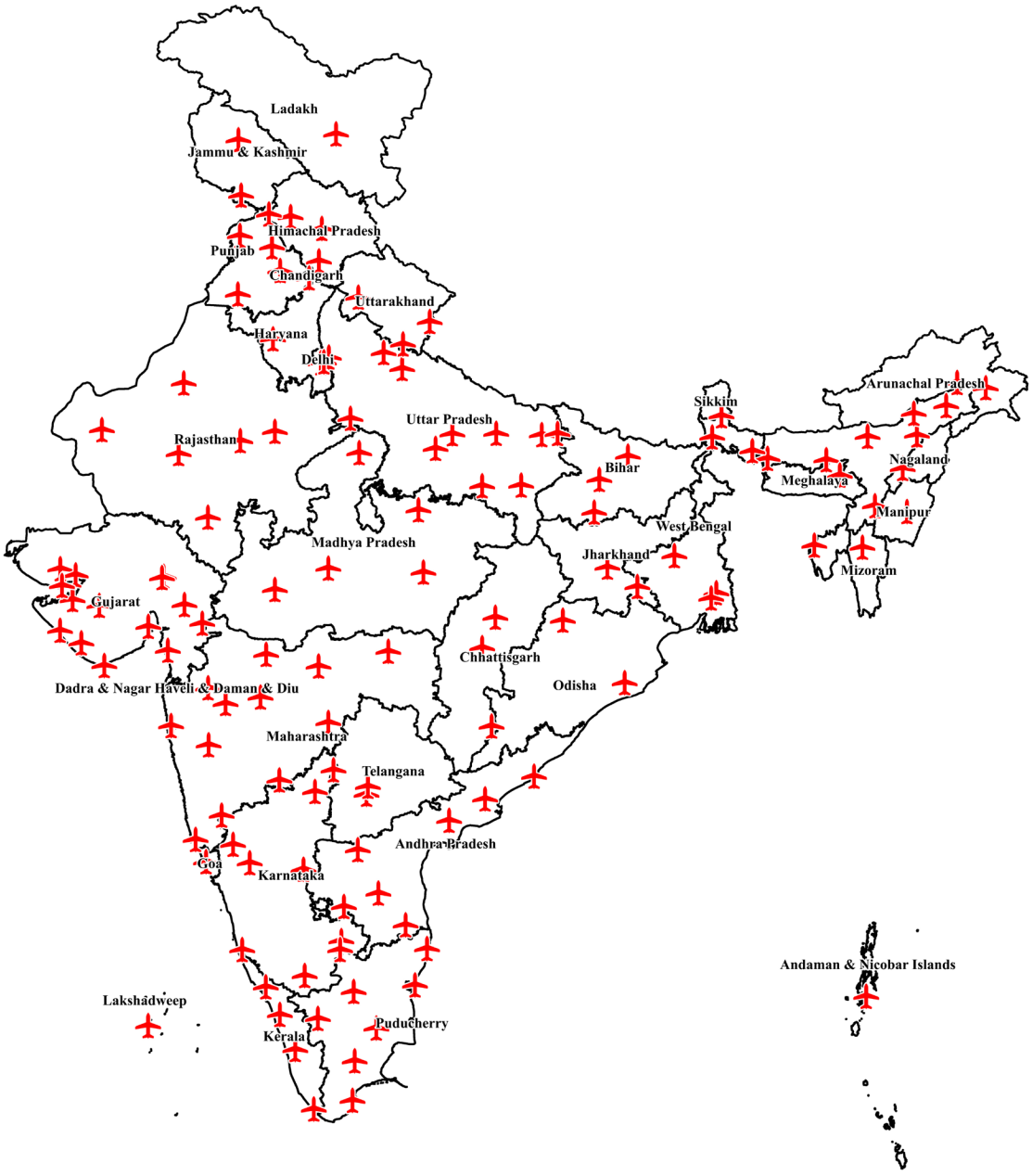
Figure 3A: Number of Operationalised Airports in India (As of November 2016)



Year	No. of Operationalised Airports (Pre- UDAN)
November, 2016	62

Source: Ministry of Civil Aviation, MapmyIndia

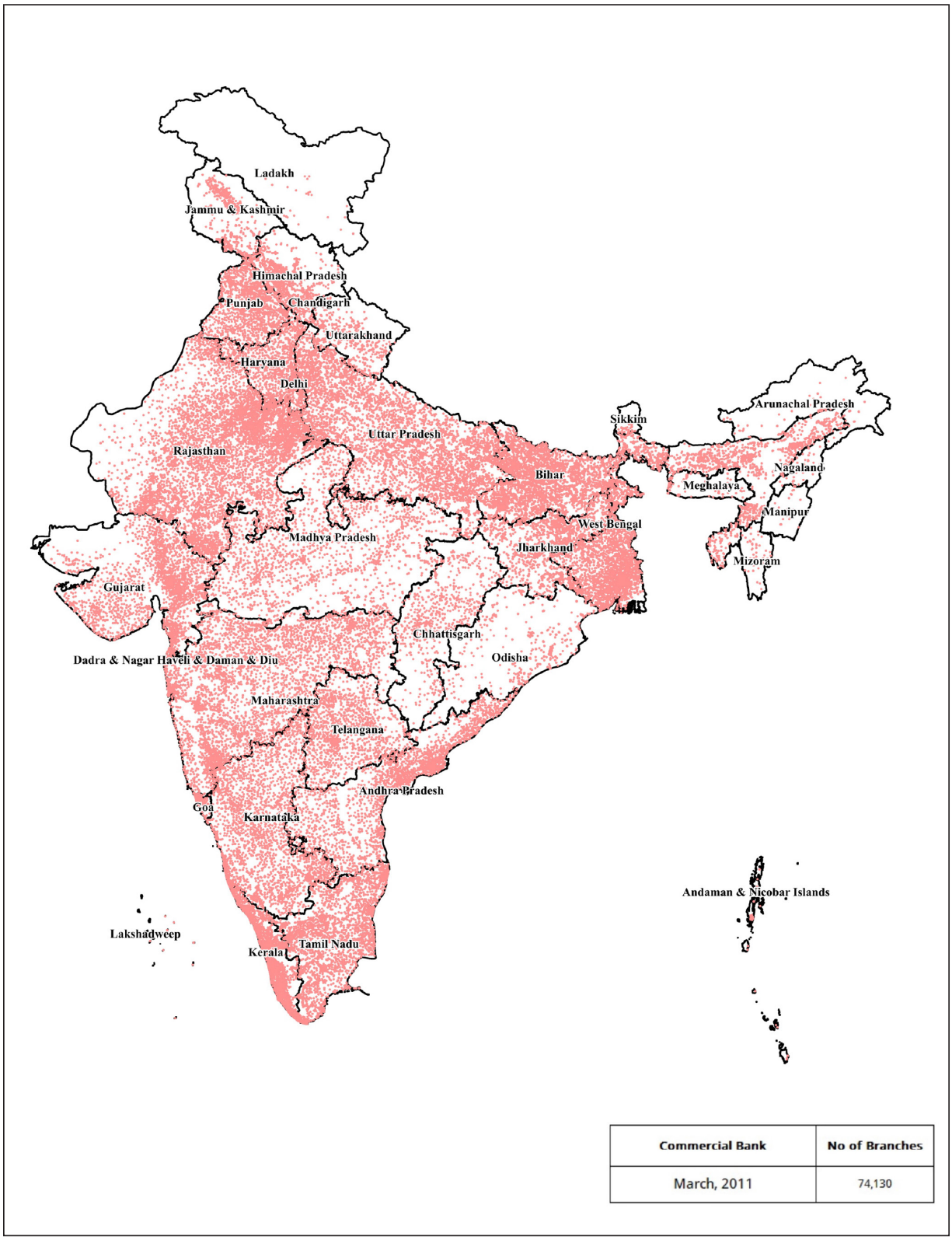
Figure 3B: Number of Operationalised Airports in India (As of December 2021)



