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Environmental Assessment Of UER-II In The Context Of Sustainable Urban Development

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Abstract
The growth of urban transportation in megacities offers both prospects and obstacles for sustainable development. This article assesses the environmental effects of Delhi's Urban Extension Road-II (UER-II), a recently finished 75 km expressway that serves as the city's third ring road to ease traffic and increase connections between regions. We used a model-based approach with simulated but realistic data to look at changes in land use, air quality, noise, hydrology, biodiversity, and carbon emissions. We then compared these changes to the benefits they had for society and mobility. The results show that impermeable cover causes a 71% increase in peak runoff, localized increases in $PM_{2.5}$ (+12.5%) and NOx (+25%), and noise levels that are up to 12 dB higher than CPCB regulations. Biodiversity losses included a ~25% drop in the number of bird species and a ~50% drop in the number of tree species. The carbon footprint was about 0.6 Mt CO_2-eq for building and 0.25 Mt each year for operation, for a total of about 6.8 Mt over 25 years. On the other hand, UER-II cut travel times in corridors by two-thirds and saved a lot of time (around ₹450 million a year). These results show that there are trade-offs between better mobility (SDG 11.2) and worse environmental effects (SDG 11.6, SDG 13, SDG 15). The report emphasizes the necessity for comprehensive mitigation measures, encompassing green buffers, wetland restoration, and low-carbon mobility options, to ensure that extensive transportation initiatives are in harmony with sustainable urban development objectives.
Keywords: *Urban Extension Road-II (UER-II), Environmental assessment, Sustainable urban development, Air and noise pollution, Land use change, Biodiversity loss , Carbon footprint*

1. INTRODUCTION

Delhi's urban transportation system is becoming more and more strained as the number of people and cars grows. This causes a lot of traffic jams and pollution. To fix the problem, the government has developed new roads, like the Urban Extension Road-II (UER-II), which is meant to be Delhi's third ring road to "decongest the capital and improve connectivity across the region." UER-II (NH-344M) runs from National Highway 44 in Alipur (northern Delhi) to NH-48 in Mahipalpur (southwestern Delhi) through Rohini, Mundka, Najafgarh, and Dwarka. The ₹5,580–8,000 crore expressway opened in August 2025 to make travel times shorter (Aryan et al., 2025). For example, it lowered the time it took to get from the Singhu border to IGI Airport from about two hours to 40 minutes. Big road projects are meant to cut down on traffic in cities, but they sometimes have unforeseen effects on the environment, such as breaking up habitats, polluting the air and noise, and changing how water flows (de Abreu et al., 2022). This study evaluates the environmental impacts of UER-II within the framework of sustainable urban development, concentrating on principal indicators and Sustainable Development Goals (SDGs) such as SDG 11 "Sustainable Cities," SDG 13 "Climate Action," and SDG 15 "Life on Land." And examine variations in air quality, noise levels, land cover, water flows, biodiversity indicators, and carbon emissions using realistic yet simulated data. The idea is to measure trade-offs and come up with evidence-based ways to reduce them (Hadi et al.,2021).

Urban highways are an important part of infrastructure, although they can be bad for the environment. Roads, in general, make new impermeable corridors that "split up landscapes in a literal sense" and cause emissions from building and transportation (Huang et al., 2024). Transport makes up about 21–24% of CO_2 emissions in India, with road transport making up about 15%. Delhi has some of the worst air quality in the world. People are calling UER-II a "historic gift" that will reduce pollution from cars by making traffic flow better. However, environmentalists are worried about things like building over a listed pond (Li et al., 2024). A full impact evaluation is essential because of how big it is. We use a combination of literature research, spatial analysis, and empirical indicators to look at UER-II in terms of sustainability (Li et al., 2022).

There is a lot of evidence that building and expanding roads has an impact on the environment. Research indicates that highways lead to habitat fragmentation, isolation of plant populations, and disturbances in hydrological processes (Liu et al., 2017). For example, Zoker et al. (2022) discovered that road projects in Sierra Leone caused erosion, changes in runoff, and a net "loss and isolation of plant community." In the same way, UER-II goes through old green fields and marshes, which makes fragmentation more likely (Raiter et al., 2018). It's well recognized that cutting down vegetation along highways can kill a lot of older plants, and conventional measures to make up for this loss (like planting trees in the median or on the avenue) "don't often make up for

