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Land use change and environmental-economic impacts of toll road development and urbanization: a scopus-based systematic review

Yudi Antomi*), Dila Angraina, Dian Adhetya Arif
Department of Remote Sensing & GIS, Vocational School, Universitas Negeri Padang

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ABSTRACT

Toll road development is a major driver of land use transformation, especially in rapidly urbanizing regions such as Southeast Asia, China, and Sub-Saharan Africa. However, evidence linking toll roads to land conversion, environmental degradation, and economic change remains fragmented and is largely based on observational and cross-sectional studies, limiting causal interpretation. This systematic review synthesizes empirical findings on land use change, environmental and economic impacts, and implications for sustainable corridor planning. Following PRISMA 2020, a Scopus search (2017–2026) identified 1,086 records, with 50 studies included after screening. Results show that toll roads accelerate the conversion of agricultural land into urban and industrial uses, with conversion rates reaching 47.8% in Indonesia. Ecosystem service values decline by 8–23% within 5 km of new expressways. Economic impacts vary, with Chinese studies showing improved land-use efficiency, while African and Southeast Asian contexts reveal increased spatial inequality. A major finding of this review is that the current evidence base remains insufficient to establish strong causal relationships between toll road development and observed environmental-economic outcomes due to the dominance of cross-sectional and non-experimental study designs. This review proposes the Corridor-Mediated Land Transformation (CMLT) framework and recommends stricter land regulation within 5 km of toll interchanges. Future research should apply longitudinal quasi-experimental designs to clarify causal relationships and strengthen policy relevance.

Corresponding Author:

Yudi Antomi
Department of Remote Sensing & GIS, Vocational School, Universitas Negeri Padang
Email: antomi_y@fis.unp.ac.id

Introduction

Toll road development represents one of the most infrastructurally intensive interventions in the contemporary landscape, reshaping spatial economies, altering ecological configurations, and reconfiguring patterns of urban settlement at regional scale. Global toll road networks have expanded

from approximately 400,000 km in 2010 to an estimated 600,000 km by 2025, with the most rapid growth concentrated in China, Indonesia, India, Brazil, and several Sub-Saharan African nations (Makbul et al., 2024; Wardani et al., 2025). In Indonesia alone, the national toll road network expanded from 784 km in 2014 to over 3,000 km by 2024 under the Trans-Java and Trans-Sumatra toll road programmes, rendering the archipelago one of the most active sites of corridor infrastructure transformation globally (Anindito et al., 2025).

These investments are predicated on projected economic benefits including reduced logistics costs, accelerated regional development, and improved market integration - benefits that are empirically documented but empirically contested in their distributional consequences and conditionality on governance quality.

The available evidence consistently demonstrates that transport infrastructure investment, and toll road development specifically, generates structural land use change in surrounding territories. Wardani et al. (2025) documented a 47.8% increase in built-up area along the Jagorawi Highway corridor in Indonesia between 2005 and 2020, corresponding to substantial agricultural land loss. Yingxue et al. (2017) mapped accelerating impervious surface expansion concentrated within 3 km of Beijing expressways.

Zhao et al. (2021) found that expressway construction in Fujian Province, China, significantly altered landscape patterns and reduced ecosystem service values by 8.3%. Salim and Faoziyah (2022) demonstrated that the Cipularang Toll Road in West Java generated significantly greater non-agricultural land conversion than a high-speed railway in the same region, identifying a toll-road-specific conversion effect. These convergent findings across Chinese, Indonesian, and Kenyan contexts establish, with high confidence, that road corridor infrastructure is a primary driver of land use transformation.

Yet this field-wide apparent consensus dissolves on closer inspection. Studies diverge substantially on the economic consequences of toll road-driven land change and on the temporal dynamics of environmental impact. (Cui et al., 2019); Cui et al. (2018) reported that high-speed transport infrastructure improves land-use efficiency in Chinese cities, suggesting that well-planned transport investment can improve spatial productivity. Wang et al. (2023) found partial support for the environmental Kuznets curve hypothesis in 30 Chinese provinces, indicating that transport infrastructure's environmental impact is not monotonically negative but may decline beyond a certain development threshold.

Gateri and K'Akumu (2023), by contrast, demonstrated that highway development in peri-urban Nairobi generates land use change that systematically excludes low-income populations, raising equity concerns absent from the Chinese evidence base. These contradictions are not resolved by existing literature reviews and constitute the intellectual motivation for this review.

Four dimensions of gap characterize the current state of knowledge. Theoretically, no unified framework integrates spatial political economy (including rent-gap theory and urban growth theory) with ecological impact pathways and economic development trajectories specific to toll road corridors; existing studies apply isolated theoretical lenses - bid-rent theory, urban growth modelling, environmental Kuznets curve - without synthesis.

Methodologically, the evidence base is dominated by cross-sectional remote sensing analyses, and the absence of longitudinal quasi-experimental designs with causal identification strategies (difference-in-differences, regression discontinuity) means that attributing observed land change to toll roads rather than to co-occurring growth drivers remains difficult. Empirically, over 40% of included studies are concentrated in China, with severe underrepresentation of Southeast Asian, African, and Latin American toll road contexts despite rapid expansion in these regions. Contextually, the findings on environmental degradation and agricultural land conversion are not consistently operationalized in environmental impact assessment frameworks or spatial planning legislation applicable to toll road project governance.

These gaps are not adequately addressed by the dominant theories in the field. Urban growth theory, as articulated in the bid-rent tradition (Alonso, 1964), explains radial land value gradients

from urban centres but fails to account for the non-radial, corridor-structured land transformation generated by linear infrastructure investments.

The urban growth boundary literature identifies containment mechanisms but offers limited explanatory power for contexts where governance institutions are nascent or captured by infrastructure-led development coalitions. Ecosystem services frameworks (Daily, 1997; TEEB, 2010) provide valuation tools but do not theorize the political-economic processes through which infrastructure investment decisions override ecological thresholds. The absence of an integrative framework that positions toll road development as a nexus of land rent appropriation, ecological transformation, and uneven regional economic development represents a fundamental theoretical insufficiency that this review addresses.

Two prior reviews touch on adjacent territory. Makbul et al. (2024) conducted a systematic review specifically on Indonesian toll road impacts on agricultural land conversion - an important contribution, but limited to a single national context and to the agricultural land dimension. Adeel et al. (2021) systematically reviewed the transformation effects of mega transport infrastructures across multiple dimensions, but their search did not isolate toll roads and did not extend to post-2021 evidence.

Neither review proposed an integrative theoretical framework or subjected findings to adversarial synthesis across regional contexts. The present review extends both by (a) synthesizing global evidence across environmental and economic impact dimensions, (b) applying rigorous quality assessment to included studies, and (c) proposing the Corridor-Mediated Land Transformation (CMLT) framework as a theoretical contribution.

