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Impact of Highways on Land Use

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Abstract: Highways are instrumental in shaping patterns of land use, particularly in regions undergoing rapid urbanization and economic transformation. This dissertation investigates the long-term impact of operational highways on land use changes, with a focus on urban expansion, the transformation of peri-urban areas, and the development of residential, commercial, and industrial infrastructure. Unlike studies that emphasize highway construction or short-term effects, this research centers on highways that have been functional for at least two decades, providing a comprehensive view of their lasting influence.

Through a detailed literature review, policy analysis, and two case studies—National Highway-48 in the National Capital Region of India and the Antalya–Alanya Highway in Turkey—the study reveals that highways significantly contribute to land conversion, particularly the shift from agricultural to urban and industrial uses. These transformations are accompanied by environmental challenges, such as biodiversity loss, soil degradation, and increased pollution, along with socio-economic implications including population relocation, infrastructure pressure, and livelihood disruptions.

The findings underscore the necessity for integrated land use planning and environmental assessments that consider the full spectrum of impacts induced by highways. By adopting sustainable development frameworks, incorporating stakeholder participation, and enhancing regulatory mechanisms, highway-induced land use changes can be better managed to support both economic growth and ecological balance.

Keywords: Highways, land use, land use planning, urbanization, National Highway

I. INTRODUCTION

1.1 Background

Highways significantly influence land use patterns by promoting urban growth, especially in fast-developing and peri-urban areas. They improve connectivity and attract real estate, industrial, and commercial development, leading to increased land value and changes in land use—often from agricultural to urban.

In India, operational highways like NH-48 have played a key role in transforming rural landscapes into urban hubs. However, this rapid transformation also raises concerns about unplanned development, farmland loss, and environmental degradation.

While many studies focus on the construction of highways, there is limited research on how long-operational highways impact land use over time. This study addresses that gap by analyzing their long-term influence on urbanization and spatial development.

1.2 Need for the Study

Highways continue to reshape land use patterns long after their construction, especially in peri-urban and rural regions. However, most existing studies focus on newly built roads or short-term impacts, neglecting the long-term effects of operational highways on land transformation.

With increasing urban sprawl and pressure on agricultural land, it becomes essential to understand how highways drive land use change over decades. This understanding can help planners anticipate future development, manage land resources more sustainably, and create informed policies.

This study is needed to fill the gap in research on the long-term impact of highways on urbanization and land use, providing insights for better urban and regional planning.

1.3 Aim of the Dissertation

- To analyse the long-term impact of operational highways on land use changes and urban growth.

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1.4 Objectives of the Study

- To study how existing highways have influenced urbanization in surrounding areas, particularly in peri-urban and rural zones.

1.5 Scope and Limitations

Scope:

- Analyse land use changes, urbanization
- Focus on highways that have been operational for at least 20 years.

Limitations:

- The study relies on secondary data, limiting the ability to incorporate real-time observations.
- It focuses on a 20-year timeline and excludes highways constructed or expanded before this period.
- Economic and environmental implications are outside the scope of this research.

1.6 Methodology

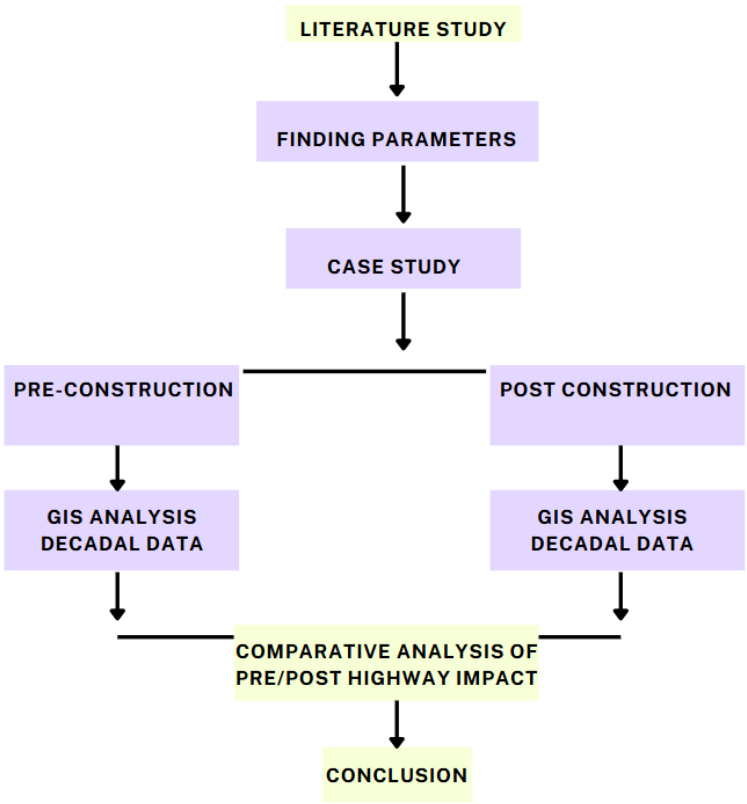

Fig. 1 Methodology flow diagram

II. LITERATURE REVIEW

2.1 Urbanization and Land Use

Urbanization is a key driver of land use change. Salas-Olmedo et al. (2011) observe that highways promote urban sprawl, converting agricultural land into residential and commercial zones. Aïkous et al. (2020) also emphasize that highways shift city boundaries and increase land value, encouraging denser development near highway corridors.

