Journal of Applied and Natural Science
15(3), 1127 - 1136 (2023)
ISSN : 0974-9411 (Print), 2231-5209 (Online)
journals.ansfoundation.org

Research Article

Effectiveness of Forest statutes in the conservation of Aravalli range in Urbanized complex- A case of Gurugram District (Haryana), India

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Article Info
https://doi.org/10.31018/jans.v15i3.4745
Received: May 24, 2023
Revised: August 27, 2023
Accepted: September 1, 2023

How to Cite
Tyagi, V. *et al.* (2023). Effectiveness of Forest statutes in the conservation of Aravalli range in Urbanized complex- A case of Gurugram District (Haryana), India. *Journal of Applied and Natural Science*, 15(3), 1127 - 1136. https://doi.org/10.31018/jans.v15i3.4745

Abstract
Gurugram is one of the major satellite cities of Delhi, which witnessed unprecedented growth in the past two decades. The city of Gurugram in Haryana State, India, has a fringe of Aravalli hills on either side as the western and the eastern range ridge. On the foothills of the eastern ridge, there has been a major development in the revenue estate of Behrampur to Nathupur, whereas, on the western ridge, the major development has been from the revenue estate of Manesar to Naurangpur of Urban development complex. Majority of the Revenue Estate in the areas in the foothills of Aravalli are covered under Punjab Land Preservation Act, 1900. The areas in Arravali ranges covered under development plans have witnessed urbanization. In contrast, the areas which are protected by forest statute and have come under Urban development plans have been saved from urban sprawls to a great extent. The present study analyses urban plans and development in areas not protected by forest statutes to those with some umbrella of protection. The successive development plans including Gurugram Developmental Plan (GDP) 2021 of 2007, GDP 2020 of 2011, GDP 2031 of 2012, and Gwal Pahari Developmental Plan of 2010 amended in 2016 has increased the commercial value of land, exposing them to urbanization due to better economic returns. The study, however, strengthens the perception that despite being prone to development opportunity, the areas covered under forest statutes or by Hon'ble court orders have been protected from urban expansion and developmental sprawl.

Keywords: Forest Statutes; Gurugram, Urban development Plans, Forest land violation, PLP Act, Aravalli Notification, Aravalli ranges, Urbanization

INTRODUCTION

Urbanization has been increasing rapidly in developing countries, leading to an expansion of urban centres and posing challenges to natural ecosystems, such as forests (Dutta, 2012;Morya, 2022;Follmann *et al.*, 2018; and Kumar & Tripathy, 2019). Gurugram, a city in the Indian State of Haryana, has experienced significant growth in recent years resulting in the degradation of its green cover (Dutta, 2012) . The factors that govern the land use changes are policy reform , population growth and economic development (Yin *et al.*, 2011) Gurugram is one of the major satellite cities of Delhi and is a part of the National Capital Region situated to the south-west of the National Capital, and home to the India's Medical Tourism Industry having one of the prominent Health Care Hospitals. It is also the second-largest national technology hub and one of India's greater financial hubs. The city's growth took off with the establishment of Maruti Suzuki India Limited in the 1970's and further extended with the opening of the Global Economy in the 1990s. The city witnessed a

sudden spurt in growth. The expansion of urbanization fragments, isolates and degenerates natural habitats, disrupts the hydrological systems and alters the ecological balance (Alberti, 2005). The approach to development should be specific to environmental, social, economic and institutional aspects of the peri-urban interface (Adriana, 2003). However, the growth process in Gurugram has been assisted by subsequent Developmental Plans for catering to the population needs of the city, including Gurugram Developmental Plan (GDP) 2021 of 2007, GDP 2020 of 2011, GDP 2031 of 2012, and Gwal Pahari Developmental Plan of 2010 amended in 2016. Gurugram's expansion is a result of neoliberal policy, wherein from the 1990s, the State has facilitated initiatives of private developers through special economic, commercial, and residential zones. Further overlapping and weak governance institutions have facilitated the over-appropriation of resources by urban residents to meet urban needs (Roth *et al.*, 2018). Expansion of settlements, roads, and other developmental works have reduced the Forest cover across Aravalli's (Rathore, 2002;Celestine, 2012). It challenges the ecosystem and causes loss of biodiversity while fulfilling the aspirations of the powerful lobbies (Shashi Mehta, 2016; Mukherjee and Rajvanshi, 2016) The developmental plans are inconsistent with the forest area and invariably result in land use change and depletion of forest cover (Kumar and Tripathy, 2019; Dutta, 2012; Haas *et al.*, 2016), and urbanization, mining, etc in the neighbourhood has affected the water quality (Nathalia *et al.*, 2017) and overall degradation of Aravalli hill ranges (Yadav and Sehrawat, 2019).The average alleviation of Gurugram is 271 meters from mean sea level and has Aravalli Ranges of the Delhi-Alwar Group on either side of the city, which runs parallel in the district One originating from the eastern range runs from revenue estate of Lakkarpur in Faridabad, running across the ridge, passing through revenue estate of Mangar, then entering Gurugram through revenue estate of Bandhwari, passing through Rojka-Gujjar, Abhaypur, Mandwar and terminating at Khuntpuri on the Sohna road. The other lineage starts from Manesar, passing through Naurangpur, Sakatpur, Gairatpur, Bhondsi, Sohna where it enters into the Nuh District and runs as a ridge parallel to the Alwar Road. These Hill Ranges are either in the ownership of the village Panchayats and in some villages under private ownership, where the municipal limits have increased, they are in the ownership of a Municipal Corporation. These Hill Ranges have been planted by the State Forest Department under the Aravalli Plantation Project. Besides they also have some natural vegetation by local flora like Ronjh, Dhak, Beri, Amaltas, Salai, Dhok, Khairi, Indrajau, Karunda etc