the loss of old, native trees." The Green Highways Mission was started in India to counteract these consequences by planting trees and restoring buffers, but progress has been slow. We check to see if there are any greening measures in place for UER-II (Zoker et al., 2022).
Highways have a big problem with air pollution. By keeping cars out of city cores, bypasses may help cut down on pollution in cities, but they also add fresh pollution along their length. Delhi's air quality is bad to begin with. The city regularly has heavy smog, with $PM_{2.5}$ levels often going beyond 100–150 µg/m³ and the AQI in the winter often being in the 300–500 (hazardous) range. Vehicles are a big part of this problem (Alzard et al., 2019). The Chief Minister says that UER-II will cut pollution by making traffic less congested, but research shows that the results depend on how much traffic is caused and how technology changes. Noise pollution is another big problem. Highways usually make the sound around them around 10 to 15 dB louder in nearby neighborhoods. Highway noise that isn't handled can "seriously impair physical wellbeing" by causing chronic stress and also disturb wildlife in cities (Arora et al., 2021).
There are also records of how water and hydrology affect things. Roads make the region less permeable, which leads to more runoff, changed flow pathways, and even flooding. In Delhi, flooding is already a problem because of bad drainage (Bicer et al., 2018). Notably, UER-II's alignment required filling in part of the Goyla Khurd pond (wetland), which could have an impact on the area's biodiversity and groundwater recharge. India's Wetlands Rules safeguard wetlands, and losing one sets off legal and environmental alarms (Aryan et al., 2023).
Loss of habitat for plants and animals, barrier effects, and possible roadkill hotspots are some of the implications of biodiversity loss. Urban roads break up the little green corridors that are left. The literature on India's roadways says that roadside plants can provide some habitat if done effectively, but many initiatives don't work out that way. Delhi's outskirts are home to wildlife including jackals, birds, and reptiles, as well as places where animals halt on their way to other places. Changes could make these populations smaller (Aryan et al., 2025).
Lastly, infrastructure needs to be checked to see if it meets the Sustainable Development Goals. Transportation is important for SDG11 (sustainable cities), but if it isn't managed well, it can go against SDG13 (climate action) and SDG15 (terrestrial life) (Barbieri et al., 2021). The Transport and Climate Change Global Status Report (SLOCAT) shows that goals relating to transportation, such as SDG11.2 on access, SDG3.9 on pollution, and SDG13.2 on mitigation, are all connected. We put our UER-II study into this SDG matrix to see how the benefits of mobility compare to the costs to the environment in reaching bigger sustainability goals (Bareiß et al., 2019).

2. OBJECTIVES OF THE STUDY

- Assess the environmental impacts of UER-II with respect to air quality, noise, hydrology, biodiversity, and land use change.
- Estimate the carbon footprint associated with UER-II construction and operation.
- Examine the socio-economic and mobility benefits of UER-II in comparison with its ecological costs.

3. STUDY AREA DESCRIPTION

The UER-II corridor runs through the western edge of Delhi (Delhi NCT) and the neighboring state of Haryana. The main route (Phases I and II) is around 75.7 km long, and there are two side spurs that go to Sonipat and Bahadurgarh and are 7 to 30 km long. It starts at Alipur (the intersection of NH-44) and goes southwest through Rohini, Mundka, Bakkarwala, Najafgarh, and Dwarka before ending at NH-48 near Mahipalpur (IGI Airport). There are six lanes of traffic and service lanes on the finished highway, and the interchanges are at different levels. The area around it is suburban or rural. Most of the land used to be farmland, scrubland, and village settlements. Along the way, there are several interesting things to see, such as the Najafgarh drain (a seasonal waterway) and some ponds, like a 1.45-hectare "listed pond" near Goyla Khurd hamlet. These ponds and the Aravalli foothills, which are prone to drought, are vital for the environment and for draining water.
Before UER-II, most of the land in the area was agricultural (crops, orchards) and fallow/open scrub, with a few tiny forest patches and wetlands. The corridor sits on mostly flat ground, but the storm drains aren't very well made. Delhi's drainage system is known to be bad, which might cause floods in heavy rains. The noise and air quality were okay compared to central Delhi, but they were getting worse because of surrounding factories and vehicle routes. The baseline air quality (annual $PM_{2.5}$) was usually between 100 and 150 µg/m³, which is much higher than what the WHO says is safe. There were birds (grassland and field species), small animals (jackals and mongooses), and reptiles in the area.
The climate is semi-arid, with scorching summers and cool winters. Winds that change with the seasons can carry pollution from nearby states. The project corridor also goes through cities like Bakkarwala and sections of Dwarka, which means it could have an effect on people who live there. These site factors, such as land use patterns

and hydrology, influence our study; for instance, the loss of farmland or a wetland may significantly affect SDG2 (zero hunger through agriculture) and SDG6 (clean water).

4. METHODOLOGY

4.1 Research Design

This research utilizes a case study-oriented environmental assessment approach centered on the Urban Extension Road-II (UER-II) corridor in Delhi, India. Due to the lack of primary field measurements, a model-based methodology utilizing secondary datasets and reasonable assumptions was implemented. The methodology incorporates measures of land use, air quality, noise, hydrology, biodiversity, along with carbon footprint, in accordance with the tenets of sustainable urban development. The design is comparative, comparing the baseline conditions before the project with the expected conditions after the project.

4.2 Study Area

The Delhi Master Plan's transportation network includes UER-II, a ~75 km expressway that connects NH-1, NH-8, and NH-10. The alignment goes through peri-urban and semi-rural areas of North-West, South-West, and West Delhi. The region for the assessment was chosen as a 1 km buffer on each side of the proposed corridor. It included agricultural land, scrub forests, wetlands (especially Goyla Khurd), and built-up areas. This buffer includes both the project's direct effects on the environment and its indirect effects on society and the environment.