2.2 Infrastructure and Land Conversion

Highways enhance accessibility, which influences land use patterns. Mothorpe et al. (2017) state that every mile of highway in urban counties can convert hundreds of acres of land, mainly from agricultural to urban use. Stigen et al. (2018) highlight that improved access makes remote areas suitable for development, impacting land value and settlement patterns.

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2.3 Agricultural Land Loss

Song et al. (2019) show that highway expansion leads to large-scale farmland loss, particularly in peri-urban areas. Agricultural zones near highways are often first to be urbanized, threatening food security and rural livelihoods.

2.4 Socio-Economic Influences

Socio-economic factors such as rising land prices, housing demand, and employment opportunities also accelerate land conversion. Aïkous et al. (2020) point out that economic growth near highways often displaces low-income agricultural communities.

2.5 Environmental Concerns

Land conversion due to highways causes fragmentation of habitats, soil degradation, and pollution. Song et al. (2019) note that highway-induced development can disrupt local ecosystems and deplete water resources if not planned sustainably.

2.6 Policy and Governance

Prashanti & Goswami (2018) highlight the importance of integrating land use assessments into Environmental Impact Assessments (EIA) for highway projects. Weak governance and lack of post-project evaluations often lead to unmanaged urban expansion.

2.7 Literature Review

Paper 1: Land Use Changes Associated with Highways (UK – Doncaster & Lincoln)
Focus: Spatial and economic effects of highway infrastructure in two urban contexts.
Key Points:
• Doncaster shows decentralization due to motorway connectivity; logistics-led growth but weak city center retention.
• Lincoln follows compact growth, supported by planning and educational infrastructure.
Relevance: Highlights how transportation infrastructure, combined with policy, shapes contrasting urban forms.

Paper 2: Highway Expansion and Land Use Change – Event Study (Montréal, Canada)
Focus: Impact of Highway 30 expansion on commercial and industrial development.
Key Points:
• Highways increase land conversion near ramps and corridors.
• Regulatory constraints limit sprawl but raise land prices.
Relevance: Demonstrates highways' dual role in stimulating development and altering land dynamics.

Paper 3: Highway-Induced Land Use and Transport Demand (Norway)
Focus: Relationship between land use changes from highways and induced traffic demand.
Key Points:
• Dynamic land use boosts vehicle kilometers traveled (VKT).
• Greater relocation occurs near high-access corridors.
Relevance: Shows that ignoring land use shifts in transport modeling can underestimate real impacts.

Paper 4: Highway and Farmland Loss (China – Hang-Jia-Hu Plain)
Focus: Expressways' role in land use transformation from 1990–2010.
Key Points:
• 89% farmland converted to built-up land near expressways.
• Urban fringe and rural areas see fragmented growth.
Relevance: Supports concerns over ecological degradation and farmland loss due to highway proximity.

Paper 5: Interstate Highways and Agricultural Land Conversion (USA – Georgia)
Focus: Long-term agricultural land loss linked to highway construction.
Key Points:
• Uses OLS and IV techniques to confirm causal link.
• Highway access accelerates non-agricultural land use.
Relevance: Offers a robust empirical approach to quantifying highway-induced land changes.

2.8 Identified Research Gaps

1.Regional Variations Missing: Many studies generalize land use impacts without addressing regional variations (differences in urban vs rural areas, or developed vs developing countries).

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2.Peri-Urban Zones Underexplored: Few studies analyze how peri-urban areas are affected by land use changes caused by highways.
3.Socio-Economic Impacts: While land use and transport demand are studied, socio-economic outcomes like housing affordability, livelihoods, and demographic shifts are rarely addressed.
4.Temporal Dynamics: Studies often focus on pre- and post-construction phases but overlook long-term operational impacts.
5.Comparative Studies Needed: Limited comparative analyses across different countries/regions
6.Environmental Factors Ignored: Most studies discuss land use changes without integrating environmental effects like biodiversity loss and soil degradation.

III. CASE STUDY

Case Study 1: Land Use and Urban Transformation Along NH-48 Corridor in the National Capital Region (NCR)

The NH-48 corridor, particularly the 127 km stretch from Gurugram to Sotanala (Behror), has emerged as a key development zone within the National Capital Region (NCR), owing to its inclusion in the Delhi-Mumbai Industrial Corridor (DMIC). This highway section cuts across rapidly urbanizing areas in Haryana and Rajasthan, catalysing massive shifts in land use and urban form.