Aravallis have great diversity in flora ranging from over 26 tree species and more than 100 herbs, shrubs and grasses (Shahabuddin, 2012;Gaury, 2017;Dulhar, 2015). The Arravalis in southern Haryana are rich in wildlife with many species reported by study conducted by WII in 2017.The ecological importance of this range cannot be undermined as they are one of the primary water sheds responsible for rainwater harvesting and recharge of groundwater table It is estimated that a hectare of forested Aravalli causes infiltration of 15.4 lakh litre per hectare per year with estimated percolation of 25.20 per cent and low monsoon and percolation of up to 36 per cent in a year (Agarwal, 2016) .The Hon'ble Supreme Court of India, in its judgment dated 18.03.2004, cited that the Central Ground Water Board report of the year 2000 has observed that fault lines of the Aravallis are responsible for the replenishment of the groundwater in the area (CGWB, 2000). In the same judgment the Hon'ble Supreme Court also observed that large-scale plantation were carried out under the Aravalli Project from 1992 up to the project period. The State of the forest report 1999 issued by the Forest Survey of India in relation to Aravalli Hill Range in Haryana has stated that there has been an increase in the forest cover of the State due to the plantation under Aravalli Project. The Hon'ble Court categorically mentioned that neither the State nor the lease holder of the mining area could be permitted to turn around and take a stand that the area covered under the Aravalli Project is not a forest (M.C Mehta versus Union of India, 2004)

Therefore, the areas in the Gurugram District which were covered under the Aravalli Plantation are deemed forests as per the observation of the Hon'ble Supreme Court, besides the 35 Revenue estates in Gurugram District that are notified under Punjab Land Preservation Act 1900 (Malik, 2008). The said Act was envisaged for the conservation of sub-soil water or the prevention of erosion and has been recorded as forest by the State Forest department. The Section 4 of the said Act prohibits the clearing or breaking up, or cultivating of land not ordinarily under cultivation prior to the publication of the notification under section of the Act; the quarrying of stone or the burning of lime at places where such stone or lime had not ordinarily been so quarried or burnt prior to the publication of the notification ; the cutting of trees or timber, and other restrictions whereas, section 5 of the Act restricts the cultivating of any land ordinarily under cultivation prior to the publication of the notification under Section 3, the quarrying of any stone or the burning of any lime at places where such stone or lime had ordinarily been so quarried or burnt; and other restrictions (Punjab Land Preservation (Chos)Act, , 1900)

The Aravalli Hill Ranges in Gurugram are also protected vide the notification under the Environment Protection Act dated 07.05.1992 widely known as Aravalli Notification. It prohibits location of any new industry

including expansion modernization, Mining processes and operations, except mining project(major minerals) with lease area' of more than five hectares covering: - (a) All new mining operations including renewal of mining leases or (b) Existing mining leases in sanctuaries or National Park-and areas without permission of the competent authority (iii) cutting of trees; (iv) construction of dwelling units, farms houses, sheds, community centres and any other activity connected with such construction (v) Electrification(laying of new transmission lines) in the area which are reserved forests, protected forests or any other area shown as "forest in the land records maintained by the state Government as on the date of this notification in relation to Gurgaon District of the State and (ii) All areas recorded (a) Gair Mumkin Pahar, or (b) Gair Mumkin Rada' or(c) Gair Mumkin Behed, or(d) Banjad Beed, or(e) Rundh in the land records maintained by the State Government as on the date of notification and (iii) all areas covered by notifications issued under Punjab Land Preservation Act under section 4 and 5 of the Act, 1900, in the State of Haryana in district Gurugram. Entire Aravalli ranges in the District Gurugram are covered with protection provided by Aravalli notification, whereas some specific areas are covered under PLP Act 1900. The land under PLP Act can be closed irrespective of ownership whether government owned, Panchayat or private land. The Hon'ble Supreme Court in array of judgments have observed that the areas under PLP Act are Forests, and any non-forestry use of such lands will invite applicability of Forest Conservation Act. In the order dated 23.06.2021, in SLP No 7220-7221 of 2017the Hon'ble Court directed to remove all unauthorized structures standing on forest land. Under the umbrella of the above protection by various statutes and Hon'ble Court orders, forest areas have been significantly protected when it comes to the expansion of development in Gurugram.

In the above background the present study aimed to understand the complex interplay between urbanization and forest conservation in Gurugram, and to explore possible policy interventions that could support the conservation and restoration of urban forests.