Year	No. of Operationalised Airports (Post- UDAN)
December, 2021	130

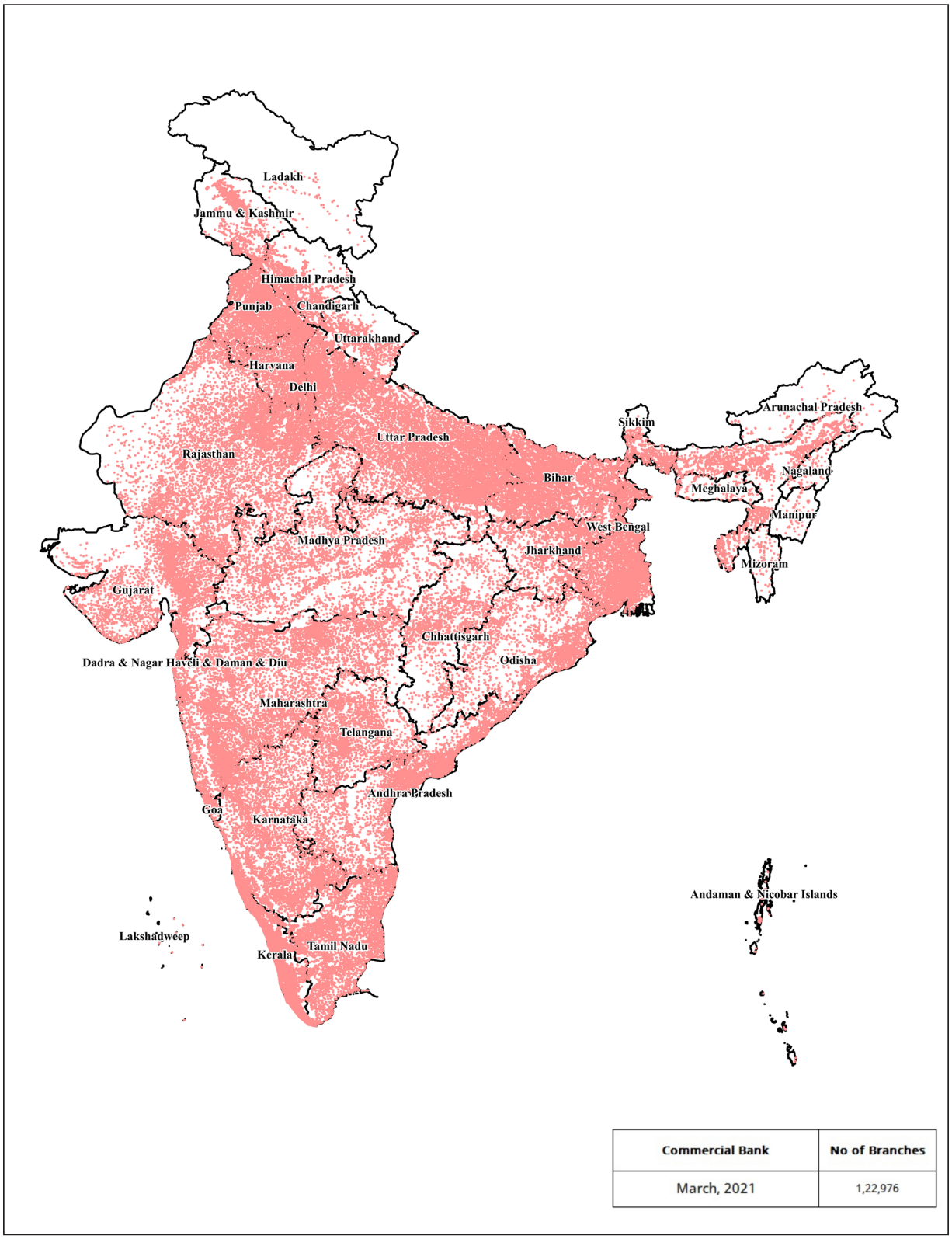
Source: Ministry of Civil Aviation, MapmyIndia

Figure 4A: Spread of Commercial Bank Branches in India (As of March 2011)



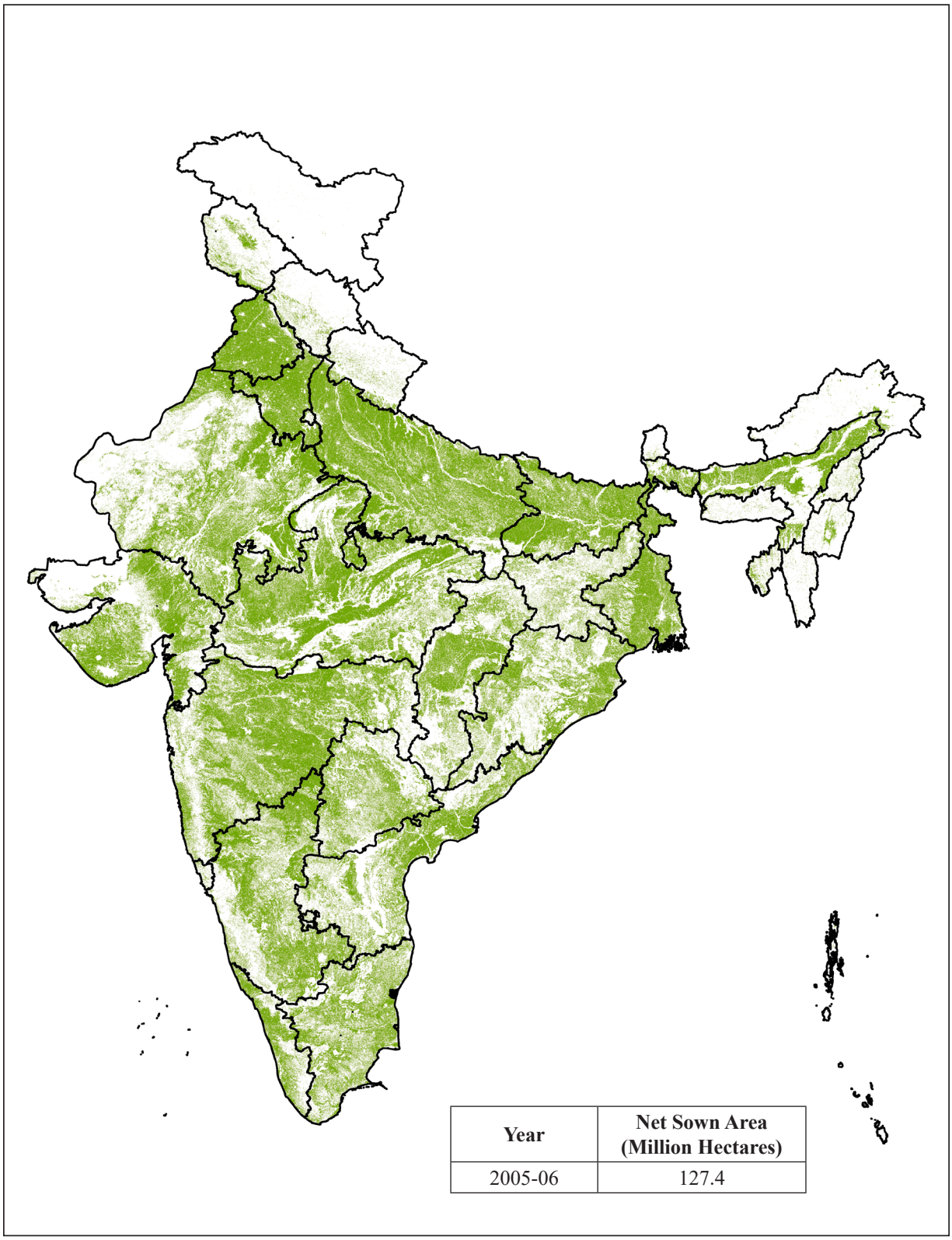
Source: Reserve Bank of India, MapmyIndia

Figure 4B: Spread of Commercial Bank Branches in India (As of March 2021)



Source: Reserve Bank of India, MapmyIndia

Figure 5A: Net Sown Area in India, 2005-06

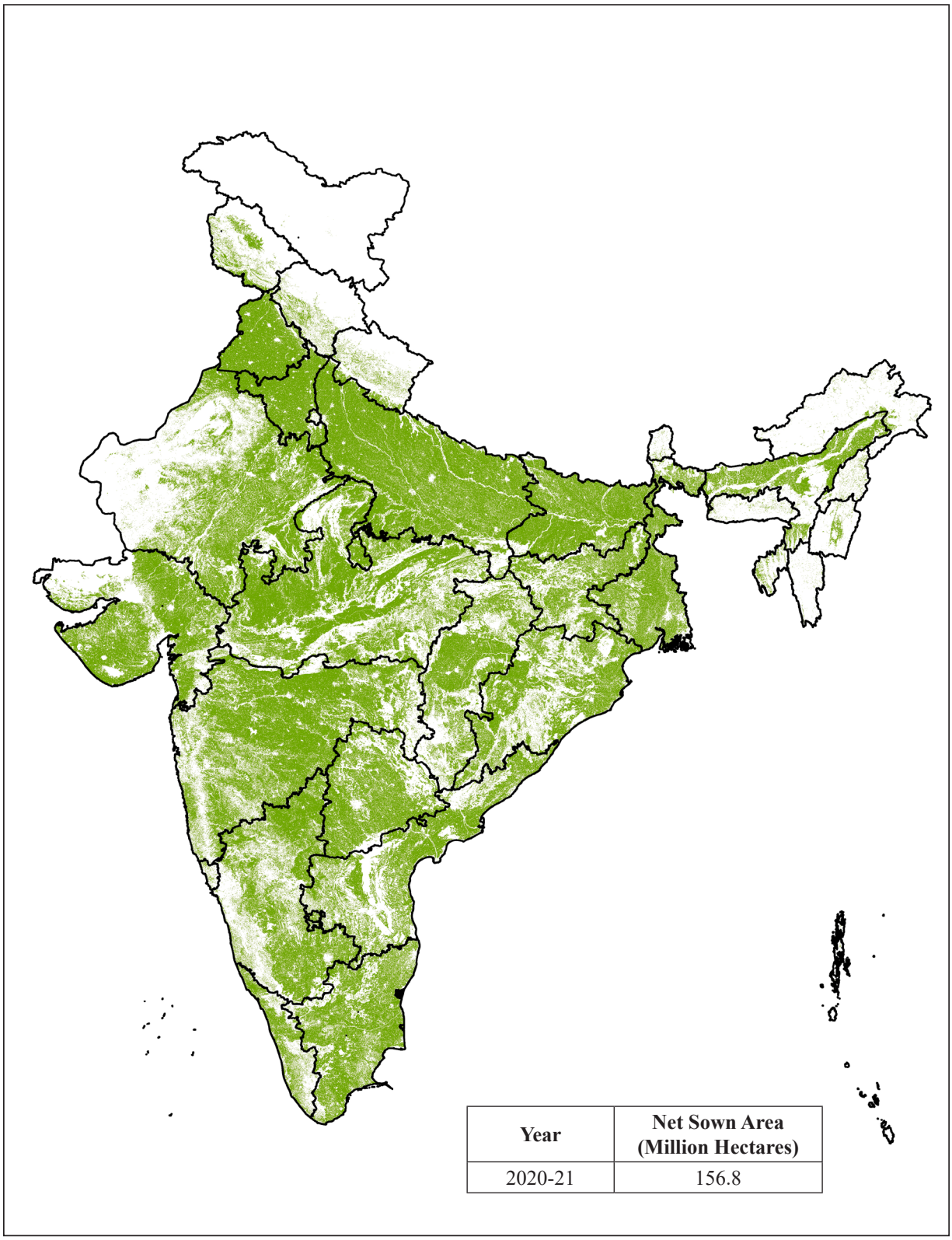


Year	Net Sown Area (Million Hectares)
2005-06	127.4

Source: Indian Space Research Organisation (ISRO)