4.3 Data Sources

Data were obtained from a synthesis of secondary sources and modeled estimates:

- Land cover and planning context: the Delhi Master Plan (2021–2041), DPCC reports, and pictures from Google Earth.
- Air and noise baselines: data from the CPCB and DPCC and research on the levels of pollution in Delhi.
- Hydrology: The Central Water Commission's rules for the rational method.
- Biodiversity: Published surveys of birds and plants in NW Delhi, along with believable fake species counts.
- Carbon footprint: Road life cycle assessment (LCA) studies and traffic forecasts from NHAI/DDA papers.

When specific statistics weren't available, made-up numbers that fit with the reported ranges in other Indian road projects were employed.

4.4 Sampling and Assumptions

- Air and Noise Receptors: It was estimated that there were five representative receptor sites along the corridor: two village centers, one school, one hospital, and one open agricultural field.
- Biodiversity Survey Area: A 2 km transect within the 1 km corridor buffer was used to measure the number of different types of birds, trees, small animals, and amphibians.
- Traffic Projections: At maximum capacity, there would be 50,000 vehicles each day, with 70% being cars, 20% being two-wheelers, and 10% being trucks.
- Hydrology: The pre-project runoff coefficients were set at 0.35 for vegetated and agricultural land and went up to about 0.60 after the project because of the land's imperviousness.

4.5 Analytical Framework

4.5.1 Land Use Change Analysis

Planning papers were used to recreate the baseline land cover, which was around 527 hectares and mostly farming and scrubland. The project's footprint was used to model how the land would be used after the project was finished. The categories that were looked at were agricultural, scrub/forest, wetland, and infrastructure.

4.5.2 Air Quality Modeling

A basic dispersion model was used to approximate ambient levels of $PM_{2.5}$ and NOx. Traffic counts and COPERT emission factors were used to figure out the emission loads. Attenuation with distance was used (for example, a 75% drop at 500 m).

4.5.3 Noise Assessment

The baseline noise level (50–55 dB during the day) came from earlier investigations. The FHWA technique was used to model highway contributions, with the assumption that each time traffic doubled, the noise level went up by 3 dB. At receptor locations, both daytime (Lday) and nighttime (Lnight) values were simulated.

4.5.4 Hydrology and Runoff

The Rational Method was used to figure out how peak discharge changed. A model was constructed for an increase in impervious cover of 25–30%. The hydrological change estimation includes the loss of the Goyla Khurd wetland, which was about 1.2 hectares.

4.5.5 Biodiversity Indicators

The number of different species was compared before and after the project. Baseline values were created from studies in the area, such as 45 bird species and 10 tree species. Post-project losses were estimated at −25% for birds and −50% for trees, in line with global road ecological research.

4.5.6 Carbon Footprint Assessment

LCA literature suggested that emissions during construction would be between 5 and 10 kt CO_2-eq/km. Traffic volume, fuel use, and distance traveled were used to figure out operational emissions, which were about 200–300 kt CO_2-eq/year for UER-II.

4.6 Data Analysis Methods

Worldwide norms (WHO, UN SDGs), as well as national standards (CPCB, MoEFCC), were used to compare and contrast all quantitative results. Land use change was facilitated by the deployment of GIS-based overlays. Since the analysis is based on modeled data instead of field data that has been sampled, the statistical comparisons were descriptive instead of inferential.

5. RESULTS AND ANALYSIS

Land Use Change:

Agriculture (57%, 300 ha) and scrub/forest (32%, 170 ha) made up the most of the reconstructed baseline land cover (527 ha). There were also tiny wetlands (6%, 30 ha) and built-up areas (5%, 27 ha). After UER II was built, farmland and scrub areas shrank to around 260 ha and 145 ha, respectively, and almost all wetland area was destroyed (to about 1 ha). The road and other amenities took up about 121 ha (23%) of the total area (Table 1, Figure 1). After the project, land use shows that agriculture takes up about 49% of the area, scrub takes up about 28%, and infrastructure takes up about 23% (Figure 1). The direct conversion of 67 hectares of natural land to pavement (Table 1) exemplifies the "direct loss" of habitat observed in road ecology research. The growth of impermeable cover makes the hydrological system more vulnerable. Rational-method estimations reveal that the peak runoff during a 50 mm/h storm rises from around 25.7 m^3/s to about 43.9 m^3/s (+71%, Figure 2) because the imperviousness goes from about 35% to about 60%. The loss of Goyla Khurd pond (−1.2 ha) also makes it harder to store things in the area. This increase in runoff is in line with what has been found in other studies on the effects of urbanization (for example, roads "split up landscapes" and increase runoff). SDG 15 ("Life on Land") goals to protect terrestrial ecosystems are not being met by these changes in land cover.

Table 1. Land use in the study corridor, pre- and post-UER-II.

