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INTEGRATION OF GREEN SPACES IN URBAN MOBILITY INFRASTRUCTURE: A REVIEW OF CO-BENEFITS FOR CLIMATE BIODIVERSITY, AND POLLUTION MITIGATION

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ABSTRACT

The Triple Planetary Crisis (TPC) of climate change, biodiversity loss, and pollution currently plagues the world, and urban mobility infrastructure is a major contributor to these issues. Although there is heightened interest in incorporating green infrastructure into transport corridors, there remains a limited understanding of how mobility-related green infrastructure addresses all three domains simultaneously, particularly in rapidly urbanising cities. Therefore, to bridge this gap, this study conducted a systematic literature review using Boolean keyword searches in the Scopus and Web of Science databases, examining 40 research articles published between 2015 and 2025. Considering climate change, road infrastructure accounted for 80% of the green space typologies examined, whereas pollution and biodiversity loss accounted for 60% and 40%, respectively. Pedestrian areas comprise two domains, whereas other mobility typologies are limited to a single domain. The highest frequency of papers discussed the integration of trees, woody plants, and conifers into road infrastructure to mitigate pollution. Critical geographic gaps were exposed, showing that the United Kingdom (25%) and China (20%) dominated the literature, while other rapidly urbanising regions were underrepresented. The results highlight the necessity of cross-domain approaches to transform urban mobility systems into multifunctional infrastructures that contribute to planetary health.

Keywords: *Urban mobility infrastructure, green space, mitigation, climate change, biodiversity loss, pollution*

1. INTRODUCTION

According to the United Nations, one of the critical challenges of the decade is the triple planetary crisis, which includes climate change, biodiversity loss, and pollution. Long-term changes in temperature and weather patterns are referred to as climate change, and these changes pose a threat to the stability of ecosystems that support life [1]. The rate at which human-caused global warming is increasing is approximately 0.2°C every ten years, and 2023 was the warmest year on record, with temperatures 1.5°C higher than the pre-industrial levels [2]. According to the World Health Organisation's projections, between 2030 and 2050, climate-related factors may result in an additional 250,000 deaths annually. These emissions are primarily caused by human activity. Studies have shown that changes in land use patterns, less natural cooling, and increased heat retention from buildings result in urban regions being the drivers of these conditions [3]. Biodiversity refers to the diversity of life between and among ecosystems. The planet's biodiversity is currently declining rapidly. This loss threatens ecological balance and weakens the planet's ability to adapt to external stressors, as evidenced by declines in species populations and ecosystem degradation. The loss of biodiversity has long-term effects on ecosystem services and human Well-being, making it a crucial part of a larger environmental issue [1], [2]. Pollution is defined by the United Nations Office for Disaster Risk Reduction as the detrimental presence of materials or heat in the environment that results in adverse effects. Malaria, AIDS, and Tuberculosis combined cause fewer deaths than air pollution, which is predicted to increase by 2050. Automobiles, factories, and agriculture are significant contributors to emissions. These contaminants worsen environmental deterioration, endanger public health, and lower air quality [1], [2]. Research indicates that failure to address these pressing issues will undoubtedly lead to a rise in physical and mental health problems, loss of food security, and extreme weather events. These will have a significant impact on low- and middle-income countries [2], [4].

Nature-based solutions, such as the "Trees in Cities Challenge" and Urban Forestry projects, promote interconnection with nature to support planetary health [2], [5]. This further emphasises the importance of integrating green spaces to mitigate the significant challenges posed by this phenomenon successfully.

The environmental impacts of mobility systems have been widely debated, and the main issues revolve around pollution, climate change, and biodiversity loss. These could be synchronised with the Triple Planetary Crisis. With anticipated increases in travel demand by 2050, UN-Habitat emphasises the necessity of integrated, climate-resilient, and inclusive mobility systems to ensure sustainable urban Development. The built and fixed physical elements that support and ease the movement of people and products within metropolitan areas are often referred to as "Urban Mobility Infrastructure". As a fundamental component of urban infrastructure, it provides equitable access to desired locations, opportunities, services, and social interactions while influencing the spatial arrangement of cities [6], [7], [8], [9], [10], [11].

Among mobility infrastructure, this study focuses particularly on urban road infrastructure, given the high priority accorded to road transport. Although green spaces are a major environmental threat, their integration to mitigate these issues is often overlooked. Therefore, this review synthesises literature from over a decade to explore how urban greening initiatives, particularly those targeting road-based mobility infrastructure, can help mitigate the Triple Planetary Crisis.

This research also endeavours to bridge the gap between research and practice by synthesising the existing body of knowledge on the inclusion of green spaces in urban mobility infrastructure and deriving implications. By systematically synthesising the scattered literature, this review provides guidelines for planners and landscape architects on the inclusion of green infrastructure in transport corridors to improve climate resilience, biodiversity, and pollution mitigation. Moreover, the results emphasise key directions for future research, particularly regarding performance and implementation. From a broader societal perspective, this study provides evidence-based planning strategies for healthier, more resilient, and sustainable urban environments.

2. MATERIALS AND METHODS

This study was conducted through a systematic literature review of the integration of green spaces to mitigate the Triple Planetary Crisis in Urban Road Infrastructure, published between 2015 and 2025. The methodology of this study comprised two phases: a bibliometric search and a comprehensive content analysis. Bibliometric data from databases were filtered using an inclusion-exclusion approach to identify papers that assessed the integration of green spaces into urban mobility infrastructure. The papers that evaluated the effects of green spaces on mitigating the Triple Planetary Crisis were then subjected to content analysis.