MATERIALS AND METHODS

Study area

The Aravalli Range, one of the oldest fold mountains in India, extends across the states of Rajasthan, Haryana, and Delhi. The western ridge of the Aravalli Range, particularly in Haryana, encompasses several revenue estates, including Bahrampur, Chakkarpur, Gwal Pahari, Ghata, and Haiderpur Viran. With their unique ecological significance, these areas face various challenges due to rapid urbanization and development pressures, primarily in the nearby city of Gurugram (Fig. 1).

A study was undertaken using Geo Information System technology in revenue estates of Bahrampur, Chakkarpur and Gwal Pahari, Ghata and Haiderpur Viran on the western ridge of Aravalli's which are under protection of PLP Act but are otherwise under the Development Plan of Gwal Pahari or Gurugram- Manesar Complex and another revenue estate of Nathupur which is not covered under PLP Act but in continuation of area of study of the selected revenue estates.

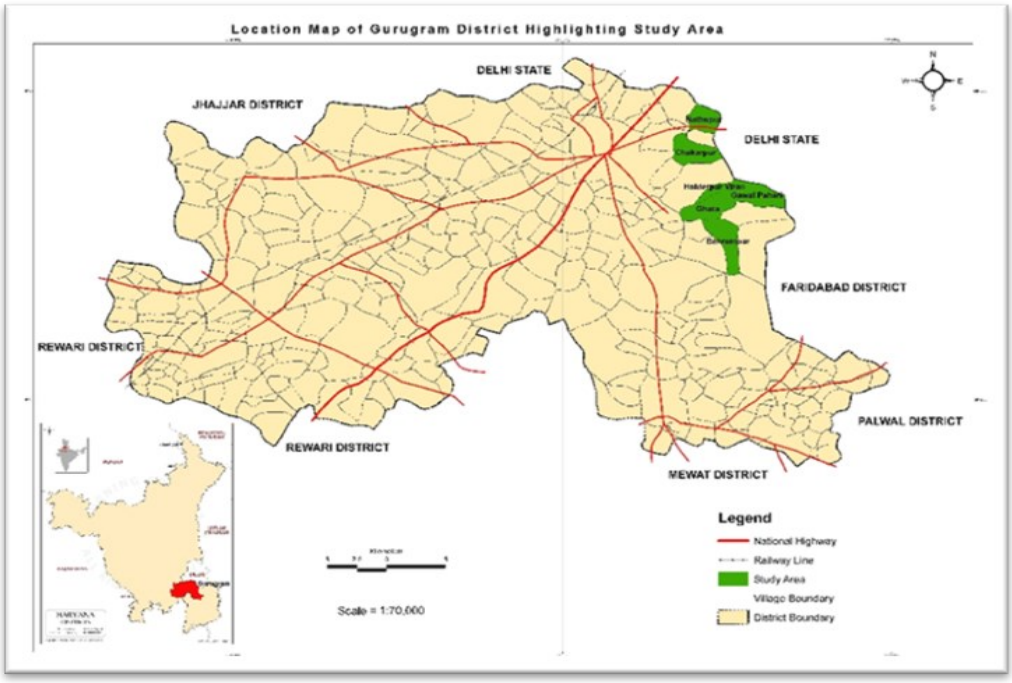


Fig. 1. *Location of revenue estates of Behrampur, Nathupur, Chakkarpur, Gwal Pahari, Ghata and Haiderpur Viran*

Methodology

The methodology involved using the satellite imageries and superimposing the digitized maps on the imageries after a time lag. Since the major development activities have undertaken in the beginning of the present millennia, the satellite imageries taken are from 2005 onwards. However, for the village Nathupur the images taken are from the year 1977 to see the progression of the land use change. The Geo Information Technology has been widely to access the land use change and also expansion of urban areas and urban land use classification. (Zhan *et al.*, 2002; Singh, 1989). Integrated GIS and remote sensing with visual interpretation provides adequate spatial vector analysis of desired land-use pattern changes (Lu *et al.,* 2004;Herold *et al*.,2001), and transgression from vegetation area to urbanized area and change in surface temperature (Nur *et al*., 2022).

Satellite Imagery

For a comparative study of the selected revenue estates, a base map of the survey of India topo- sheet of 1975 was taken and digitized as a reference year for taking the base data. The revenue estates selected were near the erstwhile Gurgaon Urban Complex to observe the progression of land use change in the revenue estate not closed under Section 4 and/ or 5 of Punjab Land Preservation Act, 1900 and the others that are closed under Section 4 and/or 5 of PLPA 1900. Most of the Notifications for closure were of 11.02.1970. The lands closed under Section 4 and/or 5 of PLP Act would require approval under Forest Conservation Act,1980 for use for any non-forestry purpose as per the directions of the Hon'ble Supreme Court in CWP 4677 of 1985 dated 18.03.2004; for that purpose, the next year for taking up comparative study was taken up as 2005 and the data obtained was IRS LISS (III), after that data was taken from satellite imagery at an interval of 5 years, World View –II , High-resolution Ortho rectified panchromatic images of 0.50 m resolution and coloured images of 1.86 m GSD of 2011 and IRS LISS(IV) images for 2017 were acquired for study areas.