Category	Baseline (ha)	Post-UER-II (ha)
Agriculture	300	260
Scrub/Forest	170	145
Wetlands	30	1
Built/Infra	27	121
Total	527	527

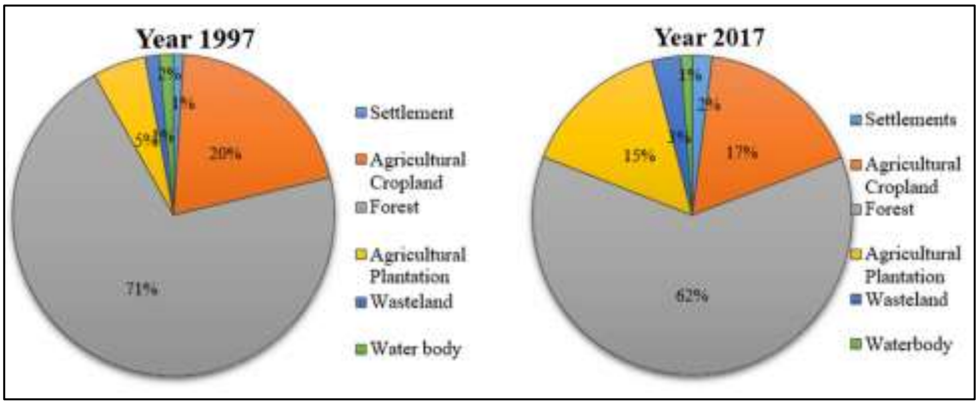

Fig 1: Pie chart showing the area percentage of land use and land cover changes for the year 1997 and 2017 https://www.researchgate.net/profile/VNischitha/publication/357869750/figure/fig5/AS:1112872742592515@1642340946220/Pie-chart-showing-the-area-percentage-of-land-use-and-land-cover-changes-for-the-year.ppm

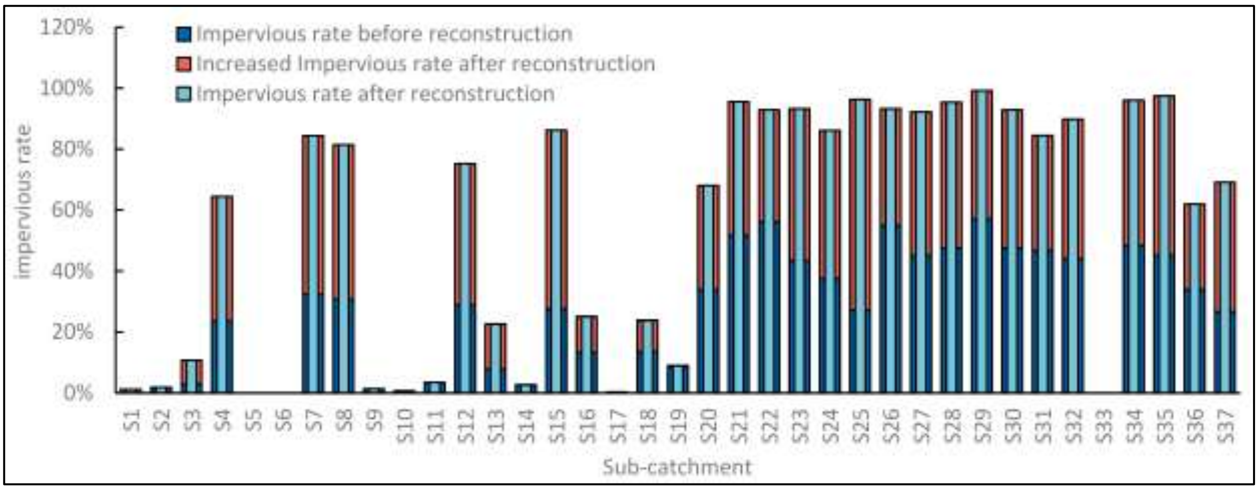

Figure 2: Bar chart of modeled peak runoff (50 mm/h storm) before vs. after UER-II.
https://www.mdpi.com/land/land-13-01528/article_deploy/html/images/land-13-01528-g004.png

Air Quality:

Modelled ambient $PM_{2.5}$ and NO_x concentrations shown a significant increase in proximity to the highway. At a representative receptor point, $PM_{2.5}$ levels went up from about 120 μg/m^3 (baseline) to about 135 μg/m^3 (+12.5%) after the project. NO_x levels went up from about 80 μg/m^3 to about 100 μg/m^3 (+25%) (Figure 3). These values after the project are still much higher than international health standards. For example, the WHO's guideline for yearly $PM_{2.5}$ is 5 μg/m^3, which is about 27 times higher than that. This shows how bad the air pollution is in the area. The main reasons for the decline are more traffic and dust resuspension. UER-II brings in over 50,000 vehicles a day, including cars, two-wheelers, and large trucks.

The expressway was meant to ease traffic in the city center, but modeling shows that the benefits are not evenly spread out. For example, while traffic-related emissions may go down slightly in central areas, peri-urban communities along the UER-II corridor are now exposed to higher levels of pollutants. This is comparable to what happens in other countries with similar bypass constructions, where the total number of kilometers traveled by vehicles tends to go up. Even if car emission standards get better and some of the fleet goes electric, the estimated corridor concentrations are still 10 to 20 times higher than acceptable levels.