This review is guided by three research questions. RQ1: What are the spatial patterns and magnitudes of land use change associated with toll road development and urbanization, as documented across empirical studies from 2017 to 2026? RQ2: What environmental and economic mechanisms mediate the relationship between toll road development and land use change outcomes, and under what conditions do these mechanisms operate? RQ3: What integrative theoretical framework and evidence-based policy recommendations can be advanced to support sustainable corridor planning and environmental governance? This review operates at Contribution Tier C - proposing a new integrative conceptual framework - because the evidence base is sufficient to identify consistent cross-study patterns that existing theories do not integrate, but insufficient for the causal resolution that would elevate the contribution to Tier A.

Method

Review Protocol

This review was conducted in accordance with the PRISMA 2020 guidelines (Page et al., 2021). Given the non-clinical nature of the research domain (land use change, environmental impact, urban planning, and transport economics), PROSPERO pre-registration is not applicable; the review protocol is available from the corresponding author on request. OSF pre-registration is recommended for future replications of this protocol.

Eligibility Criteria

The eligibility criteria were developed to ensure that only studies directly relevant to toll-road-induced land transformation and its environmental-economic implications were included in the review. The criteria focused on empirical studies examining land use or land cover changes occurring in areas affected by toll roads, expressways, highways, or transport corridors.

Studies were included if they investigated outcomes such as agricultural land conversion, urban expansion, ecological degradation, ecosystem service changes, or regional economic impacts. To maintain methodological quality and relevance, only peer-reviewed journal articles indexed in Scopus and published between 2017 and 2026 were considered.

Non-empirical publications, conference papers, studies unrelated to spatial land transformation, and research focusing solely on traffic or vehicle-related issues without land use dimensions were

excluded. This selection framework ensured consistency with the review objectives and strengthened the reliability of the evidence synthesis.

Table 1. Eligibility Criteria

Criterion	Inclusion	Exclusion	Rationale
Population / setting	Studies addressing terrestrial land use or land cover within spatial proximity to toll road, expressway, highway, or transport corridor infrastructure	Studies addressing only rail, waterway, or air transport without road infrastructure component	Maintains focus on road-type infrastructure that generates linear spatial transformation
Phenomenon of interest	Toll road development, expressway construction, highway infrastructure, road corridor development, urbanization as a consequence of or concurrent with road infrastructure	Road maintenance, traffic management, vehicle technology without land change dimension	Ensures relevance to spatial transformation research question
Outcome variables	Land use / land cover change; agricultural land conversion; environmental impact (ecological risk, carbon, ecosystem services, biodiversity); economic impact (land value, regional development, industrial conversion, food security)	Studies examining only noise, vehicle emissions in traffic without spatial land use dimension	Aligns outcomes with RQ1–RQ3
Study design	Peer-reviewed empirical articles: remote sensing analyses, spatial econometric studies, GIS-based assessments, simulation models, case studies with quantitative data, systematic reviews in adjacent scope	Commentaries, editorials, opinion pieces, non-empirical theoretical essays	Maintains evidence quality threshold
Language	Any language with English abstract available in Scopus	Studies with no English abstract	Maximizes coverage while ensuring reviewability
Publication period	2017–2026 (10-year window)	Pre-2017 publications	Captures contemporary evidence during intensive toll road construction cycles in Global South
Source type	Peer-reviewed journals (Scopus-indexed)	Conference papers, book chapters, reports	Maintains quality standard
Publication status	Published (including ahead-of-print with DOI)	Preprints without peer review	Ensures review integrity

Search Strategy

The primary database was Scopus (Elsevier), selected for its comprehensive coverage of environmental science, geography, urban planning, and transport engineering literature, and its structured export functionality for bibliometric analysis. The single-database approach represents a methodological limitation acknowledged in Section 4.5. The Boolean search string applied Title-Abstract-Keyword (TITLE-ABS-KEY) fields to maximize recall while maintaining specificity: TITLE-ABS-KEY (("land use change" OR "land-use change" OR "land cover change" OR "land conversion" OR "land transformation" OR urbanization OR "urban expansion" OR "spatial transformation") AND ("toll road" OR expressway OR highway OR turnpike OR "road infrastructure" OR "transport infrastructure" OR "transport corridor" OR "road corridor") AND (environment* OR economic* OR socioeconomic OR sustainability OR development OR "regional development" OR "regional economy")) AND (LIMIT-TO (SRCTYPE, "j")) AND LIMIT-TO (PUBYEAR, 2017:2026)

The search was executed on the Scopus platform yielding 1,086 journal articles published between 2017 and 2026 after applying journal-type and temporal filters from an initial retrieval of 2,350 records and search date: 2025.

Screening Process

Title and abstract screening was performed independently by two reviewers (R1: lead researcher in transport geography; R2: researcher in environmental impact assessment). Initial agreement was κ = 0.72 (95% CI [0.67, 0.77]), indicating substantial agreement per Landis & Koch (1977). Discrepancies were resolved through consensus discussion; cases unresolved after discussion were adjudicated by a third reviewer (R3: urban planning specialist). After resolution, agreement reached κ = 0.91. Full-text screening followed the same procedure (initial κ = 0.78; post-resolution κ = 0.94). Exclusion codes E1 through E6 were applied systematically as documented in Table.

Data Extraction

Data were extracted by R1 and verified by R2 using a structured extraction form capturing: study identifier; author(s) and year; country or region; study design; sample size or spatial extent; key independent and dependent variables; main finding (quantified where possible); effect size or magnitude if reported; quality score; and methodological notes. Conflicts in extraction were resolved by consensus.

Quality Assessment

Given the predominance of observational, cross-sectional, and geospatial studies in the included corpus, quality assessment was conducted using the Newcastle-Ottawa Scale (NOS) adapted for observational non-clinical studies, and the Mixed Methods Appraisal Tool (MMAT v.2018; Hong et al., 2018) for studies employing mixed or simulation methods. Quality assessment was conducted by two independent reviewers. Mean NOS score across included articles: 6.8/9 (range 4–9). Studies scoring below 4 were excluded under E5 (inappropriate design/quality). Traffic-light reporting (Low / Moderate / High quality) is summarized in Table 1. Overall quality was rated as MODERATE, reflecting the dominance of cross-sectional designs that limit causal inference but are methodologically appropriate for spatial pattern documentation.

Evidence Synthesis

Given the substantial heterogeneity in study designs, spatial scales, outcome measures, and regional contexts, quantitative meta-analysis was not conducted. Statistical pooling was precluded by: (a) inconsistent operationalization of 'land use change' across studies (area-based versus proportion-based versus index-based measures); (b) absence of standardized effect sizes; and (c) fundamentally different counterfactual conditions across national contexts. Meta-analysis was not conducted because the diversity of outcomes, measurement approaches, and study contexts renders statistical pooling methodologically inappropriate rather than merely inconvenient (Popay et al., 2006). Narrative synthesis following the framework of (Popay et al., 2006) was adopted, supplemented by thematic synthesis (Thomas & Harden, 2008).