2.1. Bibliometric Search

Initial article searches were conducted using the Scopus and Web of Science databases. Data retrieval was performed using a diverse set of keywords to maximise the number of results. As an example, instead of "Triple Planetary Crisis", the term was expressed using its main domains, "Climate Change, Biodiversity loss, and Pollution". All articles published in English from 2015 to 2025 were reviewed, and all information was collected from them. In this stage, 124 articles were downloaded using the following keywords:

The search query was carried out using the Boolean operation: TITLE-ABS-KEY("green space*" OR "green infrastructure" OR "blue-green infrastructure" OR "nature-based solution*" OR "urban green*" OR "ecosystem-based") AND TITLE-ABS-KEY(mitigat*) AND TITLE-ABS-KEY("climate change" OR "global warming" OR "urban heat island*" OR "carbon emission*" OR "air pollution" OR pollution OR biodiversity*) AND TITLE-ABS-KEY(road* OR street* OR "pedestrian area*" OR sidewalk* OR "public transport" OR "public transit" OR bus* OR rail* OR "bicycle lane*" OR "cycle lane*" OR cycling OR "parking space*" OR "car park*" OR bridge* OR "transport infrastructure" OR "transportation infrastructure" OR "mobility infrastructure" OR "urban mobility")

A comprehensive content analysis was conducted in two stages. Initially, duplicate papers and studies with qualitative assessments, including reviews, were excluded based on their abstracts and titles. Second, studies focusing on various mobility infrastructure types were sorted. Studies that examined the integration of green spaces to mitigate the triple planetary crisis were identified. After excluding irrelevant studies, 40 articles and their full texts were comprehensively reviewed to determine the types of mobility infrastructure, corresponding green space types, and implications and assessment methodologies. Figure 1 illustrates the methodology used in this study.

2.2. Scope and Limitations

This study is a comprehensive synthesis of a decade (2015 -2025) of concentrated research on incorporating green spaces into urban mobility infrastructure, specifically to address the interconnected Triple Planetary Crisis. This review was restricted to peer-reviewed journal articles published in English.

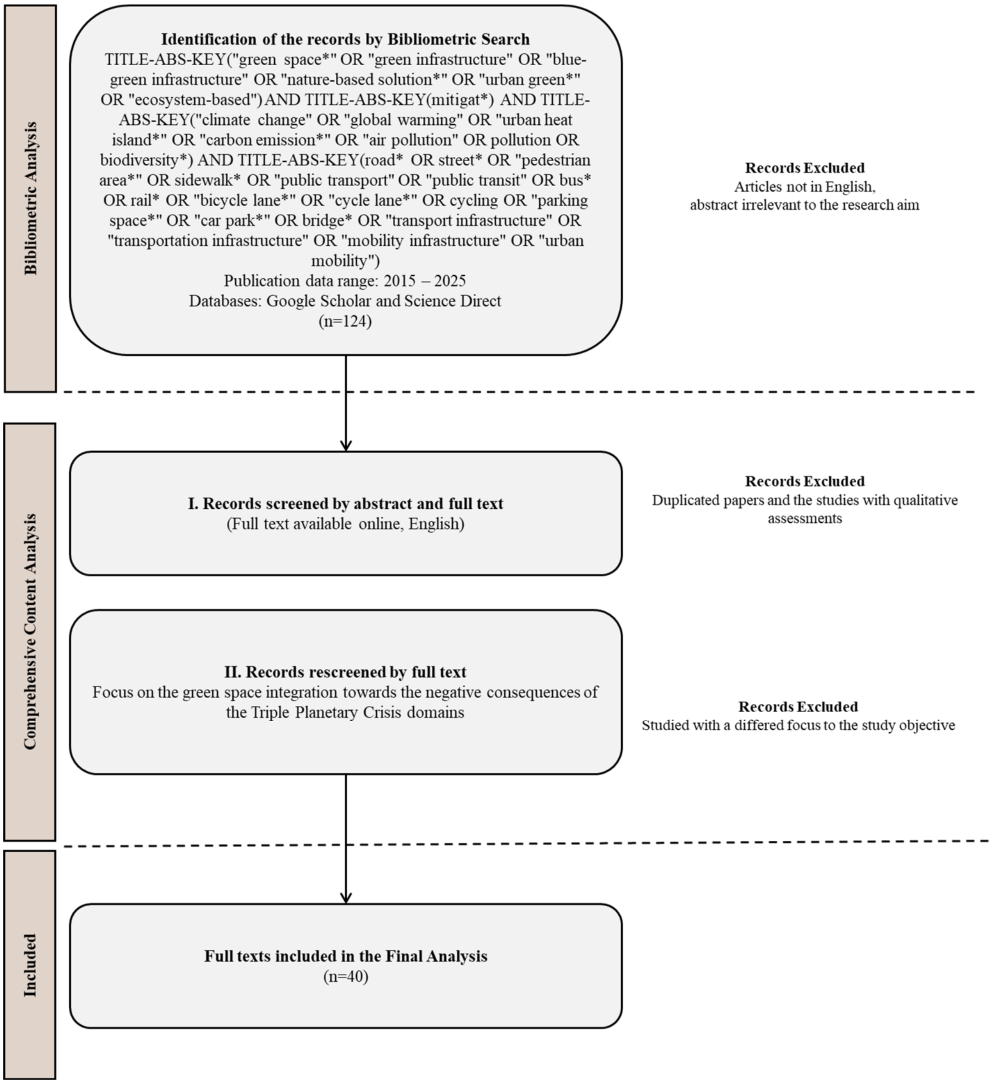


Figure 1: Systematic method of study

3. RESULTS AND ANALYSIS

3.1. Overview of the research trends in the Urban Mobility Sector

3.1.1. Geographic distribution of the studies

Figure 2 compares the geographic distribution of studies with the Global Mobility infrastructure stock. Figure 2(a) shows the Global Mobility infrastructure stock, defined as the density of built mobility infrastructure, while Figure 2(b) shows the geographic distribution of the studies as a percentage.