Cadastral map and superimposition of PLPA notified areas

The comparative study required the digitized cadastral maps of the revenue estates which were being analysed. The mussavies of the study areas were obtained from District Revenue Office and scanned and digitized to generate cadastral plani-metric vector data. Mussavies are the base map of the village with land grids and land numbers. Land numbers are called *khasra* numbers in the revenue records. These maps were georeferenced and overlaid on the ortho-rectified satellite imagery. The areas under notification under Punjab Land Preservation Act, 1900 (PLP Act) were marked on the georeferenced revenue maps with respective village / Hadbast numbers (the number of the revenue map of the village), rectangular numbers, and *killa* numbers and then superimposed on the available satellite imageries. For collection of Ground Control Points Garmin GPS navigation receiver was used. The digitization of cadastral maps required georeferenced GCP's which were transported on the maps generated to georeference them.

Cadastral vector data generation on Revenue maps

The cadastral maps of the villages were procured from the local office of the Department of Land Record Department. The maps were converted to vector format in ArcGIS base after scanning. The vector cadastral maps so prepared were superimposed with the attribute land data under PLP Act. *ArcGIS* software was used for scanning, digitization of Mussavies. Vector correction was made in the digital Mussavies and vector data pertaining to the land parcels was generated with a layer of land under Forest records (closed under PLP Act).

Mussavi is a village's base revenue map consisting of a map sheet of 16 murabbas. Each murabba (measurable land in acres) comprises of 25 *killa* (a grid of 5x5 square of 1 acre each). A *killa* is one acre of land measuring 60x60 yards. An acre/ *killa* is the smallest land parcel with ownership represented by the positive integer from 1 to 25 in mussavi. Murabba grids (200 karam x 180 karam) and *khasra* grids (40 karam x 36 karam) were generated. The murabba grid was generated using the same origin as the *killa* grid in *Arc GIS* software.

The line feature forming the murbba grid was converted to polygon feature, and each murabba's label was placed at its centroid. Each Mussavi comprises 16 murbbas. The features such as village tri-junctions, bi-junctions etc. were digitized as point features. These were located on the ground with the help of DGPS. The dimension specified on the map for each feature was digitized in consonance measures on the revenue map. The data was converted into shape file *.shp, by integrating RoR data with geo-linked spatial data. To ensure that the map so prepared is consistent with the actual land available in the revenue estate, the area of aggregate parcels was compared with the land record. It was assured that the data so compiled was the exact mosaic fit of the cadastral revenue map. This was followed by a field survey to locate the tri-junction and bi-junction points in the revenue estates to draw the cadastral boundaries.

Georeferencing of village map

Sufficient numbers of GCP's were identified on the vector cadastral map for generating the transformed model. The GCP's identified included all the tri-junction and bi

junctions to assure that the digital map so generated has the least error. Second order polynomial model or affine transformation model was applied for georeferencing of cadastral map. The values assessed the transformation model arrived for residual error at each GCP and the root mean square for the entire model was undertaken to remove any possibility of error. The root mean square(rms) error contribution is less than 3 m in either direction. The transformation model was accepted when the actual rms and residual errors arrived were less than the threshold values, and the vector cadastral map was georeferenced through affine transformation in GIS environment. New vector files were generated separately for the polygon, line and point features. The georeferenced vector file of each village was validated concerning the ortho-rectified image. The georeferenced vector file was overlaid on the reference image and initial validation was carried out through visual checking. The distance between the image and vector points was measured as displacement. During the process of overlaying the maps and georeferencing, if it was observed that the shift was more than allowable limits, then the exercise was repeated for georeferencing.

The georeferenced maps were validated by matching the boundaries of the neighbouring villages, using ortho -rectified image. The land numbers of the areas under PLP Act were depicted on the final ortho rectified maps.

RESULTS AND DISCUSSION

Comparison of the maps of the study area over a decade

Once the vector maps were georeferenced, cadastral maps were prepared. They were laid on the imageries obtained for different years, that is IRS (LISS III) for the year 2005, Word View II of 2011 and IRS (LISS IV) for 2017. The base map toposheet of the Survey of India of 1975 was digitized.

In the five revenue estates selected in continuation on the western ridge, covered under various development plans since 2007, it was observed that there was no habitation in the areas closed under the PLP Act in the base year taken for study, 1975. The revenue estates of Ghata, Haiderpur Viran and Chakkarpur area covered under the developmental plan of Gurugram - Manesar Developmental Complex of 2007,2011 and 2012 amended in 2017, whereas Behrampur, Gwal Pahari were covered under the Gwal Pahari development plan of 2010. The revenue estate of Behrampur has 923.32-acre area under PLP Act, in 2005 the area under violation was 1.8 acres which increased to 9.18 acre in 2011 and 13.73 acre in 2017, the nature of violations being mainly farmhouses (Table 1). The revenue estate of Chakkarpur has 279.25 acre of land under the Forest statute. As per GIS analysis of the satellite imagery there was violation of 33.71 acre in 2005, which remained static over the years. The nature of violation was the residential sector. The area in Ghata under Forest statute is 235.49 acre. The GIS analysis of the area showed a violation of 5.70 acres in 2005, which got reduced to 3.76 acres in 2011 and the increasing to 4.20 acres in 2017. Similarly, in the revenue estate of Gwal Pahari, the GIS analysis showed no violation in 2005 and 2011, whereas there was a marginal violation of 2.79 acre in 2017. In the revenue estate of Haiderpur Viran, the GIS analysis showed violation of 2.20 acre in 2005, 8.45 acres in 2011 and 9.95 acres in 2017. The nature of violation was a religious place of worship and Gaushala (Fig. 2).