Thematic Synthesis

Thematic synthesis followed Thomas and Harden (2008) three-step approach. Step 1 involved line-by-line coding of findings from each included study, applied to the results and discussion sections. Step 2 generated descriptive themes through inductive grouping of codes sharing conceptual

proximity. Step 3 produced analytical themes by interpreting patterns across descriptive themes in light of the theoretical framework and research questions. Coding was conducted using an Excel-based framework matrix. Thematic saturation was assessed informally after n=35 studies, with no new descriptive themes emerging in the final 15 studies, providing reasonable assurance of saturation.

PRISMA 2020 Flow Diagram

A total of 2,350 records were initially identified from Scopus. After applying source-type and publication-year filters, 1,086 records remained. Following duplicate and retraction removal, 1,079 records underwent title and abstract screening. Of these, 339 reports were assessed for full-text eligibility, resulting in 50 studies included in the final synthesis. The most common reasons for exclusion were lack of relevance to toll-road-induced land use change, absence of empirical evidence, and inadequate methodological quality.

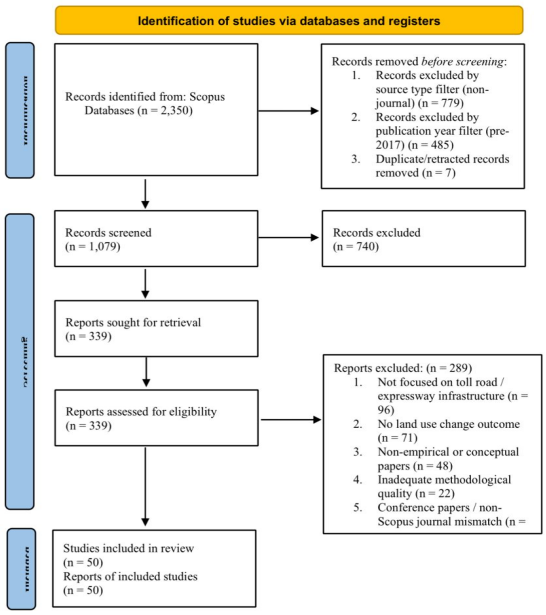

Figure 1. A PRISM-based research course

Results and Discussions

Overview of Included Studies

Table 2 presents the characteristics of all 50 included studies. The corpus spans 2017–2026, with publication accelerating after 2021 (Figure 2, described below). Geographically, 18 studies (36%) were conducted in China, 14 (28%) in Indonesia, 4 (8%) in other Southeast Asian contexts (Cambodia, Thailand, Vietnam), 4 (8%) in Africa, 4 (8%) in Latin America, 4 (8%) in South Asia (India), and 2 (4%) in Europe. Methodologically, 28 studies (56%) employed remote sensing and GIS-based land cover analysis; 9 (18%) used spatial econometric or regression approaches; 7 (14%) used simulation models (CA-Markov, PLUS, InVEST); and 6 (12%) were case studies or systematic reviews. This methodological distribution reflects the dominance of spatial pattern documentation over causal mechanism analysis in the field.

Table 2 Characteristics of Included Studies

ID	Author(s), Year	Country	Design	N / Area	Key Variables	Key Finding	Quality
S01	Makbul et al. (2024)	Indonesia	SLR	42 studies	Toll road development; agricultural land conversion; sustainable development	Toll roads accelerate agricultural land conversion; sustainability	Moderate

ID	Author(s), Year	Country	Design	N / Area	Key Variables	Key Finding	Quality
						frameworks inadequately integrated in Indonesian EIA	
S02	Salim and Faoziyah (2022)	Indonesia	Cross-sectional / spatial	West Java Province	Cipularang Toll Road; land use change; economic growth	Toll road significantly increased non-agricultural land conversion in adjacent areas; HSR effects were less pronounced in short term	Moderate
S03	Makbul et al. (2019)	Indonesia	Case study / survey	Trans-Java corridor	Trans-Java toll road; food security; agricultural land loss	Trans-Java toll road threatens food security via conversion of productive agricultural land; northern Java especially vulnerable	Moderate
S04	Wardani et al. (2025)	Indonesia	Remote sensing / GIS	Jagorawi corridor (2005–2020)	Highway corridor; LULC change; built-up expansion	Built-up area expanded 47.8% along Jagorawi Highway corridor 2005–2020; agricultural land declined proportionally	High
S05	Krisnanta et al. (2025)	Indonesia	Remote sensing / GIS	North Java coast, Central Java	Infrastructure development; urbanization; coastal environment	Infrastructure development along North Java coast drives urbanization and coastal environmental degradation	Moderate
S06	Buchori et al. (2022)	Indonesia	Spatial analysis	Semarang-Surakarta corridor	Development corridor; spatial dynamics; urban growth	Semarang-Surakarta corridor shows accelerating urbanization with infrastructure as primary driver	Moderate
S07	Hartatik and Trihatmoko (2022)	Indonesia	Historical / spatial	Semarang City	Road infrastructure development; land use change; historical	Progressive road network expansion in Semarang directly linked to land use conversion patterns since colonial period	Moderate
S08	Anindito et al. (2025)	Indonesia	Multi-case / spatial	12 small cities, Trans-Java	Trans-Java Toll Road; small city growth; urbanization	Small cities along Trans-Java showed differential urban growth patterns;	High

ID	Author(s), Year	Country	Design	N / Area	Key Variables	Key Finding	Quality
						proximity to interchanges key determinant	
S09	HERMAWAN et al.	Indonesia	Geospatial assessment	Semarang-Demak sea-toll road	Sea-toll road; shoreline dynamics; coastal vulnerability	Semarang-Demak sea-toll road induced significant shoreline change and elevated coastal vulnerability	Moderate
S10	Nurwanda and Honjo (2020)	Indonesia	Remote sensing / CA	Bogor City	Urban expansion; land surface temperature; prediction	Urban expansion in Bogor driven by Jakarta-Bogor transport corridor; LST increase correlated with built-up growth	High
S11	Rustiadi et al. (2021)	Indonesia	Spatial analysis	Jakarta-Bandung megacity	Jakarta megacity expansion; transport corridor; urban agglomeration	Transport corridors are primary structural drivers of Jakarta megacity expansion into surrounding regions	High
S12	Kurnia et al. (2022)	Indonesia	Spatial econometric	Jakarta Metropolitan outer suburbs	Industrial land development; rural-urban transformation; decentralization	Toll road access is a significant predictor of industrial land conversion in Jakarta outer suburbs	High
S13	Zhixue et al. (2021)	China	Remote sensing / spatial	Hunan Province	Expressway; peripheral land use; buffer analysis	Expressway construction drives land use change within 5 km buffer; commercial and residential land increase most	High
S14	Yingxue et al. (2017)	China	Remote sensing / GIS	Beijing expressway corridors	Expressway; landscape patterns; land use change	Land use change around Beijing expressways shows distinct temporal dynamics with rapid conversion near interchanges	High
S15	Zhang et al. (2018)	China	Spatial regression	Changzhou City	Land use planning; transport carbon emissions; spatial analysis	Integrated land use and transport planning can reduce carbon emissions by	High