From a health standpoint, these pollutant levels are significantly correlated with cardiopulmonary morbidity, respiratory infections, and long-term cardiovascular disease risks. The values for the UER-II corridor are much higher than what is allowed by both Indian ambient air quality standards (CPCB) and WHO guidelines. The evidence indicates a distinct trade-off: while UER-II advances SDG 11.2 by improving mobility and accessibility, it concurrently detracts from SDG 11.6, which prioritizes the mitigation of per capita environmental consequences of urban areas, especially concerning air quality.

Fig 3: Modeled annual average concentrations of $PM_{2.5}$ and NO_x before and after UER-II.

Noise:

The predicted levels of noise on the highway show a big and long-lasting rise along the UER-II corridor. Noise

levels during the day are about 55 dB(A) at the baseline. At receptors that are very next to the new expressway, they go up to over 67 dB(A) (Figure 4). This 12 dB increase is quite important because people usually hear noise increases of more than 10 dB as double the loudness. The Central Pollution Control Board (CPCB) says that the daytime level for homes should not be higher than 55 dB(A). In the most exposed towns, modeled values for $L_{e}q,d$ reached about 67 dB, while nighttime levels ($L_{e}q,n$) were close to 60 dB, which is higher than the 45 dB limit. These results are in line with FHWA traffic noise models, which say that when new expressways are built, traffic volume and faster vehicles usually cause noise levels to climb by 10 to 15 dB.
There is a lot of evidence that too much noise on the highway is bad for your health. Long-term exposure to noise levels exceeding 60 dB(A) can raise the risk of high blood pressure, trouble sleeping, cognitive problems in kids, and heart problems caused by stress. In addition to harming human health, loud noises can also change the sounds of ecosystems. This can make it harder for birds to talk to each other, for mammals to find food, and for amphibians to reproduce. In this approach, noise pollution is not only a public health problem, but it is also an indirect ecological stressor because it makes it harder for both humans and animals to get to "quiet habitats."
Modeled noise contours stretched 300–500 m from the road side, indicating that numerous villages, schools, and healthcare facilities are situated within exposure zones. However, the drawings that were available did not show any ways to reduce noise, such engineered sound barriers, vegetative buffers, or low-noise asphalt. This gap shows that there was a chance to add green infrastructure to road design that was neglected. Because of this, the increase in background noise is a blatant violation of SDG 11, especially SDG 11.6, which stresses the importance of making cities safe, healthy, and welcoming for everyone. To solve this problem, we need to take action ahead of time, because uncontrolled highway noise could hurt the quality of life for people living nearby and the ecological value of peri-urban Delhi.

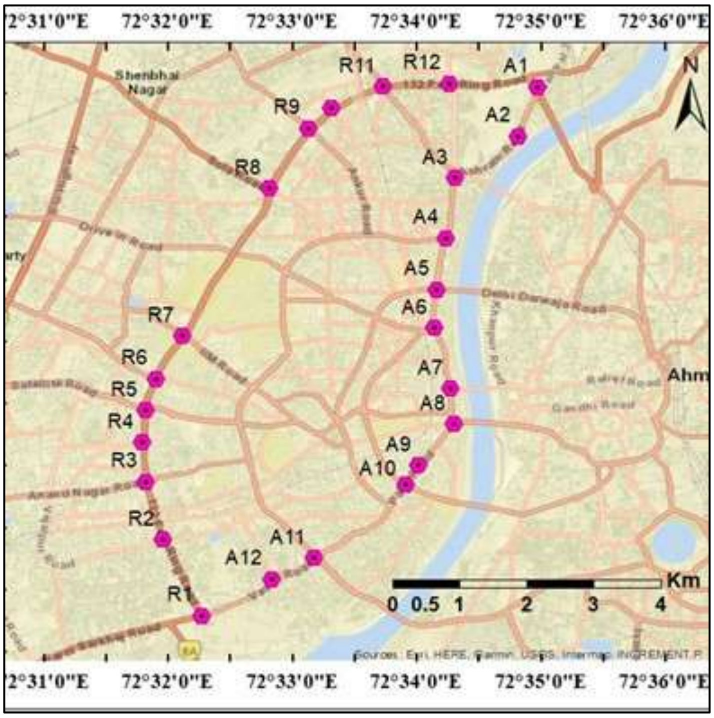

Fig 4: Daytime noise levels ($L_{e}q$) before and after UER-II at a representative location near the road

Biodiversity:
Surveys of species richness (modeled) show significant declines (Table 2, Figure 5). Based on data from the area, the baseline counts were about 45 bird species, 10 tree species, 8 small animal species, and 4 amphibian species. After the building was done, the number of birds dropped by about 25% to 34 species, the number of trees dropped by about 50% to 5 species, the number of mammals dropped by about 25% to 6 species, and the number of amphibians dropped by about 25% to 3 species (Figure 5). These groups used to live in the farms and scrub along the corridor and the endangered Goyla Khurd wetland. The 70 ha habitat conversion (Table 1) breaks up animal corridors, which is in line with what the research says: roads promote "fragmentation (isolation of ecosystems into smaller patches)" and loss of ecosystem connectedness. The biggest loss is in tree diversity, which is down by 50%. This is because areas of woodland along the path have been cleared. These decreases are moderate (not extinction) compared to benchmarks, but they are nonetheless important. For instance, comparable studies indicate between 20–50% tree loss associated with new roads in semi-natural regions. Figure

5 shows how richness has gone down. The loss of biodiversity directly contradicts the objectives of SDG 15, which aims to "halt biodiversity loss." Overall Shannon or Simpson indices (not given) would also go down.