Note: The net sown area includes the extent of crops, medicinal crops, plantations, vegetables, floriculture and orchards during Kharif, Rabi and Zaid seasons. It is estimated using multi-temporal AWiFS sensor data aboard Resourcesat-1/2 satellites

Figure 5B: Net Sown Area in India, 2020-21

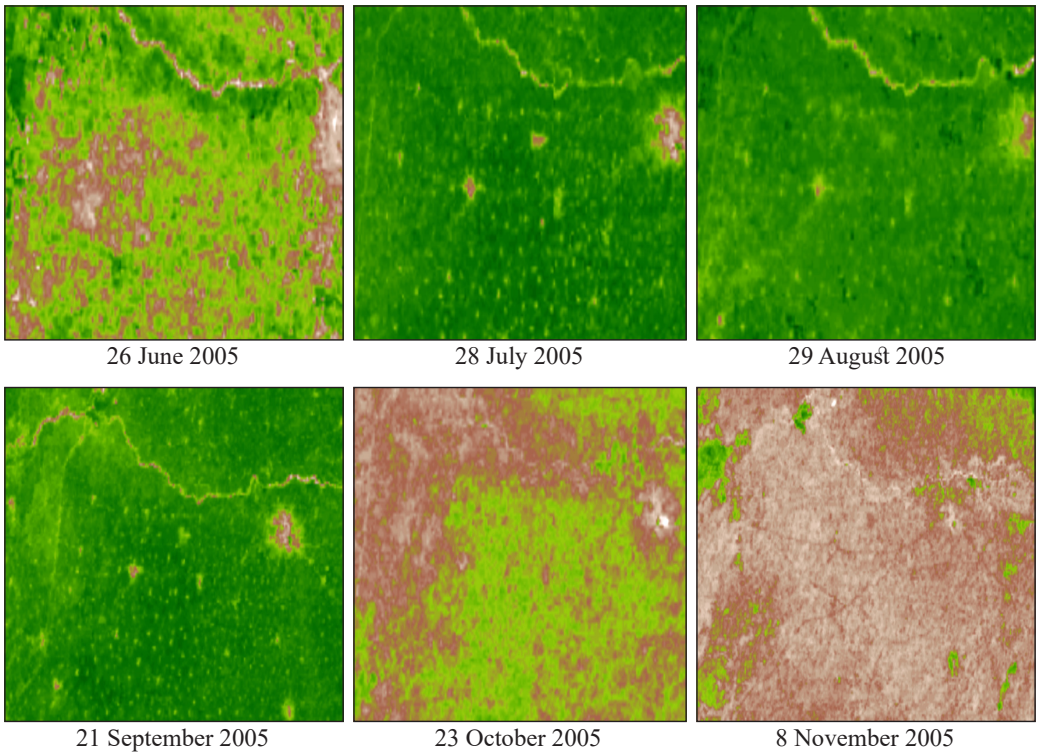


Year	Net Sown Area (Million Hectares)
2020-21	156.8

Source: India Space Research Organisation (ISRO)

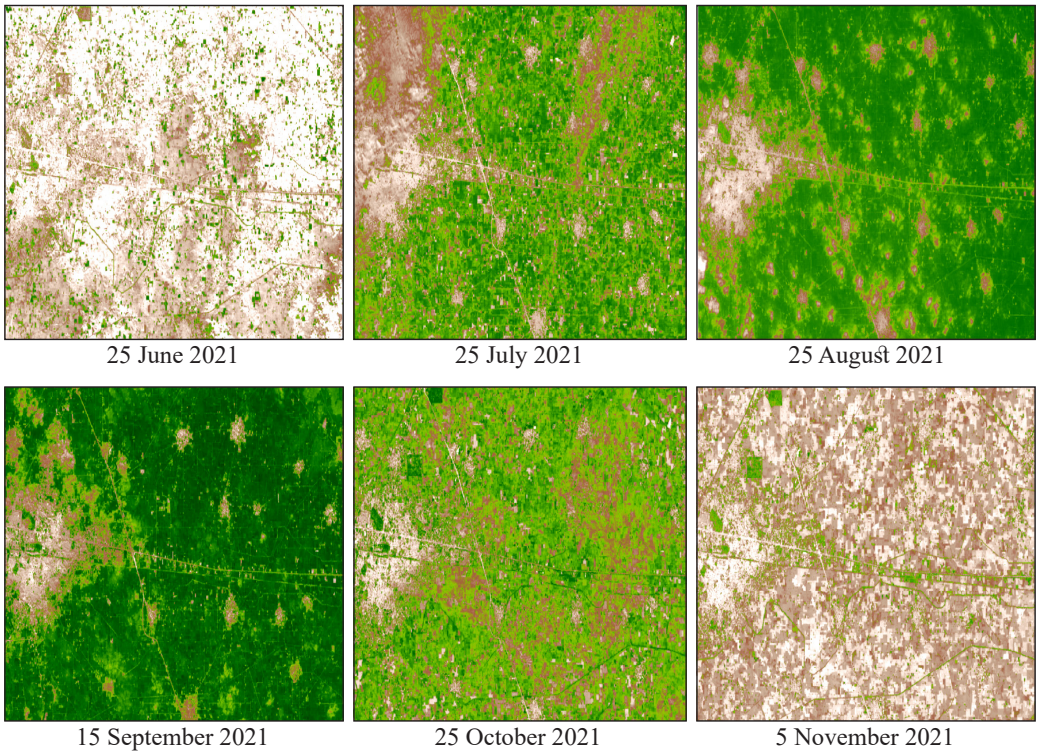
Note: The net sown area includes the extent of crops, medicinal crops, plantations, vegetables, floriculture and orchards during Kharif, Rabi and Zaid seasons. It is estimated using multi-temporal AWiFS sensor data aboard Resourcesat-1/2 satellites