The expansion of habitation has been limited in revenue estates of Behrampur, Ghata, Gwal Pahari and Haiderpur Viran. There have been some violations of 1.48 % of geographical area under forest cover in Ghata , 1.78% in Gwal Pahari, less than 1% and in Haiderpur Viran and 3.4%.in Behrampur. It was observed that there were marginal violations in the form of farm houses or religious structures except for the revenue estate of Chakkarpur, which now has an urbanized sector.

Similarly, analysis of the land use change in the village Nathupur, which is not closed under a special section of PLPAct, it was observed that in 1977 when these areas were not urbanized, there was no developmental plan in place, the major land use was agriculture with 350 hectares of area under agriculture (Fig. 3). The natural topographical features were also intact, including the natural water streams and water bodies. In 1977, only 4.7 hectares of area was under habitation, that is the erstwhile village population. The land use remained almost same in the year 1988 with 334.4-hectare area under agricultural use and

Table 1. Spatio-temporal analysis of the areas of Gurugram district under violation

Sr. No	Village Name	Forest Area (acres)	Area under Violation (acres)			
			1975	2005	2011	2017
1.	Barampur(H. B. 100)	923.32	0.0	1.84	9.18	13.73
2.	Chakarpur (H. B. 74)	279.25	0.0	33.71	33.71	33.71
3.	Ghata (H. B. 81)	235.49	0.0	5.70	3.76	4.20
4.	Gwal Pahari (H. B. 77)	285.89	0.0	0.0	0.0	2.79
5.	Haidarpur Viran (H. B. 76)	291.27	0.0	2.2	8.45	9.95

expansion of the habitation to 22.8 ha. However other features remained unviolated. In the year 1999 the agricultural use declined to 186.65 ha while urbanized area increased to 152.10 hectares, also the road network expanded to 17.99 hectares (Table 2). In 2006, the agricultural area was finally lost with increased urbanization to 291.27 ha with an open area of 46.78 hectares. By the year 2022, 410,67 hectare was urbanized, also the area under natural streams and water bodies were lost (72.6 hectares). The Urban complex now hosts residential and commercial entities in the developed sector, and the natural topographical and vegetational features are being lost completely (Nathalia et al., 2017). The spectacular urban growth in Gurgaon has been underpinned by an uneven process of land acquisition, exemption and agrarian transformation embraced by global real estate and private sector-led development (Cowan, 2018; Gupta A. T., 2022;Jain *et al.,* 2011). The real estate sector-driven rapid urban makeover has converted the peri-urban agricultural land to create production and consumption spaces for the new economy that has caused a fragmented landscape (Chatterji, 2013) . Urbanization has altered rural natural resource use patterns and created social, cultural and economic changes (Narain, 2009) and conflict in using natural resources and water (Narain and Singh, 2017). It has caused loss of common property resources, shift in agriculture, emergence of urban canals causing agrarian crisis and conflicts related to urbanization (Mishra, 2022) There is a need for applying strategic environmental assessment in planning expansion and development of Urban areas in sensitive landscapes as

