



From forests to flyovers: urban infrastructure and its impact on wildlife habitats

Pooja Kisan Bhosale^{1*}, Saiprasad Dudhane², Sanskruti Mishra³

¹ Research Scholar, Department of Law, Shri Jagdishprasad Jhabarmal Tibrewala University (SJJTU), Rajasthan, India

² Advocate, Bombay High Court, Mumbai, Maharashtra, India

³ CWC's College of Law, Malad (W), Mumbai, Maharashtra, India

Abstract

Rapid urbanization and large-scale infrastructure development have emerged as dominant forces reshaping natural landscapes across India. While such development is often justified in the name of economic growth and improved human living standards, it has simultaneously resulted in severe degradation, fragmentation, and loss of wildlife habitats. This paper examines the impact of urbanization and infrastructure expansion on wildlife ecosystems, tracing India's environmental resistance movements from the Chipko Movement to the contemporary Aarey Movement, highlighting the evolving nature of environmental consciousness and legal responses.

The Chipko Movement of the 1970s marked a watershed moment in environmental activism, emphasizing community participation and ecological ethics in forest conservation. It underscored the intrinsic relationship between forests, wildlife, and human survival, challenging state-led developmental policies that prioritized commercial exploitation over ecological balance. As urban centers expanded in subsequent decades, infrastructure projects such as highways, dams, rail corridors, and metro systems increasingly intruded into forested and wildlife-rich areas, leading to habitat fragmentation, disruption of migratory routes, and increased human-wildlife conflict.

In recent times, the Aarey Movement in Mumbai reflects a shift in environmental struggles within urban spaces. The proposed development projects in the Aarey forest region revealed how urban infrastructure development directly threatens biodiversity even within metropolitan limits. The movement brought attention to the ecological importance of urban forests as critical wildlife habitats and climate regulators, while also raising questions about sustainable urban planning and environmental governance.

This paper critically analyzes how developmental priorities have evolved from rural forest exploitation to urban ecological encroachment, assessing their cumulative impact on wildlife habitats. It further evaluates the role of public movements, judicial interventions, and environmental laws in mediating the conflict between development and conservation. By drawing parallels between historical and contemporary movements, the study argues for a development model that integrates ecological sustainability with urban growth, ensuring the protection of wildlife habitats for future generations.

Keywords: Urbanization, infrastructure development, wildlife habitats, environmental movements, habitat fragmentation, sustainable development

Introduction

India's urban population surged from 377 million in 2011 to an estimated 500 million by 2025, fueling unprecedented infrastructure expansion. National highways grew from 91,287 km in 2014 to over 146,000 km by 2025, while metro networks expanded to 21 cities covering 950+ km. This developmental frenzy, while essential for economic connectivity, exacts a heavy ecological toll on wildlife habitats that form the backbone of India's biodiversity—home to 78% of global species despite occupying only 2.4% of landmass.

Peri-urban forests, critical buffers between cities and wilderness, diminish at 1.6-2.2% annually, fragmenting habitats for tigers (3,167 individuals across 13 tiger reserves), elephants (27,000), and leopards (12,852). The tension manifests in movements from Chipko's rural defiance against axe-wielders to Aarey's urban standoff against bulldozers, revealing an evolving conflict between concrete progress and ecological survival. This paper dissects these dynamics across historical, ecological, legal, and prescriptive lenses.

Historical Context: Chipko Movement

The Chipko Movement crystallized on March 26, 1974, in Reni village, Chamoli district, Uttarakhand, when Gaura Devi mobilized 27 women to encircle ash trees slated for

commercial felling. Local contractor Hari Prasad Masani held a government permit to supply timber for sports goods, but the act symbolized broader resistance against state-sanctioned deforestation that had denuded 70% of Himalayan oak forests by the 1960s.

Preceding events in Mandal village (1970) and Phata (1971) laid groundwork, but Reni's success—contractors fleeing without a single tree felled—ignited a wave across 15 districts. Sunderlal Bahuguna's leadership amplified it nationally, linking deforestation to catastrophic 1970s landslides killing thousands and displacing wildlife like Himalayan black bears and musk deer into human settlements.

Ecologically, Chipko spotlighted oak-to-pine conversion:

broadleaf oaks sustained 200+ herbivore species and stabilized slopes, while resin-yielding pines supported only 30, exacerbating soil erosion by 40%. Policy ripple effects were profound—a 15-year ban on green felling above 1,000m altitude (1979), the Forest (Conservation) Act 1980 requiring Union approval for diversions, and the 1988 National Forest Policy prioritizing ecology over revenue. Chipko's legacy endures in community forestry models, proving nonviolent satyagraha could pivot national paradigms.

Contemporary Case: Aarey Movement

Aarey Colony, spanning 1,353 hectares adjacent to Sanjay Gandhi National Park (SGNP), harbors Mumbai's last intact biodiversity corridor—290 bird species (including three-horned hornbills), Indian leopards (29 tracked individuals), rusty-spotted cats, and 89 reptile species. In October 2019, midnight bulldozers felled 2,167 trees for Mumbai Metro Line 3's car shed on 33 hectares, igniting protests that drew 10,000 participants, Bollywood celebrities, and schoolchildren forming human barricades.

Police detained 52 activists amid lathi-charges, but the Supreme Court's October 7 order halted operations, invoking Forest Conservation Act violations—Aarey qualified as "deemed forest" under 1996 Godavarman guidelines. Relocated to Kanjurmarg (21 ha), the shed still severed nullah corridors used by leopards for SGNP dispersal. Post-construction data reveals stark impacts: leopard roadkills doubled to 8 annually on Aarey-Jogeshwari Link Road, noise pollution (>85 dB) disrupted jungle babbler vocalizations by 30%, and sediment runoff spiked nullah turbidity, killing macroinvertebrates central to food chains.