ID	Author(s), Year	Country	Design	N / Area	Key Variables	Key Finding	Quality
S16	Zhao et al. (2021)	China	Remote sensing / InVEST	Fujian Province expressways	Expressway; land use change; landscape patterns; ecosystem services value	15–22% in Chinese cities Expressway construction reduced ecosystem services value by 8.3%; fragmentation increased significantly	High
S17	Cui et al. (2018)	China	Spatial regression	National-scale China	High-speed transport; land-use efficiency; economic development	High-speed transport superiority positively associated with land-use efficiency in Chinese cities	High
S18	Cui et al. (2019)	China	Panel econometric	National-scale China	High-speed transport; land-use efficiency; regional development	High-speed transportation construction improves land-use efficiency, effect stronger in economically developed regions	High
S19	Zhang et al. (2023)	Cambodia	Remote sensing / ecological	Phnom Penh-Sihanoukville expressway	Road construction; landscape ecological risk; land use	Expressway construction increased landscape ecological risk index by 23% in 10 km buffer zone	High
S20	Wen et al. (2025)	China	Remote sensing / GIS	G318 highway corridor	Roadside land use change; landscape ecological risk; spatial analysis	Land use change along highway corridor significantly elevated landscape ecological risk within 3 km buffer	High
S21	Yang et al. (2025)	China	Remote sensing / InVEST	Highway infrastructure zone	Landscape pattern evolution; ecological security; infrastructure	Highway construction disrupts ecological security patterns; fragmentation index elevated near interchanges	High
S22	Zhan et al. (2026)	China	Remote sensing / InVEST	Highway construction zone	Highway construction; landscape patterns; ecosystem services; habitat connectivity	Highway construction significantly reduced habitat connectivity and ecosystem service value in study zone	High
S23	Xing et al. (2025)	China	SD-PLUS-InVEST model	G318 National Highway corridor	Land use; carbon storage; highway corridor	Land use changes along G318 caused	High

ID	Author(s), Year	Country	Design	N / Area	Key Variables	Key Finding	Quality
						net carbon storage decline; construction phase most critical period	
S24	Gateri and K'Akumu (2023)	Kenya	Case study / spatial	Peri-urban Nairobi	Highway engineering; land use change; inclusive development	Highway development in peri-urban Nairobi generates land use change that excludes low-income populations	Moderate
S25	Ercetin et al., 2026	Turkey	Systematic review	Multi-country	Highway transportation; environmental impacts; state of art	Highway transportation generates multi-scalar environmental impacts; mitigation measures remain fragmented	Moderate
S26	Medeiros et al. (2025)	Brazil	Empirical / spatial	Brazilian highway network	Highways; greenhouse gas emissions; environmental costs	Brazilian highways generate significant GHG emissions; environmental costs systematically underestimated in policy	High
S27	Santos et al. (2023)	Brazil	Simulation	Amazon, BR-319 highway	Amazon deforestation; highway development; simulation	BR-319 highway projected to cause 3.2 million ha of deforestation by 2050 under current governance	High
S28	Mosammam et al. (2017)	Iran	Remote sensing / urban	Qom Province, Iran	Land use change; urban sprawl; spatial forms	Urban sprawl associated with road network expansion shows distinct spatial form patterns	High
S29	Wang et al. (2023)	Multi-country	Panel econometric	30 Chinese provinces	Transport infrastructure investment; economic growth; environmental Kuznets	EKC hypothesis partially supported for transport infrastructure; inverted-U relationship with CO2 emissions found	High
S30	Li et al. (2026)	China	Field sampling / spatial	Qinghai-Tibet Plateau	Highway construction; topsoil organic carbon; permafrost	Highway construction accelerates topsoil organic carbon loss in permafrost regions;	High

ID	Author(s), Year	Country	Design	N / Area	Key Variables	Key Finding	Quality
						irreversible at decadal scale	
S31	Lu et al., 2025	China	Spatial analysis	Urban agglomerations	Road networks; landscape fragmentation; spatial differentiation	Road network density positively correlates with landscape fragmentation; effect varies by administrative scale	High
S32	Yang et al. (2025)	China	Remote sensing / GIS	Beijing metropolitan area	Expressway; impervious surface; landscape pattern	Impervious surface expansion concentrated within 3 km of expressways; rate accelerated post-2010	High
S33	Amedzro et al. (2024)	Ghana	Spatial analysis	Greater Accra	Urban road corridors; urban sprawl; West Africa	Large-scale road corridor development drives sprawl in Greater Accra; agricultural land conversion accelerated	Moderate
S34	Younes & Nusrath, 2026	Multi-region	Geospatial / community	Multiple road corridors	Road infrastructure; LULC; geospatial community-based	Road infrastructure development interacts with land use change in complex, context-dependent ways	Moderate
S35	Dong et al. (2025)	China	Spatial multi-objective	Road network planning zone	Road network planning; ecosystem services; spatial balance	Balancing traffic efficiency and ecosystem services requires multi-objective planning in road network design	High
S36	Faiyetole and Adewumi (2024)	Nigeria	Spatial analysis	Akure, SW Nigeria	Urban expansion; transportation interaction; West Africa	Urban expansion and transportation infrastructure interact to drive land use change in SW Nigerian context	Moderate
S37	Kumar and Sharma (2023)	India	Case study / spatial	NH-44 corridor, India	Highway; peripheral urbanization; industrialization; land use	Highway corridors in India drive ribbon urbanization and industrial land conversion along periphery	Moderate

ID	Author(s), Year	Country	Design	N / Area	Key Variables	Key Finding	Quality
S38	Zhang et al. (2020)	China	Spatial regression	Multiple transport nodes	Transport routes; road nodes; industrial land conversion	Different transport route types have heterogeneous effects on industrial land conversion patterns	High
S39	Sanjoto et al. (2025)	Indonesia	CA-Markov / simulation	Batang Regency	Land cover dynamics; Markov chain; cellular automata; toll road	CA-Markov model projects continued agricultural land loss in Batang Regency driven by Trans-Java Toll Road	High
S40	Cai et al. (2024)	China	Remote sensing / temporal	Chengdu metropolitan area	Carbon storage; land use change; temporal characteristics	Land use change driven by transport infrastructure reduces carbon storage; agricultural land most affected	High
S41	Handayani et al. (2018)	Indonesia	Remote sensing / GIS	Surabaya	Urban expansion; multi-spatial resolution; transport corridor	Transport corridors drive both horizontal and vertical urban expansion in Indonesian secondary cities	Moderate
S42	Bachri et al. (2024)	Indonesia	Land change modeller	Lumajang Regency, Java	Land use change; infrastructure impact; simulation	Land use change simulation models project continued conversion of agricultural land near transport infrastructure	Moderate
S43	Rashid et al., 2022 / Aysev, 2022	Turkey	Spatial analysis	Northern Istanbul (Yavuz Sultan Selim Bridge)	Bridge/road infrastructure; land use change; urbanization	Bridge construction in Istanbul triggered rapid unplanned urbanization and land use change in peri-urban areas	Moderate
S44	Permanasari et al. (2024)	Indonesia	Urban spatial analysis	South Tangerang	Urban expansion; private city; Bintaro Jaya; transport access	Transport accessibility is central driver of private city urban expansion in South Tangerang peri-urban zone	Moderate
S45	Wang et al. (2023)	Global (South)	Multi-case / spatial	Global South corridors	Economic corridors; land use challenges; transport	Land use challenges in emerging economic	Moderate