Figure 6A: Kharif Crop Cycle in Moga Distrcit of Punjab, 2005



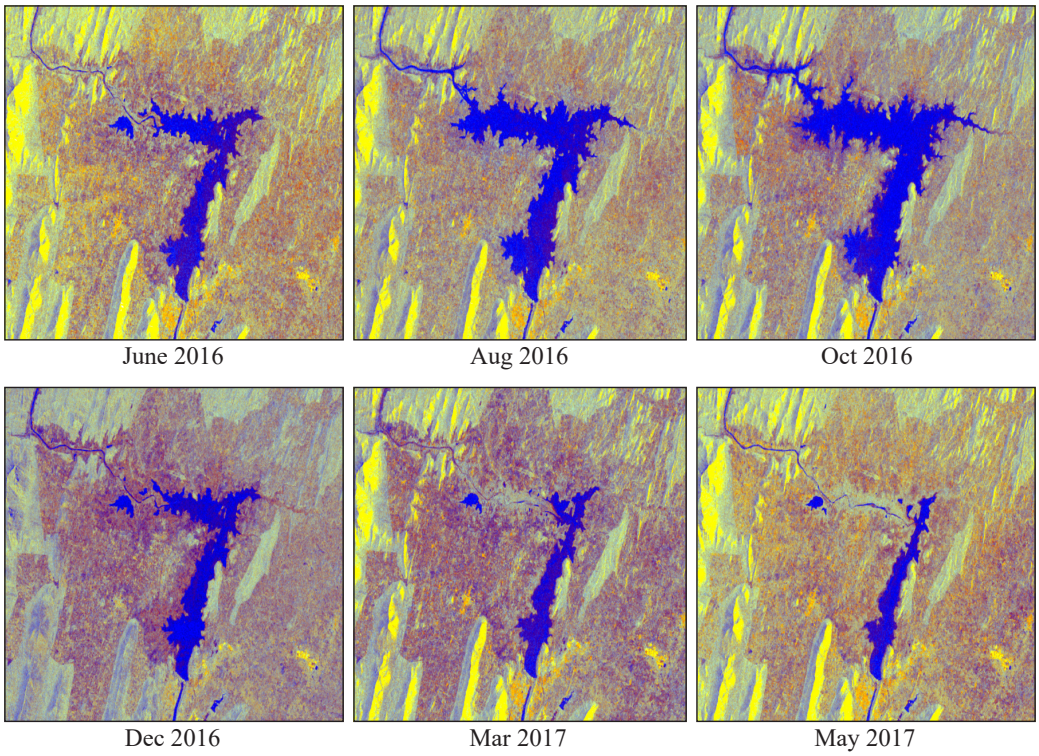
Source: ISRO, MapmyIndia

Figure 6B: Kharif Crop Cycle in Moga Distrcit of Punjab, 2021



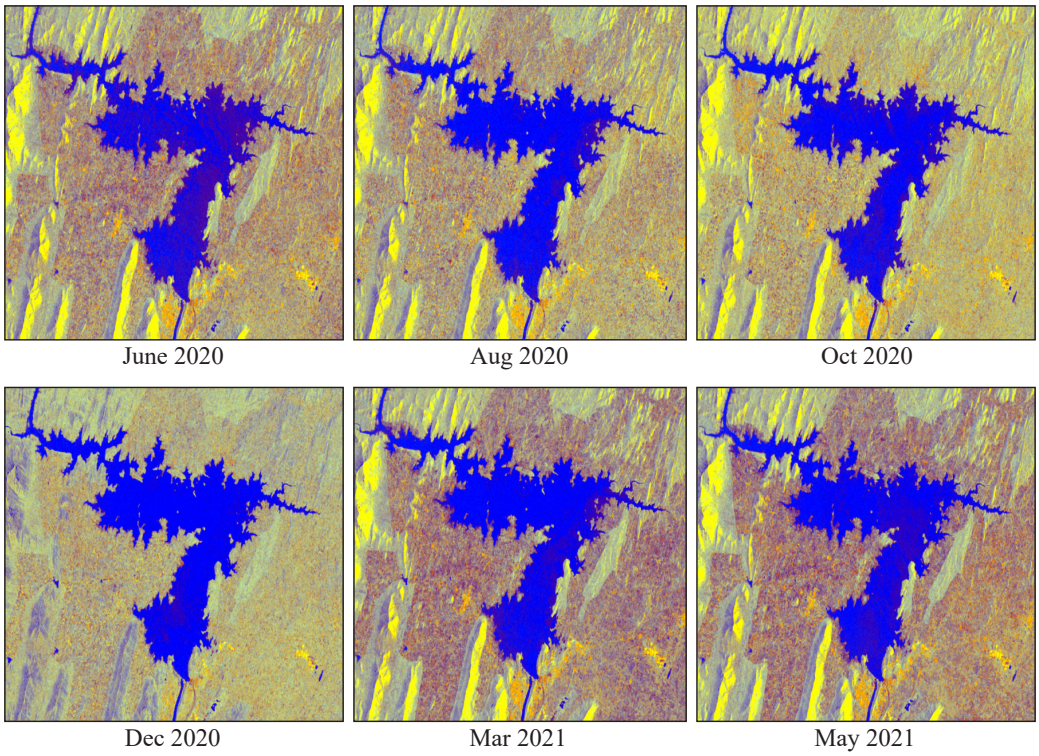
Source: ISRO, MapmyIndia

Figure 7A: Annual cycle of water storage at Stanley Reservoir, Tamil Nadu, 2016-17



Source: ISRO

Figure 7B: Annual cycle of water storage at Stanley Reservoir, Tamil Nadu, 2020-21



Source: ISRO

Figure 8A: Satellite image of Golf-course Road, Gurugram 2005

Figure 8B: Satellite image of Golf-course Road, Gurugram 2021

Source: MapmyIndia

Figure 9A: Population density in Delhi NCR 2001

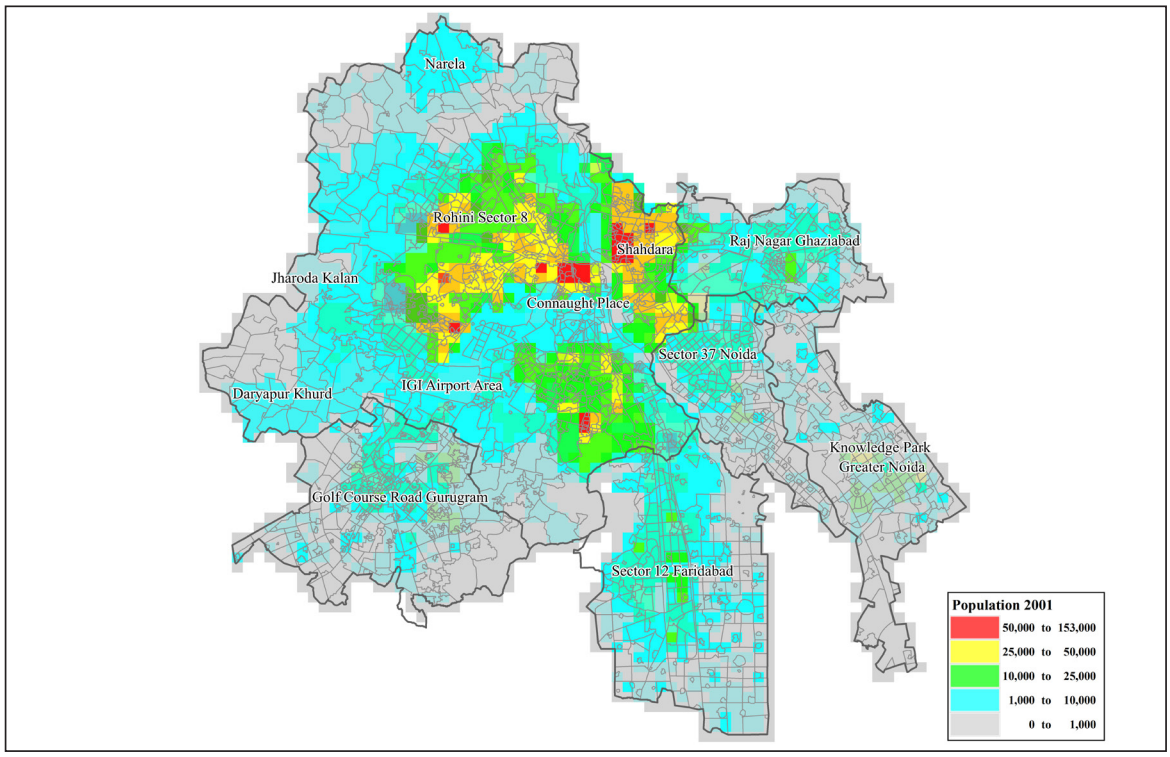
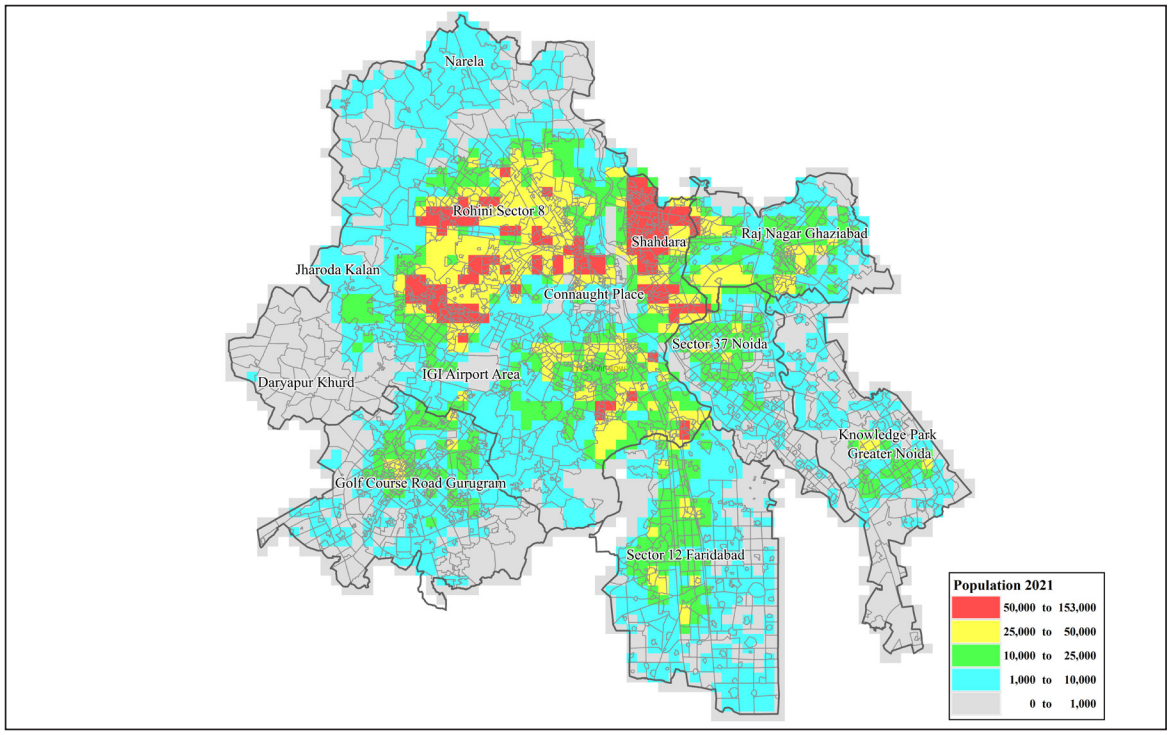


Figure 9B: Population density in Delhi NCR 2021



Source: MapmyIndia

Note : Population density has been estimated using geo-spatial mechanism and may not match census data.