Regions such as the United Kingdom (25%) and China (20%), which correspond to the highest level of studies, also have the highest mobility infrastructure stock, indicating alignment between research focus and mobility infrastructure Development in those regions. In contrast, areas with substantial infrastructure stock, such as North and South America, including Brazil (2.5%) and the USA (7.5%), are underrepresented in the literature. India (2.5%), Indonesia (5%), and Iran (5%) have sparse coverage of studies despite their higher infrastructure density. A notable gap was identified in Africa and Oceania, which have a higher mobility stock, with no studies available in the dataset.

Overall, Europe (50%) accounts for the largest share of study distribution and has high infrastructure density. Asia (42.5%) presents a mixed picture: China has been extensively studied, but other countries with rapid transport infrastructure Development are underrepresented. America (10%) exhibited a notable mismatch between the extent of its transport infrastructure and the volume of research on it.

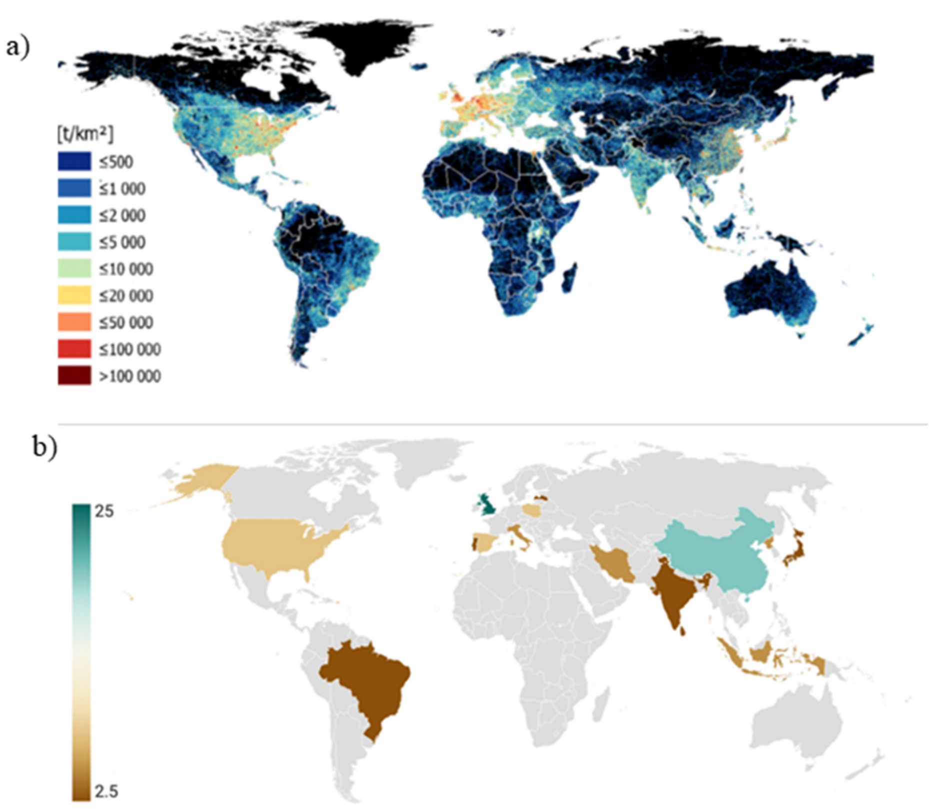


Figure 2: Comparison of the geographic distribution of studies with the global mobility infrastructure stock: a) global mobility infrastructure stock map, b) geographic distribution map of studies in percentage