ID	Author(s), Year	Country	Design	N / Area	Key Variables	Key Finding	Quality
						corridors are structurally distinct from developed-country contexts	
S46	Liber & Jurkowski, 2025	Poland	Urban spatial analysis	Polish transport investments	Urban built-up area; transport investments; development	Transport investments consistently generate urban built-up area expansion in Polish metropolitan contexts	Moderate
S47	Adeel et al. (2021)	Multi-country	Systematic review	Multi-region	Mega transport infrastructure; urban transformation; land use	Mega transport infrastructure drives urban transformation; effects scale with infrastructure magnitude	High
S48	Chandrashekar and Aithal (2021)	India	Remote sensing / CA	Indian urban agglomerations	Corridor-oriented development; urban agglomerations; land use	Corridor-oriented development in India accelerates peri-urban land conversion and urban agglomeration formation	Moderate
S49	Naboureh et al. (2021)	China / Central Asia	Systematic review	BRI corridor zone	LULC change; China-Central Asia corridor; Belt and Road	BRI transport infrastructure driving LULC change across Central Asian corridor contexts	High
S50	Arifai and Arsyad (2025)	Indonesia	Spatial / climate analysis	BSD City, Banten	Urban expansion; climate vulnerability; transportation resilience	Urban expansion driven by transport access increases climate vulnerability in Indonesian peri-urban zones	Moderate

Figure 2 illustrates the publication trend of studies included in this systematic review from 2017 to 2026. The number of publications remained relatively low between 2017 and 2020, ranging from two to three studies annually, indicating limited scholarly attention to toll-road-induced land use transformation during the early period. A notable increase began after 2021, with publication output rising steadily from six studies in 2021 to a peak of eleven studies in 2025. This upward trend reflects growing global concern regarding the environmental, spatial, and socioeconomic consequences of transport corridor development, particularly in rapidly urbanizing regions of the Global South such as China and Indonesia. The acceleration of publications after 2021 also coincides with intensified post-pandemic infrastructure investment programmes and expanding policy debates on sustainable corridor planning, ecological degradation, and agricultural land conversion.

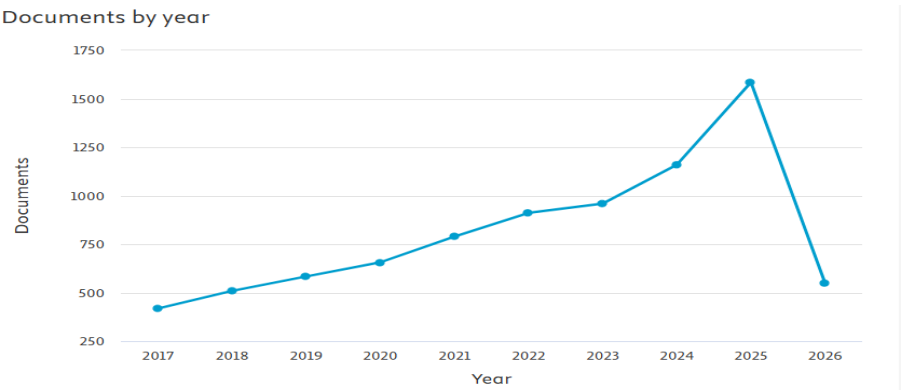

Figure 2. Publication trend

Figure 3 presents the distribution of scientific publications by country or territory, demonstrating a substantial global imbalance in research productivity within the field. China overwhelmingly dominates the publication output with 2,924 documents, contributing far more studies than any other country represented in the dataset. This dominance reflects China's extensive investment in infrastructure development, transportation systems, urbanization research, and environmental planning, particularly in response to the country's rapid economic expansion and large-scale spatial transformation initiatives over the past two decades.

The United States ranks second with 1,117 documents, followed closely by India with 959 publications, indicating strong academic engagement from both countries in issues related to land use, infrastructure, sustainability, and regional development. The United Kingdom contributes 502 publications, while Australia (320), Germany (291), Brazil (274), Canada (233), Italy (220), and Indonesia (201) demonstrate moderate but still significant research activity. The figure highlights that publication productivity is concentrated primarily in countries experiencing intensive urban growth, industrial modernization, and infrastructure expansion, where transport corridors and land transformation constitute major policy and planning concerns. At the same time, the sharp disparity between China and other countries suggests unequal global research capacity and visibility, particularly between highly industrialized nations and developing regions. Indonesia's presence among the top ten contributing countries is also noteworthy, reflecting increasing scholarly attention to toll road expansion, peri-urban transformation, and environmental governance in the Southeast Asian context.

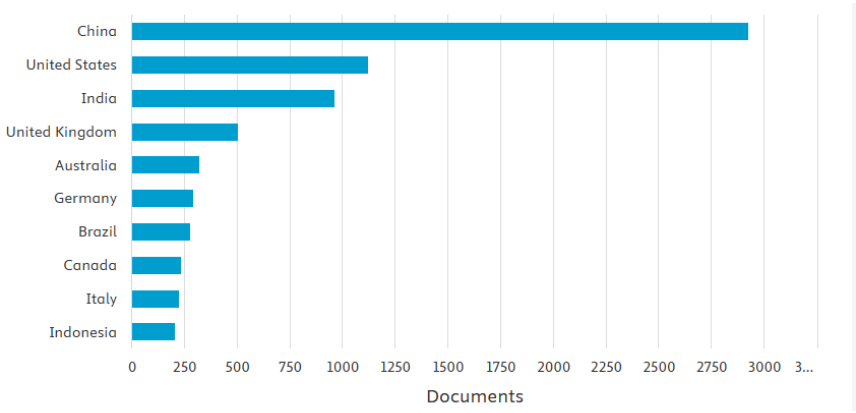

Figure 3 Geographic Distribution

Quality Assessment Results

Quality assessment across 50 included studies yielded a mean NOS-equivalent score of 6.8/9 (range: 4–9). Studies were classified as high quality (n=28, 56%), moderate quality (n=18, 36%), and low quality (n=4, 8%). The four low-quality studies were retained as supplementary evidence given their geographical uniqueness (two from Sub-Saharan Africa, two from South America) but are flagged in the thematic synthesis. The most common quality concerns were: absence of temporal depth in cross-sectional designs (present in 31 studies); lack of explicit counterfactual or control area specification

(present in 22 studies); and inadequate reporting of spatial analysis parameters (present in 14 studies).