Figure 10A: Satellite image of Bangmane Tech Park, Bengaluru 2002

Figure 10B: Satellite image of Bangmane Tech Park, Bengaluru 2021

Source: MapmyIndia

Figure 11A: Population density in Greater Bengaluru region 2001

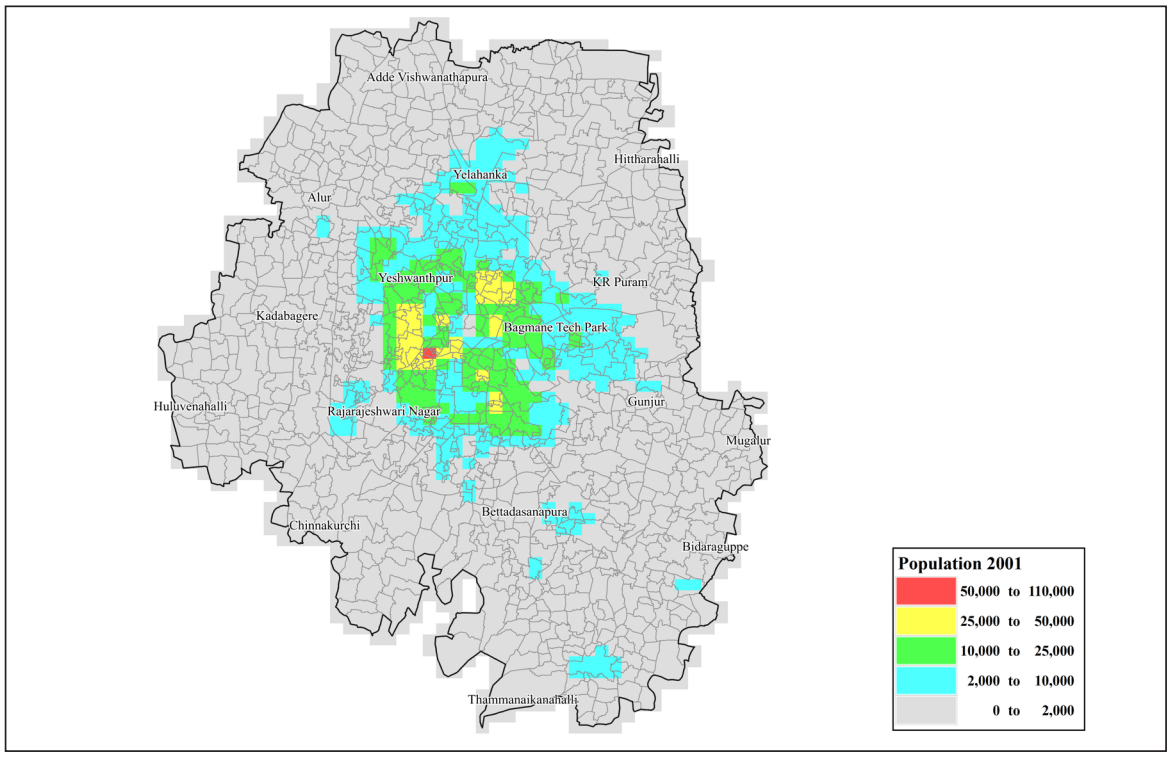
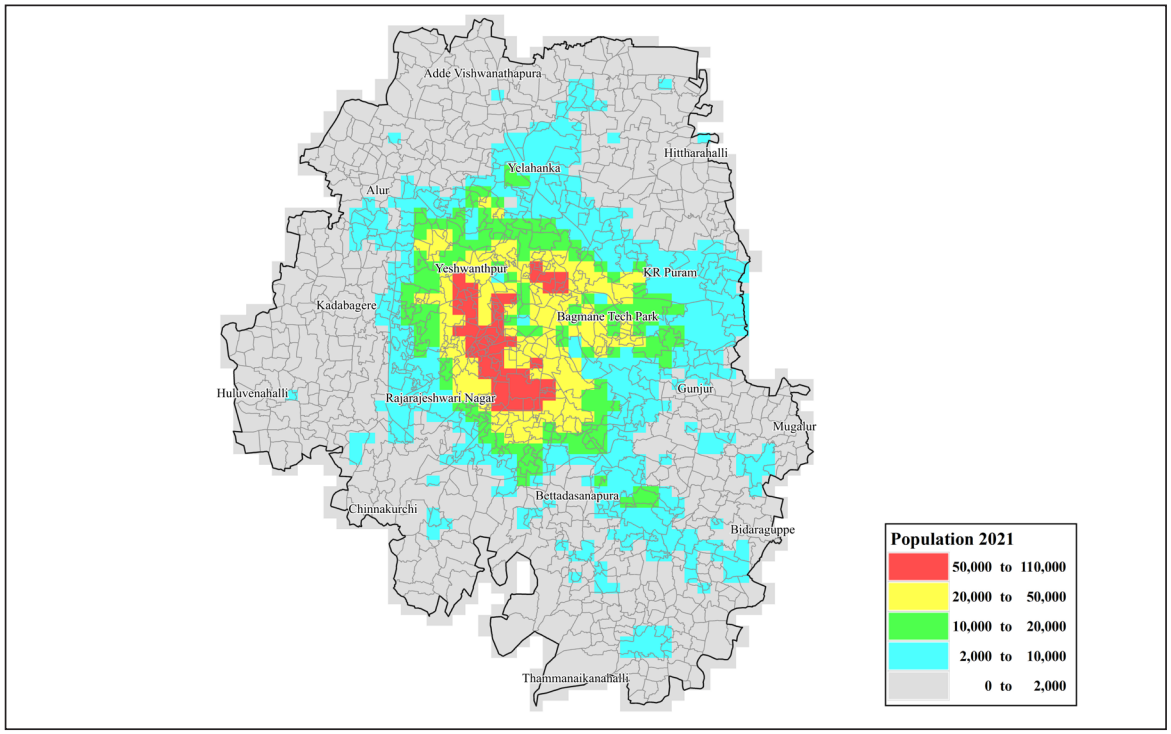


Figure 11B: Population density in Greater Bengaluru region 2021



Source: MapmyIndia

Note : Population density has been estimated using geo-spatial mechanism and may not match census data.