3.1.2. Growth of publications

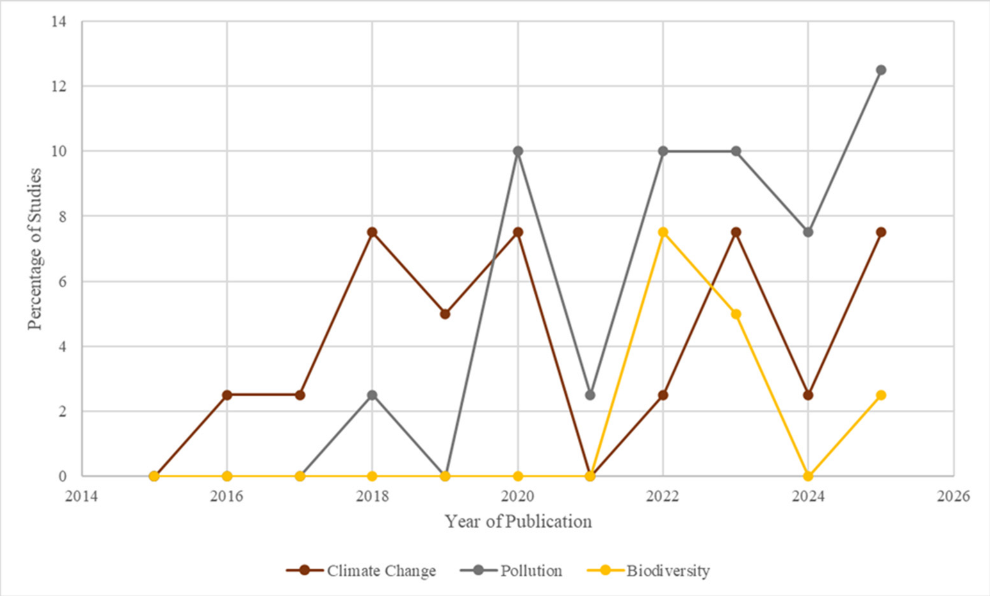
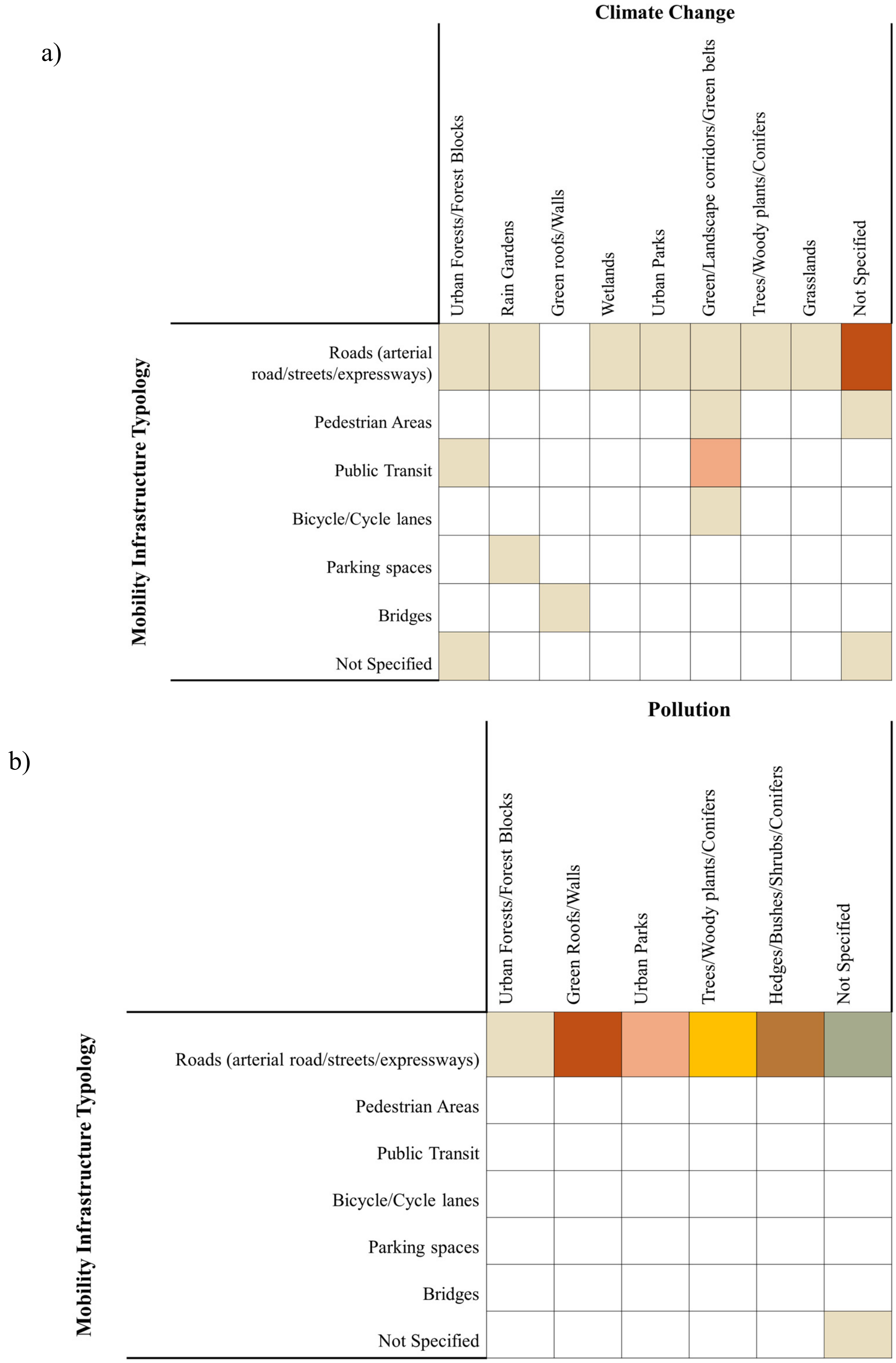


Figure 3: Publication growth rate over the decade (2015 - 2025)

Figure 3 shows the percentage of research on urban mobility infrastructure from 2015 to 2025 that focuses on climate change mitigation, biodiversity enhancement, and pollution mitigation. Research on climate change, beginning in 2015, reached its initial peak in 2018 (7.5%), followed by a decline in 2021. Despite fluctuations, studies on climate change showed a consistent pattern throughout the study period. A notable increase in scholarly concern over pollution in recent years is indicated by a significant rise in pollution-related studies in 2020 and sustained high levels from 2022 onward, culminating in the highest overall proportion in 2025 (12.5%). Biodiversity research remained largely absent until 2022, then declined sharply in 2024, followed by a slight recovery in 2025 (2.5%).

These trends indicate a transformation in research priorities over the decade. Pollution mitigation studies have emerged as a dominant area of research in recent years. In contrast, climate change mitigation studies received consistent attention from scholars, whereas biodiversity loss mitigation studies showed greater variability throughout the examined period.