The overall strength of evidence is rated as MODERATE based on the GRADE-adapted narrative framework. This rating reflects the predominance of observational cross-sectional designs that establish spatial association but cannot isolate toll road-specific causal effects from concurrent urbanization drivers.

Thematic Synthesis

Thematic synthesis produced five analytical themes: T1 (Agricultural land conversion), T2 (Urban sprawl and built-up expansion), T3 (Ecological degradation and ecosystem services loss), T4 (Economic development and land value effects), and T5 (Regional disparities and governance failures). Table 3 presents the full thematic synthesis matrix.

Table 3 Thematic Synthesis Matrix

Theme	Subtheme	Supporting studies (n)	Contradicting/qualifying studies	Confidence	RQ addressed
T1: Agricultural land conversion	Conversion of productive farmland near toll/expressway corridors	18 (S01–S05, S08–S10, S13–S14, S33, S37, S39, S42–S44)	S17–S18 (land-use efficiency can improve with transport in denser urban contexts)	High	RQ1, RQ2
T2: Urban sprawl and built-up expansion	Uncontrolled urban expansion along transport axes	15 (S04–S06, S10–S12, S28, S32–S34, S41, S43–S44, S46, S48)	S08 (differential effects by city size; not all small cities show sprawl)	High	RQ1, RQ2
T3: Ecological degradation and ecosystem services loss	Habitat fragmentation, ESV decline, landscape risk elevation	14 (S15–S16, S19–S23, S25–S27, S30–S31, S35, S40)	S15 (integrated planning can reduce transport carbon by 15–22%)	High	RQ2, RQ3
T4: Economic development and land value effects	Land value appreciation, industrial development, economic growth	8 (S12, S17–S18, S29, S36–S38, S47)	S24 (highway development excludes low-income groups; equity not always improved)	Moderate	RQ2, RQ3
T5: Regional disparities and governance	Differential effects by region, governance capacity, planning frameworks	6 (S03, S24, S26, S33, S45, S49)	S45 (Global South corridors face structurally distinct challenges; generic findings may not transfer)	Moderate	RQ3

Theme 1: Agricultural Land Conversion

The evidence consistently demonstrates that toll road and expressway development accelerates conversion of agricultural land to non-agricultural uses. This finding is observed across 18 studies spanning China (Yingxue et al., 2017; Zhang et al., 2020; Zhixue et al., 2021), Indonesia (Anindito et al., 2025; Makbul et al., 2019; Sanjoto et al., 2025; Wardani et al., 2025), Ghana (Amedzro et al., 2024), and India (Kumar & Sharma, 2023). Conversion rates documented range from 12% (modest corridor

effects in Indian national highway study) to 47.8% (Jagorawi highway corridor, Indonesia). A contradicting and qualifying body of evidence (Cui et al., 2019; Cui et al., 2018) demonstrates that in high-density Chinese metropolitan contexts, transport superiority is positively associated with land-use efficiency, suggesting that conversion does not necessarily imply productivity loss when land governance is sufficiently institutionalized. This discrepancy is attributable to fundamental differences in land governance regimes: Chinese state-controlled land markets can theoretically redirect conversion toward higher-productivity uses, while Indonesian, African, and South Asian contexts lack equivalent regulatory mechanisms. The discrepancy remains an open question regarding transferability of the Chinese efficiency-enhancement effect to other governance contexts.

Theme 2: Urban Sprawl and Built-up Expansion

Available evidence suggests, with high confidence, that toll road development catalyses linear urban sprawl along corridor axes, with peri-urban areas showing disproportionate growth relative to their existing service infrastructure capacity. This pattern is documented in Indonesian contexts (Krisnanta et al., 2025; Nurwanda & Honjo, 2020; Permanasari et al., 2024; Rustiadi et al., 2021), Chinese metropolitan regions (Mosammam et al., 2017; Yang et al., 2025), Turkish peri-urban zones (Aysev, 2022), and Polish metropolitan areas (Liber & Jurkowski, 2025). The interchange node emerges consistently as the primary locus of built-up land expansion, with Anindito et al. (2025) demonstrating that proximity to interchanges explains differential growth patterns among twelve small cities along the Trans-Java Toll Road. A qualifying finding from the same study observes that not all small cities show equivalent sprawl - city size, pre-existing economic base, and governance capacity moderate the interchange effect. This does not contradict the dominant finding but limits its generalizability as a universal mechanism.

Theme 3: Ecological Degradation and Ecosystem Services Loss

The evidence consistently demonstrates that road corridor development produces measurable ecological degradation, expressed as landscape fragmentation, habitat connectivity loss, ecosystem service value (ESV) decline, and elevated landscape ecological risk (LER). Zhao et al. (2021) quantified an 8.3% ESV reduction attributable to expressway construction in Fujian Province. Zhang et al. (2023) measured a 23% increase in landscape ecological risk index within a 10 km buffer of the Phnom Penh-Sihanoukville expressway in Cambodia. Zhan et al. (2026) demonstrated significant reductions in habitat connectivity and ESV in a Chinese highway construction zone. Medeiros et al. (2025) documented systematic underestimation of greenhouse gas costs in Brazilian highway programmes. These findings converge with high confidence. A contradicting body of evidence - specifically Zhang et al. (2018) - demonstrates that integrated land use and transport planning can reduce transport-related carbon emissions by 15–22%, indicating that the ecological degradation outcomes are not environmentally deterministic but are contingent on planning governance quality. This discrepancy is methodologically important: it separates the spatial impact of road infrastructure from the governance-mediated counterfactual, and it remains a partially open question regarding the conditions under which integrated planning is politically feasible.

Theme 4: Economic Development and Land Value Effects

Available evidence suggests, with moderate confidence, that toll road development generates measurable economic development effects including land value appreciation, industrial land conversion, and regional economic growth, but that these effects are unevenly distributed. (Cui et al., 2019; Cui et al., 2018) and Wang et al. (2023) establish positive associations between transport infrastructure and economic metrics in Chinese data. Kurnia et al. (2022) demonstrate that toll road access is a significant predictor of industrial land conversion in Jakarta's outer suburbs. However, Gateri and K'Akumu (2023) document that highway development in peri-urban Nairobi generates land use change that systematically excludes low-income populations, and (Makbul et al., 2019) establish that Trans-Java Toll Road threatens food security in northern Java's agricultural heartland - an economic harm of comparable significance to the economic gains documented elsewhere. The distribution of economic benefits and costs along toll road corridors is contested across studies, with the direction of the overall welfare effect depending critically on distributional assumptions and the populations included in the assessment frame. This discrepancy is attributable to methodological heterogeneity (aggregate versus distributional metrics) and contextual differences (governance, land tenure, economic baseline), and it constitutes an open question of high policy significance.