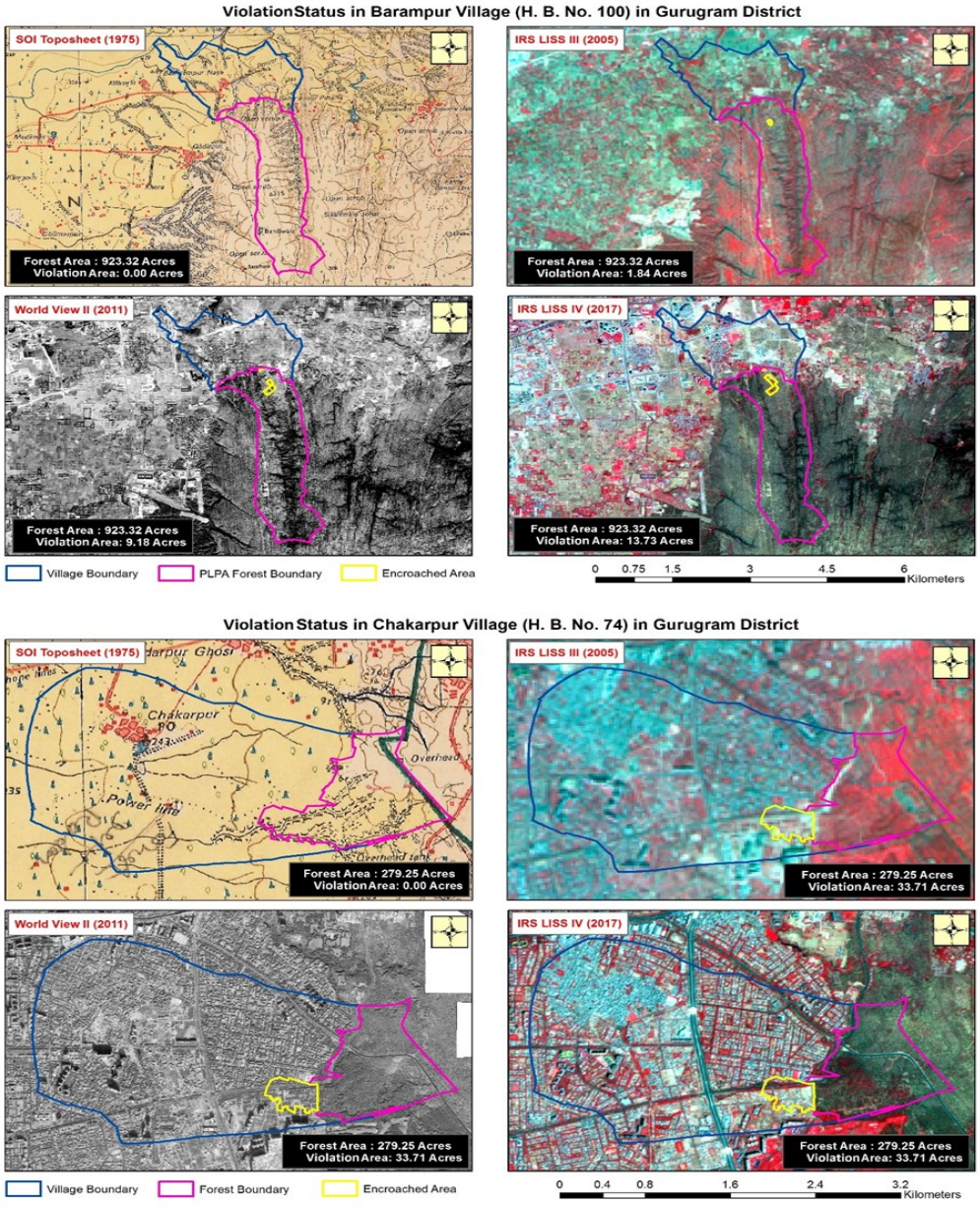
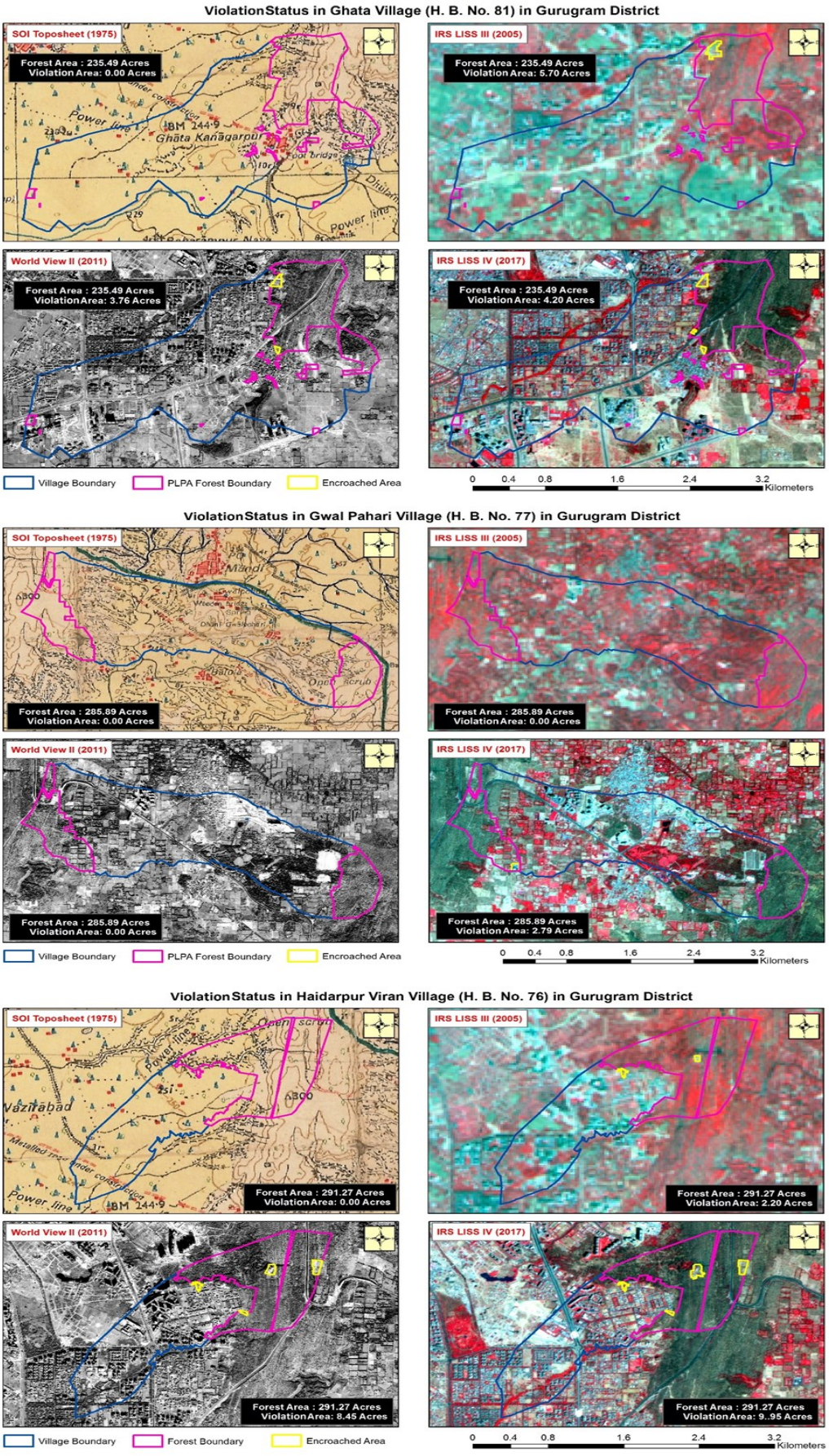