3.2. Green Spaces for Mitigation of Triple Planetary Crisis (TPC) in Urban Mobility Infrastructure



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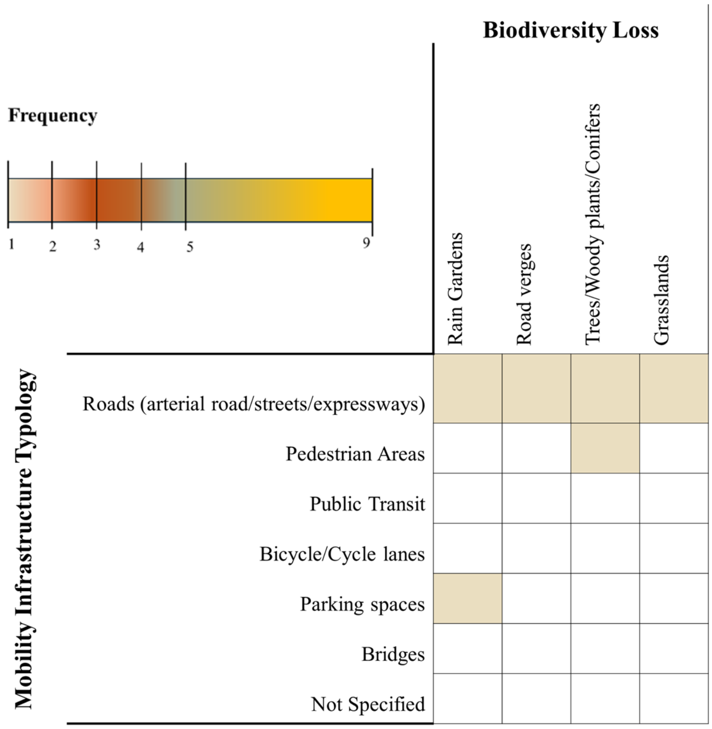

Figure 4: Green space typologies investigated in the domains of triple planetary crisis (a) climate change, b) pollution, c) biodiversity loss) with respect to mobility infrastructure types

Note: Studies that examined green space or vegetation without classifying them under a single typology are referred to as "not specified." Similarly, studies that examined transport or transport networks without designating a particular mobility typology were also included.

According to the heatmap (Figure 4), roads employ integrated green typologies to mitigate the three domains. Considering climate change, road infrastructure accounted for 80% of the green space typologies examined, whereas pollution and biodiversity loss accounted for 60% and 40%, respectively. Pedestrian Areas covered two domains: climate change and pollution. All other mobility typologies were limited to a single domain. The highest frequency of papers discussed the integration of trees, woody plants, and conifers into road infrastructure to mitigate pollution. Referring to the heatmap above, it is evident that the highest frequency of papers focuses on pollution.

3.2.1. Integrating green space for climate change mitigation

According to the matrix in Figure 4, urban parks linked to roads and green belts associated with public transit exhibited the highest level of integration (5.0%) for climate change mitigation among the studies. According to the figure, evident dynamism in green space mitigation measures was observed for roads, where multiple green space typologies were considered. In contrast, the other mobility types exhibited a single focus, with each type associated with only one or two green space typologies. This emphasises a significant gap in understanding and in the incorporation of broader, more diverse green-space-based mitigation measures into such infrastructure. It was noted that green walls, road verges, hedges, and shrubs have not been studied with respect to any mobility type related to climate change mitigation.

The integration of urban green spaces in high-activity locations, such as roads, must be prioritised to minimise the urban heat island effect. Roadside green belts showed a maximum temperature reduction of 1.5 ^{0}C compared to the non–green belts. Trees along the streetscapes followed the general cooling effects, where higher "Normalised Difference Vegetation Index (NDVI)" values signified improved photosynthetic rates and fuller leaf canopies, which maximised cooling. The installation of green walls and roofs along buildings near narrow asphalt roads has also shown a 1–2 ^{0}C temperature reduction, thereby decreasing heat-related disasters. In addition to the narrow green spaces along roads, grasslands with a higher green ratio can dissipate more energy through photosynthesis, thereby increasing the total thermal power conducted. This suggests that larger buffers result in a greater decrease in temperature. The cooling effect of continuous green spaces was greater than that of fragmented networks. The carbon sequestration ability of green spaces has also been discussed in climate change mitigation studies. Revegetation along newly constructed expressways has demonstrated carbon absorption capacity, and tree age has become a crucial factor in CO_2 absorption in forest areas. Studies have elaborated on the capacity of urban forests to absorb carbon emissions from the transportation sector.

Public transit was also associated with climate-related green space integration, notably Green or Landscape corridors, green belts, and Urban Forests. One study indicated the highest carbon absorption in forest blocks within transportation hubs. Consistent with this, another study reported the emission reduction capacity of landscape corridors connecting transportation hubs in urban centres. However, parking spaces, bicycle lanes, and bridges have received attention. Collectively maintaining green belts, green corridors, and green spaces to support cycling and pedestrian mobility could reduce climate change through cooling and evapotranspiration. Installing green roofs along a pedestrian bridge resulted in temperature reductions and microclimatic alterations that differed between the ground and bridge-deck levels. The terrain basin, soil saturated with stormwater, and hydrophytes in rain gardens showed cooling effects associated with the catchment of car parks and traffic routes.

3.2.2. Integrating green space to mitigate pollution

According to Figure 4, all the pollution mitigation studies were associated with roads, which represent streets, arterial roads, and expressways. Trees, woody plants, conifers, and flowering plants were the most prominent green space types studied in this domain, with the maximum contribution (20%) primarily when associated with roads. There is a scarcity of pollution-related studies on other infrastructure types, such as pedestrian areas, public transit, bicycle lanes, parking spaces, and bridges, whereas roads dominate dynamic green space typologies.

Broadleaved trees in near-road parks were identified as effective phytoremediators, and planting large numbers of *Polyalthia langifolia* along streets is recommended as an efficient measure to reduce air pollution in urban areas. Simultaneously, *Alstonia scholaris* controls vehicle emissions and adapts to subtropical climate conditions. Larger Particulate Matter accumulations were observed in the lower canopies of woody plants, thereby avoiding resuspension at the pedestrian level.