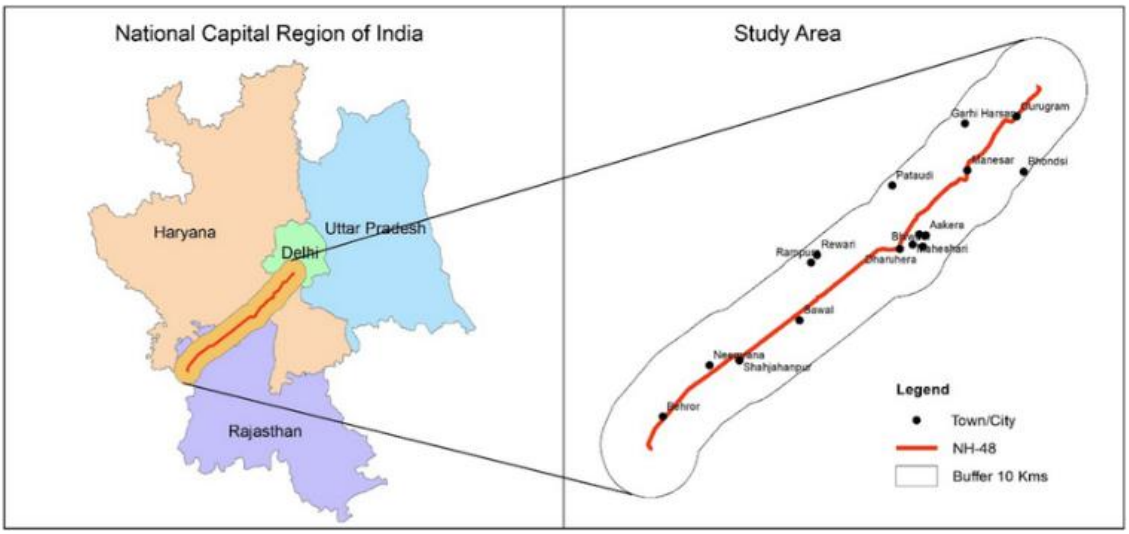

Fig. 2 Study Area

- Strategic Location: The corridor connects major industrial hubs like Gurugram, Manesar, and Neemrana, improving access to Delhi and Mumbai.
- Industrial Growth: Development of Special Economic Zones (SEZs), industrial estates, and logistics parks has significantly boosted economic activity.
- Urban Infrastructure: Towns along the corridor have seen the growth of high-rise residential complexes, retail hubs, and hospitality developments.
- Policy Support: Backed by DMIC and regional planning authorities, the area has benefited from proactive land pooling and zoning strategies.

Major Challenges:

- **Agricultural Land Loss**: Large-scale conversion of fertile agricultural land into built-up urban land has led to a decline in traditional livelihoods.
- **Unregulated Growth**: Peripheral areas experience fragmented and haphazard development due to speculative real estate activity.
- **Environmental Stress**: Increasing pollution, deforestation, and loss of green cover are prevalent near industrial zones.
- **Infrastructure Pressure**: Basic services such as waste disposal, water supply, and internal road networks lag behind rapid construction activities.

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Insight:

- While the NH-48 corridor has accelerated urban transformation and economic development, it presents clear trade-offs. The region exemplifies how **transport corridors can reshape land use** but also highlights the risks of inadequate regulatory oversight and weak environmental safeguards. There is a critical need for **balanced, sustainable planning** to ensure that economic gains do not come at the cost of ecological and social well-being.

Case Study 2: Antalya–Alanya Highway, Turkey

- The Antalya–Alanya Highway is a major transportation corridor in southern Turkey, connecting tourism and agricultural zones along the Mediterranean coast.

Infrastructure Strengths:

- The highway has improved regional connectivity, boosted tourism and trade, and enabled better access to local markets. It has also helped in the economic development of surrounding areas by reducing travel time and increasing accessibility.

Major Challenges:

- The project has led to land use changes, including loss of agricultural land and natural vegetation. It has also increased environmental concerns like soil erosion, air pollution, and habitat fragmentation due to rising traffic volumes.

Insight:

- The highway showcases how transport infrastructure can drive regional growth, but also highlights the need for planning strategies that balance development with environmental conservation.

IV. CONCLUSION

The development of highways, while essential for regional connectivity and economic growth, has profound and often detrimental effects on land use, particularly in terms of urbanization and environmental degradation. Highways like NH-48 and the Antalya–Alanya Highway are prime examples of how infrastructure development can drive the conversion of agricultural land into urban and industrial areas, contributing to urban sprawl and industrialization. However, the environmental and social consequences, such as soil degradation, habitat fragmentation, and pollution, cannot be ignored. To balance development with environmental conservation, it is essential to adopt sustainable planning practices that incorporate environmental impact assessments (EIAs), pollution control measures, and better land-use integration. Ensuring that infrastructure development does not come at the cost of local ecosystems and communities is crucial for achieving long-term sustainability. Additionally, adopting mitigation strategies, such as strategic urban planning and community engagement, will help reduce the adverse effects of highway development on land use and the environment. In conclusion, highways play a crucial role in reshaping land use patterns, but the associated challenges must be addressed through careful planning, sustainable development practices, and effective mitigation strategies to minimize their negative impacts.

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