Fig. 2. *Area under violation in villages of Gurugram district*

Fig. 2. Contd……


Violation Status in Ghata Village (H. B. No. 81) in Gurugram District
SOI Toposheet (1975)
Forest Area : 235.49 Acres
Violation Area: 0.00 Acres
IRS LISS III (2005)
Forest Area : 235.49 Acres
Violation Area: 5.70 Acres
World View II (2011)
Forest Area : 235.49 Acres
Violation Area: 3.76 Acres
IRS LISS IV (2017)
Forest Area : 235.49 Acres
Violation Area: 4.20 Acres
Village Boundary
PLPA Forest Boundary
Encroached Area
0 0.4 0.8 1.6 2.4 3.2 Kilometers
Violation Status in Gwal Pahari Village (H. B. No. 77) in Gurugram District
SOI Toposheet (1975)
Forest Area : 285.89 Acres
Violation Area: 0.00 Acres
IRS LISS III (2005)
Forest Area : 285.89 Acres
Violation Area: 0.00 Acres
World View II (2011)
Forest Area : 285.89 Acres
Violation Area: 0.00 Acres
IRS LISS IV (2017)
Forest Area : 285.89 Acres
Violation Area: 2.79 Acres
Village Boundary
PLPA Forest Boundary
Encroached Area
0 0.4 0.8 1.6 2.4 3.2 Kilometers
Violation Status in Haidarpur Viran Village (H. B. No. 76) in Gurugram District
SOI Toposheet (1975)
Forest Area : 291.27 Acres
Violation Area: 0.00 Acres
IRS LISS III (2005)
Forest Area : 291.27 Acres
Violation Area: 2.20 Acres
World View II (2011)
Forest Area : 291.27 Acres
Violation Area: 8.45 Acres
IRS LISS IV (2017)
Forest Area : 291.27 Acres
Violation Area: 9..95 Acres
Village Boundary
Forest Boundary
Encroached Area
0 0.4 0.8 1.6 2.4 3.2 Kilometers