Figure 12A: Satellite image of Bandra-Kurla, Mumbai 2001

Figure 12B: Satellite image of Bandra-Kurla, Mumbai 2021

Source: MapmyIndia

Figure 13A: Delhi Metro-rail network 2011

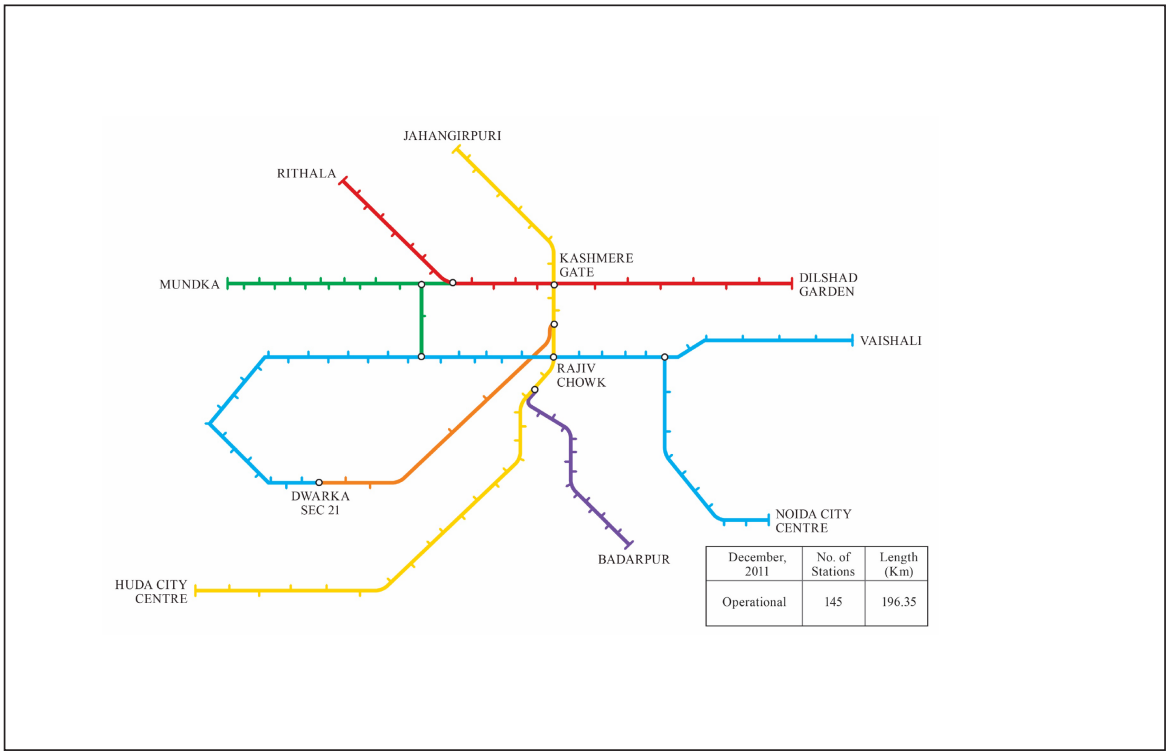
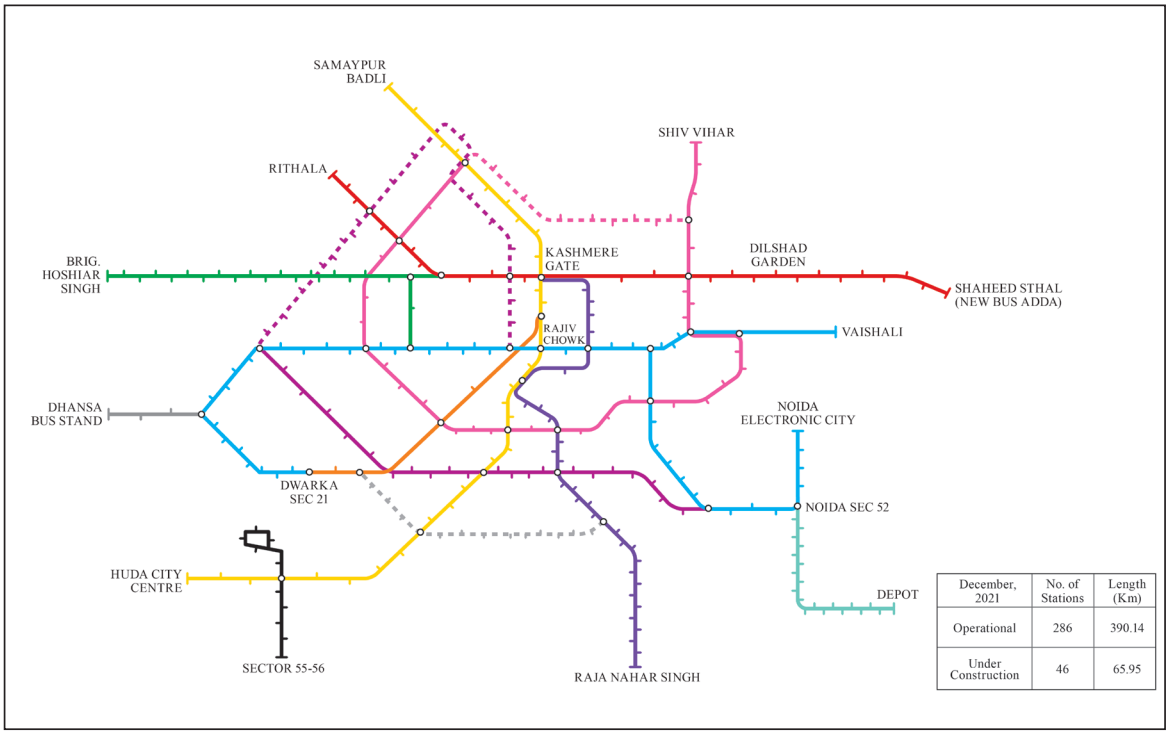
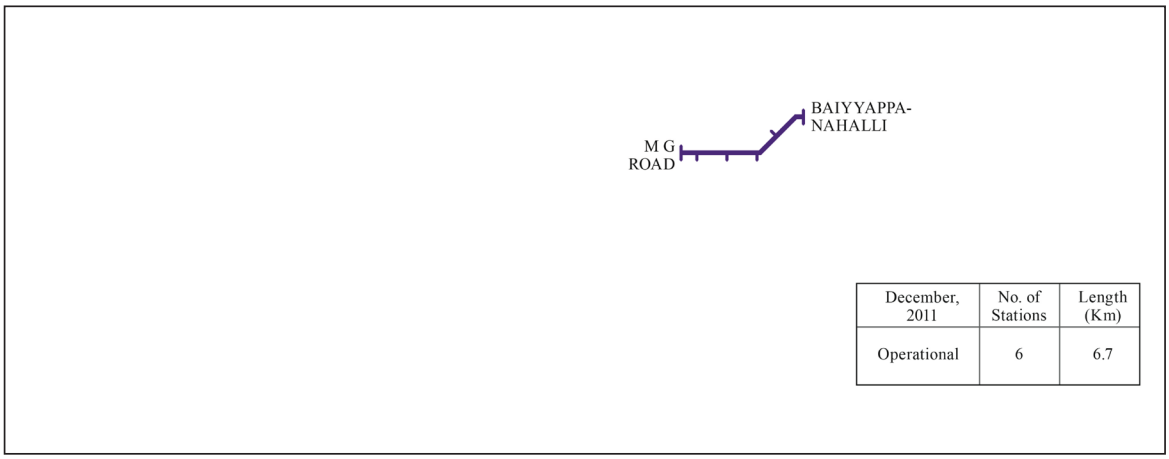


Figure 13B: Delhi Metro-rail network 2021



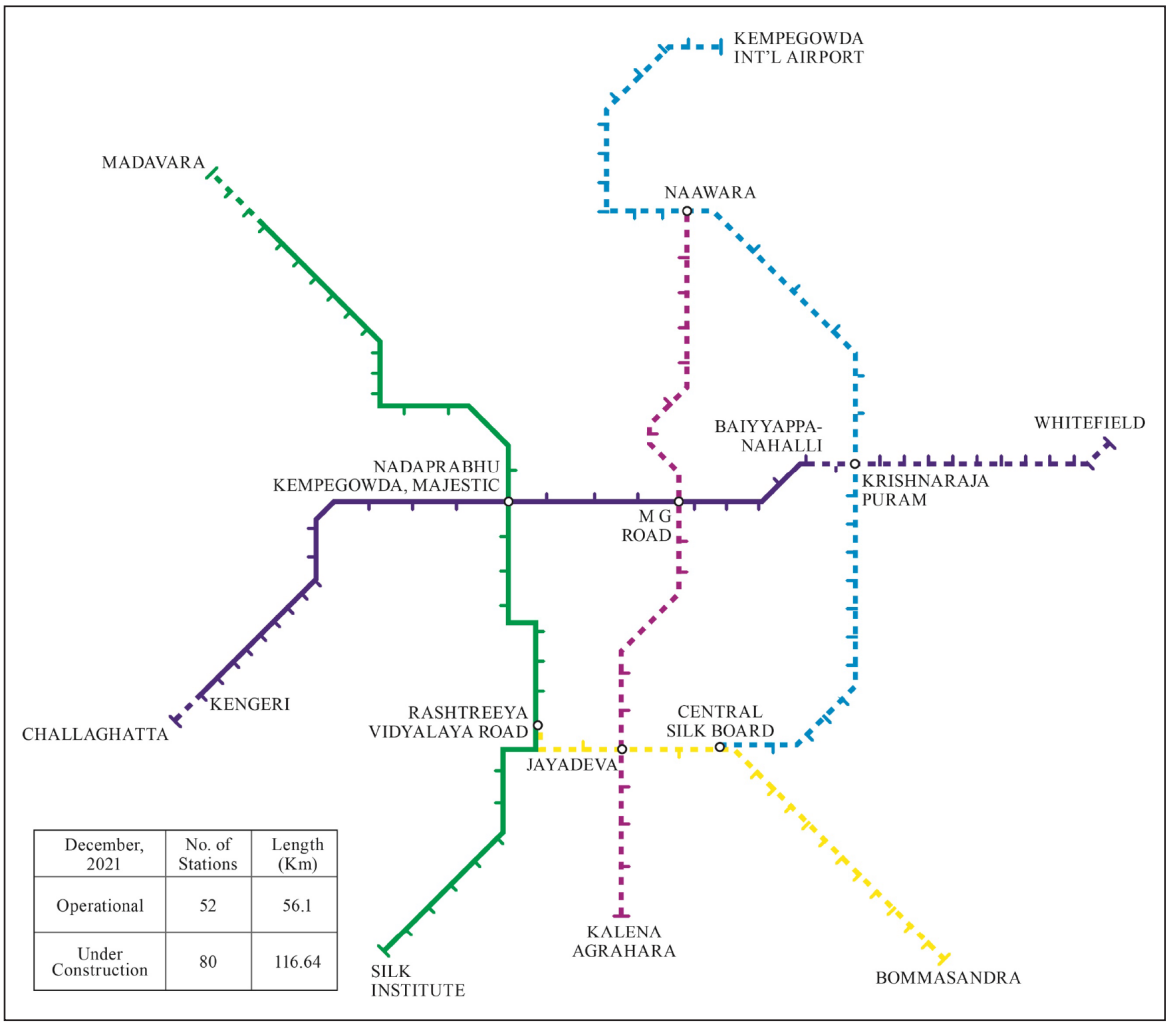
Source: Delhi Metro Rail Corporation, MapmyIndia

Figure 14A: Bangalore Metro-rail network 2011



December, 2011	No. of Stations	Length (Km)
Operational	6	6.7

Figure 14B: Bangalore Metro-rail network 2021



December, 2021	No. of Stations	Length (Km)
Operational	52	56.1
Under Construction	80	116.64