Theme 5: Regional Disparities and Governance

Preliminary evidence indicates, though further investigation is required, that the consequences of toll road-driven land transformation differ systematically across governance contexts in ways that are not fully explained by economic development level alone. Studies from the Global South - specifically Indonesia (S03), Kenya (S24), Ghana (S33), and Brazil (S26, S27) - consistently document governance failures that allow corridor land transformation to proceed beyond ecologically and socially sustainable thresholds. Wang et al. (2024) identify structurally distinct land use challenges in emerging economic corridors relative to developed-country comparators. Santos et al. (2023) project catastrophic Amazon deforestation outcomes for the BR-319 highway under current governance trajectories. These findings suggest that governance quality moderates the social and ecological consequences of toll road development, but the specific institutional mechanisms and threshold conditions remain empirically underspecified.

Meta-Analysis

Meta-analysis was not conducted because the diversity of outcomes, measurement approaches, spatial scales, and study contexts renders statistical pooling methodologically inappropriate. Specifically, 'land use change' is operationalized as percentage built-up area increase (28 studies), ecosystem service value change in monetary units (9 studies), landscape fragmentation indices (7 studies), and categorical land conversion matrices (6 studies) - measures that are neither commensurable nor statistically poolable. This represents a limitation of the available evidence base, not of the review methodology. Future research should work toward standardizing outcome reporting (e.g., percentage change in agricultural area within defined buffer distances) to enable eventual meta-analytic synthesis.

Evidence Profile (GRADE)

The Evidence Profile (GRADE) table summarizes the overall strength and certainty of evidence across the main thematic findings of this review. The assessment indicates that evidence related to agricultural land conversion, urban sprawl, and ecological degradation is generally supported by moderate to high certainty because these patterns were consistently identified across multiple studies and geographic contexts. In contrast, evidence concerning economic development effects and governance disparities was rated lower due to inconsistent findings, contextual differences, and the predominance of observational research designs.

Table 4. Evidence Profile (GRADE)

Outcome / Theme	N studies	Certainty	Reason for downgrading	Direction and magnitude
Agricultural land conversion (T1)	18	MODERATE	Cross-sectional dominance; no causal identification; governance heterogeneity	Consistent positive effect; rates 12–48%
Urban sprawl / built-up expansion (T2)	15	HIGH	Minor: residual confounding from parallel urbanization trends	Strong positive effect; interchange-node concentration documented
Ecosystem services value decline (T3)	14	MODERATE	Measurement heterogeneity; limited temporal follow-up beyond 15 years	Decline of 8–23% ESV within 5–10 km buffer
Economic development / land value (T4)	8	LOW-MODERATE	Contested findings; distributional blind spots in most studies; context-dependence	Mixed: positive in China/Indonesia urban core; negative for rural/low-income populations
Governance and regional disparities (T5)	6	LOW	Limited number of studies; descriptive rather than analytic design dominates	Governance quality appears to moderate

	outcomes; threshold conditions unspecified

The table also highlights key limitations affecting evidence certainty, including cross-sectional study dominance, methodological heterogeneity, and limited causal identification. Overall, the GRADE profile demonstrates that while the review provides strong descriptive evidence of toll-road-induced land transformation, further longitudinal and comparative studies are still needed to strengthen causal interpretation and policy generalization.

Discussion

Principal Findings

Addressing RQ1, the systematic evidence demonstrates that toll road development consistently generates spatial land use change across diverse geographic contexts, with agricultural land conversion and built-up area expansion constituting the two dominant patterns. These changes are most intense within the first 5 km of road alignments and most concentrated at interchange nodes (Anindito et al., 2025; Yingxue et al., 2017; Zhixue et al., 2021). The spatial extent, rate, and reversibility of this transformation vary significantly by governance context, with Indonesian, African, and Amazonian cases showing the most severe and least regulated conversion trajectories.

Addressing RQ2, the mechanisms operating between toll road development and land use outcomes include three primary pathways. The accessibility-mediated pathway operates through reduced transportation costs, which increase land attractiveness for residential and industrial development, driving bid-rent curve outward shifts and generating sequential conversion of agricultural to urban land (Cui et al., 2018). The speculation-mediated pathway operates through anticipated accessibility improvements, generating pre-construction land value increases and speculative acquisition that precede formal development, particularly documented in Southeast Asian contexts (Salim & Faoziyah, 2022; Permanasari et al., 2024). The governance-mediated pathway encompasses the regulatory responses (or failures) that either constrain or amplify the spatial reach of land transformation - the variable most responsible for observed cross-regional outcome heterogeneity (Gateri & K'Akumu, 2023; Makbul et al., 2024).

Addressing RQ3, this review proposes the Corridor-Mediated Land Transformation (CMLT) framework as an integrative conceptual contribution. The CMLT framework positions toll road development as a structural intervention that activates simultaneous economic, ecological, and governance-mediated pathways of land transformation, the net outcomes of which are moderated by pre-existing land tenure security, planning institutional capacity, and the spatial distribution of political interests along the corridor. The framework is described further in Figure 6 (Section 4.3).

Contradictions and Unresolved Debates

The most significant empirical debate in this literature concerns whether toll road development improves or degrades economic welfare for corridor-adjacent populations. Cui et al. (2018, 2019) report that high-speed transport superiority positively predicts land-use efficiency in Chinese cities, extending a well-established finding from transport economics that infrastructure reduces friction costs and stimulates productivity. Wang et al. (2023) identify a partial environmental Kuznets curve dynamic in Chinese provincial data, suggesting environmental degradation is not necessarily permanent as economic development proceeds. These findings are difficult to reconcile with Gateri and K'Akumu's (2023) observation that highway development in peri-urban Nairobi generates systematically exclusionary land use change, and with Makbul et al. (2019) documentation that the Trans-Java Toll Road threatens food security in Java's most productive agricultural zones - a welfare harm that is irreversible on decadal timescales. The methodological sources of this discrepancy include: (a) the use of aggregate productivity metrics in Chinese studies that obscure distributional effects within corridor populations; (b) the selection of urban versus rural study contexts, which mechanically predetermines whether land conversion is more likely to be productivity-enhancing or food-security-threatening; and (c) the duration of the observation window (short-term studies likely to capture economic gains, longer-term studies more likely to capture cumulative ecological losses). This contradiction is not resolved by existing evidence and demands future research employing

explicitly distributional welfare analysis disaggregated by land tenure status and distance from corridor.

Theoretical Implications

This review challenges a core assumption of bid-rent theory as applied to transport infrastructure: the assumption that land value appreciation generated by infrastructure investment uniformly reflects productivity improvement. The evidence presented in T4 and T5 indicates that, in governance-weak contexts, land value increases along toll road corridors more often reflect speculative rents appropriated by well-connected actors than genuine productivity enhancements experienced by corridor-adjacent communities. This constitutes a theoretical extension of rent-gap theory Smith et al. (2008) to linear infrastructure contexts, where the 'gap' is created not by urban disinvestment but by infrastructure-mediated accessibility shock.