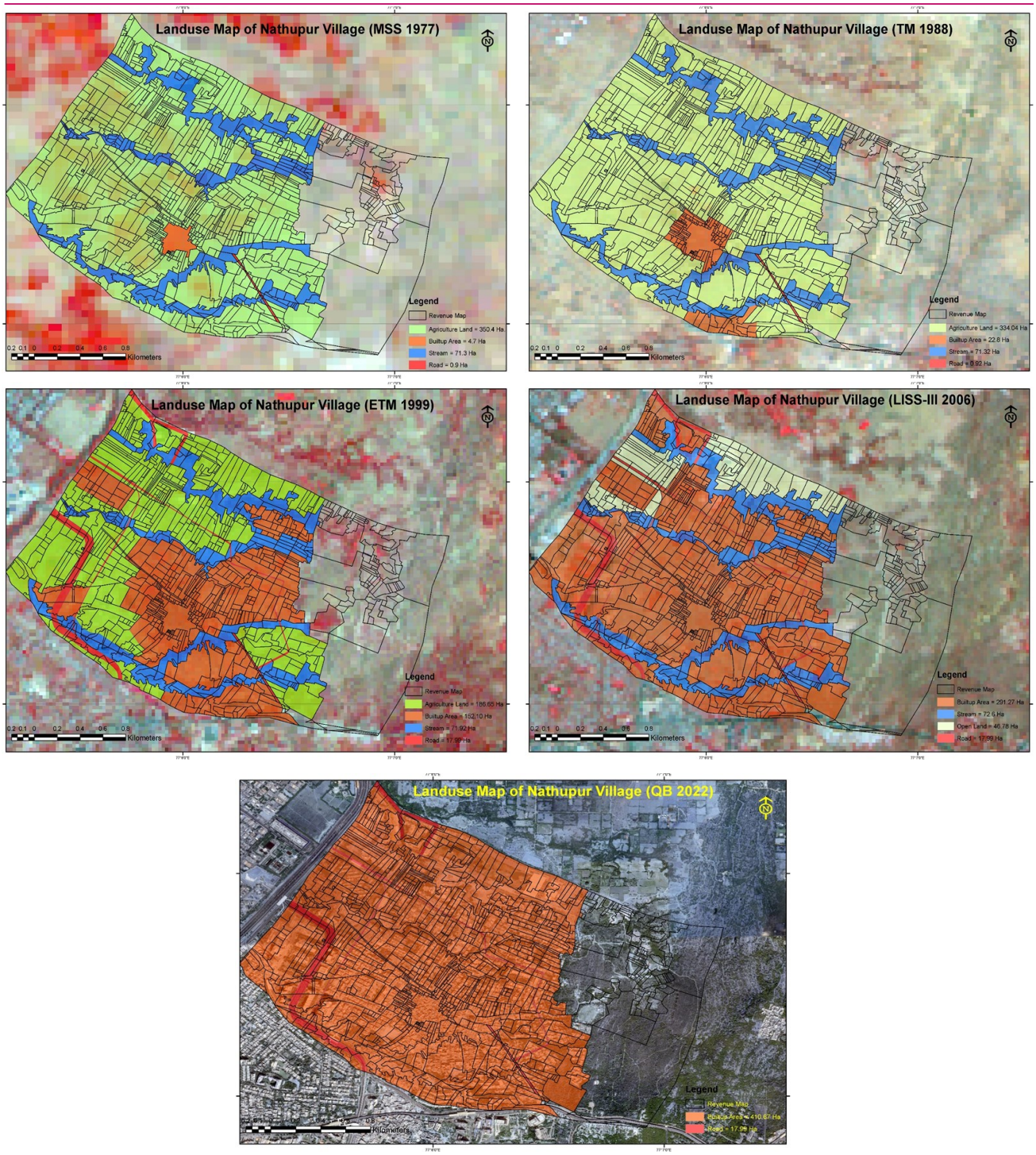


Fig. 3. *Spatio-temporal analysis of LULC map of Nathupur village*

Aravalli's in Gurugaon (Mukherjee and Rajvanshi, 2016). The public agencies and private developers are in an advantageous position because authority and access to capital have impact on other stakeholders and have a considerable hold on resource utilization, directly affecting development (Gupta, 2022; Prakash, 2017). However, despite successive Urban development plans, there has been considerable protection from urban expansion and development sprawl in areas notified under forest statutes.

To regulate the urban sprawls, the local government should be equipped under the law to handle the issue of public-private-community partnership, regulate the land use, and other ecological services for better governance and rationalization of resources (Aijaz, 2019).There is need for policies with greater participative processes in which landowners and peri-urban residents are involved in planning and natural resource optimization (Narain, 2009) with informed approach to policy interventions for urbanization for better planning

Table 2. Spatio-temporal analysis of LULC of revenue estate Nathupur

Year	Area under Agriculture	Open area	Area under Buildings/ habitation	Area under water stream	Area under roads
1977	350.4 ha	-	4.7 ha	71.3 ha	0.9 ha
1988	334.4 ha	-	22.8 ha	71.3 ha	0.9 ha
1999	186.65 ha	-	152.10 ha	71.92 ha	17.99 ha
2006	-	46.78 ha	291.27 ha	71.6 ha	17.99 ha
2022	-	-	410.67 ha	-	17.99 ha

and implementation. (Singh & Narain, 2020). This would reduce the pressure on the ecology of sensitive landscape like Gurugram for which the hill ranges are important for biodiversity, and forests act as natural carbon sinks, arrest the expansion of desert and are essential for the region's water security.

Conclusion

The land in the Revenue Estate of Behrampur, Chakarpur, Gwal Pahari, Ghata and Haiderpur Viran has both private and Panchayat ownership. Though they are covered under the Gurugram Developmental Plan of 2021 and Gwal Pahari Developmental Plan of 2021, there has not been a major violation in the forest areas, except for Chakarpur, which is under private ownership and has a residential sector carved down in the Gurugram Master Developmental Plan. In the other four revenue estates, the violations observed were mostly private farmhouses and religious places of worship Whereas, observation of the satellite imaginaries of Nathupur depict that there had been a gradual change from agricultural land and area under water bodies and streams in 1977 to almost under all area under habitation in 2022, it can be concluded that areas that had approved Developmental Plans but were covered under forest statutes and other similar regulations have resulted in protection of the forest cover in the region. Though the ownership of the land vests in private entities or panchayats in areas notified under PLP Act, there have not been extensive violations due to the expansion of the urban-industrial complex due to the umbrella of protective regulations. Urbanization can be limited if forest statutes or similar regulations protect the natural topographic features and national resources in the urban landscape as forests serve as natural carbon sinks, maintain the ecology and, in Aravalli region, contribute groundwater recharge essential for any urban-industrial complex.

Conflict of interest

The authors declare that they have no conflict of interest.

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