Source: Bengaluru Metro Rail Corporation, MapmyIndia

Figure 15A: Kolkata Metro-rail network 2011

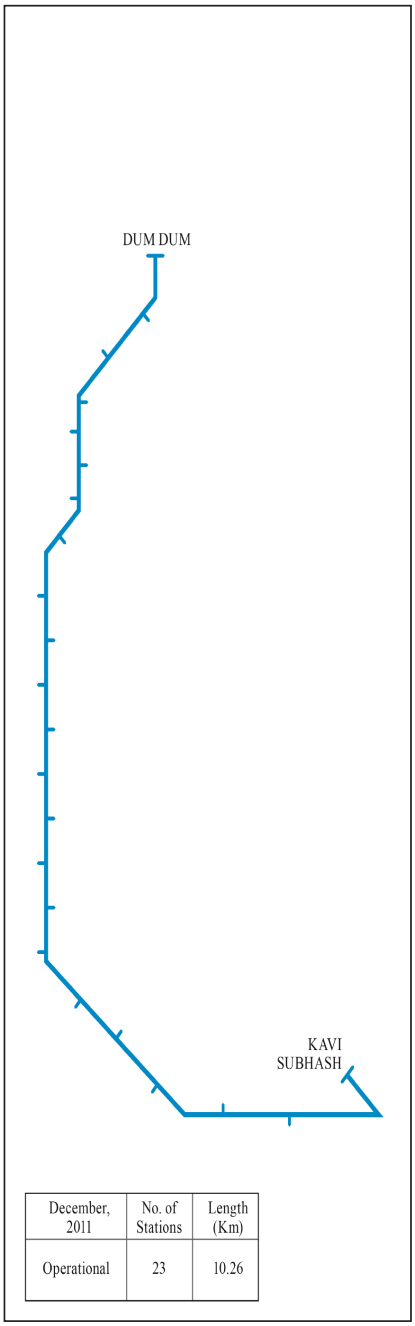
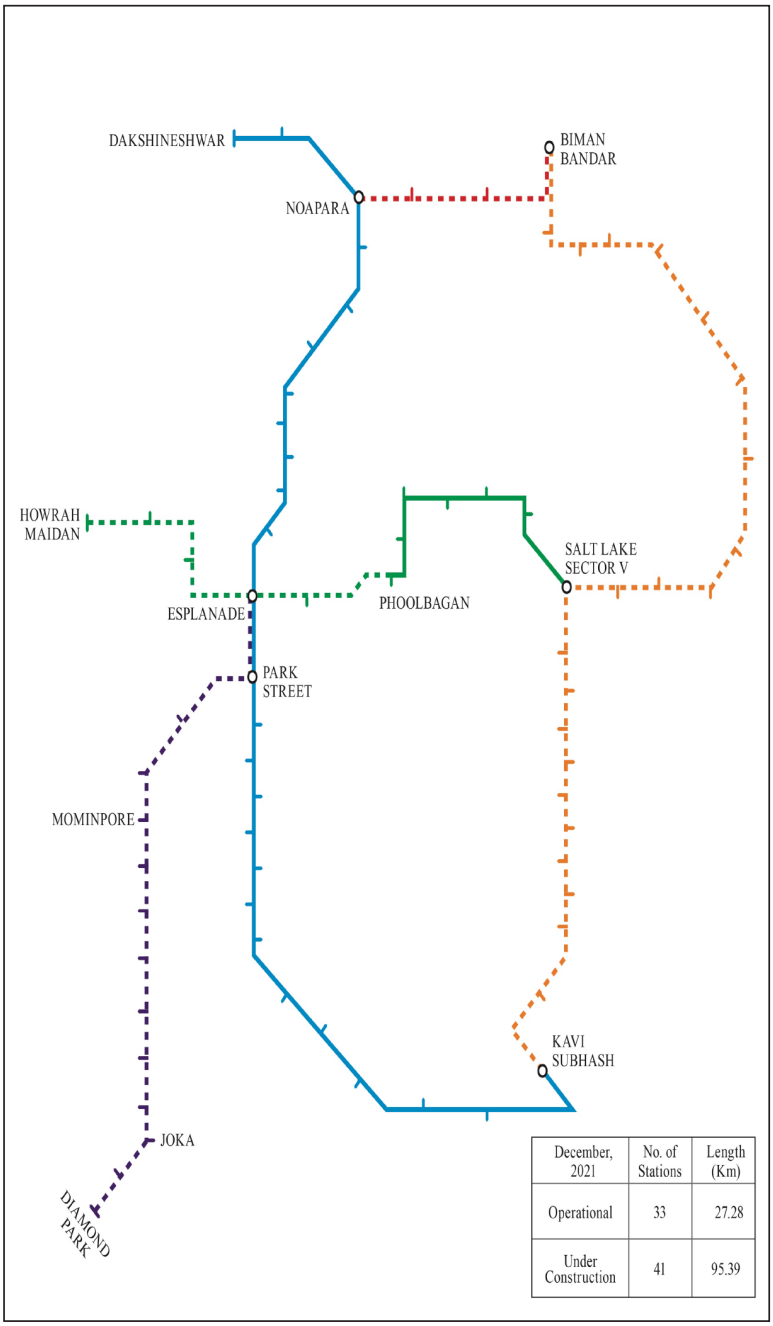
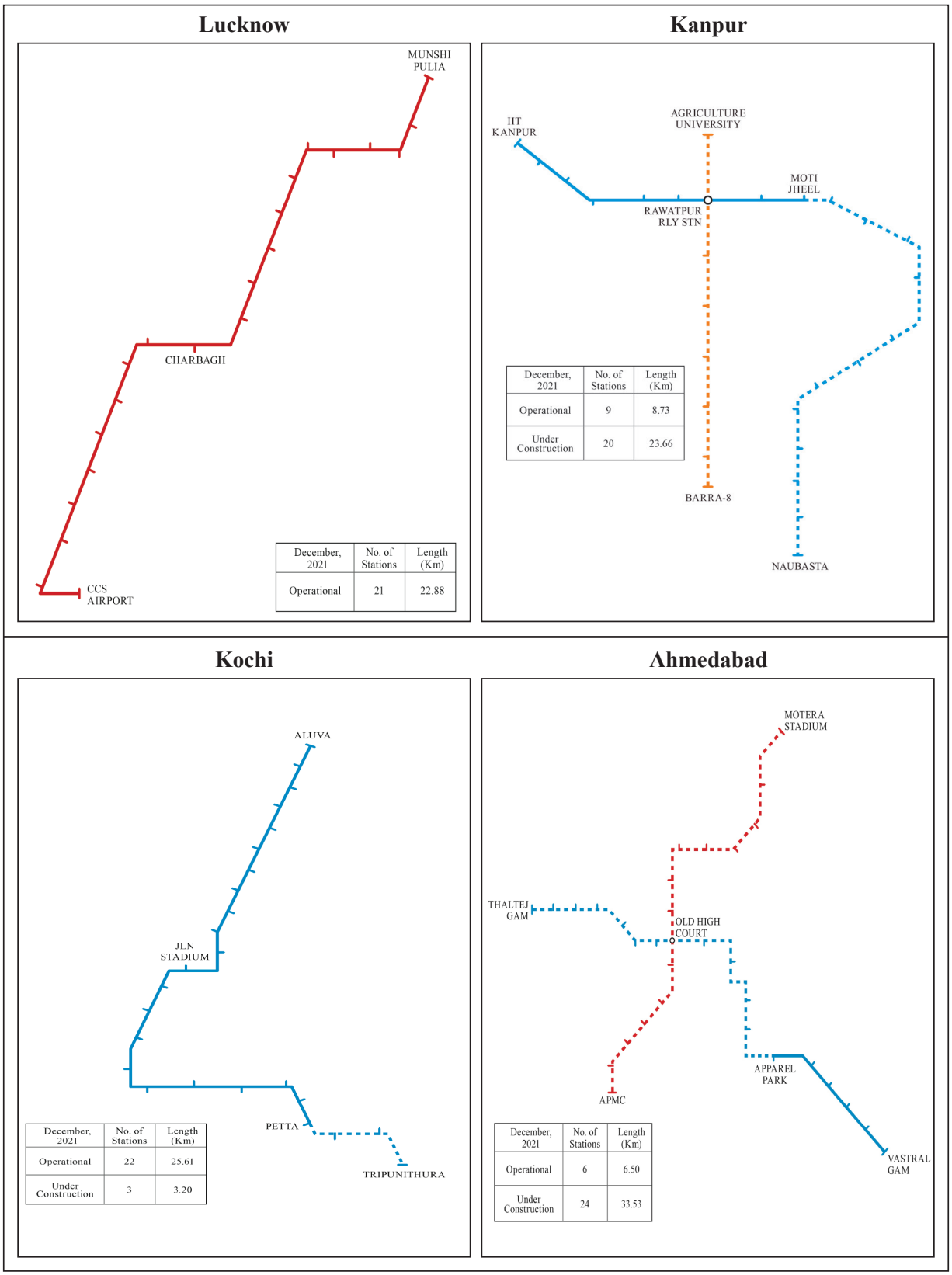


Figure 15B: Kolkata Metro-rail network 2021



Source: Kolkata Metro Rail Corporation, MapmyIndia

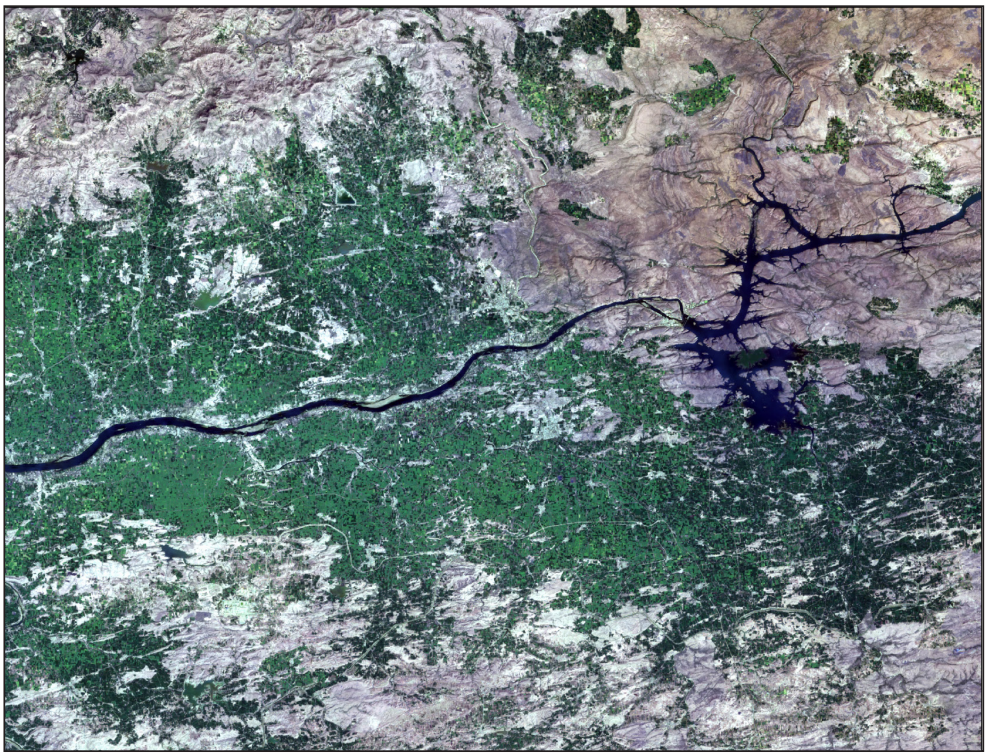
Figure 16: Metro-rail networks across different Cities 2021



Source: Uttar Pradesh Metro Rail Corporation, Kochi Metro Rail Corporation, Ahmedabad Metro Rail Corporation, MapmyIndia

Figure 17A: Satellite image of agricultural activity at Omkareshwar Reservoir, Madhya Pradesh in 2000.