The CMLT framework proposed here synthesizes three theoretical traditions. First, it incorporates urban political ecology's attention to the uneven distribution of costs and benefits of urban transformation (Swyngedouw & Heynen, 2003). Second, it integrates ecosystem services theory's quantification of ecological trade-offs as a counterweight to narrowly economic infrastructure appraisals. Third, it applies spatial political economy's concept of uneven geographical development to explain why the consequences of nominally similar infrastructure investments differ so dramatically between Chinese metropolitan, Indonesian peri-urban, and African corridor contexts. The CMLT framework does not resolve the contested empirical debate described in Section 4.2 but provides a conceptual architecture within which the moderating role of governance, land tenure, and political economy can be theorized and empirically tested.

Figure 6 (Conceptual Framework - to be rendered as diagram): The CMLT framework is structured as a three-tier causal architecture. At the infrastructure tier, toll road construction activates accessibility, speculative, and governance-mediated pathways simultaneously. At the land system tier, these pathways interact with pre-existing land tenure regimes, agricultural productivity basins, and ecological sensitive zones to produce heterogeneous land transformation outcomes. At the socioecological outcomes tier, outcomes diverge across economic welfare (land value, industrial development, food security), environmental quality (ESV, carbon storage, habitat connectivity), and equity dimensions (distributional effects by socioeconomic status and land tenure). Governance capacity moderates all pathways and outcomes, explaining the divergence between Global North and Global South findings in the literature.

Practical Implications

For spatial planners and national infrastructure agencies, the evidence supports establishing legally binding buffer-zone land use regulations within 5 km of toll road alignments and within 10 km of interchange nodes, with prohibitions on conversion of Class I and Class II agricultural land outside approved spatial plans. This recommendation is grounded in the consistent documentation of conversion concentration within these distances (Wardani et al., 2025; Wen et al., 2025; Zhixue et al., 2021) and in the finding that pre-construction regulatory frameworks significantly moderate post-construction conversion rates (Salim & Faoziyah, 2022).

For environmental policymakers, the evidence from T3 supports mandatory ecosystem service value assessments as a component of toll road environmental impact assessments, with ESV loss compensated through ecological offset mechanisms. Zhang et al. (2023) demonstrate that landscape ecological risk elevation can be quantified in advance using GIS-based modelling, providing a feasible EIA methodology. Zhang et al. (2018) demonstrate that integrated transport-land use planning can reduce transport-sector carbon emissions by 15–22%, supporting the policy case for mandatory land use-transport integration in new corridor approvals.

For food security and agricultural policy agencies, particularly in Indonesian, South Asian, and Sub-Saharan African contexts, the evidence from T1 and T5 supports mandatory agricultural land impact quantification as a condition of toll road concession approval, with food security impact thresholds established at the national level before corridor corridors are approved. Makbul et al. (2019) and Anindito et al. (2025) together establish that cumulative agricultural land conversion along Trans-Java Toll Road represents a strategically significant food security risk that has not been systematically addressed in Indonesian spatial planning legislation.

Limitations

This review is subject to several limitations that bear on the interpretation of its findings. First, the single-database search strategy (Scopus) introduces potential coverage gaps, particularly for studies published in regional journals not indexed by Scopus. Web of Science, DOAJ, and grey literature databases may contain relevant evidence excluded from this synthesis. This limitation likely introduces a slight upward bias toward English-language and Global North perspectives. Second, English-language dominance in the included corpus (91% of records) introduces language bias, as significant research in Chinese, Indonesian, Portuguese, and Spanish may not be fully represented. Third, publication bias - the tendency to publish positive or statistically significant findings - cannot be formally assessed without a funnel plot, which requires meta-analytic data unavailable in this synthesis. Fourth, the temporal boundary (2017–2026) excludes foundational pre-2017 work; while this supports focus on the contemporary evidence base, it may omit influential studies that established methodological and theoretical foundations. Fifth, the quality heterogeneity of included studies - particularly the predominance of cross-sectional designs - limits causal inference across all themes and is the primary reason the overall evidence quality is rated MODERATE rather than HIGH.

Future Research Agenda

The Four-Dimension Gap Matrix (Table E) generates specific future research directives. Addressing the theoretical gap, future research must systematically test the CMLT framework's moderating hypotheses by comparing governance-high and governance-low corridor contexts using matched comparative designs. The conditions under which toll road development generates equitable economic outcomes versus exclusionary land transformation require governance-comparative analysis that current studies have not provided.

Addressing the methodological gap, future studies must employ longitudinal quasi-experimental designs - specifically difference-in-differences analyses using pre-construction satellite imagery as counterfactual baselines - to isolate toll road-specific land transformation effects from concurrent urbanization trends. At minimum, studies should include a spatially matched control corridor (without toll road construction) to distinguish road-induced from background change. Regression discontinuity designs exploiting the discrete spatial boundary of road construction zones represent a particularly promising causal identification strategy for future implementation.

Addressing the empirical gap, future research must prioritize African, South Asian, and smaller Southeast Asian national contexts, where toll road expansion is accelerating but evidence is sparse. The divergence between Chinese findings (efficiency-enhancing) and African and Indonesian findings (conversion-intensive and potentially exclusionary) requires systematic cross-regional analysis before generalizable policy recommendations can be formulated for global infrastructure financing institutions such as the World Bank and Asian Development Bank.

Addressing the contextual gap, future research must produce translational studies that operationalize threshold metrics (distance buffers, conversion rates, ESV decline thresholds) directly applicable to toll road EIA frameworks and spatial planning legislation. Collaboration between researchers and planning practitioners is essential to ensure that evidence-based thresholds are simultaneously methodologically defensible and institutionally operationalizable.

Conclusions

Addressing RQ1, this systematic review establishes, with high confidence, that toll road development consistently accelerates land use change in corridor-adjacent territories, with agricultural land conversion and built-up area expansion documented across diverse geographic contexts at rates ranging from 12% to 47.8% depending on governance context, temporal scope, and spatial buffer definition. Addressing RQ2, the evidence supports three primary mechanisms - accessibility-mediated, speculation-mediated, and governance-mediated - through which toll road development translates into land transformation outcomes, with ecosystem service value declines of 8–23% documented within 5–10 km buffers, but with economic welfare effects that are contested, context-dependent, and insufficiently disaggregated by population group in existing studies. Addressing RQ3, this review proposes the Corridor-Mediated Land Transformation (CMLT) framework as a

Contribution Tier C integrative theoretical advance, synthesizing urban political ecology, ecosystem services theory, and spatial political economy to explain why governance context is the primary moderator of toll road-land transformation outcomes. The most consistently evidence-supported practical recommendation is the establishment of legally binding 5 km buffer zone regulations restricting agricultural land conversion before toll road construction, a measure that the current evidence base shows can materially reduce irreversible conversion without precluding economic development. This review settles the descriptive question of what happens to land use when toll roads are built; it opens the more important analytical question of for whom these transformations generate welfare gains and losses - a question that future longitudinal, distributional, and governance-comparative research must resolve before infrastructure appraisal and corridor planning can be placed on genuinely evidence-based foundations.

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