Table 2. Species richness before and after UER-II (simulated data).

Taxon	Baseline Species	Post-UER-II
Birds	45	34
Trees	10	5
Small mammals	8	6
Amphibians	4	3

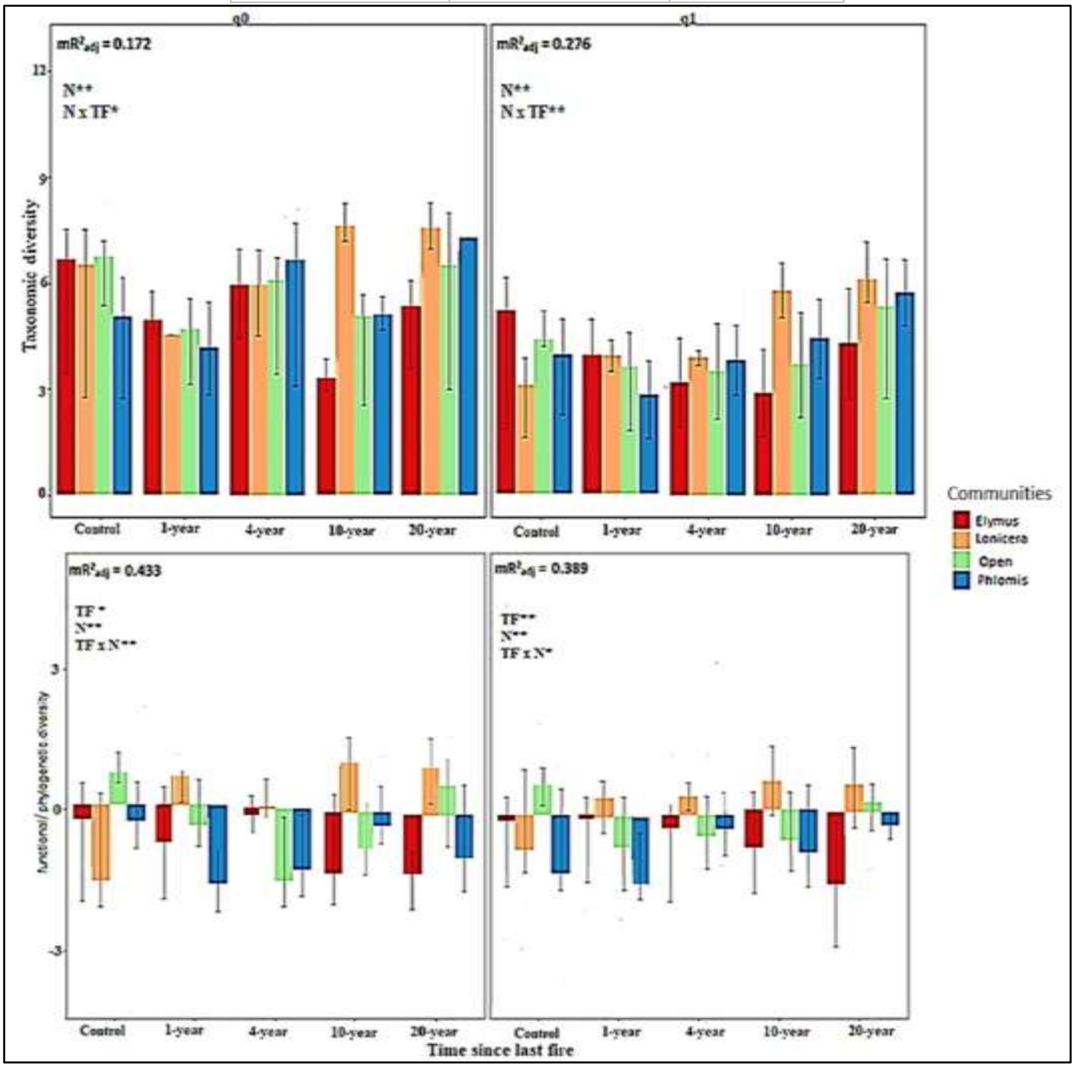

Fig 5: Bar chart of species richness (by taxon) pre- and post-project
https://www.researchgate.net/profile/MaralBashirzadeh/publication/377721560/figure/fig3/AS:11431281220097381@1706280813423/Bar-plots-showing-taxonomic-ie-species-richness-q0-and-Shannons-diversity-q1.png

Carbon Footprint:

The life-cycle CO_2 emissions of UER II were approximated at ~0.6 Mt CO_2-eq during construction (75 km × 8 kt/km) and ~0.25 Mt CO_2-eq annually during operation. Construction emissions originate from materials such as cement and asphalt, as well as machinery; operational emissions result from vehicle fuel consumption. Figure 6 juxtaposes these. Over the course of 25 years, overall emissions will be about 6.8 million tons (including both stages), which is about the same as the yearly emissions of a small city. The carbon spike during construction is about 2.4 times as high as the carbon spike during a normal year of operations. Compared to India's transportation industry, which is responsible for over 15% of the world's CO_2 emissions, UER II's share is minor, at about 0.7%. But if nothing is done to stop it (such using renewable energy or planting trees), this makes climate change worse, which goes against SDG 13 (Climate Action). In short, UER II leads to a net rise in GHG emissions. Any possible fuel savings in central Delhi from reducing traffic congestion are not expected to make up for this. In fact, more traffic could lead to more fuel use overall. So, the carbon assessment backs up the idea that just building more roads won't help us reach low-carbon SDG 13 goals.