Figure 17B: Satellite image of agricultural activity in 2019 following the building of better water infrastructure at Omkareshwar Reservoir, Madhya Pradesh.

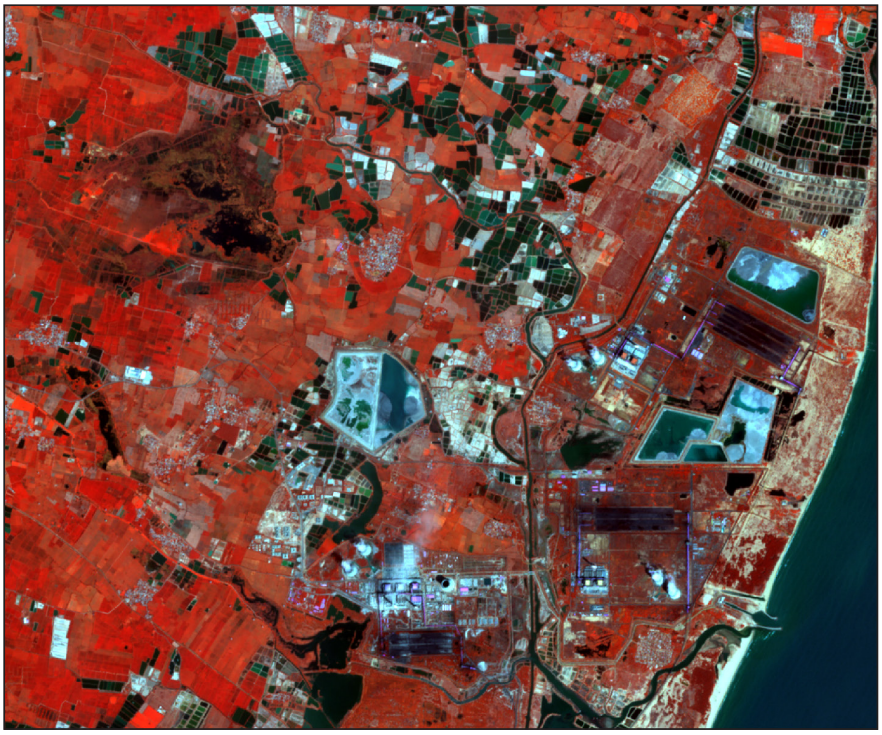


Source: ISRO

Satellite image of wasteland redeployment for industrial use in Nellore, Andhra Pradesh

Figure 18A: 2009

Figure 18B: 2021



Source: ISRO

Satellite image of Solar Power Plant development in Wasteland Area, Charanka, Gujarat

Figure 19A: 2005

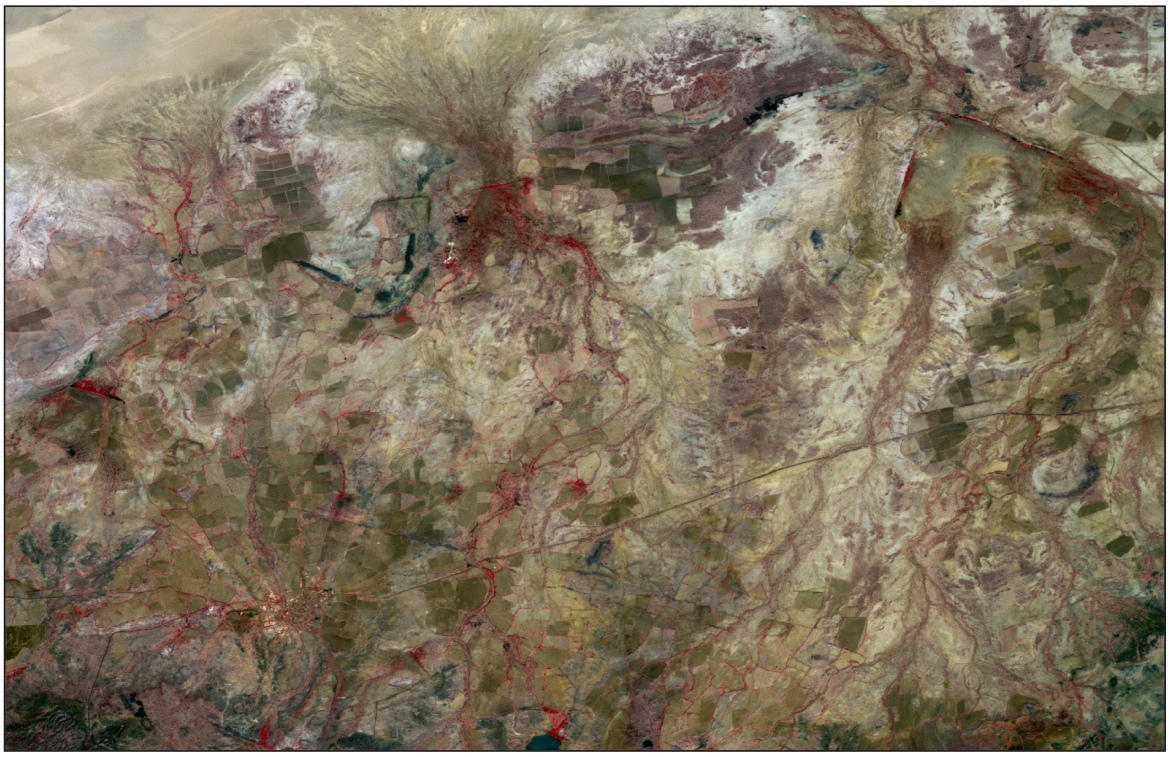
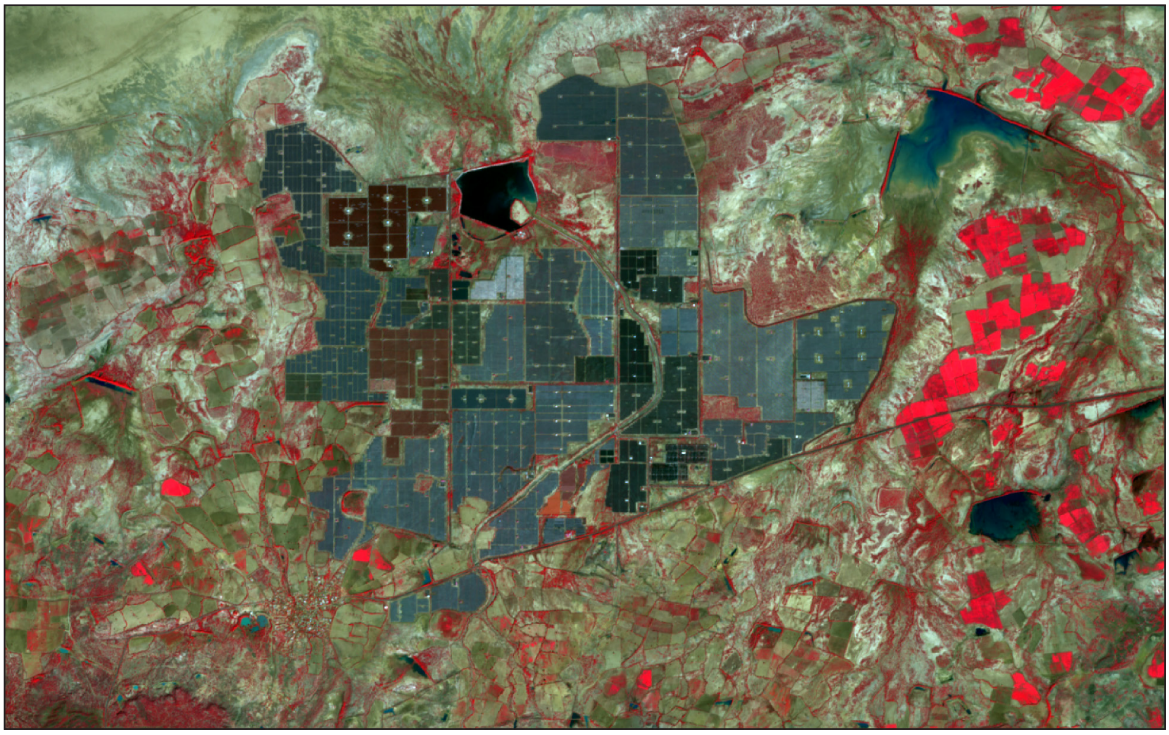


Figure 19B: 2022



Source: ISRO