Hedges or Shrubs were the next highest (15%), while green walls (10%) have also received commendable attention. This may be due to mobility areas having limited horizontal space for larger interventions. Hedges capture particulate matter through deposition, dispersion, and diffusion. Studies have shown that vegetation density, higher leaf area index, hedge depth, and other plant properties, such as shape, size, and leaf hairiness, affect hedges' ability to capture pollutants. Studies have observed a rapid and significant reduction in PM concentrations following the introduction of hedges along roads.

When the wind flowed perpendicular to the main street through the green screen, the maximum reduction in PM concentration was observed. Among the green walls or creepers, leaf area, plant species, location, exposure time, and source type were identified as influential factors in reducing pollution. Although green walls, when proposed at larger scales in street canyons, were effective in reducing local particulate levels, green roofs were considered ineffective. Compared with pollutant concentrations near sources, the concentrations were lower in urban forests along the expressways. A study examined the effectiveness of air pollution reduction by an urban park located between vehicular-traffic arterial roads; the benefits were influenced by park size, vegetation structure, and local conditions. Furthermore, the connectivity among main roads, green spaces, and water bodies enhances air mobility, serving as ventilation corridors in urban areas. In addition, it has been highlighted that inner-city green spaces near high-traffic regions could serve as buffer zones to mitigate air pollution, and their proper placement should aim to balance emissions, exposure, and spatial expansion.

In addition to the above-discussed air pollution, two studies examined the contributions of green spaces to allergenic and stormwater pollution. One study observed that clusters or linear layouts with adequate spacing could alleviate local allergenic concentrations and emphasised the need to use non-allergenic plants in developments near roads. The most effective pollutant load removal (10–44%) was achieved with green infrastructure near roads, indicating its potential to mitigate stormwater pollution.

However, the dataset is severely underrepresented in other essential types of urban mobility infrastructure, such as bicycle lanes, pedestrian areas, parking lots, public transit, and bridges.

3.2.3. Integrating green space to mitigate biodiversity loss

As shown in Figure 4, roads cover a wide range of green space typologies, including trees, urban forests, urban parks, road verges, rain gardens, and grasslands, demonstrating a multidimensional approach. Mitigation measures for pedestrian areas and parking spaces were primarily associated with trees/woody vegetation and green walls, respectively, indicating a specific use of green infrastructure.

Road verges, connecting trees, hedge growth, and fences along the road increase overall landscape connectivity. In addition, the introduction of green elements to these spaces might attract birds and insects to the road matrix. Patch-sized grasslands along roads are associated with high biodiversity; however, existing research indicates that road traffic pollution reduces the richness of flowering plants and pollinators in road environments. Rain gardens have also been incorporated into parking spaces within this domain, where a study found that the Shannon index of hydroponic plant species ranged from 0.84 to 0.96. Research has also focused on integrating trees into pedestrian areas. Although species richness was reduced on larger roads, considerable heterogeneity in environmental quality was observed along the walking routes, thereby enhancing species diversity.

3.3. Assessment Methods for Mitigating the Triple Planetary Crisis

This study further identified green space-related methodologies included in the reviewed literature.

3.3.1. Methodologies assessing climate change mitigation

The methodologies related to Climate Change rely heavily on remote sensing and GIS analysis, as well as Simulation and Machine learning modelling. Remote sensing, satellite imagery, Landsat imagery, and LiDAR data were used to assess vegetation density, Land Surface Temperature variations, and land-cover changes, providing vital insights into urban heat-island phenomena and carbon sequestration. Simulation and Machine Learning models, as shown in the table, were effective for studying microclimatic dynamics, vehicle emissions, and various planning approaches across alternative scenarios, while enhancing predictive accuracy. In addition to these technical solutions, frameworks that incorporate the superblock model, such as spatial planning and mobility reconfiguration, illustrate how design-based interventions can directly aid climate change mitigation.

3.3.2. Methodologies assessing pollution mitigation

GIS, modelling, and on-site measurements were the main foci of pollution mitigation studies. Pollutant dispersion was mapped using spatial tools, and the dynamics of pollution in air, water, and urban areas were simulated using models such as InVEST, i-Tree Eco, CFD, CTAG, and EMEP4UK. Aquatic pollution was further addressed through hydraulic and water-quality modelling. On the experimental side, field-level validation was performed using sampling and gravimetric methods. While urban surveys recorded social and behavioural characteristics, exposure assessment was supported by digital methods, including street-view photos, image-analysis software, and computational equations. Therefore, this domain combines ground-based monitoring with advanced modelling methodologies.

3.3.3. Methodologies assessing biodiversity improvement

This domain focuses on the collection and analysis of ecological data. Habitat patterns were mapped using satellite images and GIS techniques. Indices such as the Shannon Diversity Index evaluate species richness and abundance, while biodiversity surveys, questionnaires, database sampling, and site-specific field measurements directly provide species-level data. By recording community viewpoints, conducting questionnaires, and using statistical software, the focus was broadened to include socioecological aspects.

4. CONCLUSION AND RECOMMENDATIONS

Evidence synthesis indicates that all three domains of the Triple Planetary Crisis could benefit from integrating green infrastructure. Rain gardens, urban forests, and green belts have been shown to reduce temperatures and store carbon, thereby mitigating climate change. Even in busy traffic corridors, hedges, trees, and green walls showed measurable reductions in particulate matter concentrations, indicating effective pollution mitigation. Although the effects varied by context, interventions such as roadside grasslands, rain gardens, and tree-lined walking routes enhanced ecological connectedness and habitat value for biodiversity. Despite its potential, most research has focused solely on road networks, leaving other essential infrastructure types, such as parking lots, transit hubs, bridges, and bicycle and pedestrian systems, under-researched. To optimise the multifunctional role of green infrastructure in mobility planning, these deficiencies must be addressed. Research on biodiversity still relies on fragmented and less integrated methods. However, methodological advancements have produced reliable instruments for pollution and climate change studies, primarily through remote sensing, GIS, and simulation models. To capture the full range of advantages of green infrastructure, future research should integrate ecological, socio-spatial and microclimatic approaches. This review also emphasises that Europe and China dominate the global research literature on urban mobility infrastructure and the Triple Planetary Crisis, whereas rapidly urbanising regions remain under-represented. This geographical disparity limits the applicability of existing research and underscores the need for more inclusive and widely distributed research.