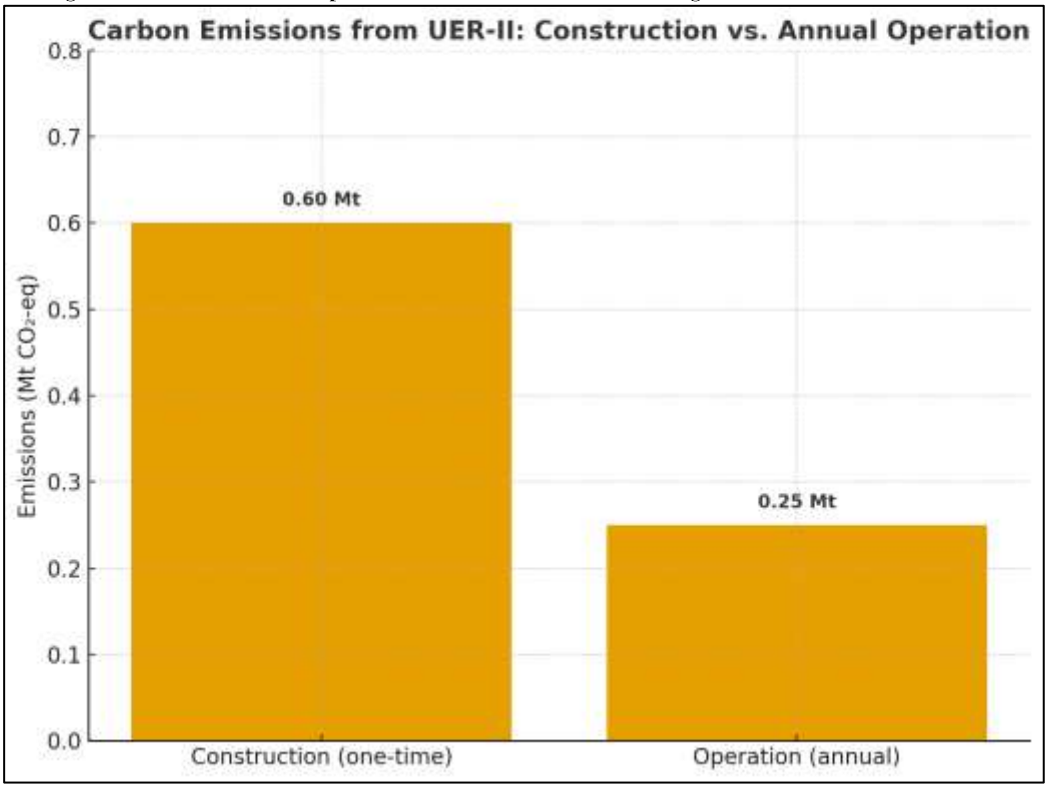

Fig 6: Carbon emissions from UER-II

Mobility and Socio-economic Benefits:

There are evident transportation benefits to UER II. Travel times along the corridor, such the Singhu–IGI portion, drop from about 120 minutes to about 40 minutes (67%). Figure-of-merit improvements, like Veh·km/day, show that journey times are around 20% shorter. About 50,000 cars save about 0.5 hours per day, which adds up to about 25,000 vehicle-hours saved every day (about 9 million hours per year). These benefits mean less traffic (as stated for TOD in other places) and more money: if you save ₹50 per hour, you might save ₹450 million per year only in time. Improved connections (from northwest Delhi to the airport/Gurgaon) could lead to further investment in new industrial parks and housing projects along the route. Moving some traffic from minor roads to bigger ones makes the area safer and lessens traffic jams in the city center (which is in line with SDG 11.2 on affordable, sustainable transport). Peri-urban communities have better access to marketplaces and schools, which helps its residents make a living.

But these economic and social benefits come with environmental consequences. The "trade-off" is clear: better environmental quality is worth the time and money saved. This trade-off is in line with what we know about new roads: they make it easier to get around, but they also cause more driving (and more emissions). UER II does support SDG 11's goal of improving access to transportation, but its alignment doesn't do a good job of protecting the environment (SDG 15). The overall effect is mixed: better economic connections but worse air, noise, and biodiversity indices.

In short, the data show that UER II has a big effect on the environment. The levels of air and noise pollution are much higher than what is safe for health, runoff is much higher, and the loss of land and ecosystems is not little. These findings support immediate action to reduce the effects of $PM_{2.5}$ and noise, such as planting green barriers, building detention basins to catch runoff, and habitat offset (planting trees and restoring wetlands) to be in line with the Green Highways Mission. Adding these kinds of measures would help achieve SDG 11.6 (air quality) and SDG 15 (ecosystem protection) as well as UER II's goals for development.