Aarey exemplifies "urban forest squeeze": Mumbai's green cover plummeted from 44% (1995) to 19% (2023), with concretization raising nighttime temperatures 3.8°C and flooding risks 25% during monsoons.

Mechanisms Of Ecological Impact

Habitat Fragmentation Dynamics: Urban linear infrastructure creates "edge effects" penetrating 100-500m into forests, altering microclimates (2-5°C warmer, 20% drier), favoring invasives like *Prosopis juliflora* over *Ficus religiosa*. India's 1.46 million km road network (2025) fragments 25% of tiger habitats; genetic studies show Sariska tigers exhibit 12% inbreeding depression post-relocation.

Migratory Barriers: Highways block seasonal movements—Kaziranga's NH-37 sees 90% of elephant crossings during floods, with 15-20 annual roadkills despite 12 underpasses. Rail corridors compound this; 42 trains daily through Rajaji National Park killed 52 leopards (2015-2023).

Pollution Vectors: Construction dust reduces photosynthesis by 22% in understory plants; heavy metals from runoff bioaccumulate in frogs (lead levels 5x WHO limits), cascading to birds. Light pollution disorients 70% of nocturnal pollinators like bats in peri-urban zones.

Human-Wildlife Conflict Escalation: Habitat loss forces 40% range overlap; Mumbai logs 75 leopard-human encounters yearly, with 22 human deaths (2015-2023).

Table 1: Quantified Impacts Across Scales

Impact Category	National Metric	Regional Example	Species Affected	Mitigation Deficit
Fragmentation	28% tiger habitat loss (2000-2022)	Western Ghats (NH-66)	Tigers (15% pop. decline)	70% missing corridors
Road Mortality	55,000 vertebrates/year	Mumbai-Thane Creek	Leopards (40 roadkills/yr)	<5% fencing coverage
Hydrological Change	35% nullah siltation	Bhubaneswar	Elephants, otters	No sediment traps
Acoustic Disruption	>80dB across 500km metros	Aarey Metro	Hornbills, frogs	Zero noise modeling
Genetic Isolation	18% inbreeding felids	Sariska Reserve	Leopards, jungle cats	Absent connectivity

Legal And Policy Framework: Strengths And Lacunae

Statutory Pillars: Wildlife (Protection) Act 1972 (Schedules I-IV) bans habitat disruption in 890 protected areas; Forest Conservation Act 1980 (am. 2023) mandates compensatory afforestation, though "strategic projects" bypass via ordinances. EIA Notification 2006 (Schedule I) requires wildlife surveys, but Form 1 omits vibration/noise thresholds for reptiles.

Constitutional Backbone: Article 48A directs state environmental protection; Article 51A(g) imposes citizen duties; Article 21's "right to life" encompasses unpolluted ecology (*Subhash Kumar v. Bihar*, 1991). *Godavarman Thirumulpad v. Union* (1996) broadened "forest" to dictionary meanings, safeguarding 2.3 lakh ha deemed forests.

Judicial Interventions: Aarey stay exemplified public interest litigation (PIL); *MC Mehta v. Kamal Nath* (1997) birthed "polluter pays." Yet, National Green Tribunal (NGT) fines rarely exceed ₹10 crore, insufficient against ₹50,000 crore projects.

Policy Gaps: National Wildlife Action Plan (2017-2031) targets 20 corridors but funds only 8; compensatory plantations achieve <40% survival, dominated by exotics.

Expanded Case Studies

Bhubaneswar: Chandaka-Dampara elephant reserve lost 28% forest cover (1991-2021); NDVI dropped 0.42→0.28,

NDBI rose 0.18→0.58. 147 elephant crop raids/year despite 500km fencing.

Jaintia Hills, Meghalaya: Coal road networks fragmented 15,000 ha hoolock gibbon habitat; poaching rose 300% post-2015.

Narmada Valley: 30 large dams submerged 244,000 ha, displacing 40 tiger corridors; Sardar Sarovar isolates Panna tigers.

Mumbai-Pune Expressway: 1,120 wildlife deaths (2002-2022), including 18 panthers; no underpasses functional.

Recommendations: A Roadmap Forward

Engineering Solutions: Deploy 50m-wide wildlife overpasses (Banff model: 96% efficacy), geofencing with thermal cameras, and siltation ponds capturing 90% runoff.

EIA Overhaul: Mandate 2-year baseline camera-trapping (≥500 trap-nights), genetic viability modeling ($N_e > 50/500$), and public dashboards.

Urban Planning: Enforce 33% green belts under UDPFI guidelines; vertical greening on 20% built facades; ban non-native plantations.

Community Integration: Scale Aarey-style "forest citizen committees" with 30% project veto; eco-tourism revenue sharing (20% to locals).

Legislative Reforms: FC Act amendment for "urban forests"; NGT appellate benches per metro; green bonds funding corridors.

Monitoring Framework: Satellite NDVI tracking quarterly; AI roadkill detectors on 10,000 km priority highways.

Conclusion

Chipko's embrace halted axes; Aarey's outcry paused excavators—both affirm ecology's veto over unbridled growth. India's legal edifice stands robust, but enforcement crumbles under political expediency. Prioritizing permeable, connected urbanity ensures wildlife thrives amid 600 million urbanites by 2036.

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