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APPENDICES

Appendix A: Summary of the studies according to the specific domain

Green Space Typology	Domain	Savings/Results	Infrastructure Category	Author/ Year
Urban Forests	Climate Change	Forests are recognised as green infrastructure that increases carbon sink capacity and reduces greenhouse gas emissions.	Not Specified	[12]
		The forest blocks have the highest carbon absorption, accounting for 91.33% of the total carbon absorption.	Transportation Hubs	[13]
		Replanting 36% of the felled area, if the removal of old trees over 50 years of age during highway construction, could restore the CO2 absorption capacity.	Expressways and arterial roads	[14]
	Pollution	Urban forests exhibited lower PM10 concentrations in all seasons than pollutant sources.	Expessways	[15]
Landscape corridor/Green Belts	Climate Change	Greening to offset annual carbon dioxide emissions in high-traffic areas.	Transportation Hub	[16]
		A maximum temperature reduction of approximately 1.05 °C was observed compared with non-green belts.	Road	[17]
		Presents the Integration of green belts and corridors in public transport, cycling, and pedestrian mobility, showing that Italian cities have adopted the best green infrastructure practices (19% difference) in transport and infrastructure compared to Spain.	Public transit, cycling, and pedestrian areas	[18]
		Continuous green corridors showed a higher heat mitigation index (> 0.75), whereas fragmented corridors showed a lower heat mitigation index (< 0.35).	Not Specified	[19]
Green Walls and Roofs	Climate Change	A temperature reduction of 1-2 0C.	Asphalt Road	[20]
		The intensive green roof reduced the ground temperature by 0.18%. Directly above the roof, the air temperature decreased by 2.87%, and at 60 m north, by 0.58%. In contrast, the extensive green roof	Pedestrian Bridge	[21]

Green Space Typology	Domain	Savings/Results	Infrastructure Category	Author/ Year
		had minimal impact, indicating varying microclimatic conditions across levels.		
	Pollution	*Hedera helix* exhibited the highest daily retention of pollutant particles, with an average specific daily removal of 94.47 mg/m2. Leaf area, plant species, location, exposure duration, and source type were identified as factors influencing pollutant retention.	Streets	[22]
		Small-scale green infrastructure is limited in its ability to remove pollutants and requires large-scale implementation, whereas green roofs are ineffective.	Roads/Streets	[23]
		Green walls and hedges were the most highly recommended, given the road characteristics of the study area.	Roads	[24]
		The green screen resulted in approximately 40% reduction in PM10, 42% in PM2.5, and 44% in PM10 under perpendicular wind conditions.	Street	[25]
Urban Park	Climate Change	Larger forested areas act as buffers against climate stressors, and their effects depend on their size, structure, and local patterns.	Atrial Road	[26]
		A newly developed park along the road features 3,349 trees, which store 77.68 metric tons of carbon and reduce atmospheric CO2, thereby sequestering 13.21 metric tons of carbon and preventing its return to the atmosphere.	Expressway	[27]
	Pollution	Larger forested areas act as a mitigation buffer against PM, and the number of emission sources and structure of the roadside vegetation barrier affect the effectiveness of mitigation.	Atrial Road	[26]
		The trees in the park could remove an average of 70.446 kg of air pollutants annually; Sulphur dioxide (SO_2) showed a 0.2909% reduction rate, PM10 a 0.0320% reduction rate, and PM2.5 a 0.0053% reduction rate.	Expressway	[27]

Green Space Typology	Domain	Savings/Results	Infrastructure Category	Author/ Year
Trees, flowering plants, Woody plants, Conifers	Climate Change	The landscape shape index influences ambient nighttime temperature along streetscapes, confirming that landscape configuration metrics are more effective than composition measures in mitigating the adverse effects of UHI.	Street	[28]
	Pollution	50 *Polyalthia longifolia* trees showed the maximum CO2 absorption and O2 production.	Street	[29]
		Areas with higher greenness tend to have lower pedestrian exposure to air pollution, and dense tree cover should be avoided in deep street canyons, as it can obstruct airflow.	Roads	[24]
		Traffic-related pollution, specifically noise and nitrogen dioxide (NO_2), negatively impacts the richness of pollinators and flowering plants.	Streetscapes	[30]
		Broadleaved trees were identified as effective phytoremediators, whereas deciduousness, high planting density, and street morphology influenced pollution dispersion.	Road	[31]
		Alstonia scholaris mitigates vehicular emissions and adapts to subtropical climates.	Road	[32]
		The impact of vegetation on air pollution is approximately 10% nationwide and 1% in cities, even with extensive tree planting.	Road/Street	[23]
		A higher PM accumulation was observed in the lower canopy. Trees and shrubs were branched from the ground to avoid resuspension at pedestrian levels. Needle- and broad-leaved species with small, hairy, and waxy leaves affect pollution reduction.	Road	[33]
		The maximum pollutant reduction was observed in the maturity range, with vegetation barrier heights of 4-6 m: dense vegetation and high leaf area index led to greater pollutant reduction.	Road	[34]