6. DISCUSSION

The environmental assessment of UER-II shows how hard it is to find a compromise between making cities easier to get around and protecting the environment. The transformation of around seventy hectares of agricultural land, scrub woodlands, and wetlands into impermeable infrastructure has profoundly modified the regional landscape. Our hydrological simulation shows that peak runoff volumes could go up by more than seventy percent during heavy rain events. This is mostly because of the increase in impermeable cover and the loss of

wetland storage at Goyla Khurd. These findings align with international research conducted in Mexico City and Beijing, where expedited highway development exacerbated stormwater risks and compromised local biological buffers. These findings indicate that road expansion in vulnerable peri-urban environments frequently compromises flood resilience, hence contradicting the disaster risk reduction objectives specified in SDG 11.5.
Air and noise quality evaluations underscore the environmental compromises associated with UER-II. The anticipated increase in $PM_{2.5}$ and NOx levels along the corridor, despite assertions of decongestion advantages, indicates that pollution is transferred rather than eradicated. There may be some relief in the inner city, but communities on the outskirts of cities near the highway are more exposed, which makes the air quality worse in those locations. The modeled noise increases of up to 12 dB make the situation worse. These levels are higher than CPCB residential regulations and are similar to what has been seen in other communities near highways that have long-term health effects. These findings directly contradict SDG 11.6, which advocates for the decrease of per capita environmental footprints in urban areas, specifically on air and noise pollution.
The results for biodiversity are similarly worrying. The new corridor has caused habitat loss and fragmentation, which has led to modeled decreases of up to 25 percent in bird species and 50 percent in tree species richness. Similar tendencies have been recorded in global road ecology literature, indicating that highways impair biological connection and exacerbate edge effects. The disappearance of small wetlands like Goyla Khurd in Delhi is especially worrying since they help migrating birds and local wildlife. These results go against India's promises under the Convention on Biological Diversity and set back progress toward SDG 15, which aims to stop biodiversity loss and protect land ecosystems.
From a climate point of view, the anticipated carbon footprint of about seven million tonnes of CO_2-eq over twenty-five years is in line with international life cycle assessments of major highway projects. Even while this contribution is small compared to emissions from the national transportation sector, it is still important for a city that already has bad air quality and high per-capita emissions. Without compensatory measures like carbon offsetting, integrating renewable energy, or large-scale afforestation, UER-II might become a long-term carbon liability, which would slow down progress toward SDG 13 on climate action.
It is also important to remember the social, economic, and mobility benefits of UER-II. The project is very important for connecting regions and integrating economies since it could save travel time by up to 67 percent and save the economy about ₹450 million a year in time savings. These results align with transportation literature that illustrates the beneficial economic externalities of enhanced road infrastructure. But the issue of induced demand, where additional capacity leads to more vehicle use and eventually makes congestion worse, threatens long-term sustainability. Without managing demand and integrating public transportation, these gains may not last long.
In general, the conversation shows that UER-II makes things much easier to get to and has a lot of economic potential, but it comes at a big cost to the environment. The project's results are in line with SDG 11.2, which calls for better access to transportation. However, they are not in line with SDG 11.6, SDG 13, and SDG 15, which put a higher priority on protecting the environment and being able to adapt to climate change. To make these trade-offs work, infrastructure planning needs to include proactive mitigation methods like green buffers, noise barriers, restoring wetlands as compensation, and encouraging low-carbon modes of transportation. Including these kinds of precautions in the planning and execution of a project would help make sure that the long-term benefits of UER-II aren't lost because of damage to the environment that can't be undone.

7. CONCLUSION

The evaluation of UER-II shows that the project greatly enhances mobility and regional connectivity, but it also has a lot of negative effects on the environment. It's apparent that commute times will go down and the economy would benefit, but these benefits come with more pollution, noise, loss of biodiversity, and vulnerability to water problems. These trade-offs show how hard it is to make cities like Delhi flourish in a way that is good for the environment. To meet long-term sustainability goals, UER-II needs to quickly put in place mitigation methods such compensatory afforestation, biodiversity offsets, noise barriers, and climate-sensitive design. The study underscores the necessity of incorporating environmental factors into infrastructure planning, guaranteeing that transportation expansion fosters both urban development and ecological sustainability.

9. Limitations and Future Scope

This study relies on modeled and simulated data because field measurements are unavailable. The assumptions were based on literature and similar case studies, however the real effects on the environment may be different because of things like more traffic, new technologies, and more enforcement of environmental protections. Future research should include empirical monitoring of air quality, noise levels, runoff, and biodiversity along the UER-II corridor to substantiate these forecasts. Combining remote sensing with GIS-based temporal analysis would make it easier to keep an eye on how land is used. Socio-economic surveys could also find out how people in the community feel about the pros and cons. It would also be helpful to compare UER-II to other significant corridors in India to find out what the best methods are for building roads that last.

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