Green Space Typology	Domain	Savings/Results	Infrastructure Category	Author/ Year
		The most prominent features identified for predicting pollutant concentration downwind of roadside vegetation barriers were vegetation dimensions, specifically, width and height.	Road	[35]
	Biodiversity Loss	The actual richness of pollinators and flowering plants is affected by traffic-related pollution.	Streetscapes	[30]
		Considerable heterogeneity was identified along walking routes, whereas large roads reduced bird species richness.	Pedestrian walking routes	[36]
Rain Gardens	Climate change	Reduction of surface temperature by 20 0C in sunny weather and by 7 0C reduction in cloudy weather compared to the surrounding streets and pavements	Parking Spaces, Traffic Routes	[37]
	Biodiversity Loss	All rain gardens scored between 0.84 and 0.96 for overall performance in the Shannon index.	Parking Spaces, Traffic Routes	[37]
Grasslands	Climate Change	The temperature dropped by 2.63 °C, resulting in a 2.63 °C amplitude of the temperature drop to the cooling effect. This indicates need for a larger heat-exchange buffer, thereby increasing the green ratio.	Road	[38]
	Biodiversity Loss	Larger patch sizes resulted in higher diversity.	Road	[39]
Hedge	Pollution	The reduction of magnetic loading in the PM2.5 fraction by 82% behind the hedge indicates that strategically located hedges (concerning species, leaf density, permeability, and height) close to emission sources offer the best efficiency and cost-effectiveness in reducing airborne particle exposure.	Road	[40]
		Green walls and hedges were the most highly recommended, given the study area's road characteristics.	Road	[24]
		A 52% PM reduction was observed after greening the hedge, attributable to increased deposition rather than changes in leaf area index, hedge density, or leaf	Road	[41]

Green Space Typology	Domain	Savings/Results	Infrastructure Category	Author/ Year
		stickiness. In contrast, a minor reduction was observed for CO and NO2.		
		At the plant scale, features such as leaf and canopy properties (shape, size, and leaf hairiness) influence the extent of particulate deposition, and a significant level of coverage and hedge depth is required, particularly to reduce the concentration of fine particles.	Road	[42]
Road verges	Biodiversity Loss	Combining fences with trees or hedgerows planted along roads increases overall landscape connectivity.	Road	[43]
Not Specified	Climate Change	Although traffic emissions on expressways were higher, CO2 emissions were not significant because the space along urban roads had a substantial effect on CO2 absorption.	Expressways and Aerial Roads	[44]
		Creating green spaces could prevent approximately 60 deaths due to climate change, demonstrating that urban vegetation has a direct and essential impact on population health.	Transport network - pedestrians, carriages, trams	[45]
		Only 10% of the block area includes green spaces in the current situation. It is recommended that UGI development be prioritised to minimise UHI increases and offset the Compact Eco-City in these high-activity regions.	Road	[46]
	Pollution	Introduction of a model for analysing particle deposition, which is a significant factor in pollution reduction by vegetation and is appropriate for a wide range of vegetation barriers.	Road	[47]
		Reducing dense planting in public green spaces near known allergy triggers while focusing on low-allergenic vegetation designs to minimise pollen exposure risks.	Road	[48]
		Downstream installation of green infrastructure demonstrated the	Road	[49]

Green Space Typology	Domain	Savings/Results	Infrastructure Category	Author/ Year
		greatest effectiveness, with a 10–44% reduction.		
		The introduction of pollutant-resistant, low-emission trees to replace high-emission conifers, the enhancement of green space connectivity and vertical greening structures, and the creation of low-emission zones are recommended.	Not specified	[19]
		The connectivity of roads, green spaces, and water bodies acts as ventilation corridors, directly enhancing air.	Road	[50]
		Inner-city: Green functions are recommended as buffers against air pollution, and green infrastructure should be integrated to balance emissions, exposure, and spatial expansion.	Road	[51]

Appendix B: Summary of the assessment methods for mitigating the Triple Planetary Crisis

Domain of Triple Planetary Crisis Mitigation	Methodology	Assessment Methods	References
Climate Change Mitigation	Remote Sensing	Remote Sensing and GIS analysis	[37], [38]
	Satelite Imagery		[12]
	Landsat Imagery		[46]
	LiDAR Derived Matrix		[28]
	ENVImet	Simulation and Machine Learning models	[20], [21]
	InVEST model		[19]
	MOVES model		[44]
	System dynamic simulation (with VENISM software)		[14]
	i -Tree Eco Model		[27]
	Geometric CFD model		[17]
	Random Forest Model		[13]
	Novel classification model		[18]
	Analytical formulas		[16]
	Superblock model		[45]
Pollution Mitigation	GIS	Remote sensing and GIS Analysis	[50]
	InVEST model		[19]

Domain of Triple Planetary Crisis Mitigation	**Methodology**	**Assessment Methods**	**References**
	i – Tree eco model	Simulation and machine learning models	[27]
	CFD model		[50]
	CTAG model		[34], [35], [47]
	Hydraulic and Water Quality Model		[49]
	Simulations		[51]
	EMEP4UK model		[23]
	Sampling and experiments	Onsite measurements	[40]
	Pollution sensors, air quality/PM monitoring equipment		[24], [25], [26], [31], [41], [48], [52]
	Consolidated Gravimetric techniques		[33], [42]
	On-site measures and Image analyzing software		[32]
	Street view images		[24]
	Computing Equations		[32]
	Urban Surveys		[48]
Biodiversity Improvement	Satelite Imagery	Remote Sensing and GIS analysis	[30]
	GIS and IT tools		[43]
	Biodiversity Surveys	Questionnaires and Surveys	[36]
	Database Sampling		[53]
	Questionnaire and Statistical software		[30]
	Site measurements		[30]
	Shannon Diversity Index		[37]